ATTACHMENT 4
TO SSWD'S OCTOBER 13, 2016 LETTER

SSWD'S DETAILED PLANS FOR THE 14 STUDIES SSWD HAS UNDERTAKEN TO SUPPORT THE RELICENSING

Study 2.1	Water Temperature Monitoring
Study 2.2	Water Temperature Modeling Study
Study 2.3	Water Quality Study
Study 3.1	Salmonid Redd Study
Study 3.2	Stream Fish Populations Study
Study 3.3	Instream Flow Study
Study 4.1	Special-Status Plants and Non-Native Invasive Plants Study
Study 4.2	Special-Status Wildlife – Raptors
Study 5.1	Endangered Species Act-Listed Plants Study
Study 5.2	ESA-Listed Wildlife – Valley Elderberry Longhorn Beetle Study
Study 5.3	ESA-Listed Amphibians – California Red-Legged Frog
Study 6.1	Recreation Use and Visitor Survey Study
Study 10.1	Cultural Resources Study
Study 11.1	Tribal Interests Study

Study 2.1

WATER TEMPERATURE MONITORING

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an effect on water temperatures.

2.0 Study Goals and Objectives

The goal of this Water Temperature Monitoring Study (Study) is to supplement existing information regarding water temperature.

The objective of the study is to collect water temperature data adequate to meet the study goals.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding water temperature in Camp Far West Reservoir and in the Bear River downstream of the reservoir is provided in Section 3.2.2.9.1 of SSWD's Pre-Application Document (PAD).

The data collected during this Study will be added to the existing water temperature data to provide a larger data set. These data will be used in the development of water temperature models (SSWD's relicensing Study 2.2) and in future discussions of habitat conditions in Camp Far West Reservoir and the Bear River.

4.0 Study Methods

4.1 Study Area

For the purpose of this Study, the Study Area includes: 1) the Bear River and Rock Creek immediately upstream from Camp Far West Reservoir; 2) Camp Far West Reservoir; 3) the Bear River downstream of Camp Far West Dam to the Feather River confluence; and 4) the Feather River immediately upstream and downstream of the Bear River confluence. Figure 4.1-1 shows the Study Area and the location and types of water temperature monitoring that will be performed in this Study.

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

Page Left Blank

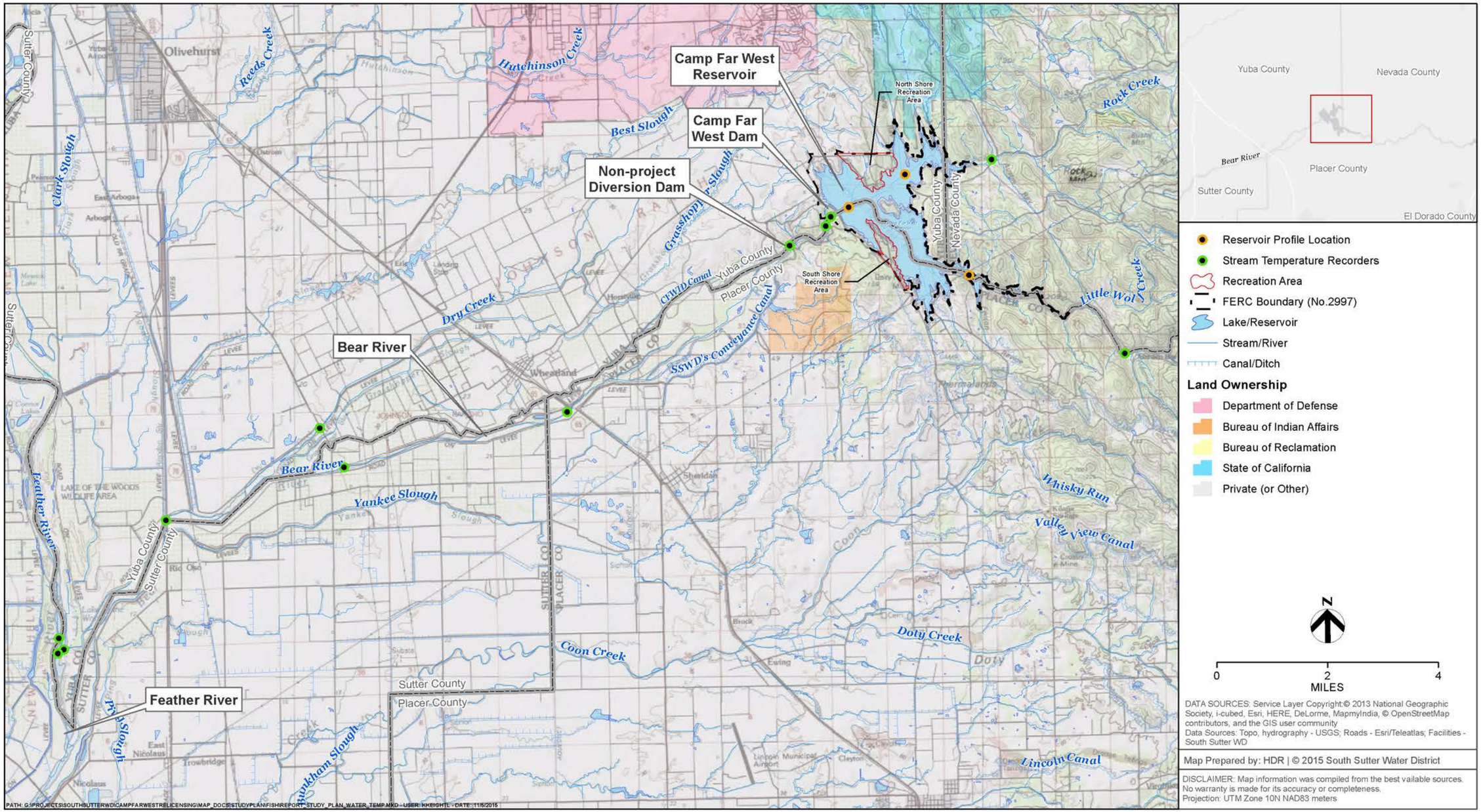

Figure 4.1-1. Water temperature monitoring locations.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, United States Fish and Wildlife Service, Cal Fish and Wildlife or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes a new occurrence of an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in Microsoft® Excel (*.xls) or HEC-DSS (*.dss) format. A viewer for *.dss files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of October 2015: http://www.hec.usace.army.mil/software/hec-dssvue/
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that detail the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be completed in three steps: 1) identify monitoring sites; 2) install and maintain recorders and collect/download data; and 3) perform quality assurance/quality control (QA/QC) of data. Steps 1 and 2 each has two components: 1) stream water temperature monitoring; and 2) reservoir water temperature monitoring. Each step is described below.

4.3.1 Step 1 – Identify Monitoring Sites

The locations where stream and reservoir water temperatures data will be collected during the Study are described below.

4.3.1.1 Stream Water Temperature

Table 4.3-1 provides a list of 12 locations at which SSWD will maintain continuous water temperature recorders in streams, and their locations are shown in Figure 4.1-1. Each of these are locations where data have been collected previously, to maintain continuous data records. To the extent possible, continuous water temperature recorders will be located near existing United

States Geological Survey (USGS) or SSWD stream flow gages in order to relate water temperature and flow.

Table 4.3-1. SSWD water temperature monitoring locations.

Location	River Mile[1]	Installation Date	Latitude	Longitude
UPSTREAM OF PROJECT AREA				
Bear River above Camp Far West Reservoir	25.1	4/10/15	39.011685	-121.220506
Rock Creek above Camp Far West Reservoir	--	8/6/15	39.063471	-121.263205
DOWNSTREAM OF PROJECT AREA				
Bear River below Powerhouse Outflow	18.0	4/10/15	39.04898	-121.31841
Bear River below CFW Spillway Channel	17.9	9/30/15	39.04719	-121.31969
Bear River below Diversion Dam	16.9	4/10/15	39.04163	-121.33235
Bear River at BRW gage, Highway 65 Crossing	11.4	4/10/15	38.99901	-121.40810
Bear River at BPG gage, Pleasant Grove Bridge	7.1	4/10/15	38.98561	-121.48329
Dry Creek above Bear River	--	12/1/15	38.99596	-121.49121
Bear River near Highway 70 Crossing	3.5	4/10/15	38.97249	-121.54343
Bear River above Feather River Confluence	0.1	4/10/15	38.93906	-121.57831
Feather River above Bear River Confluence	--	8/6/15	38.94277	-121.57928
Feather River below Bear River Confluence	--	4/10/15	38.93802	-121.58038

[1] River miles are for locations in the Bear River only.

4.3.1.2 Reservoir Water Temperature

Table 4.3-2 provides a list of locations where reservoir profiles will be collected once per month, and their locations are shown in Figure 4.1-1. The monitoring locations are meant to characterize Camp Far West Reservoir water temperatures in the Rock Creek and Bear River arms of the reservoir as well as near the dam.

Table 4.3-2. SSWD reservoir water temperature profile locations at Camp Far West.

Location	First Profile Date	Latitude	Longitude
Near Camp Far West Dam	4/9/15	39.05140	-121.31237
Rock Creek Arm of Reservoir	4/9/15	39.05972	-121.29323
Bear River Arm of Reservoir	4/9/15	39.03301	-121.27238

4.3.2 Step 2 – Install and Maintain Recorders and Collect/Download Data

4.3.2.1 Stream Water Temperature

The stream water temperature recorders in the active flow channel will have 12-bit resolution with a minimum accuracy of plus or minus 0.2^{o}C (i.e., Onset or equivalent). Each stream recorder will be contained in a durable protective housing that permits the active flow of water in and around the unit. Each stream recorder will be secured by a cable to a stable root mass, tree trunk or man-made structure, or secured using embedded rebar where necessary such that the recorder will be secured in the channel during high flow periods. The stream recorders will be installed in the channel thalweg, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads. A GPS coordinate will be taken and recorded at each installation point, along with any waypoints that may prove valuable for future retrieval, especially where there is not a defined trail leading to the access point. Photographs of the recorder site, including installation configuration, will be taken. Each recorder will be set to record water temperature at 15-minute intervals. SSWD will visit each recorder and download data monthly.

Prior to installation, each recorder will be numbered and calibrated to manufacturer's recommended specifications. SSWD will install a redundant water temperature recorder at each site. Redundant recorders will be located as close as possible to the primary recorders. Where a redundant recorder occurs, the primary recorder will be labeled with the recorder number for the site (e.g., "BR1") with the suffix "a" and the redundant recorder with the number for the site with the suffix "b." Data from both recorders will be downloaded during each scheduled visit.

During each visit, SSWD will download data into an optic shuttle or directly to a personal computer. Immediately after the data are safely downloaded, back-ups will be recorded on portable memory devices (i.e., USB "thumb drive"). Only after the raw water temperature data are safely backed-up will the optic shuttle be cleared or the data manipulated.

Prior to each download of data, a National Institute of Standards and Technology (NIST) traceable digital thermometer will be used to determine the water temperature at the recorder. The water temperature reading from the NIST-traceable thermometer will be compared to the last logger reading to check for accuracy drift of the recorder.

In addition, during each site visit, SSWD will be prepared to replace or fix a recorder installation. Should a recorder need to be replaced because it is missing or has failed, SSWD will be able to do so immediately to reduce the potential for additional data loss. Any recorder or optic shuttle that fails to download will be returned to the manufacturer for possible data recovery.

During each visit besides downloading data from the recorder, SSWD will also check equipment operation/calibration, battery life, and calibrate the instrument to manufacturer's specifications. After the recorder is removed from the water, it will be cleaned and visually inspected.

SSWD will maintain a record of all recorder installations and data downloads for a comparison between the NIST-traceable thermometer and recorder water temperature readings, and a record of any problems that were encountered in the field.

4.3.2.2 Reservoir Water Temperature Data Collection

Reservoir profiles will be taken at Camp Far West Reservoir once monthly. Sampling will occur at three locations: 1) near the dam; 2) in the Rock Creek arm of the reservoir; and 3) in the Bear River arm of the reservoir (Table 4.3.1-2 and Figure 4.1-1). A GPS receiver will be used during each successive sampling occasion to locate the geographical coordinates of each sample site. Care will be taken to identify the same site for successive profiles where water conditions and GPS accuracy allow.

SSWD will use a Hydrolab® DataSonde 5® multi-parameter water quality monitoring system (or equivalent) to measure water temperature (±0.2°C) at each of the reservoir sampling sites. Generally, measurements will be taken at 10-foot (ft) vertical increments where the change in temperature with respect to depth is low. Where the temperature gradient is higher or where measuring water temperatures near the intake elevations, 5-ft or smaller vertical increments will

be used. At each sample depth, the parameter readings will be allowed to stabilize before water temperature will be recorded. Data will be collected throughout the entire water column.

SSWD will collect a Secchi disk depth reading as an indicator of water clarity and photic zone during each reservoir water temperature profile collection. Secchi depth readings will be taken by lowering a Secchi disc over the shaded side of the boat until the disc is no longer visible from the boat. The disk will then be raised until visible, at which location the depth of the disc will be recorded in tenths of a foot, and the average of the two readings will be used as the water clarity reading for that location.

4.3.3 Step 3 – Perform QA/QC Review of Data

Following data collection, SSWD will subject all data to a QA/QC procedures including, but not limited to: 1) checking field data sheets (e.g., comparison of NIST-traceable thermometers and recorder readings) to be sure no corrections are needed; 2) spot-checking data; and 3) reviewing recorder readings and electronic data for completeness. The datasets will also be reviewed graphically to check for errors. If any datum seems inconsistent during the QA/QC procedure, SSWD will investigate the problem. Values that are determined to be anomalous will be removed from the database if the reason for the reading cannot be identified.

If data are unavailable for brief periods of the record, the missing data will be synthesized into the record using a straight line interpolation method, and the data will be indicated as "synthesized" in the record and all subsequent summaries.

The raw data files will be retained in their unaltered state for future QA/QC reference and data modified in the final record will be so indicated in the record.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for the most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The study includes standard water temperature monitoring methods.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... January 2016
Continue Data Collection..... January 2016 – December 2017
QA/QC Review ..... Ongoing

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the information is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $100,000 and $110,000.

8.0 References Cited

None.

Study 2.2

WATER TEMPERATURE MODELING STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an effect on water temperature in the Bear River downstream of the Camp Far West Dam.

2.0 Study Goals and Objectives

The goal of the Water Temperature Modeling Study (Study) is to supplement existing information regarding water temperature.

The objective of the Study is to develop a water temperature model that can be used to address the Study goal. In particular, the model should:

- Reasonably simulate reservoir and stream water temperatures resulting from Project O&M; that is, accurately reproduce observed reservoir and stream water temperatures, within acceptable calibration standards over a range of hydrologic conditions.
- Cover a range of normal variations in hydrology of the Bear River.
- Be sensitive to reservoir operations, upstream/downstream flow and meteorological conditions.

The Study does not include the development of potential requirements in the new license, or runs of the model other than described in this Study.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding water temperature in Camp Far West Reservoir and in the Bear River downstream of the reservoir is provided in Section 3.2.2.9.1 of SSWD's Pre-Application Document (PAD). As a summary:

- Stream Temperature Data
  - SSWD-gathered stream temperature data in 2015, 2016 and 2017 – upstream and downstream of Camp Far West Reservoir (see PAD Table 3.2.2-7 for list of locations)

- Reservoir Temperature Data
  - Alpers et al. study (2001-2003) [Alpers et al. 2005]
  - SSWD-gathered reservoir temperature data in 2015, 2016 and 2017 (see PAD Table 3.2.2-8 for list of locations)
- Meteorological Data
  - Publicly available data are available for download on the internet from the California Irrigation Management Information System (CIMIS, www.cimis.water.ca.gov), California Data Exchange Center (CDEC, www.cdec.water.ca.gov), National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI, www.ncdc.noaa.gov)

SSWD did not find an existing model of water temperature in Camp Far West Reservoir of the Bear River downstream of Camp Far West Dam.

Additional information to be provided by the Study is a water temperature model, which is not currently available, for Camp Far West Reservoir and the Bear River downstream of Camp Far West Dam to the confluence with the Feather River.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area includes Camp Far West Reservoir and the Bear River from Camp Far West Dam downstream to the confluence of the Bear River with the Feather River. Figure 4.1-1 provides a schematic of the Study Area with existing water temperature gage locations. Figure 4.1-2 shows a map of the Study Area.

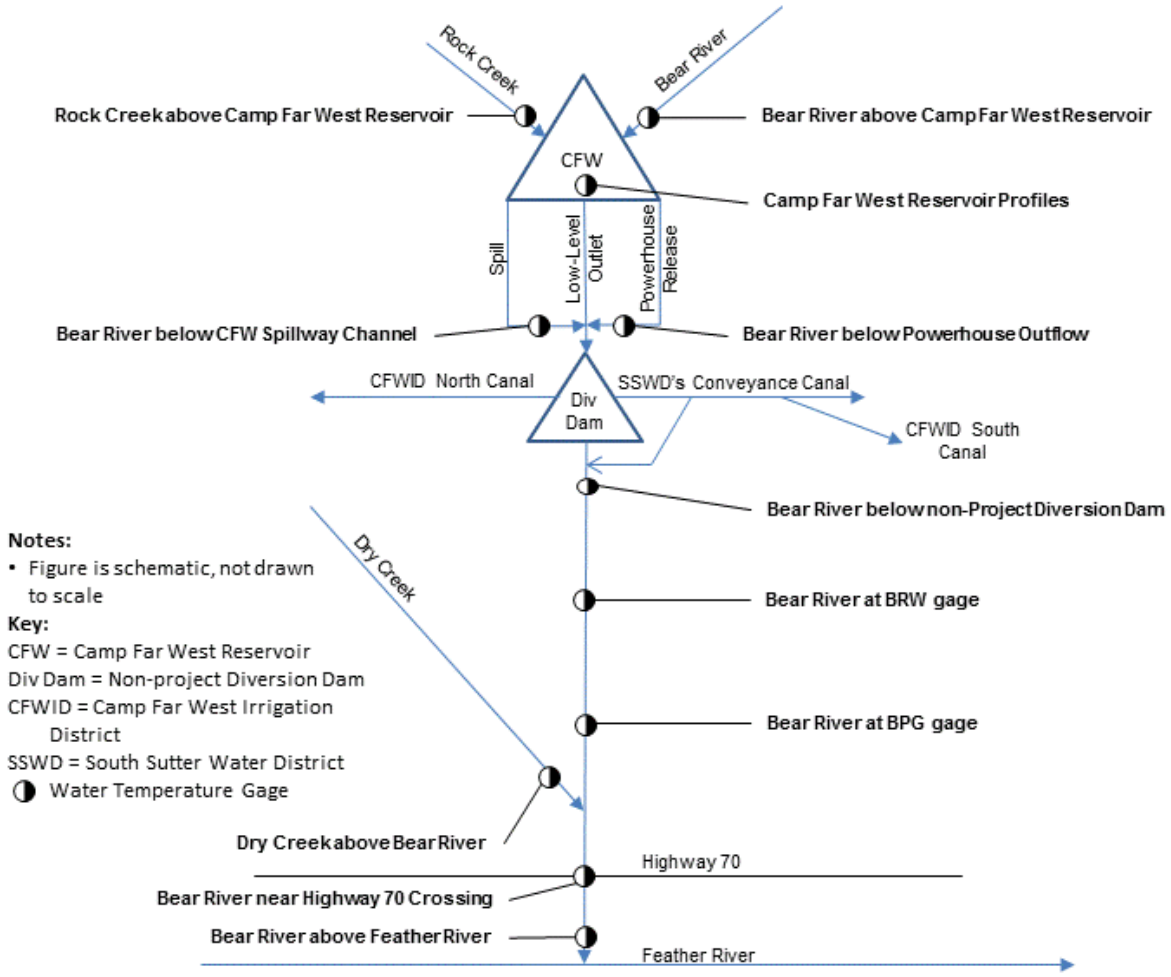

Figure 4.1-1. Water temperature gage locations.

Page Left Blank

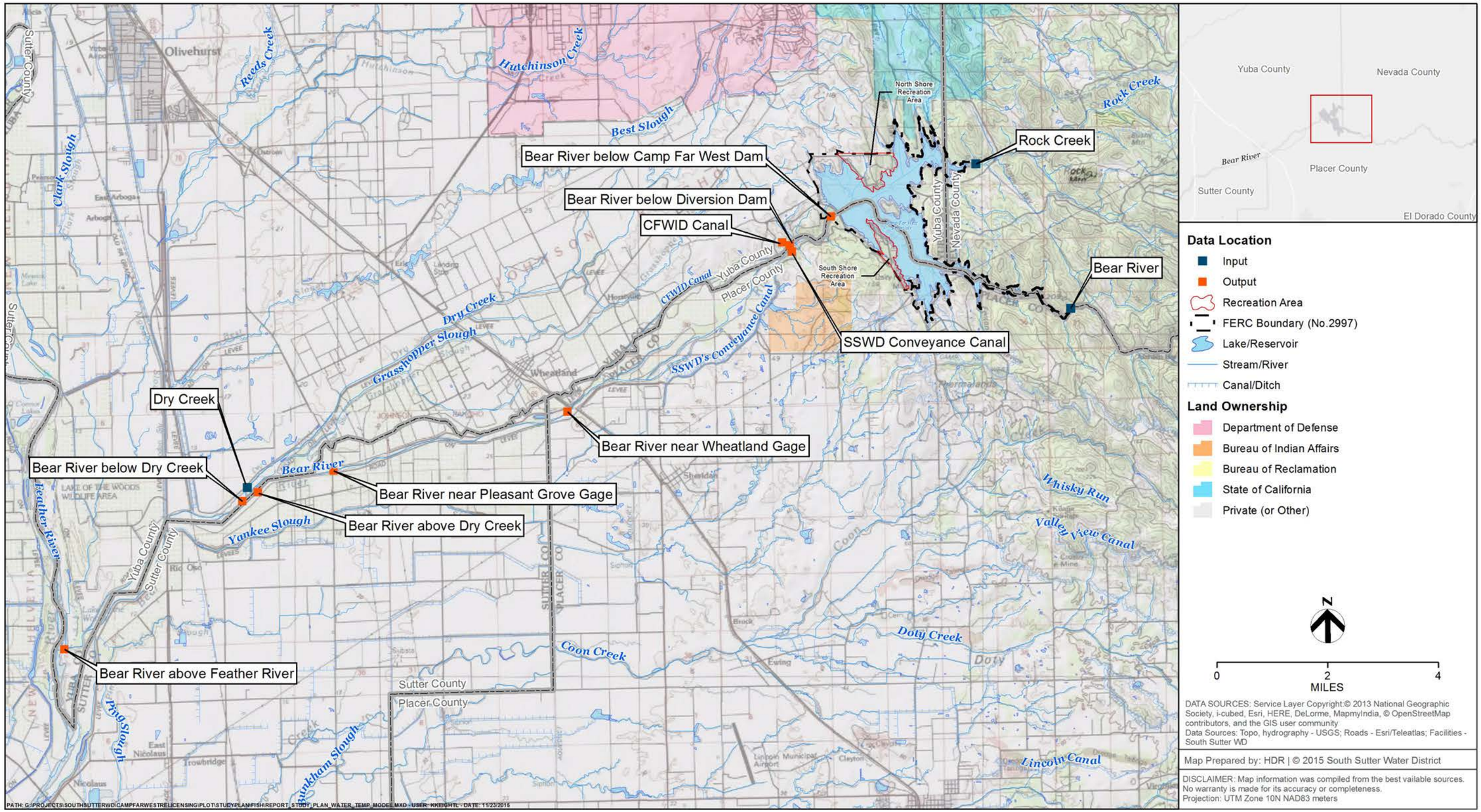

Figure 4.1-2. Study Area of Water Temperature Modeling Study.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary permits prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to National Oceanic and Atmospheric Association, National Marine Fisheries Service; United States Fish and Wildlife Service; Cal Fish and Wildlife or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic and wildlife species observed during the performance of a study. All incidental observations will be reported in Application for New License. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition the specific field tasks identified for the specific study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*), foothill yellow-legged frog (*Rana boylii*), American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.

- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an Endangered Species Act-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers (USACE) at the following website as of September 2015: http://www.hec.usace.army.mil/software/hec-dssvue/downloads.aspx in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be completed in five steps: 1) select a water temperature model platform; 2) develop and calibrate a CE-QUAL-W2 water temperature model; 3) develop an input data set; 4) validate the water temperature model; 5) develop a base case for the water temperature model; and 6) enable user-defined downstream temperature targets. Each step is described below.

Information needed to develop the model is either existing or will be developed as part of other SSWD relicensing studies, as discussed below.

Observed water temperature data is a key component in the development of a water temperature model. Little information is available regarding water temperatures in Camp Far West Reservoir and the Bear River downstream of Camp Far West Dam. In April 2015, SSWD began collecting water temperature upstream of Camp Far West Reservoir, within the reservoir, and downstream of Camp Far West Dam. These existing data are summarized in Section 3.2.2.9.1 of the PAD. Through SSWD's proposed relicensing Study 2.1, *Water Temperature Monitoring*, SSWD will

continue to monitor water temperature data through December 2017. Table 4.3-1 provides a list of locations where water temperature data have been and will be collected.

Table 4.3-1. SSWD water temperature monitoring locations.

Location	River Mile[1]	Installation Date	Latitude	Longitude
UPSTREAM OF PROJECT AREA				
Bear River above Camp Far West Reservoir	25.1	4/10/15	39.011685	-121.220506
Rock Creek above Camp Far West Reservoir	--	8/6/15	39.063471	-121.263205
DOWNSTREAM OF PROJECT AREA				
Bear River below Powerhouse Outflow	18.0	4/10/15	39.04898	-121.31841
Bear River below CFW Spillway Channel	17.9	9/30/15	39.04719	-121.31969
Bear River below non-Project Diversion Dam	16.9	4/10/15	39.04163	-121.33235
Bear River at BRW[2] gage, Highway 65 Crossing	11.4	4/10/15	38.99901	-121.40810
Bear River at BPG[3] gage, Pleasant Grove Bridge	7.1	4/10/15	38.98561	-121.48329
In Dry Creek above Bear River	--	12/1/15	38.99596	-121.49121
Bear River near Highway 70 Crossing	3.5	4/10/15	38.97249	-121.54343
Bear River above Feather River Confluence	0.1	4/10/15	38.93906	-121.57831
Feather River above Bear River Confluence	--	8/6/15	38.94277	-121.57928
Feather River below Bear River Confluence	--	4/10/15	38.93802	-121.58038

[1] River miles are for locations in the Bear River only.
[2] BRW – Bear River near Wheatland
[3] BPG – Bear River near Pleasant Grove

Another key component for a water temperature model is hydrology. Bear River unimpaired hydrology was developed as part of this relicensing from the headwaters downstream to Camp Far West Dam (see Appendix F of the PAD). Inflow and outflows to Camp Far West Reservoir and the non-Project diversion dam are input to the water temperature model. The majority of the hydrologic input data will come from SSWD's Water Operations Model output, described in Section 2.1.4.6 of the PAD. Additional hydrology input data are needed to characterize accretion data in the lower Bear River, including Dry Creek inflow to the Bear River (RM [River Mile] 5.1), and agricultural deliveries and/or returns downstream of the non-Project diversion dam. Methods developed to estimate unimpaired flow in the Bear River above Camp Far West Dam will be used to estimate historical inflow from Dry Creek.

Meteorological data are also needed to develop a water temperature model. Existing and relevant historical meteorological data are available for the weather stations listed in Table 4.3-2.

Table 4.3-2. Summary of available historical meteorological data in the Project Vicinity.

Weather Station	Operating Agency	Station ID	Period of Record	Data Type[1]
Nicolaus	CIMIS	030	1/3/1983 to 12/29/2011	Air Temperature Solar Radiation Wind Speed Dew-Point Temperature
Bear River at Camp Far West Dam	CDWR	CFW	10/1/2005 to Present	Air Temperature
Browns Valley	CIMIS	084	4/13/1989 to Present	Air Temperature Solar Radiation Wind Speed Wind Direction Dew-Point Temperature Relative Humidity

Table 4.3-2. (continued)

Weather Station	Operating Agency	Station ID	Period of Record	Data Type[1]
Beale AFB[2]	NOAA NCEI	040584	7/1/1959 to Present	Air Temperature Wind Speed Wind Direction Dew-Point Temperature Solar Radiation Descriptive Weather Observations
Sacramento Executive Airport	NOAA NCEI	047630	1/1/1931 to Present	Air Temperature Wind Speed Wind Direction Dew-Point Temperature Solar Radiation Descriptive Weather Observations

[1] Only lists available weather station data necessary to develop a water temperature model.
[2] Primary station used for development of meteorological dataset.

An estimation of channel form is also necessary to develop a reliable water temperature model. A bathymetric study of Camp Far West Reservoir was performed in 2008, and these data will be used to develop reservoir geometry input data for the water temperature model. Storage and area curves developed from the bathymetric survey are available in Section 3.2.2.4 of the PAD.

Existing information regarding channel morphology in the Bear River downstream of Camp Far West Dam is not available. However, under SSWD's relicensing Study 3.3, *Instream Flow*, SSWD will collect channel geometry data in the Bear River from Camp Far West Dam to the confluence with the Feather River. These data will be available to develop the water temperature model. If additional channel characteristics are required to properly calibrate the model, these data will be collected as part of this Study.

4.3.1 Step 1 – Select Water Temperature Model Platform

To select the water temperature model or model platforms, SSWD developed a list of required water temperature model platform attributes necessary to meet the Study goal and objectives. The attributes were:

- Produce results such that FERC and Relicensing Participants can agree on the validity of the results.
- Simulate water temperatures on an appropriate time-step to capture biologically-appropriate water temperature variability.
- Simulate water temperatures over the full range of historical hydrology and meteorology experienced by Project-affected reaches (i.e., the hydrology period of record from Water Year [WY] 1976 through WY 2014).
- Simulate the effects of Camp Far West Reservoir releases through the powerhouse, low-level outlet and spillway on downstream water temperatures due to storage changes, flow changes and outlet used.

- Simulate the effects of changes in flow from SSWD's non-Project diversion dam fish flow release outlet and spill over the diversion dam on downstream Bear River water temperatures.
- Be able to incorporate the temperature effects of upstream water projects.

Based on the selection attributes, SSWD considered the following water temperature model platforms, which had been previously used in regional FERC relicensings:

- River Water Temperature Model Platforms
  - United States Geological Survey's (USGS) Stream Network Temperature Model (SNTEMP) [Barthalow 2010]
  - USGS' Stream Segment Temperature Model (SSTEMP)
  - USGS' Hydrological Simulation Program-Fortran (HSPF) model (Aqua Terra Consultants 2005).
  - Stockholm Environmental Institute's (SEI) Water Evaluation and Planning (WEAP) system (SEI 2015)
  - USACE's Hydrologic Engineering Center RAS (HEC-RAS) model
  - Regression-based model using Microsoft® Excel
- Reservoir Water Temperature Model Platforms
  - USACE's CE-THERM-R1 (Old Dominion University 1993)
  - Danish Hydraulic Institute's (DHI) MIKE3-FM (DHI 2011)
- River and Reservoir Water Temperature Model Platforms
  - USACE's Hydrologic Engineering Center-5Q (HEC-5Q) model
  - Hydrocomp, Inc.'s HFAM II model (Hydrocomp 2012)
  - USACE's CE-QUAL-W2

The benefits and drawbacks of each of the above model platforms are discussed below.

4.3.1.1 Potential River Water Temperature Model Platforms

The model platforms described below were considered for the simulation of river reaches only.

4.3.1.1.1 SNTEMP

SNTEMP is a mechanistic, one-dimensional (1D) heat transport model for branched stream networks that predicts mean-daily and maximum-daily water temperatures as a function of stream distance and environmental heat flux. Typical applications for SNTEMP include

predicting the consequences of stream manipulation on water temperatures. Positive attributes of SNTEMP as a model platform include:

- Widely-used and well documented.
- Calculates mean-daily temperatures.
- Uses a regression model to fill in missing data.
- Geometry input is simplistic.
- Includes shading of vegetation and topography.

SNTEMP does meet a majority of the Study selection criteria; however, SNTEMP has limitations that rank it lower in some categories than other model platforms, and therefore, is not the best modeling platform to be used in the Study. Some weaknesses in using SNTEMP as a model platform include the following:

- Uses an empirical approach to predict maximum-daily water temperature.
- Temperature prediction is very sensitive to stream width parameter affecting the heat flux calculation.
- Only simulates a single year, which would require iterations to simulate multiple years.
- Does not internally calculate hydraulic conditions, which would require separate hydraulic modeling of all reaches.

4.3.1.1.2 SSTEMP

SSTEMP, developed by USGS, is a scaled-down version of the USGS model SNTEMP. SSTEMP utilizes hydrology, stream geometry, shading information, meteorological data and stream temperature data to evaluate stream water temperatures. Positive attributes of SSTEMP include:

- Analyzes effects of changing riparian shade of physical features of a stream.
- Estimates the combined topographic and vegetative shading and solar radiation penetrating the water.
- Estimates maximum-, minimum-, and mean-daily temperatures at a specified location.
- Simulates steady-state releases from a dam at the upstream end of the system.
- Used satisfactorily for a variety of simple cases.
- Can be run in batch mode, which enables the user to process multiple dates for a stream segment or multiple stream segments in series for the same day, or a combination of the two.

SSTEMP has limitations that rank it low as a modeling platform to be used in the Study. Some weaknesses in SSTEMP as a modeling platform include:

- Simulates a single stream segment for a single period of time (e.g., month, week and day).
- Streams through multiple terrain types need to be broken into sub-reaches and cannot be modeled as one continuous reach.
- Uses an empirical approach to predicting maximum-daily water temperatures.
- Turbulence is assumed to thoroughly mix the stream vertically and transversely (i.e., no micro-thermal distributions).

4.3.1.1.3 HSPF

Hydrologic Simulation Program – Fortran (HSPF) focuses on the entire hydrologic cycle and is capable of simulating a wide range of water quality constituents. HSPF uses continuous rainfall and metrological data to compute streamflow hydrology graphs and pollutant graphs. The model has many positive attributes including:

- Simulations are made on a watershed scale, including land-surface runoff and 1D stream channels.
- Simulations are made on a sub-daily time step; maximum-daily temperature is implicitly calculated.
- Includes shading of vegetation and topography.
- Capable of simulating multiple years in a single run.

There are some limitations to choosing HSPF as the modeling platform in the Study. These limitations include:

- Requires amassing a large amount of data files, which can be difficult to manage.
- Relies on volumetric calculations to determine surface area and depth of flow rather than hydraulic routing, which can limit the accuracy of the heat exchange calculation.
- Cannot simulate reservoirs.

4.3.1.1.4 WEAP

WEAP is an integrated water resources planning tool designed to simulate river-basin-wide issues including water use, equipment efficiencies, water allocations, stream flow, groundwater resources, reservoir operations, and water transfers. WEAP includes simulation of both natural, including water temperatures, and engineered components of water systems. Positive attributes of WEAP as a modeling platform include the following:

- Simulations are made on a watershed scale, including rainfall runoff, base flow, and groundwater interaction.

- Capable of simulating a broad-range of timesteps, from daily to annual.
- Includes a graphical-user interface (GUI) for data input and model setup.
- Includes linkage to a parameter estimation tool (PEST) to aid in model calibration.

Negative attributes of WEAP as a modeling platform include the following:

- Not designed to be a water temperature model; it is designed for watershed-wide evaluations and is therefore more complicated than necessary for application as a water temperature model.
- Does not have ability to simulate daily reservoir water temperatures.
- Requires compiling a large amount of data files, which can be difficult to manage.
- Requires a flow-stage-width relationship as an input rather than a hydraulic routing computation, which can limit accuracy of the heat exchange calculation.
- Hydraulic calculations are computed at a reach level, precluding calculation of mid-reach temperatures.

4.3.1.1.5 HEC-RAS

HEC-RAS is a widely applied hydraulic model for open channel flow in rivers and other water conveyances. A water quality module of the model, including temperature modeling, has been available since the release of HEC-RAS 4.0 in March 2008. The water quality component of HEC-RAS is based on a now defunct model CE-QUAL-RIV1. Positive attributes of HEC-RAS as a modeling platform include the following:

- Wide industry acceptance of HEC-RAS as a hydraulic model.
- Easily interface with HEC-DSSvue databases and model GUI.
- Capable of simulating a broad range of timesteps, from minutes to days.

Negative attributes of HEC-RAS as a modeling platform include the following:

- Not designed to be a water temperature model; it is designed for hydraulic computations and allows for water quality modeling as an add-on component.
- Lack of robust calibration parameters.
- Does not include topographic or vegetative shading.
- In active development, and subject to change with a future release of HEC-RAS.
- Requires hand-off conversion between reservoir temperature model and river model

4.3.1.1.6 Regression-Based Model in Microsoft® Excel

Using historically-measured water temperatures throughout the Project, linear regressions relating independent physical parameters such as reservoir water-surface elevation, flow, and air

temperature can be used to compute water temperatures at designated locations. Microsoft® Excel can be used with these relationships and time series of the input data as a water temperature model. Positive attributes of a regression-based Microsoft® Excel model include:

- Capable of simulating both rivers and reservoirs.
- Highly flexible and adaptable as additional information becomes available.
- Easily understood by most Relicensing Participants.
- Microsoft® Excel is a very common program and most potential users already have it.
- Can use HEC-DSS for data storage.
- Capable of simulating any period of record or time-step desired.

Negative attributes include:

- Reliability of the model is limited to the range of historically-measured data used to develop the regressions.
- Lack of ability to compute water temperatures for locations other than those with regressions and historically-measured data.

4.3.1.2 Potential Reservoir Water Temperature Models

The following section provides descriptions of model platforms evaluated for simulation of reservoirs only.

4.3.1.2.1 CE-THERM-R1

CE-THERM-R1, by the Waterways Experiment Station of the USACE, is a dynamic, 1D, horizontally averaged model used to simulate vertical profiles of water temperature in lakes and reservoirs. CE-THERM-R1 is the thermal analysis model associated with CE-QUAL-R1, which is capable of simulating a range of water quality components. CE-THERM-R1 is a reservoir model that simulates density- and wind-driven vertical mixing constituents through a series of horizontal layers. Positive attributes of CE-THERM-R1 as a modeling platform include the following:

- Widely used in reservoir simulations.
- Includes shading of vegetation and topography.
- Capable of simulating gate operations and multiple outlets.
- Capable of simulating variable vertical layer thicknesses.
- Calculates solar radiation internally based on input cloud cover and project latitude and longitude.

Negative attributes of CE-THERM-R1 as a modeling platform in the Study include the following:

- Legacy software with limited support.
- Substantial pre-processing of inputs, such as light penetration, is needed.
- Cannot simulate rivers.
- Only provides 1D, vertical profile for a reservoir.
- Does not use HEC-DSS for data exchange.

4.3.1.2.2 MIKE3-FM

MIKE3-FM, by the Danish Hydraulic Institute is a professional engineering software package for 3-D free-surface flows. Positive attributes of MIKE3-FM as a modeling platform include the following:

- Ability to model complex three-dimensional mixing.
- Flexible Mesh allows for detail to be concentrated in areas of interest.
- Graphical User Interface makes model features very accessible.

Negative attributes of MIKE3-FM as a modeling platform in the Study include the following:

- Expensive license with limited virtual machine access for participants.
- Proprietary input and output format requiring conversion for model input and output.
- For 3D simulation, tradeoffs must be made between model simplicity and computation time. May be very slow even for a simple system, if long-period simulations are needed.
- Large data requirements for calibration: temperature profiles and inflow temperatures.
- Used primarily for oceanic and delta modeling.

4.3.1.3 Potential River and Reservoir Water Temperature Models

The following section provides descriptions of model platforms capable of simulating both rivers and reservoirs.

4.3.1.3.1 HEC-5Q

HEC-5Q, by the HEC of the USACE, is a 1D model platform designed to simulate the sequential operation of a reservoir-channel system with branch network configuration. Positive attributes of HEC-5Q as a modeling platform include:

- Capable of simulating gate operations and multiple outlets.
- Contains integrated hydraulic and hydrologic routing calculations.
- Widely used and accepted platform.
- Uses HEC-DSS for easy data exchange between models.
- Uses an equilibrium temperature as an input to simplify meteorological conditions; it can be computed in an external processor.
- Capable of simulating multiple years in a single run.
- Capable of simulating reservoir vertical mixing either as a factor of water column stability or wind.
- Very short processing time; requires limited computing resources.

Negative attributes include:

- Legacy software with limited support.
- Difficult to debug input errors, if any exist.
- Lack of GUI makes visualizing connectivity difficult.

4.3.1.3.2 HFAM II

HFAM II, developed by Hydrocomp, Inc. as an upgrade to the HSPF model, is based on the Stanford method and is a continuous simulation model that can do both historical and forecast analysis. The HFAM II stream temperature models simulate flow rates and water temperatures based on upstream initial conditions for the full extent of each reach at nodes at tributary confluences and existing gage locations. The model has many positive attributes including:

- Simulates both rivers and reservoirs.
- Simulates hourly temperatures.
- Simulations can be run as forecast, analysis, probabilistic, or optimization runs.
- Provides statistical summaries of both inputs and outputs.
- Calculates mean- and maximum-daily water temperatures.
- Outputs include flow and storage in physical elements, heat exchange, mass and concentrations for sediment and nutrients.

There are some limitations to choosing HFAM II as the modeling platform in the Study. These limitations include:

- Requires amassing a large amount of data files, which can be difficult to manage.
- Exporting of data from the platform is tedious and requires export at each individual location.

4.3.1.3.3 CE-QUAL-W2

CE-QUAL-W2, by the Waterways Experiment Station of the USACE, is a two-dimensional (2D), laterally averaged, hydrodynamic water quality model for rivers, estuaries, lakes, reservoirs, and river basin system (Portland State University, 2015). The model is capable of predicting many different variables, including water–surface elevation, velocity, and temperature at longitudinal segments and vertical layers. Positive attributes of CE-QUAL-W2 as a modeling platform include the following:

- Widely used in reservoir simulations
- Well suited for relatively long and narrow waterbodies (reservoirs)
- Includes shading of vegetation and topography
- Capable of simulating gate operations and multiple outlets
- Capable of simulating multiple years in a single run

Negative attributes of CE-QUAL-W2 as a modeling platform in the Study include the following:

- Relatively calculation intensive, requiring a lot of computer resources and several hours of run time.
- Accurate representation of a reservoir requires detailed input data, including bathymetry and topographic shading.
- Requires sub-daily meteorological data inputs, which a) requires long records of input data that can be hard to manage, and b) may need to be estimated if historical data do not exist.
- Does not use HEC-DSS for data exchange.

4.3.1.4 Selection of Model Platforms

SSWD selected CE-QUAL-W2, version 3.72 (Portland State University, 2015) to simulate Camp Far West Reservoir, the non-Project diversion dam and lower Bear River because:

- Of its flexibility to be customized to represent the complexities of the Project, including reservoir outlets at different elevations
- Of its ability to simulate the entire study area (See Section 5.1) using a single model platform

- Of its ability to simulate water temperature at an hourly time step to adequately characterize diurnal water temperature variability.
- Of its ability to simulate the entire period of record
- Relicensing Participants are familiar with this modeling platform, and have agreed on the validity of the model results in other similar studies.

Limitations of CE-QUAL-W2 are:

- Model inputs and outputs are stored as text files, accessible using a text editor or Microsoft® Excel. HEC-DSS is preferred due to its use in hydrology/operations model output viewing.
- Model inputs and outputs are in metric units

Limitations listed above will be overcome by generating a spreadsheet tool that will:

- Export Water Balance/Operation Model output data as a CE-QUAL-W2 input data files in the format required, including conversion from English to metric units for compatibility
- Read in CE-QUAL-W2 output and export it to a HEC-DSS database file, converting from metric units to English units, as necessary

4.3.2 Step 2 – Develop and Calibrate the Model

SSWD will develop and calibrate the water temperature model so that inputs, assumptions, operations, and calibration are consistent with operations and factors governing water temperature in Camp Far West Reservoir and in the Bear River downstream of the reservoir.

The model will simulate Camp Far West Reservoir, Camp Far West Reservoir dam to the non-Project diversion dam below Camp Far West Reservoir, and the lower Bear River reach between the diversion dam and the Bear River confluence with the Feather River. Each will be linked in series as separate water bodies within a single CE-QUAL-W2 model. Model output will be extracted hourly to capture diurnal fluctuations in water temperatures. The model will include input and output for locations listed in Table 4.3-3.

Table 4.3-3. Water temperature model input and output locations.

Node (River Mile)	Location	Input/Output
BEAR RIVER – CAMP FAR WEST DAM REACH[1]		
25.1	Bear River Inflow into Camp Far West	Input
--	Rock Creek Inflow into Camp Far West	Input
18.0	Camp Far West Dam Release	Output
16.9	CFWID[2] North Canal Diversions	Output
16.9	SSWD Main Canal Diversions	Output

Table 4.3-3. (continued)

Node (River Mile)	Location	Input/Output
BEAR RIVER – NON-PROJECT DIVERSION DAM REACH[3]		
16.9	Non-Project Diversion Dam Release	Output
11.5	Bear River near Wheatland Gage	Output
6.8	Bear River near Pleasant Grove Gage	Output
5.2	Bear River Upstream of Dry Creek	Output
--	Dry Creek Inflow	Input
5.1	Bear River Downstream of Dry Creek	Output
0.1	Bear River Upstream of Feather River	Output

[1] Camp Far West Dam Reach – Bear Yuba River from Camp Far West Dam to the non-Project diversion dam.
[2] CFWID – Camp Far West Irrigation District
[3] Non-Project Diversion Dam Reach – Bear Yuba River from below the non-Project diversion dam to immediately upstream from the confluence with the Feather River.

Camp Far West Reservoir will be simulated in CE-QUAL-W2 as a 2D laterally-averaged reservoir. This will allow the water temperature model to capture the variability of release water temperature associated with changing water levels. Hydrologic and water temperature inputs to Camp Far West Reservoir will include the Bear River and Rock Creek. Releases from the reservoir will be modeled through the low-level outlet, the powerhouse, and the spillway. The Camp Far West Reservoir water temperature model will be calibrated for water temperature profiles at three locations in the reservoir: 1) at the dam; 2) in the Bear River arm of the reservoir; and 3) in the Rock Creek arm of the reservoir.

The reach between Camp Far West Reservoir dam and the non-Project diversion dam below Camp Far West Reservoir will be simulated in CE-QUAL-W2 as a 2D laterally-averaged reservoir. Hydrologic and water temperature inputs will include releases from Camp Far West Reservoir. Releases from the diversion dam will be made through SSWD's Conveyance Canal, Camp Far West Irrigation District's canal, or spill over the diversion dam. The diversion dam water temperature model will be calibrated to measured water temperature in the Bear River below the diversion dam (RM 16.9).

The Bear River below the diversion dam will be simulated in CE-QUAL-W2 as a 2D laterally averaged river, with inputs from the non-Project diversion dam and Dry Creek. The Bear River water temperature model will be calibrated to measured water temperature at the following locations:

- Bear River at BRW gage, Highway 65 (RM 11.4)
- Bear River at BPG gage, Pleasant Grove Bridge (RM 7.1)
- Bear River near Highway 70 (RM 3.5)
- Bear River above Feather River Confluence (RM 0.1)[1]

[1] The Bear River above the Feather River Confluence (RM 0.1) stream temperature model node will assume no backwater variability from the Feather River. The model will have limited ability to predict temperatures at this location during high flow periods in the Feather River (i.e. winter and spring months) due to backwater influence.

Available water temperature data (Table 4.3-1); meteorological data, including air temperature, atmospheric pressure, humidity, precipitation, solar radiation, and wind speed (Table 4.3-2); and physical parameters such as reservoir area-storage relationships and river channel geometry will be used for water temperature model calibration. Accretions at multiple locations throughout the Study Area will be included to preserve mass balance throughout the system. Model calibration will use publicly-available historical hydrology data and non-public hydrology data measured by SSWD corresponding to the calibration period, which will be from April 2015 through December 2016.

4.3.3 Step 3 – Develop a Relicensing Period of Record Input Data Set

Concurrent with calibration of the CE-QUAL-W2 models, SSWD will develop both a meteorological and an input-water-temperature data set for the relicensing period of record, which is WY 1976 through WY 2014.

A complete set of hourly meteorological data will be assembled from the gages listed in Table 4.3-2. The primary source gage for the data set will be Beale Air Force Base, which covers the period of record. Other meteorological gages listed in Table 4.3-2 will be used to fill data gaps on an as-needed basis.

Meteorological input data requirements for CE-QUAL-W2 include:

- Air temperature (degree Celsius or °C)
- Dew point temperature (°C)
- Wind speed (meters per second or m/sec)
- Wind direction (radians)
- Cloud cover, 0 (clear) to 10 (cloudy)
- Short wave radiation (Langleys, or W/m^2) (optional)

Incidental short-wave radiation is optional and represents only the penetrating short-wave radiation component. CE-QUAL-W2 calculates solar radiation, if not provided, from sun angle relationships and cloud cover.

Hourly input water temperatures will be determined for the Bear River, as well as Rock Creek and Dry Creek. Since limited historical water temperature data are available for Study Area tributaries for the period of record, it will be necessary to synthesize input water temperatures. Input water temperatures will be synthesized by identifying statistical relationships between available historical water temperature, meteorology and hydrology data. Ungaged accretion water temperatures will be simulated based on data measured in Dry Creek, Rock Creek, or both.

Bear River unimpaired hydrology was developed as part of this relicensing from the headwaters downstream to Camp Far West Dam (see Appendix F of the PAD). Similar methods will be

used to estimate unimpaired flow in the Bear River below the non-Project diversion dam, including Dry Creek.

Regulated hydrology data, including inflow and outflow to Camp Far West Reservoir and the diversion dam will come directly from the relicensing Water Operations Model. Outputs from this model are described in Section 2.1.4.6 of the PAD.

4.3.4 Step 4 – Validate the Model

Model validation will occur in three tasks. In the first task, SSWD will evaluate the draft CE-QUAL-W2 models by comparing modeled output to the record from January 2017 through December 2017. Significant differences between historical conditions and modeled output will be examined, and the causes identified and documented. Where substantial differences cannot be explained, the model will be recalibrated. Key validation points will be at the following locations:

- Vertical profile in Camp Far West Reservoir near the dam
- River temperature in the Bear River below the diversion dam
- River temperature at USGS Wheatland gage
- River temperature in the Bear River upstream from its confluence with the Feather River

In the second task, SSWD will meet with interested Relicensing Participates to review the model. This will include a meeting to generally introduce the parties to the model. At that meeting, the parties will be given a compact disc (CD) with the model, a Model Development Report that describes model inputs and logic and general information on running the model, and SSWD's Draft Model Validation Report. After 30 days for review, SSWD will hold a workshop with interested Relicensing Participates to review the model and discuss modifications, as appropriate.

In the last task, SSWD will finalize the model and the Model Development and Validation reports.

4.3.5 Step 5 – Develop Period of Record Base Case Model Scenario

The Base Case water temperature model run will simulate reservoir and stream temperature for the relicensing period of record, which is WY 1976 through WY 2014, under existing Project operations and water deliveries. The underlying assumption is that this Base Case represents the "No-Action Alternative." Meteorological data, boundary condition water temperature data, and hydrologic input data developed in Step 2 will be used to develop the Base Case temperature model scenario. Project operating assumptions for the Base Case are described in Section 2.1.4.6 of the PAD.

4.3.5 Step 6 – Enable User-defined Downstream Temperature Targets

CE-QUAL-W2 has the built-in ability to automate port selection from a multiple outlet structure to meet downstream temperature targets. Development of the model will include the option to use this feature. This option will be turned off for the Base Case Scenario, developed as Step 5 of this study, but could be used in future model run scenarios.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for many recent FERC hydroelectric relicensing efforts in California, including the Yuba River Development Project (FERC No. 2246), the Drum-Spaulding Project, (FERC No. 2310) and the Yuba-Bear Hydroelectric Project (FERC No. 2266). Model development, including calibration, verification, and model application will be conducted in accordance with generally accepted scientific practices.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Develop and Calibrate Model (Steps 1 and 6).....January 2017– April 2017
Develop Input Data Set (Step 2).....May 2017 – July 2017
Validate Model (Step 3).....December 2017 – March 2018
Develop Base Case (Step 4).....April 2018 – May 2018
Prepare Model (Step 5).....May 2018 – June 2018

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $100,000 and $125,000.

8.0 References Cited

Alpers, C.N., A.R. Stewart, M.K. Saiki, M.C. Marvin-DiPasquale, B.R. Topping, K.M. Rider, S.K. Gallanthine, C.A. Kester, R.O. Rye, R.C.Antweiler, and J.F. De Wild. 2008. Environmental factors affecting mercury in Camp Far West Reservoir, California. 2001–03: U.S. Geological Survey Scientific Investigations Report 2006-5008. 358 p.

Aqua Terra Consultants (in cooperation with United States Geological Survey and United States Environmental Protection Agency). 2005. Hydrological Simulation Program – Fortran, Version 12.2 Users Manual. Online document: http://www.aquaterra.com/pdf/HSPF12.2UsersManual.pdf.

Barthalow, J. M. 2010. Stream Network and Stream Segment Temperature Models Software. United States Geological Survey publication, https://www.fort.usgs.gov/products/10016.

Danish Hydraulic Institute (DHI). 2011. MIKE 21 and MIKE 3 Flow Model FM, Hydrodynamic and Transport Module, Scientific Documentation.

Hydrocomp, Inc. 2012. HFAM II Model Description. http://www.hydrocomp.com/HfamSoftware/Hfam%20II%20Description.htm.

Old Dominion University, 1993. CE-THERM-R1: A Numerical One-Dimensional Model of Reservoir Water Temperature, Version 4.0, http://sdi.odu.edu/model/cequal.php.

Portland State University, 2015. CE-QUAL-W2: A Two-Dimensional Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.72, http://www.ce.pdx.edu/w2/.

Stockholm Environment Institute, 2015. Water Evaluation and Planning System, User Guide for WEAP 2015. www.weap21.org/downloads/WEAP_User_Guide.pdf.

Study 2.3

WATER QUALITY STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) and associated recreation use have the potential to affect water quality.

This Water Quality Study (Study) addresses all pertinent water quality parameters except for water temperature, which is addressed in two separate relicensing studies: Study 2.1, *Water Temperature Monitoring*, and Study 2.2, *Water Temperature Modeling*.

2.0 Study Goals and Objectives

The goal of this Study is to supplement existing information regarding water quality.

The objective of the study is to collect information to meet the Study goal.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

The primary comprehensive plan that addresses water quality in the Project Vicinity is the State Water Resources Control Board's (SWRCB) *Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin Rivers* (CVRWQCB 1998). The Basin Plan, including designated Beneficial Uses in the Project Area,[1] is described in Section 1.3.8 of SSWD's Pre-Application Document (PAD). The Basin Plan designated Water Quality Objectives in the Project Area are provided in Table 3.2.2-5 of the PAD. In addition, Section 1.3.8 of the PAD describes Clean Water Act (CWA) Section 303(d) List of Water Quality Limited Segments in the Project Area and associated Total Daily Maximum Load (TMDL) plans.

Existing, relevant and reasonably available information regarding water quality in the Project Vicinity[2] is provided in Section 3.2.2.9.2 of the PAD. This existing and available information indicates that upstream of the Project, all Water Quality Objectives were met for the parameters available. In Camp Far West Reservoir, Water Quality Objectives were not met during one sampling event for dissolved oxygen (DO), pH and specific conductivity. In most instances, these values occurred near the bottom of the reservoir. No information is available for the Bear

[1] In this Study, "Project Area" refers to the area within and immediately adjacent to the existing FERC Project Boundary, and the Bear River downstream of the Project.

[2] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

River between Camp Far West Dam and the non-Project diversion dam. Downstream of the non-Project diversion dam, existing and available information indicates that Water Quality Objectives are not met for pH; alkalinity; DO; aluminum (total); arsenic (total); copper (total and dissolved); iron (total); manganese (total); and lead (total and dissolved).

Additional information, which will be provided by this Study, is needed to address the Study goal regarding the specific water quality parameters not met by the Basin Plan and the Project O&M activities and associated recreation that affect these parameters.

4.0 Study Methods and Analysis

4.1 Study Area

For the purpose of this Study, the Study Area includes: 1) the Bear River, approximately 1.5 miles upstream from Camp Far West Reservoir; 2) Camp Far West Reservoir; 3) the 1.3-mile-(mi)-long segment of the Bear River from Camp Far West Dam to the non-Project diversion dam; and 4) the 16.9-mi-long segment of the Bear River from the diversion dam to the Feather River confluence (lower Bear River). Figure 4.1-1 shows the Study Area.

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

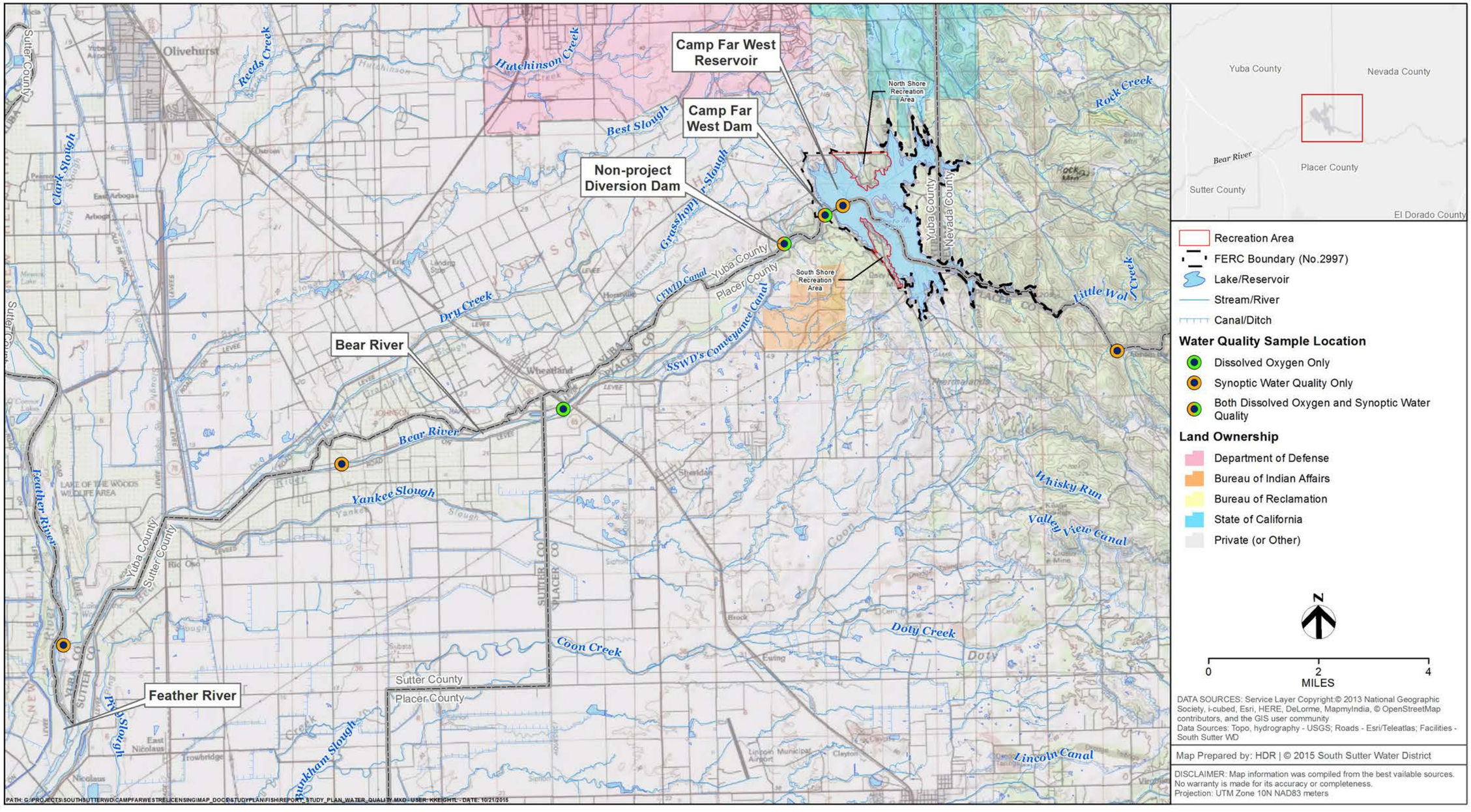

Figure 4.1-1. Water Quality Study Area and sample locations.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to National Oceanic and Atmospheric Administration, National Marine Fisheries Service; United States Fish and Wildlife Service, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.

- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in Excel (*.xls) or HEC-DSS (*.dss) format. A viewer for *.dss files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of October 2015: http://www.hec.usace.army.mil/software/hec-dssvue/.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study consists of two elements. Element 1 consists of synoptic grab sampling over three events. Element 2 consists of continuous DO monitoring over two events. The Study will be performed in six steps: 1) select water quality parameters; 2) select sampling locations; 3) collect water samples; 4) perform laboratory analyses using standard methods adequately sensitive to determine consistency with state and federal water quality standards; 5) prepare quality assurance/quality control (QA/QC) review; and 6) determine consistency with Basin Plan Objectives and designated Beneficial Use protection needs. Each of these steps is described below.

4.3.1 Step 1 – Select Water Quality Parameters

4.3.1.1 Element 1 Parameters

For the purpose of this Study, the water quality parameters and constituents to be measured in Element 1 are divided into six categories: 1) basic water quality – *in situ*; 2) basic water quality

– laboratory; 3) inorganic ions; 4) nutrients; 5) metals; and 6) herbicides and pesticides. The parameters included in each Element 1 category and associated information is listed in Table 4.3-1.

Table 4.3-1. Water quality parameters and constituents to be measured and methods, reporting limits and laboratory holding times for each.

Parameter		Method	Target Reporting Limit µg/L (or other)	Hold Time
BASIC WATER QUALITY – *IN SITU*				
Dissolved Oxygen	DO	SM 4500-O	0.1 mg/L	Field (*in situ*)
Specific conductance	--	SM 2510A	0.001 µmhos	Field (*in situ*)
pH	--	SM 4500-H	0.1 su	Field (*in situ*)
Turbidity	--	SM 2130 B	0.1 NTU	Field (*in situ*)
Secchi Disc	--	--	--	Field (*in situ*)
BASIC WATER QUALITY – LABORATORY				
Total Organic Carbon	TOC	SM 5310	0.2 mg/L	28 d
Dissolved Organic Carbon	DOC	EPA 415.1 D	0.5/0.1	28 d
Total Dissolved Solids	TDS	EPA 2540 C SM 2340 C	1 mg/L	7d
Total Suspended Solids	TSS	EPA 2520 D SM 2340 D	1 mg/L	7d
INORGANIC IONS				
Total Alkalinity	--	SM 2340 B	2000	14 d
Calcium	Ca	EPA 6010 B	30	180 d
Chloride	Cl	EPA 300.0	20	28 d
Hardness (measured value)	--	EPA 2340 B SM 2340 C	1 mg/L as $CaCO_3$	14 d
Magnesium	Mg	EPA 6010 B	1	180 d
Potassium	K	EPA 6010 B	500	180 d
Sodium	Na	EPA 6010 B	29	180 d
Sulfate	SO_4^{2-}	EPA 300.0	1.0 mg/L	28 d
Sulfide	S^{2-}	SM 4500 S2 – D	0.05 mg/L	28 d
NUTRIENTS				
Nitrate-Nitrite	--	EPA 300.0	2	28 d <pH 2
Total Ammonia as N	--	EPA 4500-NH3 SM 4500-NH3	0.02	28 d <pH 2
Total Kjeldahl Nitrogen as N	TKN	SM 4500 N	100	28 d <pH 2
Total phosphorus	TP	SM4500 P	20	28 d <pH 2
Dissolved Orthophosphate	PO_4	EPA 365.1 EPA 300.0	0.01	48 h at 4 °C
METALS (total and dissolved)				
Aluminum (total and dissolved)	Al	EPA 200.8/EPA 1638	4.0/ 0.4	180 d
Arsenic (total and dissolved)	As	EPA 200.8/1638	0.15/0.04	180 d
Cadmium (total and dissolved)	Cd	EPA 200.8/1638	0.020/0.004	180 d
Chromium, Total (total and dissolved)	Cr	EPA 200.8/1638	0.010/0.03	180 d
Copper (total and dissolved)	Cu	EPA 200.8/1638	0.10/0.01	180 d
Iron (total and dissolved)	Fe	EPA 200.8/1638	10.0/3.2	180 d
Lead (total and dissolved)	Pb	EPA 200.8/EPA 1638	0.040/0.003	180 d
Mercury (total)	Hg	EPA 1631	0.0005/0.00008	28 d
Methylmercury (total and dissolved)	CH3Hg	EPA 1630	0.00005/0.000019	90 d
Nickel (total and dissolved)	Ni	EPA 200.8/1638	0.10/0.01	180 d

Table 4.3-1. (continued)

Parameter		Method	Target Reporting Limit µg/L (or other)	Hold Time
METALS (total and dissolved) (continued)				
Selenium (total)	Se	EPA 200.8/1638	0.60/0.19	180 d
Silver (total and dissolved)	Ag	EPA 200.8/1638	0.20/0.006	180 d
Zinc (total and dissolved)	Zn	EPA 200.8/1638	0.2/0.1	180 d
Chlorpyrifos	--	EPA 8081A	0.005/0.0024 mg/L	7d
Diazinon	--	EPA 8141A	0.005/0.0029 mg/L	7d

Key:
EPA = United States Environmental Protection Agency
$CaCO_3$ = Calcium carbonate
d = days
h = hours
µmhos = micro-ohms
µg/L = micrograms per liter (equals parts per billion)
mg/L = milligrams per liter (equals parts per million)
MPN = Most Probable Number
NTU = Nephelometric Turbidity Units
SM = Standard Method
su = Standard Unit

4.3.1.2 Element 2 Parameters

Element 2 consists of measuring two parameters, DO concentration and water temperature. While DO is the parameter of interest in this Study, water temperature is often tied to DO results and will be incorporated into the analysis, through SSWD will conduct a separate *Water Temperature Monitoring Study* (Study 2.1).

4.3.2 Step 2 – Select Sampling Locations

4.3.2.1 Element 1 – Synoptic Water Quality Sample Locations

Synoptic water quality samples will be collected upstream, within and downstream of the Project. Water chemistry samples in the Bear River will be grab samples collected for laboratory analysis from the flowing water. In Camp Far West Reservoir, general water chemistry samples will be collected for laboratory analysis at two depths: within the hypolimnion and just below the surface in the epilimnion. In the event the reservoir is mixed at the time of sampling (as seen from the reservoir profile near the dam), samples will be collected from just below the surface and approximately 5 feet from the bottom. (Table 4.3-2.)

Table 4.3-2. Synoptic water quality sample locations.

Location	River Mile	Sample Depth	Notes
Bear River upstream of Camp Far West Reservoir	25.1	Surface	Co-located with Study 2.1, *Water Temperature Monitoring*, sampling location
Camp Far West Reservoir; near Dam	18.4	Surface	
		Bottom	
Bear River below Camp Far West Dam	18.0	Surface	
Bear River below non-Project Diversion Dam	16.9	Surface	
Bear River near Pleasant Grove Road Bridge	7.1	Surface	
Bear River upstream of the Feather River Confluence	0.1	Surface	

4.3.2.2 Element 2 – Continuous DO Monitoring Locations

To better understand DO concentration dynamics, continuous DO monitors will be installed at three locations: 1) in the Bear River downstream of the Camp Far West Powerhouse and low-level outlet (RM 18.0); 2) in the Bear River downstream of the non-Project diversion dam (RM 16.9); and 3) in the lower Bear River near the Highway 65 bridge (RM 11.4). Each monitor will be placed in flowing water near the surface.

4.3.3 Step 3 – Collect Samples

All data will be acquired in accordance with standard quality assurance practices.

4.3.3.1 Element 1 – Synoptic Water Quality Reservoir and Stream Sampling

Water chemistry samples will be collected from all locations three times: 1) once in the spring, when the powerhouse is operational and irrigation deliveries are occurring; 2) once in the late summer, when the powerhouse is operational and irrigation deliveries are occurring; and 3) once in the fall, when the powerhouse is off-line and releases from Camp Far West Dam are made exclusively by the low-level outlet.

4.3.3.1.1 *In Situ* Sampling

In situ water quality measurements will be made at the sample depths described in Table 4.3-2 with a Hydrolab DataSonde 5 (Hydrolab), or other instrument with similar precision and accuracy. Water temperature (±0.1°C), DO (±0.2 mg/L), pH (±0.2 standard unit, or su), specific conductance (±0.001 micromhos per centimeter [µomhos/cm]), and turbidity (± 1 NTU) will be measured at each location. Prior to and after each use, the instrument will be calibrated using the manufacturer's recommended calibration methods. Any calibration variances will be noted on the field data sheet and in the Study report, and recalibration or repair done as necessary. SSWD will note relevant conditions during each sampling event on the field data sheet (e.g., air temperature; flow, if available at a nearby gage; description of sampling location; floating material; evidence of oil and grease; and activities in the vicinity of the sampling site that could cause short-or long-term alterations to water quality, such as dredging).

4.3.3.1.2 Laboratory Samples

Each sample to be delivered to a laboratory will be collected into laboratory-supplied clean containers. Water samples to be analyzed for metals will be taken using "clean hands" methods consistent with the United States Environmental Protection Agency's (EPA's) Method 1669 sampling protocol *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria* (EPA 1995). Samples requiring filtration before metals analysis will be filtered in accordance with standard protocols in the field. Certification of filter cleanliness will be obtained from the vendor and kept in the Project files.

All sample containers will be labeled with the date and time that the sample is collected, sampling site or identification label and handled in a manner consistent with appropriate chain-of-custody protocols. The sample container will be preserved as appropriate, stored and delivered to a State of California-certified water quality laboratory for analyses of the parameters listed in Table 4.3-1 in accordance with maximum holding periods for each parameter. A chain-of-custody record will be maintained with the samples at all times. The sampling site location will be recorded using a GPS unit.

As part of the field QA program, one field blank and one equipment rinsate will be collected and submitted to the laboratory, with a target of one for every ten analyses. A field blank is a sample of analyte-free water poured into the container in the field, preserved and shipped to the laboratory with samples. A field blank for filtered samples will be similarly created, but filtered using field techniques before pouring into the container. A field blank assesses the contamination from field conditions during sampling. A rinsate is a sample of analyte-free water poured over or through decontaminated field sampling equipment prior to the collection of samples and assesses the adequacy of the decontamination processes. Two duplicate samples will also be collected to confirm the laboratory's QA process.

4.3.3.1.3 Secchi Depth Readings in Reservoirs

Prior to collecting reservoir samples, a Secchi disk will be slowly lowered into the water on the shady side of the boat until it is no longer visible, and the depth recorded. Then, the Secchi disc will be slowly raised until it just becomes visible once again and this depth will be recorded a second time. The average of the two depths will be considered the Secchi depth and recorded.

4.3.3.2 Element 2 – Continuous Dissolved Oxygen Monitoring

Continuous DO monitors will be deployed for a minimum of 14 days during two periods: 1) once in the summer when the Camp Far West Powerhouse is operational and irrigation deliveries from Camp Far West Dam are occurring; and 2) once in the fall when the powerhouse is off-line and releases from Camp Far West Dam are made exclusively by the Camp Far West Dam low-level outlet.

DO monitoring will generally follow the United States Geological Survey (USGS) published method for the operation of continuous water quality stations (Wagner et al. 2006). The DO (±0.3 mg/L or less) will be measured *in situ* at 1-hour intervals using an Onset sonde or similar device with the appropriate precision and accuracy.

Each DO monitor will be contained in a durable protective housing that permits the active flow of water in and around the unit. The protective housing will be secured by a cable to a stable root mass, tree trunk or man-made structure, or secured using embedded rebar where necessary such that the monitor will be secured in flowing water in the channel during high flow periods. The DO monitors will be installed in flowing water, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads. A GPS coordinate will be taken and recorded at each installation point, along with any waypoints that may prove valuable for future retrieval, especially where there is not a defined trail leading to the

access point. Photographs of the sampling site, including installation configuration, will be taken. Prior to installation, each recorder will be numbered and calibrated to manufacturer's recommended specifications.

Redundant recorders will be located as close as possible to the primary recorders. Where a redundant recorder occurs, the primary recorder will be labeled with the recorder number for the site (e.g., "BR1") with the suffix "a" and the redundant recorder with the number for the site with the suffix "b". Data from both recorders will be downloaded during each scheduled visit.

During each visit, SSWD will download data into an optic shuttle or directly to a personal computer. Immediately after the data are safely downloaded, back-ups will be recorded on portable memory devices (i.e., USB "thumb drive"). Only after the raw water temperature data are safely backed-up will the optic shuttle be cleared or the data manipulated. In addition, during each site visit, SSWD will be prepared to replace or fix a recorder installation. Should a recorder need to be replaced because it is missing or has failed, SSWD will be able to do so immediately to reduce the potential for additional data loss. Any recorder or optic shuttle that fails to download will be returned to the manufacturer for possible data recovery.

The data will be downloaded and the loggers inspected/maintained weekly during the deployment periods.

4.3.4 Step 4 – Perform Laboratory Analyses

4.3.4.1 Chemical Analyses

All laboratory analyses will be conducted using EPA Standard Methods or the equivalent sufficiently sensitive to detect and report at levels necessary for evaluation against State and federal water quality standards. A State of California-certified laboratory will prepare and analyze water samples for the following surface water analytical parameters:

- Basic Water Chemistry - Laboratory
- Inorganic Ions
- Metals
- Nutrients
- Petroleum Hydrocarbons

The analytes and target reporting limits associated with each parameter are listed in Table 4.3-1.

4.3.5 Step 5 – QA/QC Review

All data will be verified and/or validated as appropriate. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analysis, SSWD will subject all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of results to field blank and

rinsate results; and, identification of any data that seem inconsistent. If any inconsistencies are found, SSWD will consult with the laboratory to identify any potential sources of error before concluding that the data is correct.

All verified chemical detections, including data whose results are "J" qualified[3] will be used for this assessment. Should the laboratory need to re-extract samples and re-run the sample under different calibration conditions, the data identified by the laboratory, as the most certain, will be used. If field-sampling conditions, as measured by the field blank and the rinsate sample results, indicate that samples have been corrupted, SSWD will identify the data accordingly.

4.3.6 Step 6 – Determine Consistency with Basin Plan Water Quality Objectives

Table 4.3-3 shows the standards, criteria and benchmark values that will be used to assist with in the assessment of sample results and their consistency with the Basin Plan Objectives. The selected values primarily consist of the Title 22 drinking water standards, which are incorporated by reference into the Basin Plan itself, and the California Toxics Rule (CTR) (EPA 2000). However, when a Study analyte does not have a compliance threshold (i.e., benchmark) in one these preferred sources, benchmarks will be applied from *A Compilation of Water Quality Goals* (Marshack 2015, as amended through October 2011 – August 2014); and others as cited.

Table 4.3-3. Standards, criteria and benchmarks used for determining consistency with Basin Plan Water Quality Objectives and designated Beneficial Uses.[1]

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
BIOSTIMULATORY SUBSTANCES (COLD, SPAWN)				
Total Kjeldahl Nitrogen	TKN	None	--	--
Total Phosphorous	TP	None	--	--
CHEMICAL CONSTITUENTS (MUN)				
Alkalinity	--	20 mg/L	Marshack 2015	EPA AWQC; less than 20 mg/L can affect water treatment
Aluminum	Al	1 mg/L	DDW 2015	22 CCR §64431 Primary MCL
Arsenic	As	0.01 mg/L	DDW 2015	22 CCR §64431 Primary MCL
Cadmium	Cd	5 µg/L	DDW 2015	22 CCR §64431 Primary MCL
Calcium	Ca	None	--	--
Chromium (total)	Cr (total)	50 µg/L	DDW 2015	22 CCR §64431 Primary MCL
Chlorphyifos	--	2 µg/L	Marshack 2015	USEPA drinking water source
Copper	Cu	1.3 mg/L	DDW 2015	22 CCR §64431 Primary MCL
Diazinon	--	1.2 µg/L	Marshack 2015	California Department of Public Health notification
Lead	Pb	15 µg/L	DDW 2015	22 CCR §64431 Primary MCL
Mercury (inorganic)	Hg	2 µg/L	DDW 2015	22 CCR §64431 Primary MCL

[3] Results with a "J" qualifier are results where the chemical was detected, but there is uncertainty in the quantity. The quantity is above the method detection limit, but below the reporting limit.

Table 4.3-3. (continued)

Nickel	Ni	100 µg/L	DDW 2015	22 CCR §64431 Primary MCL
Nitrate	NO_3-N	10 mg/L	DDW 2015	22 CCR §64431 Primary MCL
Nitrite	NO_2-N	1 mg/L	DDW 2015	22 CCR §64431 Primary MCL
Nitrate + Nitrite	NO_3-N+NO_2-N	10 mg/L (combined total)	DDW 2015	22 CCR §64431 Primary MCL
Selenium	Se	50 µg/L	DDW 2015	22 CCR §64431 Primary MCL
Sodium	Na	20 mg/L	Marshack 2015	Sodium Restricted Diet[2]
DISSOLVED OXYGEN (COLD, SPAWN)				
Dissolved Oxygen	DO	> 7 mg/L (minimum)	CVRWQCB 1998	Aquatic life protection
FLOATING MATERIAL (REC-1, REC-2)				
Floating Material	--	Narrative Criteria	CVRWQCB 1998	Aesthetics – Absent by visual observation
pH (MUN, COLD, SPAWN, WILD)				
pH	--	6.5-8.5	CVRWQCB 1998	Aquatic life protection
TASTES & ODOR (MUN)				
Aluminum	Al	0.2 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Chloride	Cl	250 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Copper	Cu	1.0 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Iron	Fe	0.3 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Silver	Ag	0.1 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Specific conductance	--	900 µS/cm	DDW 2015	22 CCR §64449 Secondary MCL
Sulfate	SO_4^{2-}	250 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Total Dissolved Solids	TDS	500 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
Zinc	Zn	5 mg/L	DDW 2015	22 CCR §64449 Secondary MCL
TEMPERATURE (COLD, SPAWN)				
Temperature	--	Narrative	CVRWQCB 1998	See Water Temperature Study
TOXICITY (COLD, SPAWN, MUN)				
Alkalinity	--	20 mg/L	Marshack 2015	EPA AWQC; buffering capacity
Aluminum	Al	87 µg/L	Marshack 2015	EPA AWQC; aquatic life protective[3]
Ammonia as N (pH and Temp dependent)	NH_3-N	24.1 mg/L (CMC); 4.1-5.9 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 7.0
		5.6 mg/L (CMC); 1.7-2.4 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 8.0
		0.9 mg/L (CMC); 0.3-0.5 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 9.0
Arsenic	As	0.34 mg/L (CMC); 0.15 mg/L (CCC)	EPA 2000	CTR criteria
Cadmium (hardness dependent)	Cd	0.16 µg/L (CMC); 0.25 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		0.35 µg/L (CMC); 0.41 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		0.54 µg/L (CMC); 0.56 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		0.95 µg/L (CMC); 0.81 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$

Table 4.3-3. (continued)

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
TOXICITY (COLD, SPAWN, MUN) (continued)				
Chloride	Cl-	860 mg/L (CMC); 230 mg/L (CCC)	Marshack 2015	EPA AWQC; aquatic life protective
Chromium (hardness dependent)	Cr	47.19 µg/L (CMC); 15.31 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		83.25 µg/L (CMC); 27.0 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		116.03 µg/L (CMC); 37.64 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		176.31 µg/L (CMC); 57.19 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Chlorpyrifos	--	0.02 µg/L (CMC); 0.014µg/L (CCC)	Marshack 2015	CDFW water quality criteria
Copper (hardness dependent)	Cu	0.8 µg/L (CMC); 0.69 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		1.54 µg/L (CMC); 1.25 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		2.25 µg/L (CMC); 1.77 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		3.64 µg/L (CMC); 2.74 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Diazinon	--	0.16 µg/L (CMC); 0.1 µg/L (CCC)	Marshack 2015	CDFW water quality criteria
Iron	Fe	1 mg/L (CCC)	Marshack 2015	EPA AWQC; aquatic life protective
Mercury (total)	Hg	0.050 µg/L	EPA 2000 40 C.F.R. 131.38	CTR/Federal Register 5/18/00
Nickel (hardness dependent)	Ni	37.2 µg/L (CMC); 4.1 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		66.9 µg/L (CMC); 7.4 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		94.3 µg/L (CMC); 10.5 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		145.2 µg/L (CMC); 16.1 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Selenium (total)	Se	20 µg/L (CMC) 5 µg/L (CCC)	Marshack 2015	EPA AWQC; aquatic life protective
Silver (hardness dependent)	Ag	0.02 µg/L (CMC) Instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		0.07 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
Silver (hardness dependent)	Ag	0.13 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		0.32 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$

Table 4.3-3. (continued)

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
TOXICITY (COLD, SPAWN, MUN) (continued)				
Lead (hardness dependent)	Pb	2 µg/L (CMC) 0.086 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		5 µg/L (CMC) 0.191 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		8 µg/L (CMC) 0.303 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		14 µg/L (CMC) 0.54 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Specific conductance	--	150 µmhos	CVRWQCB 1998	Aquatic Life Protection
Zinc (hardness dependent)	Zn	9.26 µg/L (CMC) 9.33 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		16.66 µg/L (CMC) 16.79 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		23.48 µg/L (CMC) 23.68 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		36.20 µg/L (CMC) 36.50 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Turbidity	NTU	increase < 1 NTU for 1-5 NTU background; increase < 20% for 5-50 NTU background; increase < 10 NTU for 50-100 NTU background	CVRWQCB 1998	Aesthetics, disinfection

1 Note: a constituent may be listed under more than one beneficial use. When a standard or criterion was not available, benchmarks were excerpted from EPA (2003) and Marshack (2015).
2 Guidance level to protect those individuals restricted to a total sodium intake of 500 mg/day (Marshack 2015).
3 Benchmark is likely overly protective, as EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured (Marshack 2015)

Key:
AWQC = Ambient Water Quality Criteria
EPA = United States Environmental Protection Agency
CaCO3 = Calcium carbonate
CDFW = California Department of Fish and Wildlife
CMC = Criterion Maximum Concentration (1-hour acute exposure) for aquatic toxicity as defined by EPA (2000)
CCC = Criterion Continuous Concentration (4-day chronic exposure) for aquatic toxicity as defined by EPA (2000)
CCR = California Code of Regulations
CTR = California Toxics Rule
MCL = Maximum Contaminant Level
µmhos = micromhos
µg/L = micrograms per liter
mg/L = milligrams per liter
MPN = Most Probable Number
NTU = Nephelometric turbidity units
SM = Standard Method
su = standard unit

The CVRWQCB has adopted, by reference, California Title 22 maximum contaminant levels (MCL) for drinking water as Basin Plan objectives (CVRWQCB 1998), with the exception that more stringent criteria may apply as necessary for protection of specific designated Beneficial Uses. Hence, these values are adopted as the drinking water standard herein. It should be noted,

however, that chemical concentrations that were originally intended to apply to finished tap-water, rather than to untreated sources of drinking water, will be applied to the untreated reservoir or river water.

For Basin Plan Water Quality Objectives related to aquatic toxicity for ammonia and trace metals, the CTR (EPA 2000) is the preferred benchmark source. Part 40 C.F.R. Section 131.38 established Criterion Maximum Concentrations (CMC) as the highest concentrations to which aquatic life can be exposed for a short period[4] (1 hour) without deleterious effects, and Criterion Continuous Concentrations (CCC) as the highest concentration to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. When single grab samples are collected, as will be the case for this Study, it is assumed that constituent concentrations are representative of the continuous ambient condition, and CCC values are therefore used as the appropriate criteria to compare against environmental sample results.

Because of differences in acute and chronic toxicity to aquatic organisms of many elements and compounds, as well as variations with ambient water quality such as pH or hardness, several entries in Table 4.3-3 have multiple benchmarks to illustrate this range. The benchmarks for seven of the metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) addressed in this Study are reported for dissolved metals from the CTR (EPA 2000). In Table 4.3-3, benchmarks for these metals are calculated in 5 mg/L increments of hardness since the aquatic toxicity of these metals reportedly increases as hardness decreases. Similarly, the CMC and CCC levels for ammonia are a function of both pH and temperature and are presented for the temperature range of 0º-20ºC in pH increments of 1.0 su in Table 4.3-3.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The study uses standard water quality monitoring methods. Laboratory analyses are based on the recommended methods by EPA or the State of California.

6.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning ..... March 2017
Collect WQ Data – powerhouse on, diverting ..... April/May 2017
Collect WQ/DO Data – powerhouse on, diverting ..... August 2017
Collect WQ/DO Data – low-level outlet operations only ..... October 2017
QA/QC Review ..... November/December 2017

[4] Based on extended sample collection and 1-hour averaging.

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the report on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this Study in 2016 dollars is between $60,000 and $80,000.

8.0 References Cited

Central Valley Regional Water Quality Control Board (CVRWQCB). 1998. Basin Plan. Fourth Edition, The Sacramento River Basin and the San Joaquin River Basin. State of California Regional Water Quality Control Board, Central Valley Region. Revised in October 2011 with the Approved Amendments

Marshack, J. 2015. A compilation of water quality goals. California Regional Water Quality Control Board, Central Valley Region. http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/#data_downloads

State Water Resources Control Board, Division of Drinking Water (DDW). 2015. Maximum Contaminant Levels. California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring. Last update: September 23, 2015. Website accessed 10/16/15.

United States Environmental Protection Agency (EPA). 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, 40 C.F.R. 131. May 18.

_____ 1995. Method 1669: Sampling ambient water for trace metals at United States Environmental Protection Agency water quality criteria levels. EPA 821-R-95-034, United States Environmental Protection Agency, Washington, D.C.

Wagner, R.J., R.W. Boulger, Jr., C.J. Oblinger, and , B.A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3.

Page Left Blank

Study 3.1

SALMONID REDD STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an effect on anadromous fish in the Bear River downstream of a non-Project diversion dam (i.e., lower Bear River).

For the purpose of this Salmonid Redd Study (Study), "anadromous fish" refers to Chinook salmon (*Oncorhynchus tshawytscha)*[1] and steelhead *(O. mykiss).*[2] Since differentiating between anadromous and rainbow trout (i.e., resident *O. mykiss*) redds cannot be done through visual assessment alone, all *O. mykiss* redds observed will be reported as steelhead.

2.0 Study Goals and Objectives

The goal of the study is to supplement existing information regarding the spawning of salmonids in the Bear River downstream of the non-Project diversion dam.

The objectives of this Study are to gather information necessary to meet the Study goal.

This Study does not include Section 7 ESA informal consultation with the United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS).

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding anadromous fish in the Bear River downstream of Camp Far West Dam is provided in Section 3.2.3 of SSWD's Pre-Application Document (PAD). Existing information regarding spring-run Chinook salmon ESU and its critical habitat is provided in Section 3.2.5.3.8 of the PAD, and existing information regarding Central Valley steelhead its critical habitat is provided in Section 3.2.5.3.7 of the PAD.

[1] The spring-run Chinook Salmon Evolutionary Significant Unit (ESU) and its critical habitat are listed as threatened under the Endangered Species Act (ESA). In the Bear River, spring run Chinook salmon ESU critical habitat occurs from the confluence with the Feather River upstream for about 5 miles.

[2] The Central Valley steelhead Distinct Population Segment and its critical habitat are listed as threatened under the ESA. In the Bear River, Central Valley steelhead Distinct Population Segment critical habitat occurs from the confluence with the Feather River upstream to the non-Project diversion dam.

Reports issued in 1991 and 1993 by the California Department of Fish and Game,[3] (CDFG) (1991) and Reynolds et al. (1993) respectively, stated that fall flows, specifically October and November, in the lower Bear River appeared to influence the Chinook salmon run size. During years of high water in October and November, Cal Fish and Wildlife reported runs as high as 300 Chinook salmon in 1984 and as low as zero in 1985.

From 1982 through 1986, the Cal Fish and Wildlife conducted sporadic salmon surveys from the non-Project diversion dam to Highway 70, and reportedly found Chinook salmon redds, carcasses and live fish. In addition, in 2015, SSWD conducted habitat mapping surveys of the lower Bear River and found a total of 31,543 ft^2 of salmonid spawnable gravel.

Additional information, which will be provided by this Study, is needed to address the Study goal regarding Project effects on anadromous fish. Specifically, data gathered from this Study will provide information on life history timing, habitat availability/suitability, and an estimate of escapement in the lower Bear River and how these may be influenced by Project O&M.

4.0 Study Methods and Analysis

4.1 Study Area

For the purpose of this Study, the Study Area includes the section of the lower Bear River from the non-Project diversion dam to the Highway 70 Bridge (River Mile 3.5) (Figure 4.1-1). The habitat downstream of the Highway 70 Bridge is likely to be primarily utilized by anadromous fish as a migration corridor, and not for spawning.

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

[3] The California Department of Fish and Wildlife was previously the California Department of Fish and Game. In this PAD, the California Department of Fish and Wildlife if referred to as "*Cal Fish and Wildlife*" except in references that were published before the name change in 2012. In those cases, Cal Fish and Wildlife is referred to as the "*California Department of Fish and Game*" or "*CDFG*."

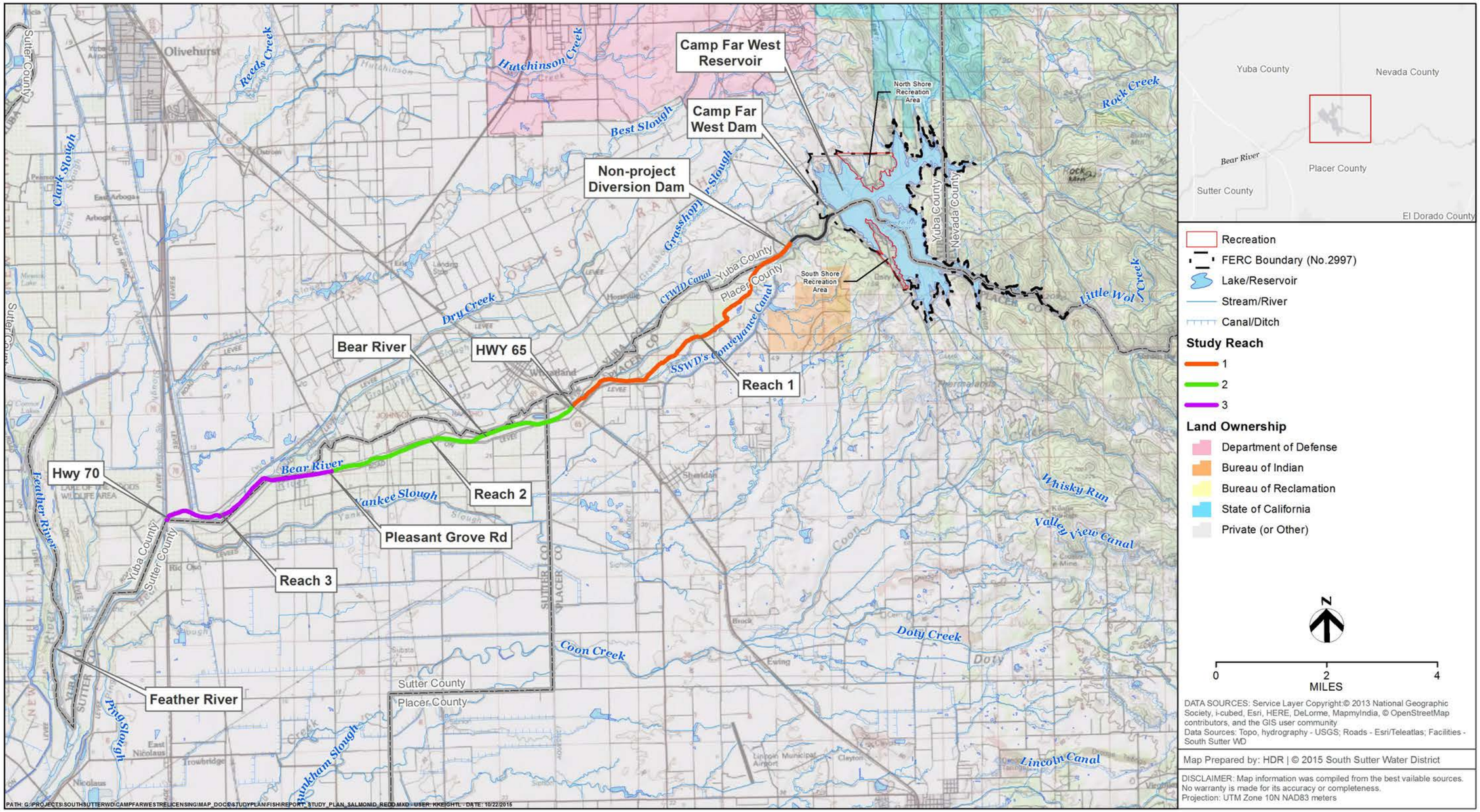

Figure 4.1-1. Study Area for the Salmonid Redd Study.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, United States Fish and Wildlife Service, Cal Fish and Wildlife or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be performed in four steps: 1) spawning gravel mapping; 2) gravel permeability 3) redd surveys; and 4) perform a quality assurance/quality control (QA/QC) review of the data and analyze the data. Each step is described below.

Redd surveys are predicated on SSWD obtaining the required federal and State of California permits for survey work.

4.3.1 Step 1 – Gravel Mapping

Potential spawning gravel sites in the entire Study Area will be mapped by a combination of inflatable kayak and on foot, as necessary. All gravel mapping will occur outside of the spawning season in order to avoid disturbing any redds. To define an appropriate level of effort or, spatial extent, surveys will be conducted within the bankfull[4] elevation, as determined in the

[4] SSWD determined during habitat mapping that the average low flow active channel width was 60 ft and the 1.5 yr. width was 112 ft. The return interval of 1.5 yr. is generally associated with bankfull discharge in unregulated systems. However, in a regulated system, the "low flow active channel" is important hydrologically because the releases from the diversion dam control flow timing and volume.

field. Potential spawning locations will be determined based on substrate size and composition. Additionally, where substrate is determined to be suitable, in wetted areas of the low flow active channel, water velocity and depth will be recorded and associated to river discharge on the day of survey. The following substrate criteria will be used to determine if a site is suitable for spawning:

- Suitable substrate size as determined by D_{50} (the particle size that 50% of the samples are equal or smaller to) of Wolman Pebble Count (Wolman 1954) ranging in diameter from 0.11 to 5.9 in. (Raleigh et al. 1986)

The Wolman Pebble Count technique will be carried out using the step-toe procedure. A transect will be selected at each potential site to record average depth and velocity at a minimum of 20 points per transect. Water velocity will be recorded using a Swoffer Current Velocity Meter. When a site is determined to meet the above criteria, its GPS coordinate will be recorded.

4.3.2 Step 2 – Gravel Permeability

In riffles within the intensive study sites selected for Instream Flow Study 03-03, gravel permeability will be measured. For particles between 0.1 to 6 inches stored in riffles, a standpipe or similar method will be used to determine fine sediment infiltration. This gravel permeability assessment will be done outside of spawning season. Methods will be as stated in Barnard and McBain (1994). A modified Terhune's permeability will be used standpipe so that permeability and dissolved oxygen can be taken without removing the standpipe. This allows us to measure and compare intragravel permeability and dissolved oxygen. A synthetic rubber plunger is placed into the pipe to evacuate water from the standpipe. Dissolved oxygen is measured using an electronic probe lowered into the evacuated standpipe, that has refilled with intragravel water.

4.3.3 Step 3 – Redd Surveys

4.3.3.1 Survey Timing and Reaches

Surveys will be conducted from October through March in order to capture the primary spawning period of both steelhead and Chinook salmon. The Study Area will be broken down into three sub-reaches as follows (Figure 4.1-1):

- Reach 1. Non-Project diversion dam to the Highway 65 Bridge
- Reach 2. Highway 65 Bridge to the Pleasant Grove Bridge
- Reach 3. Pleasant Grove Bridge to the Highway 70 Bridge

Redd surveys will occur once monthly beginning in October. If an anadromous salmonid, carcass or redd are observed during the once monthly survey, SSWD will conduct one biweekly survey until the end of March. When conditions allow (i.e. flows are safe for wading or boating) each sub-reach will be surveyed, once, on consecutive days during each survey. All surveys will be conducted when flows are safe and water clarity allows for observing redds. Any adult

salmon carcasses found during field surveys will be documented with photographs and GPS locations.

4.3.3.2 Survey Methods

Redd surveys will generally follow Gallagher et al. (2009). All redds will be identified for species use, photographed from the bank and geo-referenced. Whether redds were constructed by Chinook salmon or *O. mykiss* will be determined based on the following:

- Presence of spawning pair: Upon sighting of a redd, it will be visually assessed for an attending spawning pair and species identification. Chinook salmon generally defend their redds for 1 to 2 weeks after being built, while steelhead do not (Briggs 1953, Smith 1977). Monitoring frequency may not allow reliable species association to be determined by this observation.
- Redd construction timing. Fall-run Chinook salmon typically construct redds from October through December, while steelhead typically spawn from December through March, with peak spawning occurring in January and February (Myers et al. 1998, Moyle 2002).
- Redd size: Chinook salmon redds are larger than steelhead redds. Chinook salmon redd size in the Sacramento-San Joaquin drainages ranges from 22 to 486 ft^2 (U.S. Fish and Wildlife Service 1995). In the Sacramento River basin, average redd size for steelhead is 56 ft^2. Redd size will be based on visual estimations only.
- Gravel size. Chinook salmon construct redds in larger gravel sizes than steelhead. Sommer et al. (2001) documented that Feather River Chinook salmon preferred spawning gravel size ranges from 0.11 to 5.9 in. (Raleigh et al. 1986), while steelhead preferred gravel size for spawning ranges from 0.25 to 3.0 in. (U.S. Fish and Wildlife Service 1995). Gravel size will be based on visual estimations only.

If a determination of species cannot be made for a redd it will be reported as an unknown salmonid redd.

During redd count surveys, individual redds will be counted and uniquely labeled on data forms and in the field to avoid double counting and to allow estimation of observer efficiency (Gallagher et al. 2009). The date each redd was first observed, fish species, unique identifier number, and location will be recorded on the data form. Redds will be marked in the field by GPS and mapped on geo-referenced aerial photographs for reference during future surveys. Redds under construction will be noted as such and re-examined on consecutive surveys and classified appropriately based on their apparent completion.

For each redd, a set of visual estimations will be made to establish its overall size and characterize the hydrological conditions associated with it. The edges of the redd will be defined as the place where the gravel is no longer visibly worked or where it conforms to the surrounding substrate. Total area of the redd will be visually estimated and recorded. Meso and macro-habitat type will be recorded for each redd (i.e. riffle/edgewater, run/thalweg, etc.) Lastly, the

median grain-size of each redd will be estimated and any evidence of superimposition since the previous survey will be documented. Evidence of superimposition will be assessed by indication of whether the dimensions of any newly constructed redd overlaps the egg pocket area of the previously mapped redd at that location.

4.3.4 Step 4 – Perform QA/QC Review of Data

Following data collection, SSWD will subject all data to QA/QC procedures including, but not limited to: 1) checking field data sheets to be sure no corrections are needed; 2) spot-checking data; and 3) reviewing recorder readings and electronic data for completeness. The datasets will also be reviewed graphically to check for errors. If any datum seems inconsistent during the QA/QC procedure, SSWD will investigate the problem. Values that are determined to be anomalous will be removed from the database if the reason for the anomaly cannot be identified. A GIS technician will analyze redd polygon areas collected in the field and provide total redd area in square feet by reach.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This study has similar goals, objectives, and methods compared to most recent FERC hydroelectric relicensing efforts in California, such as the Don Pedro Relicensing (FERC Project No. 2299). In addition, the methods are similar to those used by the Lower Yuba River Accord River Management Team in Chinook salmon and steelhead redd surveys in the Yuba River downstream of Englebright Dam. When the methods are different SSWD has provided justification for the changes based on the Bear River and its anadromous fish populations.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... October 2016
Collect Redd Data ..... October 2016 – March 2017
Collect Gravel Data ..... July 2017 – September 2017
QA/QC Review ..... Ongoing throughout study

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $100,000 and $120,000.

8.0 References Cited

Barnard, K., and S. McBain. 1994. Standpipe to determine permeability, dissolved oxygen and vertical particle size distribution in salmonid spawning gravels. Fish Habitat Relationships Technical Bulletin Number 15, April 1994.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. California Fish and Game. Fish Bulletin (94): 62.

California Department of Fish and Game (CDFG). 1991. Draft Report: Lower Bear River Instream Flow and Temperature Recommendations. August 1991.

Gallagher, S.P., P.K.J. Hahn, and D.H. Johnson. 2009. Redd counts. American Fisheries Society Protocols 1953: 197-234.

Moyle, P.B. 2002. Inland Fish of California, 2nd Edition. University of California Press, Berkeley, California.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon From Washington, Idaho, Oregon, and California. Report # NMFS-NWFSC-35. NOAA Tech. Memo. U.S. Dept. Commer.

Raleigh, R.F., W.J. Miller, and P.C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Chinook Salmon. Report# Rep. 82(10.122). U.S Fish Wildl. Serv. Biol.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low 1993. Restoring Central Valley streams; a plan for action. Sacramento, CA: California Department of Fish and Game. 129p.

Smith, J.J. 1977. Distribution, movements, and ecology of the fishes of the Pajaro River system, California. Ph.D. dissertation, University of California, Davis. 230pp.

Sommer, T., D. McEwan, and G.H. Burgess. 2001. Factors Affecting Chinook Salmon Spawning in the Lower Feather River in Contributions to the biology of Central Valley salmonids. R.L. Brown. (ed.), CDFG, 269-297.

United States Fish and Wildlife Service (USFWS). 1995. Working Paper on Restoration Needs: Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California. Vol 2. Stockton, CA: Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group.

Wolman, M.G. 1954. A method of sampling coarse riverbed material. Transactions of the American Geophysical Union. 35(6): 951-956.

Study 3.2

STREAM FISH POPULATIONS STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an effect on riverine fish distribution, abundance and composition in the Bear River downstream of Camp Far West Dam.

2.0 Study Goals and Objectives

The goal of the study is to supplement existing information regarding fishes in the Bear River downstream of Camp Far West Dam.

The objective of the study is to gather qualitative information to meet the Study goal.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding fish populations in the Bear River downstream of Camp Far West Reservoir is provided in Section 3.2.5.3 of SSWD's Pre-Application Document (PAD). As a summary, no information on fish resources in the Bear River between Camp Far West Dam and the non-Project SSWD diversion dam was found, and there have been very limited fish surveys completed in the Bear River from the non-Project diversion dam to the Feather River (i.e., lower Bear River). Historically, the Sacramento-San Joaquin river drainage, which includes most of the watersheds on the west side of the Sierra Nevada, contained native fish fauna with 22 taxa, including five anadromous fish – Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), Pacific lamprey (*Lampetra tridentata*), green sturgeon (*Acipenser medirostris*) and white sturgeon (*Acipenser transmontanus*) (Moyle 1976; Lindstrom 1993; Moyle et al. 1997). Native foothill fish also included resident fishes including rainbow trout (*O. mykiss*), Sacramento hitch (*Lavinia exilicauda*), Sacramento roach (*L. symmetricus*), hardhead minnow (*Mylopharodon conocephalus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento speckled dace (*Rhinichthys osculus*), Western sucker (*Catostomus o. occidentalis*), Sacramento perch (*Archoplites interruptus*), and sculpin (*Cottus asper* and *Cottus golosus*) (Moyle et al. 1997). The lower Bear River also has previously documented populations of non-native warmwater species such as black bass (*Micropterus* spp.), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*) and catfish (*Ictalurus* spp. and *Ameiurus* spp.) (SSWD 1980). In addition, as reported in Section 3.2.3 of the PAD, SSWD qualitatively sampled the fish community in the lower Bear River by snorkel on June 10, 2015 at two locations: near the Highway 65 Bridge and below the diversion dam. A total of five species were observed,

including smallmouth and largemouth bass, mosquito fish, Sacramento sucker, and one unidentified sunfish. Young of the year were only observed for black bass.

Additional information, which will be provided by this Study, is needed to address the Study goal regarding Project effects on riverine fishes in the Bear River.

4.0 Study Methods and Analysis

4.1 Study Area

For the purpose of this Study, the Study Area includes: 1) the Bear River from Camp Far West Dam to the non-Project diversion dam; and 2) the Bear River from the non-Project diversion dam to the confluence with the Feather River. The Study Area is shown in Figure 4.1-1.

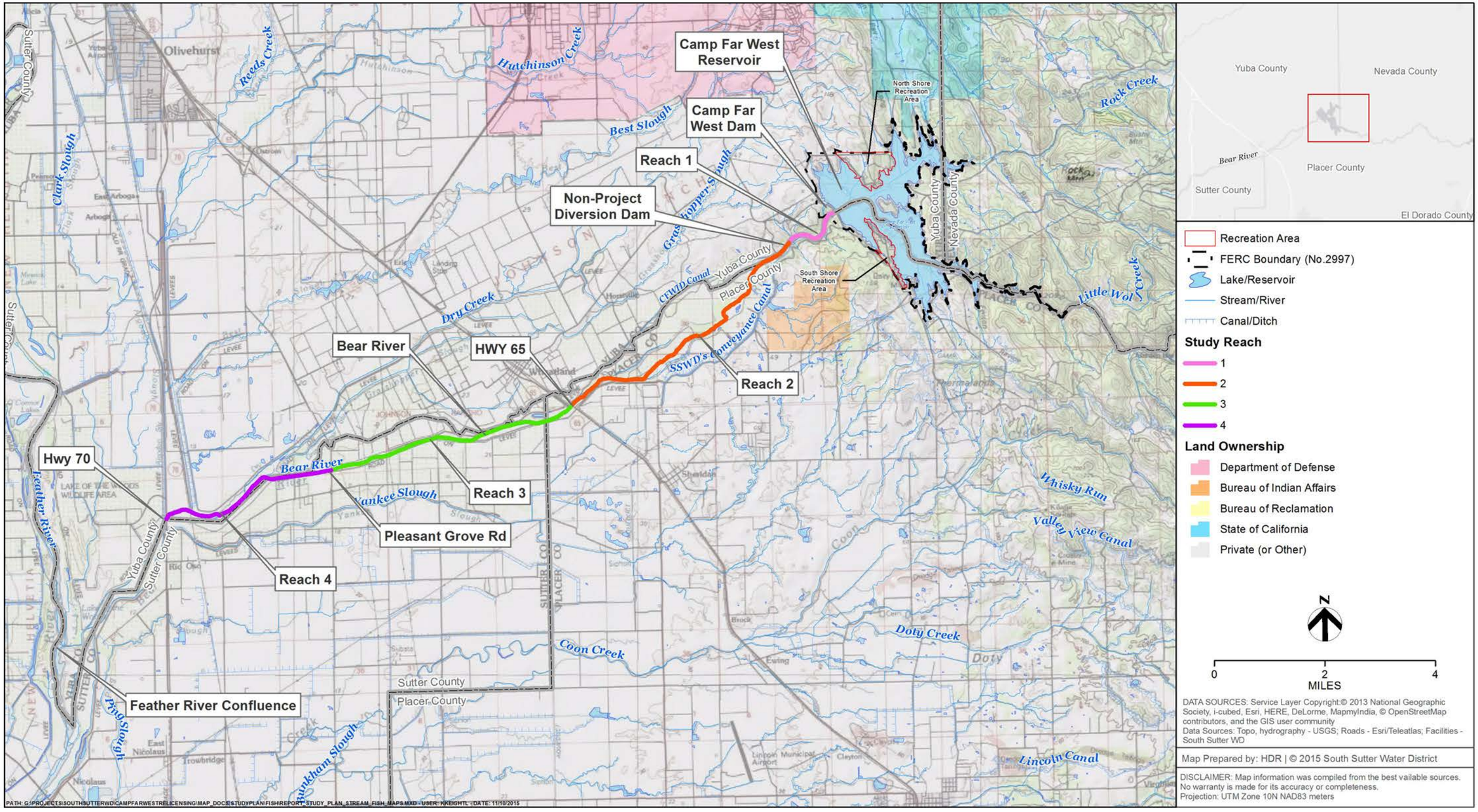

Figure 4.1-1. The Study Area for the Stream Fish Populations Study. The figure shows one survey reach between Camp Far West Dam and the non-Project diversion dam and three survey reaches between the non-Project diversion dam and the confluence with the Feather River.

Page Left Blank

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to National Oceanic and Atmospheric Association, National Marine Fisheries Service; United States Fish and Wildlife Service; Cal Fish and Wildlife; or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western

pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.

- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an Endangered Species Act- (ESA-) listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in Microsoft® Excel (*.xls) or HEC-DSS (*.dss) format. A viewer for *.dss files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of October 2015: http://www.hec.usace.army.mil/software/hec-dssvue/.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The study will be performed in three steps: 1) select sampling sites; 2) collect data; and 3) perform a quality assurance/quality control (QA/QC) review of the data and analyze the data.

Fish sampling is predicated on SSWD obtaining the required federal and State of California permits for sampling. Electrofishing will only occur in the reach from Camp Far West Dam to the non-Project diversion dam where ESA fishes are not expected to be present.

4.3.1 Step 1 – Select Sampling Sites

4.3.1.1 Camp Far West Dam Reach (Reach 1)

Qualitative electrofishing surveys will be conducted at three sites in Reach 1 (i.e., the section of river from Camp Far West Dam to the non-Project diversion dam). One site will be located in the riffle habitat immediately downstream of Camp Far West Dam; a second site will be located

midway between Camp Far West Dam and the non-Project diversion dam; and the third site will be located in the pool immediately upstream of the diversion dam (Figure 4.1-1). SSWD owns most of the land along Reach 1 and can access the upper sampling site on foot near the powerhouse and the two lower sampling sites via a boat launched near the non-Project diversion dam. Each site will be at least 25 meters in length, but the final site dimensions will be determined in the field by SSWD. All three sites will be fished once in the fall. Fall sampling allows young of the year fish to grow larger for more accurate identification

4.3.1.2 Lower Bear River (Reaches 2, 3 and 4)

Snorkel surveys will occur at three sites in the lower Bear River. One site will be located within 1 mile (mi) of the non-Project diversion dam, another site within 0.5-mi of the Highway 65 Bridge; and a third site within 0.5-mi of the Highway 70 Bridge (Figure 4.1-1). Access along each of these reaches is difficult given that it is almost entirely private property. SSWD will access sampling sites via its own land (Reach 2) or at public access points (Reaches 3 and 4). Each site will be assessed once monthly from April through June (three samples) and a fourth time in the fall to capture variations based on seasonal distribution. Fall sampling also allows young-of-the-year fish to grow larger for more accurate identification during snorkeling. Fall sampling may also have the opportunity to identify Chinook salmon, if they are present.

Where possible and appropriate, sites will: 1) include habitat representative of the overall geomorphic reach; 2) be selected using mesohabitat mapping information available when the sites are selected; 3) be chosen far enough upstream or downstream of access locations to minimize the effects of fishing on fish population results, but still be reasonably accessible to field crews; 4) be comparable between reaches where comparisons likely are to be made between sampling locations, when appropriate. In these instances, comparison Study sites will be located in sections of river with similar habitat types; and 5) be at least 25 meters in length. SSWD's goal in determining site length is to have adequate length to include sufficient usable fluvial habitat represented in that reach (e.g., riffle, pool and glide). Exact site length will be determined in the field by SSWD.

4.3.1.3 Environmental DNA

Environmental DNA (eDNA) sampling will be conducted at 500 meter intervals from the non-Project diversion dam to the confluence with the Feather River or the obvious start of back water effects. This will result in a maximum total of 55 samples per event over the 17 miles (27.4 Km) included in the study area.

4.3.2 Step 2 – Data Collection

Electrofishing (boat and backpack) is the preferred method of sampling because it allows for near-perfect identification of all captured fish as well as accurate length and weight estimates. SSWD will follow all best practices outlined by Reynolds and Kolz (2012) for the safe capture and handling of fish as well as safety of the sampling team. In instances where electrofishing will not be effective due to water conditions or the potential presence of ESA-listed fish, snorkeling will be used as the primary sampling method.

4.3.2.1 Camp Far West Dam Reach (Reach 1)

Boat-based electrofishing will be conducted at night (i.e., beginning 1 hour after sunset) in the pool habitat immediately upstream of the non-Project diversion dam, and at the selected site midway between the diversion dam and Camp Far West Dam. Sampling at night is preferred because predatory fish are more often inshore feeding during this time and all fish seem more apt to capture, perhaps due to the cover of darkness (Reynolds 1996). Boat electrofishing will take place using standard methods (Reynolds and Kolz 2012). One or two electrode booms will be employed, and the booms and boat will be outfitted with standard non-conductive material in appropriate places for safety. Electrofisher "time on" will be recorded for each sampling site and a consistent effort and pace will be employed at all sites. Fish will be identified, where possible, as to origin; hatchery or wild stock (i.e., basic visual identification, such as a clipped adipose fin). Data recorded for each fish will include species identification, length (total length of all fish species without forked caudle fins and fork length for all species with forked caudle fins), weight, and, if applicable, notes on general condition.

Backpack electrofishing will be utilized in the shallow water habitat downstream of Camp Far West Dam following the standard methods outlines by Reynolds and Kolz (2012). Backpack electrofishing will occur during daytime hours due to safety considerations while wading. Daylight also provides better light conditions for netters, especially in sites with flowing water (i.e. stream). Block nets will span the full width and depth of the sampling site. Three passes will be made with the backpack electrofishing units in the shallow water habitat. Based on the width of the channel, it is estimated that two or three backpack units will be needed to effectively sample. Field crews will consist of at least two netters for each electrofisher. If necessary, salt blocks will be placed in the stream immediately above the electrofishing station to increase conductivity. Salt blocks will be used when fish are observed escaping the direct path of the electric field generated by the electrofishing unit at elevated settings.

Fish captured by both the backpack electrofisher and boat electrofisher will be retained in aerated buckets and/or live cars until each pass is completed. Fish will be sedated as necessary and with appropriate approvals from Cal Fish and Wildlife. All fish will be identified to species and counted. Effort will be made to measure all fish. Measurements will be to the nearest millimeter (fork length for forked-tail fish and total length for all other fish) and weighed by digital scale to the nearest gram. However, measuring will cease if long holding times begin to result in mortality of captured fish. All fish removed from the site will be held in live cars or aerated buckets outside of the sampling site during subsequent passes. Captured fish will be redistributed evenly across the sampling site following completion of the final pass for the survey. Mortalities and fish condition (e.g., spinal trauma and burning) will be noted and recorded prior to release. All effort will be made to ensure sampling activities in the field will minimize potential injury or mortality to aquatic species. All data will be recorded on a standardized electrofishing form.

General information and habitat/channel metrics will be collected at each sample site. General information will include site identification, turbidity (as measured with a secchi disk), discharge (as measured at the nearest gage), crew members, number of electrofishers, date and time, air temperature, weather conditions, and GPS location. Additionally, water temperature,

conductivity, and dissolved oxygen will be collected with a Yellow Springs Instrument (YSI), or equivalent, water quality instrument. Habitat metrics collected at each meso-habitat unit within the sample site will include meso-habitat type, estimated average and maximum depth, estimated average wetted and bankfull width, dominant cover type, dominant and subdominant substrate.

Prior to electrofishing at a selected site, SSWD will walk or boat the stream-bank to directly observe the presence of any northern western pond turtles (WPT) or foothill yellow-legged frog (FYLF). If a WPT or FYLF is observed, SSWD will relocate the site upstream or downstream to a location that includes similar habitat types as the selected site, and repeat the procedure (i.e., check for WPT or FYLF and relocate site if either is observed). If WPT or FYLF is not observed, SSWD will commence electrofishing. SSWD will adhere to accepted decontamination guidelines to minimize the likelihood of transmitting diseases and the spread of aquatic invasive species.

4.3.2.2 Lower Bear River (Reaches 2, 3 and 4)

Snorkel surveys will be conducted at the three selected sites during both spring and fall. Snorkeling techniques will generally follow those outlined by Thurow (1994), Dolloff et al. (1996), and O'Neal (2007). Surveys will be conducted during midday and during periods with low annual turbidity levels.

Snorkel lanes will run the full length of the survey site. Block nets will be placed at the upstream and downstream end of the site to create a closed population. One diver will swim a lane. Generally, two to three divers (as determined by the wetted stream channel width at each site) will snorkel the lanes and record species composition and abundance. Fish will be identified, counted, and visually categorized into pre-defined length-classes (i.e., 0-2 in., >2-4 in., >4-6 in., >6-8 in., >8-10 in., >10-12 in., >12-14 in., etc.). Observers will calibrate estimated fish lengths by viewing painted wooden dowels of varying known lengths underwater. Visual estimates of length will be made in English units and later converted to metric units to avoid error. Maximum sight distance for accurate determination of fish species will be recorded on the field data form. Three replicate snorkel surveys will be performed using the same diving team to assess efficiency, obtain an estimate of survey variance, and determine a level of confidence for use in abundance estimation (Slaney and Martin 1987; Hankin and Reeves 1988). Data will be recorded on a standardized fish snorkeling survey form. The site information and habitat metrics described in Section 4.3.2.1 will also be collected at each snorkeling site. Snorkeling data will be analyzed separately from the electrofishing data.

Three consecutive seine hauls will be conducted at each site using a 10 meter x 2 meter knotless mesh nylon pole seine. Net construction will consists of 6mm mesh wing sections 4m in length and a 3mm mesh 2m x2m bag section. The seine will be set by 2-3 crew members in a round haul fashion by fixing one end on the beach while the other end is deployed wading upstream and returning to shore in a half circle. Once the lead line approaches the shore it will be withdrawn more than the cork line until fish are corralled in the bag and the lead line is on the beach. Each haul is expected to take approximately 5 minutes. Fish from each haul will be kept separate and placed in aerated 5-gallon buckets prior to processing. No seining will occur if water temperatures exceed 21°C. 20 fish from each species will be measured to the nearest

millimeter and weighed to the nearest gram, additional fish will be counted and released without anesthetic.

4.3.2.3 Environmental DNA

Environmental DNA (eDNA) will be sampled once in the fall/winter after the first freshet and once in the spring before low flow conditions. Sampling will be consistent with the protocol described in Bergman et al. (2016). For each sample, 2 liters of water will be filtered using sterile tubing and a portable peristaltic pump. No water will be transported or stored for sampling. Water samples will be filtered through a 0.45 or 0.8 micrometer sterile filter, and stored on ice for transport back to the lab. Samples will be labeled with sampling location, and volume of water filtered.

To prevent against cross contamination of samples, all tubing will be used once and discarded in a sealed trash container, which will be carried separate from all other sampling materials. In addition, each sample filter will be returned to its original packaging and sealed in a sterile secondary container prior to storage in the transport container. All filters will be kept in the secondary storage container and placed in a -20^{o}C laboratory freezer until DNA extraction is performed. Any filters that are opened but not used will be considered contaminated and discarded. Field (negative) controls and duplicates will be taken at the end of each field day.

eDNA samples will be tested for the presence of DNA from Chinook salmon, steelhead, green sturgeon, and white sturgeon.

4.3.4 Step 3 – Perform QA/QC Review of Data and Data Analysis

Following data collection, SSWD will subject all data to a QA/QC procedures including, but not limited to: 1) checking field data sheets to be sure no corrections are needed; 2) spot-checking data; and 3) reviewing recorder readings and electronic data for completeness. The datasets will also be reviewed graphically to check for errors. If any datum seems inconsistent during the QA/QC procedure, SSWD will investigate the problem. Values that are determined to be anomalous will be removed from the database if the reason for the anomaly cannot be identified.

Following a QA/QC review, data will be entered into and organized in a Microsoft® Excel spreadsheet. Some parameters may be analyzed in Microsoft® Excel while other parameters will be analyzed using published public domain scientific software for calculating stream fish population statistics. While all species will be recorded, small sample sizes of some species may limit some statistical analyses.

SSWD will complete an analysis of the seasonal population structure and fish size (based on snorkel results) in and amongst sites in the reach downstream of the non-Project diversion dam. Analysis based on electrofishing data will include the calculation of relative fish condition factor, length/weight distribution, and population structure for the Camp Far West Dam Reach sampling. Data collected during the night boat electrofishing and daytime backpack

electrofishing will be comparable based on the total "time on" of the electrofishing units and the general species composition and abundance at each site.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including the Yuba River Development Project (FERC No. 2246), Yuba-Bear Hydroelectric Project (FERC Project No. 2266), and Drum-Spaulding Project (FERC Project No. 2310). The Study utilizes standard methods with one exception, eDNA. eDNA is a relatively new sampling method but has been employed in Northern California by the Department of Water Resources and others.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... February 2017
Collect Data ..... April 2017 – October 2017
QA/QC Review ..... Ongoing throughout Study

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $120,000 and $140,000.

8.0 References Cited

Bergman PS, Schumer G, Blankenship S, Campbell E. 2016. Detection of Adult Green Sturgeon Using Environmental DNA Analysis. PLoS ONE 11(4): e0153500. doi:10.1371/journal.pone.0153500.

Dolloff, A., J. Kershner, and R. Thurow. 1996. Underwater Observation. Pages 533-554 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Hankin, D.G. and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Aquatic Science. 45: 834-844.

Lindstrom, S.G. 1993. Great Basin Fisherfolk: Optimal diet breadth modeling the Truckee River aboriginal subsistence fishery. Ph.D.diss., University of California, Davis.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press.

Moyle, P.B., P.J. Randall, R. Nichols, R.M. Yoshiyama, and R.A. Knapp. 1997. Status of Fish and Fisheries. Status of the Sierra Nevada – The Sierra Nevada Ecosystem Project, Volume II Chapter 33: 953 – 973. Don C. Erman, General Editor, and the SNEP Team. US Geological Survey Digital Data Series DDS-43.

O'Neal, J.S. 2007. Snorkel Surveys. Pages 325-340 in Salmonid Field Protocols Handbook – Techniques for Assessing Status and Trends in Salmon and Trout Populations. American Fisheries Society, Bethesda, Maryland and State of the Salmon, Portland, Oregon.

Reynolds, J.B. and A.L. Kolz. 2012. Electrofishing. Pages 305 - 361 in A.V. Zale, D.L. Parrish and T.M. Sutton. Fisheries Techniques, 3rd edition. American Fisheries Society, Bethesda, Maryland.

Reynolds, J.B. 1996. Electrofishing. Pages 221-253 in B. R. Murphy and D. W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Slaney, P.A., and A.D. Martin. 1987. Accuracy of underwater census of trout populations in a large stream in British Columbia. North American Journal of Fisheries Management 7:117-122.

South Sutter Water District (SSWD). 1980. Camp Far West Dam and Reservoir Water Power Project No. 2997, Application for license before the Federal Energy Regulatory Commission.

Thurow, R.F. 1994. Underwater methods for study of salmonids in the Intermountain West. U.S. Forest Service, Intermountain research Station, general Technical Report INT-GTR-307, Ogden, Utah.

Study 3.3

INSTREAM FLOW STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the existing Camp Far West Hydroelectric Project (Project) has a potential to affect fish habitat in the Bear River downstream of Camp Far West Dam.

2.0 Study Goals and Objectives

The goal of this Instream Flow Study (Study) is to supplement existing information regarding habitat for fishes in the Bear River downstream of Camp Far West Dam.

The objective of the Study is to collect data adequate to meet the Study goal.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

3.1 Species Records and Historical Instream Flow Study

Existing, relevant and reasonably available information regarding fishes in the Bear River downstream of Camp Far West Dam is provided in Section 3.2.3 of SSWD's Pre-Application Document (PAD). Information regarding Endangered Species Act (ESA)-listed fishes in the Bear River from the non-Project diversion dam to the Feather River (i.e., lower Bear River) is provided in Section 3.2.3 of the PAD.

As a summary, sporadic and limited fish surveys have occurred in the Bear River downstream of Camp Far West Dam. Based on this limited information, two anadromous fishes listed as threatened under the ESA (Central Valley spring-run Chinook salmon [*Oncorhynchus tshawytscha*] Evolutionarily Significant Unit [ESU] and California Central Valley steelhead [*O. mykiss*] Designated Population Segment [DPS]) have been reported to occur. Critical habitat for spring-run Chinook salmon ESU extends in the Bear River from the Feather River to approximately River Mile (RM) 5 (i.e., 5 miles upstream on the confluence), while critical habitat for CV steelhead DPS extends from the Feather River to the non-Project diversion dam at RM 16.9. In addition, four special-status fishes are reported to occur. These are CV fall- and late-fall-run Chinook salmon ESU, which is considered sensitive by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) (NMFS-S) and a species of concern (CSC) by the California Department of Fish and Wildlife (Cal Fish and Wildlife); and hardhead minnow (*Mylopharodon conocephalus*), Sacramento splittail

(*Pogonichthys macrolepidotus*) and Sacramento-San Joaquin roach (*Lavinia s. symmetricus*), each of which is considered a CSC by Cal Fish and Wildlife. Other fishes reported to occur include black crappie (*Pomoxis nigromaculatus*), Pacific lamprey (*Lampetra tridentate*), riffle sculpin (*Cottus gulosus*), speckled dace (*Rhinichtys osculus* ssp.), Sacramento squawfish (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus o. occidentalis*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), Western mosquitofish (*Gambusia affinis*), and resident trout (*O. mykiss*).

Additionally, existing information indicates that flows in October and November influence the Chinook salmon run size, with reports as high as 300 in 1984 and as low as zero in 1985.

Existing information also shows that, in some years, salmonids build redds in the lower Bear River, with most of the reported redds occurring from RM 5 to RM 16.

SSWD found that an instream flow study was conducted in the lower Bear River in the mid-1980s. The study was first reported by SSWD in 1988, and later summarized in a report by Cal Fish and Wildlife in 1991 (CDFG 1991).[1]

SSWD found little information regarding aquatic habitat in the lower Bear River. Section 3.2.1 of the PAD describes a habitat mapping study conducted by SSWD in 2015 and reported that the lower Bear River is generally less than 0.5 percent in gradient, with no falls, cascades, chutes, rapids, step runs, pocket water, or sheet flow habitat types, which are generally associated with steeper gradients and coarser substrate. The substrate of the mapped units is dominated by gravel with mostly cobble sub-dominant. Sand is a minor component though is often subdominant. Increasing amounts of exposed bedrock and cobble substrates occur in the upstream direction to just downstream of the diversion dam. Very little silt occurs in the active channel, though the banks are often composed of this finer material.

SSWD found little instream cover, and most what was observed was due to the introduced giant cane (*Arundo donax*) concentrations that line and often extend across the channel. The giant cane is pervious to flow, however, and serves to scour pools and develop some spawning gravel concentrations of spawning gravel (i.e., 2 millimeters [mm] to 64 mm), but occasionally up to 128 mm nearer the diversion dam. The report suggested that the giant cane provides cover and habitat heterogeneity.

Existing, relevant and reasonably available information regarding flows and water temperature in the Bear River downstream of Camp Far West Dam is provided in Sections 3.2.2.5 and 3.2.2.9 of the PAD, respectively.

In general, minimum flows (mean monthly) releases typically ranged between 10 and 15 cubic feet per second (cfs) from July to March and between 25 and 30 cfs in April, May and June from Water Year (WY) 1990 through WY 2014. The primary full-flow rated gage used for flow

[1] The California Department of Fish and Wildlife was previously the California Department of Fish and Game. In this PAD, the California Department of Fish and Wildlife if referred to as "*Cal Fish and Wildlife*" except in references that were published before the name change in 2012. In those cases, Cal Fish and Wildlife is referred to as the "*California Department of Fish and Game*" or "*CDFG*."

characterization in the lower Bear River is the Wheatland gage (USGS 11424000), which is located approximately 6.5 miles downstream of Camp Far West Dam and reflects releases from Camp Far West Reservoir through the powerhouse, low-level outlet and spills over Camp Far West Dam less diversions at SSWD's Conveyance Canal and CFWID's Canal. The Wheatland gage has been in active operation since October 1928. Figure 3.1-1 shows average monthly streamflow for the Bear River near Wheatland gage for WYs 1967 through 2014. Maximum monthly flows in the Bear River are significantly higher than monthly averages because they typically represent significant precipitation events.

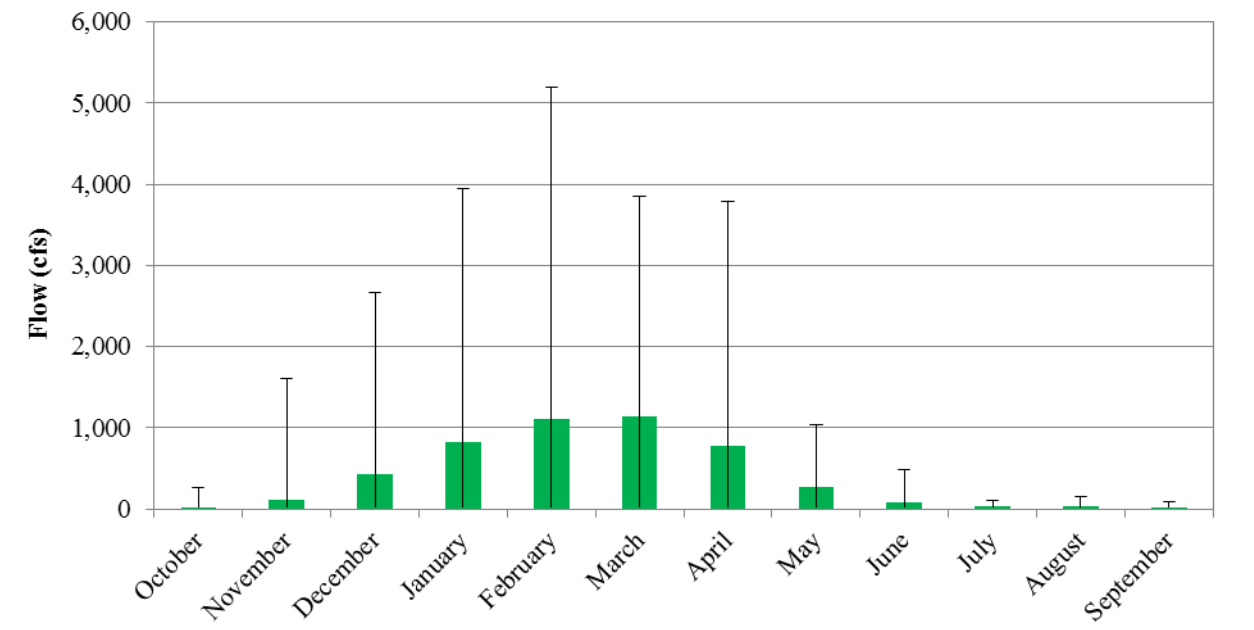

Figure 3.1-1. Mean monthly streamflow for the Bear River near Wheatland gage (USGS Gage 11424000) from WY 1967 through WY 2014.

Monthly temperature data collected by the California Department of Water Resources (DWR) from 1964 to 1987 near Wheatland reported temperatures ranging from as low as 6 degrees Celsius (°C) in winter months to as high as 30°C in the summer months. Data collected by SSWD from April 2015 to September 2015 reported mean daily water temperatures ranged from as low as 10°C just below the non-Project diversion dam in April to 30°C in early July in the vicinity of the Pleasant Grove Bridge near RM 7.4. Water temperatures in the Bear River warmed while moving downstream. At the four locations between Highway 65 (RM 11.4) and the Feather River confluence (RM 0.1), instantaneous water temperatures exceeded 20°C for most of the monitoring period.

Additional information, which will be provided by this Study, is needed to address the Study goal. Specifically, this Study will develop flow-habitat relationships for target fishes in the lower Bear River using a 2-dimensional flow model.

Analyses performed as part of this Study will use results developed during the performance of SSWD's relicensing Studies 2.1, *Water Temperature Monitoring*, 2.2, *Water Temperature Modeling*, and 3.1, *Salmonid Redds*. In addition, the Study will use data from SSWD's Water Balance/Operations Model (Appendix G in the PAD).

4.0 Study Methods and Analysis

4.1 Study Area

For the purpose of this Study, the Study Area includes the Bear River from the non-Project diversion dam to the confluence with the Feather River.[2] Figure 4.1-1 shows a map of the Study Area.

[2] The 1.3 mile-long section of the Bear River from the Camp Far West Dam and the non-Project diversion dam is not included in the Study Area because it is primarily a backwater behind the diversion dam and does not have a significant floodplain. Further, andromous fishes, one of the target species, cannot access this section of river since the diversion dam is physical barrier to upstream migration, and there is no ESA-listed critical habitat in this section of river.

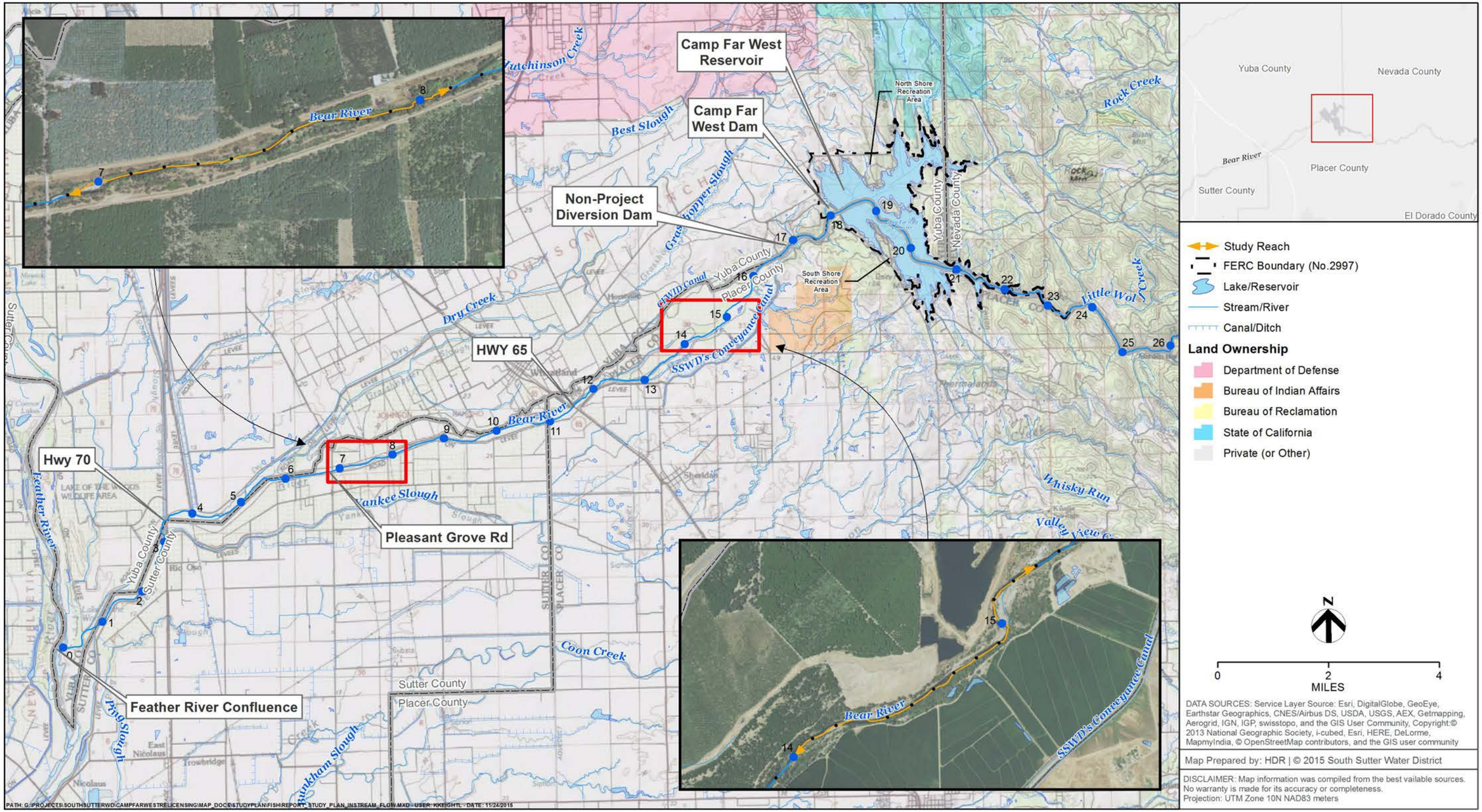

Figure 4.1-1. Study Area of Instream Flow Study.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, United States Fish and Wildlife Service, Cal Fish and Wildlife or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in Microsoft® Excel (*.xls) or HEC-DSS (*.dss) format. A viewer for *.dss files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of October 2015: http://www.hec.usace.army.mil/software/hec-dssvue/.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be performed in eight steps: 1) site selection; 2) field data collection; 3) hydraulic modeling; 4) Habitat Suitability Criteria (HSC) selection; 5) aquatic habitat modeling; 6) riparian analysis; and 7) time series modeling. Each of these steps is described below.

4.3.1 Step 1 – Site Selection

The establishment of two Study sites will be based on four sources of information: 1) existing salmon survey records from the lower Bear River in the mid 1980s (CDFW unpublished data); 2) existing habitat mapping results in SSWD's PAD; 3) existing Light Detection and Ranging (LiDAR) data collected either in 2008 or 2010 for the DWR Central Valley Floodplain Evaluation and Delineation Program and data collected in 2012 by Placer County in the lower Bear River, available through United States Geological Survey (USGS) as a National Elevation Dataset Digital Model (NOAA 2015);[3] and 4) topographic data and channel form analyses (Section 4.3.1.1, below). To ensure adequate representation of the variety of habitat types and

[3] If SSWD determines the existing LiDAR data are inadequate for the Study, SSWD will acquire airborne LiDAR data of the two Study sites. Ideally, data will be acquired during the winter, when leaves have fallen and river flow is less than 25 cfs.

channel forms present in the Study Area, each site will be long enough to sufficiently capture a diversity of channel forms and habitat types.

From preliminary information review, one site will be located between RM 15.3 and RM 14.0, and a second site will be located in the vicinity of Pleasant Grove Road, between RM 8.1 and RM 6.9.

Four level loggers will be installed in order to measure stage change in the Bear River downstream of the non-Project diversion dam. The locations will be: 1) at the upstream instream flow modeling site (between RM 15.3 and RM 14.0); 2) near the Highway 65 bridge (RM 11); 3) near the Pleasant Grove bridge (RM 7) and 4) near the Highway 70 bridge (RM 3.5).

Prior to starting field work, SSWD will invite interested and available Relicensing Participants to a one-day site review meeting. The purpose of the meeting will be to: 1) provide supporting information used to determine the final study site locations, and 2) describe the location of four stage recording pressure transducers to be installed. After reviewing the information in the morning, a short afternoon field trip will be conducted to view the instream flow study site locations.

4.3.1.1 Channel Form

To inform the process of representative site selection, a GIS-based LiDAR analysis will be used to delineate Study Area "Valley" into channel types. The "valley" will be defined as the area between the toes of the United States Army Corps of Engineers' (USACE) levees or other slope that restricts the channel from any lateral movement, which also defines the "confinement" of the channel. Confinement will be based on the width of the low flow active channel (LFAC) relative to the valley. The low flow active channel is hydrologically important in this regulated system because it reflects the dominant discharge during periods when the flow is controlled, usually between 10 cfs and 25 cfs. Based on habitat mapping and field reconnaissance, it was evident that this was where the vegetation transitions from hydric to more terrestrial types. The channel types that will be defined include, but are not limited to:

- Confined: Less than two LFAC that will fit within the valley walls.
- Moderately Unconfined: Two to four LFAC will fit within the valley walls and well developed gravel bars exist on one or both sides. Side channels and mid-channel bars are common.
- Unconfined: More than four LFAC will fit within the valley walls and floodplain is composed of a variety of vegetation types and depositional forms; floodplain is generally connected hydrologically to the main stem.

There may be other channel types within the Study Area that do not fit into these simplified categories; additional types may be added by SSWD, as needed. In addition, SSWD may modify definitions to better fit the types and range of types observed upon data review and field surveys.

To support the channel form analysis, historical aerial photographs (if existing and readily available, and of good quality) of the Study Area will be gathered from pre- and post-dam construction.

Lastly, to confirm the GIS-based LiDAR channel form classification, field validation will be conducted. In addition to the two Study sites described above, five random sites, each with a length of 20 channel widths, within each channel form identified during LiDAR analysis will be selected to quantify channel confinement, erosion extent and type along both banks, and type of bank material.

4.3.2 Step 2 – Field Data Collection

4.3.2.1 Channel Topography

For the purpose of hydraulic model surface development, additional topographic data will be collected using a variety of methods. Initially, LiDAR coverage will be evaluated and used to describe the majority of each Study site not submerged at the time the LiDAR was collected. Additional topography data collection will be completed utilizing a Real Time Kinematic (RTK) GPS topographic survey conducted on foot. In the event GPS reception is of poor quality, a Robotic Total Station (RTS), surveyed into the RTK survey network, will be used.

4.3.2.2 Substrate and Cover Type Mapping

Field crews will delineate substrate polygons covering each Study site using an iPad loaded with high resolution aerial photos and GIS layer data. Substrate polygons will be delineated based on classification strategies which correspond to substrate size for target species habitat use data (i.e., HSC) presented in Section 4.3.4. Substrate will be defined as being within the floodprone channel (the width of the channel at twice bankfull height). However, stable sediment adjacent to the more active channel should be characterized as well. Substrate and sediment will be mapped and classified into one of four storage element stability classes (after Curtis et al. 2005 and Kelsey et al. 1987) as set out in Table 4.3-1. The volume of the sediment stored in each class will be estimated by using the polygon area, and the depth will be estimated from the height above the thalweg or next lower surface. The stability of each storage elements can be assessed based on the size of the material, the location relative to the thalweg, and the age and type of vegetation.

Table 4.3-1 Storage element stability classes.

Stability Class	Description
Active	Moves at least once every few years.
Semi-Active	Susceptible to revegetation and moved every 5-20 years.
Inactive	Moves only during extreme events every 20-100 years and becomes well-vegetated in the interim.
Stable	Deposit are not accumulating under present climate or channel regime but may be susceptible to cutbank erosion.

Cover type mapping will be conducted at each Study site in detail by a combination of methods and will correspond to cover types (i.e., none, cobble, boulder/rip-rap, riparian vegetation, streamwood) for target species habitat use data (i.e., HSC) presented in Section 4.3.4.

Field mapping of riparian vegetation polygons will be performed by a crew of two botanists and the use of an iPad and a Trimble® Geo-6 (or similar) resource-grade GPS unit. Representative features will be mapped by hand directly with the devices onto pre-installed, rectified, high resolution color aerial photographs (i.e., local balloon imagery). Hard-copies of the aerial photos will also be used to map boundaries of reference polygons and make notes on their characteristics.

The GPS reference data will be exported into GIS, compiled into organized data sets and used to guide the digitizing of complete plant community/vegetation boundaries for each of the two Study areas with ArcMap 10. All resulting GIS data will be projected in NAD 83 State Plane California Zone III, Feet.

Observations of large woody material (LWM) will be documented within the bounds of the two Study sites. LWM will be counted as follows: all LWM greater than 3 feet (ft) in length within the active channel within four diameter classes (i.e., 4-12 inches [in.], 12-24 in., 24-36 in., and greater than 36 in.) and four length classes (i.e., 3-25 ft, 25-50 ft, 50-75 ft, and greater than 75 ft). More detailed measurements will be taken for key pieces located within Study sites. Key pieces of LWM are defined as pieces either longer than 0.5 times the bankfull width, or of sufficient size and/or are deposited in a manner that alters channel morphology and aquatic habitat (e.g., trapping sediment or altering flow patterns). Key piece characteristics to be recorded will include:

- piece location, either mapped onto aerial photos or documented with GPS
- piece length
- piece diameter
- piece orientation
- position relative to the channel
- whether the piece has a rootwad
- tree species or type (e.g., conifer or hardwood)
- whether the piece is associated with a jam or not
- the number of large pieces in the jam
- recruitment mechanism
- function in the channel

LWM data will be collected and results will be included within the DLA.

Lastly, surface-level photographs will be taken for documenting the physical condition and general ecological biological characteristics of the two Study areas. Each photo location will be

geo-referenced. The direction of each photo will be recorded using a compass and written descriptions for each photograph will be provided.

4.3.2.3 Hydraulic Calibration

Water Surface Elevation (WSE), discharge, and spot calibration depths and velocities will be collected throughout each model domain at three calibration flows. These hydraulic parameters will be measured using a combination of standard techniques. Spot velocities, depths and WSE measurements will be collected over the entire longitudinal profile of each model site. Site discharge will be measured at multiple locations and at least twice per day, according to standard USGS methods (Rantz 1982).

WSEs will be collected using a Trimble® R-8/10 RTK GPS or Trimble® Robotic S8 total station at a minimum of 50 spot locations throughout the wetted channel for each calibration flow. At the same locations, depth and velocity validation data will be collected by Swoffer® flow meters or an Acoustic Doppler Current Profiler (ADCP) in which data are spatially referenced using an onboard Trimble® R-10 RTK GPS.

The site discharge, or target calibration flow, is the discharge released at the control point (i.e., Project dam or diversion), whereas the measured calibration flow represents the actual discharge at the model site as measured with calibrated flow meters. The source of any differences between target and measured flows primarily depends on the accuracy of flow control at the upstream control point and intervening accretion or loss between the control point and the Study site. Discharge at each site will be measured using a combination of manual velocity meters and, if required, an ADCP near the upstream end of each site or at the best measurement location identified in the field. The model of Swoffer® velocity meter to be used is accurate at velocities ranging from 0.1 to 25.0 feet per second. Published technical specifications for the Teledyne RDI® Rio Grand 1200 kHz ADCP are: velocity accuracy: ±0.25 percent of the (water + boat), velocity ±0.25 centimeter per second, a velocity resolution of 0.1 centimeter per second and maximum water velocity of ±20 meters per second.

The three target flows for aquatic habitat modeling will be 25 cfs, 75 cfs, and 200 cfs. The target flow of 200 cfs will be used as the primary calibration data set. WSEs corresponding to flows greater than 200 cfs will be measured by field staff, or if field conditions are not considered safe, data will be collected at multiple locations in each Study site using pre-deployed stage recording devices (i.e., Onset U-20 Hobo pressure transducers). Initial WSEs will be surveyed for validation purposes when the instrumentation is installed and again when the instrumentation is removed.

It is anticipated that hydraulic-habitat relationships modeled in each Study site will extend from approximately 10 cfs to 500 cfs but this range will ultimately be dependent on the overall quality of site specific rating curves. The upper limits of the riparian inundation rating curves will be dependent on the highest flow recorded during the course of the Study.

On-site photographs will be collected to document site conditions during each survey flow event. A representative collection of site photos, arranged by calibration survey flow will provided in the report as an attachment.

In addition to the pressure transducers installed at each instream flow study site, four pressure transducers will be installed in the Bear River to document stage and flow changes throughout the reach. Exact locations will be determined during the SSWD hosted site-selection meeting. The transducers will be maintained for one calendar year.

4.3.2.4 Quality Control

For each field survey conducted, the Trimble® R8/R10 GPS receiver base station will be set up over a locally installed benchmark. The base station will record GPS positions during the survey while sending out real time kinematic corrections via a radio link to RTK rover units (R8/R10) which collect positions and data. After the first survey session, one of the day's static GPS data files collected by the base station will be submitted to the National Oceanic and Atmospheric Administration's (NOAA) Online Positioning User Service (OPUS). OPUS returns a position corrected and mapped into the high accuracy National Spatial Reference System (NSRS).

Using Trimble® Business Center software, the OPUS-corrected position will then be used to correct the network of rover collected points from that survey session. For all subsequent survey sessions, the base station will be manually assigned to the OPUS corrected position and all rover data collected in the established coordinate system consistent with the first survey session.

Field staff will record the height of the receiver above the benchmark, note the base coordinate as entered into the unit, and note serial numbers, height of receivers above ground, and file names used on each of the rovers each survey day.

4.3.2.5 Level Logger Installations

Level loggers will be installed for approximately one year beginning in late 2016 or early 2017. Onset Model U20 Leveloggers (or similar) with internal data loggers will be used to measure stage and temperature every 15 minutes. These loggers are factory calibrated and have a level accuracy of ±0.010 foot (ft) and a temperature accuracy ±0.05 degrees Celcius (°C). The accuracy of each logger will be checked periodically by comparing the instrument reading to the actual water depth. For this type of instrumentation, stream stage is related to absolute pressure, which is a combination of water pressure and atmospheric pressure. Readings will be taken to continuously measure stream stage. At each site, a level logger will be submerged at a fixed location to measure the submerged water pressure. At one location a Barologger will be installed to measure atmospheric pressure and temperature. The atmospheric pressure values will be used to calculate the true net water levels of the submerged loggers.

Loggers will be downloaded at least once every two months or as conditions allow. During each download period, care will be taken to record the exact time of level logger removal and replacement within the stream channel. In addition, the logger location will be marked with GPS

and/or flagging or photographed to ensure that the device is replaced as close to its original position as was possible. Water surface elevations will be surveyed during each download event.

During each visit, data will be downloaded to an optic shuttle or directly to a personal computer. In addition, operation/calibration, battery life, and general housing condition of the loggers will be assessed.

Stream discharge (i.e., stream flow) measurements will be taken at each site following United States Department of Interior, United States Geological Survey (USGS)-approved methods. Measurements will be performed by wading the wetted stream channel at each monitoring site. And not taken if flows are deemed unsafe to wade.

4.3.3 Step 3 – Hydraulic Modeling

4.3.3.1 Surface and Mesh Development

Hydraulic modeling for each Study site will use River2D (Steffler and Blackburn 2002). The River2D model uses the finite element method to solve the basic equations of vertically averaged 2D flow incorporating mass and momentum conservation in the two horizontal dimensions (Steffler and Blackburn 2002). The model incorporates a simplified shallow groundwater representation to allow elements at the water's edge to have vertices above and below the water surface. The location of the water's edge is interpolated from the three points of each triangular element spanning the point of zero depth. It is relevant to point out that the shallow groundwater equations used in the River2D model do not represent complex surface-groundwater exchange mechanisms (i.e., shallow/deep aquifer, water table, upwelling, gains/losses) but are only used to deal with the representation of water surface elevations in the model domain.

The main input parameters for the River2D model include channel surface topography, bed roughness (in the form of an effective roughness height), and upstream and downstream hydraulic boundary conditions (i.e., water levels and discharge). Accurate topography is the primary variable that allows for the development of a well calibrated model.

Topographic surfaces will be constructed by combining the total station survey data, RTK GPS standard survey data, bathymetric data, and the LiDAR ground return data. In order to increase the definition in areas of topographic gradient and variability, breaklines will be defined within the topographic surface. Breaklines enforce the topographic surface to 'snap' to the entire length of the line and are used to define features with large vertical gradient changes, such as cascades, tow of slopes, and boulders.

Before entering the data into the River2D model, topographic data from the site will be reviewed for errors in ArcMap and ArcScene using the high resolution imagery. Triangulated Irregular Networks (TINs) will be developed to visualize the data in two and three dimensions

Mesh development will follow procedures outlined in the R2D_Mesh Users Manual (Waddle and Steffler 2002). When building a computational mesh, it is important to optimize for computational performance without sacrificing mesh quality. Using the topographic surface

nodes to define the mesh is not recommended as the computational requirements for such a model exceed the limits of the software and currently available computer hardware. Instead, a low density uniform mesh is developed and then refined using a variety of techniques.

As recommended by the R2D_Mesh's *Users Manual*, a balance between mesh density and computational burden will be addressed in part by applying a procedure called 'wet refinement,' which places nodes at the centroid of each mesh element. This process ensures the appropriate mesh density in wetted areas only, while limiting mesh density in dry areas.

Another method used to refine the mesh is to review mesh-generated elevation contours as compared to bed elevation contours at an interval of 0.82-ft with a goal of close contour approximation. Since the topographic points and mesh nodes are not in the same location, the contours will not be exactly the same. Therefore, to increase contour agreement, additional nodes will be added in topographically complex areas.

A third method used to refine the mesh will be to identify large elevation differences between topographic data points and the interpolated elevation of each mesh triangle. Most often, large elevation differences exist in areas of high gradient (e.g., cascade) or significant localized topographic relief (e.g., cliff or vertical bank). Mesh triangles that exceed a 0.82-ft difference threshold are highlighted yellow in the mesh development software and further refined until the difference is no longer detected.

QI is a mesh quality index where a value of 1.0 represents a mesh comprised of perfect equilateral triangles. The goal minimum triangle quality index (QI) for each computational mesh is 0.15. Low QI values (i.e., <0.10) do not necessarily compromise model quality, but will increase computational run times. Tools in the mesh development software are used to improve geometry to achieve the minimum goal QI value.

One base mesh representing the model domain will be used for all simulation runs. However, it will be necessary to make small changes if model run time errors (i.e., eddy shedding velocity oscillation, extremely high velocity, or Froude number) occur. To achieve the appropriate mesh density over all simulation flows, the single mesh will be iteratively refined in the context of the full range of possible wetted areas.

4.3.3.2 Flow Model Calibration

Flow model parameters such as bed roughness (Ks, in the form of an effective roughness height), substrate transmissivity (*tr*) and eddy viscosity can be adjusted during model calibration to reflect field conditions. A stage-wise approach with target criteria for model performance will be used to guide calibration. The specific stages and criteria are discussed below.

The term Ks is scientific notation for bed roughness factor (in meters) and the term refers to gradation of material in the river. Compared to traditional one-dimensional models, where many two-dimensional effects are abstracted into the resistance factor, the 2D resistance term accounts only for the direct bed shear (Steffler and Blackburn 2002). Ks is iteratively varied as necessary to match observed water surface elevations using the default transmissivity of $tr = 0.1$. In

general, the initial Ks value entered is 1-3 times the grain size documented during field data collection. A single optimal value of Ks (i.e., homogeneous substrate material) or multiple regional Ks values (i.e., heterogeneous substrate material and/or large elevation changes) may be selected for each Study site based on the model performance results.

Groundwater transmissivity (*tr*) is a user-defined variable which corresponds to groundwater flow and the relationship to surface flow. The default value is 0.1 which ensures that ground water discharge is negligible. Because subsurface flow may be present at the Study site, the default value of *tr* will be modified to aid in the wetting and drying of off-channel or backwater areas. For comparison, results of the transmissivity sensitivity tests are compared to aerial imagery and field photos.

For the initial hydraulic model, hydraulic calibration tests will be conducted using the target calibration flow of 200 cfs. Bed roughness and transmissivity will be varied as necessary to match observed WSEs and wetted area. As part of normal calibration, K and *tr* values are incrementally adjusted through an integrative sensitivity analysis until modeled WSEs calibrated well to observed WSEs. In addition to the WSE comparisons, velocity and depth predictions were compared to field measured data to evaluate changes made to Ks.
The target criterion for mean error in WSE between simulated versus observed data is, to a large extent, based on the accuracy of the RTK GPS equipment used to measure WSE. The channel gradient and topography also take into consideration where frequent shoals, cascades, and riffle habitats can increase differences between field data and model data. In a comprehensive report on hydraulic modeling YCWA (2013) states:

> For WSE, the SRH2D v2.1 model [i.e., 2D hydraulic model] can only be as accurate locally as the bed elevation variation arising from the presence of cobble substrate throughout most of the river. This means that if a bed elevation measurement is made on the top of a cobble versus in the space between cobbles, then the model's WSE will be different between those two locations simply because of bed topography. Therefore, the benchmark for model performance for WSE is a combination of the WSE measurement error (i.e., ~0.15 - 0.2 ft) and the bed elevation uncertainty due to measurement method accuracy and bed substrate variability (i.e., ~0.25 - 0.35 ft). These errors are not uniform, but are statistically distributed with uncertainty. Therefore, WSE performance will also be statistically distributed with uncertainty. There is no single constant WSE deviation value that can be correctly stated as the acceptable threshold for model performance. Note that the highest quality topographic survey recognized by the USACE has an accuracy of 0.5 ft.

Given the expected site characteristics in the Study sites, a goal of 0.10 ft difference between simulated and observed WSE will be targeted. This target will exceed the aforementioned industry standards.

Similarly, no specific target calibration criteria exist for velocity or depth parameters as these variables are greatly influenced by the differences in topographic detail between the field

conditions, initial bed file detail, and the final bed detail resulting from the interpolated mesh. Using professional judgment and standard industry practice, velocity and depth variables are reviewed for reasonableness and significant errors in depth (i.e., 0.33 ft mean error) and velocity (i.e., 0.5 feet per second mean error) are evaluated. For all sets of model calibration variables, the correlation coefficient (r) and the coefficient of determination (r2) (i.e., percent of variance in an indicator variable explained by a factor and the measure of the proportion of variance of model results, respectively) were calculated. In general, coefficients greater than 0.7 are expected while coefficient of determination values for velocity magnitude are expected to be within a range of 0.4 and 0.8 (Pasternack 2011).

Flow field velocity vectors (i.e., the direction and magnitude) are used to evaluate velocity prediction reasonableness during the calibration process, but are otherwise not incorporated into the statistical review process.

Model convergence for a given hydraulic simulation is achieved and accepted when the inflow (Qin) equals outflow (Qout) and the solution change is nominal. Solution change is the relative change in the solution variable over the last time step. Specific criteria thresholds do not exist for these parameters and are largely based on the magnitude of the simulation discharge and the professional judgment of the modeler. The solution change goal will be 0.0001, or less. These values are consistent with recommendations for these metrics made in the River2D User Manual (Steffler and Blackburn 2002).

4.3.3.3 Rating Curve Development

Other than highly detailed topography, the downstream rating curve, also known as the downstream model boundary condition, is the most important element of the simulation process. Without site-specific field data, hydraulic simulation starting parameters (i.e., starting water surface elevations) can only be estimated and often rely on rating curves developed for another location and channel geometry.

On-site rating curves will be developed using a combination of field measurements of stage and discharge, stage recording pressure transducers and 15-minute USGS gage records. Stage recorders will be deployed at the top and bottom of the Study site to passively record stage over time. To relate WSE to discharge, WSE will be measured directly above each installed logger at the time of deployment. A barometric pressure transducer will also be located at the site to compensate for changes in atmospheric pressure. For validation purposes, WSEs are measured during calibration flow surveys in the vicinity of the recorder.

4.3.4 Step 4 – Target Species and Habitat Suitability Criteria

Based on existing and available fish information and special-status listings for the Study Area, the following two fish species will be modeled in each Study site: 1) fall-run Chinook salmon and 2) hardhead minnow. Habitat modeling for additional ESA-listed or special-status fishes will be included in this Study if results from SSWD's relicensing Study 3.1, *Salmonid Redd*, or Study 3.2, *Stream Fish Populations*, document these ESA-listed fish species or special-status fishes in the Study Area, and HSC for these fishes are readily available and applicable to the riverine conditions of the Study Area. In advance of habitat modeling, SSWD will host a one-day

technical HSC workshop to discuss the species to be modeled, modifications to the proposed HSC (if warranted) and the potential inclusion of additional species if documented during performance of Studies 3.1 or 3.2. A regional HSC expert will be in attendance and facilitate the HSC workshop. SSWD will, in good faith try to come to agreement on final HSC during the workshop, but due to schedule requirements, will proceed with modeling if no agreement is made.

Habitat suitability criteria define the range of microhabitat variables that are suitable for a particular species and lifestage of interest. Variables typically defined with HSC include depth, velocity, instream cover and bottom substrate. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively. HSC provide the biological criteria input to the River2D model which combines the physical habitat data and the habitat suitability criteria into a site-wide habitat suitability index (i.e., Weighted Usable Area or WUA) over a range of simulation flows. WUA is defined as the sum of stream surface area within a nodal area model domain or stream reach, weighted by multiplying area by habitat suitability variables, most often velocity, depth, and substrate or cover, which range from 0.0 to 1.0 each. Target species and lifestage HSC for fall-run Chinook salmon will use those developed for use during the Yuba River Development Project (FERC No. 2246) relicensing Instream Flow Study (YCWA 2013). Spawning, juvenile and rearing lifestages will be modeled.

It is anticipated that these HSC may require some modification to appropriately be used in this Study as the general river conditions under which the curves were developed may differ significantly from current conditions in the lower Bear River. Modifications to HSC will be made by a regional HSC expert familiar with the proposed curves and any changes will be thoroughly documented in the final report. HSC transferability tests, as outlined by Thomas and Bovee (1993), will not be applied to this Study, given the periodic and limited number of salmonid observations in the lower Bear River.

Hardhead will be modeled using HSC developed for Nevada Irrigation District's Yuba-Bear Hydroelectric Project (FERC No. 2266) relicensing and PG&E's Drum-Spaulding Project (FERC No. 2310) relicensing (NID and PG&E 2011). Table 4.3.2 identifies the target species, lifestages and associated HSC to be used in this Study.

Table 4.3.2. Target Species and Habitat Suitability Criteria.

Target Species	Lifestages to be Modeled	HSC Source	HSC Modification Expected
Fall-run Chinook Salmon	Spawning, fry, juvenile	YCWA 2013	Yes
Hardhead MInnow	Juvenile, adult	NID and PG&E 2011	No

Preliminary HSC for fall-run Chinook salmon are presented in Table 4.3-3 and plotted in Figure 4.3-1. As stated above, SSWD may modify these HSC based on a review of channel and flow conditions at the time when the HSC input data were collected.

Table 4.3-3. Fall-run Chinook salmon HSC values (YCWA 2013).

Life Stage	Velocity HSC		Depth HSC		Substrate[1]/Cover[2] HSC	
	ft/sec	Suitability	ft	Suiatbility	--	Suitability
Spawning	0.22	0.00	0.25	0.00	31	0.00
	0.85	0.20	0.45	0.10	32	1.00
	1.30	0.52	0.65	0.20	195	1.00
	1.55	1.00	0.75	0.50	196	0.00
	2.95	1.00	0.95	1.00	--	--
	3.25	0.50	2.00	1.00	--	--
	5.32	0.00	3.00	0.20	--	--
	--	--	4.80	0.02	--	--
	--	--	7.80	0.02	--	--
	--	--	7.90	0.00	--	--
Fry	0.00	1.00	0.00	0.00	none	0.25
	0.10	0.99	0.10	0.12	cobble	0.40
	0.20	0.95	0.20	0.31	boulder/riprap	0.33
	0.30	0.89	0.30	0.58	riparian vegetation	1.00
Fry (continued)	0.40	0.81	0.40	0.85	stream wood	1.00
	0.60	0.65	0.50	0.99	--	--
	0.70	0.56	0.60	1.00	--	--
	0.80	0.49	0.80	1.00	--	--
	0.90	0.42	0.90	1.00	--	--
	1.10	0.30	1.10	1.00	--	--
	1.30	0.22	1.20	1.00	--	--
	1.40	0.19	1.50	0.92	--	--
	1.70	0.13	1.90	0.75	--	--
	2.00	0.10	2.00	0.69	--	--
	3.62	0.00	2.30	0.55	--	--
	--	--	2.40	0.48	--	--
	--	--	2.50	0.45	--	--
	--	--	2.70	0.38	--	--
	--	--	3.10	0.26	--	--
	--	--	3.30	0.21	--	--
	--	--	3.40	0.18	--	--
	--	--	3.60	0.16	--	--
	--	--	3.70	0.14	--	--
	--	--	3.90	0.11	--	--
	--	--	4.30	0.07	--	--
	--	--	4.50	0.06	--	--
	--	--	4.60	0.05	--	--
	--	--	4.80	0.05	--	--
	--	--	5.10	0.04	--	--
	--	--	5.20	0.03	--	--
	--	--	5.60	0.02	--	--
	--	--	18.40	0.02	--	--
	--	--	18.50	0.00	--	--

Table 4.3-3.(continued)

Juvenile	0.00	1.00	0.20	0.00	none	0.30
	0.10	1.00	0.55	0.50	cobble	0.50
	0.20	0.99	1.50	1.00	boulder/riprap	0.50
	0.30	0.98	2.50	1.00	riparian vegetation	1.00
	0.40	0.97	3.50	0.35	stream wood	1.00
	0.50	0.96	5.00	0.35	--	--
	0.60	0.94	6.00	0.20	--	--
	0.70	0.92	11.90	0.00	--	--
	0.80	0.89	--	--	--	--

[1] Mean particle diameter (mm) in substrate polygons.

[2] Cover type notes: substrate polygons must contain >30% cobble or >10% boulder/riprap, and cover includes 3ft buffer around edge of riparian vegetation or 6ft buffer around stream wood.

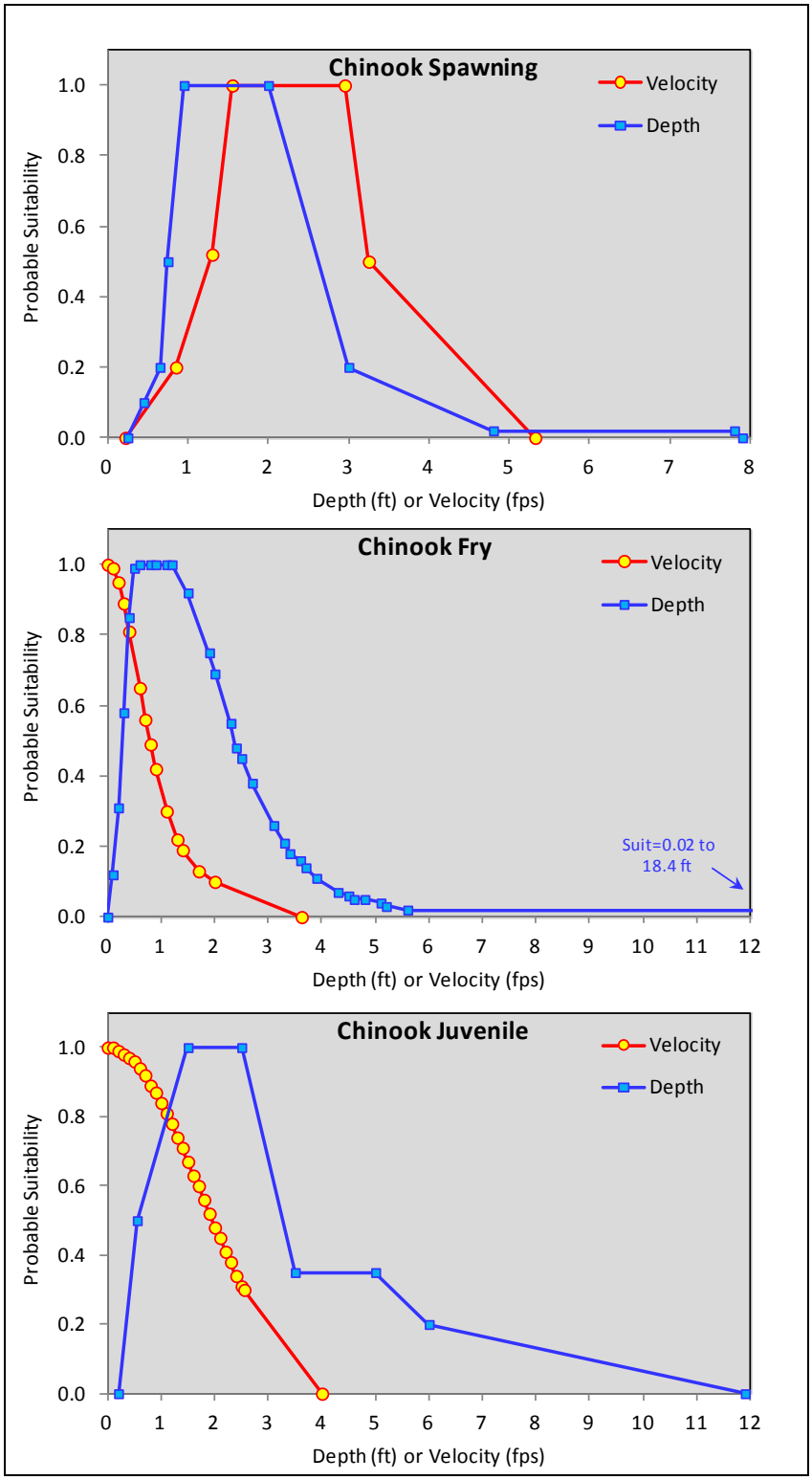

Figure 4.3-1. Depth and velocity HSC curves for spawning, fry, and juvenile fall-run Chinook salmon (YCWA 2013).

The HSC for hardhead minnow are presented in Tables 4.3-4 and plotted in Figures 4.3-2, respectively.

Table 4.3-4. Hardhead suitability for juvenile and adult life stages (NID and PG&E 2011).

Life Stage	Velocity HSC		Depth HSC	
	ft/s	Suitability	ft	Suitability
Juvenile	0.00	1.00	0.50	0.00
	0.25	1.00	0.67	1.00
	1.75	0.25	3.67	1.00
	2.60	0.00	8.71	0.10
	--	--	18.00	0.10
Adult	0.00	0.82	0.66	0.00
	0.20	1.00	2.62	1.00
	0.90	1.00	18.00	1.00
	2.13	0.22	--	--
	3.50	0.00	--	--

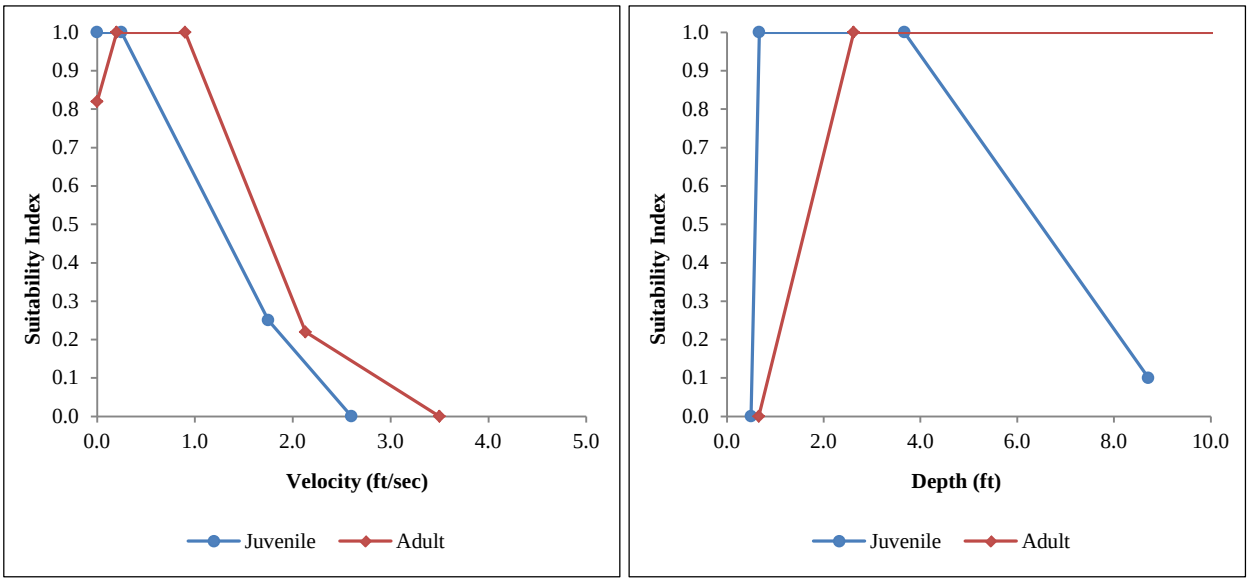

Figure 4.3-2. Hardhead minnow velocity and depth suitability (NID and PG&E 2011).

HSC for velocity and depth will be used for all target species life stages. Substrate and cover criteria will only be applied to the fall-run Chinook salmon HSC. Substrate and cover criteria will not be applied to the adult and juvenile lifestages of hardhead. In general, observations suggest that hardhead do not occupy habitat in stream channels based on substrate but are rather observed over sand-gravel-boulder substrates (Moyle 2002). Hardhead are often observed in the deepest stream habitats available, where the depth of pool or run habitat may act as cover rather than utilizing traditional cover types (i.e., undercut banks, LWM, overhanging vegetation).

Additional species may be modeled based on the results of Study 3.1, *Salmonid Redd Surveys* or Study 3.2, *Stream Fish***.**

4.3.5 Step 5 – Aquatic Habitat Modeling

4.3.5.1 Simulation Flows

A total of 18 discharges will be simulated for each Study site. Habitat suitability and WUA for all target fish species and life stages will be calculated for each simulation flow. WUA is calculated as the product of a composite habitat suitability index at every node in the domain and the area associated with each node. In order to calculate habitat suitability, four data inputs are required: a fish preference file (i.e., HSC), a channel index, depth, and velocity.

Fish preference files contain suitability values (0.0 to 1.0) for velocities, depths, and substrate/cover. A fish preference file is loaded into River2D as a text file. Depth and velocity values are provided from the model once a simulation has converged and is at a steady state. Channel index files are a River2D model file equivalent to a substrate and cover map of the entire model domain.

The WUA calculation will use the standard triple product function which multiplies depth, velocity, and channel index together. Channel index interpolation will be defined using discrete node selection (i.e., nearest node rather than a continuous linear interpolation of the channel index values from surrounding nodes). Discrete node selection is typically applied to substrate classifications such that the original substrate code value is maintained. When cover codes are defined for HSC, a continuous interpolation is applied as a gradient of cover may be best described by the interpolation function.

The sample River2D habitat model output provided below (Table 4.3-4) demonstrates how WUA is calculated at each River2D model node. The depth suitability index (DSI), velocity suitability index (VSI), and the channel index suitability index (CiSI) are multiplied together to obtain a combined suitability index (CbSI). The resulting WUA (in square meters), is a product of the CbSI and the area represented by the node. Total site WUA is the sum of nodal WUA.

Table 4.3-4. Sample section from a nodal attribute file showing habitat suitability and WUA results.

Node	x	Y	Depth (m)	Velocity (mps)	Channel Index	DSI	VSI	CiSI	CbSI	WUA (sq. m)
1	587155.1	124891.8	1.31	0.0982	6	0.52	1	1	0.52	0.1737
2	587154.6	124891.7	1.287	0.0918	1	0.551	1	0.1	0.0551	0.1424
3	587138.7	124888.3	-1.315	0	1	0	0.6	0.1	0	1.2279
4	587155.7	124891.9	1.4099	0.0984	1	0.3927	1	0.1	0.0393	0.1679
5	587156.2	124892	1.5438	0.0926	6	0.3034	1	1	0.3034	0.1834
6	587155.6	124891.4	1.1709	0.1108	6	0.7075	1	1	0.7075	0.4167
7	587142.7	124889.2	-0.224	0	1	0	0.6	0.1	0	1.4058
8	587144.3	124889.5	0.3681	0.0107	1	0.9075	0.6735	0.1	0.0611	1.2983
9	587154.9	124891.2	1.1759	0.1002	6	0.7008	1	1	0.7008	0.447

4.3.6 Step 6 – Effective Habitat Analysis

Building on the spatial habitat suitability results and the site-wide aggregation of WUA, an effective habitat analysis incorporates critical temporal and potentially habitat limiting

components to the analysis. The analysis applies constraints or limiting factors which, in this Study, will inherently include water availability but will also be focused on water temperature.

Evaluation of habitat availability over time, in combination with spatial habitat suitability results, conveys important information about the effect of changing river conditions on the habitat of fish community. Often, it is the time dependent characteristics of habitat occurrence that ultimately may limit a particular lifestage and therefore control the population (Waddle 2001).

The foundation of the effective habitat analysis is a habitat time series (HTS) for the full period of record. The HTS requires that the WUA function extend from highest mean daily flow in the hydrologic record to the lowest (i.e., 100% to 0% flow exceedance). For the Study, the WUA will be extrapolated to zero percent exceedance in two steps. First, flows will be modeled in River2D to the maximum extent acceptable within model calibration parameters established during model calibration. Second, WUA will be extrapolated from the highest modeled flow in River2D to zero percent exceedance and, extrapolated from the lowest modeled flow to 100 percent exceedance using the following approach.

A non-linear exponential extrapolation equation will be applied to the last three points of each WUA data set. The non-linear option for extrapolation follows the trend of the regression and never completely bottoms out, which is likely the most realistic trend line for WUA. If the non-linear function does not produce results as expected, a flat-line approach will be employed whereby the WUA function is extended at a constant magnitude from the last data point. In some circumstances, it is reasonable to apply the flat-line to habitat as habitat-flow relationships (i.e., HSC) for most species are not documented or well understood at the highest flows observed in a Study site.

The effective habitat model will be calculated using Microsoft® Excel. Several inputs are required. These include:

- Target Species and Lifestages. The analysis will evaluate all species and lifestages identified in Section 4.3.4.
- Periodicity. Lifestage periodicity input to the program enables the program to calculate habitat frequency for only the time of year when the lifestage of interest may be present. Periodicity will be evaluated in accordance with Table 4.3-5.

Table 4.3-5. Target species life stage periodicity.

Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
FALL-RUN CHINOOK SALMON																								
Spawning	X	X															X	X	X	X	X	X	X	X
Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Fry	X	X	X	X	X	X																	X	X
HARDHEAD MINNOW																								
Juvenile	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Adult	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- Hydrology. A baseline historical hydrology data set will be developed for use in the HTS. Its development is described below. The Project Base Case hydrologic data set will be used for all analyses. That is, each hydrologic node will be based on existing flows (i.e., the hydrologic regime that would occur under current Project operation) and will be based on the relicensing hydrology database for the period of record ranging from WY 1976 through WY 2014.

Evaluations of habitat over time are typically conducted in the form of a habitat exceedence (i.e., duration) analysis, which is particularly useful for assessing the impacts of alternative flow regimes over the complete range of discharges considered for alternative flow scenarios (Bovee et al. 1998, Waddle 2001). This curve represents the percent of time that a given amount of habitat (in square meters or square feet) is equaled or exceeded during the analysis period. This summarization also allows for the comparison of the available habitat under different flow scenarios at a given Study site.

Habitat exceedance curves are constructed in the same manner as a flow exceedance (i.e., duration) curve, but use habitat values instead of discharges as the ordered data. Although the habitat exceedance curves look like and are based on flow exceedance curves, there is no direct correspondence between the two. For example, the habitat value that is exceeded 90 percent of the time usually does not correspond to the discharge that has the same exceedance probability.

This discordance happens because of the normal bell-shaped data relationship between total habitat and discharge (Bovee et al. 1998) whereby the same habitat can be achieved with different flows. Consequently, a given habitat exceedance probability might be related to more than one discharge, and is not explicitly related to the probability of exceedance of specific flows. Habitat exceedance curves and habitat metrics derived from the curves, such as total cumulative daily habitat and area under the curve, can be used to quantify the differences in habitat between baseline and alternative conditions (Hawks Nest Hydro 2015, HDR 2014, Bovee et al. 1998).

Habitat modeling results for this Study will not be weighted by reach length (i.e., habitat type frequency) and will therefore reflect only the habitat contained within each Study site. To quantify the amount of habitat change resulting from one hydrologic scenario to another (e.g., Water Year type or operational change), summary graphics and tables will be created using a metric of the total habitat days, which is analogous to the calculation of the total area under the curve.

As previously mentioned, in addition to water availability, water temperature is the most important limiting factor for fall-run Chinook salmon in the Study Area.

Anadromous salmonid water temperature numeric guidelines developed by the United States Environmental Protection Agency (EPA) (EPA 2003) will be used to examine the suitability of water temperature conditions for fall-run Chinook salmon by Effective Habitat Analysis (EHA). These EPA guidelines are 7-day averages of the daily maxima (7DADM) water temperatures that the EPA claims maintains protection of anadromous salmonids. Although the EPA developed these guidelines based on review of literature describing water temperature-related

effects on various species of anadromous salmonids, species-specific guidelines were not developed. Table 4.3-6 shows the EPA guidelines for the anadromous salmonid lifestages that will be used in this Study.

Table 4.3-6. EPA water temperature guidelines (EPA 2003) for protection of anadromous salmonids by life stage.

Salmonid Life History Phase Terminology	7-Day Average of the Daily Maxima Guideline (°C)	Protective of:
Adult Migration	≤18°C	Salmon and steelhead migration
Spawning and Egg Incubation	≤13°C	Salmon and steelhead spawning, egg incubation and fry emergence
Juvenile Rearing and Emigration	≤16°C for "core" juvenile rearing;[1] ≤18°C for migration and non-core juvenile rearing	Salmon and steelhead rearing and juvenile migration
Smoltification	≤14°C	Composite criteria for salmon and steelhead smoltification[2]

[1] EPA recommends that for areas of degraded habitat, "*core juvenile rearing*" use covers the downstream extent of low density rearing that currently occurs during the period of maximum summer temperatures (EPA 2003).

[2] EPA establishes a guideline of ≤15°C for salmon smoltification and a guideline of ≤14°C for steelhead smoltification; but for a composite guideline for both species, the steelhead guideline of ≤14°C is applied.

One model run using the Base Case hydrology will be made for each life stage of the target species using the input data sets described above. For each 6-hour time step, there will be an associated water temperature at each node. Daily temperature at each node will be calculated using the 7DADM water temperature. Each nodal temperature value will then be compared to the temperature threshold table for each species and life stage. Threshold values for all species and life stages will be binary, meaning that if the 7DADM water temperature criterion at a given node was exceeded, the habitat will be deemed not effective and assigned a zero value. If the 7DADM nodal temperatures are less than or equal to the threshold temperature, the habitat value associated with the discharge will be maintained.

To show the results of the analysis, EHA charts and tables will be generated showing the unconstrained habitat (i.e., no temperature thresholds applied) and the constrained habitat (i.e., temperature thresholds applied). To quantify the amount of habitat change resulting from the application of temperature thresholds, summary tables will be developed. These tables summarize the percent change between habitat availability with no temperature considerations versus the effective habitat availability with temperature thresholds applied.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

The Study methods are consistent with the goals, objectives, and methods used in many recent and relevant studies in California using River2D for salmonid habitat (USFWS 2010, 2005 and 1997). The EHA has most recently been used in the Merced River Hydroelectric Project (FERC No. 2179) (MID 2013) relicensing. The Study uses standard data collection and modeling methods for 2D instream flow studies and habitat evaluations (Pasternack 2011, YCWA 2013, Steffler and Blackburn 2002, Waddle 2001, Bovee et al. 1998).

6.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning ..... October 2016 – June 2017
Collect Data .....October 2016 – October 2017
Hydraulic and Habitat Modeling ..... June 2017 – October 2017

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

This Study will incorporate data from SSWD's relicensing Studies 2.1, *Water Temperature Monitoring*; 2.2, *Water Temperature Modeling*; and 3.1, *Salmonid Redd*. The costs for implementation of those studies are not included in this Study's cost. SSWD estimates the costs in 2016 dollars to complete the Study is between $215,000 and $350,000.

8.0 References Cited

Bovee, K., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004.

California Department of Fish and Game (CDFG). 1991. Draft Report: Lower Bear River Instream Flow and Temperature Recommendations. pp. 80.

California Department of Fish and Wildlife. Unpublished. Stocking and fish survey records at Camp Far West Reservoir. Provided by Sean Hoobler on 7/3/2015.

Curtis, J.A., L.E. Flint, C.N. Alpers, and S.M. Yarnell. 2005. Conceptual model of sediment processes in the upper Yuba river watershed, Sierra Nevada, CA. USGS Staff Published Research. Paper 482.

Hawks Nest Hydro LL, 2015. Aquatic Habitat Use Instream Flow Study. Hawks Nest Hydroelectric Project. FERC No. 2512. Prepared by HDR Engineering, 2015.

HDR. 2014. Gila River Fish Habitat Study, Gila, NM. Prepared for the New Mexico Interstate Stream Commission.

Kelsey, H.M., R. Lamberson, and M.A. Madej. 1987. Stochastic model for the long-term transport of stored sediment in a river channel. Water Resources Research, Vol. 23, No. 9, pp 1738-1750.

Merced Irrigation District, 2013. Instream Flow (PHABSIM) Downstream of Crocker-Huffman Dam. Merced River Hydroelectric Project. FERC No. 2179. Prepared by HDR Engineering, 2013.Moyle, P.B. 2002. Inland Fish of California, 2nd Edition. University of California Press, Berkeley, California.

National Oceanic & Atmospheric Administration (NOAA). 2015. United States Interagency Elevation Inventory. Available online: <https://coast.noaa.gov/inventory> . Accessed February 4, 2016. Last updated 2015. NOAA's Ocean Service, Office for Coastal Management (OCM), Charleston, SC.

Nevada Irrigation District and Pacific Gas and Electric Company (NID and PG&E). 2011. Instream Flow. Technical Memorandum 3-2. Yuba Bear-Drum Spaulding Project, FERC Project Nos. 2266-096 and 2310-173. HDR Engineering, Sacramento, CA.

Pasternack G.B. 2011. 2D Modeling and Ecohydraulic Analysis. Land, Air, and Water Resources, University of California at Davis. pp.158.

Placer County. 2012. Placer Legacy Program Summary. Available online: <http://www.placer.ca.gov/bos/District2/~/media/bos/dist2/documents/PlacerLegacyReport2010_11.ashx>. Accessed: August 24, 2015.

Rantz, S.E. 1982. Measurement and computation of stream flow: Volume 1. Measurements of stage and discharge. USGS Water Supply Paper 2175.

South Sutter Water District (SSWD). 1988. Garden Bar Dam and Reservoir Water Power Project, FERC No. 5222, Application for license before Federal Energy Regulation Commission, January 1988.

Steffler, P. M. and J. Blackburn. 2002. River2D: Two-dimensional depth averaged model of river hydrodynamics and fish habitat. Introduction to depth averaged modeling and user's manual. Edmonton, University of Alberta.

Thomas, J.A., and K.D. Bovee. 1993. Application and Testing of a Procedure to Evaluate Transferability of Habitat Suitability Criteria. Regulated Rivers: Research and Management. 8(3): 285-294.

United States Environmental Protection Agency (EPA). 2003. USEPA Region *10 Guidance for Pacific Northwest. State and Tribal Temperature Water Quality Standards*. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

United States Fish and Wildlife Service (USFWS). 2010. Flow-Habitat Relationships for Juvenile Fall/Spring-Run Chinook Salmon and Steelhead/Rainbow Trout Rearing in the Yuba River. pp. 294.

_____. 2005. Monitoring of Restoration Projects in the Merced River using 2-Dimensional Modeling Methodology. 106 pp.

_____. 1997. Identification of the instream flow requirements for fall-run Chinook salmon spawning in the Merced River. Ecological Services, Instream Flow Assessments Branch. Merced River Final Report. pp. 69.

Waddle, T. and P. Steffler. 2002. R2D_Mesh. Mesh Generation Program for River2D Two Dimensional Depth Averaged Finite Element. Introduction to Mesh Generation and User's Manual. U.S. Geological Survey.

Waddle, T.J., ed. 2001. PHABSIM for Windows: User's Manual and Exercises. Fort Collins, CO. U.S. Geological Survey. 288 pp.

Yuba County Water Agency (YCWA). 2013. Technical Memorandum 7-10. Instream Flow Downstream of Englebright Dam. Yuba River Development Project. FERC Project No. 2246.

Page Left Blank

Attachment 1
Habitat Mapping Methods

Attachment 1
Study 3.3 – Instream Flow Study
Habitat Mapping Methods

1.0 Introduction

The purpose of the habitat mapping effort is to develop specific, comprehensive, and detailed information on aquatic habitat and channel morphology characteristics of the Bear River downstream of the Project to the confluence with the Feather River. There has been no coordinated approach to habitat map and little is known about the features of the channel and associated habitat. Therefore, there are significant gaps in existing data for the purposes of assessing habitat quantity, quality, and distribution in the stream reaches affected.

SSWD completed some initial habitat mapping and channel characterization prior to filing the NOI and PAD because development of aquatic study plans required a basic understanding of the general physical and biological character of the Bear River. Additional information is needed that extends along the entire Bear River.

2.0 Methods

Habitat mapping generally will follow standard methods similar to those applied in other recent relicensings in California. Habitat will be mapped using ground-based surveys. The River is generally very low gradient and flows through Quaternary alluvium so no reach breaks were noted. It is also confined by levees and highly modified from historical mining, redirection, dredging, diversions, and agricultural development.

The stream longitudinal profile was measured using maps available from Terrain Navigator Pro© (V. 7) software. Distance between contour lines was measured and a longitudinal profile was created. Map-based gradient, while an estimate, is often a good indicator of stream energy and process (Figure 1). The map gradient averages 0.1% and ranges between 0.3% just below the dam to almost flat between RM 13 and 15.5 (2 miles above Highway 65). The slope is fairly consistent throughout the reach.

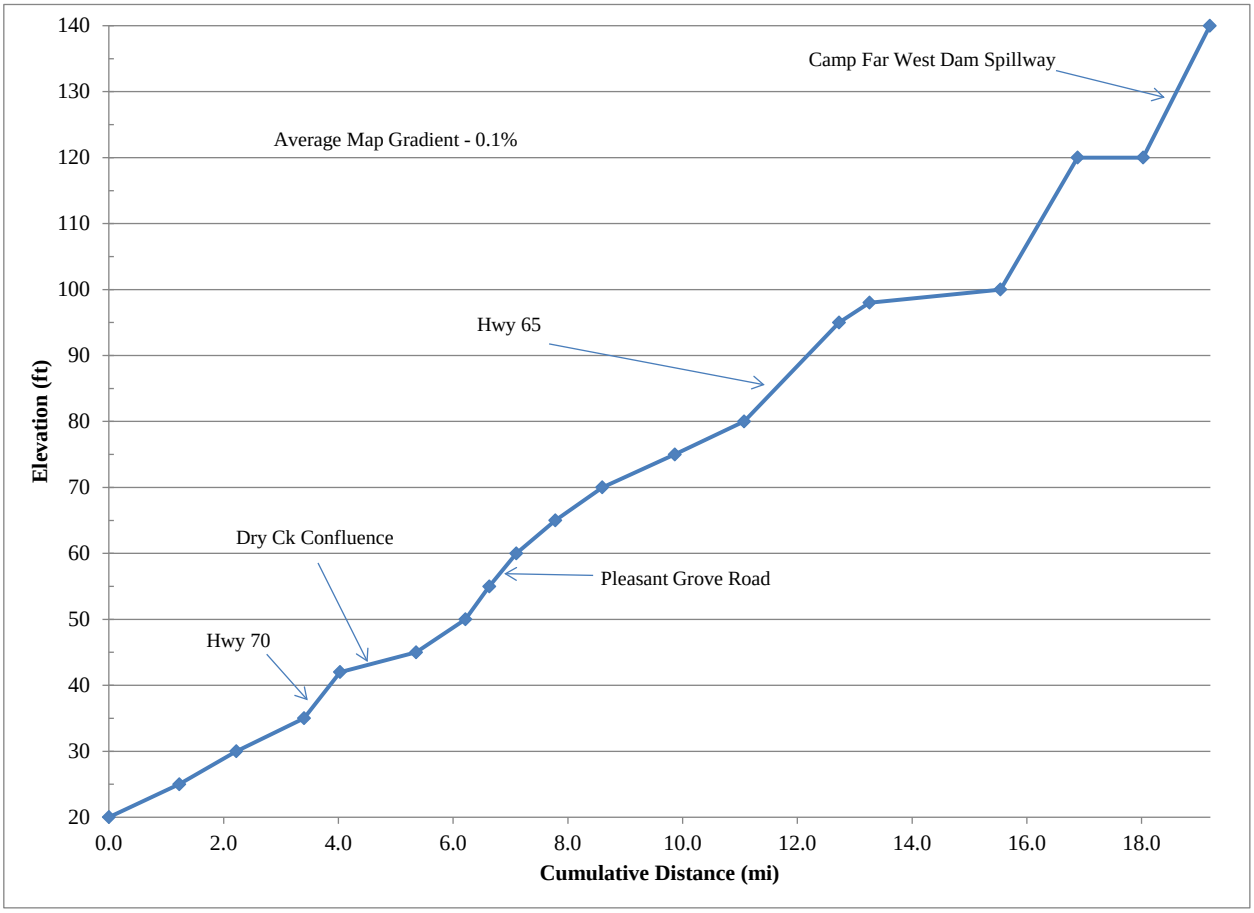

Figure 1. Longitudinal profile (based on 1:24k topographic map) of Bear River from junction with Feather River to Camp Far West Dam.

Initial field data were collected in June 2015 when discharge was controlled by SSWD at 25 cfs to maximize access and safety during fieldwork and evaluate habitat composition during the seasonal period of greatest habitat heterogeneity. Anticipating habitat based on differences in discharge is too subjective so the habitat calls are made at the survey low-flow. Further mapping will be done in the low flow period of 2016.

2.1 Study Area

Habitat mapping will be completed in the Bear River downstream of the non-Project diversion dam to the confluence with the Feather River. The backwater pond between Camp Far West Dam and the non-Project diversion dam will be noted. In 2015, RM 16.3 to 16.9, 12.1 to 12.4, and 6.4 to 7.1 was mapped in the downstream and upstream direction while wading and walking. The 4.7 mile section between Hwy 65 and the Pleasant Grove Bridge was mapped in the downstream direction while floating inflatable kayaks. Additional mapping will be completed using similar methods. No tributaries will be mapped due to dry channels, vegetation (e.g., no flow, and channels dominated by macrophytes), and private ownership.

2.2. Meso-Habitat and Channel Classification

A three-tiered habitat mapping classification system developed by Hawkins et al. (1993) will be used to assist in the identification of individual habitat units in the field. Level III categories are generally modified/adopted from McCain et al. (1990). Figure 2 shows the relationship among the three levels. At the broadest level, Level I categorizes habitats as "fast water" and "slow water." In Level II, fast water is subdivided into two categories: turbulent and non-turbulent; slow water is also subdivided into two categories: scour pool and dammed pool.

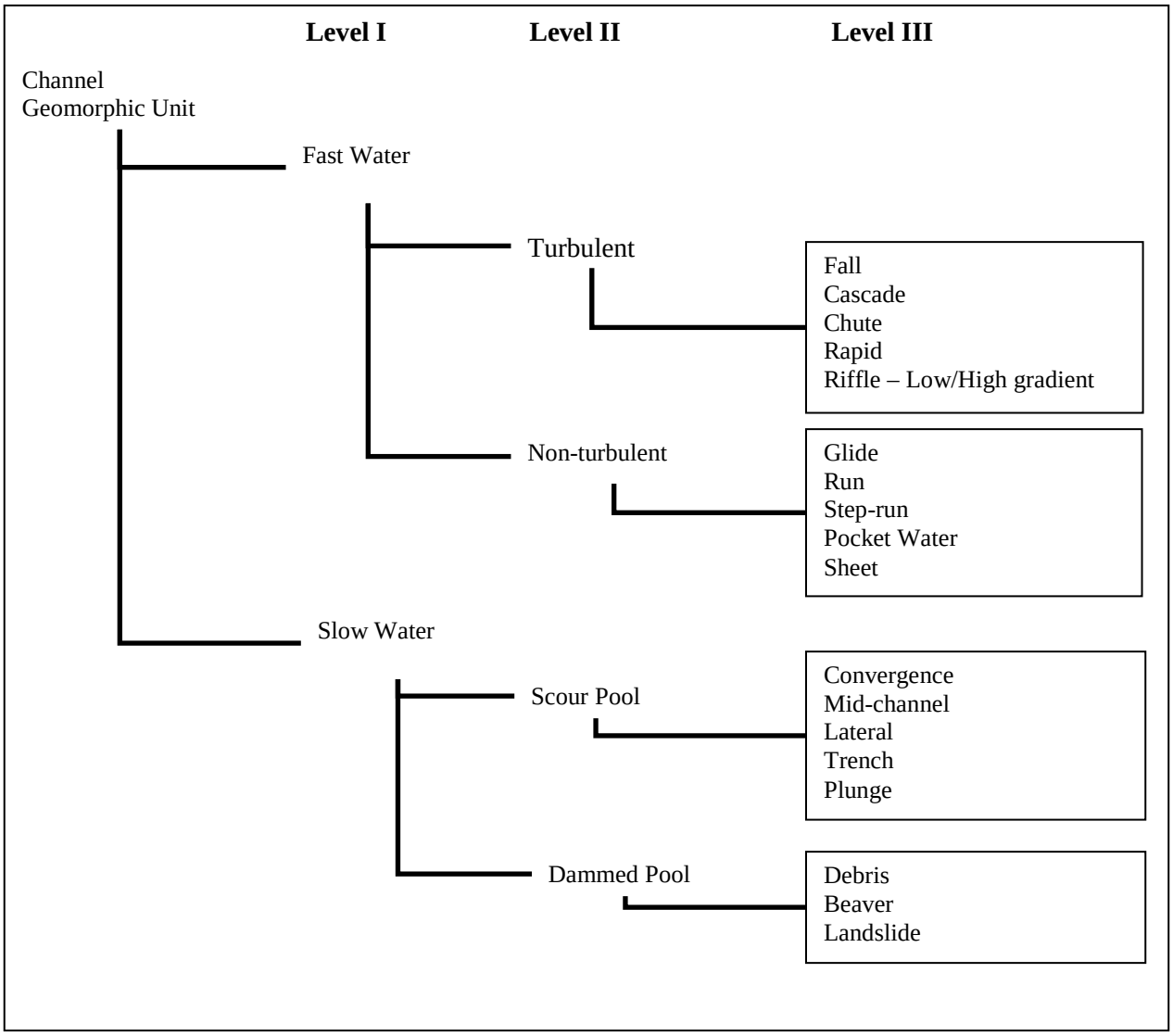

Figure 2. Key to habitat types used in the lower Bear River.

Habitat mapping will use methods developed by Hawkins et al. (1993), McCain et al. (1990) and Flosi and Reynolds (1994). Each distinct habitat unit will be numbered consecutively in the direction of travel during the day of the mapping and for an individual section. Different days or sections will also be numbered consecutively beginning with Habitat Mapping Unit 1 (HMU1)

and later combined with previous mapping for data analysis. Habitat type descriptions are listed in Table 1. Any pools created by vegetation, beavers, artificial berms, or other strong downstream control will be noted. Additional data (length, width, height, and function) will be collected for concentrations of giant cane (*Arundo donax*). The base map of the Bear River will be loaded onto a mobile device (e.g., tablet or laptop) and be utilized along with data collection software that can collect features (e.g., polygons, lines, areas, points) from an external GPS source. All cane concentrations will be collected with a differential GPS antenna capable of 1 meter or better accuracy.

Table 1. Habitat types to be used in mapping for the South Sutter Water District Bear River (Adapted from McCain et al. 1990, Armantrout 1998, Payne 1992, McMahon et al. 1996, and Hawkins et al. 1993).

I. Fast Water:			Riffles, rapid, shallow stream sections with steep water surface gradient.
	A. Turbulent:		Channel units having swift current, high channel roughness (large substrate), steep gradient, and non-laminar flow and characterized by surface turbulence.
		1. Fall:	Steep vertical drop in water surface elevation. Generally not modelable.
		2. Cascade:	Series of alternating small falls and shallow pools; substrate usually bedrock and boulders. Gradient high (more than 4%). Generally not modelable.
		3. Chute:	Narrow, confined channel with rapid, relatively unobstructed flow and bedrock substrate.
		4. Rapid:	Deeper stream section with considerable surface agitation and swift current; large boulder and standing waves often present. Generally not modelable.
		5. Riffles:	Shallow, lower-gradient channel units with moderate current velocity and some partially exposed substrate (usually cobble). • Low gradient — Shallow with swift flowing, turbulent water. Partially exposed substrate dominated by cobble. Gradient moderate (less than 4%). • High gradient — moderately deep with swift flowing, turbulent water. Partially exposed substrate dominated by boulder. Gradient steep (greater than 4%). Generally not modelable.
	B. Non-turbulent:		Channel units having low channel roughness, moderate gradient, laminar flow, and lack of surface turbulence.
		1. Sheet:	Shallow water flowing over smooth bedrock.
		2. Run / Glide:	Shallow (glide) to deep (run) water flowing over a variety of different substrates.
		3. Step Run	A sequence of runs separated by short riffle steps. Substrates are usually cobble and boulder dominated.
		4. Pocket Water:	Swift flowing water with large boulder or bedrock obstructions creating eddies, small backwater, or scour holes. Gradient low to moderate.
II. Slow Water:			Pools; slow, deep stream sections with nearly flat water surface gradient.
	A. Scour Pool:		Formed by scouring action of current.
		1. Trench:	Formed by scouring of bedrock.
		2. Mid-channel:	Formed by channel constriction or downstream hydraulic control.
		3. Convergence	Formed where two stream channels meet.
		4. Lateral:	Formed where flow is deflected by a partial channel obstruction (streambank, rootwad, log, or boulder).
		5. Plunge:	Formed by water dropping vertically over channel obstruction.
	B. Dammed Pool:		Water impounded by channel blockage.
		1. Debris:	Formed by rootwads and logs.
		2. Beaver:	Formed by beaver dam.
		3. Landslide:	Formed by large boulders.
		4. Backwater:	Formed by obstructions along banks (Recorded as a comment or note to mapping).
		5. Abandoned Channel:	Formed along main channel, usually associated with gravel bars (Not part of the main active channel - Recorded as a comment or note to mapping).

2.3 Habitat Mapping

Ground habitat mapping will be conducted on foot by teams of two individuals. Habitat units will be designated using the habitat types described in Table 1. Habitat units will be separately identified where the unit length is at least equal to the active channel width (McCain et al. 1990, Flosi and Reynolds 1994), or if the unit is otherwise distinctive. Figure 2 is a copy of the field form used for the mapping. Teams record the length and width of each habitat type unit using a laser range finder. Mapping will be contiguous (i.e., each habitat unit abuts the next unit, except for split channels, which will have the length measured but individual habitat units within each split will not be mapped but may be identified). The beginning and ending of the mapped section, and every fifth mapped unit, and every tenth characterized habitat unit, will have Global Positioning System (GPS) reading recorded in UTM NAD83 datum; locations may also be added to the field laptop as described above in Section 2.2 for identifying giant cane concentrations. Table 2 provides the definitions and description of the data to be collected that would be entered in Figure 3.

STREAM HABITAT TYPING SURVEY DATA (Camp Far West - South Sutter Water District)

Data Sheet # _____

Stream/Reach/Subreach:_____ Page _____ of _____

Team: _____ Date _____

UTM: _____**NAD 83 (Habitat unit No_____)** PM _____ Map Gradient:_____

Habitat Unit #																				
Habitat Type [1]	**FALL**	**CAS**	**CHU**	**RAP**	**FALL**	**CAS**	**CHU**	**RAP**	**FALL**	**CAS**	**CHU**	**RAP**	**FALL**	**CAS**	**CHU**	**RAP**	**FALL**	**CAS**	**CHU**	**RAP**
	HGR	**LGR**	**GLI**	**RUN**	**HGR**	**LGR**	**GLI**	**RUN**	**HGR**	**LGR**	**GLI**	**RUN**	**HGR**	**LGR**	**GLI**	**RUN**	**HGR**	**LGR**	**GLI**	**RUN**
	STEP	**POW**	**SHT**	**COP**	**STEP**	**POW**	**SHT**	**COP**	**STEP**	**POW**	**SHT**	**COP**	**STEP**	**POW**	**SHT**	**COP**	**STEP**	**POW**	**SHT**	**COP**
*note if dammed pool	**MCP**	**LAP**	**TRP**	**PLP**	**MCP**	**LAP**	**TRP**	**PLP**	**MCP**	**LAP**	**TRP**	**PLP**	**MCP**	**LAP**	**TRP**	**PLP**	**MCP**	**LAP**	**TRP**	**PLP**
Length (ft)																				
Est. Avg. Width (ft)																				
Est. Avg. Pool Depth (ft)																				
Max. Pool Depth (ft)																				
Pooltail Embedded %																				
Significant Cover? [2]	**INSIGNIF VEG**		**BLDR WOOD**		**INSIGNIF VEG**		**BLDR WOOD**		**INSIGNIF VEG**		**BLDR WOOD**		**INSIGNIF VEG**		**BLDR WOOD**		**INSIGNIF VEG**		**BLDR WOOD**	
SUBSTRATE COMPOSITION																				
Dominant Substrate	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**
	GRV	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**
Subdominant Substrate	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**
	GRV	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**
Dominant Bank Substrate	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**	**BED**	**BLD**		**COB**
	GRV	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**	**GRV**	**SND**		**SLT**
Length of LB and RB Exposed Banks (feet)																				
Confinement [4]																				
Unit Flagged/ Labeled? (Y/N)																				
Tributary Inflow in cfs																				
Landmarks or photos																				
Large Woody Debris [5] within bankful width	#	Diameter class		Length class	#	Diameter class		Length class	#	Diameter class		Length class	#	Diameter class		Length class	#	Diameter class		Length class
No. of LWD Pieces within wetted width																				
Fish Migration Barrier [6] **(y/n)?**																				
Giant Cane Accumulation (length, width, ht)																				
Giant cane function																				
Comments / Observations:																				
Fish? Wildlife? Amphibs? Backwater or side chan. amphib habitat? Riparian? Landmarks, Photo #s, Etc.																				

[1] **FALL** = Falls, **CAS** = Cascade, **CHU** = Chute, **RAP** = Rapid, **GLI** = Glide, **RUN** = Run, **STEP** = Step Run, **HGR** = High Gradient Riffle (>4%), **LGR** = Low Gradient Riffle, **POW** = Pocket Water, **SHT** = Sheetflow;
Pools: COP = Convergence, **MCP** = mid-channel pool, **LAP** = Lateral, **TRP** = Trench, **PLP** = Plunge
The minimum unit length should be 1x active channel width, unless there is something notable or unique about it.

[2] Note if cover is a significant or dominant feature of the unit:
(e.g., logs in stream, lots of boulders, >25% surface area has instream or low overhanging vegetation, etc.) **Q/C initials:**

[4] Channel Confinement: **1**=Confined Shallow; **2**=Confined Deep; **3**=Moderate Confined (<2x wetted channel width); **4**=Unconfined (>= 2 wetted channel widths)

[5] Criteria for LWD is:any downed wood at least partially within bankfull width of channel, exceeding 3' length, minimum diameter of 4" at the large end
Size classes: 4-**12",** 12-**24",** 24-**36",or** 36**"+ x** 3-**25',** 25-**50',** 50-**75',** 75**'+** (ie. 4 | 25 = 4-12", 25-50').
Key pieces (longer than 1/2 bankful, or modify channel morph or hab) mapped on IPAD incl. l, d at large end, rootwad?, jam?, function.

[6] Waterfalls, high velocity chutes or cascades at approx bankful flows. NOTE VERTICAL DROP and IF CONDITIONAL or PERMANENT

Notes regarding access points (road condition, bridge crossings, trails, etc.)

Figure 3. Field form used for ground-based habitat mapping.

Table 2. Description of data collected during habitat mapping.

Stream/Reach	Note on every data sheet
Team	Note initials
UTM	Get UTM every 5th unit (NAD 83) - note if at top or bottom or unit
PM & Map Gradient	Note parent material in assessed reach from geologic map; measure gradient from Terrain Nav Pro (office, before or after).
Habitat Unit #	Numbered sequentially, usually from downstream to upstream. Note if this is not the case
Habitat Type	Circle one of the choices, or write something else in if necessary (e.g., "marsh")
Length (ft)	Measured in feet, with hip chain. Clean up your string periodically
Estimated Average Width (ft)	Average width of entire unit, estimated by eye, periodically checking your estimates with a stadia rod or tape. Usually this is bankfull, but in this regulated system, bankfull is hard to describe. Define the "low-flow active channel" where there is hydraulic connectivity with the low flow channel. The boundary is usually marked by a distinctive change to vegetation more dominated by upland species.
Estimated Average Pool Depth (ft)	Where practical, take some measurements across the channel to help develop your estimate. Particularly interested in whether most of the pool is greater than 3 ft deep or not.
Estimated Maximum Pool Depth (ft)	Measure where practical. Estimate otherwise
Pooltail Embedded	Degree to which gravel or larger substrates are vertically embedded in sand or smaller substrates.
Significant Cover?	Is cover a dominant feature of the unit? Or is it just a bit of veg overhang on the edges, and some boulder substrate?
Dominant Substrate	Dominant particle size, by area. Silt, Sand (<2mm or 1/8"), Gravel (2-64mm or 1/8-2.5"), Cobble (64-256mm or 2.5-10"), Boulder (>0"), Bedrock
Subdominant Substrate	Next most dominant particle size, by area
Dominant Bank Substrate	Dominant particle size, by area. Silt, Sand (<2mm or 1/8"), Gravel (2-64mm or 1/8-2.5"), Cobble (64-256mm or 2.5-10"), Boulder (>10"), Bedrock - for the bank.
Bank Erosion (ft)	If stream banks are exposed and actively eroding and provided sediment to the active stream channel, quantify the total length on both the right and left banks (cumulative distance) as you are walking along and total in this column.
Confinement	Channel Confinement: 1=Confined Shallow (<4'); 2=Confined Deep (>4'); 3=Moderate Confined (<2x wetted channel width); 4=Unconfined (≥2 wetted channel widths)
Tributary Inflow in cfs	Estimate trib inflow, and get water temperature of the trib and mainstem upstream of it. GPS the location.
Unit Flagged/Labeled (Y/N)	Flag units frequently, near a unit boundary, indicating up and downstream unit numbers. Label with metal tags a little less frequently. Frequency depends on length of units. Think about a year from now, how far would you like to hike up and downstream with a group of stakeholders, looking for positive identification of which habitat unit you were in? Generally marking every 5 units is a good idea, but it really depends on how long the units are.
Landmarks	Note if landmarks are near unit, to help relocate it. e.g., trib confluences, roads, bridges, trails, unique rock formations or bedrock outcrops, large trees of an atypical species, man-made structures or quasi permanent debris, campgrounds, waterfalls, old car bodies, etc. "Big rock" or "tall tree" are not very helpful. GPS whenever possible and convenient, particularly if it has been awhile since you were at a good landmark. River Left or River Right is looking downstream.
Large Woody Debris (all or part within bankfull)	Note all of it along the way, by habitat unit number. "All pieces of wood lying within the bankfull width of the channel that exceed 3' length, and 4" diameter at the large end. Wood must be both downed, and with a portion lying within the bankfull channel, and dead or dying to be considered LWD. Divide into average size classes, and tally the total number of LWD pieces in each size class." Size classes we will use are maximum diameters of 4-12 inches, 12-24, 24-36, or >36 inches. Lengths are 3-25, 25-50, 50-75 and >75 feet. These are total lengths, not just length in the channel. KEY LWD has to measure 1/2 bankfull width or longer or longer to be counted, so which length classes you might use are dependent on stream width (e.g., a 30ft wide stream would only use classes from 10-25ft on up, because the log would have to be at least 15ft to be counted). Additional key pieces may also be deposited in such a manner that alters channel morphology and/or aquatic habitat such as trapping sediment or altering flow pattern. Put key pieces on IPAD and add length, diameter at large end, if it has a root wad, and if it is part of a jam
Large Woody Debris (in wetted width)	Separate category: the number of pieces found within the wetted width
Fish Migration Barrier?	Note significant waterfalls or high velocity chutes, or any weirs or other man-made obstacles. Be sure to GPS it.
Giant cane accumulations	Estimate length, width, and height of giant cane accumulation. Place location on IPAD. Note function: creates backwater, forces pool/scour, traps and sorts sediment, creates side channel, or other (give description).
Comments/Observations	
Fish? Wildlife? Amphibians? Backwater or side channel amphibian habitat? Riparian? Etc.	Did you see some adult or juvenile fish? Idea of species? Any wildlife, such as deer, otters, amphibians, etc. that the wildlife biologists would be interested in? Are there wet backwater or side channel areas, especially with nearby or overhanging cover, that provides good habitat for amphibians, that the amphibian biologists might want to consider for TES species surveys? If you find good amphibian habitat, GPS it. Is the riparian vegetation notably lush, or wide, or are you in a marsh area?
QA/QC	Non-notetaker checks all columns and boxes after sheet is full to make sure everything is filled out.

The habitat attributes defined in Table 2 were quantified and recorded for each unit mapped. Two levels of ground-based mapping occurred:

- "Fully mapped" units which include quantified variables such as bankfull width, pool depth, substrate, large woody debris (LWD), substrate and bank material, etc. (Figure 2, Table 2)
- "Characterized" units which note the meso-habitat type, length, maximum pool depth, and some with photographs and/or comments of notable details such as the existence of frogs, access and mining activity.
- Along the entire length: LWD will be tallied, key LWD pieces will be marked on the IPAD, giant cane accumulations will be marked on the IPAD.

Habitat frequency will be based on the total length of each habitat type as a percentage of the entire length mapped.

Crews will identify potential barriers to upstream anadromous fish movement using professional judgment and used handheld GPS units to record the locations. Significant tributary junctions and potential fish passage barriers will be noted within the habitat unit in which they occur.

Photographs will be taken of each fully mapped and at many characterized habitat units, generally from the bank or center of channel looking upstream. Occasionally, photos may need to be taken from the banks or from the top of the unit looking downstream, but these differences will be noted. Photographs will be organized into a Word document and labeled with the original unit number; within the reach it was mapped. Summaries of the field data will be entered into an Excel data workbook and data will be summarized into tables and charts and provided electronically.

Prior to mapping, the USGS gage at Highway 65 was visited to determine the level of the water at a 1.5 and 2.5 year return frequency. These are return intervals generally associated with bankfull discharge in unregulated systems. However, in a regulated system, the low flow active channel is important hydrologically because the releases from the diversion dam control timing and volume. Since Camp Far West has no sluice gates, Bear River is also subject to higher and more frequent floods than generally seen in other regulated systems. The stage of the 1.5 and 2.5 year frequency floods was noted at the gage site and used in many of the habitat unit measurements to get an idea of where the frequent flood flows were reaching.

Constructed and natural levees have created an incised channel wherein the 1.5 yr. recurrence interval flows (6.45 ft. staff gage, 2,656 cfs, Figure 4) will flood the entire river plain. Figures 5, 6, and 7 show the low flow active channel (about 4.16 staff gage, 916 cfs), the 1.5 yr. stage (6.45 ft. staff gage, 2,656 cfs), and 2.5 yr. recurrence interval (11.45 staff gage, 7,894 cfs).

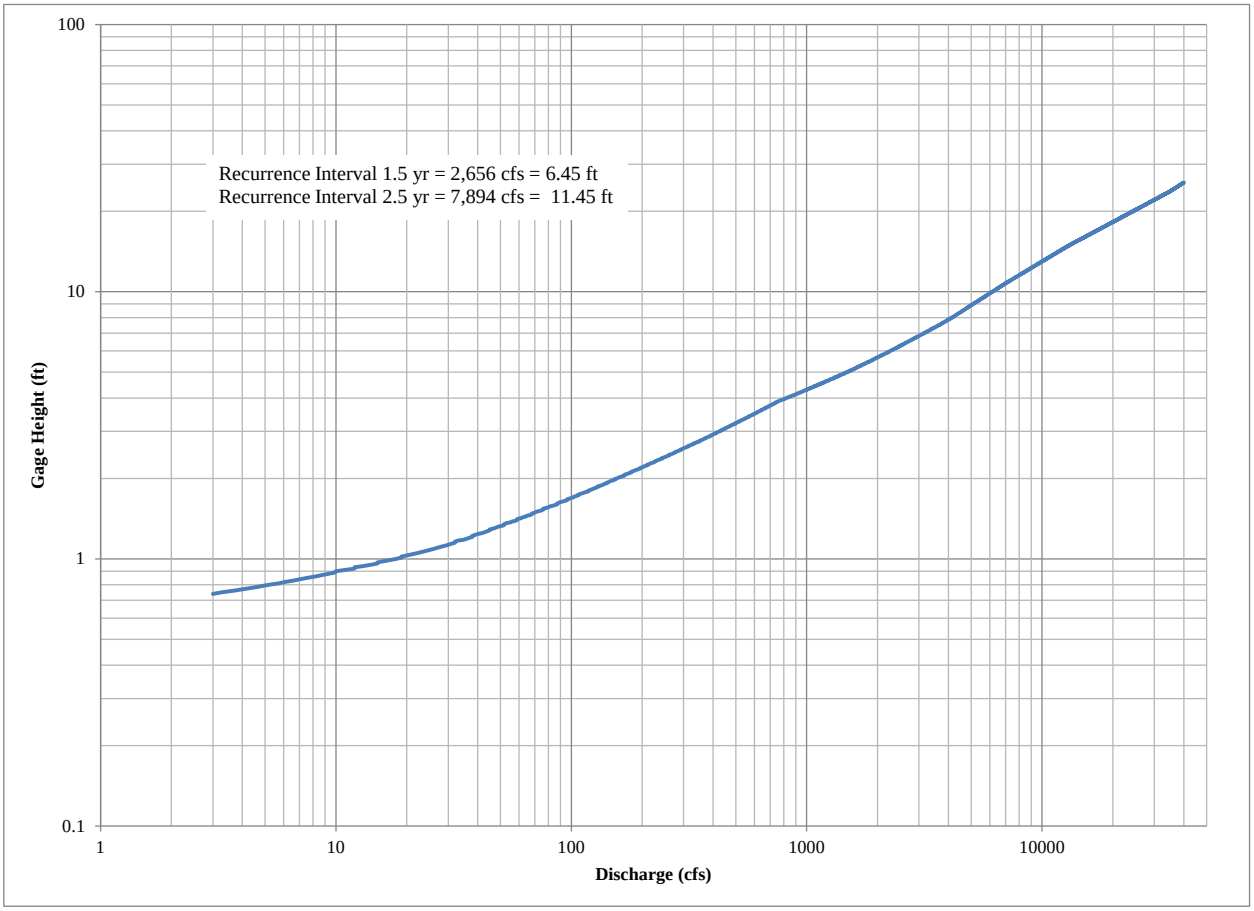

Figure 4. Rating curve for USGS Gage 11424000 near Wheatland at Highway 65 (RM 11.5) based on regulated flow data 1964-2015.

Figure 5. Bear River near Wheatland (RM 11.5, USGS gage 1142400). Stadia rod is being held at the "low flow active channel" where the vegetation transitions from hydric to more terrestrial types. Rough estimate of staff gage elevation is 4.16 ft. (916 cfs). Flow at gage on date of measurement (6-10-15) was 26 cfs.

Figure 6. Bear River near Wheatland (RM 11.5, USGS gage 1142400). Stadia rod is being held at the 1.5 yr. recurrence interval at staff gage elevation of 6.45 ft. (2,656 cfs).

Figure 7. Bear River near Wheatland (RM 11.5, USGS gage 1142400). Stadia rod is being held at the 2.5 yr. recurrence interval at staff gage elevation of 11.45 ft. (7,894 cfs).

3.0 References Cited

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

Flosi, G., and F. L. Reynolds. 1994. California salmonid stream habitat restoration manual, 2nd edition. California Department of Fish and Game, Sacramento, California, USA.

Hawkins, C. P., J. L. Kershner, P. A. Bisson, M. D. Bryant, L. M. Decker, S. V. Gregory, D. A. McCullough, C. K. Overton, G. H. Reeves, R. J. Steedman, and M. K. Young. 1993. A hierarchical approach to classifying habitats in small streams. Fisheries. 18(6): 3-12.

McCain, M., D. Fuller, L. Decker, and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHR Currents: R-5's fish habitat relationships technical bulletin. No. 1. US Dept. of Agriculture, Forest Service, Pacific Southwest Region, Arcata, California.

McMahon, T.E., A.V. Zale, and D.J. Orth. 1996. Aquatic Habitat Measurements. Pages 83-120 IN B. Murphy and D. Willis, (eds.). Fisheries Techniques, 2nd edition. American Fisheries Society.

Page Left Blank

Study 4.1

SPECIAL-STATUS PLANTS AND NON-NATIVE INVASIVE PLANTS STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an effect on special-status plants and lead to the spread of non-native invasive plants (NNIP).

For the purpose of this Special-status Plants Study (Study), a special-status plant is a plant species that has a reasonable possibility of being affected by Project O&M or associated recreation and meets one or more of the following criteria: 1) is listed by the Sacramento, California, office of the United States Department of the Interior, Fish and Wildlife Service (USFWS) as a Species of Concern (USFWS-S); 2) listed by the California Department of Fish and Wildlife (Cal Fish and Wildlife) as a California Rare (SR) species under the Native Species Plant Protection Act; 3) Fully Protected (FP) under California law; 4) listed as threatened or endangered under the California Endangered Species Act (CESA); or 5) listed on the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Plants.[1]

For the purpose of this Study, NNIP an NNIP is a plant species listed as a noxious weed by the California Department of Food and Agriculture (CDFA).[2,3]

2.0 Study Goals and Objectives

The goal of this Study is to supplement existing information regarding special-status plant species or the spread of NNIPs.

The objective of this Study is to gather the information necessary to meet the Study goal.

The Study does not include the development of potential requirements in the new license.

[1] Botanical species listed as threatened or endangered, or a candidate or proposed for listing, under the Endangered Species Act (ESA) are addressed in a SSWD's relicensing Study 5.1, ESA-Listed Plants.

[2] CDFA-designated noxious weeds are typically assigned one of three ratings: 1) A-list plants are mandated for eradication or control; 2) B-list plants are widespread plants that Agricultural Commissioners may designate for local control efforts; and 3) C-list plants are considered too widespread to control (CDFA 2015).

[3] Aquatic invasive plants, including algae, are not addressed in this Study.

3.0 Existing Information and Need for Additional Information

3.1 Special-status Plants

Existing, relevant and reasonably available information regarding botanical resources and special-status plants in the Project Vicinity[4] is provided in Section 3.2.4.2 of SSWD's Pre-Application Document (PAD). SSWD identified 13 special-status plants species known to occur or with the potential to occur in the Project Vicinity, five of which were in United States Geological Survey (USGS) 1:24,000 scale topographic quadrangles containing the existing Federal Energy Regulatory Commission (FERC) Project Boundary. Table 3.1-1 provides for each of these special-status plants: 1) status; 2) flowering period; 3) elevation range; 4) habitat requirements; 5) USGS quadrangle; and 6) documented occurrence in the Project Vicinity. The list has been developed as a guide of species likely to occur within the existing FERC Project Boundary; however, all special-status plant species located during the Study will be mapped and reported.

Table 3.1-1. Special-status plants known or with the potential to occur in the Project Vicinity.

Common Name/ Scientific Name	Status[1]	Flowering Period	Elevation Range (ft)	Habitat Requirements	USGS Quadrangle(s)	Known From Project
FOUND WITHIN QUARDRANGLES THAT INCLUDE THE FERC PROJECT BOUNDARY						
Mexican mosquito fern *(Azolla mexicana)*	CRPR 4.2	Aug	100-330	Marshes and swamps, ponds, slow water	Wolf	Yes, one occurrence found in seep 3, which was located along the North Shore Recreation Area
Brandegee's clarkia *(Clarkia biloba* ssp. *brandegeeae)*	CRPR 4.2	May-Jul	200-3,000	Chaparral, cismontane woodland, often roadcuts	Wolf, Camp Far West, Auburn, Gold Hill, Rough and Ready, Lake Combie, Grass Valley	Yes, two small occurrences along the south side of 'riverine' reach of the reservoir
Stinkbells *(Fritillaria agrestis)*	CRPR 4.2	Mar-Jun	32-5,100	Chaparral, cismontane woodland, valley and foothill grasslands, clay and sometimes serpentinite	Camp Far West	No
Humboldt lily *(Lilium humboldtii* ssp. *humboldtii)*	CRPR 4.2	May-Jul	295-4,200	Chaparral, cismontane woodland, lower montane woodland	Wolf, Auburn, Grass Valley, Lake Combie	No
Brazilian watermeal *(Wolffia brasilensis)*	CRPR 2B.3	Apr-Dec	65-330	Marshes and swamps (assorted shallow freshwater)	Camp Far West	No
Subtotal	*5*					
FOUND WITHIN QUARDRANGLES THAT DO NOT INCLUDE THE FERC PROJECT BOUNDARY						
Big-scale balsamroot (*Balsamorhiza macrolepis)*	CRPR 1B.2	Mar-Jun	300-4,600	Chaparral, cismontane woodland, and valley and foothill grassland (sometimes serpentine)	Lincoln	No, though potential habitat present

[4] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

Table 3.1-1. (continued)

Common Name/ Scientific Name	Status[1]	Flowering Period	Elevation Range (ft)	Habitat Requirements	USGS Quadrangle(s)	Known From Project
FOUND WITHIN QUARDRANGLES THAT DO NOT INCLUDE THE FERC PROJECT BOUNDARY (cont'd)						
Sierra foothills brodiaea *(Brodiaea sierra)*	CRPR 4.3	May-Aug	164-3,100	Chaparral, cismontane woodland, usually serpentinite or gabbroic	Rough and Ready, Grass Valley, Smartville	Yes, one occurrence along south side of 'riverine' reach of reservoir[2]
Dwarf downingia *(Downingia pusilla)*	CRPR 2B.2	Mar-May	0-1,400	Valley and foothill grassland, vernal pools	Sheridan, Lincoln, Browns Valley	No
Boggs Lake hedge-hyssop (*Gratiola heterosepala)*	CRPR 1B.2, SE	Apr-Aug	30-7,880	Marshes, swamps, and vernal pools	Lincoln	No
Ahart's dwarf rush *(Juncus leiospermus* var. *ahartii)*	CRPR 1B.2	Mar-May	100-750	Valley and foothill grassland	Lincoln	No
Legenere (*Legenere limosa*)	CRPR 1B.1	Apr-Jun	0-2,900	Vernal pools	Browns Valley	No
Brown beaked rush *(Rhynchospora capitellata)*	CRPR 2B.2	Jul-Aug	150-6,600	Lower montane coniferous forest, meadows and seeps, marshes and swamps, upper montane forest	Grass Valley	No
Pincushion navarretia *(Navarretia myersii* ssp. *myersii)*	CRPR 1B.1	Apr-May	65-1,085	Vernal pools, often acidic	Lincoln	No
Subtotal	*8*					
Total	**13**					

Sources: CNPS 2015, Sycamore Associates 2013

[1] Special-status (CDFW 2015, USFWS 2015):
CRPR: California Rare Plant Rank (CNPS 2015)
1B: Species considered rare, threatened or endangered in California and elsewhere
2: Species considered rare, threatened or endangered in California, but more common elsewhere
3: More information needed about this species; review list
4: Limited distribution; watch list
.1: Species seriously threatened in California
.2: Species moderately threatened in California
.3: Species not very threatened in California
SE = State Endangered

[2] This occurrence from Sycamore Associates in 2013 is not yet in any of the online databases.

Additional information, which will be provided by this Study, is needed to address the Study goal regarding the specific location of special-status plants in relation to Project facilities, Project O&M activities, Project recreation, and any other Project-related activities that might affect special-status plants.

3.2 Non-native Invasive Plants

Existing, relevant and reasonably available information regarding NNIPs in the Project Vicinity is provided in Section 3.2.4.2 of SSWD's Pre-Application Document (PAD). SSWD identified 38 NNIP species with a reasonable potential to be affected by the Project. Table 4.0-1 provides a target list of NNIPs for this study, including the following general information for each plant: 1)

scientific name; 2) common name; 3) CDFA status; 4) flowering period; 5) elevation; 6) preferred habitat and 7) known occurrence on the Project. Data to be collected will be based on the CDFA status: any species ranked A, B or Q will receive a quantitative analysis; any species ranked C will receive a qualitative analysis.

Table 3.2-1. NNIPs known to occur or potentially occurring in the Project Vicinity.

Common Name/ Scientific Name	CDFA Status	Flowering Period	Elevation (ft)	Habitat
KNOWN TO OCCUR WITHIN THE EXISTING FERC PROJECT BOUNDARY				
Barb goatgrass *(Aegilops triuncialis)*	B	May-Aug	Below 3,300	Disturbed sites, cultivated fields, roadsides
Italian thistle *(Carduus pycnocephalus)*	B	May-Jul	Below 3,300	Roadsides, pastures, waste areas
Yellow starthistle *(Centaurea solstitialis)*	C	Jun-Dec	Below 4,300	Pastures, roadsides, disturbed grassland or woodland
Rush skeletonweed *(Chondrilla juncea)*	A	May-Dec	Below 2,000	Disturbed areas
Bermudagrass *(Cynodon dactylon)*	C	Jun-Aug	Below 3,000	Disturbed areas
Klamathweed *(Hypericum perforatum)*	C	Jun-Sep	Below 5,000	Rangeland areas, pastures, fields, roadsides, forest clearings, burned areas
Subtotal	*6*			
NOT KNOWN TO OCCUR WITHIN THE EXISTING FERC PROJECT BOUNDARY				
Russian knapweed *(Acroptilon repens)*	A	May-Sept	Below 6,200	Fields, roadsides, cultivated ground, disturbed areas
Camelthorn *(Alhagi maurorum)*	A	Jun-Aug	Below 1,640	Agricultural areas, riverbanks
Alligatorweed *(Alternanthera philoxeroides)*	A	Jun-Oct	Below 700	Shallow water, wet soils, ditches, marshes, pond margins, slow-moving watercourse
Capeweed *(Arctotheca calendula)*	A	Mar-Jun	Below 820	Disturbed sites
Plumeless thistle *(Carduus acanthoides)*	A	May-Aug	Below 4,300	Roadsides, pastures, waste areas
Musk thistle *(Carduus nutans)*	A	Jun-Jul	330-4,000	Roadsides, pastures, waste areas
Slenderflower thistle *(Carduus tenuiflorus)*	C	May-Jul	Below 3,300	Disturbed sites, roadsides, pastures, annual grasslands, waste areas
Woolly distaff thistle *(Carthamus lanatus)*	B	July-Aug	Below 3,600	Disturbed sites
Purple starthistle *(Centaurea calcitrapa)*	B	Jul-Oct	Below 3,300	Disturbed areas
Diffuse knapweed *(Centaurea diffusa)*	A	Jun-Sep	Below 7,600	Fields, roadsides
Spotted knapweed *(Centaurea stoebe* ssp. *micranthos)*	A	July-Aug	Below 8,500	Open disturbed sites, grasslands, forested areas, roadsides
Squarrose knapweed *(Centaurea virgate* var. *squarrosa)*	A	Jun-Aug	Below 4,600	Degraded rangelands
Canada thistle *(Cirisum arvense)*	B	Jun-Sep	Below 5,900	Disturbed areas
Artichoke thistle *(Cynara cardunculus)*	B	Apr-Jul	Below 1,640	Disturbed sites, open sites in grasslands, pasture, chaparral, riparian areas, abandoned agricultural fields
Scotch broom *(Cytisus scoparius)*	C	Mar-Jun	Below 3,300	Disturbed areas
Water hyacinth *(Eichhornia crassipes)*	C	Jun-Oct	Below 650	Ponds, sloughs, waterways
Medusahead *(Elymus caput-medusae)*	C	Apr-Jul	Below 6,900	Disturbed sites, grassland, openings in oak woodlands and chaparral
Oblong spurge *(Euphorbia oblongata)*	B	Apr-Aug	Below 3,300	Waste areas, disturbed sites, roadsides, fields

Table 3.2-1. (continued)

NOT KNOWN TO OCCUR WITHIN THE EXISTING FERC PROJECT BOUNDARY (continued)				
Leafy spurge *(Euphorbia virgate)*	A	Jun-Sep	Below 4,600	Waste areas, disturbed sites, roadsides, fields
Japanese knotweed *(Fallopia japonica)*	B	Jul-Oct	Below 3,300	Disturbed moist sites, roadsides, and riparian and wetland areas, upland sites where water tables are shallow
Giant knotweed *(Fallopia sachalinensis)*	B	Jul-Oct	Below 1,640	Disturbed moist sites, roadsides, and riparian and wetland areas
French broom *(Genista monspessulana)*	C	Mar-May	Below 1,600	Disturbed areas
Hydrilla *(Hydrilla verticillata)*	A	Jun-Aug	Below 650	Ditches, canals, ponds, reservoirs, lakes
Dyer's woad *(Isatis tinctoria)*	B	Apr-Jun	Below 3,300	Roadsides, fields, disturbed sites
Hairy whitetop *(Lepidium appelianum)*	B	Apr-Oct	Below 6,600	Disturbed open sites, fields, pastures
Lense-podded whitetop *(Lepidium chalepense)*	B	Apr-Aug	Below 5,000	Disturbed open sites, fields, pastures
White-top *(Lepidium draba)*	B	Apr-Aug	Below 5,000	Disturbed, generally saline soils, fields
Dalmation toadflax *(Linaria genistifolia* ssp. *dalmatica)*	A	May-Sep	Below 3,300	Disturbed places, pastures, fields
Purple loosestrife *(Lythrum salicaria)*	B	Jun-Sep	Below 5,300	Seasonal wetlands, ditches, cultivated fields
Scotch thistle *(Onopordum acanthium)*	A	Jul-Sep	Below 5,300	Disturbed areas
Tansy ragwort *(Senecio jacobaea)*	B	Jul-Sep	Below 5,000	Disturbed sites, waste places, roadsides, fields
Gorse *(Ulex europaeus)*	B	Nov-Jul	Below 1,300	Disturbed areas
Subtotal	*32*			
Total	**38**			

Sources: NRCS 2015; Cal-IPC 2015; CDFA 2015; DiTamaso and Healy 2007; Sycamore Associates 2013

Additional information, which will be provided by this Study, is needed to address the Study goal reading the potential for the spread of NNIP.

4.0 Study Methods

4.1 Study Area

The Study Area consists of four specific areas, each with a 100-foot-wide buffer around them, within the existing FERC Project Boundary: 1) the North Shore Recreation Area (NSRA); 2) the South Shore Recreation Area (SSRA); 3) the Camp Far West Dam and associated dikes and Spillway; and 4) the Camp Far West Dam Powerhouse, for a total of 505 acres. These are the areas where SSWD's Project O&M activities or Project-related recreation could affect special-status plants or spread NNIP. The facilities are described in Section 2 of SSWD's PAD, and the Study Area is shown in Figure 4.1-1.

If SSWD proposes an addition to the Project, the Study Area will be expanded, if necessary, to include areas potentially affected by the addition.

Page Left Blank

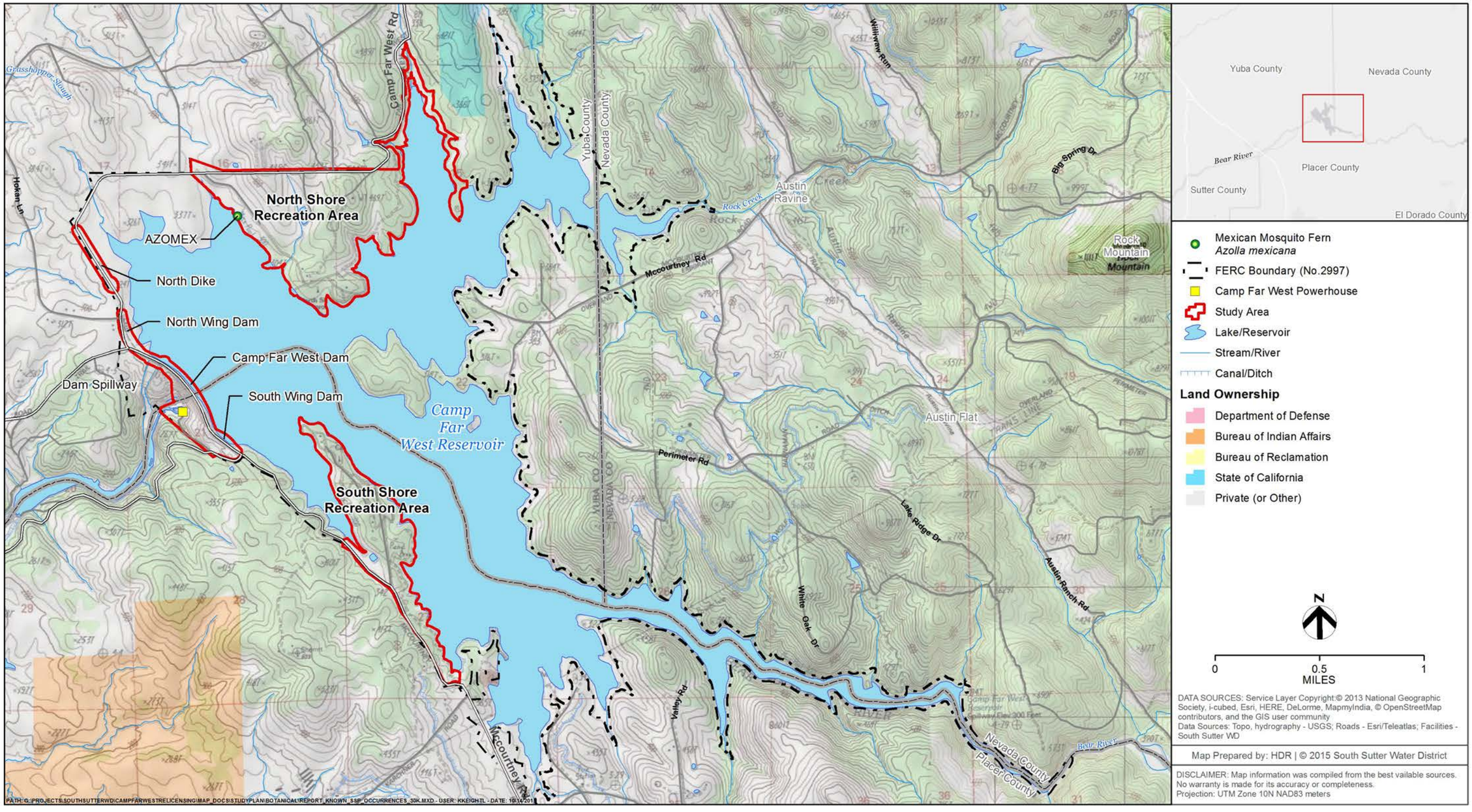

Figure 4.1-1. Study Area for Special-status Plants and NNIP.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or State Water Resources Control Board in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

Study methods will consist of the following four steps: 1) gather data and prepare for field effort; 2) conduct field surveys; 3) prepare data and quality assure/quality control (QA/QC) data; and 4) consult with SSWD's Project operations staff. Each step is described below.

4.3.1 Step 1 – Gather Data and Prepare for Field Efforts

SSWD will identify and map known occurrences of special-status plants within the Study Area, and prepare field maps for use by field survey teams. The maps will include aerial imagery, Project features, and known special-status plant and NNIP occurrences. Survey timing will be planned based on herbarium collection dates. The map will be used for guidance purpose only; all special-status plant species and NNIP located during the Study will be ultimately mapped and reported.

4.3.2 Step 2 – Conduct Field Surveys

In conjunction with SSWD's relicensing Study 5.1, *ESA-Listed Plants*, and Study 5.2, *ESA-Listed Wildlife – Valley Elderberry Longhorn Beetle*, SSWD's surveyors will conduct special-

status plant and NNIP surveys as outlined in the "Botanical Survey" section of the Cal Fish and Wildlife's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG 2009). Surveys will be comprehensive over the entire Study Area, except for areas deemed to be unsafe (e.g., due to steep, unstable terrain) by the field team, using systematic field techniques to ensure thorough coverage, with additional efforts focused in habitats with a higher probability of supporting special-status plants (e.g., serpentine outcrops) and NNIP. Surveys will be floristic in nature, documenting all species observed; taxonomy and nomenclature will be based on *The Jepson Manual* (Baldwin et al. 2012).

When special-status plants are documented within the Study Area, the following information will be collected:

- Digital photographs to describe the occurrence, its habitat, and any potential threats (i.e., at least one digital photograph will be collected for each occurrence, with other photographs to document potential threats, or as needed).
- Estimated area (i.e., approximate length and width) covered by the special-status plant population and estimated number of individual plants in the population. If plant population is estimated to cover an area greater than 0.1 acre (ac), surveyors will delineate the occurrence boundary using a GPS unit, collecting either polygon data, or sufficient point data that a realistic occurrence polygon can be constructed from the point data using GIS. For occurrences less than 0.1 ac in size, the location of the approximate center of the occurrence will be taken as point data using a GPS unit.
- Dominant and subdominant vegetation in the area.
- Estimated distance to nearest Project facility, feature, or Project-related activity.
- Activities observed in the vicinity of the population that have a potential to adversely affect the population (e.g., recreational trails and uses).
- Estimated phenology and descriptions of reproductive state.

When NNIP are found within the Study Area, the following information will be collected:

- Digital photographs, if needed, to describe the occurrence.
- For those species where "quantitative" data is required, if a plant population is estimated to cover an area greater than 0.1 ac, or if the occurrence is linear (e.g., as along a road) and greater than 100 ft long, surveyors will delineate the approximate occurrence boundary, or end-points in the case of a linear occurrence, using a handheld GPS with an accuracy of 50 ft. If occurrences are smaller than those dimensions, only a single central GPS point is needed to indicate the location of the occurrence. If a single GPS point is used to map an occurrence, the area of the NNIP population will be estimated using one of two acreage classes: up to 0.01 ac, and 0.01 to 0.1 ac. The NNIP cover of the occurrence will be characterized as either concentrated or diffuse.
- NNIP indicated with the descriptor "qualitative" will be described more generally. These

species tend to produce large or diffuse populations that may be unwieldy to map in detail. These "qualitative" species need only be mapped using a single GPS point near the center of the occurrence to indicate an occurrence. The area of the infestation will be estimated into one of four acreage classes: up to 0.1 ac, 0.1-0.25 ac, 0.25-4.0 ac, and greater than 4 ac. The NNIP cover of the occurrence will be characterized as either concentrated or diffuse.

- Estimated distance to nearest Project facility, feature, or Project-related activity.
- Activities observed in the vicinity of the NNIP population that have a potential to spread NNIPs.
- Estimated phenology and descriptions of reproductive state of that invasive occurrence.

4.3.3 Step 3 – Prepare Data and Quality Assure/Quality Control Data

Following field surveys, SSWD will develop GIS maps depicting special-status plant and NNIP occurrences, Project facilities, features, and specific Project-related impacts (e.g., dispersed use camping) and other related information collected during the Study. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes to verify locations of mapped occurrences.

4.3.4 Step 4 – Consult with SSWD's Project Operations Staff

Once the locations of occurrences in the Study Area are defined, SSWD's O&M staff will be consulted to identify Project O&M and Project-related activities that typically occur in the area of the special-status plant and NNIP occurrences that have a potential to adversely affect the special-status species or spread NNIPs.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric project (FERC No. 2179), and uses standard botanical survey methods as defined by Cal Fish and Wildlife.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... March 2017
Fieldwork ..... April 2017 – October 2017
QA/QC Review ..... Novemeber 2017

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this Study in 2016 dollars is between $81,500 and $99,500.

8.0 References Cited

Baldwin, B.G., D.H. Goldman, D.J. Keil, R. Patterson, T.J. Rosatti, and D.H. Wilken, editors. 2012. The Jepson manual: vascular plants of California, second edition. University of California Press, Berkeley.

California Department of Food and Agriculture (CDFA). 2015. Encycloweedia – Weed Ratings. Available online: <http://www/cdfa/ca/gov/plant/ipc/encycloweedia/winfo_weedratings.html>. Accessed August 8, 2015. California Department of Food and Agriculture, Sacramento, CA.

California Department of Fish and Wildlife (CDFW). 2015. California Natural Diversity Database. RareFind 5. Available online: <http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp>. Accessed July 1, 2015. California Department of Fish and Wildlife, Sacramento, CA.

California Department of Fish and Game (CDFG). 2009. Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities. Available online: <www.fws.gov/sacramento/ es/.../Listed_plant_survey_guidelines.PDF>

California Invasive Plant Council (Cal-IPC). 2015. California Invasive Plant Inventory Database. Available online: < http://www.cal-ipc.org/paf/>. Accessed: July 2, 2015. California Invasive Plant Council, Berkeley, CA.

California Native Plant Society (CNPS). 2015. California Native Plant Society Rare Plant Program – The California Rare Plant Ranking System. Available online: <http://www.cnps.org/cnps/rareplants/ranking.php>. Accessed July 2, 2015. California Native Plant Society, Sacramento, CA.

Sycamore Environmental Consultants, Inc. 2013. Biological Assessment: Camp Far West Reservoir Project. FERC No. P-2997. Sacramento, CA.

United States Department of Agriculture, Natural Resources Conservation Service (NRCS). 2015. California State-listed Noxious Weeds. Available online: < http://plants.usda.gov/java/noxious?rptType=State&statefips=06>. Accessed: August 8, 2015. United States Department of Agriculture, Natural Resources Conservation Service, Davis, CA.

United States Fish and Wildlife Service (USFWS). 2015. IPaC Information for Planning and Conservation; Version 2.1.0. IPaC Trust Resources Report for Nevada, Placer and Yuba counties, California. Available online: <http://ecos.fws.gov/ipac/>. Accessed July 1, 2015. United States Fish and Wildlife Service, Sacramento, CA.

Study 4.2

SPECIAL-STATUS WILDLIFE – RAPTORS

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) has the potential to affect special-status raptors.[1]

For the purpose of this Special-Status Wildlife – Raptors Study (Study), a special-status wildlife raptor species is a species that has a reasonable possibility of being affected by Project O&M or associated recreation and meets one or more of the following criteria: 1) protected under the Bald and Golden Eagle Protection Act (BGEPA); 2) protected under the Migratory Bird Treaty Act; 3) designated by United States Fish and Wildlife Service (USFWS) as a Bird of Conservation Concern (BCC); 4) listed by the Sacramento, CA, USFWS as Sensitive (USFWS-S); 5) designated by the California Department of Fish and Wildlife (Cal Fish and Wildlife) as a Species of Special Concern (SSC); 6) listed as threatened (ST) or endangered (SE), or a candidate or proposed for listing under the California Endangered Species Act (CESA); or 7) Fully Protected under California law (FP).

2.0 Study Goals and Objectives

The goal of this study is to supplement existing information regarding special-status raptors.

The objective of this study is to gather information, including: 1) identify and map the location of nesting sites; 2) document the presence of special-status raptors necessary to make this determination when surveys are performed; 3) identify important roosting or hunting perches; and 4) compile incidental observations of other raptors observed while conducting the study.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing and relevant information regarding known and potentially occurring special-status raptors in the Project Vicinity[2] is provided in Sections 3.2.4.3 and 3.2.4.4 of SSWD's Pre-Application Document (PAD). SSWD identified three special-status raptors that are known or have the potential to occur within the existing Federal Energy Regulatory Commission (FERC)

[1] A "raptor" is defined as a bird of prey, and are normally divided into two main groups, the diurnal (day-flying) raptors and the nocturnal (night-flying) raptors; the latter better known as owls. This Study focuses on day-flying raptors.

[2] For the purposes of the relicensing, the "Project Vicinity" is defined as the area surrounding the Project in the order of a county or USDOI, United States Geological Survey (USGS) 1:24,000 topographic quadrangle.

Project Boundary. Table 3.0-1 provides for each of these species: 1) special status; 2) suitable habitat type; and 3) recorded occurrence in the Project Vicinity.

Table 3.0-1. Special-status raptor species known to occur or likely to occur in the Project Vicinity.

Bat Species	Special Status[1]	Suitable Habitat Type	Occurrence in Project Vicinity
Bald eagle *(Haliaeetus leucocephalus)*	SE, FP & BCC	Breeding habitat usually includes areas close to coastal areas, bays, rivers, lakes, or other bodies of water that reflect the general availability of primary food sources. Preferentially roosts in conifers or other sheltered sites in winter in some areas.	The species is known to occur within the Project Vicinity (Sycamore Associates 2013). Bald eagles and a nest were observed during BA surveys on 'riverine' arm of reservoir (Sycamore Associates 2013). A bald eagle was observed at the SSRA on September 15, 2015 during SSWD's bat surveys.
Golden eagle *(Aquila chrysaetos)*	FP & BCC	Generally open country, in prairies, arctic and alpine tundra, open wooded country, and barren areas, especially in hilly or mountainous regions.	The species was identified as having the potential to occur within the Project Vicinity.
Long-eared owl *(Asio otus)*	SSC	Riparian bottomland forest with over story of willows (*Salix* sp.) and cottonwoods (*Populus* sp.); riparian forest along stream corridors (often dominated by live oak trees). Wooded areas with dense vegetation needed for roosting and nesting, adjacent open areas needed for hunting.	The species was identified as having the potential to occur within the Project Vicinity.
Northern harrier *(Circus cyaneus)*	SSC	Marshes, meadows, grasslands, and cultivated fields.	The species was identified as having the potential to occur within the Project Vicinity.
Short-eared owl *(Asio flammeus)*	SSC	Broad expanses of open land with low vegetation for nesting and foraging are required.	The species was identified as having the potential to occur within the Project Vicinity.
Swainson's hawk *(Buteo swainsoni)*	ST	Breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs and agricultural or ranch.	This species was found adjacent to the Project Vicinity within the Nicolaus, Sheridan, Wheatland and Verona quads.
White-tailed kite *(Elanus leucurus)*	FP	Savanna, open woodland, marshes, partially cleared lands and cultivated fields, mostly in lowland situations.	The species was identified as having the potential to occur within the Project Vicinity.

Source: CDFW 2015

[1] Status:
BCC= Bird of Conservation Concern
ST= State Threatened
FP= Fully Protected
SE= State Endangered
SSC= Species of Special Concern

Additional information, which will be provided by this Study, is needed to address the Study goal. The Study will identify the specific location of special-status raptors in relation to Project facilities, and normal Project O&M activities that might affect these special-status raptor species.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area encompasses the FERC Project Boundary encompassing the Camp Far West Reservoir. The Study Area is shown in Figure 4.1-1.

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

Page Left Blank

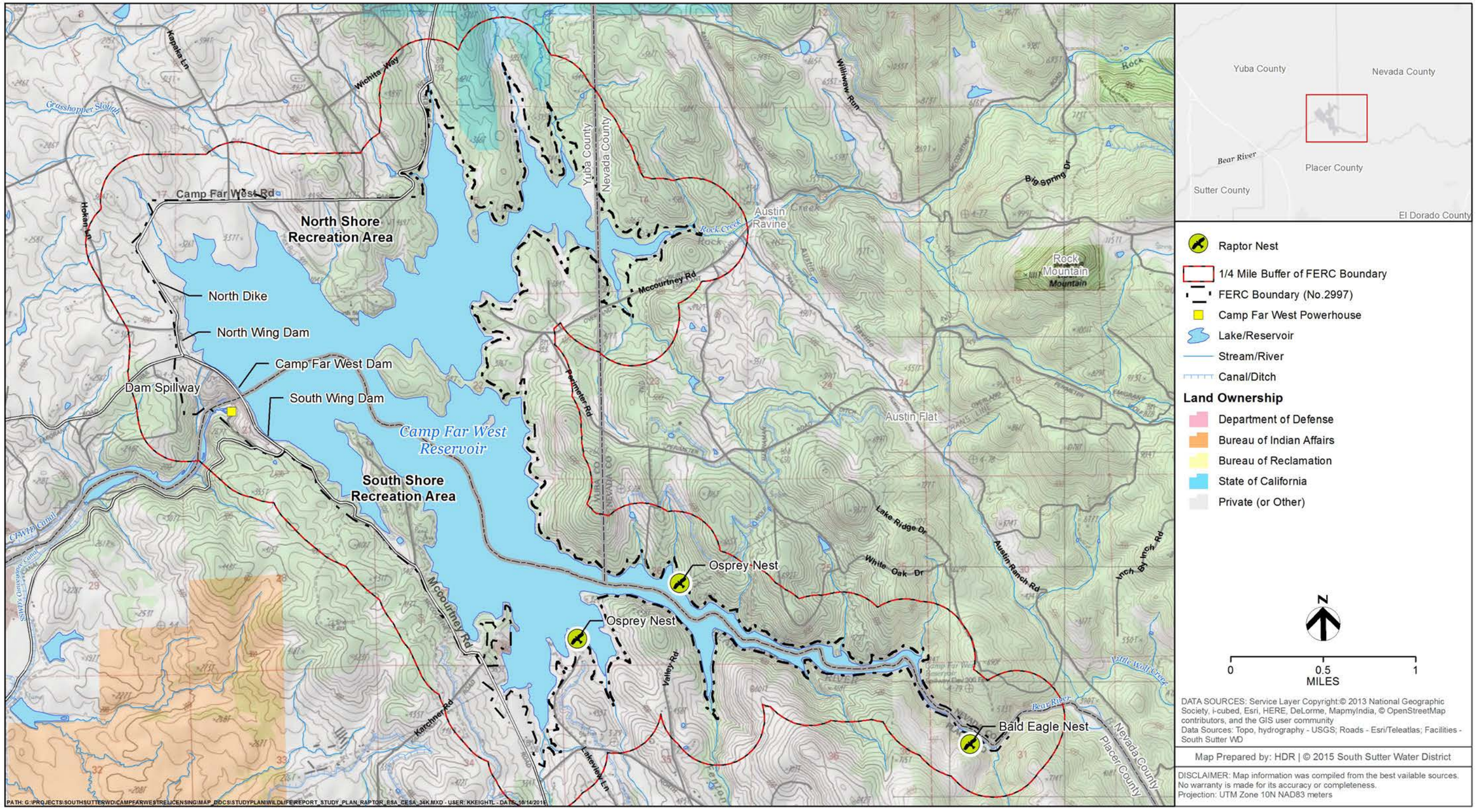

Figure 4.1-1. Study Area for Special-status Wildlife Raptors.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary permits prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to National Oceanic and Atmospheric Administration, National Marine Fisheries Service; USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic and wildlife species observed during the performance of a study. All incidental observations will be reported in the Application for New License. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation during this study will include, but are not limited to: osprey (*Pandion haliaetus*), any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*), foothill yellow-legged frog (*Rana boylii*), American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Study Methods

The Study consists of the following three steps: 1) identify and map known raptor nest sites and other occurrences within the Study Area; 2) conduct surveys following specific protocols for bald eagle, golden eagle and Swainson's hawk; and 3) perform quality assurance/quality control (QA/QC) review. Each step is described below.

4.3.1 Step 1 – Identify and Map Known Nest Sites

SSWD will identify and map known occurrences of bald eagle, golden eagle and Swainson's hawk sightings, nests and roosts in the Study Area. The map will be based on existing CWHR data, CNDDB data, discussions with wildlife biologists, discussions with Project Operations Staff, and incidental sightings by field staff during fieldwork on Camp Far West Reservoir.

4.3.2 Step 2 – Raptor Surveys

4.3.2.1 Bald Eagle

4.3.2.1.1 Winter Surveys

SSWD will conduct wintering bald eagle surveys and winter night roost surveys according to the *Protocol for Evaluating Bald Eagle Habitat and Populations in California* (Jackman and Jenkins 2004). Survey methods include:

- Wintering Bird Surveys. One or 2-day surveys will be conducted monthly along Camp Far West Reservoir from December through February (i.e., three surveys, at least 2 weeks apart) to capture peak wintering activity. The January survey will be conducted during the 2-week nationwide, mid-winter bald eagle survey c, unless inclement weather prohibits safe surveys. The surveys will either be conducted from a helicopter or boat depending on weather conditions and accessibility.
- Winter Night Roost Surveys. Winter night roost surveys will be conducted once monthly from December through February. Surveys will be conducted in the afternoon/early evening in areas where bald eagles were observed wintering in an effort to identify any night roosts. If roosts are located, the number of bald eagles will be recorded as they move from foraging to roosting habitat. These locations will be revisited the following morning, approximately 30 minutes before sunrise for at least 2 hours to count the number of bald eagles leaving the roost. If a stand is identified as a probable night roost, the area will be revisited during the day to search for any evidence of bald eagle use (e.g., feathers or castings) and the exact location will be recorded by GPS. The survey forms derived by Jackman and Jenkins (2004) will be used for both the wintering and night bald eagle roost surveys.

4.3.2.1.2 Nest Surveys

SSWD will conduct nesting bald eagle surveys according to the *Bald Eagle Breeding Survey Instructions* (CDFG 1999) and *Protocol for Evaluating Bald Eagle Habitat and Populations in California* (Jackman and Jenkins 2004). Nesting territories will be checked at least three times during the nesting season (primarily February through July). Survey methods include:

- Determine Occupancy of Territories and Early Incubation. Territories will be checked in early March, as weather conditions allow, in areas that have historical data available. Data collected at each site will consist of: 1) presence of bald eagle adults; 2) courtship behavior; 3) evidence of nest repair or construction; 4) incubation; 5) observation of old nests; and 5) identification of any new nests. Surveys will be performed from a boat, GPS coordinates will be recorded, and photographs taken for all nests observed.
- Confirm Occupancy of Territories and Presence of Eggs/Nestlings. Surveys will be conducted in late April or early May to determine whether the bald eagle breeding pair surveyed in March is still tending the nest (e.g., incubating eggs or tending nestlings).

The number of eggs/nestlings, bird behavior, and any other relevant observations will be recorded. These surveys will be conducted in the same manner as the initial surveys.

- Determine Nest Success. Surveys will be conducted in mid-June to determine how many bald eagle nestlings are approaching fledgling age. These surveys will be conducted in the same manner as the other nesting surveys. The Cal Fish and Wildlife California Bald Eagle Nesting Territory Survey Form will be utilized during all nesting surveys.

4.3.2.2 Golden Eagle

SSWD will conduct nesting golden eagle surveys according to the *Interim Golden Eagle Inventory and Monitoring; and Other Recommendations* (USFWS 2010) and *Protocol For Golden Eagle Occupancy, Reproduction, and Prey Population Assessment* (Driscoll 2010). Nesting territories will be checked four times during the nesting season (i.e., primarily February through July), with each survey spaced at least 30 days apart . Survey methods include:

- Occupancy Survey: Between January 1 and February 28, conduct one 4-hour survey to document courting behavior and nest building. Data collected should include: 1) description and GPS location of any nests or partial nests, 2) description and GPS location of any perches, 3) number of adults observed and behavior, 4) number of subadults observed and behavior, 5) GPS location of all golden eagles observed, and 6) weather.

- Incubation Survey: During March, conduct one 4-hour survey to document nests and egg incubation. Data collected should include: 1) description and GPS location of any nests or partial nests, 2) description and GPS location of any perches, 3) number of adults observed and behavior, 4) number of subadults observed and behavior, 5) number of eggs observed, 6) GPS location of all golden eagles observed, and 7) weather.

- Nestling Survey: Between April 1 and May 15, conduct one 4-hour survey to document nestlings. Data collected should include: 1) description and GPS location of any nests or partial nests, 2) description and GPS location of any perches, 3) number of adults observed and behavior, 4) number of subadults observed and behavior, 5) number of nestlings observed, description of plumage, and behavior, 6) GPS location of all golden eagles observed, and 7) weather.

- Fledgling Survey: Between May 15 and June 30, conduct one 4-hour survey to document fledglings. Data collected should include: 1) description and GPS location of any nests or partial nests, 2) description and GPS location of any perches, 3) number of adults observed and behavior, 4) number of subadults observed and behavior, 5) number of fledglings observed, description of plumage, and behavior, 6) GPS location of all golden eagles observed, and 7) weather.

4.3.2.3 Swainson's Hawk

SSWD will conduct nesting Swainson's hawk surveys according to the *Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley* (SHTAC 2000). Survey periods are described below.

- Survey Period I. Survey period I will fall between January-March 20. Survey period I serves as an opportunity to scout potential nest locations prior to species arrival from wintering habitats. Additionally, the surveyor has the opportunity to locate and map competing species nest sites.
- Survey Period II. Survey period II will occur March 20- April 5 and focus on arrival and nest building. This period requires three full surveys. Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. Both males and females are actively building and visiting their selected nest site frequently. Later in this survey period, territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.
- Survey Period III. Survey period III will fall April 5 – April 20 with a purpose to observe nest building and egg laying. Survey time will occur during daylight hours and as needed to monitor known nest sites only. This period requires three full surveys. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Following the male to the nest may be the only method to locate it.
- Survey Period IV. Survey period IV will occur April 21-June 10 to observe known nest sites and incubation. Survey time will occur from sunrise to 1200 and 1630 to sunset. This period requires three full surveys. Adult females are known to be in brood position during this time. Nests are typically built in heavily vegetative sections of trees.
- Survey Period V. Survey period V will occur June 10 – July 30 to observe post-fledgling activity. Survey time will occur from sunrise to 1200 and 1600 to sunset. This period requires three full surveys. Adults are known to be active near nest site. Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree.

4.3.2.4 Incidental Raptor Sightings

During the Study, SSWD will record any raptor sightings and nests observed, photograph the nest, and record the location using GPS; this includes, but is not limited to, northern harrier, short-eared owl, long-eared owl, and white-tailed kite. If reasonably possible, SSWD will make a determination as to whether the raptor nest is active or inactive during the survey year.

4.3.3 Step 3 – Quality Assurance/Quality Control Data

SSWD will perform a QA/QC review of all data, including maps and sightings.

5.0 Schedule

SSWD anticipates the schedule to complete special-status raptor studies as follows:

Planning ..... November 2016
Field Work: Wintering Surveys ..... December 2016 – Feb 2017
Field Work: Nesting Surveys ..... March 2017 – July 2017
QA/QC ..... July 2017

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

6.0 Consistency of Methodology with Generally Accepted Scientific Practices

For bald eagle, this Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The study uses well established procedures from Cal Fish and Wildlife, USFWS and other reputable sources.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $50,000 and $70,000.

8.0 References Cited

California Department of Fish and Wildlife (CDFW). 2015. California Natural Diversity Database. RareFind 5. Available online: <http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp>. Accessed July 1, 2015. California Department of Fish and Wildlife, Sacramento, CA.

California Department of Fish and Game (CDFG). 1999. Bald Eagle Breeding Survey Instructions. November 1999. Sacramento, CA.

Driscoll, D.E. 2010. Protocol for Golden Eagle Occupancy, Reproduction, and Prey Population Assessment. American Golden Eagle Research Institute. Apache Jct., AZ.

Jackman, R.E. and J.M. Jenkins. 2004. Protocol for Evaluation Bald Eagle Habitat and Populations in California. Prepared for U.S. Fish and Wildlife Service. Sacramento, CA.

Sycamore Associates. 2013. Biological Assessment: Camp Far West Reservoir Project. FERC No. P-2997. Sacramento, CA.

Swainson's Hawk Technical Advisory Committee (SHTAC). 2000. Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley. Available online: < https://www.wildlife.ca.gov/Conservation/Birds/Swainson-Hawks>. Accessed September 7, 2016. Last updated May 31, 2000.

United States Fish and Wildlife Service (USFWS). 2010. Interim Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations. Carlsbad, CA.

Page Left Blank

Study 5.1

ENDANGERED SPECIES ACT-LISTED PLANTS STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an adverse effect on Endangered Species Act (ESA-listed) plants.

For the purpose of this Endangered Species Act-Listed Plants Study (Study), an ESA-listed botanical species is a species that has a reasonable possibility of being affected by Project O&M or associated recreation and is listed under the ESA as endangered (FE) or threatened (FT) or is a botanical species which is a candidate or proposed for listing under the ESA.

2.0 Study Goals and Objectives

The goal of this Study is to supplement existing information regarding ESA-listed plant species.

The objective of this Study is to gather the information necessary to meet the Study goal.

This Study does not include Section 7 ESA informal consultation with the United States Department of the Interior, Fish and Wildlife Service (USFWS).

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding botanical resources in the Project Vicinity[1] is provided in Section 3.2.4.2 of SSWD's Pre-Application Document (PAD). Existing, relevant and reasonably available information regarding ESA-listed plant species known or with a potential to occur in the Project Vicinity is provided in Section 3.2.5 of the PAD. SSWD identified one ESA-listed plant species that has a reasonable potential to occur in the Project Vicinity. Table 3.0-1 provides for this species: 1) status; 2) flowering period; 3) elevation range; 4) habitat requirements; and 5) documented occurrence in the Project Vicinity. The list has been developed as a guide of ESA-listed species likely to occur within the existing Federal Energy Regulatory Commission (FERC) Project Boundary; however, all ESA-listed plant species located during the Study will be mapped and reported.

[1] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

Table 3.0-1. ESA-listed plant species potentially occurring in the Camp Far West Hydroelectric Project Vicinity.

Common Name/ Scientific Name	Status[1]	Flowering Period	Elevation Range (ft)	Habitat Requirements	Occurrence in Project Vicinity[2]
Hartweg's golden sunburst (*Pseudobahia bahiifolia*)	FE, SE, CRPR 1B	Mar-Apr	50-500	Valley and foothill grassland, cismontane woodland (CNPS 2015)	Present in quads (Knights Ferry and Yuba City) adjacent to the Project Vicinity (CNPS 2015).

[1] Regulatory Status:
CRPR: California Native Plant Society California Rare Plant Rank
1B: Species considered rare or endangered in California and elsewhere
FE: Federal Endangered Species
SE: CESA Endangered Species

[2] Occurrence in Project Vicinity: Some of the USGS topographic quadrangles are found entirely within the Project Vicinity and some are partially within the Project Vicinity. Results based on CNPS nine-quadrangle search.

None of the available reports are from surveys within the existing FERC Project Boundary.[2]

Additional information, which will be provided by this Study, is needed to address the Study goal. The Study will provide the specific location of ESA-listed plants in relation to Project facilities, Project O&M activities, Project recreation, and any other Project-related activities that might affect ESA-listed plants.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area consists of four specific areas, each with a 100-foot-wide buffer around them, within the existing FERC Project Boundary: 1) the North Shore Recreation Area (NSRA); 2) the South Shore Recreation Area (SSRA); 3) the Camp Far West Dam and associated dikes and Spillway; and 4) the Camp Far West Dam Powerhouse, for a total of 505 acres. The facilities are described in Section 2 of SSWD's PAD, and shown in Figure 4.1-1.

If SSWD proposes an addition to the Project, the Study Area will be expanded, if necessary, to include areas potentially affected by the addition.

[2] The FERC Project Boundary is the area SSWD uses for normal Project operations and maintenance and is shown on Exhibits J, K and G of the current license.

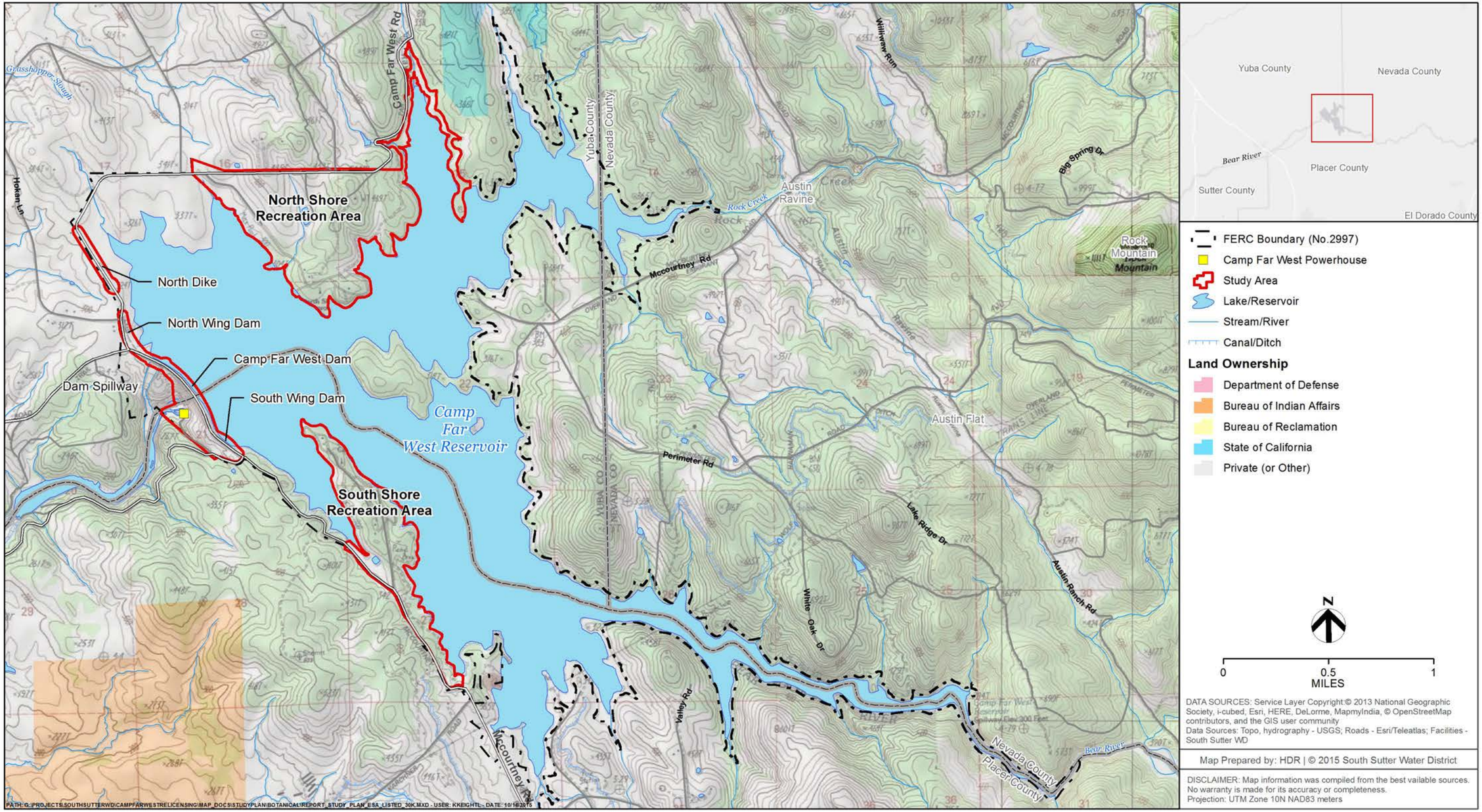

Figure 4.1-1. Study Area for ESA-listed Plants.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

Study methods will consist of the following four steps: 1) gather data and prepare for field effort; 2) conduct field surveys; 3) prepare data and quality assure/quality control (QA/QC) data; and 4) consult with SSWD's Project operations staff. Each step is described below.

4.3.1 Step 1 – Gather Data and Prepare for Field Efforts

SSWD will identify and map known occurrences of ESA-listed plants within the Study Area, and prepare field maps for use by field survey teams. The maps will include aerial imagery, Project features, and known ESA-listed plant occurrences. Survey timing will be planned based on herbarium collection dates.

4.3.2 Step 2 – Conduct Field Surveys

In conjunction with the SSWD's relicensing Study 4.1, *Special-Status Plants* and Study 5.2, *ESA-listed Wildlife – Valley Elderberry Longhorn Beetle*, SSWD's surveyors will conduct ESA-listed plant surveys as outlined in the "Botanical Survey" section of the Cal Fish and Wildlife's *Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities* (CDFG 2009). Surveys will be comprehensive over the entire Study Area, except for areas deemed to be unsafe (e.g., due to steep, unstable terrain) by the field team, using systematic field techniques to ensure thorough coverage, with additional efforts focused in habitats with a higher probability of supporting ESA-listed plants. Surveys will be floristic in nature, documenting all species observed; taxonomy and nomenclature will be based on The Jepson Manual (Baldwin et al. 2012).

When an ESA-listed plant is documented within the Study Area, the following information will be collected:

- Digital photographs to describe the occurrence, its habitat, and any potential threats (i.e., at least one digital photograph will be collected for each occurrence, with other photographs to document potential threats, or as needed).
- Estimated area (i.e., approximate length and width) covered by the ESA-listed plant population and estimated number of individual plants in the population. If plant population is estimated to cover an area greater than 0.1 acre (ac), surveyors will delineate the occurrence boundary using a GPS unit, collecting either polygon data, or sufficient point data that a realistic occurrence polygon can be constructed from the point data using GIS. For occurrences less than 0.1 ac in size, the location of the approximate center of the occurrence will be taken as point data using a GPS unit.
- Dominant and subdominant vegetation in the area.
- Estimated distance to nearest Project facility, feature, or Project-related activity.
- Activities observed in the vicinity of the population that have a potential to adversely affect the population (e.g., recreational trails and uses).
- Estimated phenology and descriptions of reproductive state.

4.3.3 Step 3 – Prepare Data and Quality Assure/Quality Control Data

Following field surveys, SSWD will develop GIS maps depicting ESA-listed plant occurrences, Project facilities, features, and specific Project-related impacts (e.g., dispersed use camping) and other related information collected during the Study. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes to verify locations of ESA-listed plant occurrences.

4.3.4 Step 4 – Consult with SSWD's Project Operations Staff

Once the locations of ESA-listed plant occurrences in the Study Area are defined, SSWD's O&M staff will be consulted to identify Project O&M and Project-related activities that typically occur in the area of the ESA-listed plant populations that have a potential to adversely affect ESA-listed plant populations.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings; and the Study uses standard botanical survey methods as defined by the Cal Fish and Wildlife.

6.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning ..... May 2017
Fieldwork ..... June 2017 – October 2017
QA/QC Review .....Ongoing

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

For the purpose of estimating the cost for this Study, SSWD assumed that much of the Study fieldwork cost would be covered under SSWD's relicensing Study 4.1, *Special-Status Plants*. The remaining cost to complete this ESA-Listed Plants Study is related primarily to reporting, and SSWD estimates the cost in 2016 dollars is between $10,400 and $12,700.

8.0 References Cited

Baldwin, B. G., D. H. Goldman, D. J. Keil, R. Patterson, T. J. Rosatti, and D. H. Wilken, editors. 2012. The Jepson manual: vascular plants of California, second edition. University of California Press, Berkeley.

California Department of Fish and Game (CDFG). 2009. Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities.

Available online: <www.fws.gov/sacramento/es/.../Listed_plant_survey_guidelines.PDF>

California Native Plant Society (CNPS). 2015. California Native Plant Society Rare Plant Program – The California Rare Plant Ranking System. Available online: <http://www.cnps.org/cnps/rareplants/ranking.php>. Accessed July 2, 2015. California Native Plant Society, Sacramento, CA.

Page Left Blank

Study 5.2

ESA-LISTED WILDLIFE – VALLEY ELDERBERRY LONGHORN BEETLE STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) and Project recreation have a potential to affect valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) or VELB, a wildlife species listed as threatened under the federal Endangered Species Act (ESA).

2.0 Study Goals and Objectives

The goal of this ESA-Listed Wildlife – Valley Elderberry Longhorn Beetle Study (Study) is to supplement existing information regarding VELB..

The objective of this Study is to gather the information necessary to meet the Study goal. Specifically, this Study will gather information, including: 1) identify and map the location of appropriate blue elderberry (*Sambucus nigra* ssp. *caerulea*) shrubs, the host plant for VELB; 2) classify habitat where blue elderberry shrubs are found into riparian or non-riparian,[1] and whether the shrubs are isolated or clumped; and 3) classify blue elderberry shrub stem size; and 4) document the presence or absence of VELB or evidence of VELB indicators on the blue elderberry shrubs when surveys are performed.

This Study does not include Section 7 ESA informal consultation with the United States Department of the Interior, Fish and Wildlife Service (USFWS).

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding VELB in the Project Vicinity[2] is provided in Section 3.2.5 of SSWD's Pre-Application Document (PAD). Based on this information, two elderberry shrubs were observed during surveys for the 2013 Biological Assessment, though no exit holes were present. Both shurbs were in upland communities near the margin of the Camp Far West Reservoir (Sycamore Associates 2013).

[1] In this Study, riparian habitat is "*the vegetation zone and other biological resources contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic (lakes) and lentic (rivers, streams, or drainage ways) water bodies."* (USFWS 1997).

[2] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

Additional information, which will be provided by this Study, is needed to address the study goal. The Study will develop information regarding the specific location of blue elderberry shrubs, and any indications of VELB use, in relation to Project facilities, Project O&M activities, Project recreation, and any other Project-related activities that might affect VELB.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area consists of four specific areas, each with a 100-foot-wide buffer around them, within the existing Federal Energy Regulatory Commission (FERC) Project Boundary: 1) the North Shore Recreation Area (NSRA); 2) the South Shore Recreation Area (SSRA); 3) the Camp Far West Dam and associated dikes and Spillway; and 4) the Camp Far West Dam Powerhouse, for a total of 505 acres. The facilities are described in Section 2 of SSWD's PAD, and shown in Figure 4.1-1.

If SSWD proposes an addition to the Project, the Study Area will be expanded, if necessary, to include areas potentially affected by the addition.

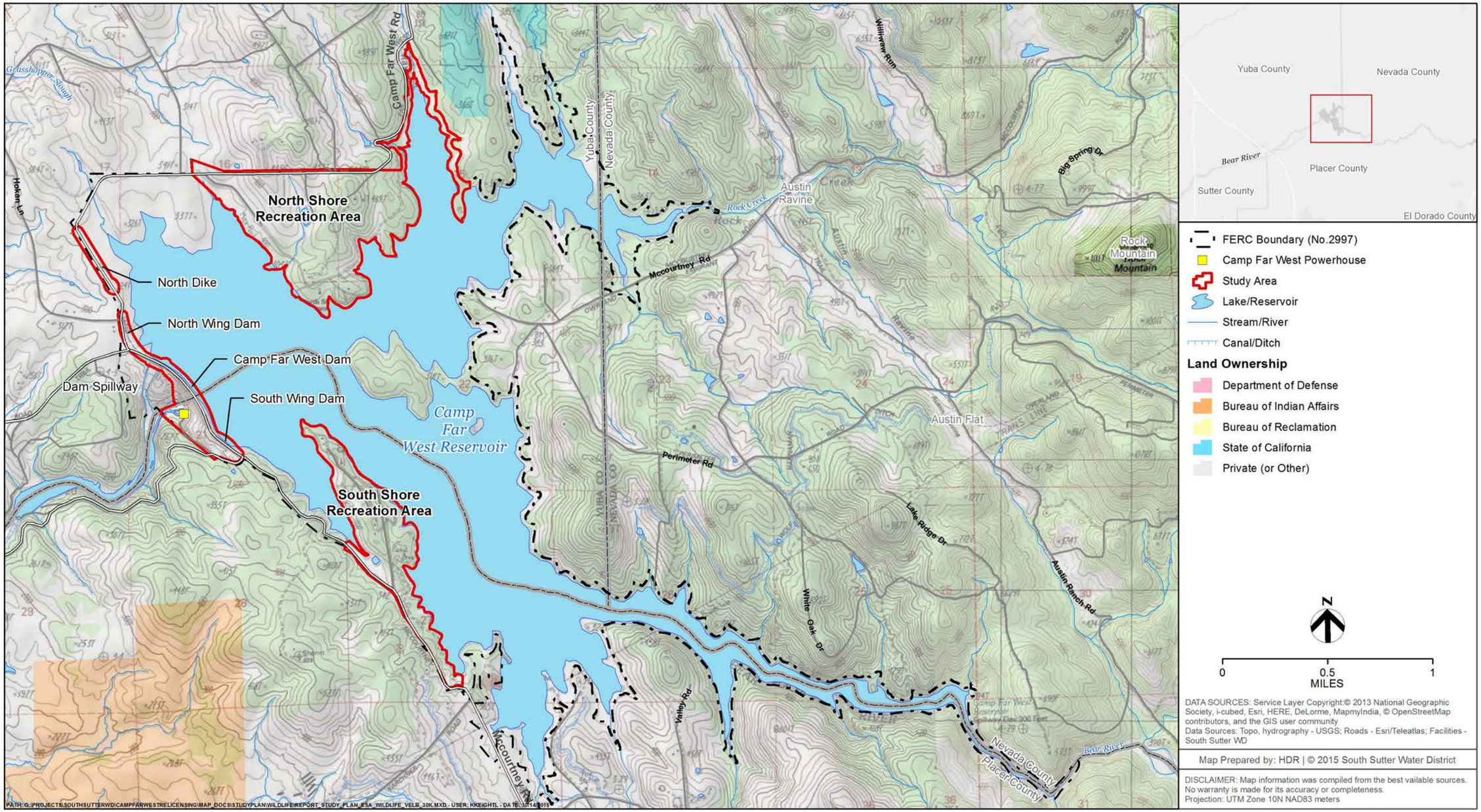

Figure 4.1-1. Study Area for ESA-listed Wildlife Valley Elderberry Longhorn Beetle.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3 meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be completed in five steps: 1) map known occurrences of blue elderberry shrub and VELB; 2) conduct field surveys for blue elderberry plants; 3) conduct surveys for evidence of VELB; 4) prepare data and quality assure/quality control (QA/QC) data; and 5) consult with Project operation staff. Each step is described below.

4.3.1 Step 1 – Map Known Occurrences

SSWD will identify and map known occurrences of blue elderberry shrubs and VELB within the Study Area, and prepare field maps for use by field survey teams. The maps will include aerial imagery, Project features, and known elderberry plant and VELB occurrences. Survey timing will be planned based on herbarium collection dates.

4.3.2 Step 2 – Conduct Field Surveys for Elderberry Plants

In conjunction with SSWD's relicensing Study 4.1, *Special-Status Plants*, and Study 4.1, *ESA-Listed Plants*, SSWD will document all occurrences of elderberry plants within the Study Area,

except for areas deemed to be unsafe (e.g., due to steep, unstable terrain) by the field team, with GPS and take photographs of each occurrence.

When an elderberry shrub is documented within the Study Area, the following information will be collected:

- Digital photographs to describe the occurrence, its habitat, and any potential threats (i.e., at least one digital photograph will be collected for each occurrence, with other photographs to document potential threats, or as needed).
- Estimated area (i.e., approximate length and width) covered by the elderberry plant population and estimated number of individual plants in the population. If plant population is estimated to cover an area greater than 0.1 acre (ac), surveyors will delineate the occurrence boundary using a GPS unit, collecting either polygon data, or sufficient point data that a realistic occurrence polygon can be constructed from the point data using GIS. For occurrences less than 0.1 ac in size, the location of the approximate center of the occurrence will be taken as point data using a GPS unit.
- Dominant and subdominant vegetation in the area.
- Estimated distance to nearest Project facility, feature, or Project-related activity.
- Activities observed in the vicinity of the population that have a potential to adversely affect the population (e.g., recreational trails and uses).
- Estimated phenology and descriptions of reproductive state.

In addition, occurrences will be documented by classifying the largest stem at ground level of the elderberry shrub into one of three categories: 1) greater than or equal to 1 inch, but less than or equal to 3 inches; 2) greater than 3 inches but less than 5 inches; and 3) greater than or equal to 5 inches (USFWS 1999). SSWD will classify the habitat surrounding the elderberry shrub as either riparian or non-riparian and indicate whether the shrub was isolated or part of a larger clump.

4.3.3 Step 3 – Conduct Surveys for Evidence of VELB

All elderberry shrubs with one or more stems measuring 1.0 inch or greater in diameter at ground level will be thoroughly searched for beetle exit holes (i.e., external evidence of beetle presence). The exit holes should be characterized as to whether they are recent (i.e., shavings present) or not. If holes are found that are suspected not to be VELB boreholes, they will be documented and an explanation of why they are not suspected to be VELB boreholes will be provided.

4.3.4 Step 4 – Prepare Data and Quality Assure/Quality Control Data

Following field surveys, SSWD will develop GIS maps depicting VELB and elderberry occurrences, Project facilities and features, and other information collected during the Study. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes on locations of any VELB and elderberry occurrences.

4.3.5 Step 5 – Consult with Project Operations Staff

Once the locations of elderberry plants are defined, SSWD's O&M staff will be consulted to identify Project O&M and Project-related activities that typically occur in the area of the shrub or VELB that have a potential to adversely affect the elderberry shrub or VELB.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric project (FERC No. 2179), and the Study uses standard botanical survey methods as defined by USFWS (USFWS 1999).

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... April 2017
Fieldwork ..... May 2017 – September 2017
QA/QC Review ..... Ongoing
Consult with Project staff ..... October 2017

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available. Confidential information will not be included in public records, but provided to USFWS.

7.0 Level of Effort and Cost

For the purpose of estimating the cost for this Study, SSWD assumed that much of the Study fieldwork cost would be covered under SSWD's relicensing Study 4.1, *Special-Status Plants*. The remaining cost to complete this Study is related primarily to reporting, and SSWD estimates the cost in 2016 dollars is between $14,000 and $17,100.

8.0 References Cited

Sycamore Environmental Consultants, Inc. 2013. Camp Far West Reservoir Project Biological Assessment. Sacramento, CA.

United States Department of Interior, Fish and Wildlife Service (USFWS). 1997. A system for mapping riparian areas in the western United States. U.S. Department of the Interior, U.S. Fish and Wildlife Service, National Wetlands Inventory, St. Petersburg, FL.

_____. 1999. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. U.S. Fish and Wildlife Service, Sacramento, California.

Page Left Blank

Study 5.3

ESA-LISTED AMPHIBIANS – CALIFORNIA RED-LEGGED FROG

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) and Project recreation have the potential to affect California Red-legged Frog (CRLF) (*Rana draytonii*), which is listed as threatened under the Endangered Species Act (ESA).

2.0 Study Goals and Objectives

The goal of this ESA-Listed Amphibians - California Red-legged Frog Study (Study) is to supplement existing information regarding CRLF.

The objective of the study is to collect data adequate to meet the study goals.

This Study does not include Section 7 ESA informal consultation with the United States Department of the Interior, Fish and Wildlife Service (USFWS).

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing and relevant information regarding known occurrences of CRLF in the Project Vicinity[1] is provided in Section 3.2.5 of SSWD's Pre-Application Document (PAD). Table 3.0-1 summarizes CRLF habitat requirements by life stage.

Table 3.0-1. California red-legged frog habitat requirements by life stage.

Egg Masses	Larvae	Juveniles and Adults
In ponds or backwater pools of streams, usually attached to emergent vegetation (cattail and bulrush). Sometimes found at sites without emergent vegetation (e.g., some stock ponds). The presence of dense riparian vegetation (particularly willows) is also a positive indicator of suitable breeding habitat. Permanently or seasonally flooded water bodies may be used.	Same habitat as eggs; also in slow-moving, shallow riffle zones, and shallow margins of pools. Larvae spend most time in submerged vegetation or organic debris.	Frogs may stay at breeding sites or move to summer habitats. Emergent and/or riparian vegetation, undercut banks, semi-submerged root masses; open grasslands with seeps or springs with dense growths of woody riparian vegetation, willows; cattail, bulrush, and willow are good indicators for suitable habitat. Associated with deep (<0.7 – 1.5 m), still or slow-moving water. Juveniles prefer open, shallow aquatic habitats with dense submerged vegetation. In seasonally dry areas, frogs may aestivate in moist spaces under boulders, logs, watering troughs, etc.

[1] In this Study, the "Project Vicinity" is defined as the area surrounding the Project in the order of a county or USDOI, United States Geological Survey (USGS) 1:24,000 topographic quadrangle.

Additional information, which will be provided by this Study, is needed to address the Study goal. The Study will include a site specific assessment of habitat suitability for CRLF in relation to Project facilities and normal O&M activities that might affect CRLF.

4.0 Study Methods

4.1 Study Area

For the purpose of this Study, the Study Area consists of the area within the existing Federal Energy Regulatory Commission (FERC) Project Boundary and an area extending 1 mile from the boundary. USFWS describes a "project action area" as the area directly or indirectly affected by the proposed action. This area will usually be larger than the "project footprint" and should cover the range of impacts. For the purposes of SSWD's Project, the project action area is a 1-mile[2] area around the FERC Project Boundary, as generally advised by USFWS (2005). The Study Area is shown in Figure 4.1-1.

[2] Based on studies that tracked movements of adult CRLF with attached radio-transmitters, 1.0 mile is within the known range of long-distance movements, although most individuals moved less than 0.34 miles (Bulger et al., 2003, Fellers and Kleeman 2007).

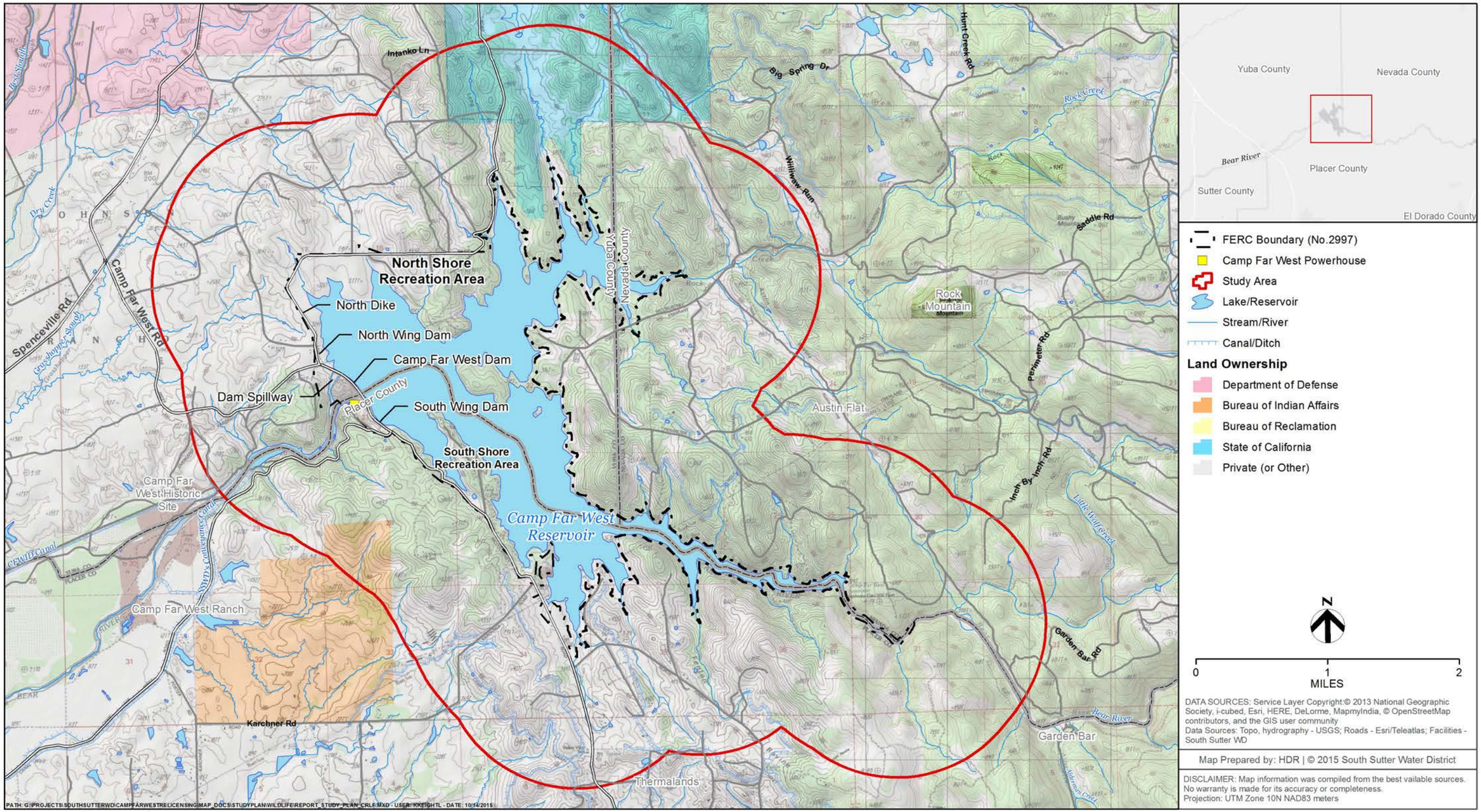

Figure 4.1-1. Study Area for ESA-listed Amphibians – CRLF.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be completed in three steps: 1) perform a site assessment to describe and map aquatic and terrestrial habitats in the study area; 2) perform quality assurance/quality control (QA/QC) of data; and 3) consult with Project operations staff. Each step is described below.

4.3.1 Step 1 – Site Assessment

SSWD will perform a site assessment that will include the following elements. Known occurrences of CRLF within the Study Area will be identified and mapped, based on agency records, museum records, and other existing information. Locations of habitats in the Study Area potentially suitable for CRLF breeding will then be identified and mapped based on review of existing aerial imagery, National Wetland Inventory maps, and any existing on-the-ground photographs. Other aquatic habitats potentially affected by the Project that may be utilized by CRLF for dispersal, foraging, or predator avoidance will also be identified and mapped.

If habitat mapping indicates the presence of habitats potentially suitable for CRLF breeding within the existing FERC-Project Boundary, SSWD will conduct a field reconnaissance of these areas in accordance with USFWS (2005) guidelines. A Habitat Site Assessment Data Sheet

(Appendix D of USFWS 2005) will be completed at each site that is examined, along with photographs depicting habitat and other notable findings. Data to be collected during field reconnaissance will include water depth at the time of the site assessment, bank-full depth, stream gradient (i.e., percent slope), substrate, and description of bank. The presence of fish, non-native crayfish, and American bullfrog will be noted.

To obtain additional information regarding American bullfrog occurrence, three site visits will be performed at the two sewage lagoons associated with the North and South Recreation Areas and Camp Far West Reservoir. These visits will occur in warm weather periods when bullfrogs are typically active and separated by about 2-3 weeks. During each visit the surveyors will record the number of American bullfrogs of any life stage that are observed and heard at each location. Before closely approaching each site, the surveyors will sit quietly and listen for 15 minutes, noting the estimated number of calling male bullfrogs (i.e., males produce advertisement calls, a loud, deep, sonorous "jug-o-rum" or similar sound). The surveyors will also walk along the shorelines approximately 2 meters from the edge of the water and note the number of bullfrogs that jump into the water upon approach, including counts of juvenile bullfrogs, which often make an "alarm" call (i.e., high pitched squawk, chirp, or bleat) as they leap. At Camp Far West Reservoir, surveyors will identify areas that appear suitable for bullfrogs and will perform the auditory surveys as described above at these locations up to a maximum of six sites.

Habitats within the Study Area outside of the existing FERC Project Boundary will be characterized from aerial imagery, existing site photographs, and other existing descriptive information. Aquatic habitats will be mapped and characterized by habitat type (e.g., pond, creeks or pool) and apparent seasonality. Upland habitats within the Study Area will be characterized based on description of upland vegetation communities, land uses, and any potential barriers to CRLF movement.

4.3.2 Step 2 – Perform QA/QC Review of Data

Following desktop information gathering and any field reconnaissance, SSWD will develop GIS maps depicting aquatic habitat locations, Project facilities and features, and other information collected during the study. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes.

4.3.3 Step 3 – Consult with Project Operations Staff

Once the site assessment has been completed, Project operations staff will be consulted to identify Project O&M and Project-related activities that typically occur near suitable habitat for CRLF.

5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including the Yuba River Hydroelectric Project

(FERC No. 2246), Merced River Hydroelectric Project (FERC No. 2179), and Yuba River Development Project (FERC Project No. 2246). The Study utilizes standard site assessment methods.

6.0 Schedule

SSWD anticipates the schedule to complete the study as follows:

Planning ..... April 2017
Desktop Data Review ..... April 2017 – May 20176
Field Reconnaissance ..... May – July 2017
QA/QC Review ..... July 2017

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the information on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $15,000 and $20,000.

8.0 References Cited

Bulger, J.B., N.J. Scott, Jr., and R.B. Seymour. 2003. Terrestrial activity and conservation of adult California red-legged frogs *Rana aurora draytonii* in coastal forests and grasslands. Biological Conservation 110:85–95.

Fellers, G.M. and P.M. Kleeman. 2007. California red-legged frog (*Rana draytonii*) movement and habitat use: implications for conservation. Journal of Herpetology 41:276–286.

United States Fish and Wildlife Service (USFWS). 2005. Revised guidance on site assessments and field surveys for California red-legged frog. August 2005.

Study 6.1

RECREATION USE AND VISITOR SURVEY STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) may have an adverse effect on recreational resources.

2.0 Study Goal and Objectives

The primary goal of this Recreation Use and Visitor Surveys Study (Study) is to define the preferences, attitudes, and characteristics of the Project's primary recreation user groups. Information from a survey of users will provide an understanding of the preferences of various Project recreation user groups. The survey will also describe user preferences for various types of recreation opportunities, the level of acceptability of experiential impacts, and support for existing and alternative management options. Specific Study goals and objectives are to:

- Describe the preferences, attitudes, and characteristics of the Project's recreation users. Specific objectives include:
  - Describing recreation visitors and their trip characteristics, including seasonality and type of user;
  - Describing recreation visitors' activities at Project recreation areas;
  - Identifying recreation issues such as safety, conflicts, or crowding;
  - Describing user preferences and expectations for the recreation settings and facilities, and their tolerances for various conditions, particularly water surface elevation (WSE);
  - Describing recreation visitors' socio-demographic characteristics and potential barriers to participation in recreation activities; and
  - Describing users' attitudes toward management actions that might be used to improve experiences or address problems

- Collect information about current project recreational activities and future demand for activities that occur within the Study Area. Specific objectives include:
  - Identify the amount, activity type, and spatial and temporal distribution of existing and desired recreation use within the Project;
  - Identify project-related recreation opportunities in the Project Vicinity that may have substantial unmet demand. Identify potential constraints or barriers to recreation use, in particular those potentially related to existing project operations or management;

- Roughly estimate future demand within the Project through the estimated term of the new license (30 to 50 years); and
- Assess the regional uniqueness and relative significance of the Project's primary recreation opportunities.

- Collect information about current project boat ramp functional use levels and the impact to the availability of access to recreational opportunities on the reservoir. Specific objectives include:
  - Identify the functional end of the developed and undeveloped low-water boat ramps; and
  - Identify any public access impacts related to reservoir-based recreational activities, primarily boating and angling.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding recreational resources in the Project Vicinity[1] is provided in Section 3.2.6 of SSWD's Pre-Application Document (PAD). Section 3.2.6.2 of the PAD includes a description, in detail, of the existing Project recreation facilities and opportunities at Camp Far West Reservoir, including an evaluation of the condition of existing facilities. Table 3.0-1 provides a summary of these facilities.

Table 3.0-1. Recreation facilities at the Camp Far West Hydroelectric Project's North Shore Recreation Area (NSRA) and South Shore Recreation Area (SSRA).

Facility	Amenity	NSRA	SSRA
Family Campgrounds	No. Sites (standard)	70	67
	Sites (RV with hookups)	10	none
	Parking Spurs	1 spur per site	1 spur per site
	Overflow Parking Spaces	None	18 single
	Restrooms	2 flush	1 flush, 2 vault
Group Campgrounds	Sites	2, 25-person group sites, 1, 50-person horse camp site	1, 50-person group site
	Parking Spaces	none[1]	10
	Restrooms	4 portable chemical toilets	none[2]
Day Use Areas	Picnic Sites	20	33
	Swim Beaches	1	1
	Parking Spaces	none[3]	44
	Restrooms	1 flush	none[4]
Boat Ramps	Number	1, 4-lane concrete ramp	1, 2-lane concrete ramp
	Parking Spaces	82 single, 73 vehicle with trailer	52 vehicle with trailer
	Restrooms	1 flush	1 flush

[1] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

Table 3.0-1. (continued)

Facility	Amenity	NSRA	SSRA
Dispersed Use Areas[5]	Sites	2	2
	Restrooms	6 portable chemical toilets	6 portable chemical toilets
Other Facilities	Store	1	1
	RV Dump Stations	1	1
	Concessionaire Trailers	2	1

[1] Parking is available in open areas adjacent to the group sites, but is not designated or defined.
[2] The group campsites use the adjoining family campground restroom building.
[3] The day use area (picnic area and swim beach) uses the adjoining boat ramp parking area for parking.
[4] The picnic area uses the adjoining boat ramp restroom building.
[5] The dispersed use areas provide day use and overnight opportunities with minimal facilities (roads, portable chemical toilets and trash cans).

Section 3.2.6.3 of SSWD's PAD provides a summary of the recreation opportunities and facilities available in the Bear River downstream of the Project. Of significance, Section 3.2.6.4 of the PAD summarizes the Project recreation use with an estimate of Project recreation use from 1991 through 2010.

Additional information, which will be provided by this Study, is needed to inform the requirements of the new license as they pertain to recreation. The Study will develop information to address the gaps in the existing information on recreation user opportunities at the Project, including but not limited to the angling and boating experiences, adequacy of facilities, effects of project operations on existing recreation experience, and to understand recreational use impacts. This information will inform the development of a Recreation Facilities Plan for the Project. Additional information collected within this Study will be used to close the gaps in the existing information on what recreation users think about recreation opportunities, current use levels, and projected use for the term of the next license period on the Project. In addition, refining the existing data collection efforts of SSWD's concessionaire will provide daily site occupancy data at each of the Project campgrounds to accurately assess if any Project campgrounds are approaching or exceeding physical capacity during the recreation season. Project operations result in varying water surface elevations (WSE) that impact the availability or functionality of the two developed boat ramps for reservoir recreation users. Information collected in this Study will identify and address the specific functional levels of the developed boat ramps.

4.0 Study Methods and Analysis

4.1 Study Area

For the purpose of this Study, the Study Area includes the Camp Far West Reservoir and, particularly, the NSRA and SSRA as shown in Figure 4.1-1.

If SSWD proposes an addition to the Project, the Study Area will be expanded, if necessary, to include areas potentially affected by the addition.

Page Left Blank

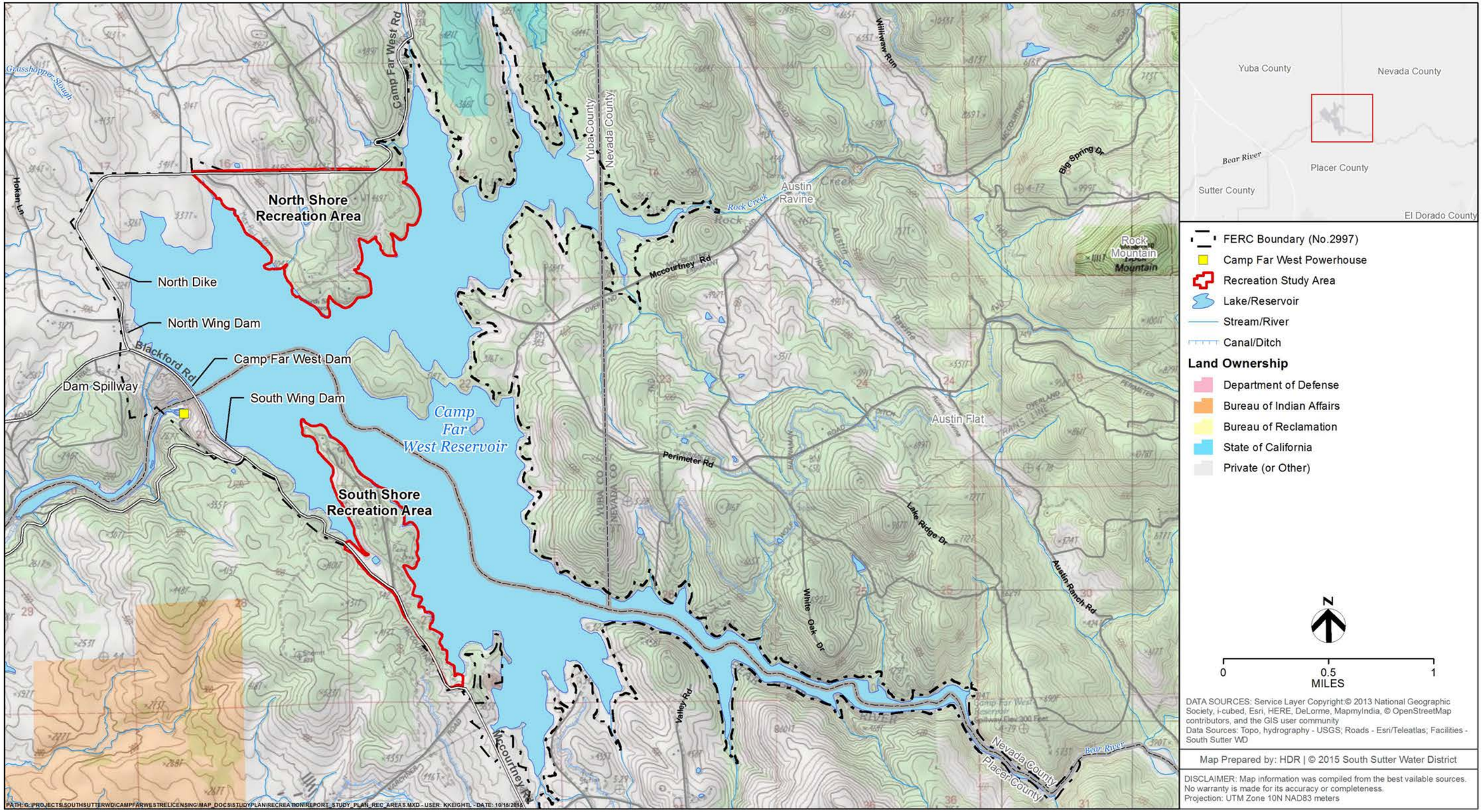

Figure 4.1-1. Study Area for Recreation Use and Visitor Survey.

Page Left Blank

4.2 General Concepts

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study

sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).

- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft Excel® and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Study Methods

The Study methods consist of five steps. These include: 1) identifying recreation uses and visitor attitudes, beliefs, and preferences at Camp Far West Reservoir recreation areas; 2) estimating current recreation use and occupancy at the Project; 3) identify future use and demand opportunities; 4) evaluating the functional periods of the Project-developed boat ramps; and 5) perform data analysis.

4.3.1 Step 1 – Identify Recreation Uses and Visitor Attitudes, Beliefs, and Preferences at Project Recreation Resource Areas

SSWD will conduct observation and visitor surveys and utilize concessionaire entrance gate records to gather information to address the Study goals and objectives at each of the Project recreation area Study sites. Table 4.3-1 summarizes the Study sites and the various Study methods that will be utilized or administered at each Study site.

Table 4.3.1-1. Study sites for visitor observation surveys.

Recreation Area	Facility Type	Study Sites	Study Sub-Sites	Observation Survey	Visitor Survey	Concessionaire Records
NSRA	Campgrounds	Family Campground	Campsites	--	X	X
		RV Campground	Campsites	--	X	X
		Group Campground	Campsites	--	X	X
		Horse Camp	Campsites	--	X	X
	Day Use Areas	Picnic Area	Picnic sites	X	X	--
			Parking area	X	--	--
		Swim Beach	Shoreline	X	X	--
		Dispersed Use Areas	Shoreline	X	X	--
		Boat Launch	Parking area	X	X	--
SSRA	Campgrounds	Family Campground	Campsites	--	X	X
		Group Campground	Campsites	--	X	X
	Day Use Areas	Picnic Area	Picnic sites	X	X	--
			Parking areas	X	--	--
		Swim Beach	Shoreline	X	X	--
		Dispersed Use Areas	Shoreline	X	X	--
		Boat Launch	Parking area	X	X	--

4.3.1.1 Concessionaire Records

SSWD will utilize visitor use data collected by the concessionaire at the entrance gate of each developed recreation area to estimate the Project recreational use. The concessionaire will record for each recreation area on a daily basis the following visitor use parameters:

- Total visitor use (number of people entering the recreation area)
- Type of use (day use versus overnight use)
- Total number of campsites occupied for each campground type (e.g., family campground, RV campground, group campgrounds and horse campground)

4.3.1.2 Observation Survey

SSWD surveyors will conduct observation surveys to gather on-site data related to the recreational uses by Project visitors at the Study sites identified in Table 4.3.1-1. The purpose of the observation surveys is to identify shoreline recreational uses occurring at the day use facilities and dispersed use areas of the recreation area that provide access to the shoreline. In addition, the observations surveys will be used to record the utilization of: 1) day use facility parking areas at the boat launches and picnic areas; 2) picnic sites; and 3) dispersed campsites at the dispersed use areas. SSWD will utilize the concessionaire records for campground utilization and, thus, not conduct observation surveys at the campground facilities.

The SSWD surveyor will count and record the time, date, location, number of vehicles, vehicles with trailers and the type of trailer, vehicles with racks for boats, trailers, boats, people, day groups, overnight groups**,** and the types of recreation activities. The surveyor will also record the percent occupancy by location. Observations will be made, and recorded by site and area to

include parking outside provided parking areas. These data will be used to identify the types of recreation activities visitors participate in at the Project. In addition, these data will also be used to calculate aspects of the Project recreation use estimate. Once the counts are completed, the surveyor will also administer an on-site recreation visitor questionnaire survey to randomly selected recreation visitors.

4.3.1.3 Visitor Survey

SSWD surveyors will conduct visitor surveys to gather on-site visitor use and preference data at all the facilities within the NSRA and the SSRA each (Table 4.3.1-1). The visitor survey will collect visitor perceptions, attitudes, and satisfaction levels on current resource conditions (i.e. users' feelings towards current water or use levels), visitors' zip codes, user characteristics, recreational activities, recreation facility development, management concerns, and overall recreational experiences. Non-response bias will also collected during visitor survey collection, whereby SSWD's surveyor will collect the following information from visitors who refuse to complete the survey – reason, observed activity, gender and age (if possible). For all survey efforts, the number of refusals will be recorded. SSWD will administer surveys either as an on-site survey or a mail-back windshield survey depending upon the type of Study site as described below.

4.3.1.3.1 Types of Visitor Surveys

On-Site Visitor Survey

SSWD will administer an on-site visitor survey at all sites where recreation visitors are readily visible and willing to participate at Project recreation areas (e.g., campgrounds, picnic areas, boat launches and trailheads). Only members of a group who are 18 years or older will be asked to complete a survey. SSWD's recreation researchers will train surveyors on random selection techniques for choosing groups at a site and participants within groups, introduction strategies, recording, and tracking refusals. A target number of users to be surveyed during each period will be established based on target survey completions for the entire recreation season for each recreation area (refer to Section 4.3.1.3).

Mail-Back Windshield Visitor Survey

SSWD will administer a mail-back windshield visitor survey at recreation Study sites where recreation visitors are not present, but their vehicles are. In these cases, a mail-back version of the visitor survey will be left on vehicle windshields with self-addressed envelopes and postage for convenient response and return. A survey packet of information will be left on the windshield and will include the survey, a self-addressed stamped envelope, and a cover letter which explains the purpose of the survey. SSWD will number each survey in order to track both on-site response and windshield response rates. SSWD anticipates utilizing mail-back surveys at boat launches and dispersed use areas.

4.3.1.3.2 Visitor Survey Development

The visitor survey will address the Study objectives identified in Section 4.0. Survey topics will address items such as visitors' perceptions of the following:

- existing and desired recreation facilities
- reservoir water levels on experience
- satisfaction with shoreline access and opportunities
- comparison of project recreation areas to other regional recreation areas that provide similar recreation opportunities
- personal safety
- crowding
- conflict
- actual and desired activities
- constraints or barriers to participation that are potentially within SSWD's or agencies control (e.g. lawlessness, campfire use, parking access and fees)
- ways to enhance their recreation experience

The draft of the survey instrument is provided in Attachment 6.1A at the end of the Study plan. Prior to survey implementation, the survey instrument will be pre-tested in the field with recreation users. The intent of the pre-test is to receive feedback on readability, length, and general understanding of survey content. If necessary, minor changes to the survey instrument may be made to make the survey easier to complete and/or understand.

4.3.1.3.3 Field Reconnaissance, Logistics and Preparation

This task will involve logistical preparation for existing use data collection, including: developing draft data forms and associated databases; developing field work logistics and protocols; field crew training; selection of sampling dates; pre-testing field logistics and protocols, and revising schedules, logistics, or protocols based on preliminary findings.

4.3.1.4 Sampling Approach and Data Collection

4.3.1.4.1 Target Number of Visitor Surveys

SSWD will focus on a survey population based on the overall Project recreation use estimate for 2010, which was 139,110 visitor days (DWR 2011). Since the NSRA and SSRA provide the same opportunities, SSWD considers both areas to be the same survey population, and not distinct survey populations. Thus, the total target survey sample size for the Project will be at least 383 surveys, which was calculated using a 95 percent confidence interval with a sampling error no more than plus or minus 5 percent (Salant and Dillman 1994). Since it is not apparent how varied the Project sample population is, SSWD may chose to use a more conservative sampling approach that utilizes a "50/50 split," which means the sample population is relatively varied. A result of this "50/50 split" approach means SSWD will have a higher survey sample size than if it was apparent that the sample population was less varied (i.e. an "80/20" split

whereby most people have a certain characteristic and a few do not). Thus, since the "split" is not known ahead of time, the best approach is to be conservative and use the "50/50 split" (Salant and Dillman 1994).

To proportionately distribute the total number of target surveys for each recreation area, SSWD compared the number of sites and the open seasons of each recreation area. Overall, the NSRA accounts for approximately 60 percent of the total recreation sites at Camp Far West Reservoir. However, since the NSRA is open year-round and the SSRA is only open seasonally or roughly half of the year, SSWD has further weighted the distribution of surveys towards the NSRA (i.e., 80% of the total). Table 4.3.1-2 displays the target number of surveys for each recreation area.

Table 4.3.1-2. Target number of visitor surveys for each recreation area.

Recreation Area	Target Surveys	
	Number of Surveys	Percent of Total
North Shore Recreation Area	306	80%
South Shore Recreation Area	77	20%
Total	**383**	**100%**

SSWD will make a good faith effort to secure the target number of surveys identified by site or groupings of sites. However, even after following survey protocol, there may be sites where the target cannot be met. SSWD will continuously monitor the survey returns, and if survey targets are not being met at Study sites, SSWD will re-evaluate the sampling frequency to determine if additional efforts should be made at these Study sites; and if the distribution of the surveys should be altered, particularly if the SSRA open season is significantly different than 6 months. Also, for all Study sites, SSWD will continue the survey effort throughout the established survey season, even if the target survey numbers have been met, and will make every effort to achieve the survey target goals.

4.3.1.4.2 Sampling Frequency

The sampling frequency will be divided into two categories – peak and off-peak seasons. The peak season for all recreation use and activities on the Project is from May through September. The off-peak season is from January through April, and from October through December.

The sampling frequency for the peak season will be:

- One randomly selected weekday day per month
- One randomly selected weekend day (Saturday or Sunday) per month
- One pre-selected holiday day (Saturday, Sunday or the holiday day) for each of the three-day holiday weekends, including Memorial Day, Independence Day and Labor Day holiday weekends (3 holiday weekend survey days total)

The sampling frequency for the off-peak season will be:

- One randomly selected weekday day per month
- One randomly selected weekend day (Saturday or Sunday) per month

SSWD will conduct one day of preliminary testing to clarify any problems/confusion with the survey instrument and/or process. Holiday survey days will not be done during the off-peak season.

4.3.1.4.3 Random Sampling and Stratification

SSWD will conduct a roving use survey using a stratified two-stage (geographic and temporal) probability sampling approach (Malvestuto, 1996; Pollock et al. 1994). During the survey, SSWD's surveyor will conduct an observation survey (see Section 4.3.1) and a visitor survey (see Section 4.3.1) at all the recreation area facilities identified in Table 4.3-1. The survey sample will be stratified by recreation area, type of day (weekdays, non-holiday weekends, and holiday weekends), and time of day.

4.3.1.4.4 Timing of Sampling

SSWD's surveyors will vary the times each survey site is visited to ensure a range of visitation times and potential user groups over the course of the survey period. To ensure SSWD's surveyors visit the facilities and study sites at different times, the surveyors will visit each facility following the same circuit or route, but will start at a the next facility on the circuit for each successive survey day.

4.3.2 Step 2 – Estimate Current Recreation Use and Occupancy at Project Recreation Areas

SSWD will accomplish this element in two parts. First, for each recreation site, SSWD will calculate the average existing use levels for several recreation parameters (e.g., people, vehicles, overnight groups and facility occupancy) by day type (e.g., weekend, weekday and holiday), and by time of day (e.g., morning and afternoon) during the survey recreation season. In addition, for each Project recreation site or group of sites, SSWD will calculate the frequency distribution of observed recreation activities during the surveyed recreation season.

Second, SSWD will estimate the existing annual day and overnight visits to the Project recreation areas in Recreation Days[2] (RDs) by utilizing SSWD's concessionaire records and, if necessary, the observation survey data. SSWD's concessionaire records will consist of the number of campsites reserved/occupied at each of the developed campgrounds.

[2] A Recreation Day, as defined by FERC, equals a visit to an area for recreation purposes for any portion of a 24-hour period.

4.3.3 Step 3 – Identify Future Use and Demand Opportunities

SSWD will identify the future use and demand opportunities from three perspectives: 1) assessing the existing unmet demand; 2) assessing future recreation demand; and 3) assessing the regional uniqueness and significance of the Project recreationally. Each of these perspectives is described in detail below.

4.3.3.1 Existing Unmet Demand Assessment

Existing recreation use does not always represent the total existing recreation demand because there may be constraints that limit participation. While there are many potential constraints on recreation use (e.g., lack of free time, cost, geographic distance, lack of skills or equipment), a subset of participation constraints may be closely associated with site-specific management (e.g., limited access to lands or water, use limits or full occupancies at facilities, project operations that eliminate or diminish the quality of experiences and opportunities, or the lack of information about available recreation opportunities). To assess the general level of unmet demand for the Project recreation resources, SSWD will perform the three tasks described below.

4.3.3.1.1 Task 1 – Assess Statewide and Regional Unmet Recreation Demand Information

SSWD will review and summarize relevant information from the 2012 California Public Attitudes Outdoor Recreation Survey (CDPR 2014). If available, SSWD will review other sources of Project Area[3] and Project region demand. The focus of this assessment will be to identify possible recreation activities with substantial unmet demand with a qualitative discussion of participation constraints and whether these constraints are likely affected by Project O&M.

4.3.3.1.2 Task 2 – Collect Unmet Project Area Recreation Demand Information

SSWD will collect additional unmet recreation demand information from Project visitors in SSWD's visitor surveys. The visitor surveys will ask visitors if there are any reservoir-based recreation activities they are interested in participating in at the Project, but cannot because of some form of barrier or other existing condition.

4.3.3.1.3 Task 3 – Identify Potential Activities with High Unmet Demand within the Project Area

SSWD will identify potential activities with high unmet demand in the Project Area based on the review of unmet demand information derived from the California Department of Parks and Recreation (CDPR), the Project visitor survey, Project monitoring data, and any other regional unmet demand sources (if any). Analysis will also attempt to identify likely barriers or constraints on participation, and whether those are related to Project operations or recreation management decisions.

[3] In this Study, "Project Area" refers to the area within and immediately adjacent to the existing FERC Project Boundary, and the Bear River downstream of the Project.

4.3.3.2 Future Recreation Demand Assessment

This element of the Study will provide information regarding the projected future recreation use at the Project over the estimated period of the new License (50 years). Obviously, projecting the future is a speculative activity, especially over a 50-year period. These projections, though, can be useful for general planning purposes to identify potential management issues that may occur in the future. This approach will include four tasks.

4.3.3.2.1 Task 1 – Review Existing Recreation Use Trends

Since past use often helps predict future use, SSWD will review trends of recent Project recreation use. Likely sources of Project use will be Davis-Grunsky Act annual monitoring reports, concessionaire records and observation data.

4.3.3.2.2 Task 2 – Review Existing Population and Recreation Activity Participation Projections

SSWD will summarize existing information on future projections from the California Department of Finance on projected population growth rates of the counties where the majority of the Project visitors originate from. SSWD will also research projections for recreation activities from the United States Department of Agriculture Forest Service (Bowker et al. 2012) and other appropriate sources on future projections.

4.3.3.2.3 Task 3 – Review Reasonably Foreseeable Events that May Influence Future Use

Reasonably foreseeable events in the watersheds may reasonably be expected to influence recreation use in the watershed over the license period. If an event is determined to be reasonably foreseeable, SSWD will make a qualitative assessment of its potential affect on future recreation use (if feasible).

4.3.3.2.4 Task 4 – Estimate Future Recreation Use over the License Period

Based on historical trends, future growth projections, and likely foreseeable actions in the watershed, SSWD will use professional judgment to estimate Project recreation use and facility utilization over the expected term of the new license (30 to 50 years). These estimates must be considered very speculative and will only provide a general indication of how recreation use is expected to change over the license period. For the Project recreation use estimate projection, SSWD will rely on the population growth rates where the majority of Project visitors reside to project use. For the facility utilization projections (campgrounds, picnic areas and boat launch parking areas), SSWD will rely on the activity participation indices developed by the Forest Service (Bowker et al. 2012) for developed camping, picnicking and motorized boating.

4.3.3.3 Regional Uniqueness and Significance Assessment

This component of the Study will assess the regional uniqueness of the Project's primary recreation opportunities in three tasks.

4.3.3.3.1 Task 1 – Review Results of Visitor Questionnaires

SSWD will review the results of the visitor survey questionnaire that address regional uniqueness and significance. In addition, SSWD will identify the primary activities and opportunities of visitors surveyed, which SSWD anticipates will be boating, water sports (i.e, water skiing, wakeboarding, etc.), camping, fishing, picnicking, and swimming.

4.3.3.3.2 Task 2 – Identify Regional Recreational Opportunities

SSWD will identify the geographic draw of the Project's top primary recreation opportunities identified in Task 1 above. SSWD will assess the geographic extent of visitors' origins and location of the alternative recreation resource areas where visitors participate in their primary recreation activities. SSWD will identify regional alternatives for comparable facilities or areas from sources such as guidebooks, on-line web resources, state and national parks, the United States Department of the Interior, Bureau of Land Management (BLM), United States Department of Agriculture, Forest Service (Forest Service), and county tourism sources.

4.3.3.3.3 Task 3 – Assess the Uniqueness and Significance of the Project-Related Recreation Opportunities

SSWD will analyze the visitor responses to a typical survey question that asks visitors to rate the relative uniqueness of the project reservoir they visited. The question has pre-set responses using a 5-point scale with a rating of 1 meaning the reservoir provided an "extremely common" opportunity and a rating of 5 meaning the reservoir provided an "extremely unique" opportunity. Based on the average responses, SSWD will categorize the relative uniqueness of the Project using the following categories.

- Rating of 1.0 = extremely common
- Rating of 1.1 to 2.0 = common
- Rating of 2.1 to 3.0 = somewhat common
- Rating of 3.1 to 4.0 = somewhat unique
- Rating of 4.1 to 4.9 = unique
- Rating of 5.0 = extremely unique

In addition, text will describe what is unique and special about the most popular recreation opportunities based on the comments provided by the visitors on the visitor survey.

4.3.4 Step 4 – Evaluation of the Functional Periods of the Project Developed and Undeveloped Boat Ramps

SSWD will identify the functional periods of the Project's two developed boat ramps at the North Shore and South Shore Recreation Area boat launch facilities. First, SSWD will identify the constructed top and lower end of the two boat ramps to determine the functional WSE range of each boat ramp. A boat ramp is considered functional from the constructed top of the boat ramp down to 3 feet above the lower end of the constructed ramp per the California State Parks Division of Boating and Waterways (DBOW) design guidelines (DBOW 1991). If undeveloped or informal ramps or areas are utilized below the developed boat ramps for launching boats at either recreation area, then SSWD will make the same functional period evaluation for the informal ramp areas. Second, SSWD will compare the daily median reservoir WSE for the period of record (1968 – 2014) by water year type against the functional WSE range of each developed and undeveloped ramp to identify the periods of the recreation season (year-round) that the boat ramps are functional. The output of this evaluation will be tables and/or figures that identify the functional periods for each of the two boat ramps by water year type.

4.3.5 Step 5 – Data Analysis

4.3.5.1 Visitor Surveys

Survey responses should provide a rich source of information about visitor use patterns, characteristics, preferences, and perceptions. The raw data will be entered into a statistical database program (SPSS) that will allow visitor survey responses to be analyzed, taking an "opportunity perspective" by grouping users who are doing similar activities in each project recreation area. Information will be presented in tabular or graph format that indicates the number and percent frequency of visitor survey responses and further summarized in narrative form. Observation use data will address the types and frequency of use occurring within each project recreation resource area.

The Study objectives and issues will be addressed through analysis of the responses to questionnaires and observation data. Survey responses will be coded, edited and entered for analysis through a separate effort. Descriptive statistics will be employed to explain visitor responses to each of the survey questions. For each Study Area, survey analyses will depend on the nature of the recreation users, but will likely focus on the following perspectives:

- Day users
- Overnight users
- Developed facility users
- Dispersed use area users
- Anglers
- Boaters

5.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning .....December 2016– January 2017
Collect Data .....January 2017 – December 2017
QA/QC Review.....January 2018
Data Analysis.....February 2017 – April 2018

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the report on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

6.0 Consistency of Methodology with Generally Accepted Scientific Practices

SSWD's methodology for planning, implementing, and analyzing visitor surveys is consistent with professional practice (Salant and Dillman 1994; Watson et al., 2000). In addition, SSWD will be implementing professional accepted survey practices for contacting visitors and choosing sample sizes (Dillman 2000). Assessing existing recreation use through a combination of observation and questionnaire surveys is a common practice for large geographic areas that contain multiple accesses to desired recreation use areas (Malvestuto 1996, Pollock et al. 1994, and USDA Forest Service 1995). In addition, assessing future recreation demand through an evaluation of existing use, demographic data and participation trends and projections in the region is common practice (Kelly and Warnick 1999). Furthermore, these methodologies were utilized as part of the relicensing process for other recent California relicensings including the Upper American River Project (FERC Project No. 2101), South Feather Power Project (No. 2088), DeSabla-Centerville Project (No. 803), Upper Drum-Spaulding Project (No. 2310),Yuba-Bear Hydroelectric Project (No. 2266), Merced River Hydroelectric Project (No. 2179); and Yuba River Development Project (No. 2246).

7.0 Level of Effort and Cost

SSWD estimates the cost to complete this Study in 2016 dollars is between $95,000 and $125,000.

8.0 References Cited

Bowker, J.M. A.E. Askew, H.K. Cordell, C.J. Betz, S.J. Zarnoch, and L. Seymour. 2012. Outdoor Recreation Participation in the United States - Projections to 2060: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-160. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 34 p.

California Department of Parks and Recreation (CDPR). 2014. Survey on Public Opinions and

Attitudes on Outdoor Recreation in California 2012. Sacramento, California.

California Department of Water Resources (DWR). 2011. 2010 Report on Recreational Operation at Projects Financed Under the Davis-Grunsky Act: South Sutter Water District, Camp Far West Reservoir. Sacramento, California.

California State Parks Division of Boating and Waterways (DBOW). 1991. Layout, Design and Construction Handbook for Small Craft Boat Launching Facilities. Sacramento, California. 40 pp.

Dillman, D.A. 2000. Mail and Internet Surveys: The Tailored Design Method. John Wiley & Sons.

Kelly, J. and R. Warnick. 1999. Recreation Trends and Markets. Sagamore Publishing, Champaign, IL.

Malvestuto, S.P. 1996. Sampling the Recreational Creel Fisheries Techniques (Chapter 20), 2nd edition. American Fisheries Society.

Pollock, K.H., C.M. Jones, and T.L. Brown. 1994. Roving Creel Survey. Angler Survey Methods and Their Applications in Fisheries Management (Chapter 11). American Fisheries Society. Special Publication 25. Bethurda, M.D.

Salant, P. and D.A. Dillman. 1994. How to Conduct Your Own Survey. John Wiley and Sons, Inc.

United States Department of Agriculture Forest Service (Forest Service). 1995. Techniques and Equipment for Gathering Visitor Use Data on Recreation Sites (Personal Observation, page 23 -25; Traffic Counters, page 19-23; and Visitor Surveys, page 35-37).

Watson, A.E., D. N. Cole, D. L. Turnery, and P. S. Reynolds. 2000. Wilderness Recreation Use: A Handbook of Methods and Systems, October 2000. United States Forest Service Rocky Mountain Research Station General Technical Report-56. Ogden, Utah.

Page Left Blank

Study 10.1

CULTURAL RESOURCES STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) and associated Project recreation have the potential to affect cultural resources.

For the purpose of this Cultural Resources Study (Study), "cultural resource" refers to any prehistoric or historic district, site, building, structure, or object, regardless of its National Register of Historic Places (NRHP) eligibility.[1]

2.0 Study Goals and Objectives

The goal of the Study is to supplement existing information regarding historic properties[2] and cultural resources not evaluated for the NRHP.

The objective of this Study is to gather the information necessary to meet the Study goal by filling gaps in the existing data using field and research methods to identify cultural resources in the Study Area.

This Study does not include National Historic Preservation Act (NHPA) Section 106 informal consultation with the State Historic Preservation Officer (SHPO) or interested Native American tribes. Section 106 consultation will be conducted separately, outside of this Study.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding cultural resources within the existing Federal Energy Regulatory Commission (FERC) Project Boundary plus an additional 0.25-mile (mi) radius around the boundary[3] is provided in Section 3.2.10 of SSWD's Pre-Application Document (PAD). SSWD identified 39 previously recorded cultural resources within the FERC Project Boundary, 37 of which are archaeological sites and two of which are

[1] This Study does not address traditional cultural properties (TCP), which are addressed in Study 11.1, *Tribal Interests*.

[2] As defined under 36 C.F.R. Section 800.16(l), "historic properties" are prehistoric or historic archaeological sites, buildings, structures, objects, districts, or locations of traditional use or beliefs that are included in, or eligible for inclusion in, the National Register of Historic Places (NRHP). Historic properties are identified through a process of evaluation against specific criteria found at 36 C.F.R. Section 60.4.

[3] The PAD refers to this area as the "Initial Cultural Data Gathering Area." This area was included in the cultural literature review and records searches for PAD.

historic structures. In addition, SSWD identified 38 previously recorded isolated artifacts within the FERC Project Boundary, 35 of which are prehistoric and three of which are historic. SSWD's review of historical maps indicates that there are approximately 53 potential historic-era sites or features that may be located within the existing FERC Project Boundary.

Portions of the FERC Project Boundary have been previously surveyed for cultural resources. However, many of these investigations are more than 10 years old. Professional standards change over time, as do site and field conditions. As a result, all but one of the previously investigated areas within the Study Area will be included in the field survey, particularly because the existing and relevant information indicates that the lands within the existing FERC Project Boundary are highly sensitive for both prehistoric and historic cultural resources. Additionally SSWD's review of historic maps suggests the possibility that undocumented historic-period cultural resources may still be present within the FERC Project Boundary. A survey was recently completed by Mead & Hunt (2013) for the 5-foot boundary above the Camp Far West Reservoir normal maximum water surface elevation and incorporates the area that will not be included in this Study.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area includes most lands, Project facilities and features within the existing FERC Project Boundary, including the North Shore Recreation Area, South Shore Recreation Area, Camp Far West Dam and associated dikes and spillway, the Camp Far West Dam Powerhouse and the Camp Far West Reservoir, for a total of 2,280 acres. The facilities are described in Section 2 of SSWD's PAD, and the Study Area is shown in Figure 4.1-1.

It is anticipated that the Study Area and the Area of Potential Effects (APE), that will be defined during the NHPA Section 106 consultation, are synonymous, pending the SHPO's concurrence on the APE. As defined in 36 C.F.R. Section 800.16(d), an APE is:

> ...the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

If SSWD proposes an addition to the Project or Project-related effects are identified outside of the Study Area, the Study Area (and subsequently the APE) will be expanded as necessary to include areas potentially affected by the addition.[4]

[4] Outside of this Study and as part of its Section 106 consultation, if any changes to the APE are proposed, SSWD will consult with tribes and agencies regarding the modification, and consult with the SHPO for concurrence on the revised APE.

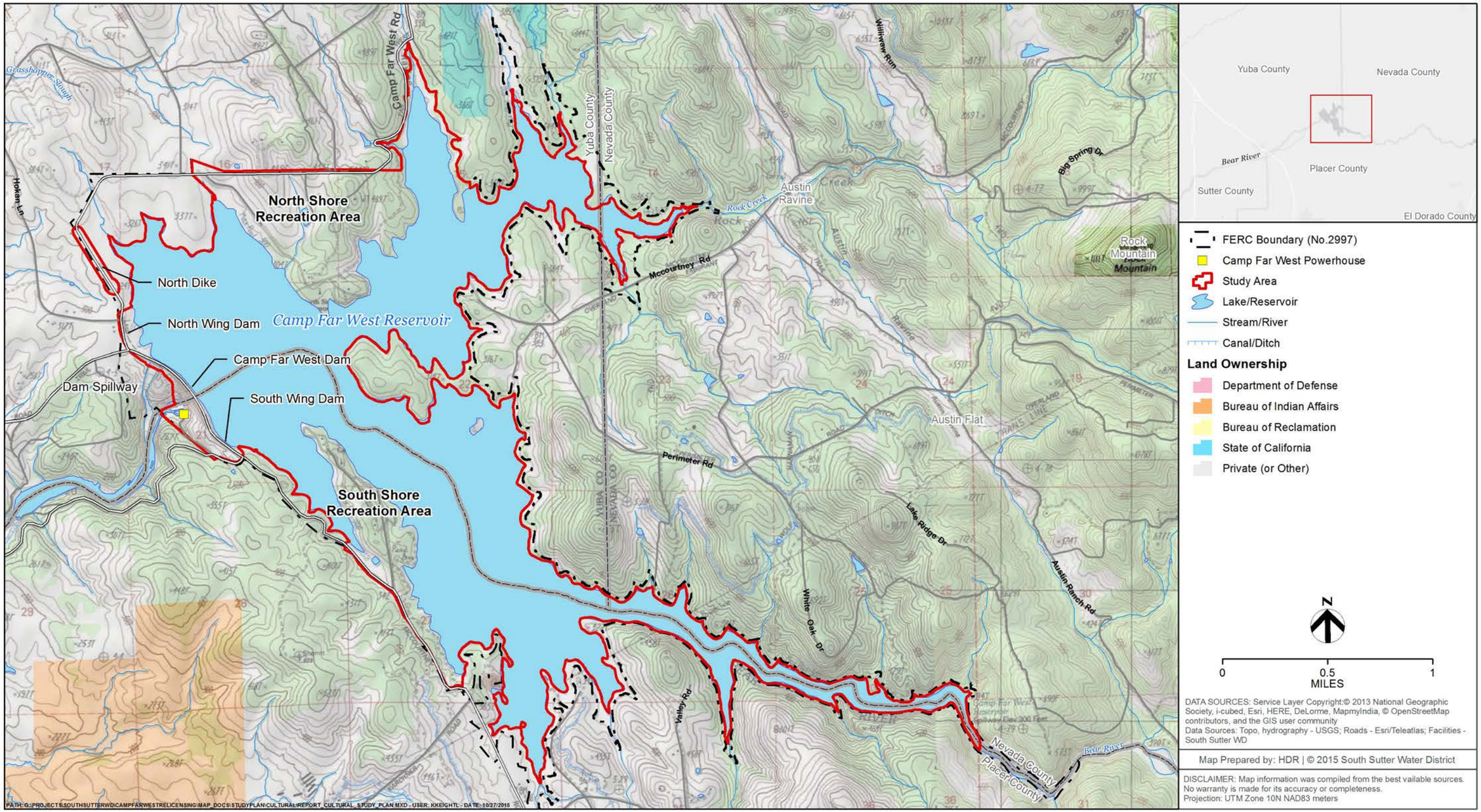

Figure 4.1-1. Study Area for Cultural Resources Study.

Page Left Blank

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study.
- SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- When SSWD becomes aware of a variance to the study plan, SSWD will issue an e-mail to FERC, United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), United States Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (Cal Fish and Wildlife) and the State Water Resources Control Board (SWRCB) describing the variance and reason for the variance. SSWD will summarize in its Draft Application for New License (DLA) and in its Final Application for New License (FLA) all study plan variances.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to:

bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.

- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm in both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be performed in four steps: 1) archival research; 2) field survey and identification of resources; 3) identification and assessment of potential Project effects on identified cultural resources; and 4) reporting. Each of these steps is described below.

4.3.1 Step 1 – Archival Research

Information has been obtained from existing, relevant and reasonably available sources to assist in identifying data gaps relevant to identifying historic properties. These data revealed previous cultural resources surveys and recorded cultural resources within or directly adjacent to the Study Area. Additional archival research will be conducted under this Study. Appropriate

repositories to be visited during this effort may include those listed below as well as at others as they are identified during the Study to obtain additional information specific to cultural resources in the Study Area. The results of the archival research will serve as the basis for preparing the prehistoric and historic contexts against which cultural resources identified during the Study may be understood and potentially evaluated for the NRHP at a later date.

Potential places/repositories to be visited include:

- Oral histories, as applicable
- State Library, Sacramento
- Special Collections, Meriam Library, California State University, Chico

4.3.2 Step 2 – Field Survey and Identification of Resources

4.3.2.1 Archaeological Field Survey

Following completion of Step 1, SSWD will conduct a field survey to verify locations of previously recorded cultural resources and to identify previously unknown cultural resources, if present, in the Study Area. This will be completed by examining all accessible lands within the Study Area. Locations within the Study Area that cannot be accessed in a safe manner (e.g., locations containing dense vegetation or unsafe slopes) will not be surveyed; these areas will be identified in the Study report and an explanation for survey exclusion will be provided.

Field methods will include crew members walking parallel transects spaced 15-20 meters apart. In areas containing moderately dense vegetation or moderately steep terrain, the survey strategy may employ 20- to 40-meter transects. All topographical features encountered in moderate areas, and considered to be sensitive for cultural resources (e.g., springs and drainages) will be thoroughly inspected. Lands typically inundated by Camp Far West Reservoir that become accessible during the survey season as a result of normal reservoir drawdown or other O&M activities will be examined. To accommodate low water levels, the field survey of the reservoir will be scheduled to occur as close to the periods of annual low reservoir levels as possible, depending on weather conditions. Additionally, each site identified during the survey will be assessed for Project-related effects including, but not limited to, water fluctuation, wave action, and vegetation management activities. The areas examined during the field survey will be plotted onto the appropriate United States Geological Survey (USGS) 1:24,000 scale topographic quadrangle.

The field survey will be supervised by qualified, professional archaeologists (i.e., individuals who meet the Secretary of the Interior's Standards for professional archaeologists). The field survey will follow the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (NPS 1983).

Locations of previously recorded cultural resources will be verified and the sites re-recorded only if their existing site records or other documentation do not meet current standards for recording, or if the condition and/or integrity of the property has changed since its previous

recording. Newly discovered cultural resources, including isolated finds, will be fully documented following the recordation procedures outlined in *Instructions for Recording Historical Resources* (OHP 1995), which utilizes State of California, Department of Parks and Recreation (DPR) 523 Forms A-L. A sketch map will be drawn to-scale for re-documented archaeological sites, if needed, and for newly discovered sites. Sites, historic built resources, and isolates will be photographed using digital photography. The locations of archaeological sites, historic built resources, and isolates documented during the survey will be plotted onto the appropriate USGS 1:24,000 scale topographic map by hand at the time of discovery, and the locations recorded using a GPS receiver in accordance with the procedures outlined above in Section 4.2. The GPS data will be based on the North American Datum (NAD) 83 and utilize the Universal Transverse Mercator (UTM) system. The mapped resource locations are considered to be confidential and will only be included in documents related to the Section 106 consultation and provided only to those on a need-to-know basis (e.g., tribes, SHPO and FERC).

4.3.2.2 Built Environment Inventory

A field inspection and documentation of historic (i.e., 45 years old or older) built-environment resources (i.e., buildings and structures) located within the Study Area will be undertaken by qualified, professional individuals meeting the Secretary of the *Interior Qualification Standards for Architectural and Engineering Documentation*. Historic built-environment resources will be recorded or re-recorded to meet current DPR standards. This will include digital color photography and sketch maps of individual features that show the relationship between buildings and structures. The historic built environment resources identified during the Study will be assessed together, as a system, as well as on an individual basis.

4.3.3 Step 3 – Identify and Assess Potential Project Effects on Cultural Resources

During Step 2, SSWD will document any Project-related effects identified at cultural resources in the Study Area. This information will be used to inform the need for any NRHP evaluations that may occur under the NHPA Section 106 consultation.

4.3.4 Step 4 – Reporting

SSWD will prepare a report at the conclusion of the Study that includes the following sections: 1) Study Goals and Objectives; 2) Methods; and 3) Results of the study. The report will include maps that clearly depict the following on USGS 1:24,000 topographic maps: the area examined; current inventory coverage in the areas surveyed, and intensity of the survey coverage. The Study report will be a summary of findings that excludes sensitive, confidential, and privileged information for purposes of the public relicensing process. A separate report will be filed as "Privileged" with FERC that contains all sensitive, confidential, and privileged information resulting from the Study. The Privileged report will be distributed to interested tribes and the SHPO for review and comments as part of the NHPA Section 106 consultation process that will be conducted by SSWD outside of this Study.

6.0 Schedule

SSWD may schedule the field survey at any time the weather permits, but will schedule survey below the normal maximum water surface elevation of Camp Far West Reservoir to accommodate, to the extent possible, annual, normal drawdowns and low water levels. Camp Far West Reservoir is historically at its lowest level in September. SSWD anticipates the schedule to complete the study as follows:

Archival Research (Step 1) ..... April 2016 – September 2016
Field Survey (Step 2) ..... November 2016 – January 2017
Report Preparation (Steps 3 & 4) ..... February 2017 – June 2017

The Study report will be included in SSWD's DLA and FLA. As described above, a separate report will be filed as "Privileged" with FERC that contains all sensitive, confidential, and privileged information resulting from the Study. The Privileged report will be distributed to interested tribes and the SHPO for review and comments as part of the NHPA Section 106 consultation process that will be conducted by SSWD outside of this Study.

7.0 Consistency of Methods with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The methods are consistent with the ACHP's guidelines (ACHP 2007).

8.0 Level of Effort and Cost

SSWD estimates the cost to complete this study in 2016 dollars is between $83,000 and $138,400.

9.0 References Cited

Advisory Council on Historic Preservation (ACHP). 2007. *Policy Statement Regarding Treatment of Burial Sites, Human Remains, and Funerary Object*. Washington, D.C.

Mead and Hunt. 2013. Cultural Resources technical Report. FERC Project No. 2997. Amendment Prepared for South Sutter Water District.

Office of Historic Preservation (OHP). 1995. Instructions for Recording Historical Resources. March 1995. Sacramento, CA.

United States Department of Interior, National Park Service (NPS). 1983. *Archaeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines in the Federal Register, September 29, 1983 (48FR44716).* Department of the Interior, Washington, D.C.

Study 11.1

TRIBAL INTERESTS STUDY

October 2016

1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) has the potential to affect tribal interests.

For the purposes of this Tribal Interests Study (Study), tribal interests include Indian Trust Assets (ITA), Traditional Cultural Properties (TCPs), and agreements that may exist between tribes and other entities.[1] Each of these has the potential to be an historic property.[2]

ITAs are legal interests in property held in trust by the United States (U.S.) for Indian tribes or individual Native Americans. The U.S. Secretary of the Interior, acting as the trustee, holds many assets in trust. ITAs can be real property, physical assets, or intangible property rights. Examples of ITAs are lands, including reservations and public domain allotments; mineral or water rights; hunting and fishing rights; other natural resources; and money or claims. While most ITAs are on reservations, they may also be found off-reservation. A characteristic of an ITA is that it cannot be sold, leased, or otherwise alienated without the U.S. government's approval. ITAs do not include things in which a tribe or individuals have no legal interest. For example, off-reservation sacred lands or archaeological sites in which a tribe has no legal interest are not ITAs.

TCPs are explained and defined in Parker and King (1998:1) as follows:

> One kind of cultural significance a property may possess, and that may make it eligible for inclusion in the [National] Register, is traditional cultural significance. "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices. Examples of properties possessing such significance include:
>
> - a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world;
> - a rural community whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents;

[1] This Study does not address other cultural resources, which are addressed in Study 10.1, *Cultural Resources*.

[2] Historic Properties, as defined under 36 C.F.R. 800.16(l), are any prehistoric or historic sites, buildings, structures, objects, districts, or locations of traditional use or beliefs (i.e., TCPs) that are included in, or eligible for inclusion in, the National Register of Historic Places.

- an urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices;
- a location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice; and
- a location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historic identity.

A traditional cultural property, then, can be defined generally as one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community.

Agreements that are considered tribal interests consist of contracts between a tribe and private land owner or land-managing agency that provide tribes with access to a landowner or agency's property for fishing, gathering of traditional plants, or other tribal practices.

2.0 Study Goals and Objectives

The goal of the Study is to supplement existing information regarding tribal interests.

The objective of this Study is to gather the information necessary to meet the Study goal by filling gaps in the existing data using field and research methods to identify tribal interests.

This Study focuses only on obtaining the data necessary to meet the Study goal and is not intended to serve as the tool for conducting National Historic Preservation Act (NHPA) Section 106 informal consultation with the State Historic Preservation Officer (SHPO) or interested Native American tribes. Section 106 consultation will be conducted separately, outside of this Study.

The Study does not include the development of potential requirements in the new license.

3.0 Existing Information and Need for Additional Information

Existing, relevant and reasonably available information regarding tribal interests within the existing Federal Energy Regulatory Commission (FERC) Project Boundary plus an additional 0.25-mile (mi) radius around the boundary[3] is provided in Section 3.2.11 of SSWD's Pre-Application Document (PAD). SSWD found that the area within the existing FERC Project

[3] The PAD refers to this area as the "Initial Cultural Data Gathering Area." This area was included in the cultural literature review and records searches for the PAD.

Boundary did not include any Indian reservation lands, other lands under tribal ownership or sacred lands. Further, SSWD did not find any documented ITAs or TCPs within this area, or any tribal agreements that pertain to lands within this area. However, existing and relevant information indicates that lands within the existing FERC Project Boundary and the surrounding area are highly sensitive for both prehistoric and historic cultural resources. Previous studies did not include ethnographic or TCP investigations. It is important to perform these studies to determine whether unidentified tribal interests occur within the Study Area. A list of potentially interested tribes is provided in Table 4.3.2-1 below in Section 4.3.2.

4.0 Study Methods and Analysis

4.1 Study Area

The Study Area includes all lands, Project facilities, and Project features within the existing FERC Project Boundary, including the North Shore Recreation Area, South Shore Recreation Area, Camp Far West Dam and associated dikes and spillway, the Camp Far West Dam Powerhouse and the Camp Far West Reservoir, for a total of 2,280 acres. The Study Area is shown in Figure 4.1-1 below.

Page Left Blank

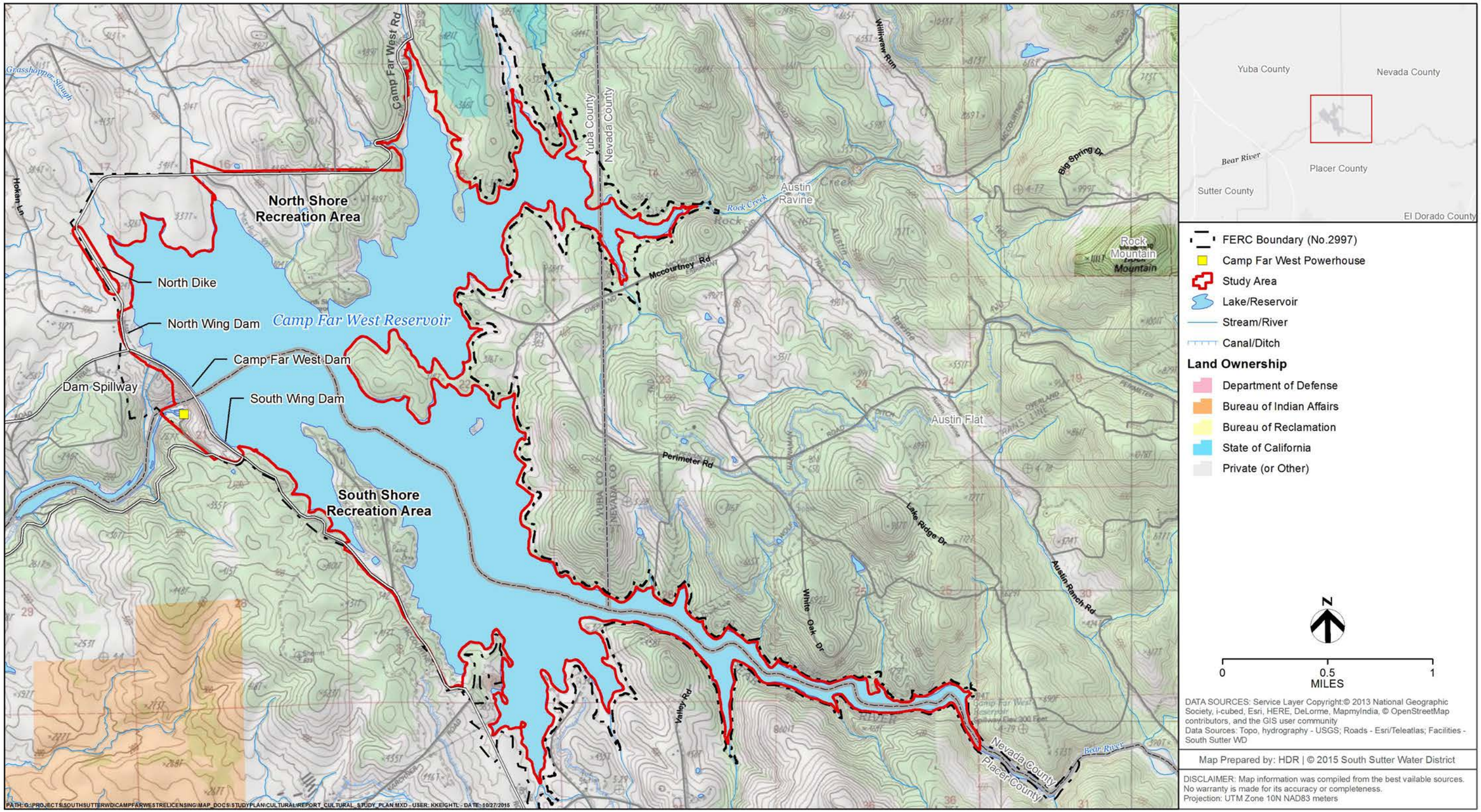

Figure 4.1-1. Study Area and Vicinity for Tribal Interests Study.

Page Left Blank

It is anticipated that the Study Area and the Area of Potential Effects (APE), that will be defined during the NHPA Section 106 consultation, are synonymous, pending the SHPO's concurrence on the APE. As defined in 36 C.F.R. Section 800.16(d), an APE is:

> …the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

If SSWD proposes an addition to the Project or Project-related effects are identified outside of the Study Area, the Study Area (and subsequently the APE) will be expanded as necessary to include areas potentially affected by the addition.[4]

4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary permits prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3-meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to NMFS, USFWS, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee (FGDC) compliant.

[4] Outside of this Study and as part of its Section 106 consultation, if any changes to the APE are proposed, SSWD will consult with tribes and agencies regarding the modification, and consult with the SHPO for concurrence on the revised APE.

- SSWD's field crews conducting relicensing studies will record incidental records of aquatic and wildlife species observed during the performance of a study. All incidental observations will be reported in Application for New License. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), any bats or positive sign of bats, Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*), foothill yellow-legged frog (*Rana boylii*), American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.
- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfection) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in HEC-DSS format. A viewer for these files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers (USACE) at the following website as of March 2008: http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htmin both Microsoft® Excel and *.DSS formats.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

4.3 Methods

The Study will be performed in five steps: 1) archival research; 2) tribal consultation and identification of resources; 3) site visits; 4) identify and assess potential Project effects on tribal properties; and 5) reporting. Each of these steps is described below.

4.3.1 Step 1 – Archival Research

Information has been obtained from existing, relevant and reasonably available sources to assist in identifying data gaps relevant to identifying tribal interests. Additional archival research will be conducted to augment the existing data and may include the following repositories, if appropriate:

- University of California, Berkeley, the Bancroft Library
- California State Library, California Room
- North Central Information Center, California State University, Sacramento (CSU, Sacramento)
- National Archives and Records Administration, Pacific Region, San Francisco
- National Park Service Preservation Brief 36
- Phoebe Hearst Museum of Anthropology
- Other appropriate repositories identified during the research

4.3.2 Step 2 – Tribal Consultation and Identification of Resources

Following the ethnographic literature review discussed in Step 1, the next step in identifying potential tribal interests will involve tribal consultation and interviews. Consultation and any fieldwork and potential tribal interest documentation shall be consistent with National Register Bulletin No. 38, *Guidelines for Evaluating and Documenting Identification of Traditional Cultural Properties* (Parker and King 1998).

In order to facilitate tribal consultation, SSWD intends to retain a qualified, professional ethnographer who meets the standards for ethnography as defined in Appendix II of National Register Bulletin No. 38. SSWD will coordinate its selection of the ethnographer with the assistance of interested tribes and other interested cultural/tribal stakeholders.

This Study will include contacting the representatives identified during PAD preparation and listed in Table 4.3.2-1.

Table 4.3.2-1. Potentially Interested Tribes and tribal representatives identified by the NAHC for the Camp Far West Hydroelectric Project relicensing.

Tribe	Tribal Representative
Colfax-Todds Valley Consolidated Tribe	Pamela Cubbler
	Judy Marks
Tsi-Akim Maidu	Don Ryberg, Chairperson
	Eileen Moon, Vice Chairperson
	Greyson Coney
United Auburn Indian Community of the Auburn Rancheria (UAIC)	Gene Whitehouse, Chairperson
	Jason Camp, Tribal Historic Preservation Officer
	Marcos Guerrero, Tribal Preservation Committee
Enterprise Rancheria of Maidu Indians	Glenda Nelson, Chairperson
Mooretown Rancheria of Maidu Indians	Gary Archuleta, Chairperson
	Guy Taylor
	Laura Winner
Nevada City Rancheria	Richard Johnson, Chairperson
	Shelly Covert, Secretary

The ethnographer will coordinate with tribal representatives (i.e., tribal chairs, tribal councils, elders, as directed by the tribes) to define the scope and breadth of interviews. The ethnographer will arrange for interviews with identified tribal informants to establish times and locations acceptable to the tribal Interviewees. Tribal interviewees and the ethnographer may visit the Study Area together to accurately define potential tribal interests. If necessary, SSWD will arrange for an initial introductory meeting between SSWD, tribal representatives and the ethnographer.

Interviews may be conducted on a one-on-one basis with the ethnographer. The oral traditions and information collected during the interviews will be used to help define potential tribal interests in the Study Area, and assist in making sound judgments and management decisions in Project planning.

If participating tribes do not wish to disclose the locations of any potential tribal interests, the ethnographer will instead work with the tribes to identify the general issues and concerns that the tribe(s) may have regarding potential impacts of the Project upon resources identified by the tribe(s) and further work with the tribes to develop agreeable measures to address these concerns.

4.3.3 Step 3 – Site Visits

Tribal interviewees, or a physically capable tribal representative, and SSWD's ethnographer may wish to visit cultural resource sites (i.e., locations containing artifacts, features, or other physical remains from past human activities) identified during the Study or during SSWD's Study 10.1, *Cultural Resources*. The purpose of the visit would be to provide tribal representatives the opportunity to examine any sites of interest to the tribes that were encountered during the Cultural Resources Study fieldwork, and to enable the ethnographer to obtain additional information on potential tribal interests that may be associated with the sites. SSWD or SSWD's ethnographer will make a reasonable effort to reach out to interested tribes to invite participation in cultural resources site visits by calling, sending letters by way of the U.S. Postal Service, or through electronic mail. If any ethnographic sites (e.g., locations of tribal interests or activities that may or may not contain the physical remains from past or present activities) are identified

during background research, tribal representatives may also wish to visit those locations. Depending on the tribes' wishes, the ethnographer may also visit the ethnographic sites.

4.3.5 Step 4 – Identify and Assess Potential Project Effects on Tribal Interests

During Step 4, SSWD will document any Project-related effects identified at tribal interests located in the Study Area. This information will be used to inform the need to conduct any NRHP evaluations that may occur under the NHPA Section 106 consultation.

4.3.6 Step 5 – Reporting

SSWD will prepare a report that includes the following sections: 1) Study Goals and Objectives; 2) Methods; and 3) Results of the study. The Study report will be a summary of findings that excludes sensitive, confidential, and privileged information for purposes of the public relicensing process.

A separate report will be filed as "Privileged" with FERC that contains the sensitive, confidential, and privileged information resulting from the study. The Privileged report will be distributed to interested tribes and the SHPO for review and comments as part of the NHPA Section 106 consultation process that will be conducted outside of this Study. A draft of the Privileged report will be provided to the tribes for a 30-day review and comments, and then submitted to the SHPO for 30-day review and concurrence on the report. With the tribes' approval, the report will be submitted to the North Central Information Center. Any written comments received by SSWD within the review period will be addressed in the final Privileged report filed with FERC. Any TCPs identified during the Study will be evaluated for potential listing in the NRHP in the Privileged report to be filed with FERC.

7.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning/Pre-field Arrangements (Step 1).....May 2016 – July 2016
Field Work (Steps 2 & 3).....August 2016 – December 2016
Office Work and Report Preparation (Steps 4 & 5)..... December 2016 – July 2017

The Study report will be included in SSWD's DLA and FLA. As described above, a separate report will be filed as "Privileged" with FERC that contains all sensitive, confidential, and privileged information resulting from the Study.

8.0 Consistency of Methods with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No.

2299), Yuba River Development Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The methods are consistent with the ACHP's guidelines.

9.0 Level of Effort and Cost

SSWD estimates the cost to complete this Study in 2016 dollars is between $121,500 and $139,000.

10.0 References Cited

Parker, Patricia L., and Thomas F. King. 1998. *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. Revised. National Register Bulletin 38. U.S. Department of the Interior, National Park Service, National Register, History, and Education Division, Washington, D.C.