VOLUME III
DRAFT PROPOSED TECHNICAL STUDY PLANS

Lower Mokelumne River Hydroelectric Project FERC Project No. 2916

October 2025

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

Volume III
Draft Proposed Technical Study Plans

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DRAFT WATER QUALITY STUDY PLAN (WR-1)

Lower Mokelumne River Hydroelectric Project

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DRAFT WATER QUALITY STUDY PLAN (WR-1)

Lower Mokelumne River Hydroelectric Project

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1.0 Introduction

This Water Quality Study (WR-1) plan addresses water quality monitoring at the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916; Lower Mokelumne River Project or Project). Results of the Water Quality Study will be used to assess water quality in relation to standards and objectives set by the Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board (CRWQCB 2019), Central Valley Region, and the Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Watershed (Bay-Delta Plan; California State Water Resources Control Board [CSWRCB] 2024). It will also be used to provide water temperature inputs to the Water Temperature Study.

2.0 Project Nexus and Study Rationale

Project operations and maintenance activities could affect water quality in Project-affected stream reaches and Project reservoirs. The WR-1 study results will inform the development of potential license requirements. This study is needed to assess water quality in the Project-affected reservoirs and river reaches.

3.0 Study Goals and Objectives

The goals and objectives of the WR-1 study are as follows:

- Characterize existing project water quality of Project reservoirs and Project-affected river reaches.
- Collect water quality data to supplement existing information.
- Assess water quality conditions in relation to the objectives/criteria of the Basin Plan (CRWQCB 2019) and other water quality standards.

4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity. Relevant management goals include compliance with the following:

- Basin Plan beneficial uses and water quality objectives (CRWQCB 2019).
- Bay-Delta Plan, including the Healthy Rivers and Landscapes Program (CSWRCB 2024).
- East Bay Municipal Utility District (EBMUD) P-2916 license (FERC 1981).
- California Toxics Rule (CTR) "Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (65 Federal Register (FR) 31682).
- National Toxics Rule (NTR) "Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants" (57 FR 60848).

5.0 Geographic Scope

The geographic scope of this study includes the Mokelumne River inflow to Pardee Reservoir, through the outflow of Camanche Reservoir downstream to the Woodbridge Irrigation District Dam.

6.0 Existing Information and Need for Additional Information

Extensive water quality data have been collected in the Project area by EBMUD as part of their P-2916 license (FERC 1981) including the following:

- Reservoir water quality monitoring stations
    - Water temperature, dissolved oxygen (DO), pH, specific conductivity, chlorophyll, blue green algae, phycocyanin concentration, and turbidity
- River/facility water quality monitoring stations
    - Water temperature, DO
- Bacterial water quality sampling
    - Bacteriological (i.e., Bac-T) sampling
- Heavy metal testing
    - Copper, zinc

Further information, including the duration and frequency of sampling, is detailed in the Pre-Application Document (PAD).

7.0 Study Methodology

The following describes the water quality sampling field program, which includes seasonal in-situ water quality measurements; seasonal water quality grab sampling; reservoir/lake profiles; and laboratory analysis and reporting.

7.1. Water Quality Sampling Locations

- Existing water quality sampling locations will be sampled in study Year 1, as identified in Table 7-1 (river reaches) and Table 7-2 (reservoirs) and depicted on Figure 7-1 (river reaches) and Figure 7-2 (reservoirs).
- Exact sampling locations will be determined in the field based on sampling suitability (i.e., well-mixed and deep enough for representative sampling) and accessibility.
- Sampling locations will be documented using hand-held global positioning system (GPS) units.

Table 7-1. River reach water quality sampling locations.

Station Name	Brief Description	River Mile Location	Parameters to be Measured	Latitude/ Longitude
HWY49 U.S. Geological Survey station Mokelumne R NR Mokelumne Hill CA (1139500).	Upper Mokelumne River at Highway 49 crossing.	TBD	In-situ; General Water Quality Grab Sample	X: 6498509.709 Y: 2300666.712
Middle Bar Boating Takeout	Boating takeout area on the Mokelumne River above Pardee Reservoir	TBD	Bacteria	TBD
Below Pardee Dam	Outflow below Pardee Dam	TBD	In-situ; General Water Quality Grab Sample	TBD
Below Camanche U.S. Geological Survey station Mok R Bl Cam Dam (11323500)	Mokelumne River at the below Camanche Dam day use area	TBD	In-situ; General Water Quality Grab Sample; Bacteria	TBD
Mackville	Lower Mokelumne River at Mackville Road via Stillman Magee Park public access	TBD	Bacteria	X: 6391094.632 Y: 2261660.436

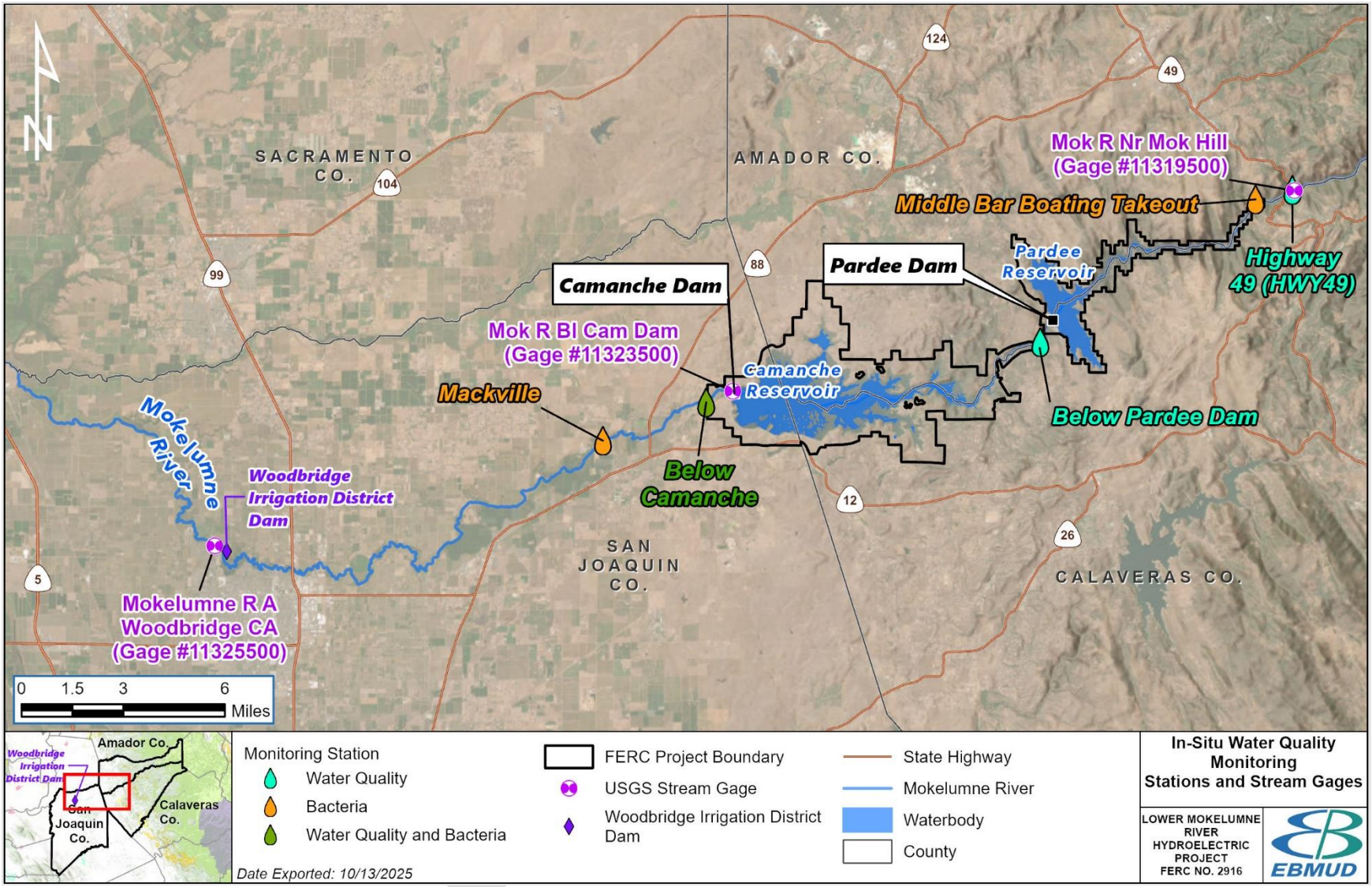

Figure 7-1. Lower Mokelumne Project in-situ water quality monitoring stations and stream gages.

Table 7-2. Reservoirs sample locations.

Station Name	Brief Description	Parameters to be Measured	Latitude/ Longitude
Pardee Reservoir			
LOGBOOM	Upstream reservoir inlet at floating log boom used to block debris flows into the reservoir	In-situ Profile; General Water Quality Grab Sample	TBD
PARI	Reservoir interior water quality station adjacent to small creek inflow.	In-situ Profile; General Water Quality Grab Sample	TBD
PARBR	Reservoir near boat ramp	Bacteria	
PATW	Pardee Reservoir at Intake Tower	In-situ Profile; General Water Quality Grab Sample Harmful Algae / Cyanotoxins	TBD
PADA	Pardee Dam	In-situ Profile; General Water Quality Grab Sample	TBD
Camanche Reservoir			
CAMA	Upstream station accessible in most years	In-situ Profile; General Water Quality Grab Sample	TBD
PENN	Adjacent to abandoned Penn Mine	Continue Existing Protocol Mine Drainage Sampling	TBD
CAMI	Interior reservoir	In-situ Profile; General Water Quality Grab Sample	TBD
CAMNS- 1 CAMNS-2	Adjacent to north shore recreation area	Bacteria	TBD
CAMSS-1 CAMSS-2	Adjacent to south shore recreation area	Bacteria	TBD
CAMD	Camanche Dam	In-situ Profile; General Water Quality Grab Sample Harmful Algae / Cyanotoxins	TBD

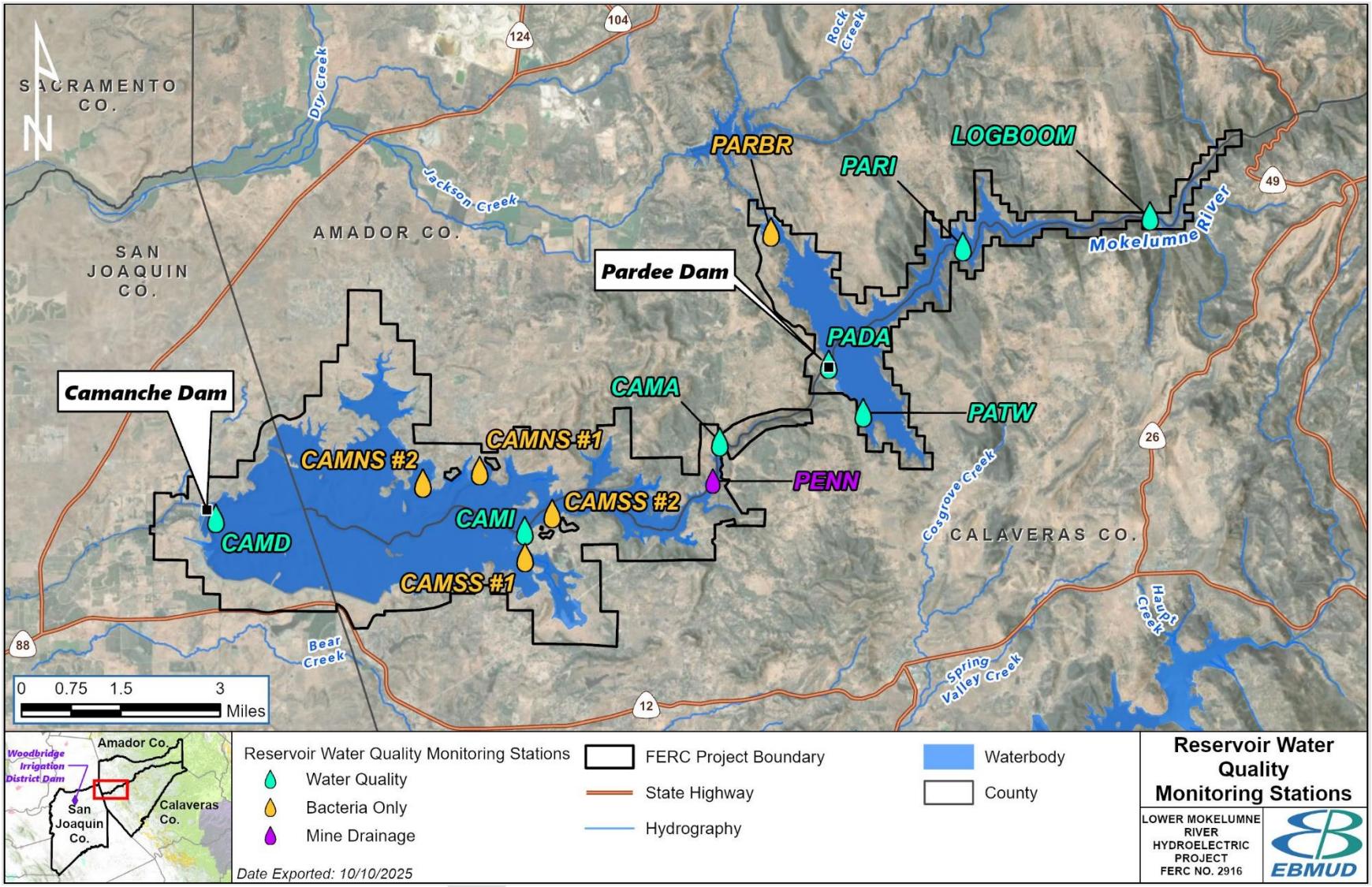

Figure 7-2. Lower Mokelumne Project reservoir water quality monitoring stations.

7.2. Spring/Fall In-situ Field Measurements

7.2.1. River Reaches

- In-situ water quality measurements to be collected: DO (mg/L and percent saturation), pH, specific conductance (µS/cm), alkalinity (mg/L), turbidity (NTU), and water temperature (°C).
    - Samples to be collected once during the late spring/early summer (May/June) during high flow, and once during the late summer/early fall baseflow period (September/October).
    - At the stream sampling locations, measurements to be made approximately 0.1 meter (~3.9 inches) beneath the surface in flowing, well-mixed riffle or run areas.
    - Samples to be collected using a multi-parameter water quality meter (HydroLab, YSI, or similar DataSonde) and field kit (e.g., alkalinity).
    - Pre- and post-sampling calibration of in-situ instrumentation to be conducted following the manufacturer's instructions.

7.2.2. Reservoirs

- Collect reservoir/lake profiles (DO, pH, specific conductance, turbidity, and water temperature).
- Collect samples monthly in April through October.
- Water quality profiles in the reservoirs/lake will be based on a ≤1 meter (~3.3 feet) sampling interval through the entire water column.
- Collect Secchi disk depth measurements of water clarity in each reservoir/lake.
- Collect samples using a multi-parameter water quality meter.
- Conduct pre- and post-sampling calibration of in-situ instrumentation following the manufacturer's instructions.

7.3. Spring/Fall Water Quality Grab Samples

- Collect water quality grab samples at Project-affected stream segments and reservoirs.
    - Samples will be collected once during the late spring/early summer (May/June) during high flow, and once during the late summer/early fall baseflow period (September/October).
    - At stream sampling locations, grab samples will be collected approximately

0.1 meters (~3.9 inches) beneath the surface in flowing, well-mixed riffle or run areas.
    - At lake sampling locations, grab samples will be collected from the epilimnion (1 meter/3.3 feet deep) and hypolimnion (mid-depth between the thermocline and lake bottom). If the lakes are not stratified, then water grab samples will be collected approximately 1 meter from the surface and at mid-depth from the surface to lake bottom.

- Collect samples consistent with Environmental Protection Agency (EPA) protocols for each analyte (see Section 7.7, Laboratory Analysis below) and consistent with general water quality sampling methods (U.S. Geological Survey 2019).
    - The sampling team shall employ a strict quality assurance/quality control (QA/QC) program, including the collection of equipment blanks, field blanks, and field replicates.
    - Water quality samples will be decanted into laboratory-supplied sample containers and analyzed at a state-certified water quality laboratory.
    - The sample containers will be labeled with the date and time that the sample is collected and the sampling site or identification label.
    - The sample container will be preserved (as appropriate), stored, and delivered to a state-certified water quality laboratory for analyses in accordance with maximum holding periods.
    - A chain-of-custody record will be maintained with the samples at all times.

7.4. Bacterial Sampling

- Collect surface water bacteriological samples at five relatively evenly spaced times during the month of July for total and fecal coliform and *Escherichia coli* (*E. coli*) at the locations in Table 7-1 and Table 7-2.

7.5. Methylmercury Sampling

- Test up to 10[1] each of edible-sized sport fish (black bass [*Micropterus*], rainbow trout [*Oncorhynchus mykiss*], brown trout [*Salmo trutta*], crappie [*Poxomis*], bluegill [*Lepomis macrochirus*], catfish [*Siluriformes*]) captured in each reservoir (Pardee and Camanche) during fish surveys conducted under the Fish Population Study for concentrations of both total and methylmercury.
- Testing of fish in the Lower Mokelumne River (downstream of Camanche Dam) is not proposed. The existing Office of Environmental Health Hazard Assessment

[1] If less than 10 edible-sized fish of each species are captured, then all captured fish will be tested.

(OEHHA) advisory for anadromous fish and other sportfish in the Lower Mokelumne River (OEHHA 2022) will be used to provide consumption advisories downstream of Camanche Dam.

7.6. Harmful Algae Blooms/Cyanotoxins

- Continue EBMUD's existing sampling regime for Pardee and Camanche reservoirs for harmful algal blooms and cyanotoxins (e.g., monthly, or more frequently when algal activity is high). If algal blooms are observed in the reservoir, additional testing for cyanotoxins will be carried out. If the presence of cyanotoxins is suspected or confirmed, appropriate signage would be placed in the area to warn visitors of the danger.

7.7. Laboratory Analysis

- Water quality samples collected during the field program will be processed by a state-certified laboratory approved by the CSWRCB for chemical analysis.
- The parameters to be analyzed by the analytical laboratory are provided in Table 7-3.
- The laboratory will report each chemical parameter analyzed with the laboratory method detection limit, reporting limit, and practical quantification limit. The laboratory will attempt to attain reporting detection limits that are at or below the applicable regulatory criteria.
- Compare the water quality sampling results to the water quality objectives/criteria identified in the Basin Plan (CRWQCB 2019) and with other relevant water quality standards (e.g., California Toxics Rule, National Toxics Rule).
- Submit fish samples to an analytical laboratory for individual fish muscle tissue analysis (fillets). The results of the fish muscle tissue analyses will be summarized in a table and will include the fish identification number, date and time collected, total and fork length, weight, and total/methylmercury concentrations. Average total and methylmercury concentrations by species will be calculated. The mercury concentrations will also be presented relative to fish weight in graphical format and compared to appropriate OEHHA and/or EPA screening value guidelines.

Table 7-3. Water quality sampling parameters.

Parameter	Analysis Method	Sample Holding Times	Sample Locations to be Analyzed
Water Quality Monitoring Parameter			
***In-Situ* Measurements**			
DO	Water Quality Meter	Not Applicable	All
Secchi Depth	Secchi Disk	Not Applicable	Reservoir
pH	Water Quality Meter	Not Applicable	All
Water Temperature	Water Quality Meter	Not Applicable	All
Specific Conductance	Water Quality Meter	Not Applicable	All
Laboratory Analysis Parameter			
General Grab Sample Parameters			
Nitrate/Nitrite	EPA - 353.2	48 hours	All
Ammonia as N	EPA - 350.1	28 days	All
Total Kjeldahl Nitrogen	EPA - 351.2	28 days	All
Total Phosphorus	EPA - 365.2	28 days	All
Ortho-phosphate	EPA - 365.1	48 hours	All
Total Dissolved Solids	EPA - 160.1	7 days	All
Total Suspended Solids	EPA - 160.2	7 days	All
Total Alkalinity	EPA - 310.1	14 days	All
Bacteria			
Total Coliform	EPA - SM9222B	8 hours	Recreation Locations
Fecal Coliform	EPA - SM9222B	8 hours	Recreation Locations
E. coli	EPA - SM9223B	8 hours	Recreation Locations
Fish Tissue Mercury			
Methylmercury	EPA – 1631e	48 hours	All
Mercury - Total	EPA – 1631e	48 hours	All

7.8. Additional Sampling (if needed)

- If water quality sampling results indicate exceedances of objectives/criteria identified in the Basin Plan or with other relevant water quality standards, EBMUD will consult with CSWRCB, resource agencies, and the Technical Working Group, and, if appropriate, will implement a second year of water quality sampling (2028) focused on those parameters that were exceeded. The specific sampling approach will be developed in consultation with CSWRCB, resource agencies, and the Technical Working Group.

7.9. Reporting

- Document study methods and results in a Water Quality Technical Study Report (TSR). The TSR will include summary tables and maps, as appropriate.
- Upon request, provide data to resource agencies and interested parties in a Microsoft Excel spreadsheet (electronic format).

8.0 Schedule and Deliverables

This is proposed as a single-year study; this includes a draft and final Water Quality TSR. The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Water Quality Study schedule.

Date	Activity
August 2026	FERC SPD
April 2027 – March 2028	Collect Data, Analyze, and Prepare Draft Technical Report
August 2027	Provide a Study Progress Update in the Initial Study Report (ISR)
August 2027 – July 2028	If Necessary, Collect Second Year Water Quality Data for Select Parameters and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating stakeholder feedback.

10.0 References

(CRWQCB) California Regional Water Quality Control Board. 2019. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region Fifth Edition – 2019. The Sacramento River Basin and The San Joaquin River Basin.

(CSWRCB) California State Water Resources Control Board. 2024. Draft Sacramento-San Joaquin Delta Bay-Delta Plan Updates. Retrieved from https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/2024/drft-sacdelta-bdplan-updates.pdf

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

(OEHHA) Office of Environmental Health Hazard Assessment. 2022. Information about the Advisory for Eating Fish from the Lower Mokelumne River (Sacramento and San Joaquin counties). Issued November 2022.

U.S. Geological Survey. 2019. National Field Manual for the Collection of Water-Quality Data (NFM). U.S. Geological Survey Water Resources Mission Area. Retrieved September 24, 2025, from https://www.usgs.gov/mission-areas/water-resources/science/national-field-manual-collection-water-quality-data-nfm.

DRAFT WATER TEMPERATURE STUDY PLAN (WR-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT WATER TEMPERATURE STUDY PLAN (WR-2)

Lower Mokelumne River Hydroelectric Project

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1.0 Introduction

This study plan addresses water temperature modeling of the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916; Lower Mokelumne River Project or Project). The study will make use of pre-existing CE-QUAL-W2 water temperature models of Pardee and Camanche reservoirs and SNTEMP/RSM4 models, as appropriate. Results of the hydrologic operations model (see Hydrology and Operations Modeling Study Plan) will be used to provide hydrologic model inputs. Water temperature (inflow/outflow and reservoir profiles) and meteorological data will be collected/compiled to inform the modeling (see Water Quality Study Plan). In addition, a climate change meteorological dataset will be incorporated into the water temperature modeling. The model will be used to analyze water temperature effects of the existing Project and potential scenarios for both current conditions and future climate change conditions.

2.0 Project Nexus and Study Rationale

Project operations and maintenance activities could affect water temperature in Project-affected river reaches and Project reservoirs. The Water Temperature Study (WR-2) results will inform development of potential license requirements.

3.0 Study Goals and Objectives

The goals and objectives of the study are as follows:

- Review existing water temperature model applications for Pardee and Camanche reservoirs and the Lower Mokelumne River and update if necessary.
- Compile historical water temperature and meteorological data and collect additional meteorological and water temperature data to calibrate and/or validate water temperature models.
- Model water temperature for the existing Project and other potential infrastructure/hydrology operation scenarios under existing climate conditions and future climate change conditions that will be identified prior to study plan implementation.

4.0 Relevant Resource Management Goals and/or Public Interest Considerations

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity. Relevant management goals include the following:

- Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan) beneficial uses and water quality objectives (California Regional Water Quality Control Board 2019).
- East Bay Municipal Utility District (EBMUD) P-2916 license compliance (FERC 1981).

5.0 Geographic Scope

The geographic scope of this study includes the Mokelumne River inflow to Pardee Reservoir, through the outflow of Camanche Reservoir downstream to the Woodbridge Irrigation District Dam.

6.0 Existing Information and Need for Additional Information

Extensive water temperature data have been collected in the Project area by EBMUD as part of their P-2916 license (FERC 1981) and are detailed in the Pre-Application Document (PAD). Collection of water temperature data will continue throughout the relicensing process, and additional sites will be added if necessary for modeling purposes. Water temperature data collection includes inflow temperatures to Pardee Reservoir, in-lake profiles (Pardee and Camanche), and reservoir outflow temperatures.

In addition to water temperature data, the following information and/or tools are available for use in the Water Temperature Study:

- Results of the Hydrologic and Operations Modeling Study will provide hydrologic inputs for the temperature models already developed by EBMUD.
- The existing CE-QUAL-W2 (Pardee and Camanche reservoirs) and SNTEMP/RSM4 (run-of-river model between Pardee and Camanche reservoirs) water temperature models will be used, as applicable.
- Local weather data for the model period (1997–2023) are available from local weather stations at Camp Pardee, Camanche Dam, and Stockton Airport (cloud cover). Meteorological data from other stations and weather networks might also be used to fill gaps in the existing datasets, as necessary.
- Downscaled climate change projections applicable to the Project area, including air temperature, relative humidity, and wind speed, are available from Cal-Adapt or from other studies. These projections can be used to scale local weather data for the purpose of modeling future climate conditions.

This study is needed to develop temperature modeling tools that can be used to accurately represent project water temperature over a representative period of record (POR) for existing Project operations and alternative Project operations. The purpose of the modeling is to analyze potential effects of alternative operations on water temperatures released from Camanche Dam.

7.0 Study Methodology

The following describes the study approach for developing the water temperature modeling and analysis.

7.1. Water Model Development

- Conduct a minimum of three stakeholder water temperature modeling Technical Working Group (TWG) meetings to review and help guide the temperature modeling approach.
- Assess the suitability of existing CE-QUAL-W2 (Pardee and Camanche reservoirs) and SNTEMP/RSM4 (between Pardee and Camanche reservoirs) water temperature models to model daily water temperature. For the Lower Mokelumne River, evaluate the suitability of the existing SSTEMP model and the statistical relationship for 7-day average daily maximum (MM7DADM) water temperature to model daily average temperature. If necessary, update the models or develop new models.
- Incorporate the capability to model alternative infrastructure at Camanche Dam to better access cold water.
- Calibrate and/or validate models using historical water temperature and meteorological data.

7.2. Data Collection and Analysis

- Water Temperature Data
  - Retrieve historical water temperature data and collect water temperature data during the first and second study years as part of ongoing monitoring or supplemental monitoring as part of the Water Quality Study Plan:
    - River Reaches
    - Downstream of Dams and/or Spillway
    - Reservoir Profiles
  - Data will be reviewed for quality assurance and to ensure that field equipment records data correctly. At the conclusion of the field season, data will be evaluated for use in water temperature models.
  - The water temperature data will be shared and reviewed in coordination with the Instream Flow and Egg Survival fish and aquatic studies.

- Meteorological Data
    - Download data from local meteorological data stations for the modeling period of record:
        - Air Temperature
        - Dew Point Temperature/Relative Humidity
        - Wind Speed
        - Wind Direction
        - Solar Radiation
        - Cloud Cover
    - Meteorological data will be reviewed for quality assurance and will be evaluated for use in the water temperature models.
- Incorporate the climate change air temperature/meteorological dataset(s) for a climate change analysis.

7.3. Water Temperature Modeling and Analysis

- During the second study year, use the water temperature models to model existing Project operations and other potential scenarios daily for water temperature using results of hydrological modeling (see Hydrology and Operations Modeling Study Plan) under both current and future climate conditions.
- The results of the proposed aquatic study plans (e.g., Egg Survival) will be used to define specific objectives to improve downstream salmon health. If improvements are necessary to achieve objectives, various alternatives would be evaluated for meeting those objectives, including infrastructure options. Final development of infrastructure alternatives may occur after completion of this study plan; if this occurs, modeling results will be provided in the Final License Application.

7.4. Reporting

- The study methods and results will be documented in a Water Temperature Technical Study Report (TSR). The TSR will include summary tables and maps, as appropriate.
- Upon request, data will be provided to resource agencies and interested stakeholders in a digital format.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Water Temperature TSR. The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Water Temperature Study schedule.

Date	Activity
August 2026	FERC SPD
September 2026	Conduct First Year Studies
September 2026 –July 2027	Model Development and Data Collection and Prepare Draft TSR (for completed study elements)
August 2027	File Initial Study Report (ISR)
August 2027	Conduct Second Year Studies
August 2027 – July 2028	Data Collection, Model the Existing Project and Alternatives, and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating stakeholder feedback.

10.0 References

California Regional Water Quality Control Board. 2019. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region Fifth Edition – 2019. The Sacramento River Basin and The San Joaquin River Basin.

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

DRAFT HYDROLOGY AND OPERATIONS MODELING STUDY PLAN (WR-3)

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
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October 2025

DRAFT HYDROLOGY AND OPERATIONS MODELING STUDY PLAN (WR-3)

Lower Mokelumne River Hydroelectric Project

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1.0 Introduction

This Hydrology and Operations Modeling Study (WR-3) plan addresses hydrology and operations modeling of the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916; Lower Mokelumne River Project or Project), including inflow hydrology, reservoir operations, flood control, water supply, power generation, and outflow hydrology. The WR-3 study will make use of the East Bay Municipal Utility District's (EBMUD's) existing EBMUDSIM-RW planning and operations model for the Project. Historical and perturbed hydrology inflow datasets will be incorporated into the modeling. The model will be used to analyze operations of the existing Project and potential scenarios for both current conditions and future climate conditions. Results of the hydrologic operations modeling will be used to provide hydrologic model inputs to other studies (e.g., Water Temperature Study, Instream Flow Study).

2.0 Project Nexus and Study Rationale

Project operations and maintenance activities affect hydrology in Project-affected reservoirs and Project stream reaches. The WR-3 study results will inform the input into other studies that will then help with development of potential license requirements.

3.0 Study Goals and Objectives

The goals and objectives of the WR-3 study are as follows:

- Model the existing Project hydrology and other potential hydrology/operations scenarios.
- Perform a hydrologic alteration analysis, which involves evaluating changes in streamflow resulting from potential changes in operations across different hydrologic scenarios.
- Conduct a high flow frequency analysis for hydrology scenarios by evaluating peak flow characteristics and annual exceedance probabilities.

4.0 Relevant Resource Management Goals

Existing management plans such as the Water Control Manual, Joint Settlement Agreement, D-1641, Urban Water Management Plans/Water Shortage Contingency Plan, as well as relevant water rights will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity. Relevant management goals include the following:

- Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan) beneficial uses and water quality objectives (California Regional Water Quality Control Board 2019).
- EBMUD P-2916 license compliance (FERC 1981).
- Urban Water Management Plans.
- Water Shortage Contingency Plan.

5.0 Geographic Scope

The geographic scope of this study begins at the Mokelumne River inflow to Pardee Reservoir, through the outflow of Camanche Reservoir downstream to the Woodbridge Irrigation District Dam.

6.0 Existing Information and Need for Additional Information

Extensive data on hydrology and operations have been collected in the Project area by EBMUD as part of their P-2916 license (FERC 1981) and are detailed in the Pre-Application Document (PAD). Collection of these data will continue throughout the relicensing process.

The primary sources of hydrologic and operational data for this study include:

- U.S. Geological Survey gages (Gage Nos. 11319500, 11323500, and 11325500);
- EBMUD's historical records:
    - Pardee and Camanche reservoir storage operations
    - Diversions for domestic water supply
    - Powerhouse operations
    - Reservoir releases, including minimum instream flow requirements; and
- Flood frequency information data developed by the United States Army Corps of Engineers (1981).

7.0 Study Methodology

The following describes the WR-3 study approach for developing Project hydrology and operations models.

7.1. Hydrology Model Development

- Conduct a minimum of three stakeholder hydrology modeling Technical Working Group (TWG) meetings to review and help guide the hydrology modeling approach.
- Use the 1997–2023 period of record (POR) for hydrological modeling to align with the model period being used in the Water Temperature Study.
- Use EBMUD's existing EBMUDSIM-RW operations model to characterize the existing Project and other potential scenarios' daily average flow hydrology for the POR based on the modeling working group input, as appropriate.
    - Include all existing constraints on the river and reservoirs such as flood control requirements, water supply demand, instream flow requirements, and water rights.
- Identify the best available climate change hydrology data/modeling applicable to the Mokelumne watershed (e.g., EBMUD Urban Water Management Plan climate change analysis study). Incorporate the data into the hydrology model (HEC-HMS) being developed by EBMUD to characterize future climate change hydrology (existing Project and other potential hydrology/operations scenario[s]) over the term of the Project license (e.g., 50 years).

7.2. Hydrologic Alteration Analysis

- Analyze and compare existing Project and other potential hydrology/operations scenario(s) daily average flows using the following data and approaches in select Project-affected stream segments (e.g., Richter et al. 1996).
    - Monthly flow exceedance plots/tables for the POR
    - Time-series plots for the POR
    - January to December (annual) plots/tables showing mean daily and 95 percent, 90 percent, 75 percent, 50 percent (median), 25 percent, 10 percent, and 5 percent exceedance flows

- Tables and summary analysis showing the following metrics of interest:
  - Monthly timing and magnitude of mean and median flow conditions (e.g., high and low flows)
  - Magnitude, duration, and timing of annual high flow and low flow conditions (1-day, 3-day, 7-day, monthly, etc.), including the presence of pulse flow events
  - Rate, timing, and frequency of hydrograph changes (e.g., rate and timing of the declining limb of the spring high flow hydrograph)

7.3. High Flow Frequency Analysis

For the hydrology modeling scenarios, do the following:

- Determine the best method to estimate peak flow from peak daily flow (e.g., Chen et al. 2017) used in the hydrology modeling and generate a 1997–2023 annual peak flow data set.
- Use a Weibull or Log-Pearson Type III distribution (Gotvald et al. 2012; Flynn et al. 2006) and estimate the high-flow (annual daily peak) annual exceedance probabilities for the 1997–2023 POR.

7.4. Reporting

- The study methods and results will be documented in a Hydrology Technical Study Report (TSR). The TSR will include summary tables and maps, as appropriate.
- Upon request, data will be provided to resource agencies and interested parties in a Microsoft Excel spreadsheet (electronic format).

8.0 Schedule and Deliverables

This is proposed as a single-year study, which includes a draft and final Hydrology and Operations Modeling TSR. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Hydrology and Operations Modeling Study schedule.

Date	Activity
August 2026	FERC SPD
September 2026 – July 2027	Model Development and Prepare Draft TSR (for completed study elements)
August 2027	File Initial Study Report (ISR)
August 2027 – July 2028	Complete Additional Model Alternative Analyses if Needed and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application (FLA)

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

California Regional Water Quality Control Board. 2019. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region Fifth Edition – 2019. The Sacramento River Basin and The San Joaquin River Basin.

Chen, B., W.F. Krajewski, F. Liu, W. Fang, and Z Xu. 2017. Estimating instantaneous peak flow from mean daily flow. Hydrology Research 48(6): 1474–1488.

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

Flynn, K.M., W.H. Kirby, and P.R. Hummel. 2006. User's manual for program PeakFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines: U.S. Geological Survey Techniques and Methods Book 4, Chapter B4, 42 pgs.

Gotvald, A.J., N.A. Barth, A.G. Veilleux, and Charles Parrett. 2012. Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012-5113, 38 p., 1 pl.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology 10:1163-1174.

United States Army Corps of Engineers. 1981. Camanche Dam and Reservoir Mokelumne River, California Water Control Manual. Sacramento District. September.

DRAFT FISH POPULATION STUDY PLAN (FA-1)

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT FISH POPULATION STUDY PLAN (FA-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
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1.0 Introduction

This Fish Population Study (FA-1) plan for the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) evaluates fish populations in the Project reservoirs and river reaches. The purpose of the study is to 1) document fish species distribution and relative abundance; 2) characterize fish populations (e.g., growth, condition factor, age structure); and 3) characterize stocking and fish hatchery operations. Results of the FA-1 study will be used to characterize Project fish populations and fish management.

2.0 Project Nexus and Study Rationale

Project operations and maintenance activities have the potential to affect fish populations in the Lower Mokelumne Project reservoirs and river reaches. The FA-1 study results will inform the development of potential license requirements.

3.0 Study Goals and Objectives

The study goals and objectives of the FA-1 are as follows:

- Document fish species composition, distribution, and abundance in the reservoirs;
- Collect fish from the reservoirs for mercury testing;
- Document fish species composition, distribution, and abundance in the Lower Mokelumne River;
- Characterize fish stocking;
- Characterize fish hatchery operations (e.g., species, production goals, genetics, funding); and
- Analyze the fish data and characterize population trends, fish growth, condition factor, and population age structure in the reservoirs and river reaches.

4.0 Relevant Resource Management Goals

The Joint Settlement Agreement and Water Quality and Resource Monitoring Program includes the following management goals:

(1) providing, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife, and riparian resources in good condition;

(2) contributing toward the state and federal fishery restoration goals; and

(3) sustaining the long-term viability of the salmon and steelhead fishery.

5.0 Geographic Scope

The geographic scope of the FA-1 study primarily spans the Mokelumne River inflow to Pardee Reservoir through the outflow of Camanche Reservoir and downstream to the Woodbridge Irrigation District Dam.

6.0 Existing Information and Need for Additional Information

Extensive data on fish populations have been collected in the Project area by EBMUD as part of their P-2916 license (FERC 1981). Existing information related to fish populations and the Mokelumne River Fish Hatchery is documented in Section 4.04, Fish and Aquatic Resources, in the Pre-Application Document (PAD). This study is intended to continue fish population monitoring during the first- and second-year study seasons (e.g., 2026–2027), document the fishery in the Project-related reservoirs and river reaches, and document fish stocking and hatchery operations.

7.0 Study Methodology

Ongoing fish monitoring efforts in Pardee and Camanche reservoirs and in the Mokelumne River reaches will continue as currently and historically implemented. Historical data from previous studies will serve as baseline information for the proposed efforts. The FA-1 study methods include reservoir fish sampling, fish mercury testing, river fish sampling, fish handling, fish stocking operations, and hatchery operations.

7.1. Reservoir Sampling

Pardee and Camanche reservoirs will be sampled by boat electrofishing during the late summer/fall of 2026 to monitor species composition and relative abundance at the locations identified in Figure 7-1 and Table 7-1. Each transect will be sampled once. This includes the boat-accessible portions of upper Camanche Reservoir.

- Electrofishing transects will be sampled at night using an electrofishing boat.
    - Sampling time and distance will be recorded for catch-per-unit-effort (CPUE) calculations.
- In situ water quality data (temperature, dissolved oxygen, and turbidity) will be collected at each sampling location.

7.2. Fish Mercury Testing

- Up to 10[1] edible-sized sport fish of each species (black bass [*Micropterus*], rainbow trout [*Oncorhynchus mykiss*], brown trout [*Salmo trutta*], crappie [*Pomoxis*], bluegill [*Lepomis macrochirus*], catfish [*Siluriformes*]) captured in each of the reservoirs (Pardee and Camanche) will be collected and frozen for later testing of both total and methylmercury. Fish will be placed in clean plastic bags for transport to the laboratory using chain-of-custody procedures (U.S. Environmental Protection Agency 2000).
- The mercury testing and analysis are discussed in the Water Quality Study (WR-1) plan.

[1] If less than 10 edible-sized individuals of a species are captured, all individuals will be collected for mercury sampling.

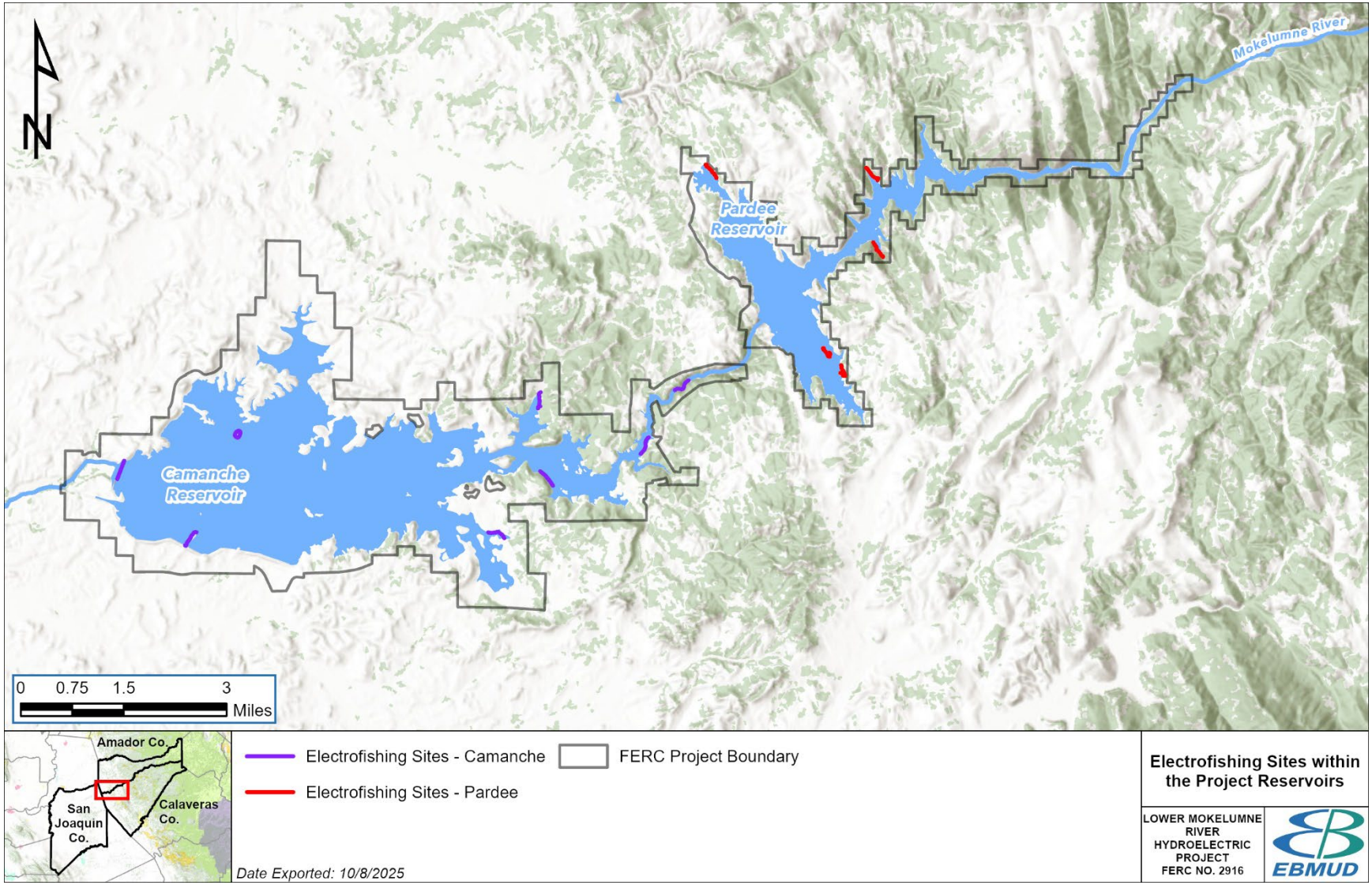

Figure 7-1. Pardee and Camanche reservoirs electrofishing sites.

Table 7-1. Locations for boat-electrofishing in Pardee and Camanche reservoirs.

Site Number	START Marker GPS Location		END Marker GPS Location	
Camanche Reservoir				
CR 1	121° 1' 24.63"W	38° 13' 33.734"N	121° 1' 24.63"W	38° 13' 16.446"N
CR 2	121° 0' 4.818"W	38° 12' 31.919"N	120° 59' 59.415"W	38° 12' 53.104"N
CR 3	120° 59' 26.723"W	38° 14' 2.236"N	120° 59' 25.154"W	38° 14' 1.968"N
CR 4	120° 54' 44.367"W	38° 14' 2.236"N	120° 54' 49.724"W	38° 13' 54.942"N
CR 5	120° 55' 13.272"W	38° 13' 42.251"N	120° 54' 57.437"W	38° 13' 41.2"N
CR 6	120° 53' 7.134"W	38° 13' 40.41"N	120° 52' 55.288"W	38° 13' 55.346"N
CR 7	120° 56' 56.201"W	38° 12' 52.47"N	120° 56' 31.315"W	38° 12' 52.427"N
CR 8	120° 52' 50.805"W	38° 14' 3.559"N	120° 56' 31.315"W	38° 12' 52.427"N
Pardee Reservoir				
PR 1	120° 51' 57.331"W	38° 17' 22.534"N	120° 51' 47.559"W	38° 17' 13.399"N
PR 2	120° 49' 19.93"W	38° 17' 19.637"N	120° 49' 11.364"W	38° 17' 12.658"N
PR 3	120° 49' 6.356"W	38° 16' 14.734"N	120° 49' 17.187"W	38° 16' 27.242"N
PR 4	120° 44' 46.908"W	38° 18' 0.509"N	120° 44' 52.26"W	38° 17' 58.902"N
PR 5	120° 49' 48.269"W	38° 14' 46.659"N	120° 49' 45.401"W	38° 14' 50.014"N

7.3. River Sampling

A combination of rotary screw traps, bypass trapping, boat electrofishing, and video monitoring will be employed to monitor fish in the Lower Mokelumne River (Figure 7-2 and Table 7-2) during first and second year studies (e.g., 2026 and 2027).

- Previously established sampling sites along the Lower Mokelumne River will be sampled using boat electrofishing following the methods from previous efforts (outlined in Meador et al. 1993) to ensure data standardization.
    - Each site will be sampled with three passes: one on each bank and one mid-channel.
    - Sampling will be conducted once per site in the spring.[2] Sampling time and length will be recorded for CPUE calculations.
- One rotary screw trap, VINO, at river mile (RM) 54.3 (Elliot Road Bridge), below the salmonid spawning locations, will be used to monitor salmonid production, and a

[2] Abbreviated sampling at a subset of sites in summer and winter—abbreviated due to temperatures and steelhead spawning, respectively—may also be conducted by EBMUD.

downstream rotary screw trap, GOLF (RM 38.4, Lower Sacramento Road Bridge), and a smolt bypass trap at the Woodbridge Irrigation District Dam (WIDD) will be used to monitor salmonid emigration phenology and abundance (Table 7-2).

  - Sampling will be conducted starting December (or January) and typically lasts through June.
  - The traps will be fished daily Monday through Friday, with estimates generated on weekends and holidays.
  - Traps will be checked and fish worked up daily and released downstream.
  - Multiple efficiency tests will be conducted throughout the season using wild fish when salmon catch is high enough to produce a group of test fish. Hatchery fish will be used when not enough wild fish are available. Test fish for calibration will be marked. Test fish for VINO will be released approximately 0.25 rkm upstream of the trap location. Test fish for GOLF will be released below the face of the WIDD, approximately 0.1 rkm upstream of the trap location. The test fish will be distributed proportionally to the flow across the river at each location.

- The existing video monitoring station at the WIDD will continue to be operated for monitoring run size and phenology of adult salmon and steelhead.
  - Monitoring will be year-round except for the period in late winter when the Woodbridge Irrigation District drains Lodi Lake at the WIDD to complete maintenance. Monitoring may also cease during July, if flows below WIDD are around 35 cfs.

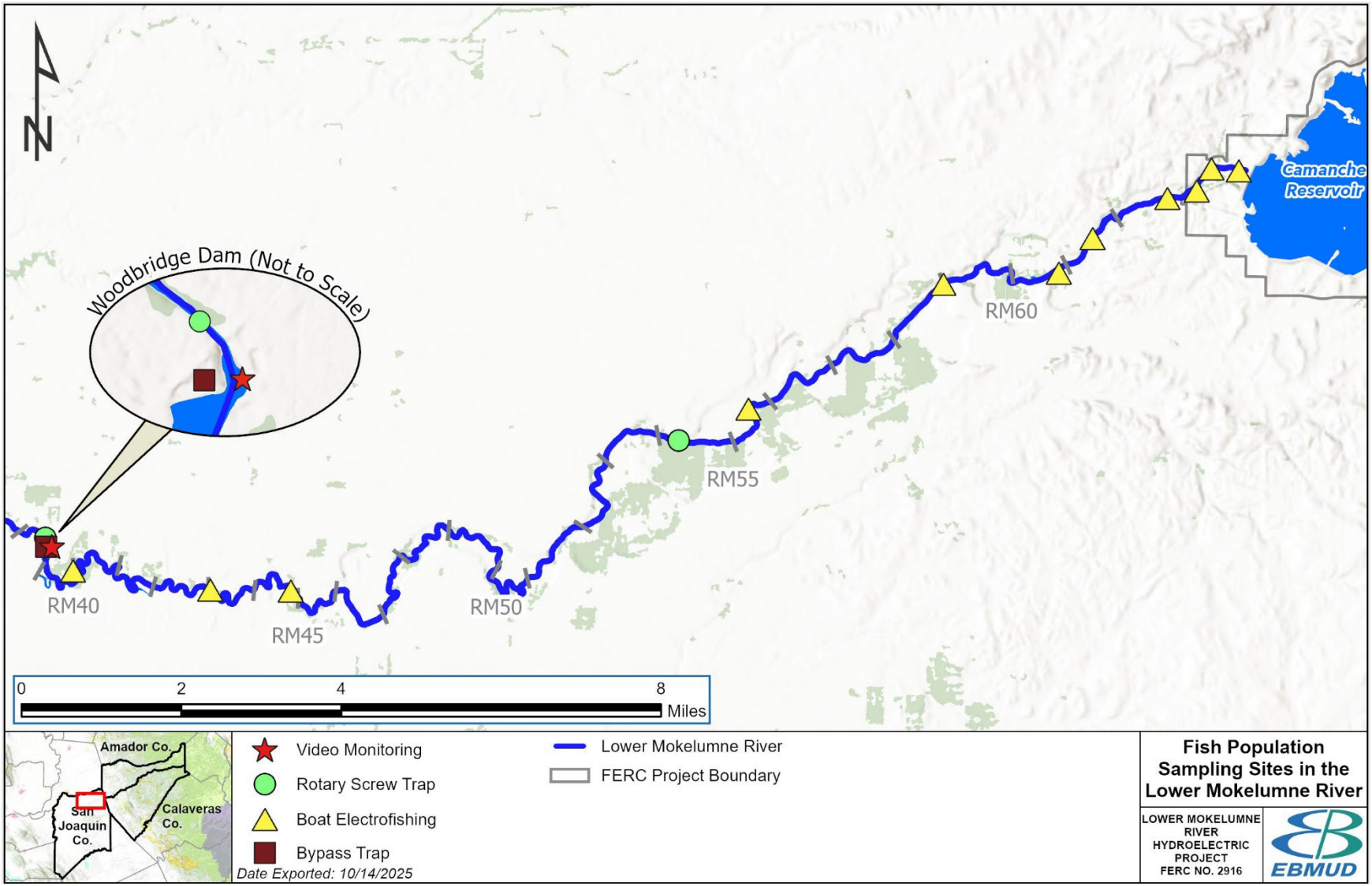

Figure 7-2. Fisheries sampling sites in the Lower Mokelumne River.

Table 7-2. Sampling type and location for all fish sampling efforts in the Lower Mokelumne River.

Sampling Method	Site Number	Site Name	Latitude	Longitude	River Mile
Rotary Screw Trap	RST 1	Vino	38.17645	-121.15345	54.3
	RST 2	Golf	38.15787	-121.29876	38.4
Bypass Trap	BT	WIDD	38.15627	-121.29859	38.6
Video Monitoring	VM	WIDD	38.15632	-121.29727	39
Boat Electrofishing	LMR 1	BELCAMDAM	38.22627	-121.02512	63.9
	LMR 2	VANASSENE	38.22659	-121.03141	63.5
	LMR 3	AIB	38.22257	-121.03477	63.1
	LMR 4	SPANGLER	38.22119	-121.0415	62.7
	LMR 5	AFRAMEG	38.21384	-121.05863	61.5
	LMR 6	ABOVE88BW	38.20754	-121.06636	60.9
	LMR 7	MACKVILLEG	38.2054	-121.09289	59.0
	LMR 8	BIGBENDG	38.1825	-121.1375	55.7
	LMR 9	TRAINBRIDG	38.14889	-121.24234	44.9
	LMR 10	HWY99G	38.14896	-121.26082	43.0
	LMR 11	LAKELODIE	38.15221	-121.29238	40.0

7.4. Fish Handling

Captured fish will be handled as follows:

- All fish will be kept in aerated 5-gallon buckets, the electrofishing boat live well, or similar, filled with water from the area of capture.
- Fish will be monitored for signs of stress, and holding conditions will be adjusted accordingly (lower density, more aeration, cooler water).
- All fish will be identified to species and enumerated. During electrofishing surveys, the first 50 specimens of each species are measured (fork length, millimeters) and weighed. During rotary screw trap and bypass trap operations, total length, fork length (millimeters), and weights of the first 50 Chinook salmon and the first 20 of every incidental species are recorded.
- If necessary to minimize handling stress, subsampling may be implemented.
- As necessary, fish will be anesthetized with carbon dioxide to minimize handling time and stress.

7.5. Fish Stocking

- Historical fish stocking records and fish stocking during the first and second study years (e.g., 2026 and 2027) will be summarized (e.g., numbers, species, size).
- Fish stocking goals/strategy will be summarized.
- If data are available, fish stocking, sampled fish CPUE, and fishing success will be correlated.

7.6. Hatchery Operations

- Historical hatchery operations (e.g., species, production goals, genetics, funding) will be summarized.
- Ongoing hatchery operations (e.g., species, production goals, genetics, funding) will be summarized.
- Any limiting factors related to successful hatchery operations will be identified.

7.7. Analysis

- Species distributions, relative abundance, and condition will be evaluated for the study years and summarized for comparison to previous years.
- CPUE will be reported for each species and age class (young-of-year, juveniles, adults).
- Trends in reservoir, river, stocking, and hatchery operations data (e.g., species, distribution, relative abundance, size, condition factor, age) will be evaluated.
- Relationships between observed trends and physical conditions (e.g., flows, water year type, water temperature, ocean conditions) and management actions (e.g., stocking, hatchery operations, ocean/river harvest, habitat restoration) will be described.
- Where possible, factors limiting the reservoir and river fisheries will be identified.

8.0 Schedule and Deliverables

This is proposed as a 2-year study. The deliverables include a draft and final Fish Population Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Fish Population Study schedule.

Date	Activity
August 2026	FERC SPD
November 2026	Prepare Draft TSR
August 2027	File Initial Study Report (ISR)
November 2027	Prepare an Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected to meet the study objectives. The study schedule and materials have been developed to build on existing information, fill data gaps, and incorporate feedback from interested parties.

10.0 References

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

Meador, M.R., T.F. Cuffney, and M.E. Gurtz. 1993. Methods for sampling fish communities as a part of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 93-104. p 40.

U.S. Environmental Protection Agency. (2000). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume I: Fish Sampling and Analysis. Third Edition. Office of Science and Technology. Office of Water. U.S. Environmental Protection Agency. Washington, D.C.

DRAFT INSTREAM FLOW STUDY PLAN (FA-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT INSTREAM FLOW STUDY PLAN (FA-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

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1.0 Introduction

This Instream Flow Study (FA-2) plan evaluates instream flows for aquatic habitat in the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916; Lower Mokelumne River Project or Project), particularly in the Lower Mokelumne River from the Camanche Dam to the Woodbridge Irrigation District Dam. Results of FA-2 will be used to understand the relationship between flows and aquatic resources and inform flow regime management in the Project river reaches.

2.0 Project Nexus and Study Rationale

Project operations and maintenance activities have the potential to affect instream flows and aquatic resources in the Lower Mokelumne River. The FA-2 study results will inform development of potential license requirements.

3.0 Study Goals and Objectives

The goals and objectives of the FA-2 study are to characterize instream flows for aquatic habitat in the Lower Mokelumne River, particularly from Camanche Dam to the Woodbridge Irrigation District Dam. Specific goals are as follows:

- Summarize the previous instream flow modeling.
- Establish an Aquatic Technical Working Group (TWG).
- Identify the species and life stages and habitat suitability criteria for instream flow modeling.
- Use habitat versus flow relationships to develop a time series analysis of aquatic habitat under existing Project hydrology and other potential hydrology/operations scenarios.
- Identify the time periods, flow conditions, and life stages when habitat may be a limiting factor for aquatic resources (fish, benthic macroinvertebrates, other aquatic species, and riparian vegetation) for existing Project operations and other potential hydrology/operations scenarios.
- Characterize riparian flow and sediment transport conditions in the Lower Mokelumne River.

4.0 Relevant Resource Management Goals

The primary resource management goals are outlined in the Joint Settlement Agreement. The goals include:

(1) providing, to the extent feasible, habitat quality and availability in the Lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition;

(2) contributing toward the state and federal fishery restoration goals; and

(3) sustaining the long-term viability of the salmon and steelhead fishery.

5.0 Geographic Scope

The geographic scope of this study includes the Lower Mokelumne River from Camanche Dam downstream to the Woodbridge Irrigation District Dam.

6.0 Existing Information and Need for Additional Information

Instream flow data for aquatic habitat has been developed in the Project area by the East Bay Municipal Utility District (EBMUD) as part of their P-2916 license (FERC 1981). Existing information is documented in Section 4.04, Fish and Aquatic Resources, in the Pre-Application Document (PAD). This study will characterize instream flows and their relationship to availability of aquatic resources under existing Project and other potential operational scenarios.

7.0 Study Methodology

The study methods include a review of previous instream flow modeling, establishment of an Aquatic Technical Working Group (Aquatic TWG), identification of target species/life stages, development of habitat suitability criteria, hydrodynamics modeling, habitat modeling, and riparian/sediment transport modeling.

7.1. Summarize Previous Instream Flow Modeling

- Summarize the instream flow modeling that has been conducted previously (data collection locations, calibration flows, target species and life stages, habitat suitability criteria, weighted usable area, rationale/criteria for establishment of current minimum instream flows).

7.2. Establish Aquatic TWG

- Establish an Aquatic TWG to provide input and technical review of modeling procedures/decisions (e.g., modeling species/life stages, hydrodynamics modeling, habitat modeling).
- Conduct a minimum of three working meetings to review and provide input on the instream flow modeling.

7.3. Identify Target Species and Life Stages

- Coordinate with the Aquatic TWG to identify the target species and/or guilds and life stages for modeling based on management importance and/or sensitivity to Project operations.
- EBMUD proposes to model Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*, anadromous rainbow trout) life stages (adult migration and holding, spawning, incubation, juvenile rearing, and outmigration) and wetted benthic habitat.

7.4. Develop Habitat Suitability Criteria

- Coordinate with the Aquatic TWG to develop habitat suitability criteria for each target species and/or guilds and life stages using existing information.

7.5. Hydrodynamic Modeling

- Use the existing United States Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) hydrodynamic model to model hydraulics over a wide range of flows in the Lower Mokelumne River modeling reaches.

7.6. Habitat Modeling

- Use the habitat suitability criteria to model aquatic habitat over a wide range of flows in the Lower Mokelumne River modeling reaches.
- Develop a time series analysis of habitat (1997–2023) for existing conditions and potential scenarios (as appropriate) using the hydrology/operations modeling scenarios in the Hydrology and Operations Modeling Study for both existing and future climate.
    - Provide time series plots and monthly exceedance plots to characterize habitat relationships for each species and life stage and modeling scenario.
- Use the habitat time series and results from the Water Temperature, Egg Survival, Juvenile Survival, and Fish Population Study Plans to identify time periods, flow conditions, and life stages when habitat may be a limiting factor for aquatic resources (fish, benthic macroinvertebrates, and riparian resources) under existing Project operations and other potential scenarios (as appropriate) for existing and future climate hydrology.

7.7. Riparian Habitat and Sediment Transport

- Characterize riparian habitat flow conditions in the Lower Mokelumne River (flow magnitude, frequency, and hydrograph descending limb characteristics).
    - Coordinate with the Wetland, Riparian, and Littoral Habitats Study Plan to select up to 10 total cross sections at representative locations along the Lower Mokelumne River.
    - Develop stage-discharge relationships over a range of flows (high to low) at each of the cross sections.
    - Coordinate with the Wetland, Riparian, and Littoral Habitats Study Plan to characterize the relationship between riparian vegetation and flow conditions.
- Evaluate sediment transport conditions in the Lower Mokelumne River.
    - Identify locations to characterize sediment transport and bankfull flow, potentially at the same locations where riparian cross-sectional data were collected.

- Characterize sediment size information (e.g., D_{50}) and bankfull indicators at the study locations.
- Calculate initiation of motion flow and bankfull discharge at each study location using the HEC-RAS model.
  - Derive channel hydraulic conditions (flow depth, velocity, energy slope, and bed shear stress) over a range of high flows.
  - Determine flows necessary for initiation of sediment transport (motion) using critical shear stress for observed sediment sizes.
  - Estimate discharge at the bankfull indicators using the modeled water surface elevations.
- Use the results from the Hydrology and Operations Modeling Study Plan to characterize the duration and frequency of sediment transport flows for each scenario.

8.0 Schedule and Deliverables

This is proposed as a 2-year study. It includes a draft and final Instream Flow Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Instream Flow Study schedule.

Date	Activity
August 2026	FERC SPD
September 2026	Hydraulic and Habitat Modeling
April 2027– March 2028	Collect Data, Analyze, and Prepare Draft Technical Report
August 2027	Provide a Study Progress Update in the Initial Study Report (ISR)
August 2027–July 2028	Complete Modeling and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected to meet the study objectives. The study schedule and materials have been developed to build on existing information, fill data gaps, and incorporate feedback from interested parties.

10.0 References

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

DRAFT RESERVOIR FISH HABITAT STUDY PLAN (FA-3)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District

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October 2025

DRAFT RESERVOIR FISH HABITAT STUDY PLAN (FA-3)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

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1.0 Introduction

This Reservoir Fish Habitat Study (FA-3) plan addresses reservoir fish habitat for the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project). The study will make use of data from the Hydrology and Operations Modeling Study and the Water Temperature Study to assess cold- and warm-water fish habitat in Pardee and Camanche reservoirs over the modeling period of record (POR) 1997–2023. The study will be used to analyze reservoir fish habitat for the existing Project and alternative scenarios for both current climate and future climate change conditions.

2.0 Project Nexus and Study Rationale

Project operations have the potential to affect reservoir fish habitat in the Project reservoirs. The reservoir fish habitat study results will inform the development of potential license requirements.

3.0 Study Goals and Objectives

The goals and objectives of the study are to characterize the management of reservoir water surface elevations and its relationship to fish habitat availability under existing Project operations and other potential hydrology/operations scenarios for current and future climate conditions. This includes the following:

- Characterize existing Project operations daily water surface elevations and pool habitat volumes (cold water, warm water, dissolved oxygen) at each reservoir using the hydrology and water temperature models in the Hydrology and Operations Modeling Study and Water Temperature Study and the historical dissolved oxygen data (1997–2023).
- Characterize other potential hydrology scenarios for Project daily water surface elevation patterns and pool habitat volumes (cold water, warm water, dissolved oxygen) at each reservoir using the hydrology and water temperature models in the Hydrology and Operations Modeling Study and Water Temperature Study and the historical dissolved oxygen data (1997–2023).

4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity.

5.0 Geographic Scope

The geographic scope of this study includes the fish habitat in Pardee and Camanche reservoirs.

6.0 Existing Information and Need for Additional Information

Data on fish and fish habitat have been collected in the Project area by the East Bay Municipal Utility District as part of their P-2916 license (FERC 1981). Existing information is documented in Section 4.04, Fish and Aquatic Resources, of the Pre-Application Document (PAD). This study is needed to characterize the management of reservoir water surface elevations and its relationship to availability of fish habitat under existing Project and potential alternative operations.

7.0 Study Methodology

The hydrology and water temperature models developed in the Hydrology and Operations Modeling Study and Water Temperature Study will be used to characterize reservoir fish habitat over the 1997–2023 POR for existing Project operations and for alternative scenarios (as appropriate) for both existing and future climate conditions.

7.1. Fish Assemblage

- Summarize the fish assemblage in each reservoir using information from the Fish Population Study. Use the data to identify important reservoir fish habitat (e.g., cold water and warm water habitat).

7.2. Habitat Modeling

For existing Project hydrology and other potential hydrology/operations scenarios:

- Model daily reservoir hydrology (elevation, volume).
- Model daily reservoir water temperature.
- Use historical dissolved oxygen profiles to characterize dissolved oxygen profile relationships over the modeling POR by season and water year type/reservoir volume:
    - Summarize the historical dissolved oxygen profile data.
    - Summarize the dissolved oxygen profiles for ranges of <5 milligrams per liter (mg/L) (not suitable fish habitat), ≥5 to <7 mg/L (suitable for warm water fish), and ≥7 mg/L (suitable for warm and cold water fish) by seasons and water year types/reservoir volume (California Regional Water Quality Control Board [CRWQCB] 2019).
    - Develop an approach to apply the dissolved oxygen relationships to the daily model runs.
- Quantify the daily time series of cold-water habitat (volume with water temperature ≤20 degrees Celsius [ºC] and dissolved oxygen ≥7 mg/L, typical temperature and dissolved oxygen requirements for cold water species) (e.g., Bjornn and Reiser 1991; CRWQCB 2019).

- Quantify the daily time series of warm-water habitat (volume with water temperature >20ºC and dissolved oxygen ≥5 mg/L, typical temperature and dissolved oxygen requirements for warm water species).

7.3. Analysis

Characterize the time series of cold and warm water fish habitat volume for each scenario over the POR:

- Develop a daily time series figure of habitat volume.
- Develop monthly exceedance plots of habitat volume for each month (January to December).
- Identify any potential habitat limiting time periods, such as time seasons or water year types with comparatively low habitat availability.
- Compare habitat availability between existing and alternative hydrology/operations scenarios.

8.0 Schedule and Deliverables

This is proposed as a single-year desktop study. The deliverable includes a draft and final Reservoir Fish Habitat Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Reservoir Fish Habitat Study schedule.

Date	Activity
August 2026	FERC SPD
September 2026 – July 2027	Model hydrology, water temperature, and dissolved oxygen and Develop a Draft TSR
August 2027	File Initial Study Report (ISR)
August 2027 – July 2028	Model additional scenarios if needed, develop an Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected to meet the study objectives. The study schedule and materials have been developed to build on existing information, fill data gaps, and incorporate feedback from interested parties.

10.0 References

Bjornn, T.C. and Reiser, D.W. (1991) Habitat Requirements of Salmonids in Streams. In: Meehan, W.R., Ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, American Fisheries Society Special Publication, 19, 83-138.

(CRWQCB) California Regional Water Quality Control Board. 2019. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region Fifth Edition – 2019. The Sacramento River Basin and The San Joaquin River Basin.

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

DRAFT SPECIAL STATUS AMPHIBIANS AND AQUATIC REPTILES STUDY PLAN (FA-4)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT SPECIAL STATUS AMPHIBIANS AND AQUATIC REPTILES STUDY PLAN (FA-4)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District

375 11th Street

Oakland, California 94607

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1.0 Introduction

This Special Status Amphibians and Aquatic Reptiles Study (FA-4) plan addresses special-status amphibians and aquatic reptiles for the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project). The purpose of the FA-4 study is to document special-status amphibians and aquatic reptiles and their habitats in the study area.

2.0 Project Nexus and Study Rationale

Special-status amphibians and reptiles and their habitat are known or could potentially occur in the FERC Project boundary. Implementation of Project operations and maintenance activities could result in direct loss or disturbance of individuals or their habitat. The FA-4 study results will inform development of potential license requirements.

3.0 Study Goals and Objectives

The FA-4 study goals and objectives are as follows:

- Identify and map potential habitat for northwestern pond turtle (NWPT) (Actinemys marmorata) in the study area.
- Document the distribution and abundance of NWPT populations in the study area.
- Document the presence of potential NWPT nesting habitat near Project facilities.
- Sample eDNA for NWPT and foothill yellow-legged frog (FYLF) (Rana boylii).
- Continue existing monitoring required under the Safe Harbor Agreement for California red-legged frog (CRLF) (Rana draytonii) and California tiger salamander (CTS) (Ambystoma californiense). Continue to document the presence of western spadefoot (WS) (Spea hammondii) during monitoring.
- Characterize habitat for giant garter snake (GGS) (*Thamnophis gigas*) and WS.

4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity.

- The East Bay Municipal Utility District (EBMUD) has entered into a Safe Harbor Agreement (SHA or Agreement) with the purpose of (1) promoting the enhancement and management of habitat for CRLF and CTS (also valley elderberry longhorn beetle [*Desmocerus californicus dimorphus*]) on EBMUD watershed lands in San Joaquin, Amador, and Calaveras counties; and (2) providing certain regulatory assurances to EBMUD. The SHA serves as the basis for the U.S. Fish and Wildlife Service (USFWS) to issue an enhancement of survival permit (Permit) pursuant to Section 10(a)(1)(A) of the Endangered Species Act (ESA). The Permit authorizes the incidental taking of CRLF, CTS, and valley elderberry long-horn beetle associated with the enhancement and conservation management of these species' habitats, other lawful uses of the property (as described in Section 10 of the SHA), and the potential future return of any eligible land to pre-Agreement conditions (baseline) within the period during which the Permit is in effect.

Relevant management plans and agreements include the following:

- California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians (California Department of Fish and Wildlife [CDFW] 2015).
- Recovery Plan for the California Red-legged Frog (USFW 2002).
- Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (USFW 2017a).
- Recovery Plan for the Giant Garter Snake (USFW 2017b).
- Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFW 2005).
- Safe Harbor Agreement for East Bay Municipal Utilities District Lands in San Joaquin, Amador, and Calaveras Counties, June 2009 (USFWS and EBMUD 2009).

5.0 Geographic Scope

The geographic scope for each species is provided below:

- For NWPT, the study area spans the Pardee and Camanche reservoirs and the Lower Mokelumne River below Camanche Dam to Woodbridge Irrigation District Dam [WIDD]).
- For FYLF, the study area includes the Lower Mokelumne River below Camanche Dam to WIDD.
- For CRLF, CTS, and WS, the study area consists of ponds, vernal pools, and other seasonal wetlands within the FERC Project boundary.
- For GGS and WS habitat mapping, the study area is 1 mile around the FERC Project boundary.

6.0 Existing Information and Need for Additional

Existing data on special-status amphibians and aquatic reptiles in the Project area are included in EBMUD's Lower Mokelumne River Project Pre-Application Document (PAD) (EBMUD 2025) Sections 4.04, Fish and Aquatic Resources, and 4.05, Wildlife Resources.

EBMUD has been conducting ongoing surveys required under the SHA. This includes:

- Annual CRLF and CTS habitat assessment, dip net surveys, and visual encounter surveys,
- Documentation of non-native predators and predator control activities,
- Documentation of WS when conducting CTS and CRLF assessments and surveys,
- Incidental observations of NWPT during wildlife studies, and
- Indication that FYLF have not been observed in the Project study area.

Based on review of available information, the following potential information gaps were identified:

- Document the habitat and distribution/abundance of NWPT.
- Document the location of suitable habitat and presence/absence of FYLF.
- Document the presence/absence of CRLF, CTS, and WS.
- Document the location of suitable habitat for GGS and WS.

7.0 Study Methodology

7.1. Northwestern Pond Turtle

7.1.1. Habitat Characterization

- Develop NWPT habitat suitability criteria in cooperation with resource agencies and relicensing participants.
- Develop a geographic information system (GIS) map of potential NWPT nesting habitat locations in the study area. Proposed GIS selection criteria include:
- 500-meter (~547-yard) buffer around perennial streams and reservoirs;
- Slope of less than 60 degrees;
- Southeast, south, or southwest aspect;
- Canopy cover of less than 10 percent (this criterion will be used if suitable vegetation maps exist);
- Compacted soils of clay or loam (this criterion will be used if suitable soil maps exist); and
- Identification of portions of habitat near Project facilities or Project areas where ground disturbing activities may occur.
- Conduct a field reconnaissance survey of potential nesting locations identified in the GIS map near Project facilities where project maintenance activities occur.

7.1.2. Distribution and Abundance

- Identify and map known occurrences of NWPT within the study area based on agency consultation and a review of existing information.
- Study sites for NWPT will be approximately co-located with the Fish Population Study electrofishing study sites on Pardee and Camanche reservoirs and on the Lower Mokelumne River (see Figure 7-1 and Figure 7-2; Table 7-1 and Table 7-2). Study sites will be selected for backwaters and slow-moving water that have basking sites and terrestrial and aquatic escape cover.
- Conduct visual encounter surveys (VES) at pool or backwater habitats at the survey sites using the protocol of Bury et al. (2012). The protocol involves scanning (with and without binoculars) pool habitats for basking turtles and edge habitats for turtles either on shore or entering the water.

- Identify emergent logs either connected to shore or surrounded by water that are large enough to provide perches for turtles.
- Prepare and submit a California Native Species Field Survey Form for all NWPT recorded to the California Natural Diversity Database.
- Provide an electronic database (Microsoft Excel spreadsheet) of NWPT sampling data (date, location, species) to resource agencies.
- Obtain additional NWPT presence information from recording incidental sightings made during implementation of other aquatic and wildlife technical studies (e.g., Water Temperature Study, Water Quality Study, and Fish Population Study).

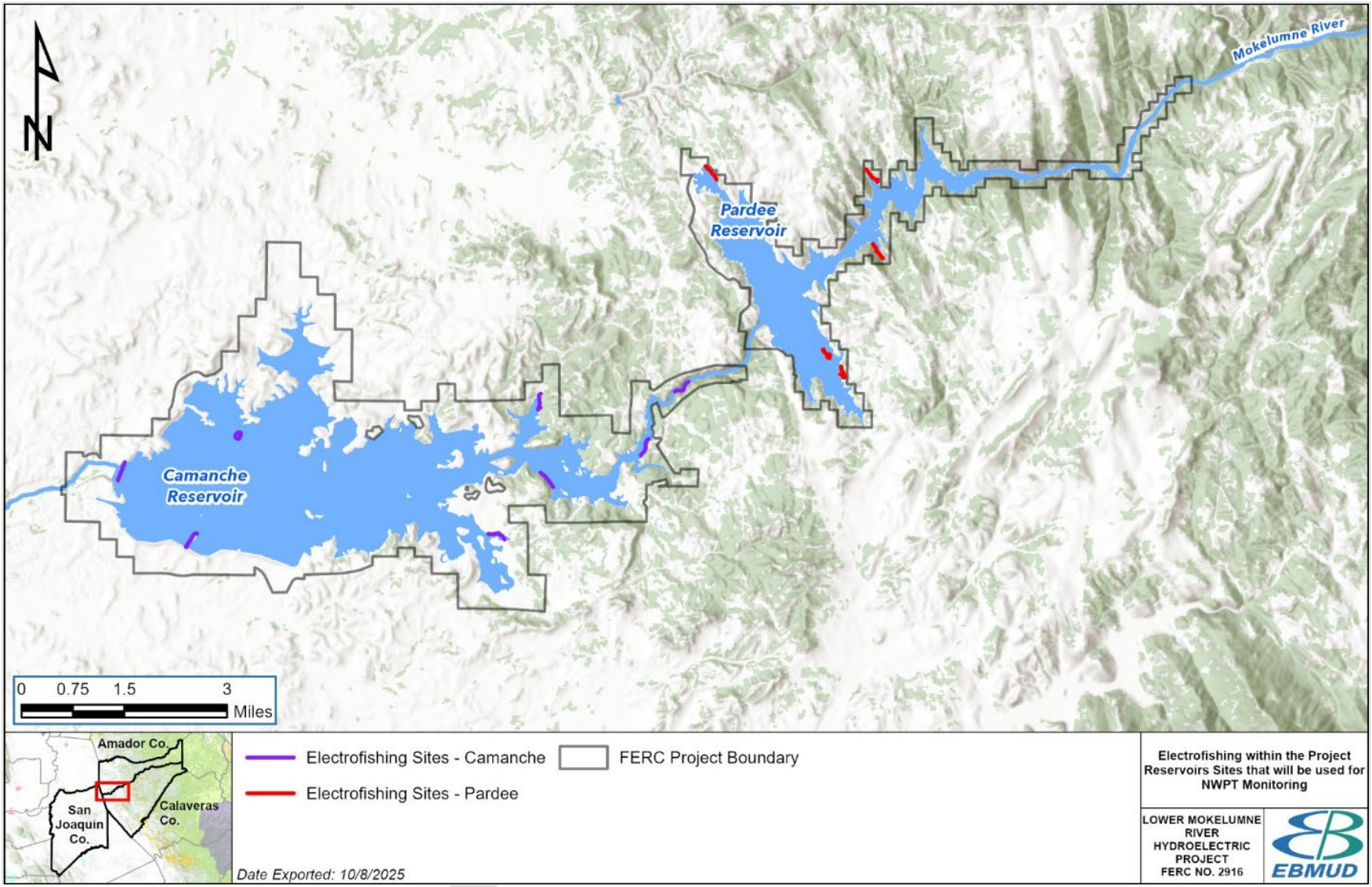

Figure 7-1. Pardee and Camanche reservoirs electrofishing sites that will be used for NWPT monitoring.

Table 7-1. Locations for NWPT sampling in Pardee and Camanche reservoirs.

Site Number	START GPS Coordinates		END GPS Coordinates	
Camanche Reservoir				
CR 1	121° 1' 24.63"W	38° 13' 33.734"N	121° 1' 24.63"W	38° 13' 16.446"N
CR 2	121° 0' 4.818"W	38° 12' 31.919"N	120° 59' 59.415"W	38° 12' 53.104"N
CR 3	120° 59' 26.723"W	38° 14' 2.236"N	120° 59' 25.154"W	38° 14' 1.968"N
CR 4	120° 54' 44.367"W	38° 14' 2.236"N	120° 54' 49.724"W	38° 13' 54.942"N
CR 5	120° 55' 13.272"W	38° 13' 42.251"N	120° 54' 57.437"W	38° 13' 41.2"N
CR 6	120° 53' 7.134"W	38° 13' 40.41"N	120° 52' 55.288"W	38° 13' 55.346"N
CR 7	120° 56' 56.201"W	38° 12' 52.47"N	120° 56' 31.315"W	38° 12' 52.427"N
CR 8	120° 52' 50.805"W	38° 14' 3.559"N	120° 56' 31.315"W	38° 12' 52.427"N
Pardee Reservoir				
PR 1	120° 51' 57.331"W	38° 17' 22.534"N	120° 51' 47.559"W	38° 17' 13.399"N
PR 2	120° 49' 19.93"W	38° 17' 19.637"N	120° 49' 11.364"W	38° 17' 12.658"N
PR 3	120° 49' 6.356"W	38° 16' 14.734"N	120° 49' 17.187"W	38° 16' 27.242"N
PR 4	120° 44' 46.908"W	38° 18' 0.509"N	120° 44' 52.26"W	38° 17' 58.902"N
PR 5	120° 49' 48.269"W	38° 14' 46.659"N	120° 49' 45.401"W	38° 14' 50.014"N

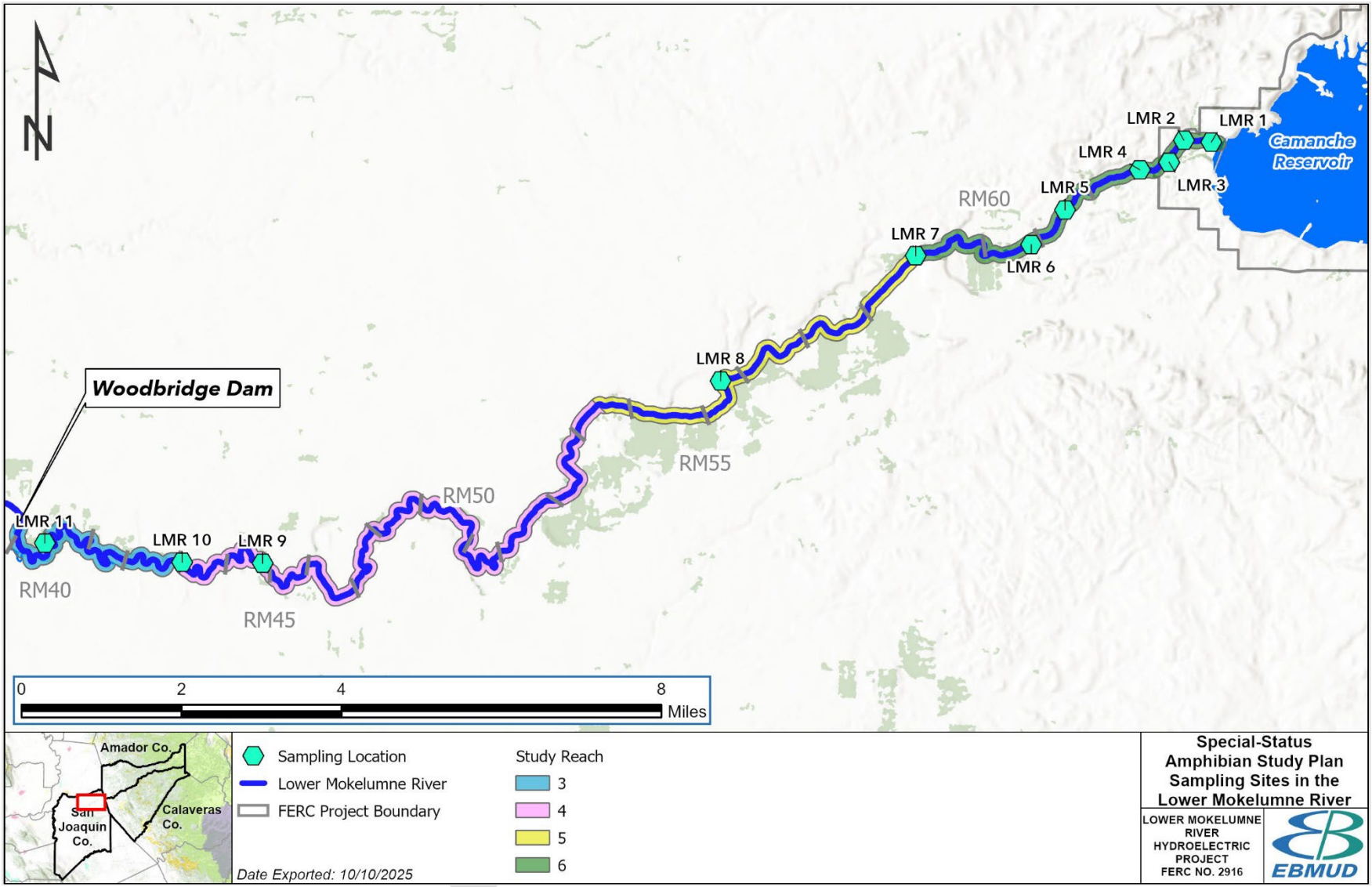

Figure 7-2. Fisheries sampling sites at which NWPT surveys will occur in the Lower Mokelumne River.

Table 7-2. Sampling locations for NWPT in the Lower Mokelumne River (co-located with fish sampling sites).

Site Number	Habitat	Site Name	River Reach	Latitude	Longitude	River Mile
LMR 1	Dam basin	BELCAMDAM	6	38.22627	-121.02512	63.9
LMR 2	Glide	VANASSENE	6	38.22659	-121.03141	63.5
LMR 3	Off-channel contiguous pool	AIB	6	38.22257	-121.03477	63.1
LMR 4	Run	SPANGLER	6	38.22119	-121.0415	62.7
LMR 5	Glide	AFRAMEG	6	38.21384	-121.05863	61.5
LMR 6	Off-channel pool	ABOVE88BW	6	38.20754	-121.06636	60.9
LMR 7	Glide	MACKVILLEG	5	38.2054	-121.09289	59.0
LMR 8	Split-channel glide	BIGBENDG	5	38.1825	-121.1375	55.7
LMR 9	Glide	TRAINBRIDG	4	38.14889	-121.24234	44.9
LMR 10	Glide	HWY99G	4	38.14896	-121.26082	43.0
LMR 11	Lake	LAKELODIE	3	38.15221	-121.29238	40.0

7.1.3. Water Temperature

- Evaluate output from the Water Temperature Study to compare NWPT habitat conditions and/or growth under the existing Project and alternatives (as appropriate) (Ashton et al. 2015; Snover et al. 2015).
- Correct VES observations for biases in detectability that occur due to the proportion of time NWPT spend basking and are visible to surveyors based on water temperature (Ruso et al. 2017) (inverse relationship between water temperature and detectability).

7.2. eDNA for Northwestern Pond Turtle and Foothill Yellow-Legged Frog

- Environmental DNA (eDNA) will be sampled at each of the monitoring sites (Figure 7-1 and Figure 7-2; Table 7-1 and Table 7-2) for NWPT and FYLF.
- FYLF eDNA sampling will occur from April to July to align with the breeding season.
- NWPT eDNA sampling will occur from June to August to align with warm temperatures and consequently higher activity.
- The eDNA sampling method will be consistent with Carim et al. (2016) or the most appropriate methodology current at the time of sampling. The method includes the following:

  - Five liters of water will be filtered from the sampling site, taking care not to contaminate the sample water or filter.
  - The filter will be dried for 30 seconds and secured in a plastic bag with desiccant beads and protected from water, heat, and sunlight.
  - The samples will be immediately (<1 week) sent to a qualified laboratory for processing.
- eDNA results (detection/non-detection) for NWPT and FYLF markers will be reported. If data suggest the potential for presence of NWPT and/or FYLF at a location, then EBMUD will coordinate with agencies and discuss the potential for focused visual encounter survey (presence and abundance) if the area has not already been visually surveyed for NWPT.

7.3. California Red-legged Frog, California Tiger Salamander, and Western Spadefoot

- Continue to implement annual surveys for CRLF and CTS consistent with methods and requirements outlined in the SHA (USFWS and EBMUD 2009).
- As part of the CRLF and CTS survey, also document the presence of WS.

7.4. Giant Garter Snake and Western Spadefoot Habitat

- Map potential aquatic and upland habitat for GGS and WS as part of habitat mapping completed under the Botanical Resources Study Plan and Wetland, Riparian, and Littoral Habitats Study Plan.

8.0 Schedule and Deliverables

The FA-4 study is proposed as a single-year study; it includes a draft and final Special-Status Amphibians and Aquatic Reptiles Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Special-Status Amphibians and Aquatic Reptiles Study schedule.

Date	Activity
August 2026	FERC SPD
August 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

Ashton, D.T., J.B. Bettaso, H.H. Welsh Jr. 2015. Changes across a decade in size, growth, and body condition of Western Pond Turtle (*Actinemys marmorata*) populations on free-flowing and regulated forks of the Trinity River in northwest California. Copeia 103: 621–633.

Bury, R.B., D.T. Ashton, R. Horn. 2012. Visual encounter surveys, in Western Pond Turtle: biology, sampling techniques, inventory and monitoring, conservation, and management. Northwest Fauna 7: 29–35.

Carim, K.J., McKelvey, K.S., Young, M.K.; Wilcox, Taylor M.; Schwartz, Michael, K. 2016. A protocol for collecting environmental DNA samples from streams. Gen. Tech. Rep. RMRS-GTR-355. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 18 p.

(EBMUD) East Bay Municipal Utility District. 2025. Lower Mokelumne River Project Pre-Application Document.

Merz, J.E. and Setka, J.D. 2004. East Bay Municipal Utility District. Riverine Habitat Characterization of the Lower Mokelumne River, California.

Ruso, G.E., E. Meyer, and A.J. Das. 2017. Seasonal and diel environmental conditions predict Western Pond Turtle (*Emys marmorata*) behavior at a perennial and an ephemeral stream in Sequoia National Park, California. Chelonian Conservation and Biology 16: 20–28.

Snover, M.L., M.J. Adams, D.T. Ashton, J.B. Bettaso, H.H. Welsh, Jr. 2015. Evidence of countergradient growth in western pond turtles (*Actinemys marmorata*) across thermal gradients. Freshwater Biology 60: 1944–1963.

(USFWS) U.S. Fish and Wildlife Service. 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, OR. viii + 173 pp.

_____. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, OR. xxvi + 606 pages.

_____. 2017a. Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (*Ambystoma californiense*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, CA. v + 69pp.

_____. 2017b. Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, CA. vii + 71 pp.

USFWS and EBMUD. 2009. Safe Harbor Agreement for East Bay Municipal Utility District Lands in San Joaquin, Amador, and Calaveras Counties. June 2009.

DRAFT EGG SURVIVAL STUDY PLAN (FA-5)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT EGG SURVIVAL STUDY PLAN (FA-5)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District

375 11th Street

Oakland, California 94607

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1.0 Introduction

This Egg Survival Study (FA-5) plan for the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) addresses Chinook salmon (*Oncorhynchus tshawytscha*) egg survival. The purpose of this study is to quantify egg survival and identify potential sources of mortality.

2.0 Project Nexus and Study Rationale

Chinook salmon egg survival in the Lower Mokelumne River could potentially be affected by Project operations and maintenance activities. Results from this FA-5 study will inform the development of potential license requirements.

3.0 Study Goals and Objectives

The overall goal of the FA-5 study is to evaluate the factors that influence Chinook salmon egg survival from deposition to fry emergence for the purpose of informing management strategies for the East Bay Municipal Utility District (EBMUD) related to reproductive success in the Lower Mokelumne River. Study objectives include evaluating existing information related to variation in egg mortality in response to environmental data and investigating additional factors related to egg survival. The specific study objects are as follows:

- **Compile and analyze historical data from the Lower Mokelumne River** to evaluate egg survival on the Lower Mokelumne River related to physical, chemical, and biological factors.

- **Evaluate the role of thiamine deficiency complex (TDC) by monitoring the thiamine levels** within salmon eggs at the Mokelumne River Fish Hatchery (MRFH) and applying results to estimate thiamine-dependent in-river Chinook salmon fry mortality.

- **Investigate in the laboratory the role of water temperature and dissolved oxygen on egg survival** at hatching and emergence of hatchery-sourced eggs.

- **Quantify in-river egg survival rates** by recording hatching and emergence survival for eggs in artificial and naturally built redds in-situ and monitoring potential survival correlates, including water temperature, dissolved oxygen, flow, fine sediment, pathogens/infections, predation, and parentage.

- **Evaluate reach-scale spawning habitat quality** and its potential impact on observed egg survival by monitoring water quality, sediment composition, water temperature, oxygen levels, flow rates, and gravel scour.

- **Develop a mechanistic/empirical model for egg survival** using the data compiled as part of this FA-5 study and other pertinent information to help inform management strategies (e.g., flow releases, water temperature).

4.0 Relevant Resource Management Goals

The Joint Settlement Agreement, Water Quality and Resource Monitoring Program specifies the most relevant resource management goals that apply to this study:

- Goals include (1) providing, to the extent feasible, habitat quality and availability in the Lower Mokelumne River to maintain fishery, wildlife, and riparian resources in good condition; (2) contributing toward the state and federal fishery restoration goals; and (3) sustaining the long-term viability of the salmon and steelhead fishery.

5.0 Geographic Scope

The geographic scope includes areas of the Lower Mokelumne River below Camanche Dam to Elliot Road Bridge where the majority of Chinook salmon spawning occurs.

6.0 Existing Information and Need for Additional Information

Existing information related to egg survival in the Project area that EBMUD has developed as part of their P-2916 license (FERC 1981) is documented in Section 4.04, Fish and Aquatic Resources, in the Pre-Application Document. This FA-5 study is needed to quantify egg survival in the Lower Mokelumne River below Camanche Dam under existing Project and potential alternative operations.

7.0 Study Methodology

7.1. Compilation and Analysis of Historical Data

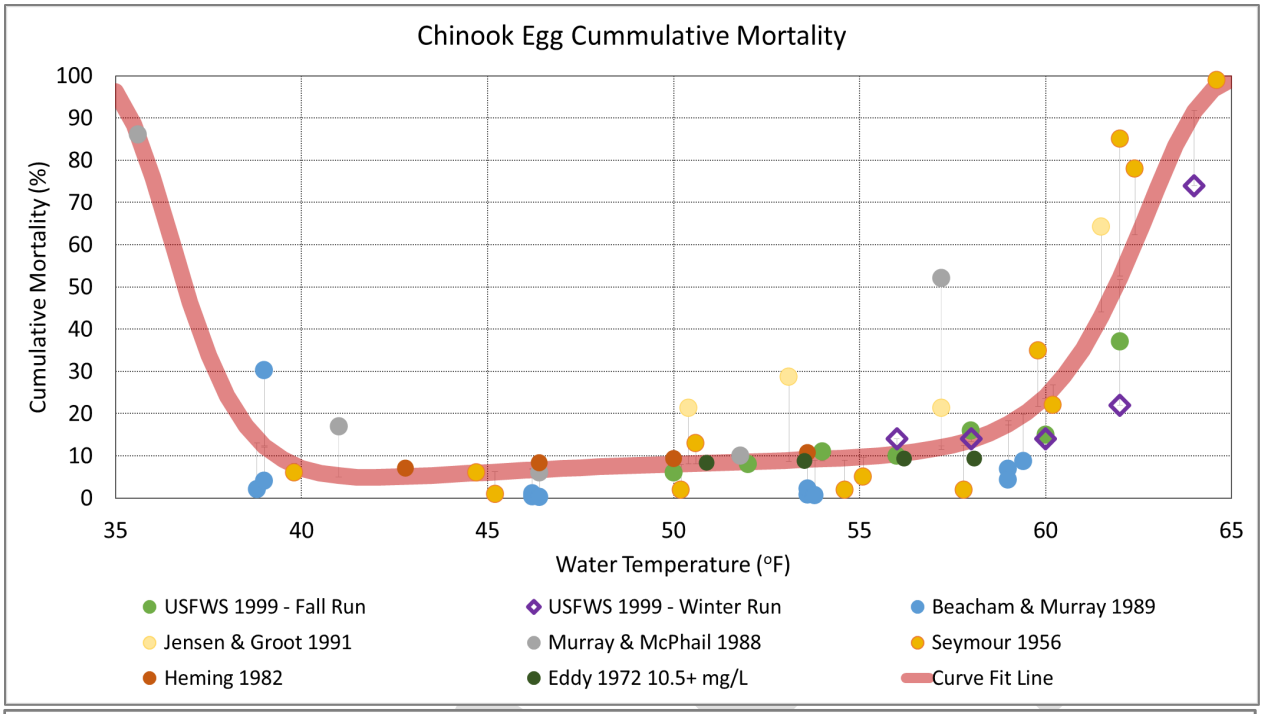
- Empirical data collected by EBMUD since 2009 related to the estimated number of redds, redd superimposition, number of eggs per redd based on published female size/egg estimates (Kauffman et al. 2009), and rotary screw trap information downstream of the spawning area will be compiled and related to water temperature and dissolved oxygen data collected in the river.

- The data will be compared with published literature on egg survival (e.g., Seymour 1956; Heming 1982; Murray and McPhail 1988; Beacham and Murray 1989; Jensen and Groot 1991; Reiser et al. 1998; U.S. Fish and Wildlife Service [USFWS] 1999; Geist et al. 2006; Johnson et al. 2012) (Figure 7-1) to identify relationships between various correlates and egg survival and required accumulated thermal units (ATUs) to hatch/emergence (Figure 7-2).

7.2. Thiamine Deficiency Complex

- During each month of the salmon spawning season, collect 10 g of eggs from 30 female broodstock, along with head muscle, otoliths, eyes, and scales. This effort will expand egg thiamine surveillance to assess temporal variation in thiamine levels across the Chinook salmon run.

- Since thiamine levels of Chinook salmon sampled at the hatchery will be representative of in-river conditions, develop thiamine-dependent mortality estimates for in-river fry (e.g., Mantua et al. 2025).



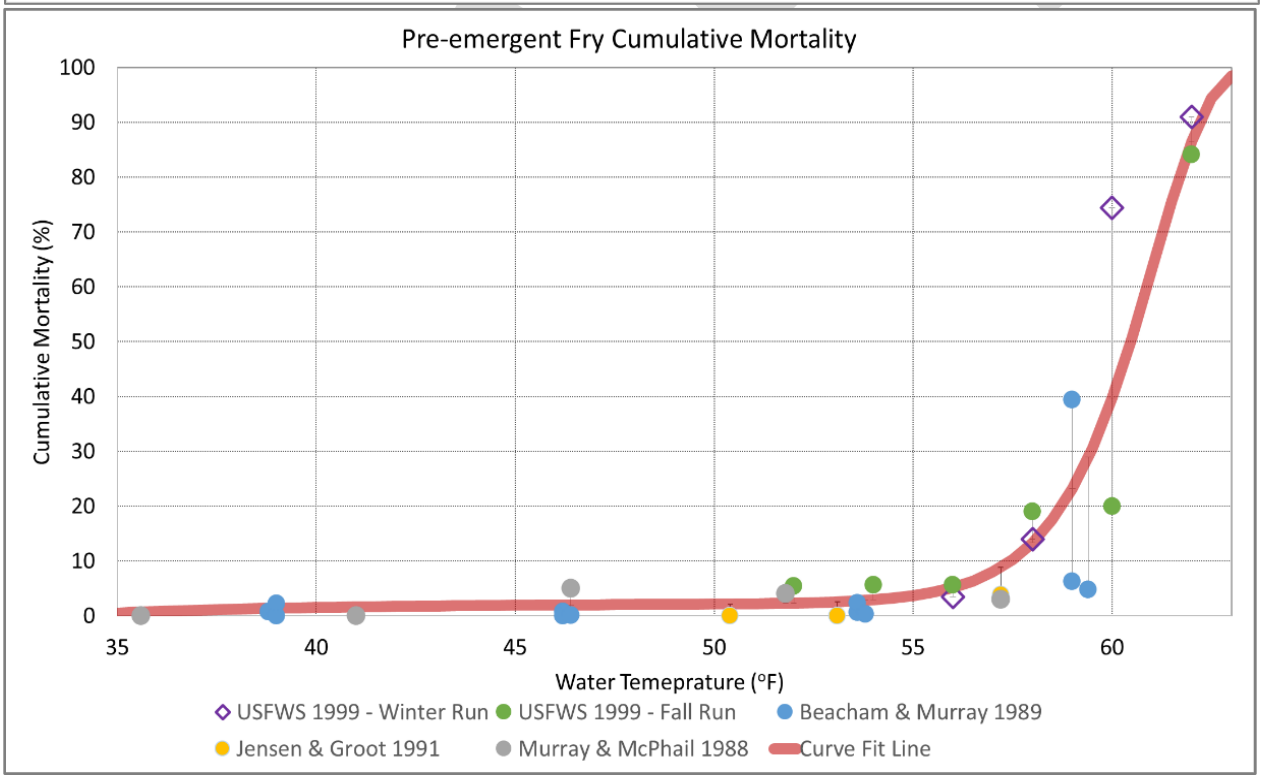
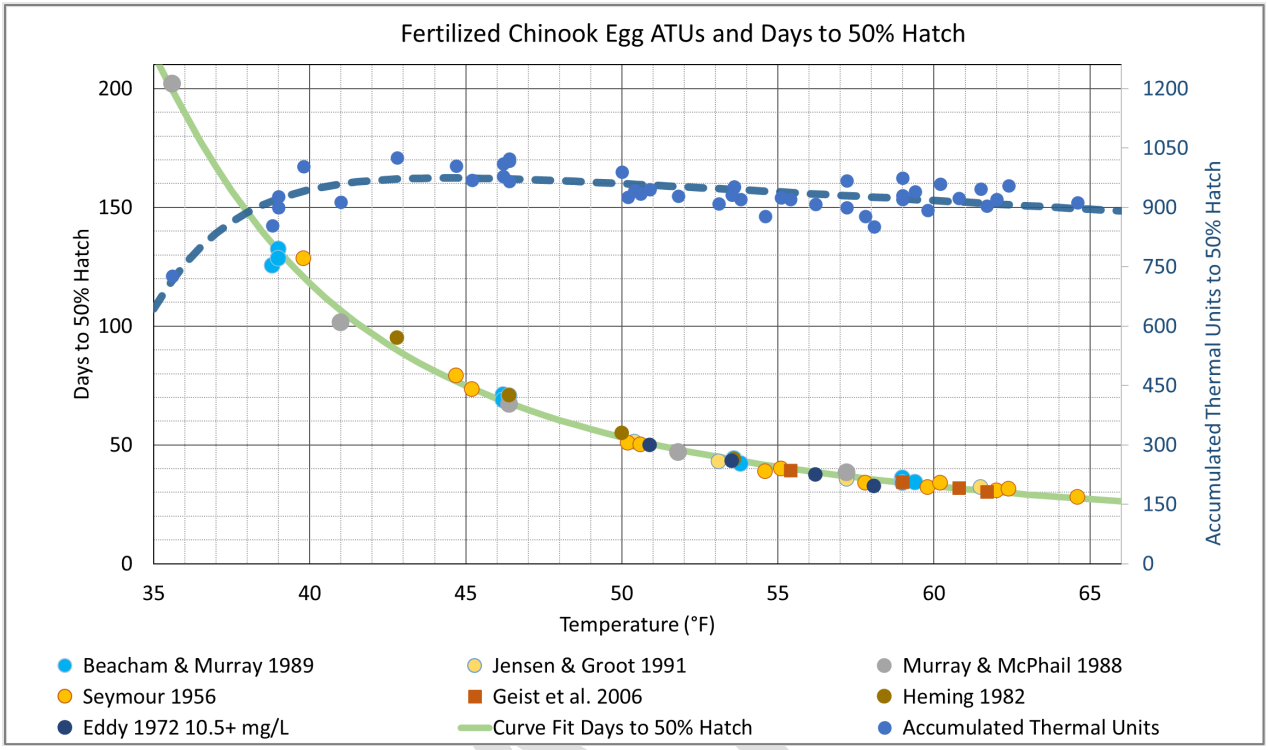


Figure 7-1. Example egg and pre-emergent fry mortality versus water temperature data for Chinook salmon.



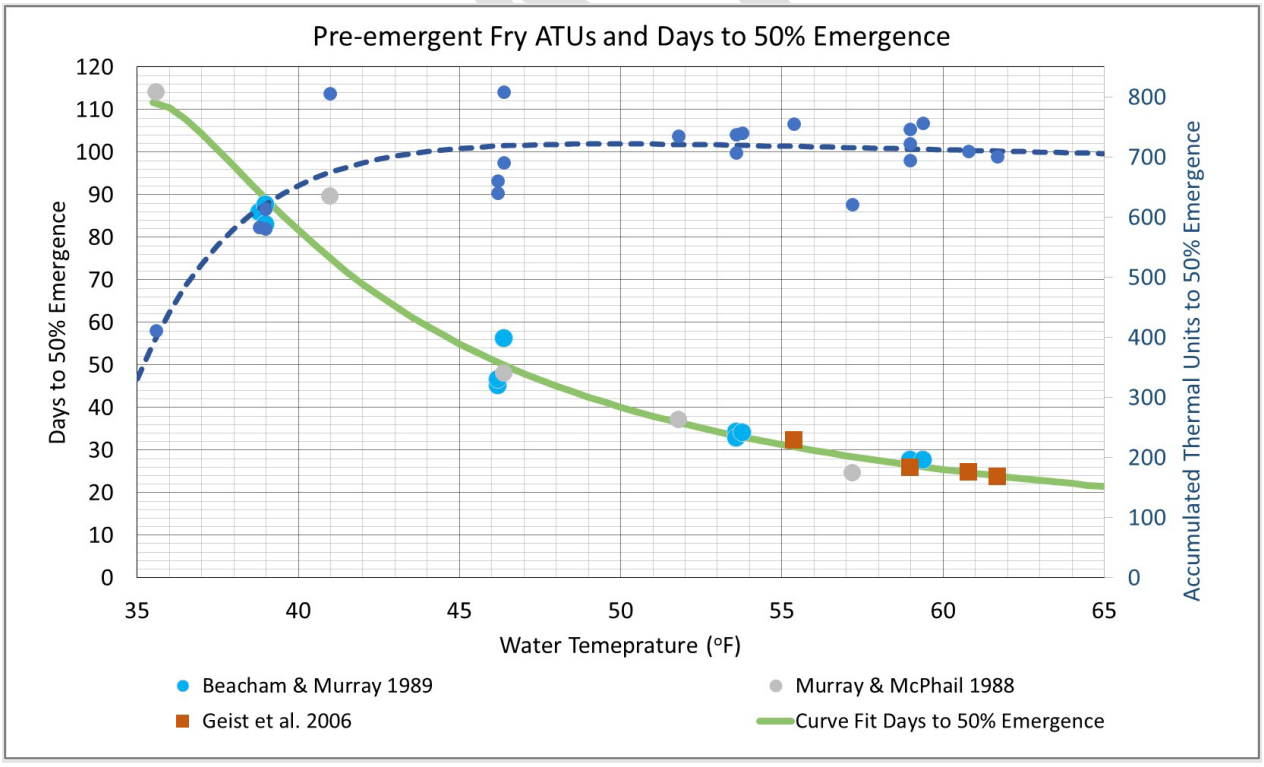


Figure 7-2. ATUs based on degrees Fahrenheit (°F) for Chinook salmon egg 50 percent hatch (top) and 50 percent hatch to 50 percent emergence (bottom) (ATUs °C = 5/9 * ATUs °F).

7.3. Laboratory Water Temperature and Dissolved Oxygen Evaluation

- A hatchery-based empirical study will use hatchery-collected eggs exposed to various water temperatures and dissolved oxygen treatments to identify thresholds for mortality.
    - Three temperature treatments following methods from Geist et al. (2006) (Figure 7-3) with varying starting temperatures that follow the observed Lower Mokelumne River declining thermal regime will be applied starting in mid-October.
    - High, medium, and low temperature treatments will be based on historical observations in the Lower Mokelumne River.
    - Treatment starting temperatures will span the observed lower threshold below which the effect on embryonic survival is negligible to the upper incipient lethal temperature for embryo viability (USFWS 1999; EPA 2003; Geist et al. 2006).
    - A hatchery standard water temperature control will also be implemented.
    - Three dissolved oxygen treatments will be used (e.g., saturation, 5 mg/L, and 3.5 mg/L). Data from previous laboratory studies will be used to identify the minimum viable dissolved oxygen threshold (e.g., Eddy 1972; Geist et al. 2006).
    - The experiments will, to the extent possible, mimic gravel conditions and flow-through rates similar to natural redds.

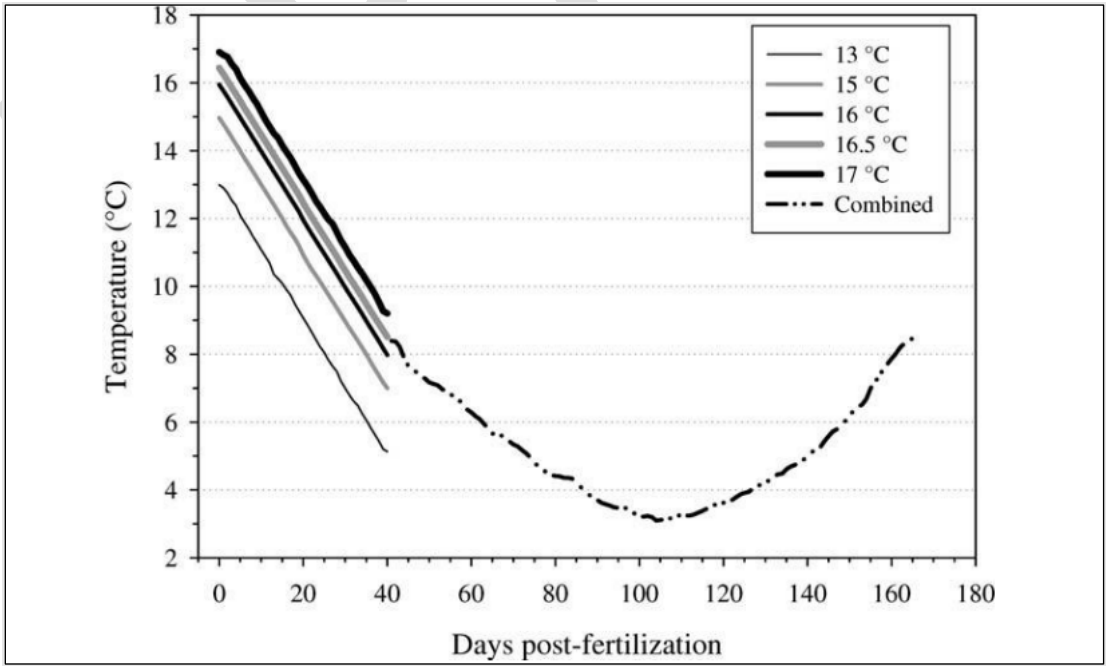


Figure 7-3. Example of fall-run Chinook salmon incubation temperatures from Geist et al. (2006).

7.4. In-river Egg Survival Rates

7.4.1. Study Sites

- Artificial redds will be placed in known spawning areas (following approach in Workman and Mesick 2011; Johnson et al. 2012) across three environmentally distinct reaches of the Lower Mokelumne River between the Camanche Dam and Elliot Road Bridge (Figure 7-4):
    - Camanche Tailwater Reach: influenced by reservoir discharges resulting in warmer water during peak spawning.
    - Mid-Reach Thermo-variable Zone: exhibits strong diurnal temperature fluctuations due to solar radiation and air exposure.
    - Lower-Gradient Reach: slow-moving segment with reduced dissolved oxygen and elevated water temperatures.

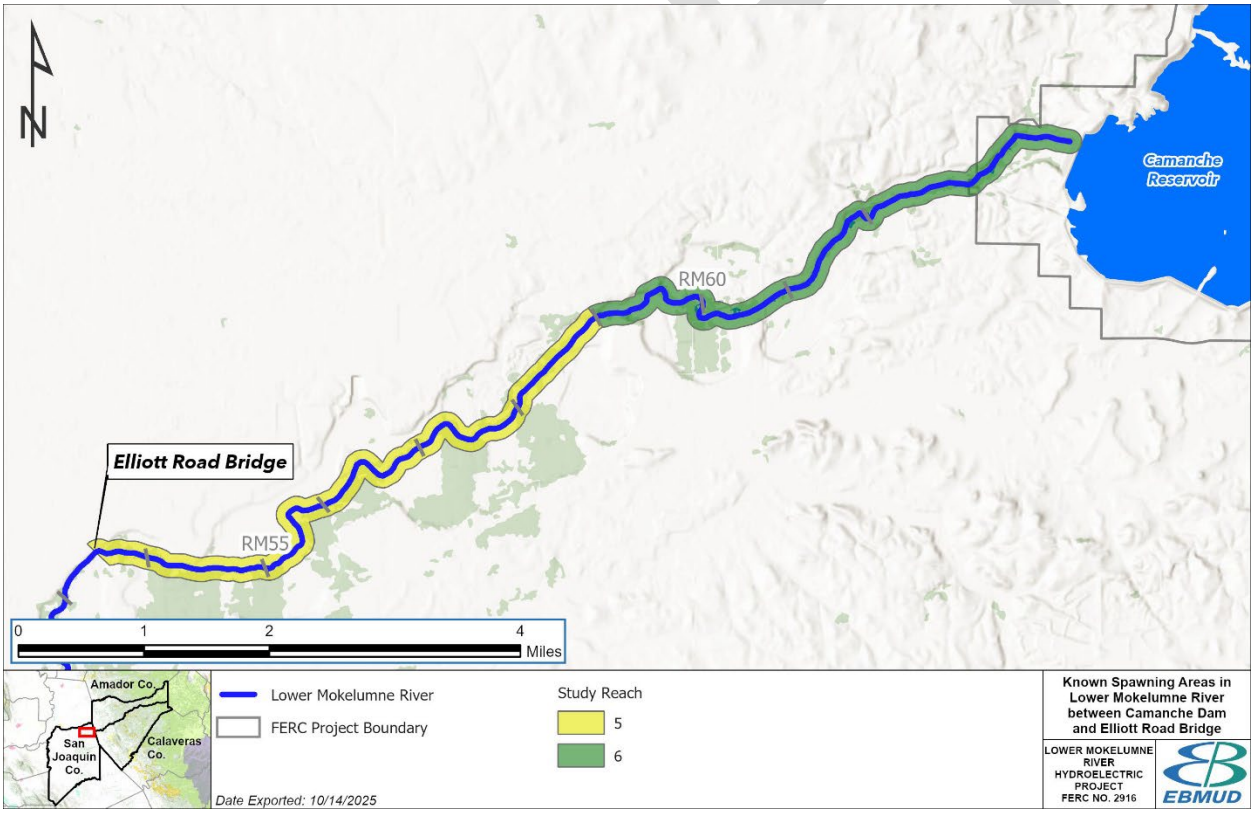


Figure 7-4. Egg Survival Study reach, Lower Mokelumne River from Camanche Dam to Elliott Road Bridge.

7.4.2. Timing

- Artificial redds will be deployed in three separate multi-week intervals, at the beginning, middle, and end of the date range that wild fall-run Chinook salmon naturally spawn in the Lower Mokelumne River.

7.4.3. Artificial Redds

7.4.3.1. Redd Number and Parentage

- Ninety total artificial redds will be spread equally among reaches.

- Parentage will be controlled to account for individual variability in egg survival. Approximately 10 females and 20 males (1 female: 2 males per egg group) will be used as broodstock, with each cross providing equal eggs to each reach. Eggs from individual spawning pairs will be placed in distinct egg boxes.

- A control egg box containing 100 eggs from each parental cross will be incubated in the hatchery.

7.4.3.2. Redd Construction

- Redd construction methods will follow Johnson et al. (2012).
    - Locations for artificial redd construction will be selected near active, naturally constructed redds or where redds were documented in previous years.
    - A bottomless 5-gallon bucket will be used to construct the egg pocket of the redd and prevent backfilling during placement of the egg box. A tail spill will then be built over the egg pocket.
    - One hundred eggs placed in modified W-V (or similar) egg boxes will be buried at a depth of 30 centimeters (11.8 inches) within the redd to mimic natural spawning conditions.
    - W-V egg box modifications based on Johnson et al. (2012) include a mesh lining in the egg box to keep emerging fry from leaving and gravel placed within the egg box to emulate natural conditions.

7.4.3.3. Fertilization and Egg Placement

- Eggs will either be fertilized at the hatchery by hatchery staff or fertilized on site. If fertilized at the hatchery, they will be transported to the egg placement site. If fertilized on site, milt will be suspended in a small amount of river water and then poured into the 0.5-liter bag containing the eggs. The newly mixed gametes will be set aside for approximately 2 minutes to allow water hardening before being gently poured evenly over the gravels of the submerged egg box.

7.4.3.4. Hatch and Emergence Survival Estimates

- Half the W-V egg boxes will be inspected for survival at 50 percent hatch (Figure 7-2) and subsequently replaced in the artificial redd. The other half will be inspected for survival when ATUs are consistent with 50 percent emergence.

7.4.4. Naturally Built Redds

- Emergence traps will be placed over 36 natural redds (12 in each reach) across the same spatial and temporal breadth as the artificial redd deployment. Emergence trapping will follow methods from Field-Dodgson (1983) and Stillwater Sciences (2007). Depending on the size of the run each year, the number of natural redds with emergence traps may need to be adjusted downward.

- Eggs per female estimates from the available Lower Mokelumne River data (e.g., Kauffman et al. 2009) will be combined with observed emergence to calculate survival to emergence for naturally built redds.

- At ATUs consistent with 50 percent hatch, a subset of the redds will also be sampled for pre-hatch mortality.

- TDC will be evaluated for emerged fry based on swimming ability and behavior.

7.5. Reach-scale Spawning Habitat Quality

7.5.1. Hyporheic Environment

- Standpipes will be driven into several patches of gravel representative in each reach that are representative of the artificial and natural redds every 2 weeks to measure water temperature, dissolved oxygen, and pH. Intergravel permeability will be measured following the methods outlined in Barnard and McBain (1994).
    - The number of locations will be based on the observed variability but will not exceed 10 in each reach.
    - Water quality measurements will be taken at the gravel surface, 15 centimeters (5.9 inches), and 30 centimeters (11.8 inches) deep in the substrate.
- Artificial redd sensors (e.g., miniDOTs) deployed in each artificial redd will collect continuous temperature and dissolved oxygen data throughout the study.

7.5.2. Gravel Quality

- Wolman pebble counts (Wolman 1954) and McNeil core samples will be used in spawning riffles at a reach level to characterize surface and subsurface grain-size distributions. This will be completed before spawning occurs.

- Scour will be quantified in each riffle hosting artificial redds with wiffle ball scour chains.

7.5.3. Environmental Monitoring

- Temperature and flow data collected and modeled under the Water Temperature (WR-2) and Hydrology Operations and Modeling (WR-3) study plans will be leveraged to evaluate correlations between environmental conditions and mortality.

- At a minimum, continuous water temperature and dissolved oxygen measurements within the river water column will be collected at each site hosting redds to document spatial and temporal trends in water temperature and dissolved oxygen.

7.5.4. Reach-scale Spawning Activity and Habitat Availability

- Continue EBMUD's ongoing redd surveys and evaluation of superimposition throughout the study period.

7.6. Data Analysis and Egg Survival Model

- Develop a model predicting survival from the environmental data compiled for this study. Incorporate additional data in the literature on egg survival as appropriate. Incorporate the Contingency Study results if they are conducted.

- Model the existing period of record (2009 – present) and alternative scenarios as appropriate.

8.0 Schedule and Deliverables

This is proposed as a 2-year study; it includes a draft and final Egg Survival Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Egg Survival Study schedule.

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9.0 Level of Effort and Cost

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10.0 References

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 No. 15). U.S. Department of Agriculture, Forest Service, Eureka, CA. https://www.krisweb.com/krissheepscot/krisdb/html/krisweb/biblio/gen_usfs_barnardetal_1994_fhr15ba.pdf

Beacham, T.D., and C.B. Murray, CB. 1989. Variation in developmental biology of sockeye salmon (*Oncorhynchus nerka*) and Chinook salmon (*O. tshawytscha*) in British Columbia. Canadian Journal of Zoology 67(8):2081–2089.

Bratovich, P., M. Neal, A. Ransom, P. Bedore, and M. Bryan. 2020, September 23. Chinook salmon early life stage survival & Folsom Dam power bypass considerations. Sacramento Water Forum; HDR, Inc.; Robertson-Bryan, Inc. https://www.waterforum.org/wp-content/uploads/2020/09/Water-Forum-Water-Temp-Embryo-Survival-TM-9-23-20.pdf

Eddy, R. M. 1972. The Influence of Dissolved Oxygen Concentration and Temperature on the Survival and Growth of Chinook Salmon Embryos and Fry. Thesis, Oregon State University.

EPA (U.S. Environmental Protection Agency). 2003. EPA 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.

FERC (Federal Energy Regulatory Commission). 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

Field-Dodgson, M.S. 1983. Emergent fry trap for salmon. The Progressive Fish-Culturist 45(3):175–176. https://doi.org/10.1577/1548-8659(1983)45[175:EFTFS]2.0.CO;2

Geist, D.R., C.S. Abernethy, K.D. Hand, V.I. Cullinan, J.A. Chandler, and P.A. Groves. 2006. Survival, development, and growth of fall Chinook salmon embryos, alevins, and fry exposed to variable thermal and dissolved oxygen regimes. Transactions of the American Fisheries Society 135(6):1462–1477. https://www.noaa.gov/sites/default/files/legacy/document/2020/Oct/07354626728.pdf

Heming, T.A. 1982. Effects of temperature on utilization of yolk by Chinook salmon (*Oncorhynchus tshawytscha*) eggs and alevins. Canadian Journal of Fisheries and Aquatic Sciences 39(2):184–190.

Jensen, J.O.T., and E.P. Groot. 1991. The effect of moist air incubation conditions and temperature on Chinook salmon egg survival. In J. Colt & R. J. White (Eds.), American Fisheries Society Symposium (Vol. 10, pp. 529–538). American Fisheries Society.

Johnson, C. L., P. Roni, and G.R. Pess. 2012. Parental effect as a primary factor limiting egg-to-fry survival of spring Chinook salmon in the upper Yakima River Basin. Transactions of the American Fisheries Society 141(5):1295–1309. https://doi.org/10.1080/00028487.2012.690815

Kauffman, R.C., A.G. Houck, M. Workman, and J.J. Cech Jr. 2009. Chinook salmon length/fecundity: A regression model for the Mokelumne River, California. Ca. Fish and Game 95(2):86-105.

Mantua, N.J., and 34 Authors. 2025. Widespread thiamine deficiency in California salmon linked to an anchovy-dominated marine prey base. Proceedings of the National Academy of Sciences 122(26):e2426011122. https://doi.org/10.1073/pnas.2426011122

Merz, J.E., J.D. Setka, G.B. Pasternak, and J.M. Wheaton. 2004. Predicting benefits of spawning-habitat rehabilitation to salmonid (*Oncorhynchus* spp.) fry production in a regulated California river. Canadian Journal of Fisheries and Aquatic Sciences 61(9):1433–1446.

Murray, C.B., and J.D. McPhail. 1988. Effect of incubation temperature on the development of five species of Pacific salmon (*Oncorhynchus*) embryos and alevins. Canadian Journal of Zoology 66(2):266–273.

Reiser, D.W., A. Olson, and K. Binkley. 1998. Sediment deposition within fry emergence traps: A confounding factor in estimating survival to emergence. North American Journal of Fisheries Management 18(3):713–719. https://doi.org/10.1577/1548-8675(1998)018<0713: SDWFET>2.0.CO;2

Seymour, A.L. 1956. Effects of temperature upon young Chinook salmon (Doctoral dissertation). University of Washington, Seattle, WA.

Stillwater Sciences. 2007. Tuolumne River fine sediment management project: Chinook salmon survival to emergence study (Agreement No. 2001-C208). Report prepared for the Tuolumne River Technical Advisory Committee, Turlock and Modesto Irrigation Districts, and California Bay-Delta Authority.

USFWS (U.S. Fish and Wildlife Service). 1999. Effects of temperature and dissolved-oxygen conditions on hatchery and wild fall and winter Chinook salmon embryos and alevins: Final report (Region 1). https://www.noaa.gov/sites/default/files/legacy/document/2020/Oct/07354626852.pdf

Walkotten, W.J. 1976. An improved technique for freeze-sampling streambed sediment (Research Note PNW-RN-281). U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

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

Workman, M., and C. Mesick. 2011. Preliminary report of implementation of Chinook salmon egg survival study for the San Joaquin River Restoration Program, Fall 2011. U.S. Fish and Wildlife Service.

DRAFT JUVENILE MORTALITY STUDY PLAN (FA-6)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

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1.0 Introduction

This Juvenile Mortality Study (FA-6) plan addresses juvenile Chinook salmon (*Oncorhynchus tshawytscha*) survival for the Lower Mokelumne River (Lower Mokelumne River Hydroelectric Project, Federal Energy Regulatory Commission [FERC] No. 2916, Lower Mokelumne River Project or Project). The purpose of this FA-6 study is to quantify juvenile survival and identify sources of mortality.

2.0 Project Nexus and Study Rationale

Juvenile Chinook salmon survival in the Lower Mokelumne River could potentially be affected by Project operations and maintenance activities. Results from this FA-6 study will inform development of potential license requirements.

3.0 Study Goals and Objectives

The overall goal of this study is to evaluate the factors that influence juvenile Chinook salmon survival from post-emergence to their outmigration from the Project area for the purpose of informing management strategies related to juvenile recruitment success in the Lower Mokelumne River. The study objectives are as follows:

- **Compile and analyze historical biological, physical, and chemical data** from redd surveys, juvenile trapping, and water quality/flow monitoring on the Lower Mokelumne River to evaluate juvenile survival related to physical, chemical, and biological factors.
- **Evaluate the role of thiamine deficiency complex (TDC)** in juvenile mortality (in coordination with the Egg Survival Study [FA-5]).
- **Monitor physical/chemical environmental conditions** (water temperature, dissolved oxygen, etc.).
- **Quantify juvenile abundance** based on redd counts and fry emergence in coordination with the FA-5 study.
- **Monitor reach-specific juvenile survival rates** by tagging juvenile salmon and tracking their downstream movements from spawning areas to the Woodbridge Irrigation District Dam (WIDD) and downstream to the Consumnes River.
- **Evaluate spatial mortality bottlenecks** by identifying and/or monitoring:
    - Reach and habitat-specific mortality (e.g., predation, entrainment, water temperature),
    - Habitat and flow-related exposure to mortality sources (e.g., predator density, entrainment),
    - Competition, and
    - Growth and bioenergetics (e.g., growth versus water temperature).
- **Develop a mechanistic empirical model for outmigration survival** using the data developed in this FA-6 study and other pertinent information to inform management strategies (e.g., juvenile rearing habitat, migration corridors, and instream flows).

4.0 Relevant Resource Management Goals

The Joint Settlement Agreement and Water Quality and Resource Monitoring Program includes the following management goals:

(1) Providing, to the extent feasible, habitat quality and availability in the Lower Mokelumne River to maintain fishery, wildlife, and riparian resources in good condition;

(2) Contributing toward the state and federal fishery restoration goals; and

(3) Sustaining the long-term viability of the salmon and steelhead fishery.

5.0 Geographic Scope

The FA-6 study area includes the Lower Mokelumne River from Camanche Dam to WIDD .

6.0 Existing Information and Need for Additional Information

Existing information related to juvenile salmon survival in the Project area that the East Bay Municipal Utility District (EBMUD) has developed as part of the existing license (FERC 1981) is documented in Section 4.04, Fish and Aquatic Resources, in the Pre-Application Document (PAD). This study is needed to quantify juvenile Chinook salmon survival in the Lower Mokelumne River below Camanche Dam under existing Project and potential alternative operations. Based on review of available information, the following potential information gaps were identified related to juvenile Chinook salmon outmigration survival:

- Quantitative data on outmigration survival.
- Identification of the factors (physical, chemical, and biological) that influence survival from post-emergence to through outmigration from the Mokelumne River.
- An accurate model to inform management strategies related to juvenile recruitment success in the Lower Mokelumne River.

7.0 Study Methodology

The FA-6 study methodology includes analyzing historical data (Section 7.1) and developing new information during the first and second (e.g., 2026 and 2027) study seasons (Sections 7.2 through 7.7)

7.1. Compilation and Analysis of Historical Data

- Compile historical flow, water temperature, dissolved oxygen, and juvenile catch/survival data from the Lower Mokelumne River (2009 to 2025).
- Quantify historical redd density and estimated fry abundance (2009 to 2025).
- Identify correlations between historical physical, chemical, and biological survey data and survival estimates. Use catch data from existing rotary screw traps (RSTs), Woodbridge Irrigation District (WID) bypass trap, and redd survey efforts (2009 to 2025) to estimate annual fry production, survival from spawning grounds to the first RST, and survival between traps (Table 7-1).

Table 7-1. Annual abundance estimates at trapping sites and survival between sites for out-migrating fall-run Chinook salmon smolts based on catch at the two RSTs and trap efficiency metrics.

Brood Year	Upstream Abundance Estimate	Downstream Abundance Estimate	Survival Between Traps (%)
2009	124,279	67,349	54.19
2010	842,570	281,500	33.41
2011	202,772	51,799	25.55
2012	1,203,754	147,590	12.26
2013	595,070	169,864	28.55
2014	431,677	61,305	14.20
2015	856,127	134,593	15.72
2016	No Estimate	326,455	N/A
2017	456,372	40,117	8.79
2018	4,693,253	2,799,209	59.64
2019	214,226	24,097	11.25
2020	197,004	82,145	41.70
2021	107,931	61,415	56.90
2022	≥ 842,449*	184,242	≤ 21.84
2023	1,781,298	444,117	24.93

*Incomplete abundance estimate (trap pulled on March 16, 2023).

7.2. Thiamine Deficiency Complex

- As part of the Egg Survival Study (FA-5), thiamine monitoring at the Mokelumne River Fish Hatchery (MRFH) will be expanded to evaluate thiamine levels throughout the Chinook salmon run.
- Incorporate fry mortality estimates attributed to thiamine deficiency complex developed as part of the Egg Survival Study (FA-5) into in-river juvenile mortality.

7.3. Physical/Chemical Conditions

- Continue operating current monitoring sites (Table 7-2; Figure 7-1) for physical/chemical data (e.g., temperature and dissolved oxygen) to represent reach-specific conditions. Leverage the existing temperature and water quality monitoring in the Water Temperature Study (WR-2) and in the Egg Survival Study (FA-5).

Table 7-2. Physical/chemical monitoring sites.

Sites	Description	Parameters
BELOW CAMANCHE	Mokelumne River Near McIntire Road Lat: 38.220984° Long: -121.039486° Elev: **85.5** ft	Stage/Discharge Water Temperature
MACKVILLE	"Mackville" Mokelumne River Near Clements Lat: 38.204996° Long: -121.093345° Elev: **67**.3 ft	Stage/Discharge Water Temperature
ELLIOTT	"Elliott" Mokelumne River Near Lockeford Lat: 38.177925° Long: -121.165522° Elev: **47.0** ft	Stage/Discharge Water Temperature
VICTOR	"Victor" Mokelumne River Nr Victor Lat: 38.150636° Long: -121.196607° Elev: **41.0** ft	Stage/Discharge Water Temperature
GOLF	Mokelumne River At Woodbridge Lat: 38.158699 Long: -121.30338 Elev: **16.6** ft	Stage/Discharge Water Temperature
THORNTON	Mokelumne River Near Thornton (Msl G.H. Record) Lat: 38.209843° Long: -121.380717° Elev: **2.0** ft	Stage Water Temperature

Figure 7-1. Map of physical/chemical monitoring sites.

7.4. Quantifying Juvenile Abundance

- Use redd survey data, estimates of eggs per redd, and cumulative emergence rates produced by the Egg Survival Study to estimate total fry production in the spawning area for each study year (2026 and 2027).
- Use the catch at the two RSTs and the WIDD bypass trap, as appropriate, to estimate the timing, life stage, and number of out-migrating fish based on catch and trap efficiency metrics.

7.5. Monitoring Reach-Specific Juvenile Survival Rates

7.5.1. Fish Capture, Handling, and Tagging

- Capture wild Chinook salmon juveniles via backpack and boat electrofishing, fyke traps, and/or seining efforts (as permits allow) within the spawning reach and at the Elliot Road and WIDD RSTs.
- As part of EBMUD's ongoing acoustic telemetry program, Chinook salmon will be implanted with Juvenile Salmon Acoustic Telemetry System (JSATS) tags and released adjacent to the MRFH. As many wild-origin juveniles as possible (of the appropriate size) will be captured (e.g., fyke nets, RSTs) for tagging. Due to constraints in obtaining sufficient numbers of appropriately sized wild juveniles that meet the minimum tag-to-body weight ratio, hatchery-reared juvenile salmon will be used as surrogates, as necessary, to evaluate reach-specific and overall in-river survival through the lower Mokelumne River. Final JSATS tag configuration will depend on the tag model selected but is anticipated to include a 5-second transmission interval and an estimated battery life of 36–40 days. Modeling results will be assessed with consideration of hatchery–wild salmon differences.
- Apply an appropriate external batch mark to smaller wild juvenile Chinook salmon weekly. Capture and tag fish in the spawning area and at the Elliot Road RST (see Section 13.5.2, Tracking Infrastructure, below).
- Captured fish will be held in aerated containers with site water and processed on shore following approved animal care protocols. Each fish will be measured (fork length, millimeters) and weighed (grams).

7.5.2. Tracking Infrastructure

- Maintain the currently operating array of 10 JSATS receiver arrays between Camanche Dam and the Consumnes River.

- Provide visual inspection at RSTs for externally marked fish.

7.5.3. Rotary Screw Trap and Bypass Trap Operations

- Monitor out-migrating juveniles by continuing operation of the RSTs and the WIDD bypass trap. Assess the current RST monitoring/efficiency protocols and adjust, if needed, to complete this study.

7.6. Evaluation of Spatial Mortality Bottlenecks

7.6.1. Reach and Habitat-Specific Mortality

- Evaluate reach and habitat-specific survival of acoustic tagged fish by monitoring tag detections at consecutive JSATS receivers. Conduct boat-based active tracking surveys following the outmigration to locate acoustic tags that did not complete outmigration and represent likely mortalities. Collect any additional relevant data in the area of tag relocations (habitat type, diversion presence, etc.).
- Use the acoustic telemetry data to assess if observed tag movement is consistent with predation (upstream movements, sedentary, etc.). If applicable, use multivariate mixture models to distinguish behavior states associated with out-migrating juvenile salmon versus predators (Romine et al. 2014; Buchanan and Whitlock 2022).
- Quantify recaptures of batch-marked fish and use RST efficiency calculations to estimate fish survival between recovery locations.
- Conduct tethered fish mortality experiments (100 fish) (Mensinger 2024) in habitats initially identified as low, medium, and high predation mortality risk (see Section 7.6.2 below).
- Characterize entrainment risk at known unscreened diversions. Use EBMUD's database of known unscreened diversions in the study area (volume diverted, season of operation, etc.). Identify the locations with the highest entrainment risk (season, location, pumping volume) and determine the best way to quantify entrainment risk at the specific sites (e.g., entrainment sampling, hydrodynamics/behavior modeling, e.g., Goodwin et al. 2023, or other). Quantitatively estimate entrainment at the highest risk sites. Characterize any potential correlations of water temperature and water quality with observed mortality.

7.6.2. Habitat and Flow-Related Mortality Sources

- Characterize habitat types throughout each reach (backwater pools, side channels, floodplain habitat, Lake Lodi, etc.) and quantify the associated predation risk (high, medium, low).
    - Quantify predator density in habitats using data collected during boat-electrofishing surveys as part of the Fish Population Study (FA-1) plan and collect additional data, as needed, to characterize high, medium, and low predation-risk areas.
    - Correlate observed acoustic tag, marked fish, tethered fish mortality, and predator fish density with habitat predation risk.
- Quantify fish transit time within each reach based on telemetry and marked fish data and associate it with varying flow levels.

7.6.3. Competition

- Use data collected in the Fish Population Study (FA-1) and supplemental electrofishing in this study (Section 7.6.2) to quantify the density of fish species that potentially compete for food and/or habitat.

7.6.4. Growth and Bioenergetics

- Quantify growth from RST data and relate growth to water temperature using the most current bioenergetics models for juvenile Chinook salmon. Use measured length and weight data collected at the RSTs to quantify growth.

7.7. Mechanistic Empirical Model of Juvenile Outmigration Survival

- Develop a mechanistic model (fish behavior, predation) with survival probabilities and environmental data (flow, hydraulics, water temperature, dissolved oxygen) collected in this study. Validate the model using data from the period of record (2009 to present) including redd surveys, RST data, fish tagging data, daily water temperature, flow, and dissolved oxygen.

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10.0 References

Buchanan R.A., P.L. Brandes, and J.R. Skalski. 2018. Survival of juvenile Fall-run Chinook Salmon through the San Joaquin River Delta, California, 2010-2015. North American Journal of Fisheries Management 38:663-679

Goodwin, R.A.; Y.G. Lai; D. E. Taflin; D. L. Smith; J. McQuirk; R. Trang; and R. Reeves. 2023. Predicting near-term, out-of-sample fish passage, guidance, and movement across diverse river environments by cognitively relating momentary behavioral decisions to multiscale memories of pas hydrodynamic experiences. Front. Eco. Evo,, 14 June 2023.

Buchanan R.A. and S.L. Whitlock. 2022. Diagnosing predated tags in telemetry survival studies of migratory fishes in river systems. Animal Biotelemetry 10:13

(FERC) Federal Energy Regulatory Commission. 1981. Order Issuing License for East Bay Municipal Utility District Project No. 2916. Issued March 10, 1981.

Mensinger, M. 2024. Characterizing Predation Risk During Atlantic Salmon Smolt Migration. Dissertation, University of Maine. August 2024. https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=5108&context=etd.

Romine, J.G., R.W. Perry, S.V. Johnston, C.W. Fitzer, S.W. Pagliughi, and A.R. Blake. 2014. Identifying when tagged fishes have been consumed by piscivorous predators: application of multivariate mixture models to movement parameters of telemetered fishes. Animal Biotelemetry 2:3

DRAFT
WILDLIFE RESOURCES STUDY PLAN (TERR-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT
WILDLIFE RESOURCES STUDY PLAN (TERR-1)

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

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1.0 Introduction

East Bay Municipal Utility District's (EBMUD) Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) operations and maintenance activities may have the potential to affect special-status wildlife species and their habitat that are known to or have the potential to occur in the Project area. The purpose of this Wildlife Study (TERR-1) plan is to document special-status wildlife species observed and map their habitats in the study area. Special-status amphibians and aquatic reptiles are covered in the Special Status Amphibians and Aquatic Reptiles Study (FA-4) plan.

2.0 Project Nexus and Study Rationale

Special-status wildlife resources and their habitats are known to or could potentially be present in the FERC Project boundary. Implementation of Project operations and maintenance activities could potentially result in direct loss or disturbance of individuals or their habitat.

3.0 Study Goals and Objectives

The goals and objectives of the TERR-1 study are as follows:

- Identify special-status wildlife species potentially occurring in California Wildlife Habitat Relationships (CWHR) habitats documented as part of the Botanical Resources Study Plan.
- Map potential habitat for monarch butterfly (*Danaus plexippus*) (i.e., milkweed) in conjunction with special-status plant surveys completed as part of the Botanical Resources Study Plan.
- Document wintering and nesting bald eagle (*Haliaeetus leucocephalus*) in the vicinity of Project reservoirs and Project-affected reaches.
- Document bat roosts present on Project facilities and identify bat species present.
- Document wildlife mortality at Project facilities.
- Map deer migration routes and important areas in relation to Project facilities.

4.0 Relevant Resource Management Goals and/or Public Interest Considerations

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity. EBMUD has entered into a Safe Harbor Agreement (SHA or Agreement) with the purpose of (1) promoting the enhancement and management of habitat for California red-legged frog (*Rana draytonii*), California tiger salamander (*Ambystoma californiense*), and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) on EBMUD watershed lands in San Joaquin, Amador, and Calaveras counties; and (2) providing certain regulatory assurances to EBMUD. The SHA serves as the basis for the U.S. Fish and Wildlife Service (USFWS) to issue an enhancement of survival permit (Permit) pursuant to Section 10(a)(1)(A) of the federal Endangered Species Act (ESA). The Permit authorizes the incidental taking of California red-legged frog, California tiger salamander, and valley elderberry longhorn beetle associated with the enhancement and conservation management of these species' habitats, other lawful uses of the property (as described in Section 10 of the SHA), and the potential future return of any eligible land to pre-Agreement conditions (baseline) within the period during which the Permit is in effect.

EBMUD's SHA and relevant management plans include the following:

- Safe Harbor Agreement for East Bay Municipal Utilities District Lands in San Joaquin, Amador, and Calaveras Counties, June 2009 (USFWS and EBMUD 2009).
- California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians (California Department of Fish and Wildlife [CDFW] 2015).
- Draft Revised Recovery Plan for Valley Elderberry Longhorn Beetle (USFWS 2018).
- Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005).

Wildlife resources are a subject of public interest at the local, state, and national level. Public interest statements obtained from relicensing participants are listed below:

- Interest Statement: Direct loss or disturbance of individual wildlife species or their habitat.

5.0 Geographic Scope

The geographic scope of the TERR-1 study is described in Section 5.1 below.

5.1. Special-Status Wildlife Surveys

- For identification of special-status species potentially occurring in CWHR habitats, the study area is the FERC Project boundary and 1 mile outside the boundary.
- For wildlife reconnaissance surveys, the study area is the area where operations and/or maintenance occurs around Project facilities, plus a protective buffer. Refer to Table 5-1 for the survey area by facility type.
- For monarch butterfly habitat surveys, the study area is lands within the FERC Project boundary where operations and/or maintenance activities are conducted, plus a protective buffer. Milkweed host plants (*Asclepias* spp.) will be documented in conjunction with special-status plant surveys conducted under the Botanical Resources Study Plan.
- For bald eagle wintering and nesting surveys, the study area is Project reservoir and Project-affected reaches.
- For special-status bat roost surveys, the study area is Project facilities.
- For wildlife mortality, the study area is Project facilities.
- For deer migration routes and important areas, the study area is 1 mile around the FERC Project boundary.

Table 5-1. Special-status wildlife survey area.

Project Facility Type	Survey Area
Dams, Dikes, and Spillways	
Pardee Dam	100 feet
Pardee South Spillway	100 feet
Jackson Creek Dike and Spillway	100 feet
West End Dike	100 feet
Camanche Dam	100 feet
Camanche Spillway	100 feet
Dikes 1 – 6	100 feet
Penstocks	
Pardee Penstock	15 feet on either side
Camanche Penstock	15 feet on either side
Powerhouses and Switchyards	
Pardee Powerhouse and Switchyard	Within and up to 15 feet around the perimeter fence
Camanche Powerhouse and Switchyard	Within and up to 15 feet around the perimeter fence
Ancillary and Support Facilities	
	15 feet around the perimeter
Stream Gages	
	10 feet around gages
Project Access Roads	
	20 feet on either side
Recreation	
Trails	15 feet on either side
Pardee Recreation Area	150 feet around recreation facilities
Camanche North Shore Recreation Area	150 feet around recreation facilities
Camanche South Shore Recreation Area	150 feet around recreation facilities
Camanche Hills Hunting Preserve	150 feet around recreation facilities
Mokelumne River Fish Hatchery	150 feet around hatchery and associated facilities
Mokelumne Day Use Area	150 feet around recreation facilities

6.0 Existing Information and Need for Additional Information

Extensive data on wildlife resources in the Project area are available and included in EBMUD's Lower Mokelumne River Project Pre-Application Document (PAD) (EBMUD 2025). EBMUD has been conducting ongoing surveys for several special-status wildlife species as part of their Mokelumne Watershed Routine Maintenance Agreement (EPIMS Notification No. SJN-25163-R2) (CDFW 2022), as part of the SHA (USFWS and EBMUD 2009), and on a voluntary basis. Specifically, this includes the following surveys for special-status wildlife:

- Mokelumne Watershed Routine Maintenance Agreement:
    - Annual general nesting bird surveys (raptors and songbirds) during maintenance activities conducted within the nesting season (February 1 – August 31),
    - Annual Swainson's hawk (*Buteo swainsonii*) surveys conducted consistent with the *Recommending Timing and Methodology for Swainson's Hawk Nesting Surveys In California's Central Valley* (CDFW 2000), and
    - Annual burrowing owl (*Athene cuniculata*) surveys conducted consistent with the *Staff Report on Burrowing Owl Mitigation* (CDFW 2012).
- SHA:
    - Valley elderberry longhorn beetle habitat surveys every 3 years (i.e., elderberry shrub counts).
- Voluntary:
    - Annual bald eagle nest monitoring (every 2 weeks during the nesting season) at Camanche and Pardee reservoirs, and
    - Game species counts to support the Camanche Hills Hunting Preserve.

Based on review of available information, the following potential information gaps were identified:

- Identify special-status wildlife species potentially occurring in CWHR habitats documented as part of the Botanical Resources Study Plan,
- Identify potential habitat for monarch butterfly (i.e., milkweed),
- Document bat roosts present on Project facilities and identify bat species present,
- Document wildlife mortality at Project facilities, and
- Identify deer migration routes and important areas in relation to Project facilities.

7.0 Study Methodology

7.1. Special-Status Wildlife Surveys

For the purposes of this study, a special-status wildlife species is defined as any animal species that is granted status by a federal or state agency. Federally listed species granted status by USFWS under the ESA include threatened (FT), endangered (FE), proposed threatened or endangered (FPT, FPE), candidates for listing (FC), or proposed for delisting (FPD). Also included are those species listed by USFWS as Birds of Conservation Concern (BCC), which include "species, subspecies, and populations of all migratory nongame birds that, without additional conservation action, are likely to become candidates for listing under the ESA of 1973" (USFWS 2021).

State of California listed wildlife species that are granted status by the CDFW under the California Endangered Species Act (CESA) include threatened (ST), endangered (SE), fully protected species (CFP), and California Species of Special Concern (SSC).

The study approaches for special-status general wildlife surveys, monarch butterfly habitat surveys, bald eagle wintering and nesting surveys, special-status bat roost surveys, wildlife mortality documentation, and deer migration and important area identification are provided below.

7.1.1. General Wildlife Surveys

- Identify and map known occurrences of special-status wildlife species within 0.25 mile of the FERC Project boundary and Project-affected reaches based on agency consultation and a review of existing information. Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).

- Identify special-status wildlife species potentially occurring within CWHR designations based on *A Guide to Wildlife Habitats of California* (Meyer and Laudenslayer 1988). Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).

    - CWHR wildlife habitats and sensitive natural communities will be documented as part of the Botanical Resources Study Plan.

- Conduct wildlife reconnaissance surveys in conjunction with special-status plant surveys.

    - Species will be recorded as present if they are observed, species-specific vocalizations are heard, or if diagnostic field signs are found (e.g., scat, tracks,

pellets). Special attention will be given to identify and map potential fawning habitat for mule deer.

- Wildlife taxonomy will be based on California's Wildlife, Volumes I, II, and III (Zeiner et al. 1988-1990).
- Survey methods will include both zigzag and linear transects depending on the survey area and terrain. Zigzag transects cover more ground and work well in larger habitat areas (e.g., annual grasslands and woodlands), while linear transects work well in narrow habitats (e.g., riparian).
- For each special-status species observed, a California Natural Diversity Database (CNDDB) field survey form will be completed and submitted to CDFW.
- An electronic database (Microsoft Excel spreadsheet) will be developed of special-status wildlife for distribution to resource agencies and interested relicensing participants.

- Record incidental observations of any special-status species during all field surveys completed in support of the relicensing of the Project.

7.1.2. Monarch Butterfly Habitat Surveys

- Document the location of monarch butterfly habitat (i.e., milkweed) in conjunction with special-status plant surveys (Botanical Resources Study Plan).
    - Digital photographs, global positioning system (GPS) information, an estimate of the number of individuals present, and a description of associated habitats will be collected for each milkweed population observed.
- Develop a geographic information system (GIS) map and table identifying the location of milkweed and overlay information on Project facilities.

7.1.3. Bald Eagle Wintering and Nesting Surveys

- Identify and map known occurrences of bald eagles, roosts, and nests within the study area, based on agency consultation and a review of existing information. Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).

- Conduct protocol-level bald eagle wintering and nesting surveys according to the Protocol for Evaluating Bald Eagle Habitat and Populations in California (Jackman and Jenkins 2004). A summary of the survey requirements is provided below.

7.1.3.1. Bald Eagle Wintering Surveys

Wintering surveys will consist of two types of surveys—wintering bird surveys and winter roost surveys.

- Wintering Bird Surveys

  Single-day surveys will be conducted monthly from December through February (three surveys, at least 2 weeks apart). Unless weather prohibits safe surveys, the January survey will be conducted during the USFWS 2-week nationwide bald eagle winter survey to allow comparisons with statewide population trends. Surveys will be completed by helicopter or boat, depending on weather conditions and accessibility. Data will be recorded on data sheets developed by Zack et al. (1997), as modified by Jackman et al. (2004).

- Winter Night Roost Surveys

  Winter night roost surveys will be conducted once a month (December through February) in areas where wintering eagles are observed. To find potential night roost areas, bald eagles will be visually observed as they move from foraging habitat to potential night roosts in the late afternoon. The number of eagles entering the probable night roost will be recorded.

  Probable night roost areas will be revisited the following morning for at least 2 hours beginning one-half hour before sunrise. Eagles observed returning to foraging habitat will be counted. Once a forest stand is identified as a probable night roost, a daytime survey will be conducted to look for evidence of use by bald eagles (feathers, castings) and to GPS or pinpoint the location used for roosting.

7.1.3.2. Bald Eagle Nesting Surveys

The objective of bald eagle nesting surveys is to monitor the breeding status of existing nests and to locate any new nests. The results of each survey will be reported on the CDFW Bald Eagle Nesting Territory Survey Form.

- Determine New Nests and Occupancy of Existing Nests

  Conduct a survey in late February through March (as early in the season as possible, but contingent upon weather conditions) to determine whether the survey area (suitable breeding habitat) is occupied by bald eagles and, if so, to determine their breeding status. The survey shall include observations of any old nests, as well as identification of any new nests in the area. Presence or apparent absence of adult bald eagles, courtship behavior, and nest construction will be recorded.

- Determine Presence of Eggs/Nestlings

  Conduct a survey during the mid-nesting season, late April through May, to determine the presence of eggs/nestlings in known nests. All nesting sites documented in the initial survey will be evaluated to determine the presence of adults and number of eggs and/or nestlings.

- Determine Nest Success

  Conduct a survey during the late nesting season, early June through early July, to determine nest success.

  - Develop a GIS map of bald eagle wintering and nesting sites in relation to Project reservoirs and Project-affected reaches.
  - Prepare and submit California Native Species Field Survey Forms for all bald eagles recorded to the CNDDB.

7.1.4. Special-status Bat Roost Surveys

Special-status bat surveys consist of a facility assessment, visual roost survey, and guano DNA sampling. This approach includes methods that allow confirmation of individual bat species present in a facility. Other methods such as acoustic sampling or mist netting are not included. Acoustic sampling was not included because it would only identify the species present in the vicinity of the facility, without confirming the species roosting in the facility. Mist netting has not been included because this method has a higher risk of transmitting white nose syndrome fungus.

7.1.4.1. Facility Assessment

- Conduct an initial desktop assessment of Project facilities to determine each facility's potential to support bat roosts. Information to be reviewed includes:
  - Existing photographs of Project facilities, and
  - Descriptions of Project facilities from the PAD (EBMUD 2025).
- Conduct a preliminary visual assessment of Project facilities, during wildlife reconnaissance surveys, to determine the potential to support bat roosts.
- Develop a list of Project facilities potentially supporting bat roosts (by facility type).
- Prepare and submit to agencies a preliminary visual assessment summary that includes the following:
  - Survey methods
  - List of Project facilities evaluated
    - Description of facility features that represent potential roosting habitat
    - Description of facility features that do not represent potential roosting habitat
  - Photographs
  - Description of the surrounding environmental conditions

7.1.4.2. Conduct Roost Survey

- Visual Roost Survey
    - Conduct a visual roost survey at Project facilities identified as potentially supporting roosting bats. The assessment will be conducted (June through July) during the end of the maternal roosting period when colonies may still be present, but after the critical sensitive period (i.e., parturition and early nursing period).
    - Facilities will be closely inspected for bat roost sign (e.g., skeletons, dead young, placentas, guano deposits, urine staining, and culled insect parts) and/or live bats. If live bats are not observed, but bat roost sign is present, spotlights and high-powered flashlights will be used in combination with binoculars for more detailed examination of the potential roost sites.
    - To prevent the introduction of *Pseudogymnoascus destructans*, a fungal pathogen causing the emerging white-nose syndrome responsible for widespread mortality in North American bats, methods described in the most recent National White-nose Syndrome Decontamination Protocol (White-nose Syndrome Response Team 2024) will be implemented to decontaminate clothing and equipment prior to entering potential roosts.
    - If bat roosts are present but the species cannot be determined visually, then species will be determined using guano DNA sampling (if suitable fresh guano is available). Specific methods for guano DNA sampling is provided below.
    - A map and table will be developed documenting the location of bat roosts and species present, if applicable.
- Guano DNA Sampling
    - DNA samples will be collected at roost sites where fresh guano is available and where bat species cannot be determined visually during the roost survey.
    - The samples will be stored in a stabilizing solution to prevent DNA degradation and submitted to the Genidaqs SM Molecular Biology and Genetics Lab (Cramer Fish Sciences) for DNA sequencing and species identification.
    - DNA sequences will be compared to species-specific genetic markers developed by Walker et al. (2016) and further verified by comparison to samples at the National Center for Biotechnology Information DNA sequence database.

- A map and table will be developed identifying the location of guano DNA sampling and species present, if applicable.

7.1.5. Wildlife Mortality

- Review and summarize existing wildlife mortality reports. This will include, but is not limited to, the annual summary report developed under the SHA.
- Document wildlife mortality observed during implementation of studies conducted to support relicensing of the Project.
- Develop a map and table documenting wildlife mortality in relation to Project facilities.

7.1.6. Deer Migration and Important Areas

- Review California State Geoportal datasets and other available literature to identify mule deer migration corridors and other important areas.
- Develop map of migration routes and important areas (e.g., winter and summer ranges, migration stopover locations) based on literature review and consultation with CDFW.
- Overlay information on Project facilities.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Wildlife Resources Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026 is outlined below in Table 8-1.

Table 8-1. Potential Wildlife Resources Study schedule.

Date	Activity
August 2026	FERC SPD
December 2026	Initiate Bald Eagle Wintering Survey
September 2026 – February 2027	Conduct Agency Consultation and Desktop Analyses
June 2027 – August 2027	Analyze Data and Prepare Draft TSR (includes preliminary data)
August 2027	File Initial Study Report (ISR)
August 2027 – February 2028	Analyze Data and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

CDFW (California Department of Fish and Wildlife). 2000. Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley. May 31, 2000.

_____. 2012. Staff Report on Burrowing Owl Mitigation. March 7, 2012.

_____. 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Edited by Armand G. Gonzales and Junko Hoshi, PhD. Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA.

_____. 2022. East Bay Municipal Utility District Mokelumne Watershed Routine Maintenance Agreement; Lake and Streambed Alteration Agreement for Routine Maintenance Activities (EPIMS Notification SJN-25163-R2).

EBMUD (East Bay Municipal Utility District). 2025. Lower Mokelumne River Project Pre-Application Document. Jackman, R.E., and J.M. Jenkins. 2004. Protocol for Evaluating Bald Eagle Habitat and Populations in California.

Mayer, K.E., and W.F. Laudenslayer. 1988. A Guide to Wildlife Habitats of California. State of California, Department of Fish and Game. Sacramento, CA.

USFWS (U.S. Fish and Wildlife Service). 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, OR. xxvi + 606 pages.

_____. 2018. Draft Revised Recovery Plan for Valley Elderberry Longhorn Beetle. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, CA. iii + 18 pp.

_____. 2021. Birds of Conservation Concern 2021.USFWS Division of Migratory Bird Management. Arlington, VA.

USFWS and EBMUD. 2009. Safe Harbor Agreement for East Bay Municipal Utility District Lands in San Joaquin, Amador, and Calaveras Counties. June 2009.

Walker, F.M., C.H.D. Williamson, D.E. Sanchez, C.J. Sobek, and C.L. Chambers. 2016. Species from Feces: Order-Wide Identification of Chiroptera from Guano and Other Non-Invasive Genetic Samples. PLoS ONE 11(9): e0162342. https://doi.org/10.1371/journal.pone.0162342.

White-nose Syndrome Response Team. 2024. United States National White-nose Syndrome Decontamination Protocol. – March 2024. www.WhiteNoseSyndrome.org

Zeiner, D., W. Laudenslayer, Jr., K. Mayer, and M. White, eds. 1988-1990. California's Wildlife Volumes I, II, and III. California Department of Fish and Game, Sacramento, CA.

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BOTANICAL RESOURCES STUDY PLAN (TERR-2)

Lower Mokelumne River Hydroelectric Project
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October 2025

DRAFT BOTANICAL RESOURCES STUDY PLAN (TERR-2)

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1.0 Introduction

East Bay Municipal Utility District's (EBMUD's) Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916; Lower Mokelumne River Project or Project) operations and maintenance activities may have the potential to affect botanical resources. The purpose of this Botanical Resources Study (TERR-2) plan is to identify and map the location of sensitive natural communities, special-status plant species, and non-native invasive plants (NNIPs) in the study area.

2.0 Project Nexus and Study Rationale

Sensitive natural communities, special-status plant species, and NNIPs are known or could potentially be present in the FERC Project boundary. Implementation of Project operations and maintenance activities may result in loss of sensitive natural communities, loss of special-status plant species, or the spread or introduction of NNIPs. The Project nexus and study rationale are as follows:

- Project operations and maintenance may result in direct loss or degradation of California Wildlife Habitat Relationship (CWHR) habitats and sensitive natural communities, including communities afforded special recognition by state and federal agencies.
- Project maintenance activities may result in removal or disturbance of special-status plants, lichens, and moss populations.
- Project maintenance activities may result in introduction or spread of NNIPs.

3.0 Study Goals and Objectives

The study goals are as follows:

- Document CWHR habitats and sensitive natural communities adjacent to Project facilities.
- Document special-status plant, lichen, and moss populations at Project facilities.
- Document NNIPs adjacent to Project facilities.

4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity.

Relevant management plans include the following:

- California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians (California Department of Fish and Wildlife [CDFW] 2015).
- Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (U.S. Fish and Wildlife Service [USFWS] 2005).

Botanical resources are a subject of public interest at the local, state, and national level. Public interest statements obtained from relicensing participants are listed below:

- Interest Statement: Loss or degradation of habitats or sensitive natural communities.
- Interest Statement: Removal or disturbance of special-status plant, lichen, and moss populations.
- Interest Statement: Potential spread or introduction of NNIPs.

5.0 Geographic Scope

The geographic scope, for each study component, is described in Sections 5.1 and 5.2 below.

5.1. CWHR Habitats and Sensitive Natural Communities

For CWHR habitats and sensitive natural communities, the study area is the FERC Project boundary and 1 mile outside.

5.2. Special-Status Plants and Non-Native Invasive Plants

For the purposes of the special-status plants and NNIP studies, the study area includes lands within the FERC Project boundary where operations and/or maintenance activities are conducted, plus a protective buffer. Refer to Table 5-1 for the survey area by facility type.

Table 5-1. Special-status plant and NNIP survey area.

Project Facility Type	Survey Area
Dams, Dikes, and Spillways	
Pardee Dam	100 feet
Pardee South Spillway	100 feet
Jackson Creek Dike and Spillway	100 feet
West End Dike	100 feet
Camanche Dam	100 feet
Camanche Spillway	100 feet
Dikes 1 – 6	100 feet
Penstocks	
Pardee Penstock	15 feet on either side
Camanche Penstock	15 feet on either side
Powerhouses and Switchyards	
Pardee Powerhouse and Switchyard	15 feet around the perimeter fence
Camanche Powerhouse and Switchyard	15 feet around the perimeter fence
Ancillary and Support Facilities	
	15 feet around the perimeter
Stream Gages	
	10 feet around gages
Project Access Roads	
	20 feet on either side

Project Facility Type	Survey Area
Recreation	
Trails	15 feet on either side
Pardee Recreation Area	150 feet around recreation facilities
Camanche North Shore Recreation Area	150 feet around recreation facilities
Camanche South Shore Recreation Area	150 feet around recreation facilities
Camanche Hills Hunting Preserve	150 feet around recreation facilities
Mokelumne River Fish Hatchery	150 feet around hatchery and associated facilities
Mokelumne Day Use Area	150 feet around recreation facilities

6.0 Existing Information and Need for Additional Information

Data on botanical resources in the Project area are available and included in EBMUD's Lower Mokelumne River Project Pre-application Document (PAD) (EBMUD 2025). Based on review of available information, the following potential information gaps were identified:

- Updated information on CWHR habitats and sensitive natural communities,
- Updated information on special-status plant, lichen, and moss populations, and
- Updated information on NNIPs.

7.0 Study Methodology

7.1. CWHR Habitats and Sensitive Natural Communities

- Develop habitat maps of the study area based on Classification and Assessment with CWHR habitat descriptions (Mayer and Laudenslayer 1988; CDFW 2021).
    - Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).
- Verify the accuracy of CWHR data and update habitats using recent aerial photographs.
- Conduct ground-truthing of habitats within 0.25-mile of Project facilities, concentrating in areas where concerns about habitat identification or boundaries arise from review of aerial photographs. Inaccessible areas will not be ground-truthed.
    - Within the large CWHR habitats, sensitive natural communities (i.e., ranks S1 – S3) by CDFW (2025) will also be identified and mapped using the Manual of California Vegetation classification system (Sawyer et al. 2009) as part of the ground-truthing survey.
    - Wetland, riparian, and littoral habitats will be mapped as part of the Wetland, Riparian and Littoral Habitats Study Plan (EBMUD 2025).
- Develop a geographic information system (GIS) map of habitats and sensitive natural communities and overlay information on Project facilities.

7.2. Special-Status Plants

For the purposes of this study plan, a special-status plant is defined as any plant or moss species that is granted protection by a federal or state agency. Federally listed plant species granted status by the USFWS under the federal Endangered Species Act (ESA) include threatened (FT), endangered (FE), proposed threatened or endangered (FPT, FPE), candidate (FC), or listed species proposed for delisting (FPD).

State of California listed plant species, which are granted status by the CDFW under the California Endangered Species Act (CESA) include state threatened (ST), state endangered (SE), and state rare (SR).

Under the California Environmental Quality Act (CEQA), special-status plants are also defined to include those species identified in the California Native Plant Society (CNPS)

California Rare Plant Rank (CRPR) system as rare, threatened, or endangered plants in California. This includes the following CRPR:

- 1A (presumed extirpated in California and either rare or extinct elsewhere);
- 1B (rare, threatened, or endangered in California and elsewhere);
- 2A (presumed extirpated in California, but common elsewhere); and
- 2B (rare, threatened, or endangered in California, but common elsewhere).

The study approach for special-status plants is provided below.

- Identify and map known occurrences of special-status plants within the study area, based on agency consultation and a review of existing information. Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).
- Develop a list of special-status plant species potentially occurring in the Project area based on literature review and agency consultation. A preliminary list is provided in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).
- Conduct focused special-status plant surveys, according to the Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities (CDFW 2018).
    - Field surveys will be conducted at the proper time of year when rare, threatened, or endangered species are both evident and identifiable. Generally, this is when the plants are flowering. Based on the blooming periods for plants known or potentially occurring within the Project vicinity, three surveys would be conducted (March, May, and July) (Table 7-1, TERR).
    - Timing of surveys will be verified based on reference population monitoring. Agencies will be notified of survey population monitoring results and proposed survey dates prior to implementation of surveys.
    - Systematic field techniques will be implemented (e.g., zigzag patterns, random meandering, and linear transects) in the study area.
    - Areas that cannot be safely accessed will be surveyed using binoculars, to the degree possible.
    - If a special-status plant species population is identified on the perimeter of the study area, the study area will be expanded to document the full extent of the population.

Table 7-1. Special status plant blooming periods.

Species	Federal Status	State Status	California Rare Plant Rank (CRPR)	Bloom Period											
				Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Ione Manzanita (Arctostaphylos myrtifolia)	FT	—	1B.2	■	■	■								■	■
Fleshy Owl's Clover (Castilleja campestris var. succulenta)	FT	CE	1B.2			■	■	■							
Ione Buckwheat (Eriogonum apricum var. apricum)	FE	CE	1B.1							■	■	■	■		
Irish Hill Buckwheat (Eriogonum apricum var. prostratum)	FE	CE	1B.1						■	■					
Boggs Lake hedge-hyssop (Gratiola heterosepala)	—	CE	1B.2				■	■	■	■	■				
Sacramento Orcutt grass (Orcuttia viscida)	FE	CE	1B.1				■	■	■	■					
Henderson's bent grass (Agrostis hendersonii)	—	—	3.2				■	■	■						
Hoover's calycadenia (Calycadenia hooveri)	—	—	1B.3							■	■	■			
Tuolumne button-celery (Eryngium pinnatisectum)	—	—	1B.2					■	■	■	■				
Big-scale balsamroot (Balsamorhiza macrolepis)	—	—	1B.2			■	■	■	■						
Spicate calycadenia (Calycadenia spicata)	—	—	1B.3					■	■	■	■	■			
Bisbee Peak rush-rose (Crocanthemum suffrutescens)	—	—	3.2				■	■	■	■	■				

Species	Federal Status	State Status	California Rare Plant Rank (CRPR)	Bloom Period											
				Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Mariposa cryptantha (Cryptantha mariposae)	–	–	1B.3				■	■	■	■					
Dwarf downingia (Downingia pusilla)	–	–	2B.2			■	■	■							
Stanislaus monkeyflower (Erythranthe marmorata)	–	–	1B.1			■	■	■							
Parry's horkelia (Horkelia parryi)	–	–	1B.2				■	■	■	■	■	■			
Ahart's dwarf rush (Juncus leiospermus var. ahartii)	–	–	1B.2			■	■	■							
Legenere (Legenere limosa)	–	–	1B.2			■	■	■							
Pincushion navarretia (Navarretia myersii var. myersii)	–	–	1B.1				■	■							
Patterson's navarretia (Navarretia paradoxiclara)	–	–	1B.3					■	■	■					
Sanford's arrowhead (Sagittaria sanfordii)	–	–	1B.2					■	■	■	■	■	■		

Proposed survey period based on the blooming periods for plants known or potentially occurring within the Project vicinity. The timing of surveys will be verified based on reference populations monitoring completed in coordination with resource agencies.

Legend:

Federal Status
FE = Federally **Endangered**
FT = Federally Threatened

State Status
CE = California Endangered

CNPS Rare Plant Rank (CNPS RPR)
1B = Rare, threatened or endangered in California and elsewhere.
2B = Rare in California but more common elsewhere.
4 = Plants of limited distribution – a watchlist
_.1 = Seriously threatened in California (over 80 percent of occurrences threatened/high degree and immediacy of threat)
_.2 = Moderately threatened in California (20 to 80 percent occurrences threatened)
_.3 = Not very threatened in California (<20 percent of occurrences threatened or no current threats known)
CBR = Considered but rejected

  - Botanists will also document the location and extent of any population of milkweed (*Asclepias* spp.) (the host plant for the monarch butterfly [*Danaus plexippus*]). Refer to the Wildlife Resources Study Plan (EBMUD 2025) for specific data to be collected.
  - Surveys will be floristic in nature, and taxonomy will be based on The Jepson Manual (Baldwin et al. 2012). A comprehensive list of species observed during field surveys will be compiled.
  - Digital photographs, global positioning system (GPS) information, an estimate of the number of individuals present, and a description of associated habitat will be collected for each special-status plant population observed.
  - Moss specimens will be collected and labeled with the date and collection location. Moss specimens will later be identified to species by a qualified bryologist.
- Develop a GIS map of special-status plant populations and overlay information on Project facilities.
- Prepare and submit California Native Species Field Survey Forms for all special-status plant populations recorded to the California Natural Diversity Database (CNDDB).

7.3. Non-Native Invasive Plants

The California Invasive Council (Cal-IPC) defines NNIPs as plants that 1) are not native to, yet can spread into wildland ecosystems, and that also 2) displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes (Cal-IPC 2025).

The study approach for NNIPs is provided below.

- Identify and map known occurrences of NNIPs based on agency consultation and a review of existing information. Preliminary information is presented in the Lower Mokelumne River Project (FERC No. 2916) PAD (EBMUD 2025).
- Develop a list of priority NNIPs for focused NNIP surveys. This list will incorporate priority NNIPs identified through consultation with agencies.
- Conduct focused NNIP surveys in conjunction with special-status plant surveys.
- Collect data and report survey results as follows:

- Data collected will include species, location, and number of acres infested by NNIPs.
- If an NNIP population is identified on the perimeter of the study area, the study area will be expanded to document the extent of the population.
- Levels of infestation will be reported as: low (<5 percent cover); moderate (6–25 percent cover), and high (>25 percent cover). Areas that have been surveyed and found to be weed-free will also be identified.

- Develop a GIS map of noxious weeds and invasive non-native plants and overlay information on Project facilities.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Botanical Resources Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential Botanical Resources Study schedule.

Date	Activity
August 2026	FERC SPD
February 2027 – March 2027	Conduct Agency Consultation and Reference Populations Visits
June 2027 – August 2027	Analyze Data and Prepare Draft TSR (includes preliminary data)
August 2027	File Initial Study Report (ISR)
August 2027 – January 2028	Analyze Data and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

Baldwin, B.G., D. Goldman, D.J. Keil, R. Patterson, and T.J. Rosatti (Editors). 2012. The Jepson Manual, Vascular Plants of California. Second Edition.

(Cal-IPC) California Invasive Plant Council. 2025. California Invasive Plant Inventory. California Invasive Plant Council: Berkeley, CA. Available at: www.cal-ipc.org

(CDFW) California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Edited by Armand G. Gonzales and Junko Hoshi, PhD. Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA.

_____. 2018. Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities. State of California, California Natural Resources Agency, Department of Fish and Wildlife. March 20, 2018.

_____. 2021. Biogeographic Data Branch, California Wildlife Habitat Relationship System, Version 10.1.29. Sacramento, CA. Available at: https://wildlife.ca.gov/Data/CWHR

_____. 2025. California Natural Community List. February 27, 2025. Available at: https://wildlife.ca.gov/Data/VegCAMP/Natural-Communities#sensitive

(EBMUD) East Bay Municipal Utility District. 2025. Lower Mokelumne River Project Pre-Application Document.

Mayer, K.E., and W.F. Laudenslayer. 1988. A Guide to Wildlife Habitats of California. State of California, Department of Fish and Game. Sacramento, CA.

Sawyer et al. 2009. Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society, Sacramento.

USFWS (U.S. Fish and Wildlife Service). 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, OR. xxvi + 606 pages.

DRAFT
WETLAND, RIPARIAN, AND LITTORAL HABITATS STUDY PLAN (TERR-3)

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT
WETLAND, RIPARIAN, AND LITTORAL HABITATS STUDY PLAN (TERR-3)

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

Lower Mokelumne River Hydroelectric Project
FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

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1.0 Introduction

East Bay Municipal Utility District's (EBMUD) Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) operations and maintenance activities may have the potential to result in direct loss or degradation of Waters of the United States/State (e.g., riverine, freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, vernal pool) and riparian habitats. The purpose of this Wetland, Riparian, and Littoral Habitats Study (TERR-3) plan is to document the location of Waters of the U.S./State and riparian habitats in the study area.

2.0 Project Nexus and Study Rationale

Project operation and maintenance activities could result in direct loss or degradation of jurisdictional Waters of the U.S./State or riparian habitats.

3.0 Study Goals and Objectives

The goals and objectives of the TERR-3 study are as follows:

- Document Waters of the U.S./State and riparian habitats adjacent to Project facilities and reaches affected by the Project.
- Determine the relationship between riparian habitats and flow conditions in Project-affected reaches.

4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current management goals and objectives in the Project vicinity. Relevant management plans include the following:

- California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians (California Department of Fish and Wildlife [CDFW] 2015).

Wetland, riparian, and littoral resources are a subject of public interest at the local, state, and national level. Public interest statements obtained from relicensing participants are listed below:

- Lower Mokelumne River Project (FERC Project No. 2916) Joint Settlement Agreement (U.S. Fish and Wildlife [USFWS], CDFW, and EBMUD 1998).
- Interest Statement: Direct loss or degradation of Waters of the U.S./State and riparian habitats.

5.0 Geographic Scope

The geographic scope of the TERR-3 study is described in Table 5-1 below.

- For documentation of Waters of the U.S./State, the survey area is lands within the FERC Project boundary where operations and/or maintenance activities are conducted, plus a protective buffer. Refer to Table 5-1 for the survey area.
- For documentation of riparian habitats, the survey area is Project-affected reaches and riparian cross-section locations. The geographic scope of this study begins at the Mokelumne River inflow to Pardee Reservoir, through the outflow of Camanche Reservoir downstream to the Woodbridge Irrigation District Dam.
- For the relationship between riparian habitats and flow conditions, the study area is riparian cross-section locations on Project-affected stream reaches.

Table 5-1. Waters of the U.S./State survey area.

Project Facility Type	Survey Area
Dams, Dikes, and Spillways	
Pardee Dam	100 feet
Pardee South Spillway	100 feet
Jackson Creek Dike and Spillway	100 feet
West End Dike	100 feet
Camanche Dam	100 feet
Camanche Spillway	100 feet
Dikes 1 – 6	100 feet
Penstocks	
Pardee Penstock	15 feet on either side
Camanche Penstock	15 feet on either side
Powerhouses and Switchyards	
Pardee Powerhouse and Switchyard	15 feet around the perimeter fence
Camanche Powerhouse and Switchyard	15 feet around the perimeter fence
Ancillary and Support Facilities	
	15 feet around the perimeter
Stream Gages	
	10 feet around gages
Project Access Roads	
	20 feet on either side

Project Facility Type	Survey Area
Recreation	
Trails	15 feet on either side
Pardee Recreation Area	150 feet around recreation facilities
Camanche North Shore Recreation Area	150 feet around recreation facilities
Camanche South Shore Recreation Area	150 feet around recreation facilities
Camanche Hills Hunting Preserve	150 feet around recreation facilities
Mokelumne River Fish Hatchery	150 feet around hatchery and associated facilities
Mokelumne Day Use Area	150 feet around recreation facilities

6.0 Existing Information and Need for Additional

Data on wetland, riparian, and littoral habitats in the Project area are available and included in EBMUD's Lower Mokelumne River Project Pre-Application Document (PAD) (EBMUD 2025). Based on review of available information, the following potential information gaps were identified:

- Mapping of Waters of the U.S./State and riparian habitats adjacent to Project facilities and reaches affected by the Project, and
- The relationship between riparian habitats and flow conditions in Project-affected reaches.

7.0 Study Methodology

7.1. Preliminary Mapping Jurisdictional Waters of the U.S/State and Riparian Habitats

- Develop preliminary maps of jurisdictional Waters of the U.S./State and riparian habitat based USFWS National Wetlands Inventory (NWI) mapping.
    - Preliminary information is presented in EBMUD's PAD Section 4.06, Wetland, Riparian, and Littoral Habitats (EBMUD 2025).
    - Verify the accuracy of data and update information using recent aerial photographs.

7.2. Ground-truthing Field Verification

7.2.1. Jurisdictional Waters of the U.S/State

- Conduct ground-truthing of jurisdictional Waters of the U.S./State within the survey area, concentrating in areas where questions on classification or boundaries arise from review of aerial photographs. Inaccessible areas will not be ground truthed.
    - Global positioning system (GPS) information will be collected to document location of jurisdictional Waters of the U.S./State.
    - At each aquatic feature, dominant plant species will be recorded within tree, shrub, and herbaceous cover types.
- Develop a geographic information system (GIS) map of jurisdictional Waters of the U.S./State and overlay information on Project facilities.

7.2.2. Riparian Habitats

- Map the extent of riparian habitat along Project-affected reaches using a combination of high-resolution aerial imagery and field observations at riparian cross sections.
    - Riparian communities will be classified based on A Manual of California Vegetation (Sawyer et al. 2009).
- Develop a GIS map of riparian habitat along Project-affected reaches.

7.2.3. Characterize Relationship between Riparian Vegetation and Flow Conditions

- Characterize the relationship between the riparian and flow conditions in Project-affected reaches:
    - Establish up to 10 cross sections, as needed, at representative locations along Project-affected reaches.[1]
        - Using riparian habitats as described above in Section 7.2.2., cross-section locations will be selected according to the percent of riparian vegetation cover by each of the communities observed in the Project-affected reach (e.g., communities with higher cover along the reach would have more cross sections than communities with lower cover).
        - Characterize riparian vegetation and substrate along the length of each cross section. Obtain the following data at the cross sections:
            - GPS coordinates headpin locations,
            - Photograph (across, upstream, and downstream),
            - Woody riparian vegetation (percent cover and age class2 for dominant woody riparian trees/shrubs, by species),
            - Herbaceous riparian/wetland (percent cover of riparian/wetland herbaceous and graminoid plants, by species), and
            - Substrate composition (size class / percentage of substrate types).
    - Develop stage-discharge relationships over a range of flows (high to low).
- Develop a summary of the relationship between existing inundation characteristics (e.g., timing, frequency, depth, and width of inundation) and the distribution of dominant riparian species within Project-affected reaches.
- Compare and contrast existing Project hydrology to without Project hydrology in relation to riparian recruitment and maintenance in Project-affected reaches.

[1] The Mokelumne River below Camanche Dam extends beyond EBMUD-owned property and overlaps with private land. Therefore, selection of cross sections will be dependent on access permissions.

[2] Age class structure will be determined based on categories of shrub stem densities per individual and tree diameters, as follows: Young (Y): shrubs with less than 10 stems per individual or trees with diameters (diameter at breast height [DBH]) less than 3 inches; Medium-aged (M): shrubs with between 10 and 60 stems per individual or trees with DBHs between 3 and 9 inches; and Old/Mature (O): shrubs with more than 60 stems per individual or trees with DBHs greater than 9 inches.

8.0 Schedule and Deliverables

This is proposed as a single-year study and includes a draft and final Wetland, Riparian, and Littoral Habitats Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential Wetland, Riparian, and Littoral Habitats Study schedule.

Date	Activity
August 2026	FERC SPD
June 2027 – August 2027	Analyze Date and Prepare Draft TSR (includes preliminary data)
August 2027	File Initial Study Report (ISR)
August 2027 –March 2028	Analyze Data and Prepare Updated Draft TSR
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application (FLA)

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

(CDFW) California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Edited by Armand G. Gonzales and Junko Hoshi, PhD. Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA.

(EBMUD) East Bay Municipal Utility District. 2025. Lower Mokelumne River Project Pre-Application Document.

Sawyer et al. 2009. Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society, Sacramento.

(USFWS) U.S. Fish and Wildlife Service, CDFW, and EBMUD. 1998. Lower Mokelumne River Project (FERC Project No. 2916-004), Joint Settlement Agreement. March 23, 1998.

DRAFT ENVIRONMENTAL JUSTICE STUDY PLAN (EJ-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT ENVIRONMENTAL JUSTICE STUDY PLAN (EJ-1)

Lower Mokelumne River Hydroelectric Project

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1.0 Introduction

The Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) operations have the potential to affect environmental justice (EJ) communities if they exist within or adjacent to the Project boundary. This EJ Study (EJ-1) would identify whether EJ communities are present within the geographic scope of analysis and, if found, evaluate the effects of relicensing and continued operation of the East Bay Municipal Utility District (EBMUD) Lower Mokelumne River Project. The purpose of this EJ-1 study plan is to provide EJ communities with opportunities for meaningful involvement in the relicensing process.

2.0 Project Nexus and Study Rationale

This EJ-1 study will assist California State Water Resources Control Board staff with the EJ component of its California Environmental Quality Act (CEQA) review related to relicensing the Project.

3.0 Study Goals and Objectives

The goals and objectives of the EJ-1 study are as follows:

- Identify the presence of EJ communities that may be located within the study area.
- Develop strategies to conduct outreach to identified EJ communities to ensure meaningful involvement in the relicensing process is achieved.
- Evaluate whether the Project will have disproportionately high and adverse effects on identified EJ communities within the study area.

4.0 Relevant Resource Management Goals

EJ is one of the goals and considerations of EBMUD. EJ is a subject of public interest at the local and state level. The public interest consideration is reflected in a number of local and state plans and guidance documents, including the following:

- EBMUD's (2022) Diversity, Equity, and Inclusion Strategic Plan.

5.0 Geographic Scope

The geographic scope of the EJ-1 Study would be all census block groups within, and that intersect with, a 1-mile radius around the Project boundary.

6.0 Existing Information and Need for Additional Information

6.1. Existing Information

Identification of EJ communities will be conducted for the Pre-Application Document (PAD).

6.2. Need for Additional Information

EJ communities within the study area will be identified in the PAD. Outreach efforts may be needed to ensure meaningful involvement, and further analysis is needed to determine effects.

7.0 Study Methodology

- Data Gathering and Statistics Tables
  - U.S. Census data
- Identification of EJ Communities Based on Minority Populations
- Identification of EJ Communities Based on Low-Income Populations
- Identification of Non-English-Speaking Populations
- Mapping Efforts
  - ArcGIS
- Outreach Efforts
  - Develop an outreach strategy.
    - Identify willing community organizations.
    - Identify opportunities to involve EJ communities.
    - Develop printed and/or digital materials to distribute (include multilingual materials if non-English-speaking communities are identified).
  - Conduct outreach.
    - Distribute outreach materials in the most effective ways to reach EJ communities.
- EBMUD Project Effects on EJ Communities

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final EJ Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential EJ Study schedule.

Date	Activity
August 2026	FERC SPD
September 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

(EBMUD) East Bay Municipal Utility District. 2022. Diversity, Equity, and Inclusion Strategic Plan https://splashpad.ebmud.com/application/files/2916/4633/5086/Diversity_Equity_and_Inclusion_Strategic_Plan.pdf

DRAFT RECREATION FACILITIES INVENTORY AND CONDITION ASSESSMENT STUDY PLAN (REC-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT RECREATION FACILITIES INVENTORY AND CONDITION ASSESSMENT STUDY PLAN (REC-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

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1.0 Introduction

The Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) operations may have the potential to affect Project recreation sites and facilities within the Project boundary. Data collected through this Recreation Facilities Inventory and Condition Assessment Study (REC-1) will be used to assess the effects of continued Project operations on Project recreation sites and facilities and will inform development of protection, mitigation, and enhancement measures in the Draft License Application (DLA), if needed.

2.0 Project Nexus and Study Rationale

Section 10(a) of the Federal Power Act requires FERC to ensure that the Project, as licensed, will be best adapted to a comprehensive plan for improving or developing the Lower Mokelumne River for the use or benefit of multiple public benefits, including recreation. This REC-1 study will help inform FERC's licensing decisions relative to public recreation within the Project boundary.

3.0 Study Goals and Objectives

The goals and objectives of the REC-1 study are as follows:

- **Goal:** Inventory FERC-approved recreation sites within the Project boundary.
  - **Objective:** Field verify, map, and document recreation facilities and amenities within the Project boundary.
  - **Objective:** Document the general condition of recreation facilities and amenities and describe their maintenance, inspection, and/or management practices.

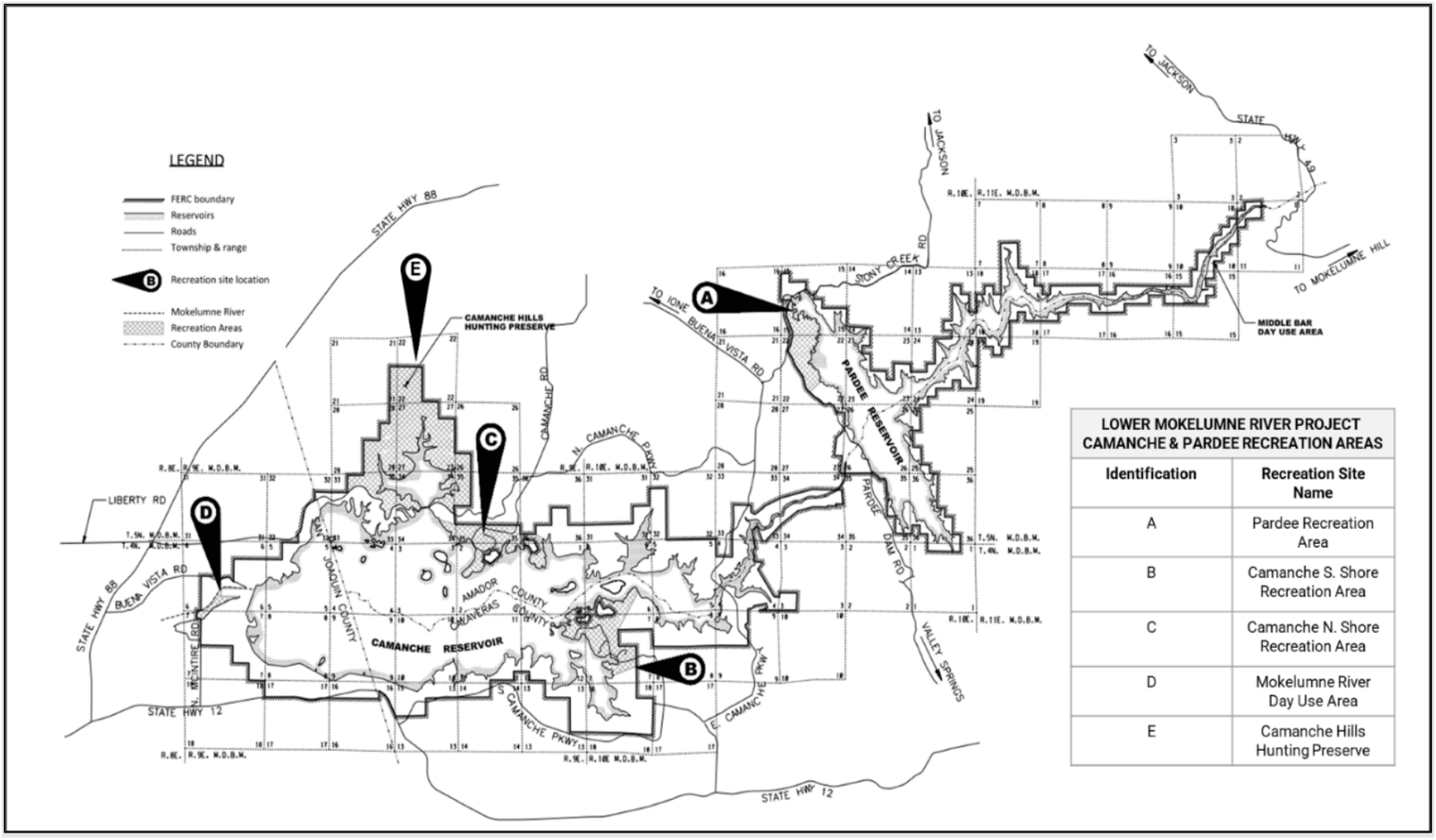
4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current recreation management goals and objectives in the Lower Mokelumne River Project vicinity. Relevant management plans include the following (FERC 2023):

- California Department of Parks and Recreation. 2021. California's 2021-2025 Statewide Comprehensive Outdoor Recreation Plan (SCORP).
- California Department of Parks and Recreation. 2021. Designing Parks Using Community-Based Planning.
- California Department of Parks and Recreation. 2021. California's Vision for Park Equity.
- Amador County. 2016. Amador County General Plan.
- Calaveras County. 2019. Calaveras County General Plan.
- Calaveras County. 2025. Parks and Recreation Master Plan.
- San Joaquin County. 2016. San Joaquin County General Plan.
- East Bay Municipal Utility District (EBMUD). 2008. Mokelumne Watershed Master Plan.

5.0 Geographic Scope

The geographic scope of the REC-1 study includes FERC-approved recreation sites within the Project boundary, as show on Figure 5-1. Sites include Pardee Recreation Area, Camanche South and North Shore Recreation Area, Mokelumne River Day Use Area, and Camanche Hills Hunting Preserve.



LOWER MOKELUMNE RIVER PROJECT CAMANCHE & PARDEE RECREATION AREAS	
Identification	**Recreation Site Name**
A	Pardee Recreation Area
B	Camanche S. Shore Recreation Area
C	Camanche N. Shore Recreation Area
D	Mokelumne River Day Use Area
E	Camanche Hills Hunting Preserve

Figure 5-1. Lower Mokelumne River Project FERC-approved recreation sites.

6.0 Existing Information and Need for Additional Information

6.1. Existing Information

The following provide currently available information on Project recreation facilities and their condition:

- EBMUD Recreation Management Plan
- State and Federal Database Reviews
- Recreation Inventory Maps
- EBMUD Data and Publications

6.2. Need for Additional Information

An updated inventory of recreation facilities and amenities (e.g., picnic tables, trash receptables, firepits) is needed to inform relicensing.

7.0 Study Methodology

Field surveys will be conducted at FERC-approved recreation sites within the Project boundary. Information collected during field surveys will be documented on a Recreation Site Inventory Form. Information to be collected will include the following:

- Global positioning system (GPS) location of the facilities;
- Type, number, and condition of amenities provided at each site;
- An estimate of parking capacity;
- Ownership and management;
- Hours/seasons of operation;
- Existing safety, security, and informational (signage) measures;
- Observation of site use and accessibility;
- Suitability of facilities to provide opportunities for people with disabilities to participate in recreation opportunities; and
- Accompanying photographs.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Recreation Facilities Inventory and Condition Assessment Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the DLA. A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential Recreation Facilities Inventory and Condition Assessment Study schedule.

Date	Activity
August 2026	FERC SPD
September 2026 – July 2027	Conduct Study
September 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

(FERC) Federal Energy Regulatory Commission. 2023. Comprehensive Plans. Available online: https://www.ferc.gov/media/comprehensive-plans.

DRAFT RECREATION USE AND NEEDS STUDY PLAN (REC-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT RECREATION USE AND NEEDS STUDY PLAN (REC-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

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1.0 Introduction

The Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) operations may have the potential to affect recreation use and needs. This Recreation Use and Needs Study (REC-2) would evaluate the necessity for potential modifications to the existing Project recreation sites based on use and needs identified.

2.0 Project Nexus and Study Rationale

Section 10(a) of the Federal Power Act requires FERC to ensure that the Project, as licensed, will be best adapted to a comprehensive plan for improving or developing the Lower Mokelumne River for the use or benefit of multiple public benefits, including recreation. This REC-2 study will help inform FERC's licensing decisions relative to public recreation within the Project boundary.

3.0 Study Goals and Objectives

The goals and objectives of the study are as follows:

- **Goal 1:** Characterize the existing use of FERC-approved recreation sites in the Project boundary.
    - **Objective:** Estimate the recreation use at each FERC-approved recreation site by day type (i.e., weekday, weekend, peak weekend).
    - Objective: Evaluate visitor feedback regarding perception and experience at each FERC-approved recreation site.
    - Objective: Estimate the current recreational fishing effort in Pardee and Camanche reservoirs.
- **Goal 2:** Identify current and future needs related to FERC-approved recreation sites in the Project boundary.
    - **Objective**: Evaluate whether recreation capacity and existing facilities and amenities at FERC-approved recreation sites meet current needs.
    - **Objective:** Estimate future recreation use of FERC-approved recreation sites.
    - **Objective:** Estimate future needs for potential new recreation sites and facilities.

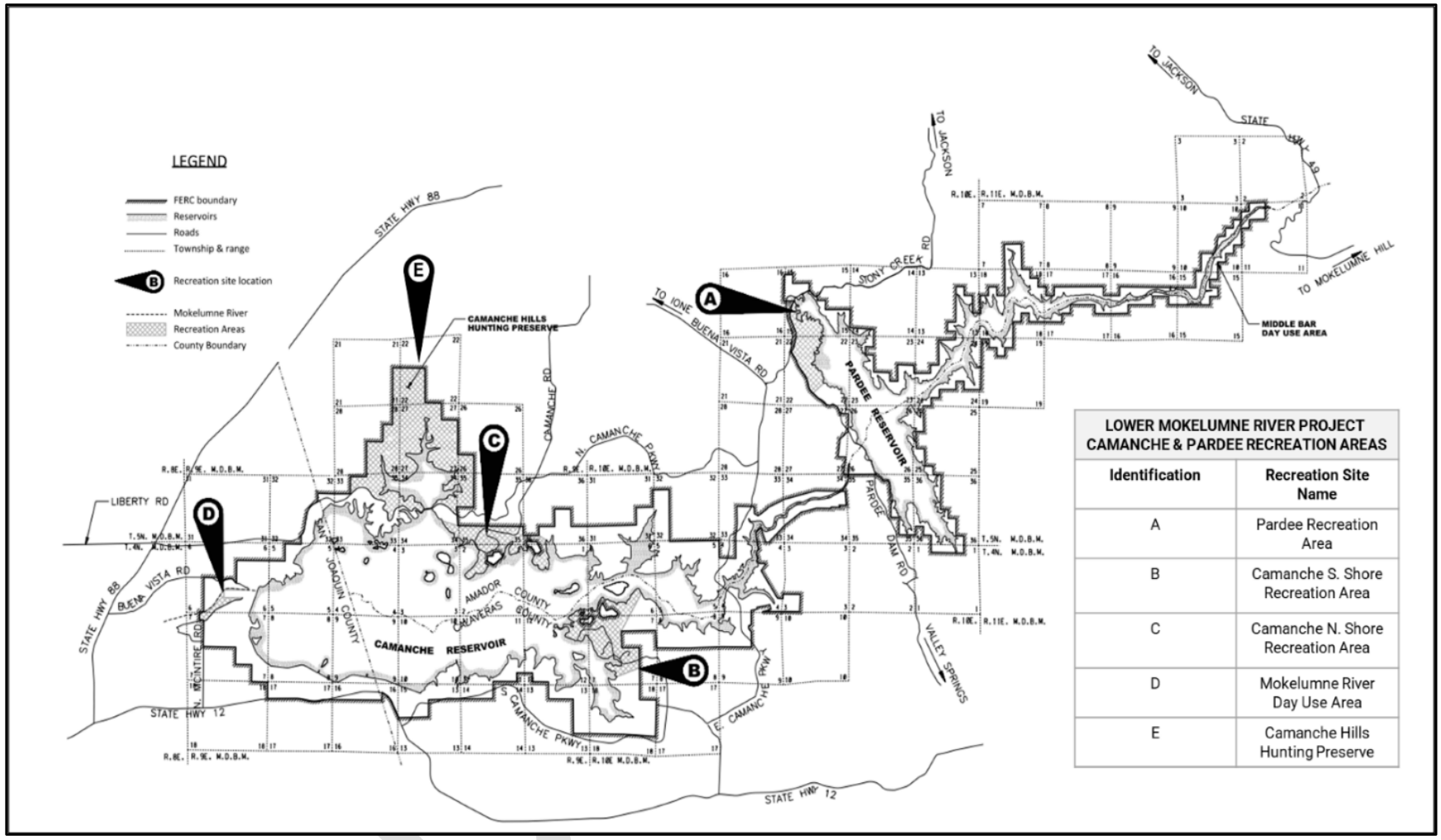
4.0 Relevant Resource Management Goals

Existing management plans will be reviewed and used to develop a baseline understanding of the current recreation management goals and objectives in the Lower Mokelumne River Project vicinity. Relevant management plans include the following:

- California Department of Parks and Recreation. 2021. California's 2021-2025 Statewide Comprehensive Outdoor Recreation Plan (SCORP).
- California Department of Parks and Recreation. 2021. Designing Parks Using Community-Based Planning.
- California Department of Parks and Recreation. 2021. California's Vision for Park Equity.
- Amador County. 2016. Amador County General Plan.
- Calaveras County. 2019. Calaveras County General Plan.
- Calaveras County. 2025. Parks and Recreation Master Plan.
- San Joaquin County. 2016. San Joaquin County General Plan.
- East Bay Municipal Utility District (EBMUD). 2008. Mokelumne Watershed Master Plan.
- California Department of Fish and Wildlife Stocking and Historical Creel Survey Data.
- Strategic Plan for Trout Management (California Department of Fish and Game 2003).
- Fisheries Techniques*, Third Edition* (Zale et al., 2013).

5.0 Geographic Scope

The geographic scope of this study includes FERC-approved recreation sites located within the Project boundary, as shown on Figure 5-1. Sites include Pardee Recreation Area, Camanche South and North Shore Recreation Area, Mokelumne River Day Use Area, and Camanche Hills Hunting Preserve.



LOWER MOKELUMNE RIVER PROJECT CAMANCHE & PARDEE RECREATION AREAS	
Identification	**Recreation Site Name**
A	Pardee Recreation Area
B	Camanche S. Shore Recreation Area
C	Camanche N. Shore Recreation Area
D	Mokelumne River Day Use Area
E	Camanche Hills Hunting Preserve

Figure 5-1. Lower Mokelumne River Project FERC-approved recreation sites.

6.0 Existing Information and Need for Additional Information

6.1. Existing Information

The following provide currently available information on Project recreation site use and needs:

- EBMUD Recreation Management Plan
- State and Federal Database Reviews
- Recreation Inventory Maps
- Visitor Attendance
- Fish Stocking Data
- Recreation Card and QR Code User Experience Surveys
- EBMUD Data and Publications
- FERC Form 80

6.2. Need for Additional Information

Additional information regarding the use and visitation of FERC-approved recreation sites, to be collected during the Recreation Use and Needs Study, is needed to inform relicensing.

7.0 Study Methodology

A variety of data collection techniques will be used to obtain the information necessary to meet the study goals and objectives listed in Section 3.0. Data collection will include:

- spot counts,
- recreation use visitor intercept surveys, and
- creel surveys.

Creel surveys will be conducted according to the standard protocols published in *Fisheries Techniques, Third Edition* (Zale et al. 2013).

Existing data will be reviewed to inform current recreation use as well as projected future recreation needs at FERC-approved recreation sites. Existing data will include United States Census Bureau data, SCORP, EBMUD existing recreation data, and other relevant, available data and literature.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Recreation Use and Needs Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential Recreation Use and Needs Study schedule.

Date	Activity
August 2026	FERC SPD
September 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final TSR)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study plan were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating feedback from interested parties.

10.0 References

California Department of Fish and Game. 2003. Strategic Plan for Trout Management. A plan for 2004 and beyond.

(FERC) Federal Energy Regulatory Commission. 2023. Comprehensive Plans. Available online: https://www.ferc.gov/media/comprehensive-plans.

Zale, A.V., D.L. Parrish, and T.M. Sutton, editors. 2013. Fisheries Techniques. Third Edition. Maryland: American Fisheries Society. January.

DRAFT CULTURAL RESOURCES STUDY PLAN (CR-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District

375 11th Street
Oakland, California 94607

October 2025

DRAFT CULTURAL RESOURCES STUDY PLAN (CR-1)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

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Terms and Abbreviations

A	
APE	Area of Potential Effects
ARSR	Archaeology Resources Study Report
C	
CFR	Code of Federal Regulations
CRMP	Cultural Resources Management Plan
E	
EBMUD	East Bay Municipal Utility District
F	
FERC	Federal Energy Regulatory Commission
G	
GIS	Geographic Information System
GPS	Global Positioning System
H	
HPMP	Historic Properties Management Plan
N	
National Register	National Register of Historic Places
NHPA	National Historic Preservation Act of 1966
NPS	National Park Service
O	
OHP	California Office of Historic Preservation
P	
Project	Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916)
T	
TCP	Traditional Cultural Property
TCR	Tribal Cultural Resource

1.0 Introduction

The East Bay Municipal Utility District (EBMUD) has identified the need to conduct cultural resource studies, including inventories of archaeological sites, built environment resources, Traditional Cultural Properties (TCPs), and Tribal Cultural Resources (TCRs). The Cultural Resources Study (CR-1) will consider archaeological sites and built environment resources. (American Indian TCPs and TCRs will be considered within the Tribal Ethnography Resources Study Plan.)

The relicensing of the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project) is a federal undertaking that requires compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). Therefore, the Project's relicensing requires consideration of the effects on historic properties (i.e., sites, buildings, structures, objects, or districts that are listed or eligible for listing on the National Register of Historic Places [National Register]) within the Project boundary or where the Project may have effects outside of the Project boundary.

Accordingly, as part of the relicensing effort, studies will be required to identify known and potential historic properties, to evaluate their eligibility for listing on the National Register, and to develop measures for avoiding or resolving adverse Project effects.

This CR-1 plan details the objectives, geographic extent, and methods for proposed cultural resources inventories to be completed as part of the relicensing effort. These studies will in turn inform the future development of a Historic Properties Management Plan (HPMP), which will consider the effects of continued Project operations and maintenance on the historic properties of the Project area. Effects may be direct (e.g., result of ground-disturbing activities), indirect (e.g., public access to Project areas), or cumulative (e.g., caused by a Project activity or public access in combination with other past, present, and reasonably foreseeable future projects).

Among the effects to be considered in the Section 106 compliance process are those on cultural and religious significance to Native American Tribes. These effects and their potential resolutions are identified by formal consultation and are described further in Section 5.3 of this study plan below.

2.0 Study Goals and Objectives

This CR-1 study has the following goals: 1) to meet FERC compliance requirements under Section 106 of the NHPA, as amended, by determining if Project-related activities and public access will have an adverse effect on historic properties; and 2) to identify all archaeological sites and built environment resources within the Area of Potential Effects (APE), determine historic properties and cultural resources, and develop the HPMP based on those results.

3.0 Geographic Scope

Under 36 Code of Federal Regulations (CFR) 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historical properties, if any such properties exist." For cultural resources, the Project boundary equates to the APE.

The Cultural Resources Study area also encompasses a 0.25-mile buffer around the Project boundary/APE to provide background on a wider range of archaeological resources. This range would include potentially significant resources that may be located just outside the Project boundary that would be affected by Project operation and maintenance.

4.0 Existing Information and Need for Additional Information

The primary information sources for this summary are the Camanche and Pardee Reservoirs Cultural Resources Management Plan (CRMP; DeBaker and Siskin 2019) and the recent historic property survey by Demarais et al. (2023). As part of the background research for the 2019 CRMP, cultural resources records searches were conducted at the Northern California Information Center of the California Historical Resources Information System (for portions of the study area within Amador County) and the Central California Information Center (for Calaveras and San Joaquin counties). An updated records search was requested in 2021 as part of the 2023 built-environment survey, though it was not discussed in the main text. This review presents the updated records search data, with some modifications to remove redundant entries.

4.1. Previous Studies

Formal archaeological study of the area began in the 1950s through early 1960s, with reconnaissance surveys and excavations conducted in advance of the construction of Camanche Reservoir (Payen 1962; Johnson 1967). These studies predated the advent of the NHPA, and there was no expectation of systematic inventory nor consultation over effects on cultural resources. These early studies provide the bulk of information about the precontact archaeological resources of the area. Many of the archaeological sites then recorded have since been inundated by the filling of Camanche Reservoir.

Subsequent cultural resources studies began in the early 1980s and continue to the present day. These studies have been driven by compliance with cultural resources law, many on behalf of EBMUD, but also the Bureau of Land Management, Pacific Gas and Electric Company (PG&E), and other agencies. Some 40 archaeological studies have taken place within the study area. Most of these are small surveys, which in aggregate cover only a small fraction of the study area.

Surveys of built-environment resources include the Penn Mine project (Nilsson et al. 1999) and, in advance of the current relicensing effort, a built-environment survey of the FERC boundary was recently conducted (Demarais et al. 2023), as discussed below, providing an essentially complete inventory of these resources.

4.2. Previously Recorded Resources

Cultural resources of the Project area include built-environment resources (historic properties), archaeological sites, and (potentially) Tribal cultural resources.

4.2.1. Built-Environment Resources

The 2023 built-environment inventory formally recorded 54 built-environment resources within the FERC boundary and identified 43 more potential properties that were not formally recorded, mostly because their ages could not be determined. Most of the recorded resources are associated with EBMUD's development of the Pardee and Camanche reservoirs and with recreational development. (Demarais et al. 2023)

There are two National Register-listed historic properties in the APE, including the Middle Bar Bridge at the upstream end of Pardee Reservoir and the Pardee Dam and Reservoir System District, the latter including the main Pardee Dam and Powerhouse, the Jackson Creek Spillway, Pardee South Spillway, and the Pardee Outlet Tower as contributing elements. Demarais et al. (2023) also recommended the portion of the Mokelumne Aqueduct within the FERC boundary as eligible. The Penn Mine Historic District has been determined National Register-eligible, but Demarais et al. recommended re-evaluation due to the time elapsed since that determination.

Demarais et al. (2023) recommended 46 other recorded resources not eligible for the National Register, or not suitable for evaluation because they were not of sufficient age. Some resources, such as the system of dikes on Camanche Reservoir, were recommended individually ineligible, but potentially eligible as contributing elements of a district not yet formally recorded.

4.2.2. Archaeological Sites

There are 175 recorded archaeological sites within the study area, of which 122 are within the FERC boundary. The 175 sites include 114 precontact sites, 25 dating to the historic period, 8 with both precontact and historic-period components, and 28 for which no information was available because the studies were in progress at the time of the records searches.

4.2.3. Religious and Cultural Significance to Tribes

In addition to this study, a separate Tribal Ethnography Resources Study will take place. To date, no TCPs or other places of religious or cultural significance to Indian Tribes have yet been formally recorded in the study area. These must be identified via Tribal consultation, which will take place during the Tribal Ethnography Resources Study. NHPA

regulations require that consultation provides the Tribe(s) with a reasonable opportunity to identify their concerns about historic properties; advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance; articulate their views on the undertaking's effects on such properties; and participate in the resolution of adverse effects.

5.0 Study Methodology

Based on the existing data described above, a reasonable and good-faith effort is required to identify historic properties that may be affected by the Project. As described in 36 CFR § 800.4(b)(1), this may be accomplished through sample field investigations and/or field surveys that are implemented in accordance with the Secretary of the Interior's Standards and Guidelines for Identification (National Park Service [NPS] 1983). FERC is required to consider any other applicable professional standards and Tribal, state, or local laws or procedures to complete the identification of historic properties.

5.1. Archaeological Inventory

To assist FERC in meeting its compliance obligations, and to develop appropriate management measures for historic properties within the APE, EBMUD will complete an archaeological inventory.

The general standard for archaeological inventories in the region is pedestrian surface survey, with systematic, complete coverage via controlled transects. While surface survey alone may fail to identify deeply buried sites, most subsurface deposits do have some surface indications, such as cultural materials in rodent burrow backdirt.

5.1.1. Records Search Update and Additional Background Research

As part of the inventory, an up-to-date accounting of all previously recorded archaeological sites within the APE will be required, as all such sites must be accounted for during the field survey. The archaeological records search for the APE was last updated in 2021. This search should be updated to include more recent work as part of this study.

Additional background research should also be conducted as part of a more complete records search effort, primarily to provide context for historic-period sites discovered during survey. This would include searches of land patents; Government Land Office plats; historical maps and aerial photos; census records; newspaper accounts; scholarly research; and any relevant maps or other materials at EBMUD offices.

5.1.2. Field Survey

The field survey will be supervised by one or more qualified professional archaeologists (i.e., individuals who meet the Secretary of the Interior's Professional Qualifications Standards for Archaeology at 36 CFR Part 61) who will participate in all field work. Field surveys must include a Cultural Representative, at the Tribe's option.

During the survey, archaeologists will walk parallel transects spaced at no more than 20 meters (approximately 22 yards), as vegetation and terrain allow within the Project's APE. If conditions allow, lands typically inundated by Project reservoirs will be examined if they become accessible during the survey season. Areas within the APE that cannot be accessed in a safe manner (e.g., locations with dense vegetation or unsafe slopes) will not be included within the survey or recording of archaeological resources; these areas will be identified in the resulting survey report, and an explanation for variations in survey coverage will be provided.

Locations of previously recorded archaeological sites will be verified, and their site records will be updated when the existing documentation does not meet current standards for recording or if the condition and/or integrity of the property has changed since its previous recording. The archaeologists will determine if sketch maps for previously documented sites require revision to describe current site conditions more accurately.

Newly discovered archaeological resources, including isolated finds, will be documented following the documentation procedures outlined in *Instructions for Recording Historical Resources* (California State Office of Historic Preservation [OHP] 1995), which utilizes California Department of Parks and Recreation DPR523 forms. Sketch maps will be drawn to scale. All site constituents, including artifacts and features, will be described, photographed, and mapped.

Field personnel will use global positioning system (GPS) receivers to document the location of cultural resources, including site boundaries, artifacts (including isolates), and features. These data will be compiled in a Project-wide geographic information system (GIS) and provided to EBMUD at the conclusion of the survey to assist with future management of these resources.

Detailed protocols for field survey, including Tribal involvement, and procedures to follow in the event of discovery of human remains, are laid out in the 2019 CRMP.

5.1.3. National Register Evaluation

National Register evaluations will be completed where applicable and where sufficient information is available. However, archaeological sites often cannot be evaluated at the survey phase, unless they can be found to contain National Register-eligible qualities based on surface features alone (e.g., pictographs) or ineligible due to a clear lack of physical integrity (e.g., redeposited materials). Some sites will therefore remain unevaluated and treated as eligible for the National Register until further formal

evaluations can take place. Detailed, site-specific recommendations, as part of relicensing, for formal evaluations will be developed in the HPMP.

Archaeological site locations are considered highly sensitive due to the potential for intentional or accidental damage and looting should these locations become known to the general public. All site records and figures depicting site locations will be contained in confidential appendices in the inventory report and must be treated as confidential throughout the relicensing process.

5.2. Built-Environment Inventory

Inasmuch as a detailed built-environment survey of the APE has recently been completed (Demarais et al. 2023), EBMUD has already met its mandate to make a reasonable and good-faith effort to identify these resources. The 2023 survey made a number of recommendations that EBMUD will address via a supplementary built-environment study.

5.3. Coordination with Other Studies

To the extent feasible, archaeological and built-environment resources field studies will be coordinated with each other and with other Project-related studies, in particular the Tribal Ethnography Resources Study, and information shared as appropriate. Native American TCPs, while a type of historic property subject to Section 106 of the NHPA, will be documented via consultation, as described in the Tribal Ethnography Resources Study. Any non-Native TCPs will be documented as part of the built-environment and/or archaeological inventories.

Cultural field studies should be conducted in a manner that does not affect other sensitive natural resources. Project sponsors and/or their contractors should not violate other federal or state laws or regulations protecting natural resources, including but not limited to the Endangered Species Act and Clean Water Act. Project sponsors should consider that Tribes may use natural resources for subsistence or specific ceremonial uses and should avoid affecting those uses or events while conducting studies.

6.0 Reporting and Historic Properties Management Plan

The results of the study will be reported in Exhibit E of the License Application, which will include a summary of the information and findings of the technical studies. Figures and other pertinent data supporting the summary in Exhibit E will be appended to the License Application. The archaeological records and other sensitive information will be included in a confidential appendix withheld from public disclosure, in accordance with Section 304 (16 United States Code 4702-3) of the NHPA.

It is anticipated that FERC will enter into a programmatic agreement with the Advisory Council on Historic Preservation, OHP, and any other agencies or entities FERC elects to include. One of the programmatic agreement stipulations will be the completion and implementation of an HPMP to be included with the License Application.

The HPMP will consider direct and indirect effects of continued Project operation and maintenance on National Register-listed or eligible archaeological and built-environment resources and will require avoidance and protection of specified resources, whenever possible. Processes and procedures will be developed for general and site-specific treatment measures, including minimization and mitigation measures to be taken should license implementation create unavoidable adverse effects to historic properties. The HPMP will include an Evaluation Plan and schedule for evaluating unevaluated resources.

7.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final Technical Study Report (TSR). The TSR will include text, summary tables, figures, and maps, as appropriate. A Draft TSR will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TSR will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 7-1.

Table 7-1. Potential Archaeology Study schedule.

Date	Activity
August 2026	FERC SPD
September 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final ARSR)
March 2029	File Final License Application

8.0 Level of Effort and Cost

The methods and approach described in this study were selected as representing an appropriate balance between cost effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating stakeholder feedback.

9.0 References

DeBaker, C., and B. Siskin. 2019. Camanche and Pardee Reservoirs Cultural Resources Management Plan. Prepared by Far Western Anthropological Research Group, Inc, Davis, CA.

Demarais, L., C. van Onna, H. Goldman, R. Krause, C. Longiaru, J. Eddy, N. White, and C. Moffett. 2023. Master Survey Report, East Bay Municipal Utility District, Federal Energy Regulatory Commission Project #2916, Amador, Calaveras, and San Joaquin Counties, California. PaleoWest, LLC, Walnut Creek, CA.

Johnson, J.J. 1967. The Archaeology of the Comanche Reservoir Locality, California. Sacramento Anthropological Society Papers 6. Sacramento Anthropological Society, Sacramento, CA.

Nilsson, E., et al. 1999. Comprehensive Report: Archaeological Inventory, Recordation, and Evaluation Within the Penn Mine Long-Term Solution Project Area, Calaveras County, California. Dames & Moore, Inc., Sacramento, CA.

(NPS) National Park Service. 1983. Part IV Department of the Interior, Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines. Federal Register 48(190): 44716.

(OHP) California State Office of Historic Preservation. 1995. Instructions for Recording Historical Resources. Sacramento, CA. March 1995.

Payen, L. 1962. Prehistoric Rock Art in the Northern Sierra Nevada, California. Sacramento State College.

DRAFT TRIBAL ETHNOGRAPHY RESOURCES STUDY PLAN (CR-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

October 2025

DRAFT TRIBAL ETHNOGRAPHY RESOURCES STUDY PLAN (CR-2)

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

East Bay Municipal Utility District
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Terms and Abbreviations

A	
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effects
C	
CFR	Code of Federal Regulations
CRMP	Cultural Resources Management Plan
D	
DPR	Department of Parks and Recreation
E	
EBMUD	East Bay Municipal Utility District
F	
FERC	Federal Energy Regulatory Commission
H	
HPMP	Historic Properties Management Plan
N	
NAHC	Native American Heritage Commission
National Register	National Register of Historic Places
NHPA	National Historic Preservation Act of 1966
NRB	National Register Bulletin
P	
PA	programmatic agreement
Project	Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916)
O	
OHP	California Office of Historic Preservation
T	
TCP	Traditional Cultural Property
TRS	Tribal Resource Ethnography and Ethnohistoric Research Study or Tribal Ethnography Resources Study

1.0 Introduction

The East Bay Municipal Utility District (EBMUD) has identified the need to conduct a Tribal Resource Ethnographic and Ethnohistoric Research Study (Tribal Ethnography Resources Study or TRS; CR-2) for the relicensing of the Lower Mokelumne River Hydroelectric Project (Federal Energy Regulatory Commission [FERC] Project No. 2916, Lower Mokelumne River Project or Project). There has been minimal investigation to date of the following: 1) the American Indian ethnography of the Project area, 2) the potential for American Indian Traditional Cultural Properties (TCPs), or 3) the potential for other American Indian resources, some of which may be eligible for listing in the National Register of Historic Places (National Register). This CR-2 study is intended to address the need to conduct this research. Potential resource areas include TCPs; Tribal economic ventures; resources of traditional, cultural, or religious importance; and environmental considerations of importance to the American Indian community.

2.0 Study Goals and Objectives

The principal goal of this CR-2 study plan is for EBMUD to assist FERC, as its non-federal representative, in meeting its compliance requirements under Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, by determining if licensing of the Project will have an adverse effect upon historic properties, in this case Tribal resources. Following 18 Code of Federal Regulations (CFR) §5.6 (d)(3)(xii) and §5.9(b)(1), the goals and objectives of the Tribal Ethnography Resources Study Plan are to identify Tribal resources that may be affected by operations and maintenance of the Project. Tribal resources will be identified through archival research, oral interviews, and field visits and to ensure that such places are not affected by ongoing operation and maintenance. Initial archival research has indicated that an ethnographic overview of the Project area has not yet been conducted.

3.0 Geographic Scope

Under 36 CFR 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historical properties, if any such properties exist." For Tribal resources, the Project boundary is preliminarily assumed to equate to the APE. The overall proposed CR-2 study area, however, encompasses a larger area comprising a 0.25-mile buffer around the APE.

4.0 Existing Information and Need for Additional Information

The primary source of information about Tribal resources and interests, which will be gathered via future consultation, is the interested Tribes themselves. In the interim, this review uses existing ethnographic literature (Merriam 1907; Kroeber 1925; Levy 1978) as summarized in the 2019 Cultural Resources Management Plan (CRMP; DeBaker and Siskin 2019).

The state Native American Heritage Commission (NAHC) maintains a list of potentially interested Tribes that project proponents can request at the outset of consultation. EBMUD obtained a list for the current Project (see Interested Tribes in Section 4.2 below).

4.1. Ethnography

The Camanche and Pardee reservoirs region is located along an indistinct territorial boundary of the Plains Miwok, the Northern Sierra Miwok, and the Northern Valley Yokuts (Merriam 1907). The Sierra Miwok encompassed the western slopes of the Sierra Nevada between the Fresno River to the south and the Cosumnes River to the north and extended into the lower foothills along the eastern edge of the Central Valley. Kroeber (1925) indicated that the sites fall within the territory of the Northern Sierra Miwok and depicted the ethnographically recorded villages of *Upüsüni*, located approximately 4.5 miles north along Jackson Creek, and *Sakayak-ümni*, located approximately 7 miles west along the Mokelumne River downstream of the Camanche Reservoir. A discussion of the traditional lifeways of these groups is presented in Section 4.10, Cultural Resources, in the Pre-Application Document. Today, these groups are represented politically by a variety of organized Tribes, both federally and state recognized.

4.2. Interested Tribes

EBMUD has identified the following Tribes who may have an interest in the Project area, including both federally recognized and other NAHC-listed Tribes:

- Buena Vista Rancheria of Me-Wuk Indians
- Calaveras Band of Mi-Wuk Indians
- California Valley Miwok Tribe
- Chicken Ranch Rancheria of Me-Wuk Indians
- Colfax-Todds Valley Consolidated Tribe of the Colfax Rancheria

- Ione Band of Miwok Indians
- Jackson Rancheria Band of Miwuk Indians
- Nashville Enterprise Miwok-Maidu-Nishinam Tribe
- North Valley Yokuts Tribe
- Pakan'yani Maidu of Strawberry Valley Rancheria
- Shingle Springs Band of Miwok Indians
- Susanville Indian Rancheria
- Tule River Indian Tribe
- United Auburn Indian Community of the Auburn Rancheria
- Washoe Tribe of Nevada and California
- Wilton Rancheria

4.3. Current Cultural Resource Management

Working in consultation with the Calaveras Band of Mi-Wuk Indians, EBMUD prepared a CRMP for Camanche and Pardee reservoirs in 2019. The CRMP outlines the regulatory requirements related to protecting and preserving archaeological and Native American resources. It identifies the range of anticipated cultural and Tribal resources that might be found in the vicinity of the two reservoirs and describes protocols and management measures for archaeological and Tribal cultural resources. The CRMP also outlined a decision-making process for determining if activities on the watershed require FERC approval and/or State Historic Preservation Office consultation, and it includes protocols, monitoring, and management guidelines in the event that cultural resources are identified. The CRMP contains confidential culturally privileged information and will be updated continuously in consultation with Tribes and will assist EBMUD in the development of a Historic Properties Management Plan (HPMP).

EBMUD hosted Early Engagement meetings in September and October of 2024 to help inform data gathering and identify interested parties and potential concerns, including a session for Tribes specifically that was held on October 2, 2024. EBMUD also hosted a FERC Relicensing Project “Open House” on October 29, 2024, at Pardee Center and invited community groups, resource agencies, Tribes, and other interested parties.

No TCPs or other Tribal resources are currently documented within the study area. However, Tribes have a demonstrated interest in preserving the many precontact and ethnohistoric archaeological sites within the Project area.

5.0 Study Methodology

The study investigation will make a good-faith effort for proper communication with Tribal leaders as laid out in FERC's *Policy Statement on Consultation with Indian Tribes in Commission Proceedings*, issued July 23, 2003 (Docket No. PL03-4-000; Order No. 635). There was also a FERC revision for conducting consultation with Indian Tribes issued on October 17, 2019 (Docket No. PL20-1-000; Order No. 863). The investigation will follow FERC Regulations at 18 CFR § 2.1c, which added a policy statement on consultation with Tribes in FERC proceedings.

All phases of the study investigation will be conducted in accordance with the American Indian community consultation standards outlined by the implementing Regulations of Sections 101 and 106 of the NHPA and discussed in the 2012 Advisory Council on Historic Preservation (ACHP) publication *Consultation with Indian Tribes in the Section 106 Review Process: A Handbook*.

Potential TCP documentation, consultation, and any necessary fieldwork will be implemented in accordance with Section 106 of the NHPA, as amended, and shall take into consideration National Register Bulletin (NRB) No. 38, *Guidelines for Evaluating and Documenting Identification of Traditional Cultural Properties* (Parker and King 1998).

Study documentation will also be implemented in accordance with FERC Regulations and with Section 106 of the NHPA, as amended, if such resources are potential historic properties, and shall take into consideration NRB No. 38 (Parker and King 1998) among other NRBs.

National Register evaluations will be conducted in adherence with NRB No. 15, *How to Apply the National Register Criteria for Evaluation* (National Park Service 1997), and other NRBs as appropriate.

5.1. Archival Research

As needed during the implementation of the study, archival research will be conducted at most of the repositories identified in the following text to obtain additional information specific to the prehistory, ethnography, and history of the Project area. The results of the archival research will 1) provide primary data to create a background American Indian ethnohistory of the proposed study area; and 2) inform the Tribal resources historic context against which such resources may be evaluated for the National Register.

The EBMUD ethnographer will conduct background archival research of the study area; the Tribes are also invited to do so. This will involve visits to many repositories, which may include the following:

- California State Archive, Sacramento
- California State Library, California History Room, Sacramento
- Huntington Library, San Marino
- Merriam (C. Hart) and Harrington (J.P.) notes
- National Archives and Records Administration, San Bruno
- University of California Bancroft Library, Berkeley
- University of California, C. Hart Merriam Collection, Davis

5.2. Meetings with Tribal Governments

During the relicensing, EBMUD will conduct meetings with Tribal governments or administrators, and/or attendance at Tribal Council meetings is proposed to provide Project data to Tribal groups, elicit areas of interest, identify appropriate Tribal informants, and establish protocols for conveying information.

All the Tribal groups listed in Section 4.2 above will be contacted via telephone, letter, or email at a minimum to elicit their interest.

5.3. Interviews

Interviews are critical for identification, description of significance, and evaluation of potential effects to Tribal resources. EBMUD proposes conducting interviews with interested and responsive Tribes to better understand their priorities and perspectives. Individuals to interview will be identified in collaboration with each participating Tribe. The methods and nature of the interviews are expected to vary from person to person: some may be held in the field Project area, others held in private homes, and still others held via telephone or teleconference. Interview records are similarly likely to be variable regarding confidentiality protocols and the Tribal expert's willingness to share. Recording methods (e.g., handwritten notes, video, audio tape) will be determined by consulting with the informant.

5.4. Documentation and Evaluation

Three main categories of Tribal resources are anticipated, which include 1) Tribal places; 2) TCPs; and 3) Tribal government matters. Each category will be documented in a

different manner. Tribal places may be potential historic properties, places associated with the ancestral past, places related to current gathering and/or hunting practices, or other resource types. Those that qualify as potential historic properties will be documented on California Department of Parks and Recreation (DPR) 523 forms as appropriate and with Tribal permission, while others will be described in the study. TCPs will be documented on DPR 523 forms, with Tribal community permission, and Tribal government resources may be documented in the study or may be larger or different resource types (e.g., documentation of Indian allotments in the study area). All resources will be documented and described according to Tribal values and submitted for review to Tribal representatives. National Register evaluation of Tribal resources suitable for DPR 523 documentation will use site-specific procedures to identify historic context of the resource, boundaries, jurisdiction or land ownership, Tribal significance, integrity from a Tribal perspective, and contributing characteristics. Evaluation of other resource types may occur at the managerial or agency level. After documentation is complete, it will be provided for review and comment to the California State Office of Historic Preservation (OHP) and the Tribes.

5.5. Coordination with Other Studies

Other resource areas may have a connection to Tribal resources. This includes not only cultural resources, but also biological areas, water, trails, and recreation. As needed, the Tribal resource expert will work to assist other resource experts in identifying Tribal resources with connections to their technical study. Assistance to the cultural resource team is anticipated to aid field identification and documentation of historic American Indian resources, potential gathering areas, and other places that may have value to Indian Tribes.

6.0 Reporting

The results of the CR-2 study will be reported in Exhibit E of the License Application, which will include a summary of the information and findings of the technical studies. Figures and other pertinent data supporting the summary in Exhibit E will be appended to the License Application. Tribal resource documentation and other sensitive information will be included in a confidential appendix withheld from public disclosure, in accordance with Section 304 (16 United States Code 4702-3) of the NHPA. The California Public Records Act similarly exempts site data from disclosure, while Public Resources Code Section 21082.3(c) contains provisions specific to confidentiality related to any information submitted by an American Indian Tribe during the environmental review process, including, but not limited to, the location, description, and use of the Tribal cultural resources.

A draft detailed technical report will be prepared and provided for review to the OHP and Tribes to include 1) regulatory, environmental, and cultural contextual statements; 2) discussion of research methods; 3) discussion of Tribal resources that are not also cultural resources; 4) description and evaluation of resources that are assessed as potential historic properties; and 5) conclusions, to include management considerations. Appendices are anticipated to include ethnobiological tables, chronological contact logs, specific historical reference materials, and more. The study will identify all potential and actual Project effects from a Tribal perspective, provide Tribal suggestions for mitigation or modification of impacts, and provide a structural basis for FERC to conduct their National Environmental Policy Act analysis for this technical resource area.

7.0 Historic Properties Management Plan

It is anticipated that FERC will enter into a programmatic agreement (PA) with the ACHP, California OHP, and any other agencies or entities FERC elects to include. One of the PA stipulations will be the completion and implementation of an HPMP to be included with the license or License Application.

The HPMP will consider direct and indirect effects of continued Project operation and maintenance on National Register-eligible and unevaluated Tribal resources, and it will require avoidance and protection of specified resources, whenever possible. Processes and procedures will be developed for general and resource-specific treatment measures, including mitigation measures to be taken should license implementation create unavoidable adverse effects to historic properties.

8.0 Schedule and Deliverables

This is proposed as a single-year study; it includes a draft and final TRS Report. The TRS Report will include text, summary tables, figures, and maps, as appropriate. A Draft TRS Report will be provided for review and comment following study completion. Comments will be incorporated as appropriate, and a Final TRS Report will be included with the Draft License Application (DLA). A draft study schedule based on the Study Plan Determination (SPD) issuance of August 2026, is outlined below in Table 8-1.

Table 8-1. Potential Tribal Ethnography Resources Study schedule.

Date	Activity
August 2026	FERC SPD
September 2027	File Initial Study Report (ISR)
August 2028	File Updated Study Report (USR)
October 2028	File DLA (Final Technical Study Report)
March 2029	File Final License Application

9.0 Level of Effort and Cost

The methods and approach described in this study were selected as representing an appropriate balance between cost-effectiveness and level of effort while meeting the study objectives. The study schedule and materials have been developed to streamline time and effort by building on existing information, filling data gaps, and incorporating stakeholder feedback.

10.0 References

DeBaker, C., and B. Siskin. 2019. Camanche and Pardee Reservoirs Cultural Resources Management Plan. Prepared by Far Western Anthropological Research Group, Inc, Davis, CA.

Kroeber, A.A. 1925 Handbook of the Indians of California. Bulletins of the Bureau of American Ethnology, Volume 78. [Reprinted 1976, New York: Dover Publications, Inc.].

Levy, R. 1978. Eastern Miwok. In: Heizer, R.F. editor. Handbook of North American Indians, Volume 8: California. Smithsonian Institution, Washington, D.C. pp. 398–413.

Merriam, C.H. 1907. Distribution and Classification of the Mewan Stock of California. American Anthropologist 9:338–357.

National Park Service. 1997. How to Apply the National Register Criteria for Evaluation. National Register Bulletin 15. Washington D.C.: National Park Service. Originally published 1990. Revised 1991, 1995, 1997.

Parker, P.L., and T.F. King. 1998. Guidelines for Evaluating and Documenting Traditional Cultural Properties. National Register Bulletin 38. Originally published 1990 (revised 1992), U.S. Department of the Interior, National Park Service. Washington, D.C.