RESPONSE TO FEBRUARY 16, 2018 REQUEST FOR ADDITIONAL INFORMATION, RESOURCE AGENCY LATE FILING, AND OTHER RELATED INFORMATION

ATTACHMENT A

DON PEDRO AND LA GRANGE HYDROELECTRIC PROJECTS SUMMARIES OF THE RESULTS AND APPLICATION OF STUDY REPORTS

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Don Pedro and La Grange Hydroelectric Projects
Summaries of Study Results and Applications of Study Reports

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
Don Pedro Hydroelectric Project Studies		
Recreation Resources (RR)		
RR-02	Whitewater Boating Take-Out Improvement Feasibility Study	The purpose of the Districts' *Whitewater Boating Take-Out Improvement Feasibility* study (RR-02) was to (1) assess the feasibility of improving the existing take-out location at the Ward's Ferry Bridge for continued use by whitewater boaters and (2) evaluate the feasibility of physical improvements to the Ward's Ferry Bridge location and alternative take-out locations. Evaluation of take-out concerns and challenges experienced at Ward's Ferry Bridge included (1) commercial rafters use of the bridge deck for retrieving gear and rafts via truck cranes, resulting in traffic congestion on the bridge and violation of County ordinances related to traffic obstruction and (2) general public congestion on and along the bridge and adjoining roadway because most rafts arrive at Ward's Ferry Bridge during a two- to three-hour period because rafting is scheduled to coincide with the release of peaking flows from CCSF's Holm powerhouse, which occurs on a daily basis from about 7:00 am to 11:00 am during the commercial rafting season. Neither congestion at Ward's Ferry nor the use of the Ward's Ferry Bridge in violation of County ordinances is related to Don Pedro Project operations. Study results indicate that improving conditions at the whitewater boat take-out at Ward's Ferry appears to be technically feasible, and towing boats to the Moccasin Point Recreation Area is also technically viable. Given the current use levels and starting/arrival schedules, the Districts' proposed to construct a platform on river left that can support a truck crane and to relocate the current bathroom to river right. The Districts' also proposed that the long-term maintenance of the proposed take-out facility be the joint responsibility of whitewater rafters, Tuolumne County officials, and the Districts. Police coverage to ensure traffic control and public safety is a County responsibility. Both of the study's technically feasible take-out options, i.e., at Ward's Ferry Bridge and at the existing Moccasin Recreation Area, have advantages over other take-out sites. The Ward's Ferry Bridge and Moccasin Recreation Area sites: (1) minimize or eliminate the necessity for flat-water paddling; (2) contain the footprint of site improvements to an existing disturbed area to avoid impacts at alternative sites that are not disturbed; and (3) minimize maintenance and potential for damage due to vandalism by limiting built facilities to what is necessary to address the identified issues.
RR-03	Lower Tuolumne River Lowest Boatable Flow	The purpose of the *Lower Tuolumne River Lowest Boatable Flow* study (RR-03) was to determine if minimum flows released from the Don Pedro Project under the current license provide boatable flows for non-motorized, recreational river boating in portions of the lower Tuolumne River where boat put-ins and take-outs are available. Study results indicate that flows of 175 cfs and 200 cfs are both boatable and enjoyable in the study reaches, i.e., Old LaGrange Bridge (RM 50.5) to Riverwalk Park in Waterford (RM 31.5) and Riverdale Park (RM 12) to Shiloh Bridge (RM 3.5). The lower Tuolumne River offers flat-water boating opportunities with higher gradients in the upstream portion from Old La Grange Bridge to Turlock State Recreation Area, where gradient averages approximately 6 ft/mi. Below Waterford, the river gradient averages less than 2 ft/mi. Boaters identified similar opportunities to boat flat-water river reaches in Central California, including the lower Merced River near Snelling and the lower Stanislaus River below Knights Ferry and below Orange Blossom. The boating "season" is generally considered to be May through October. The Districts' proposed flows for the lower Tuolumne River would provide boating opportunity, with flows of at least 200 cfs, measured at the La Grange gage, from RM 52 to RM 25.9 (Fox Grove Park) throughout the entire April through October period in all water year types. Flows of at least 200 cfs would be provided downstream of RM 25.9 in all water year types in April and May, and from June through October during

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		holiday periods and certain pre-scheduled weekends, except in "critical" water years when flows downstream of RM 25.9 would remain at 75 cfs from June 1 through October 15.
Water and Aquatic Resources (W&AR)		
W&AR -01	Water Quality Assessment	The purpose of the *Water Quality Assessment* (W&AR-01) was to (1) characterize existing water quality conditions in Don Pedro Reservoir and the lower Tuolumne River, the latter measured at the point of discharge from the Project and (2) determine if water quality variables were consistent with the Central Valley Regional Water Quality Control Board's Basin Plan Objectives (CVRWQCB 1998). Study results indicate that water quality in the Project Area is good. As water flows downstream through the Don Pedro Hydroelectric Project boundary, it is clear, DO is near saturation at riverine sites and in the epilimnion of the reservoir, alkalinity is low, and pH is near neutral. Fecal coliform bacteria are below or near detection limits near potential sources. Nitrogen and phosphorous occur at concentrations generally less than 1 mg/L, and algae blooms are not observed. Hardness, turbidity (i.e., 0 to 8 NTU), and nutrient concentrations remain generally constant. No specific adverse Project effects are occurring, so no water quality related enhancement measures were proposed by the Districts. Temperature-related issues were treated as a distinct issue as discussed below.
W&AR -02	Project Operations Water Balance Model	The purpose of the *Project Operations Water Balance Model* (W&AR-02) was to develop a computer model to simulate current Don Pedro Project operations and alternative potential future Project operations. The Operations Model was developed to simulate operations for a period of analysis that covers a range of historical hydrologic conditions and to simulate basic decisions made during Project operations for flood control management, water supply, river releases, reservoir levels, and hydropower generation. The Operations Model is a comprehensive, site-specific model, with a daily time-step that includes the operations of both the Don Pedro and La Grange projects and the water supply operations of CCSF's Hetch Hetchy facilities. The Operations Model was vetted by relicensing participants and is available to them for their use in evaluating existing conditions and potential future Project operations. The Operations Model is the one of five separate models linked together to simulate reservoir storage and water supply operations, reservoir outflows, reservoir temperatures (W&AR-03), lower Tuolumne River flows, lower Tuolumne River temperatures (W&AR-16), and in-river effects of Project operations on fall-run Chinook salmon (W&AR-06) and *O. mykiss* (W&AR-10). The model was used in the development of all flow-related resource enhancement measures.
W&AR -03	Reservoir Temperature Model	The purpose of *Reservoir Temperature Model* (W&AR-03) was to (1) develop a reservoir temperature model that accurately reproduces observed reservoir temperatures, within acceptable calibration standards, over a range of hydrologic conditions, (2) provide output that can be used to inform other studies, analyses, and models, and (3) predict potential changes in reservoir thermal conditions under alternative potential future operating scenarios. The size, shape, and operational complexities of the Don Pedro Reservoir (including the continuing presence of the old Don Pedro Dam) led to the selection of a three-dimensional model to reliably estimate the thermal behavior of the reservoir under a wide range of alternative future scenarios. Reservoir bathymetry data collected as part of this study was used as input to develop reservoir geometry. The Reservoir Temperature Model provided input for evaluation of temperature-related benefits associated with the Districts' resource enhancement measures proposed for the lower Tuolumne River.

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W&AR -04	Spawning Gravel in the Lower Tuolumne River	The purpose of the *Spawning Gravel in the Lower Tuolumne River* study (W&AR-04) was to characterize (1) the cumulative effects of sediment storage in Don Pedro Reservoir and (2) the ongoing effects of upstream diversion on coarse and fine bed material storage and salmonid spawning habitat in the lower Tuolumne River channel. This study quantified the changes in coarse and fine bed material stored in the lower Tuolumne River over the period of 2005-2012, updated prior estimates made by McBain & Trush (2000; 2004) of coarse sediment and suitable spawning habitat in the lower Tuolumne River, and estimated the current maximum potential spawning populations of fall-run Chinook and *O. mykiss* under baseline conditions. The study results were used to guide the Districts' proposed coarse and fine sediment management measures in the lower Tuolumne River. The Districts relied on results of this study to define the scope and requirements of RPM-1, *Augment Current Gravel Quantities through a Coarse Sediment Management Program*. RPM-1 calls for a coarse sediment management program consisting of a 10-year infusion of 75,000 tons of properly-sized coarse sediment (about 10 times the amount lost from bed storage), with concentration on priority riffles and pools in the dominant spawning reach. As part of this study, a coarse sediment budget was developed through sediment transport modeling and analysis of changes in bed topography, which indicate that without gravel augmentation, the channel in the first 12.4 mi downstream of La Grange Diversion Dam (LGDD) would slowly degrade in response to a reduction in coarse sediment supply caused by the Don Pedro Dam. Approximately 5,913–8,720 tons of coarse (>2 mm) bed material was lost from storage in this reach (encompassing the Dominant Salmon Spawning Reach) between 2005 and 2012. Gravel augmentation has helped increase coarse sediment storage in the reach, and 94 percent of the coarse sediment added through augmentation has so far been retained. The loss of coarse sediment (spawning gravel) over the 8-year period (2005-2012) amounts to an average bed lowering of only 13 millimeters. This loss was more than made up by the gravel augmentation projects that were undertaken. The study also found that under current conditions there is sufficient spawning gravel in the gravel-bedded areas of the lower Tuolumne River to support about 50,000–60,000 fall-run Chinook and over 800,000 *O. mykiss.* The results of sediment transport modeling and topographic differencing, both conducted as part of this study, suggest that augmented coarse sediment is being mobilized short distances during infrequent high flow events (e.g., during WY 2006 and WY 2011). Prolonged retention of augmented coarse sediment may allow the gravel framework to fill with fine sediment from non-Project tributaries downstream of the LGDD, a finding that informed the development of RPM-2, *Provide Gravel Mobilization Flows of 6,000 to 7,000 cfs* and RPM-4, *Gravel Cleaning*. This study also provided input to the W&AR-06 and W&AR-10 salmonid population models. The estimates developed by the study of changes in reservoir storage volume occurring over the 45-year life of the Don Pedro Project indicated that very little storage had been lost to sediment storage (less than 1%). Due to the fact that these estimates are at a gross level and comparisons of current and 1960s topography are of dissimilar accuracy, the only reliable use of this information was to confirm that use of the original storage-elevation data in the Operations Model was acceptable.
W&AR -05	Salmonid Population Information Integration and Synthesis	The purpose of the *Salmonid Population Information Integration and Synthesis* (W&AR-05) was to compile and synthesize all readily available and relevant information regarding in-river and out-of-basin factors affecting Chinook salmon and *O. mykiss* in the Tuolumne River. The synthesis reflects the results of monitoring conducted since the 1995 Settlement Agreement and issuance of FERC's 1996 Order, changes in Tuolumne River conditions since 1995 (e.g., from the 1997 flood and changes to the lower Tuolumne River flow schedule required by FERC's 1996 order), and recent advances in the understanding of Central Valley salmonid populations (e.g., genetic structure, hatchery influences, the effects of Delta and ocean conditions, temperature suitability, etc.).

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		Results of the synthesis were applied in the development of the in-river Chinook and *O. mykiss* population models (W&AR-06 and W&AR-10, respectively). The hierarchy of relevant information consisted of (1) in-river specific data; (2) San Joaquin tributaries data; (3) other Central Valley streams' data where relevance could be shown; and (4) other peer-reviewed literature where relevance to the Tuolumne River is demonstrated. Examples of river-specific data include results of multi-year rotary-screw trap monitoring, seine surveys, macroinvertebrate surveys, redd surveys, adult fish counting weir monitoring, snorkel surveys, and instream flow versus habitat relationships.
W&AR -06	Tuolumne River Chinook Salmon Population Model	The purpose of the *Tuolumne River Chinook Salmon Population Model* (W&AR-06) was to (1) provide a quantitative salmon production model to investigate the influences of various factors on the life-stage-specific production of fall-run Chinook salmon in the Tuolumne River, (2) identify critical life-stages that may represent a life-history "bottleneck," and (3) compare relative changes in population size between potential alternative management scenarios and water year types, drawing upon site-specific data, existing literature, and additional information identified in the *Salmonid Population Information Integration and Synthesis Study* (W&AR-05). Independent life-stage specific sub-models were developed using a series of functional relationships and associated parameters to predict Tuolumne-River-specific life history progression from adult upmigration through spawning, egg incubation, fry and juvenile rearing, to smolt emigration. The calibrated and validated model may be used to examine the relative influences of various factors on the life-stage specific production of Chinook salmon in the Tuolumne River, and to identify critical life stages that may represent a life-history "bottleneck." The in-river population model was developed to evaluate comparisons of relative changes in Tuolumne River fall-run Chinook juvenile production among potential alternative flow management scenarios. The model was also used to compare alternative flow scenarios proposed by other parties. The model indicates that predation is a primary factor influencing in-river production of Chinook, followed by the dominance of out-of-basin hatchery fish in the escapement, redd superimposition, the numbers of fry-size fish that exit the Tuolumne River early, spawning gravel quality, spawning gravel quantity (at high escapement levels), rearing capacity (at high escapement levels), water temperature, and disease. The Chinook Salmon population model informed the development of flow measures included in the Districts' Preferred Plan, which substantially increase in-river fall-run Chinook production while protecting the Districts' and CCSF's water supplies.
W&AR -07	Predation Study	The purpose of the *Predation Study* (W&AR-07) was to assess the effects of predation on rearing and outmigrating juvenile Chinook salmon and *O. mykiss* in the lower Tuolumne River. The study evaluated predation-related mortality on Tuolumne River fall-run Chinook juveniles as well as abundance of piscivore-sized fish (>150 mm fork length [FL]) between Waterford and Grayson. Estimates of abundance were 2,837-3,676 largemouth bass, 2,719- 3,555 smallmouth bass, 148-196 striped bass, and 74-98 Sacramento pikeminnow. Predation rates (i.e., number of Chinook salmon per predator) were generally highest for striped bass, followed by predation rates of smallmouth bass and largemouth bass. Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to consume nearly 15 percent of the total potential juvenile Chinook salmon consumed by these four predator species. Smallmouth bass were estimated to consume about 49 percent of juvenile Chinook salmon and largemouth bass were estimated to consume about 37 percent of juvenile Chinook salmon. Only 4 percent of salmon juveniles survived between the two rotary screw traps the Districts maintain in the river. The estimated losses due to predation found by the study make it plausible that most, if not all, losses of juvenile Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 could be attributed to non-native predatory fish species. This study provides an important finding about the factors affecting fall-run Chinook productivity in the lower Tuolumne River. Results of this study informed the W&AR-06 population model and these measures RPM-6, *Fish Counting and Barrier Weir* and RPM-7, *Predator Control and Suppression*. Given the similarity in densities of predatory species between this study and previous studies conducted in the lower Tuolumne River, and the similarities between predation rates between this study and other predation rates observed for the same

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		species, the Districts conclude that absent a robust predator control and suppression plan, other measures intended to benefit in-river fall-run Chinook production will have little success.
W&AR -08	Salmonid Redd Mapping	The purpose of *Salmonid Redd Mapping* study (W&AR-08) was to document Chinook salmon and *O. mykiss* spawning locations, timing, densities, and redd superimposition from RM 52 to RM 22 (i.e., the gravel-bedded reach of the lower Tuolumne River). Study results indicate that there is a strong positive relationship between upriver location (i.e., increased river mile) and Chinook spawning usage. Although Reach 1 (RM 52 to RM 47.4) contains less than 25 percent of the available suitable spawning habitat in the Tuolumne River (McBain and Trush 2004), more than half of the Chinook salmon spawning activity is consistently observed in this reach. While redd densities in two restored riffles (RM 50.6 and RM 51) were the two highest densities observed for all 88 riffles surveyed, there was no statistical difference between mean redd densities in restored riffles versus unrestored riffles during 2012/2013. The rate of redd superimposition was also highest within Reach 1, accounting for 50.5 percent of observed superimposition events during 2012/2013. For fall-run Chinook, a total of 90 percent of new redds were observed between October 29 and November 21 and 78 percent between November 5 and November 21. Less than 2 percent of new redds were observed after December 13. For *O. mykiss*, new redds were observed from early January through early April with peak observations in April. A total of 97 percent of the *O. mykiss* redds were located upstream of RM 42. This study and prior redd surveys were used to inform W&AR-06 and W&AR-10 and the Districts' proposed measure RPM-8: S*uperimposition Reduction Program.*
W&AR -10	*Oncorhynchus mykiss* Population Model	The purpose of the *Oncorhynchus mykiss Population Model* (W&AR-10) was to provide a quantitative population model to (1) investigate the relative influences of various factors on the life-stage specific production of *O. mykiss* in the Tuolumne River, (2) identify critical life-stages that may represent a life-history "bottleneck," and (3) compare relative changes in population sizes between potential alternative flow scenarios and water year types, drawing upon site-specific data, existing literature, and additional information identified in the *Salmonid Population Information Integration and Synthesis Study* (W&AR-05). Independent life-stage specific sub-models were developed using a series of functional relationships and associated parameters to predict life history progression from adult upmigration through spawning, egg incubation, fry and juvenile rearing, resident rearing, to smolt emigration. Model results indicate that neither spawning habitat nor rearing habitat is limiting for *O. mykiss* in the lower Tuolumne River. Although an occasional anadromous *O. mykiss* (steelhead) has been observed in the Tuolumne River (a total of 16 in nine years of monitoring), there is not a population of steelhead in the Tuolumne River. Genetic testing performed on lower river *O. mykiss* in 2017 indicates that the genetic marker for anadromy is relatively frequent for lower river *O. mykiss* (Blankenship and Miller 2018). The lack of an anadromous *O. mykiss* (steelhead) population indicates either that current in-river conditions favor residency or *O. mykiss* that choose to exit the system do not return. Population modeling also indicates that caution must be exercised in the development of flow proposals for fall-run Chinook so they do not adversely affect *O. mykiss* fry. High flows intended to aid fall-run Chinook juvenile outmigration may adversely affect *O. mykiss* fry by displacing fry to downstream locations where they are later subject to predation or high temperatures. The *O. mykiss* population model informed the development of flow measures in the Districts' Preferred Plan, which would increase in-river *O. mykiss* production while protecting the Districts' and CCSF's water supplies.

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W&AR -11	Chinook Salmon Otolith Study	The purpose of the *Chinook Salmon Otolith Study* (W&AR-11) was to examine the microstructure and microchemistry of Chinook otoliths[1], to identify (1) whether returning adults originated from hatcheries or other rivers and (2) the age and size of "wild" fish when they moved from their river of origin into the Sacramento-San Joaquin Delta and when they moved from the Delta into the ocean. The results of this study indicated relatively high straying of hatchery fish into the Tuolumne River. Results also showed that fish emigrating as fry were very unlikely to return to the river as adults. In combination with IFIM study results (see below), this study informed the development of the Districts' Preferred Plan by identifying instream flows which would optimize habitat for in-channel rearing while minimizing the potential for downstream displacement of fall-run Chinook fry[2]. This study also demonstrated the increasing presence and dominance of hatchery strays in the Tuolumne River fall-run Chinook population. Based on Lindley et al. (2007), the Tuolumne River fall-run Chinook population is seriously impacted due to the presence of high numbers of hatchery fish. Adult counting at the weir located at RM 24.5 has also documented the dominance of hatchery strays in the escapement. For example, in the 2015/2016, 2016/2017 and 2017/2018 escapements, approximately 25.3 percent, 23.8 percent, and 30.3 percent of the adult returns were adipose fin-clipped (FISHBIO 2016, 2017, and In Draft), matching CDFW's constant fractional marking program for hatchery fish, thereby indicating that nearly 100 percent of the escapement over the last three years consists of hatchery fish from other areas. The information described above led to the Districts' proposal to design, construct, and contribute substantially to the operations of a Tuolumne River Fall-run Chinook Restoration Hatchery to be operated by CDFW. The proposed restoration hatchery program would be implemented in accordance with procedures that prevent or minimize adverse impacts on the fitness, size, abundance, run-timing, and distribution of wild fish. The proposed program would be structured in an attempt to counter current adverse Chinook population trends, to the degree possible, in the Tuolumne River through the spawning and rearing of fish selected by CDFW to best represent the wild Tuolumne River stock. The program would allow for the stocking of fish within the basin and as a result produce individuals that are adapted to the extent practicable to conditions in their natal environment.
W&AR -12	*Oncorhynchus mykiss* Habitat Survey	The purpose of the *Oncorhynchus mykiss Habitat Survey* (W&AR-12) was to (1) provide information on the distribution, abundance, and quality of *O. mykiss* habitat in the lower Tuolumne River, particularly with regard to the role of large woody debris (LWD), (2) provide an estimate of the quantities of LWD entering Don Pedro Reservoir on an annual basis, and (3) develop a LWD budget to compare the average annual volume and frequency of LWD removed from Don Pedro Reservoir with the average annual volume and frequency of LWD stored in the lower Tuolumne River. Nearly all pieces of LWD that are collected by the Don Pedro Recreation Agency in the Tuolumne River Arm of Don Pedro Reservoir are transported into the reservoir from upstream. It is reasonable to assume that, given the piece sizes, a majority of this wood would flush through the lower river during high flows if it were not trapped by Don Pedro Reservoir. Because of the large size of the lower Tuolumne River compared to the relatively small size of woody material captured by Don Pedro Reservoir, the Don Pedro Project has little effect on LWD-

[1] Calcium carbonate structures in the inner ear of fish that grow in proportion to the overall growth of the individual, such that daily or weekly growth increments can be measured to allow the age and fish size at various habitat transitions to be identified.

[2] On September 29, 2017, CDFW wrote a letter to the Districts on the subject of flow releases from Don Pedro Reservoir expressing concern about potential high flow releases stating "Large wintertime releases can cause redd scouring as well as downstream displacement of fry." CDFW, while acknowledging the potential for adverse effects due to displacement by higher flows in January, February, and early March, have recommended flows which would require such higher flow releases in this same time period. See September 29, 2017 letter from Julie Vance, Central Region Manager to Steve Boyd (TID) and Anna Brathwaite (MID).

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		related habitat dynamics in the lower river. The importance of LWD in habitat formation decreases with increasing channel width. The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 ft, and because of this LWD has a limited effect on channel morphology in this reach. Compared to smaller streams, Bilby and Bisson (1998)[3] observed that wood has less effect on channel form in larger streams, which is consistent with the W&AR-12 surveyors' observations that LWD has a limited effect on channel morphology in the lower river. This study also found that "there is abundant *O. mykiss* habitat in the lower Tuolumne River between RM 51.8 and RM 39.5." (see page 6-5). The study further found that "the amount of instream cover (a component of overall habitat) in the form of boulders, aquatic vegetation, small woody debris, and terrestrial vegetation is very low." This study was used to inform the Districts' proposed measure RPM-3: *Improve Instream Habitat Complexity*, which consists of the placement of boulders in specific locations in the upper segment of the lower Tuolumne River to increase cover for *O. mykiss*, and potentially fall-run Chinook juveniles. Increased cover is expected to decrease territory size and promote higher densities of *O. mykiss* juveniles.
W&AR -13	Fish Assemblage and Population between Don Pedro Dam and La Grange Dam	The purpose of the *Fish Assemblage and Population between Don Pedro Dam and La Grange Dam* study (W&AR-13) was to (1) characterize the species composition, relative abundance, and condition factor of fish in the reach of the Tuolumne River between Don Pedro Dam and LGDD and (2) characterize the functional habitat in the reach as either riverine or lacustrine. Study results indicate this reach of the Tuolumne River contains two fish species: rainbow trout and prickly sculpin. The current trout population exhibits multiple age classes (four), likely indicating that successful natural reproduction is occurring in the reach. No known stocking has occurred in this reach. Rainbow trout were observed at sites characterized as lacustrine and riverine indicating that they are able to effectively occupy the range of available habitat within the study area. Overall, the fish condition and health of the species in the study area is average. Data suggest that the prickly sculpin population also exhibit multiple age classes (potentially 3). Successful natural reproduction may be occurring in the study area. Similar to rainbow trout, the overall fish condition and health of prickly sculpin in the reach is average. Because there are no adverse effects of the Don Pedro Hydroelectric Project on fish in the La Grange headpond, no enhancement measures are proposed for this reach.
W&AR -14	Thermal Performance of Wild Juvenile Oncorhynchus Mykiss in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature And In-River Assessment of Swimming and	The purpose of the *Thermal Performance of Wild Juvenile Oncorhynchus mykiss in the Lower Tuolumne River: a Case for Local Adjustment to High River Temperature* (W&AR-14) ("*Swim Tunnel Study*") was to investigate the thermal performance of wild juvenile *O. mykiss* that populate the lower Tuolumne River with respect to the seasonal maximal water temperatures they experience during the summer months. The study was conducted by researchers from U. C. Davis and the University of British Columbia. The study measured the aerobic scope of a sample of wild juvenile *O. mykiss* captured in the lower Tuolumne River tested on site in a swim tunnel respirometer. The study revealed that wild *O. mykiss* from the lower Tuolumne River maintained 95 percent of their peak aerobic scope across an impressive temperature range (17.8–24.6°C). The thermal range for peak performance corresponds to local high river temperatures, but represents an unusually high temperature tolerance compared with conspecifics and congeneric species from northern latitudes. This high thermal tolerance suggests that *O. mykiss* at the southern limit of their indigenous distribution may be locally adjusted relative to more northern populations (Verhille et al 2017). Moreover, up to a temperature of 23°C, all test fish could at least double their routine oxygen uptake (a FAS value >2.0), which is sufficient aerobic capacity for the fish to properly digest a meal and maintain position in the river. The *Swim Tunnel Study* was developed into a paper and published in the journal, *Conservation Physiology*, in November 2016 (see Verhille et al 2016) and is now part of the peer-reviewed scientific literature on the subject of thermal tolerance of salmonid species.

[3] Bilby, R.E. and P.A. Bisson. 1998. Function and distribution of large woody debris. In River Ecology and Management. Naiman R.J. and R. E. Bilby (Eds.). New York, Springer, p. 324-346.

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
	Feeding Behaviors and Inferences of Metabolic State of Oncorhynchus mykiss in the Lower Tuolumne River Study	The purpose of the *In-River Assessment of Swimming and Feeding Behaviors and Inferences of Metabolic State of Oncorhynchus mykiss in the Lower Tuolumne River Study* (W&AR-14) was to evaluate (1) if the observed tail-beat frequency of lower Tuolumne River *O. mykiss* holding station in water currents at typical lower river habitats was less than the maximum tail-beat frequency measured for lower Tuolumne River *O. mykiss* holding station in the swim tunnel study, (2) using tail-beat frequency to evaluate how the in-river metabolic rate of *O. mykiss* holding station in the river compares with the maximum metabolic rate measured at the same temperature in the swim tunnel respirometer, and (3) evaluate whether observed prey strike frequencies of *O. mykiss* in the river decrease with increasing water temperature. The study involved the deployment of underwater video cameras to evaluate the swimming, feeding, and avoidance activity of *O. mykiss* in the Tuolumne River. Based on the video analysis, fish at ambient water temperatures significantly exceeding the EPA (2003) guidance were predicted to have an excess aerobic capacity well beyond that needed to swim, feed, and maintain station against the river current in their usual habitat. These results support the hypothesis that the thermal performance of wild juvenile *O. mykiss* from the Tuolumne River represents an exception to that expected based on the 7DADM guidance set out by EPA (2003) for Pacific Northwest *O. mykiss*. Moreover, given that the average absolute aerobic scope remained within 5 percent of peak performance up to a temperature of 24.6°C and that all Tuolumne River *O. mykiss* tested maintained a factorial aerobic scope value >2.0 up to 23°C, the authors recommended that a conservative upper aerobic performance limit of 22°C, instead of 18°C, be considered as acceptable for this population. These two studies as well as other site-specific observations obtained during multiple snorkel studies were used to inform the development of water temperature indices for Tuolumne River *O. mykiss.*[4] These temperature indices, developed using values established by Bratovich et al. (2012) and modified based on the Tuolumne River swim tunnel and tailbeat frequency studies, along with other information, were adopted at the May 18, 2017 meeting of the Reintroduction Assessment Framework Plenary Group, which included representatives from NMFS and CDFW[5]. Results from these studies were also used to develop the over-summering flow regime for the lower Tuolumne River included in the Districts' Preferred Plan.
W&AR -15	Socioeconomics	The purpose of the *Socioeconomics Study* (W&AR-15) was to quantify the baseline economic values and socioeconomic effects of current Don Pedro Project operations. This study results included estimates of the economic values of the water supplies for consumptive uses, water-based recreation, and hydroelectric power generation of the Don Pedro Project. This study was used to estimate the socioeconomic effects of alternative instream flow and reservoir management proposals.
W&AR -16	Lower Tuolumne River Temperature Model	The purpose of the L*ower Tuolumne River Temperature Model* (W&AR-16) is to simulate current and potential future water temperature conditions in the lower Tuolumne River from the outlet of Don Pedro Dam to near the confluence with the San Joaquin River. The model was able to reproduce the observed river water temperatures within a reasonable level of accuracy for both the calibration year of 2011 and the validation year of 2012. This model represents the best tool available for predicting temperatures in the lower Tuolumne River under different flow regimes.

[4] The temperature indices and associated species' periodicities are presented in the final *Upper Tuolumne River Temperature and Timing* table (included in the FLA for the La Grange Hydroelectric Project. i.e., Table 1.3-2 on page 1-16 of the FLA).

[5] La Grange Hydroelectric Project Reintroduction Assessment Framework Plenary Group. 2017. La Grange Reintroduction Assessment Framework – May 18, 2017 Final Meeting Notes. [Online] URL: http://www.lagrange-licensing.com/Documents/20170804_LG%20May%2018_Final%20Mtg%20Notes.pdf.

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		The Operations Model and 3-D Reservoir Temperature Model provide the necessary inputs to the river temperature model, which in turn, with the Operations Model's instream flows, provide the input to the fish population models. The river temperature model was also used to inform the development of flows proposed to meet over-summering water temperature indices in the lower river in the *O. mykiss* habitat reach (down to approximately RM 42).
W&AR -17	Don Pedro Reservoir Fish Population Survey	The purpose of the *Don Pedro Reservoir Fish Population Survey* (W&AR-17) was to collect baseline information concerning the distribution and occurrence of fish resources in Don Pedro Reservoir. The results of the survey substantiate existing information that current Project operations and resulting habitat conditions, along with ongoing fishery management programs, support quality warm-water and coldwater fisheries in Don Pedro Reservoir. The study results are consistent with the reported high quality of warm-water fisheries, including those for three species of black bass. All three black bass species were prominent in gill net and electrofishing surveys and angler surveys conducted as part of this study. Bass nesting habitat conditions were found to be of suitable quality and abundance to support population recruitment that, along with the current bass stocking program, has provided a popular, high quality bass fishery. The surveys also confirmed the presence of quality salmon and trout fisheries. Reservoir conditions in spring and fall are sufficient to provide access to potential trout and salmon spawning streams; however, the coldwater fisheries in the reservoir are dependent upon stocked hatchery fish. The power tunnel intake at Don Pedro Reservoir is located about 250 ft or more below the water surface throughout most years, so it is very unlikely that warm-water fish species are entrained at the Don Pedro Project. Stocked cold-water species occupy cooler, deeper water during some periods of the year, but gill net sampling showed that densities of coldwater fish are extremely low in deep water, so entrainment of coldwater species is also likely to be infrequent. The findings of this study are consistent with all available evidence that suggests that current habitat conditions in Don Pedro Reservoir support quality coldwater and warm-water fisheries. Because the Districts' Proposed Action would have no adverse effects on fish and aquatic resources in Don Pedro Reservoir, the Districts proposed no fish and aquatics related environmental measures for implementation in or around the reservoir.
W&AR -18	Sturgeon Study	The purpose of the *Sturgeon Study* (W&AR-18) was to (1) conduct a literature review and synthesize applicable studies and reports on green sturgeon life history and habitat requirements in the Central Valley and San Joaquin River basin and (2) evaluate the potential for green sturgeon to be affected by Project operations and maintenance activities. There is no evidence that adult, larval, or juvenile green sturgeon currently or historically occupied the Tuolumne River. There are some habitat features within the river that meet requirements for various life stages of green sturgeon; however, this does not mean that the species would be able to complete its life cycle in the river. Sturgeon require specific combinations of "suitable" habitat conditions for breeding and rearing, as indicated by spawning fish that do not use many sites containing apparently suitable substrate, velocity, and depth (Beamesderfer et al 2005). Because 36 years of fisheries monitoring have been conducted without encountering any sturgeon, it can be concluded that Project operations are not likely to affect or influence habitat availability for green sturgeon in the Tuolumne River. As such, the Districts' Proposed Action does not include measures aimed at addressing green sturgeon or the species' habitat.

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
W&AR -19	Lower Tuolumne River Riparian Information and Synthesis	The purpose of the *Lower Tuolumne River Riparian Information and Synthesis Study* (W&AR-19) was to review, summarize, and report information describing the condition of riparian resources and habitats along the lower Tuolumne River. Native riparian vegetation occupies 2,691 acres along a nearly continuous but variable-width band along the lower Tuolumne River corridor. Riparian vegetation along the lower Tuolumne River has increased by approximately 18 percent since it was last mapped in 1997, in large part due to steady survival of existing vegetation and to active planting on several restoration sites within the riparian corridor. Areas with the greatest extent of native riparian vegetation per river mile were mapped along the 12 miles immediately downstream of LGDD. Closer to the confluence with the San Joaquin River, several large restoration projects have also increased the extent of native riparian vegetation. Areas with the least riparian vegetation and narrowest riparian corridor are located in the reach between RM 10.5 to 19.3, which includes the urban areas of Modesto and Ceres. This study was used to inform the proposed shaping of the descending limb of the snowmelt runoff hydrograph in wet and above normal years to mimic natural conditions based on predicted spill levels, a measure that would benefit seed deposition and potentially germination of native riparian plant species.
W&AR -20	*Oncorhynchus mykiss* Scale Collection and Age Determination	The purpose of the *Oncorhynchus mykiss Scale Collection and Age Determination Study* (W&AR-20) was to use scale data to estimate the age-at-length relationship of *O. mykiss* in the lower Tuolumne River. Annual growth appeared consistent and comparable for each of the four years and each of the three age groups of *O. mykiss* assessed for this study, as well as comparable to *O. mykiss* in other rivers. Data from this study were used to estimate fish growth rates, fish size-at-age, and fish size at spawning and to make inferences about food availability for the *Oncorhynchus mykiss* Population Model (W&AR-10), which in turn was used to inform the development of flow measures in the Districts' Preferred Plan, which would increase in-river *O. mykiss* production while protecting the Districts' and CCSF's water supplies.
W&AR -21	Lower Tuolumne River Floodplain Hydraulic Assessment	The purpose of the *Lower Tuolumne River Floodplain Hydraulic Assessment* (W&AR-21) was to (1) develop a hydraulic model for the lower Tuolumne River that simulates the interaction between flow within the main channel and the floodplain downstream of the LGDD to the confluence with the San Joaquin River and (2) apply model results to estimate floodplain juvenile salmonid rearing habitat. A detailed hydraulic model was developed for 52 miles of river and overbank area using the best available topographic and bathymetric data, including a set of new in-channel transects to characterize potential hydraulic controls. The TUFLOW modeling platform was used in the study due to the platform's ability to model complex local hydraulics and features present in the study area including ponds, pools, narrow flow paths connecting river and overbanks, flow paths connecting overbank ponds, and hydraulic structures. Overall, the results of the study show that flows above bankfull discharge are associated with increases in habitat area for juvenile life stages of lower Tuolumne River salmonids. Much of the historical floodplain has been closed off by levees to protect gravel mining, agriculture, and urban areas. Of the estimated 13,000 acres of historical forest area in the Tuolumne River corridor, there currently remains about 2,200 acres. Based on the detailed modeling of the Tuolumne River floodplain by the current study, at 6,000 cfs the inundated floodplain is approximately 1,030 acres. At 3,000 cfs the inundated floodplain is 440 acres. The Floodplain Hydraulic study, as requested by resource agencies and approved by FERC, went beyond developing just the estimate of inundated acreage versus flow relationship and evaluated the usable fry and juvenile Chinook rearing habitat on the floodplain based on depth and velocity characteristics. The study found that at 6,000 cfs, the total Chinook fry rearing habitat is 350 acres (34%) of the inundated acreage and juvenile rearing habitat is 530 acres, or about 50 percent of the inundated acreage. At 3,000 cfs, suitable Chinook fry rearing habitat is 220 acres, or 50 percent, of the inundated acreage, and juvenile rearing habitat is 250 acres, or 57 percent, of the inundated acreage.

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		This study was used to inform the salmonid population models and used to compare floodplain fry and juvenile rearing habitat to in-channel fry and juvenile rearing habitat. Tuolumne River population model studies and IFIM studies showed that in-channel fry and juvenile rearing habitat are not limiting for fall-run Chinook or *O. mykiss.*
n/a	Development of Tuolumne River Flow and Water Temperature Without Dams Model	The purpose of the *Development of Tuolumne River Flow and Water Temperature Without Dams Model* was to simulate water temperature in the mainstem Tuolumne River from above Hetch Hetchy Reservoir to the confluence with the San Joaquin River, in the absence of the Don Pedro Project, Hetch Hetchy Reservoir, and La Grange headpond. The "without dams" condition is intended to represent a river with no reservoirs or regulation, but not intended to be a "pre-development" representation. Comparison of the 7DADM temperatures under with- and without-dams conditions upstream of the Don Pedro Project indicates that summer 7DADM water temperatures would be substantially warmer, up to 4.5°C, in the absence of the upstream Hetch Hetchy impoundments than they are under existing conditions The without-dams simulation reveals that 7DADM water temperatures in the Tuolumne River mainstem, in the absence of impoundments, would approach thermal equilibrium upstream of the current location of the Don Pedro Project. A supplemental analysis conducted by the Districts (Watercourse Engineering 2018) confirms that the EPA (2003) guidelines are often exceeded in the upper Tuolumne River mainstem (defined as the reach above the Don Pedro Hydroelectric Project Boundary to Early Intake) for various spring-run Chinook and anadromous *O. mykiss* (steelhead) life-history stages, despite the cooling effects of Hetch Hetchy flow releases in the upper basin. Exceedances of the frequency revealed by the analysis would make it difficult for spring-run Chinook to complete their life histories in many years. Indeed, if EPA (2003) guidelines actually applied to the upper Tuolumne River, natural conditions would not have supported populations of spring-run Chinook or in some years steelhead because of high water temperatures.
n/a	Lower Tuolumne River Instream Flow Study	The purpose of the *Lower Tuolumne River Instream Flow Study* was to determine instream flows necessary to maximize fall-run Chinook salmon and *O. mykiss* production and survival throughout their various life stages. The final report was submitted to FERC in April 2013 and became part of the record of relicensing studies. Results of the PHABSIM analysis of weighted usable area (WUA) versus flow for each species and life stage were developed and presented in the report. Results of analyses of substrate and cover were also presented. Results for Chinook salmon fry show peak WUA values (e.g., ≥95% of maximum) at approximately 50-100 cfs, with relatively high WUA values (e.g., ≥80% of maximum) below 125 cfs. Results for Chinook salmon juveniles show peak WUA values at approximately 75–225 cfs, with relatively high WUA values below 400 cfs. Results for Chinook salmon spawning show peak WUA values at approximately 250–350 cfs, with relatively high WUA values from 175 to 475 cfs. Results for *O. mykiss* fry show peak WUA values below approximately 75 cfs, with relatively high WUA values at flows ≤125 cfs. Results for *O. mykiss* juveniles show peak WUA values at approximately 75–275 cfs, with relatively high WUA values at flows ≤500 cfs. Results for *O. mykiss* adults show peak WUA values at flows ≥350 cfs, with relatively high WUA values at flows ≥200 cfs. Results for *O. mykiss* spawning show peak WUA values at ≥375 cfs, with relatively high WUA values at flows ≥225 cfs. The FERC-approved PHABSIM study was used to inform the development of the instream flows included in the Districts' Preferred Plan and in the development of the W&AR-06 and W&AR-10 population models.
n/a	Lower Tuolumne River: Pulse Flow Study Report	The Districts also conducted a study of floodplain habitat suitability for fry and juvenile fall-run Chinook and *O. mykiss* under pulse flows as required by FERC and submitted a final report to FERC in June 2012. The purpose of the *Lower Tuolumne River: Pulse Flow Study* was to (1) assess habitat suitability and habitat segmentation for lower Tuolumne River fish species during pulse flow conditions and (2) gather empirical data on the relationship between water temperature and flow during pulse flow events.

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		As reported by McBain and Trush (2000), floodplain habitat is limited along the lower Tuolumne River due to multiple factors, and the majority of over-bank areas identified for this study occur in areas formerly occupied by dredger tailings upstream of RM 40.3. Overall, the results of the study show that pulse flows above bankfull discharge are associated at the locations studied with short-term increases in suitable over-bank habitat area for juvenile life stages of Tuolumne River salmonids. Suitable habitat areas for juvenile salmonid life stages most rapidly increase between bankfull discharges on the order of 1,000 cfs to flows of 3,000 cfs, corresponding to floodplain inundation, and increase less rapidly at nearly all sites studied herein up to the highest flows modeled (5,000 cfs). This study also noted that the highest frequency of stranding and entrapment of juvenile Chinook salmon in historical stranding surveys (1990–1992, 1994–1996, 1999–2000) occurred at sites similar to those used in this study (RM 48.8 to RM 45.9) at flows between 1,100–3,100 cfs (TID/MID 2001). Thus, in addition to concerns related to the water supply implications of attempting to provide and maintain floodplain inundation flows during non-flood conditions, it is likely that there is some tradeoff between potential benefits of additional rearing habitat and the stranding and entrapment of juvenile salmonids as high-flows recede from overbank areas. This study was used as input to the W&AR-06 fall-run Chinook population model. *O. mykiss* in the Central Valley do not generally use floodplains for rearing. A number of sources show that anadromous *O. mykiss* (steelhead)/rainbow trout do not use floodplains for rearing, see Bustard and Narver (1975), Feyrer et al. (2006), Swales and Levings (1989), Keeley et al. (1996), Moyle et al. (2007).
La Grange Hydroelectric Project Studies		
n/a	La Grange Project Fish Barrier Assessment	The purpose of the *La Grange Project Fish Barrier Assessment* was to evaluate the extent to which the LGDD and the La Grange powerhouse act as barriers to the upstream migration and spawning of adult fall-run Chinook salmon and, if they occur in the lower Tuolumne River, anadromous *O. mykiss* (steelhead). Specific objectives included determining the number of adult fall run Chinook and anadromous *O. mykiss* (steelhead) migrating upstream to LGDD and the La Grange powerhouse over two migration seasons (2015-2016 and 2016-2017), comparing these fish to total escapement, and evaluating pre-spawn mortality rates, if any, of fish that arrive at the LGDD and the La Grange powerhouse and do not move back downstream to spawn. As part of the assessment, the Districts also collected instantaneous temperature, turbidity, and dissolved oxygen data at both the main channel and tailrace channel fish monitoring weir locations. Results of the *Fish Barrier Assessment* indicate that *O. mykiss* passages detected in the vicinity of the La Grange facilities during the study predominantly represent movement of "resident" *O. mykiss* rearing in and around the La Grange powerhouse tailrace. Fall-run Chinook salmon are present below the La Grange Project, although the study did conclude that fish exhibiting persistent upstream migration (i.e., defined as fish that move upstream to the La Grange facilities and do not return to downstream spawning habitat) made up less than 1 percent of the observations during the two-year monitoring period. This may be because nearly all fall-run Chinook salmon below the La Grange Project during the study were hatchery strays (TID/MID 2017h). Previous studies in the lower Tuolumne River have also found that hatchery fish make up a large proportion of the annual spawning runs, and the proportions of hatchery fish have been increasing in recent years (TID/MID 2016c). There are no hatcheries on the lower Tuolumne River, so hatchery fish are out-of-basin strays. Anadromous salmonids are known to home to natal streams with high fidelity (Hasler et al. 1978; Cooke et al. 2011). Chinook of hatchery origin that stray into the lower Tuolumne River are likely exhibiting a variety of movement behaviors, including upstream and downstream movement, and searching to identify appropriate homing cues to return to natal locations. Furthermore, although the Tuolumne River population may consist primarily of hatchery strays, these fish appear to be reproducing successfully in the Tuolumne River with little impact on overall in-river production. Pre-spawn mortality of fall-run Chinook below the La Grange facilities was extremely low and did not appear to affect Chinook production during the study period. These observations were also consistent with the low levels of pre- or partial-spawn mortality data collected during CDFW surveys conducted in previous years. Water quality data collected indicated that in general, satisfactory conditions were present for aquatic life. However, during the first year of the assessment (2015), there was a brief period from late September through October during which daily instantaneous measurements of dissolved

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		oxygen below 8.0 mg/L were recorded at the tailrace channel weir location. The low instantaneous dissolved oxygen levels appeared to be a localized event, as dissolved oxygen levels at the main channel weir remained above 8.0 mg/L during the same period. To further evaluate the potential cause of this spatially and temporally isolated event, the Districts proposed to monitor dissolved oxygen from September 1 to November 30 each year for the first two years of a new La Grange FERC operating license. If results indicate a specific cause for low dissolved oxygen exists, the Districts will develop and submit an action plan to FERC in year three of the license term.
n/a	n/a	Prior to and during the Don Pedro relicensing and La Grange licensing processes, the Districts released a minimum flow of approximately 5 to 10 cfs to the plunge pool downstream of LGDD at all times to sustain favorable water quality conditions for resident and migratory fish species. Additional water resources studies conducted as part of the Don Pedro Hydroelectric Project relicensing (see above) indicated no adverse effects on water resources in the La Grange headpond or the lower Tuolumne River would be expected as the result of continued hydroelectric power generation at the Project. But to continue ensuring consistent and adequate flow to support aquatic resources in the mainstem Tuolumne River reach downstream of the LGDD, the Districts propose to formalize current Project operations to provide a minimum flow of approximately 5 to 10 cfs to the plunge pool downstream of LGDD at all times.
n/a	Topographic Survey/Hydraulic Study of the Sluicegate Channel	The purpose of the *Topographic Survey/Hydraulic Study of the Sluicegate Channel* was to collect information to evaluate the effects of Project operation on stream flow and anadromous fish habitat in the Tuolumne River between LGDD and the La Grange USGS gage. Topographic measurements included longitudinal measurements of the mainstem Tuolumne River, the TID sluice gate channel, the La Grange powerhouse tailrace channel, and the large cobble and bedrock island. Two points of hydraulic control were identified in the mainstem channel and two points of hydraulic control were identified in the La Grange powerhouse tailrace channel. Depth measurements along the surveyed longitudinal profiles were recorded under discharges identified in the Revised Study Plan (RSP). In 2016, a hydraulic study of the TID sluice gate channel was completed. If the La Grange powerhouse trips off line, the sluice gate(s) located adjacent to the penstock intakes is immediately opened to maintain discharge in the tailrace channel. When powerhouse operation is restored, the sluice gate(s) closes. An 18-inch pipe delivers approximately 5 to 10 cfs from the forebay structure to the sluice gate channel continuously, maintaining flowing water to the sluice gate channel (TID/MID 2017k). The Districts performed field survey measurements of topography and water surface elevation in the channel below the sluice gate at the constant flow from the 18-inch pipe, which was measured to be approximately 8 cfs and at a sluice gate flow of 80 cfs. This information and water surface elevation data were used to develop a HEC-RAS (version 5.0.3) hydraulic model, and plot cross-section and longitudinal depth profiles to quantify the stage-flow relationship during operation of the sluice gates to enable the evaluation of the potential for fish stranding (TID/MID 2017k). Modeled HEC-RAS outputs indicate zones of continuous water connectivity and an absence of isolated pools during the changing flows following gate closure. This matches field observations made during the La Grange study program after gate closure. Unsteady flow analysis of a two-minute gate closure event (in which the flow rate changes from 100 to 5 cfs) indicates the existence of a continuous flow channel as flow is reduced to the approximate minimum of 5 cfs (TID/MID 2017k).
n/a	Salmonid Habitat Mapping	He purpose of the *Salmonid Habitat Mapping* study was to examine the potential effects of Project operations on anadromous fish habitat in the Tuolumne River in the vicinity of the LGDD and La Grange Project facilities. Results indicate that the main channel in the study area is dominated by pool habitat, including a plunge pool immediately downstream of the LGDD, a large mid-channel pool adjacent to the MID hillside discharge, and two smaller pools in the lower portion of the channel. There are a total of three small, low-gradient riffles with no spawnable substrate in the lower portion of the main channel. The tailrace channel includes two riffles, one of which includes spawnable substrate, along with one run in the lower portion of the channel. The upper portion of the tailrace channel includes a single pool with turbulent flow from the La Grange powerhouse discharge along with a glide associated with the tailout of this pool. Estimated average width of habitats in the tailrace channel is approximately 50 feet. The TID sluice gate channel is a high-gradient step-pool that originates at the TID canal and empties into the pool at the upstream portion of the tailrace channel. For fall-run Chinook salmon, the total area of suitable spawning gravel within the tailrace channel was estimated to be 13,610 ft^2. Of that area, 9,014 ft^2 was estimated to meet the spawning depth and velocity criteria at approximately 175 cfs (Table 3.5-7). There was no suitable spawning gravel found in the Tuolumne River main channel or TID sluice gate

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		channel, and no suitable spawning substrate found for *O. mykiss* at any location within the study area. No specific adverse Project effects are occurring, nor were any specific potential enhancements identified.
n/a	Fish Presence and Stranding Assessment	The purpose of the *Fish Presence and Stranding Assessment* was to formally document fish observations in the vicinity of the LGDD, La Grange powerhouse tailrace, and the TID sluice gate channel, evaluate fish presence in the sluicegate channel and, if needed, relocate fish, and to document redd dewatering, if any, in the tailrace channel over two migration seasons (i.e., fall through spring). During the 2015-2016 monitoring period, juvenile Sacramento pikeminnow and juvenile Sacramento sucker accounted for 95 percent of the observations. During the 2016-2017 monitoring period, adult fall-run Chinook salmon accounted for 98 percent of the observations. The majority of these observations were likely the same individual fish observed multiple times over consecutive days. A constant minimum channel maintenance flow of approximately 5 to 10 cfs is provided in the sluice gate channel at all times to significantly reduce the risk of stranding any fish that may enter the channel during a high-flow event (due to the La Grange powerhouse tripping offline). The La Grange powerhouse tripped offline, and the TID sluice gate opened a total of 29 times, 18 times with a duration ranging from 0.25 to 505.5 hours (median 40.5 hours) during the 2015-2016 monitoring period and 11 times ranging from 1.0 to 29.75 hours (median 10.0 hours) during the 2016-2017 monitoring period. During each event, TID operators and a qualified biologist were on site and surveyed the channel for stranded fish as the sluice gate was closed and flow was reduced to the minimum flow of approximately 5 to 10 cfs. Adult fall-run Chinook salmon were documented to enter the sluice gate channel during periods when the sluice gates were opened and at minimum flow conditions during both monitoring seasons (a total of 7 occasions). Given that a minimum flow of 5 to 10 cfs is maintained in the sluice gate channel, stranding of fish in this channel has been extremely rare. The occurrence of stranding in the sluice gate channel was limited to a single event during the study. To evaluate the potential for dewatering of redds, water level data collected in the tailrace channel over the past two years were evaluated. Results show that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline resulting in a relatively stable flow in the tailrace channel. Based on water level data recorded at 15-minute intervals, the maximum elevation change between readings was 0.57 foot during the 2015-2016 monitoring season. Monitoring data indicated that no redds were dewatered in the tailrace. Given that the sluice gates open immediately when the La Grange powerhouse trips offline, there is very little risk of dewatering the tailrace channel during these operational changes. To assess whether fish enter the TID sluice gate channel and become stranded, the Districts propose to install a fish exclusion barrier at the channel entrance. The fish exclusion barrier will allow the sluice gate to divert powerhouse flows during an outage while preventing fish from entering the sluice gate channel where dewatering or stranding could occur once hydropower generation is restored. Once constructed, sluice gate channel maintenance flows of approximately 5 to 10 cfs will no longer be necessary.
n/a	Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes	The purpose of the *Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes* was to evaluate the potential impact of certain La Grange powerhouse facilities on adult fall-run Chinook salmon and *O. mykiss*. Specific objectives included documenting resident *O. mykiss* and adult anadromous salmonid behavior in the vicinity of the La Grange powerhouse discharge, describing behavior in relation to operations, and determining if fish are moving into the draft tubes of operating units. During the 2015-2016 migration season, an imaging sonar unit was deployed immediately downstream of the Unit 1 draft tube pit to evaluate fish behavior during operations and potential entry into the unit. Study results indicate that the area in the vicinity of the draft tube pit was occupied frequently by adult fish. Weir counts from the *Fish Barrier Assessment* indicated that the majority of observations at the tailrace weir were of adult salmonids, although striped bass, Sacramento pikeminnow, common carp and goldfish were also observed. Though fish presence in the vicinity of the La Grange powerhouse was evident, individuals were detected most frequently in the foreground of the field of view and not close to the draft tube. It appears that adult fish often occupy the area in front of the powerhouse but do not approach the draft tube. This result was evident during both Unit 1 On and Unit 1 Off

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		conditions. Adult fish were not observed to occupy the area under the draft tube when Unit 1 was operational. Furthermore, fish were rarely observed occupying the area under the draft tube when Unit 1 was not operational. The study results indicate that there is likely an extremely low risk of fish entering the draft tube and it is even less likely that a fish would swim vertically up the draft tube and leap into and be injured as a result of contacting the turbine runners in Unit 1 while it is in operation. Given that both units at LGDD are vertically-oriented Francis units with conical, straight-drop draft tubes (not elbow draft tubes) and the low steel of the turbine runner is significantly above tailwater elevation during normal operation, it is likely that the study results apply to both units. These results were corroborated by field crews that were on site daily (Fish Presence and Stranding Assessment [TID/MID 2017f]) throughout the study period, which reported no observations of injuries or mortalities of adult fish that would have indicated evidence of fish being struck by turbine blades (TID/MID 2017g). No specific adverse Project effects are occurring, so no potential enhancements were identified.
n/a	Fish Passage Facilities Alternatives Assessment Upper Tuolumne River Reintroduction Assessment Framework and Voluntary Studies	*Fish Passage Facilities Alternatives Assessment* The purpose of the *Fish Passage Facilities Alternatives Assessment* was to investigate the feasibility of providing upstream and downstream passage of spring-run Chinook salmon and anadromous *O. mykiss* (steelhead) at the La Grange and Don Pedro dams, and included identifying, developing, and evaluating concept-level passage alternatives. The study was implemented in two phases: (1) Phase 1 consisted of gathering information on facility siting, facility sizing, general biological and engineering design parameters, and hydrology and operational considerations within a collaborative framework to allow agency input on information necessary to further develop alternatives and (2) Phase 2 included the development of functional site layouts, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable construction and O&M costs for select fish passage alternatives. Considerations addressed during the development of preliminary functional layouts for upstream and downstream passage alternatives included (1) major facility design elements, (2) O&M, (3) anticipated facility performance, and (4) costs of the facilities. The results of these tasks were then used to investigate the overall technical feasibility of each potential fish passage facility alternative. Results of the *Fish Passage Alternatives Assessment* indicated that of the five potential upstream fish passage alternatives, only a Collection, Handling, Transport, and Release (CHTR) facility was determined to be technically feasible. The remaining four alternatives were not determined to be technically feasible based on the evaluation factors. Of the alternative concepts developed, none of the alternatives investigated that were volitional in nature could be considered likely to meet performance standards given the 213 feet of total reservoir fluctuation that can occur at Don Pedro Reservoir during the anticipated period of migration. None of the downstream alternatives were determined to be technically feasible based on the study's evaluation factors. Of the technologies evaluated, only one alternative is of a type that is currently in operation: Alternative D2A, a floating surface collector near Don Pedro Dam. The remaining alternatives represent downstream fish passage technologies that are yet to be applied in practice at a full scale, and it cannot be known how or whether such a facilities will work. Therefore, these alternatives are experimental. In each case, there are no facilities in existence to provide an adequate operational history that can inform the engineering, operational, or performance aspects of the alternatives. For all alternatives, the anticipated reservoir passage efficiency and collection efficiency standards are not likely to meet the performance standards required at other high dam facilities in operation. For all alternatives, including D2A, the anticipated Don Pedro Reservoir passage efficiency and facility collection efficiency would be highly unlikely to provide safe and effective juvenile passage, or achieve the performance standards required at other high dam facilities that are in operation. Operation of a floating surface collector near Don Pedro Dam is highly unlikely to provide timely or effective downstream fish passage for outmigrating anadromous salmonids. The high head nature of the dam combined with the dramatic (i.e., up to 213 feet) fluctuations in reservoir surface elevation in Don Pedro Reservoir and associated seasonal changes in temperature and velocity create challenging conditions for fish collection. No existing collection facilities currently operate under such dynamic conditions and operation of a juvenile downstream collection facility at the head of reservoir would be experimental in nature (TID/MID 2017d).

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		Upper Tuolumne River Reintroduction Assessment Framework During a Phase 1 workshop convened as part of the *Fish Passage Alternatives Assessment*, held on May 20, 2015, the Districts provided an overview of the types of design information required to inform the development and evaluation of fish passage alternatives, and to further the design process, the need for this information to be provided by NMFS, as the agency with management jurisdiction over the salmonid species being considered for fish passage. The Districts also outlined the purpose and need for providing fish passage facilities in the broader context of the feasibility of anadromous fish reintroduction to the upper Tuolumne River. Because anadromous fish are not present in the upper Tuolumne River, the design, construction, and operation of fish passage facilities is intrinsically linked to the needs of the fish populations under consideration for reintroduction. The related question of the feasibility of fish reintroduction encompasses consideration of such issues as genetics of introduced and resident species, colonization strategy, source population, habitat suitability, carrying capacity, recreation impacts, socioeconomic effects, and compatibility with current uses, among other variables. Consideration of all these questions suggested the need for a broader reintroduction planning framework within which to evaluate the sizing, characteristics, configuration, operations, effectiveness, and cost of fish passage facilities. Through additional workshops, the Districts and all licensing participants developed and approved of a conceptual framework for considering fish passage feasibility and assessing overall reintroduction viability, as advised by Anderson et al. (2014). This conceptual framework is intended to provide a comprehensive, collaborative, and transparent approach for evaluating the full range of potential questions and issues associated with the future reintroduction of anadromous fish to the upper Tuolumne River. In addition to considering aspects of the technical feasibility of building and operating fish passage facilities at the Don Pedro and La Grange projects, the framework considers the interrelated issues of ecological feasibility, biological constraints, economics, regulatory implications, current uses of the resource, and other considerations relevant to reintroduction. On January 27, 2016, the Districts, in collaboration with licensing participants, began the implementation of the upper *Tuolumne River Reintroduction Assessment Framework* (*Assessment Framework*). At this meeting, a draft implementation process and schedule, a summary of existing available information, and a preliminary studies list (to address information gaps) was developed to help define 2016 and 2017 activities. In advance of the 2016 field season, the Districts developed study plans for seven additional studies in collaboration with *Assessment Framework* participants that would be voluntarily implemented by the Districts. These studies addressed habitat, spawning gravels, instream flows and peaking, hatchery stocking practices, macroinvertebrates, and socioeconomic and regulatory considerations and were in addition to (1) two voluntary studies already being conducted by the Districts in the upper Tuolumne River with regards to water temperature modeling and migration barriers and the (2) *Fish Passage Alternatives Assessment*. All of these studies were intended to support a comprehensive evaluation of fish introduction feasibility into the upper Tuolumne River. Study reports for these voluntary studies have been filed as part of the La Grange FLA and as part of a subsequent filing made by the Districts on March 15, 2018. The Districts conducted additional evaluations after filing the La Grange FLA to evaluate population sustainability of spring-run Chinook in the upper Tuolumne River, Tuolumne River *O. mykiss* genetics, and further evaluated EPA (2003) temperature guidelines using the upper Tuolumne River temperature model. In total, 13 studies were conducted by the Districts to support the *Assessment Framework*. The results of these upper river studies are presented and evaluated comprehensively as part of the document *Feasibility of Successfully Introducing Anadromous Fish into the Upper Tuolumne River Basin* (TID/MID 2018), filed with FERC on March 15, 2018. Analysis of data collected by the Districts and evaluation of other sources of information demonstrate that attempts to introduce anadromous salmonids into the upper Tuolumne River basin are unlikely to be successful. Supporting study results indicate that physical habitat availability and water temperature would limit anadromous fish production in the upper Tuolumne River basin. Much of the riverine habitat, particularly in the tributaries, is inaccessible due to natural migration barriers. Dramatic flow fluctuations due to peaking operations associated with CCSF's Holm Powerhouse would greatly limit physical (i.e., hydraulic) habitat suitability in the mainstem Tuolumne River. Also, much of the habitat in

Study No.	Study Title	Use of Study Results to Inform Proposed Future Operations and PM&E Measures
		the accessible portions of the tributaries is hydraulically and/or thermally unsuitable for salmonids. Competition with resident fish and predation would influence the productivity of any introduced anadromous fish. Selection of donor stocks would require careful consideration of genetics and impacts on the source populations and resident fish established in the receiving waters. Life-cycle modeling shows that survival of juvenile fish passed downstream would be low due to an array of factors, including introduced predators, habitat alteration, and water diversions, among others. The costs of constructing, operating, and maintaining fish passage facilities would be high, and successfully operating and maintaining an experimental downstream fish passage facility would be infeasible due to a variety of constraints. In addition, regulatory changes to how resources are managed in the Tuolumne River and Don Pedro Reservoir could result in substantial socioeconomic impacts, the most significant of these being potential constraints on the operation of CCSF's Hetch Hetchy Project. Moreover, as noted by Anderson et al. (2014), in the case of introductions requiring adaptation to new habitat (i.e., the upper Tuolumne River basin) it would likely require decades before populations could become established. The authors further state, "Combined with the multiple generations probably required to achieve potential benefits, this suggests that reintroduction will rarely be a quick fix for improving the status of an ESU or population at immediate risk of extinction." NMFS has not conducted sufficient research and planning to justify the introduction of spring-run Chinook into the upper Tuolumne River or to connect the *O. mykiss* population upstream of the Don Pedro Project with the one located downstream of LGDD. Furthermore, NMFS has not given reasonable consideration to alternative recovery strategies for the Tuolumne River Basin. As Anderson et al. (2014) point out, "It is also important to remember that reintroduction is only one management option. In some cases, reintroduction may be essential for the conservation of a particular life history type or evolutionary lineage. In other cases, management strategies designed to improve the reproductive success, survival, and productivity of extant populations might offer a better return on the investment dollar than reintroduction. Therefore, based on the results of the evaluations described above, the Districts did not propose to pursue the development of fish passage facilities or other measures to introduce spring-run Chinook and/or anadromous *O. mykiss* (steelhead) into the upper Tuolumne River.