**Priority 2: Provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids.**

### Species Information

**What salmonid species are you targeting?**

Juvenile Central Valley spring-run Chinook salmon are the primary target of the spring flow pulse provided by the proposed project. April represents the peak month for outmigration of juvenile spring-run Chinook from the Feather and Sacramento River basins.

Winter-run Chinook juveniles and juvenile steelhead in the Sacramento River downstream of Verona (the confluence with the Feather River) will also benefit from the flow pulse provided by the proposed project.

Steelhead smolts emigrating from the Feather and Sacramento River basins will also benefit, but insufficient data are available to quantify these benefits.

### Additional locations in the application, supporting documentation or attachments (document name, page number, table number, other) where the flow related habitat needs of each species are described.

The basis for expected flow-related benefits are described and source-referenced in the Cramer Fish Sciences Technical Memorandum (CFS 2017) See also Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 (CFS 2017 report) in WSIP funding application.

Also see NMFS (2016a) and NMFS (2017) referenced in CSF 2017 report.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

### REV 2: Magnitude of ecosystem improvements

**What is the expected magnitude of the ecosystem improvement that will address this priority?** Magnitude should be expressed as: a) the change from current conditions without the project to current conditions with the project, and b) the change from 2030 conditions without the project to 2030 conditions with the project. How did you estimate this value? If the ecosystem improvement will benefit multiple salmonid species or runs, provide the magnitude of the ecosystem improvement for each species or run separately.

In 2030 conditions, the project provides for seven additional April, Feather River flow pulses over 82 years of simulated hydrology (MBK 2017). Over fifty years of operations with the project (2030 conditions) these April flow pulses are expected to provide a net benefit of 10,115 additional ADULT Central Valley spring-run Chinook salmon and 10,941 additional ADULT Sacramento River winter-run Chinook salmon. Additionally, the flow pulses are expected to provide an estimated net increase of 95 additional ADULT steelhead trout.

In the 2070 condition, the project provides for five additional April, Feather River flow pulses over 82 years of simulated hydrology (MBK 2017). Over fifty years of operations (2070 conditions) these April flow pulses are expected to provide a net benefit of 715 additional ADULT Central Valley spring-run Chinook salmon and 3,273 additional ADULT Sacramento River winter-run Chinook salmon. Additionally, the flow pulses in 2070 are expected to provide an estimated net increase of 62 additional ADULT steelhead trout.

Methods used to assess and quantify these methods are described in the Cramer Fish Sciences Technical Memorandum See Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 (CFS 2017 report) in WSIP funding application.

See Revised MBK Engineers Technical Memorandum and spreadsheets provided as part of the Appeal.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

Additional locations in the application, supporting documentation or attachments (document name, page number, table number, other) where the magnitude of the ecosystem improvement is described and quantified.
The basis for expected flow-related benefits are described and source-referenced in the Cramer Fish Sciences Technical Memorandum. See Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 (CFS 2017 report) in WSIP funding application. Also see NMFS (2016a) and NMFS (2017) referenced in CSF 2017 report.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

### REV 3: Spatial and temporal scale of ecosystem improvements.

What is the geographical extent (e.g. river miles, acres) of the ecosystem improvement that will address this priority?

Flow pulses associated with the project will effect approximately 60 river miles of the Feather River (from the Thermalito Afterbay Outlet to Verona) and 67 river miles of the Sacramento River (from Verona to Rio Vista).

Additional locations in the application, supporting documentation or attachments (document name, page number, figure name or number, other) where the geographical extent of the ecosystem improvement is documented or mapped.

https://www.sacramentoriver.org/sac_river_atlas.php
http://www.water.ca.gov/orovillerelicensing/docs/wg_study_reports_and_docs/EWG/sp-g2_interim_report_part_c%20.pdf

When during the year will the project provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids? How are flows likely to vary with hydrologic conditions (i.e. among water year types) a) under current conditions with and without the project, and b) in 2030 with and without the project? If the ecosystem improvement will benefit multiple salmonid species or runs, provide the timing of ecosystem improvements for each species or run separately.

The flow pulse will occur in the month of April. With 2030 conditions, over 82 years of historic hydrologies the flow pulse occurs seven-six times. Five times in dry water years and twice once in an extremely dry water year. Since flow pulses occur in years with generally low river flows (without the project), greater benefits are achieved for target salmonids (the assumed flow-survival relationship is non-linear, see Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 (CFS 2017 report) for more information).

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

### REV 4: Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers to achieve ecosystem benefits.

Provide additional information on how this ecosystem improvement will be incorporated into the adaptive management and monitoring program. If available, provide examples of objectives, performance measures, thresholds, or triggers that could be used to manage benefits associated with this priority.

Natural resource management entities (DWR, NMFS, CDFW, USFWS, USBR) regularly conduct survival studies on outmigration of juvenile Chinook salmon and steelhead. A relevant performance metric for the proposed project would be an observed flow-survival relationships consistent with the predicted flow-survival relationships described by NMFS (2017) and utilized in the project analysis (CFS 2017). New information on the patterns of flow-survival or emigration timing for spring-run and winter-run Chinook juveniles may suggest changes in the timing or magnitude of flow pulses provided by the project. See Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 (CFS 2017 report) in WSIP funding application.

IRWD will participate in and support flow-survival studies relevant to evaluating performance of the flow pulses in achieving expected ecosystem benefits.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.
### REV 5: Immediacy of ecosystem improvement actions and realization of benefits

**Immediacy of ecosystem improvement**: Number of months from grant encumbrance until the proposed ecosystem improvement is completed (i.e., the expected timeframe until the improvement is implemented or construction is completed).

The project will require 3 years and 6 months for construction and is expected to begin storing water available for flow pulses by the year 2025. The year in which the first flow pulse will be delivered is dependent on future hydrologies and cannot be predicted in advance.

**Realization of ecosystem improvement**: Number of months from the time the ecosystem improvement is completed (i.e., project is implemented or construction is complete), until the benefit associated with this priority can be observed (i.e., when measurable improvements can be observed and quantified).

Analysis conducted by MBK indicates 26 flow pulses will occur with the project over 82 years of historic hydrologies (2030 conditions). If we assume each historic water year is an independent event, then there is 8.57.3% probability of a project flow pulse occurring in any year after the project is fully operated. There is a greater than 50% probability of at least one project related flow pulse occurring within ten years of the project operating.

**REV 6: Duration of ecosystem improvements**

How long (number of years) after realization (as calculated under REV 5 above) is the ecosystem improvement expected to address this priority? Maximum is 100 years. Explain how this value was determined and whether the magnitude of the ecosystem improvement is anticipated to change over time.

After realization, a minimum of 138,860,000 AF of groundwater will need to accrue in the Ecosystem Benefits account in order to make a flow pulse. Assuming historic hydrologies and each water year occurs as independent event, flow pulses associated with the project are expected to occur with an annual probability of 8.57.3%. The ecosystem improvement will address this priority whenever a flow pulse occurs.

**REV 7: Consistency with species recovery plans and strategies, initiatives, and conservation plans**

Does the ecosystem improvement meet any goals or objectives established in existing species recovery plans, initiatives, or conservation plans including but not limited to the NOAA Fisheries Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead; State Wildlife Action Plan; Central Valley Joint
Venture Implementation Plan, San Joaquin County Multi-Species Habitat Conservation Plan and Open Space Plan, Draft Solano Multi-Species Habitat Conservation Plan, East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan, Draft Recovery Plan for the Giant Garter Snake, and California Water Action Plan? If so which goals, objectives, or actions will be met? Why?

Yes. Flow pulses to improve rearing and outmigration survival of winter-run Chinook salmon, spring-run Chinook salmon and steelhead are identified in the NMFS recovery plan for the species. Specifically, Actions IDs SFB-1.3, DEL-1.1, DEL-1.3, and FER-1.10 from the 2014 NMFS recovery plan. In addition, the Biological Opinion for operation the Oroville Facilities (NMFS 2016) specifically calls for evaluation of Feather River flow pulses to benefit spring-run Chinook, steelhead and green sturgeon.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

Additional locations in the application, supporting documentation or attachments (page number, table number, other) where the consistency with goals, objectives, or actions from recovery plans, initiative, or conservation plans are discussed.

See Cramer Fish Sciences Report under file name IRWD_Tab 4-A2-CFS_TechMemo_Final.docx included in the Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

REV 8: Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values

Provide a map that shows the extent of the ecosystem improvement that will address this priority (e.g. river miles that meet the temperature benefits). Provide additional instructions or clarification to reviewers who will be viewing this map (i.e. describe the color and/or label that identifies the spatial extent of the ecosystem improvement). If available, also submit supporting electronic files such as a .kmz file or ArcGIS layer associated with the maps provided.

The ecosystem benefits associated with the project will occur within the active channel of the Feather River. A map of the Feather River is included in under Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2, see IRWD_FeatherRiverMap.pdf.

Explain why this location was selected. How is the location beneficial to the targeted species in the context of local environmental conditions and the target species’ needs?

The Feather River was selected because of its function as a corridor of water conveyance for the State Water Project and because the Feather River hosts in-river and hatchery spawning. Feather River spring-run Chinook salmon both part of the listed CV spring-run Chinook salmon ESU (NMFS 2016b). NMFS, in their most recent five-year review of CV spring-run, assigned a recovery priority for spring-run Chinook salmon in the Feather River of 5 (with 1 being the highest priority, 12 being the lowest priority) (NMFS 2016b). These determinations are based upon the evolutionary legacy the Feather River spring-run stock represents, because the stock continues to exhibit a CV spring-run Chinook salmon migration timing, and because of habitat and management improvements required as part of the Oroville Facilities FERC Relicensing Settlement Agreement.

Project flow pulses originating in the Feather River affect the Sacramento River downstream of Verona and thereby benefit spring-Chinook, winter Chinook and steelhead originating from points upstream in the Sacramento River basin.

Per CFS, though natural origin of steelhead smolts occur in the Feather River, information on their abundance and emigration timing is highly uncertain (NMFS 2016b). In contrast, annual production of steelhead smolts by Feather River Hatchery (FRH) is well understood. FRH steelhead are released into the Feather River in late winter/early spring. CFS assumed all FRH steelhead releases occur at Boyd’s Pump for survival benefits associated with the pulse flow.

See Cramer Fish Sciences Report included in Physical Public Benefits Tab, Ecosystem Benefits Section, Attachment 2 – CFS 2017 report for references cited above.
See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.

Is the ecosystem improvement location adjacent to, or near, other areas already being protected or managed for conservation values? Explain the proximity of the ecosystem improvement to other areas already being protected or managed for conservation values and any hydrologic connectivity that may occur between these locations.
The Feather and Sacramento River corridors are adjacent to numerous habitat features managed for conservation of anadromous salmonids and other species. For example, existing or future floodplain enhancements on the Feather and Sacramento River could benefit from project flow pulses if those flow pulses helped to extend or achieve floodplain inundation in conjunction with flow pulse events originating from other water sources. The flow pulses provided by the project are not expected to appreciably inundate floodplain features alone, but could compliment other such efforts.

Are the flows provided physically accessible by the targeted species in all year types? If not, explain barriers that may exist between the targeted species and ecosystem improvements.

Yes. The Feather and Sacramento Rivers are essential migratory corridors for juvenile salmonids in April of all water year types.

Additional locations in the application, supporting documentation or attachments (document name, page number, figure name or number, other) that describe and quantify the spatial extent of the ecosystem improvement, the proximity of the ecosystem improvement to other areas already being protected or managed for conservation value, and the degree to which hydrologic connections (if any) occur between the ecosystem improvement and areas already being protected or managed for conservation value.

None that can be specifically identified and quantified.

**REV 9: Efficient use of water to achieve multiple ecosystem benefits**

How will water provided to address this priority be managed? Explain design efficiencies and operational strategies intended to maximize the efficiency of water allocated to ecosystem improvements that address this priority.

Ecosystem benefits for this priority are achieved when a flow pulse is released. In the years when flow pulses are released, Delta carriage water costs are reduced because project water was exported during periods of Delta surplus with no carriage water cost and stored in the export service area. The model used to calculate these benefits assumes 20 percent carriage water and the 3 percent conveyance loss can be saved when extracting water from the project for delivery within the export service area instead of meeting those demands from Oroville Reservoir.

Additional locations in the application, supporting documentation or attachments (document name, page number, figure name or number, other) that describe the design efficiencies and operational strategies used to maximize water efficiency under this priority.

For a description and details on design efficiencies and operational strategies to maximize water efficiency, see page 6 of the MBK Engineers’ Report included under Feasibility and Implementation Risk Tab, Attachment 1 - Technical Feasibility (MBK Engineers, 2017 report), and see also Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 – CFS 2017 report. See Revised MBK Engineers Technical Memorandum and spreadsheets provided as part of the Appeal.

**REV 10: Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change.**

Which environmental uncertainties associated with this priority were considered in the project siting, design, and operation? How were these uncertainties incorporated into project siting, design, or operation? Examples of environmental uncertainties include, but are not limited to: sea level rise, temperature changes, changes in precipitation, landslides, erosion, earthquakes, wildfires, drought events, and flooding events.

MBK Engineers (MBK) performed uncertainty analyses related to potential climate change, the California Water Fix, and the project’s performance during drought. Using the results from these uncertainty analyses, CFS determined the change in winter-run and spring-run adult Chinook salmon over fifty years of project operations. Under 2070 climate change conditions, the project provided a net benefit of 7,154,283 (range of 476-953) spring-run Chinook and 7,324,223 (range of 48-97) winter-run Chinook, and a net benefit of 62 (range of 42-83) steelhead under 2070 climate change conditions. Under the California Water Fix future condition the project provided a net benefit of 10,444,623 (range of 696-1392) spring-run Chinook, and net benefit loss of 74,444,223 (range of 50-99) winter-run Chinook, and a net benefit of 130 (range of 87-174) steelhead. The reason for net loss of winter-run Chinook is because North Delta diversions associated with the California Water Fix more directly impact winter-run Chinook smolts than do South Delta exports. Further information on the uncertainty analyses preformed can be found in the MBK Engineers’ and the CFS reports under Feasibility and Implementation Risk Tab, Attachment 1 - Technical Feasibility (MBK Engineers, 2017 report) and also Physical Public Benefits Tab, Ecosystem Benefits, Attachment 2 – CFS 2017 report. See Revised MBK Engineers Technical Memorandum and spreadsheets provided as part of the Appeal.

See Revised CFS Technical Memorandum and models and Supplemental Technical Memorandum on Steelhead Benefits provided as part of the Appeal.
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