

Kern Fan Groundwater Storage Project

FEASIBILITY REPORT

Attachment 8: Preliminary Operations Plan

October 21, 2019
Updated April 13, 2020



Kern Fan Groundwater Storage Project

Preliminary Operations Plan

Benefit Calculation, Monetization and Resiliency Tab Attachment 2

The Kern Fan Groundwater Storage Project (Kern Fan Project or Project) will be operated to provide both public and non-public benefits by recharging and storing State Water Project (SWP) unallocated Article 21 water in the Kern County Subbasin of the San Joaquin Valley Groundwater Basin in wet years and extracting water when needed in dry years to provide ecosystem, emergency supply, and water supply benefits.

Key features of the Preliminary Operations Plan include:

1. Modeling and Analytical Approach
2. Project Facilities (Phase 1 and Phase 2)
3. Project Water Supply, Storage and Integration with SWP
4. Operations for Public and Non-Public Benefits
5. Uncertainties and Preliminary Adaptive Management Strategies

1. Modeling and Analytical Approach

Water Supply and Operations Modeling

MBK Engineers prepared an analysis based on the computer modeling for the Kern Fan Project. This analysis involved the use of CalSim II model results to depict the without Project (Baseline) scenario. The CalSim II model simulates operations of the Central Valley Project (CVP) and SWP in order to meet existing environmental and regulatory requirements, contract obligations and other system requirements. The model considers the effects of the Project extending to the Delta for source of water for the Project and upstream on the Feather River for ecosystem benefits. Project operations is expected to affect the following locations:

1. Delta outflows
2. SWP Delta exports
3. Flows in Feather and Sacramento Rivers and inflows to Delta
4. Storage in Lake Oroville
5. Storage in San Luis Reservoir
6. Water supplies for non-public benefit

The expected storage capacity associated with the Project that was modeled is 100,000 AF. This storage capacity was allocated into three groups of Project beneficiaries as follows:

- 25,000 AF to Ecosystem Benefits
- 37,500 AF to IRWD and Dudley Ridge Water District (DRWD)
- 37,500 AF to Rosedale and Kern County Water Agency (KCWA)

MBK Engineers estimated the Project yield using the CalSim II model results that depict the without-Project (Baseline) scenario within a spreadsheet model. The operation of Project is then layered onto the baseline operation of the CalSim II results to simulate the with-Project scenario. Project benefits are then determined and quantified by comparison of the with-Project and without-Project scenarios. The Baseline scenario for this analysis is the Water Storage Investment Program (WSIP) 2030 CalSim II model dated November 2, 2016. This model simulation is described as a without-project, 2030 and 2070 future conditions with projected climate and sea-level conditions for a thirty-year period centered at 2030 (WSIP 2030).

In addition to analyzing the project performance with the 2030 and 2070 WISP conditions an uncertainty analyses of potential future climate change and the California WaterFix were analyzed. MBK Engineers Technical Memorandum provides additional detail on the analytical approach and is included in **Feasibility and Implementation Risk Tab, Attachment 1** of the WSIP funding application.

Project Operations for Ecosystem Benefits

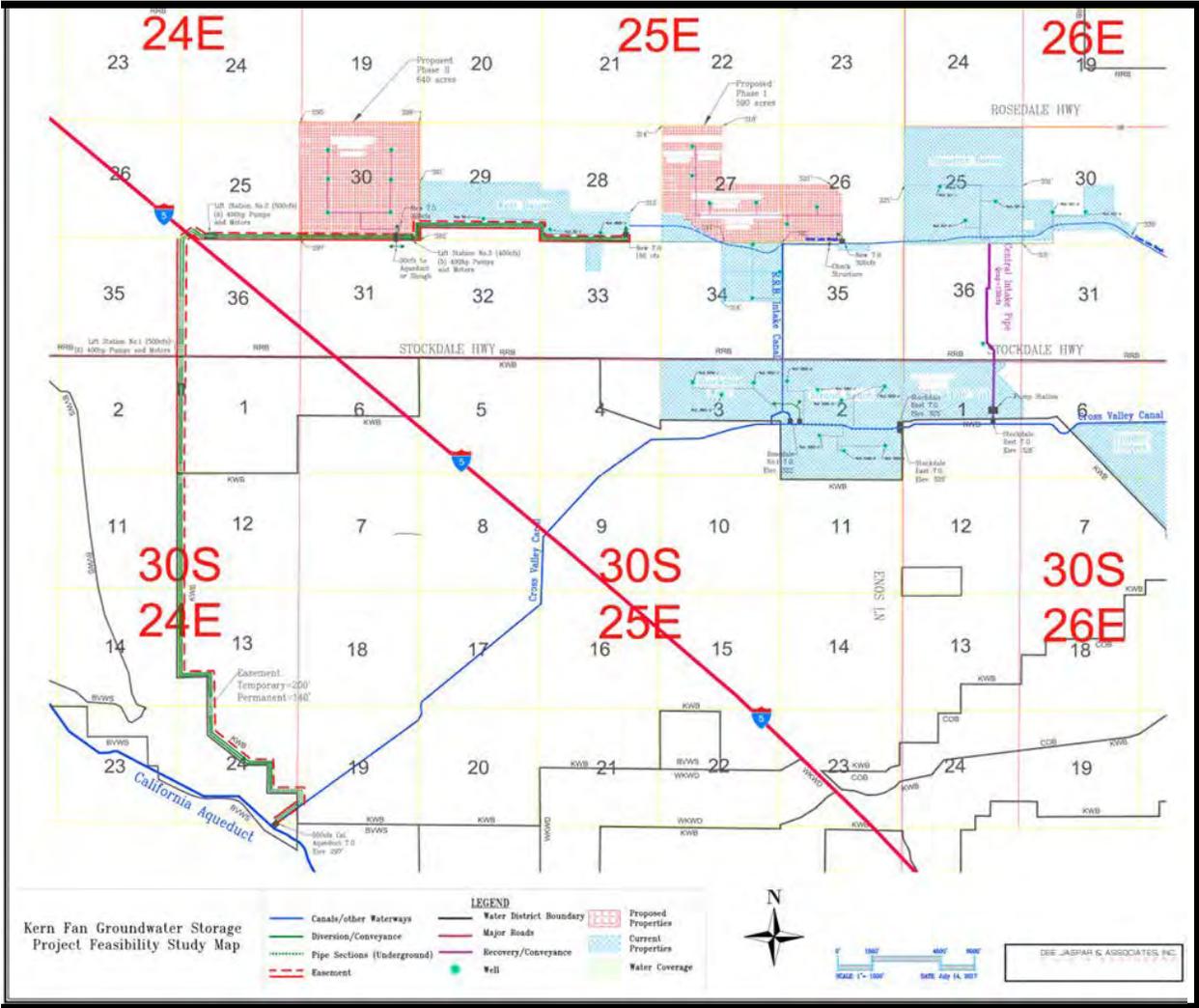
Cramer Fish Sciences (CFS) prepared a quantitative analysis and assessment of the Kern Fan Project's operations for ecosystem benefits. CFS consulted with MBK Engineers to analyze how additional system water from the Project could provide ecosystem benefits in the Delta. CFS found that the Kern Fan Project provides benefits meeting Ecosystem Priority 2 and Priority 12 criterion, specifically for the spring-run and winter-run Chinook salmon. CFS identifies that optimal pulse releases from Lake Oroville in the month of April provide the greatest benefit for the ecosystem priorities. The CFS Technical Memorandum provides additional detail on the project operations for ecosystem benefits and methods for quantifying ecosystem benefits and is included in **Physical Public Benefits Tab, Attachment 2** of the WSIP funding application.

2. Project Facilities

The Project includes the construction of water banking facilities on two project sites, over two phases. The Project sites are ideally located for recharge and recovery water banking activities within the Kern Fan. The Project lands and facility locations described herein may change during the property acquisition phase of the Project but the general location, facility sizes and ownership distribution are expected to remain similar. The Project will be integrated with the SWP by using existing capacity in the California Aqueduct and the Cross Valley Canal, constructing new conveyance, turnout and pumping facilities

As shown in Figure 1, Phase 1 lands could include about 640 acres located within Township 29 South (T-25S), Range 25 East (R-25E), Sections 26 and 27. Phase 2 lands could be comprised of about 640 acres located in T-25S, R-25E, Section 30.

Figure 1: Location Map of Kern Fan Groundwater Storage Project



Recharge, Recovery and Conveyance

A two-phased approach would be taken to the development of the Kern Fan Project. An engineering Concept Study was prepared for the Project which provides more detail of the project facilities and costs which is included under the **Benefit, Calculation, Monetization, Resiliency Tab, Attachment 9** of the WSIP application.

Phase 1

The first phase would be to develop the proposed third project site as contemplated in the Environmental Impact Report for the Stockdale Integrated Water Banking Project which would include the purchase of approximately 640 acres of land within Rosedale's service area in the Kern Fan. The first phase would include constructing conveyance facilities, recharge facilities, and 6 recovery wells and pipelines as necessary to develop a fully functioning water banking project.

The existing conveyance system that will supply recharge water to the Phase 1 lands is via the Goose Lake Slough or from the Cross Valley Canal (CVC) via the Rosedale Intake Canal. A new check structure would be constructed in the Goose Lake Slough with a reinforced concrete turnout structure constructed behind it to convey water from the Goose Lake Slough to the Phase 1 property. The anticipated recharge at the Phase 1 lands would initially be 230 cfs (0.7 ac-ft/d) and then drop to an approximate maintenance rate of 115 cfs (0.35 ac-ft/d).

The Goose Lake Slough currently has capacity to service Rosedale's existing West Basin recharge area. Therefore an alternative conveyance will be needed to convey water to Rosedale's West Basins which will also be used in the Phase 2 of the Kern Fan Project. A new reinforced concrete turnout at the California Aqueduct would be constructed under Phase 1 and canal to convey up to 500 cubic feet per second (cfs) approximately ten miles to the easterly end of the Rosedale's existing West Basins and Phase 2 property. Three lift stations would be needed for conveyance to the Project and the West Basins. Each lift station would also include a gravity bypass line with a slide gate to allow the reverse flow of recovery water back to the California Aqueduct.

Phase 1 would also include construction and equipping of six recovery wells with each well having an approximate capacity of 5 to 6 cfs. The Phase 1 recovery wells would be capable of returning water to the new canal, or the Goose Lake Slough or to the CVC via the Rosedale Intake Canal.

Phase 2

Phase 2 of the Kern Fan project would involve acquiring an additional 640 acres of land within Rosedale's service area for additional water banking facilities to meet the full expected project capacities. Water would be conveyed to this property from the California Aqueduct using the same Project diversion and canal constructed in Phase 1. The proposed Phase 2 property would be developed for the recharge and recovery of ground water. The anticipated recharge at this proposed property would initially be 230 cfs (0.7 ac-ft/d) and then drop to an approximate

maintenance rate of 115 cfs (0.35 ac-ft/d). Phase 2 would include the construction and equipping of six recovery wells and associated conveyance pipelines.

Extraction of previously recharged water from both the Phase 1 and Phase 2 lands will occur during times of need when other available supplies are short to maximize the project's public and non-public benefits. A total of twelve new extraction wells will be constructed for the Project with a combined expected recovery capacity of up to 70 cfs. Each well will have a discharge capacity of approximately 5 to 6 cfs, and will be operated to minimize significant impacts to neighboring wells and will meet all Title 16 drinking water quality standards. The Phase 1 recovery wells would be designed to be capable of returning or exchanging water to the California Aqueduct by discharging to the Rosedale Intake Canal that flows to the Cross Valley Canal. The Phase 2 recovery wells will be designed to return water to the California Aqueduct using a gravity bypass line that allows reverse flow of the new proposed Project canal.

3. Project Water Supply, Storage and Integration with SWP

Project Water Supply

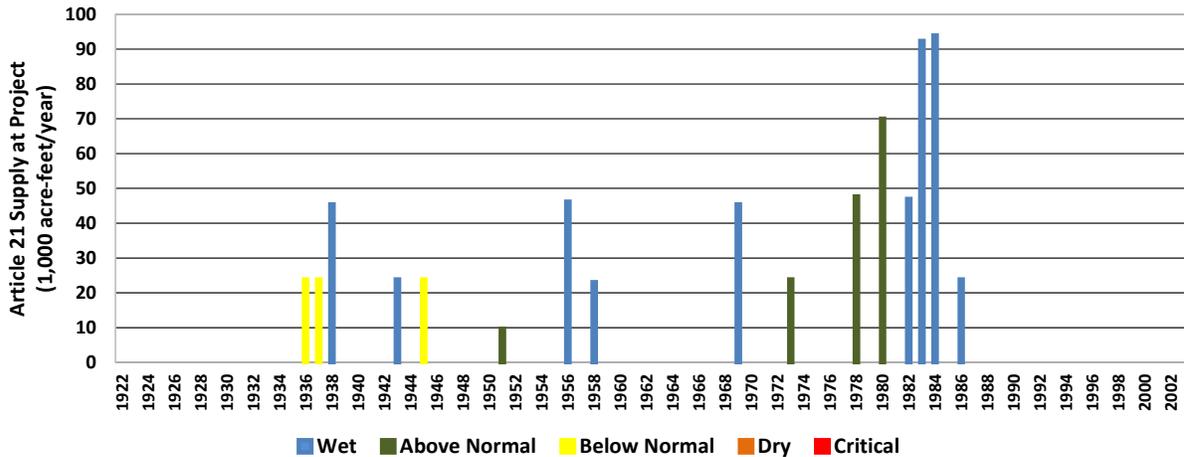
The Project will be located in Kern County and operated to support the SWP. The Project will operate by storing water supplied by the SWP under the Article 21 Program when available. Unallocated Article 21 water is available in accordance with long-term Water Supply Contracts for State Water Contractors who have signed the Monterey Amendment. Unallocated Article 21 water is available when there is water in excess of SWP needs, typically in wet years when precipitation and runoff in the Delta watershed exceed long-term averages. This Article 21 water supply will be delivered to the Project utilizing available capacity in the California Aqueduct to a new Project turnout to be constructed near the CVC.

MBK's spreadsheet model (MBK Engineers, 2017) calculates the water supply available to the Project as additional Article 21 available from the Delta. The CalSim II Baseline simulation includes existing Article 21 demands and deliveries. The spreadsheet model simulates the additional Article 21 demand of the Project and the associated increase in SWP Delta exports. Additional Article 21 deliveries to the Project are simulated when there is:

1. Available surplus in the Delta in excess of existing regulatory requirements and demands
2. Available export capacity and the SWP Banks Pumping Plant
3. The SWP portion of the San Luis Reservoir is full in the Baseline

Figure 2 presents a summary of available Article 21 water supply to the Project diversion from the California Aqueduct by water year type (Sacramento Valley Year Type Index) based on WSIP 2030 CalSim II modeling results. This available supply is calculated by considering constraints on available Banks pumping capacity, conveyance capacities in the California Aqueduct, the capacity to convey water from the California Aqueduct to the Project, and conveyance losses. On an average annual basis, available Article 21 supply at the project diversion from the California Aqueduct is 8 thousand acre feet (TAF) with most of the supply available during Wet years. There is no Article 21 supply during dry and critical years.

Figure 2: Article 21 Supply at Project Diversion



MBK models include delivery of up to 100,000 AF of unallocated SWP Article 21 water into the Kern Fan Project. These deliveries would be made on behalf of IRWD as a landowner in Dudley Ridge Water District (DRWD) and Rosedale as a sub-unit of the Kern County Water Agency (KCWA). During dry years and when needed, IRWD as a land owner in DRWD, DRWD and Rosedale would rely on the stored flows to provide non-public water supply benefits that improve water supply reliability.

Based on historical data, results of water modeling (MBK Engineers) indicate that in 2030 the Project would typically recharge Article 21 water during normal and wet periods, which on average occur in about 24 of 30 years. While Project storage will vary and be dependent upon water supply, demand and operations, the average annual Project storage is estimated at 18,000 AF at the end of October.

Project Storage

The Unallocated Article 21 water supplies recharged and stored in the Kern Fan Project will be allocated to the Project beneficiaries as follows:

- 25% to the Public or Ecosystem account
- 37.5% to the IRWD/DRWD account
- 37.5% to the Rosedale account

MBK’s analysis simulated water stored in each of the three accounts. Water stored in each account is subject to a loss percentage of 10% for Rosedale, 12.5% for Ecosystem and 15% for IRWD. Project recharge rates are simulated as a function of recharge in preceding months based on IRWD and Rosedale experience and assumptions made in the Draft Concept Study (Dee Jasper & Associates, 2017).

Approximately 25 percent of the stored water would be held as SWP system water that would be used for ecosystem benefits purposes. This 25 percent of the water would be made available for

ecosystem benefits through 1-for-1 exchanges that would occur when the water is extracted from the ground. The 1-for-1 exchanges would result in Table A water, that is held in Lake Oroville, being reclassified as SWP system water and the SWP system water being extracted from the ground, being reclassified as Table A water. The Table A water would be used to meet DRWD and Rosedale SWP Table A demands either directly or through operational exchanges. The SWP system water left in Oroville Reservoir would then be used to provide short-term ecosystem pulse flows to generate ecosystem benefits by improving habitat for fish in the Feather and Sacramento Rivers and Delta. The 1-for-1 exchanges would result in the water extracted from the ground and used by DRWD and Rosedale being classified as Table A water and the water left in Oroville Reservoir for use in providing ecosystem benefits being classified as SWP system water.

Figure 3 presents an overview of the Kern Fan Project operations coordinated with SWP facilities.

Figure 3

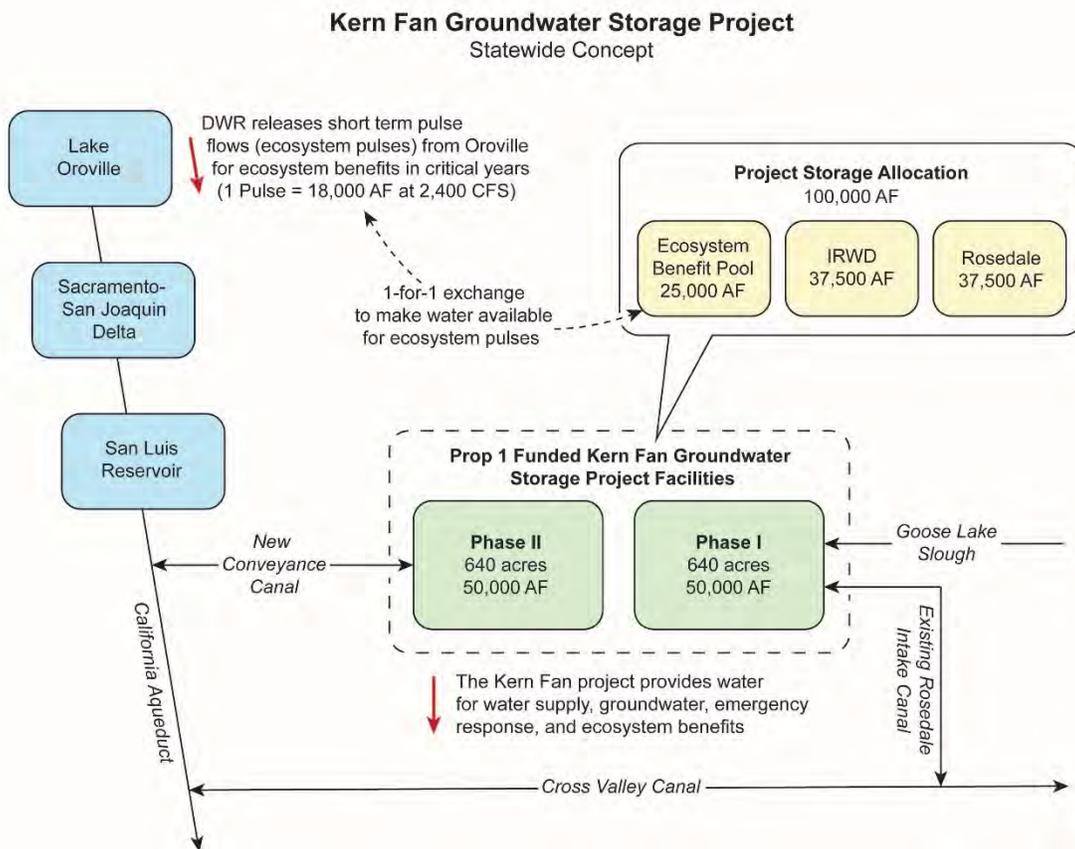
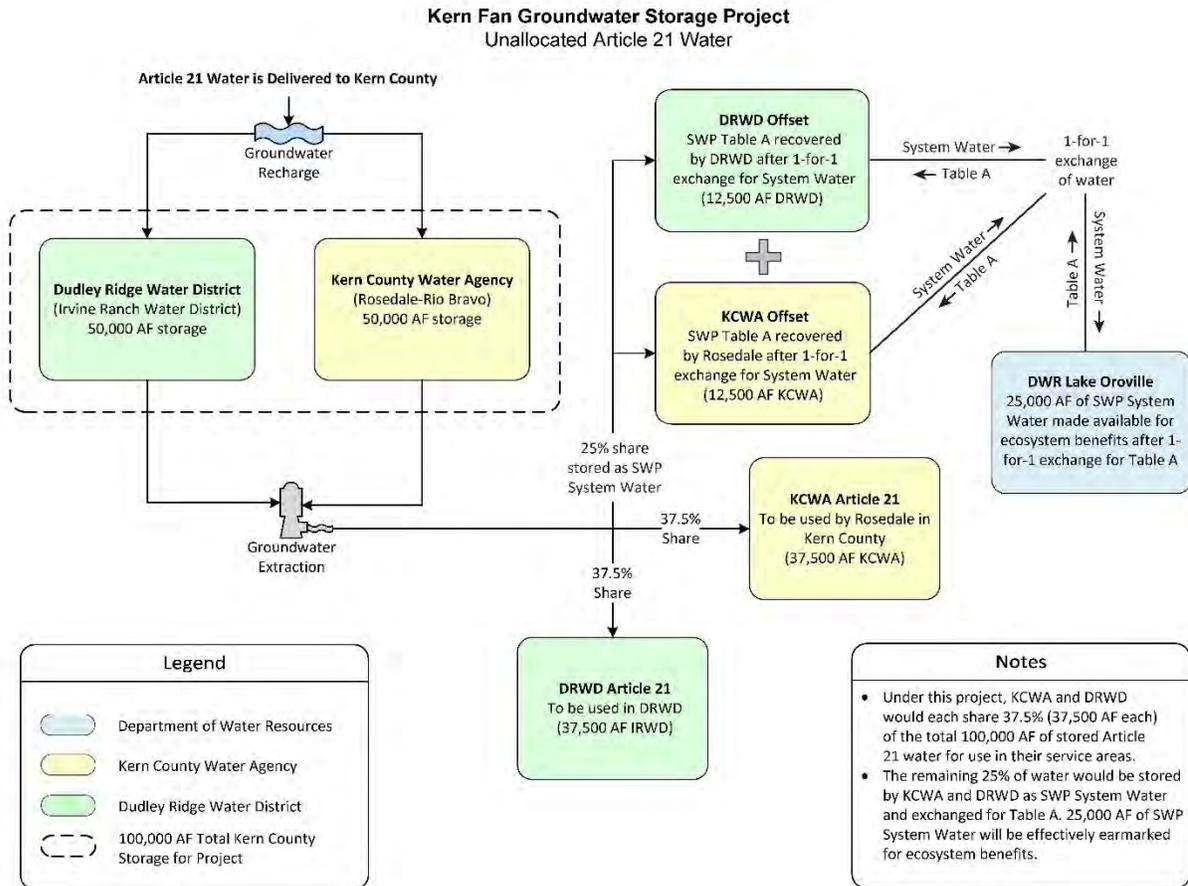


Figure 4 presents a conceptual diagram of how unallocated Article 21 water will be provided to the Project beneficiaries and how the Project yields system water for the Ecosystem account. As shown, up to 100,000 AF unallocated Article 21 water would be requested by participating SWP contractors, DRWD and KCWA, and delivered to the Project for storage. Stored water is distributed to project beneficiaries by percentage and later recovered and/or exchanged for use by the project beneficiary to provide public and non-public benefits.

Figure 4: Conceptual Project Operations



4. Operations for Public and Non-Public Benefits

Project Operations with SWP for Public Benefits

The Project will provide ecosystem and water quality benefits for the Delta and its tributaries by recharging and storing up to 100,000 acre-feet (AF) of unallocated Article 21 water in the Kern County groundwater basin for subsequent extraction for use during periods of need. The Project offers exceptional flexibility to DWR in managing SWP supplies for improved operations of the State water system. Water can be used from the Project's Ecosystem account to provide multiple benefits.

Approximately 25 percent of the water stored in the Project is designated for the Ecosystem account which would be held as SWP system water to be used for ecosystem benefits purposes when needed. Operation of the Project will be coordinated with that of the SWP to enable the DWR to release pulses of water from Oroville Reservoir when water is needed for fish spawning, rearing, and migration. The pulse flows (Ecosystem Pulses) will provide measurable improvements to environmental habitat in the Feather River downstream of Oroville Dam, and in the Sacramento River, from its confluence with the Feather River through the Delta thus meeting the criteria for WSIP Ecosystem Priorities 2 and 12 benefits.

Oroville Reservoir Operations:

The MBK analysis documents how the Project will be integrated with Oroville Reservoir operations. Approximately 25 percent of the stored water in the Project would be held as SWP system water that would be used for ecosystem benefits purposes. This 25 percent of the water would be made available for ecosystem benefits through 1-for-1 exchanges that would occur when the water is extracted from the ground. The 1-for-1 exchanges would result in Table A water, that is held in Lake Oroville, being reclassified as SWP system water and the SWP system water being extracted from the ground, being reclassified as Table A water. The Table A water would be used to meet DRWD and Rosedale SWP Table A demands either directly or through operational exchanges. The SWP system water left in Oroville Reservoir would then be used to provide short-term Ecosystem Pulse to generate ecosystem benefits by improving habitat for fish in the Feather and Sacramento Rivers and Delta. The magnitude and duration of the Ecosystem Pulses will be determined based on the volume of water available in the ecosystem account and the expected fisheries benefit. The Project will target making Ecosystem Pulses in drier years when Oroville Reservoir will not make flood control releases. See MBK's Technical Memorandum for more information on the modeling and impacts of the Project operations with the operations of the Oroville and the San Luis Reservoirs.

Operations for Ecosystem Benefits in Delta (Public Benefit - Ecosystem Priorities 2 & 12)

As described in Section 3 and in **Program Requirements Tab, Attachment 1** of the WSIP funding application, approximately 25 percent of the stored water by the Project would be held as SWP system water that would be used for ecosystem benefits purposes. The system water would be available for use by DWR through 1-for-1 exchanges that would provide short-term ecosystem pulse flows to generate ecosystem benefits by improving habitat for fish in the

Feather and Sacramento Rivers and Delta. This provides flexibility to DWR by making water available for instream flows when needed in dry and critical dry years.

MBK Engineers described the water project operations, river flows and water supply results associated with the Project. Cramer Fish Sciences (CFS) working with MBK Engineers utilized these same simulated flows including pulse flows and water project operations and CFS's quantitative analysis shows substantial net benefits to spring-run and winter-run Chinook salmon. Per the CFS analysis, the ecosystem pulses will improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids. CFS identified the month of April as the period that may provide the greatest benefit to ecosystem priorities.

MBK's modeling looked at the ecosystem pulse released from Oroville in April or May to improve habitat conditions for rearing, downstream migration of spring and winter-run Chinook, and benefits to other fish species. During dry and critical periods, which account for the remaining 6 of 30 years on average, ecosystem pulses would be released from Oroville Reservoir to provide net improvements in ecosystem habitat in the Delta. Per MBK's analysis, it is anticipated that the Project would apply six ecosystem pulses of 18,000 AF over 3.75-day periods in April at 2,400 cfs during dry or critical years. April was selected as a period of high relative abundance for downstream migration and rearing of juvenile salmon, however, the Project operation offers flexibility to accommodate DWR's operation of Oroville Reservoir and the SWP.

CFS found that overall for the 2030 condition, it is estimated that the spring-run of Chinook salmon would increase between 107 to 252 due to the ecosystem pulses. Winter-run Chinook salmon would also increase between 20 to 38 with the ecosystem pulses. Though April flow pulses are expected to benefit multiple fish species and life stages, the quantitative analysis focuses on assessing benefits to out-migrating juvenile spring-run and winter-run Chinook salmon. CFS also noted that reductions in estimated annual adult Chinook occur in some years as a result of increased Delta diversions associated with the Project, but these losses are outweighed by much larger benefits which accumulate across all years.

From MBK's report, Figure 5 below shows the frequency of the Ecosystem Pulses by water year type. As noted earlier, the pulses are made during Dry and Critical years when Feather River flows are lower and pulses may create a higher potential for benefits to the ecosystem. Figure 6 shows an average pulse flow rate by month. In this analysis, April was selected as the month for Ecosystem Pulses. The operations could be modified to provide Ecosystem Pulses in May, under actual operations.

Figure 5. Frequency of Ecosystem Pulses

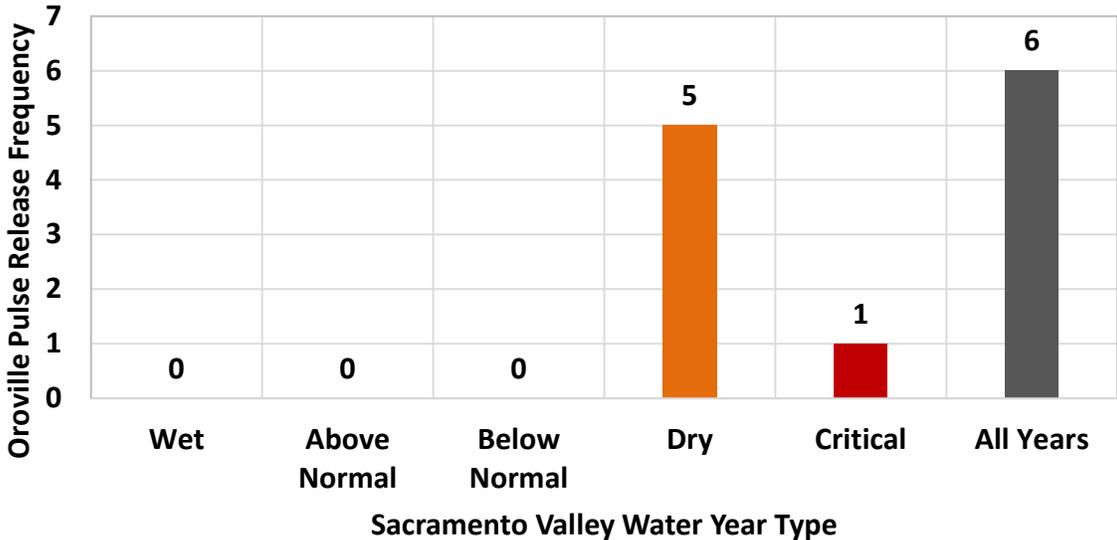
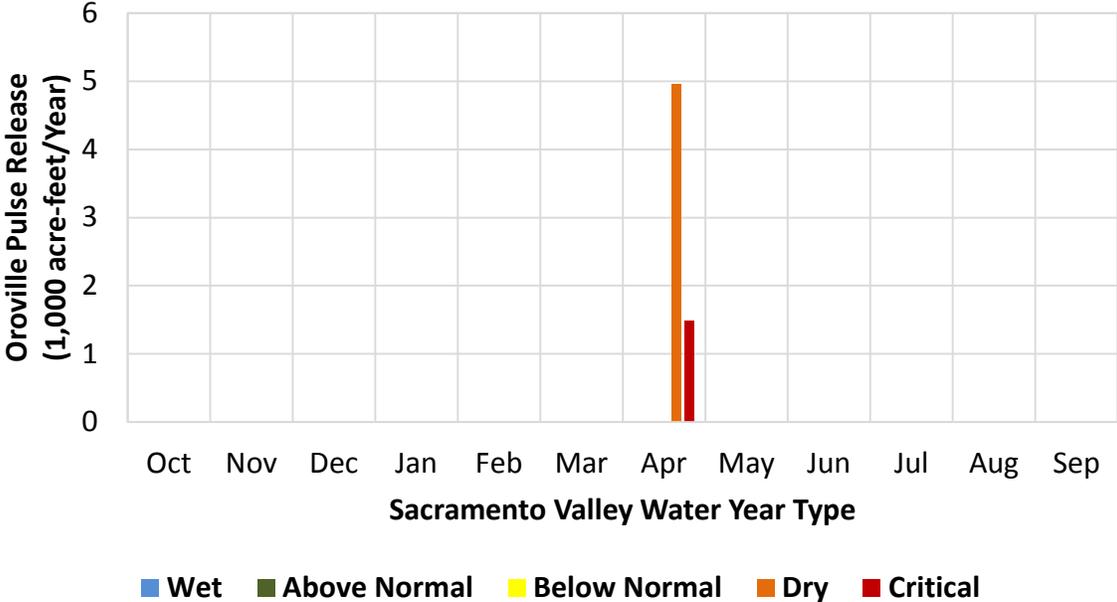


Figure 6. Pulse Release Volume



From MBK’s report, Figure 7 also shows a reduction in Oroville Reservoir releases in February. In most years, the reduction of Oroville Reservoir occurs in July following release of Ecosystem Pulse in April, with the exception of in 1977. In 1977, the ecosystem pulses are made in April and Oroville storage remains lower under the Project conditions until the next available opportunity to refill the reservoir, which comes in February of 1978, when the reservoir releases are reduced to compensate for Ecosystem pulses released in April 1977. Thus, Oroville Reservoir releases are lower in February 1978 under the Project conditions, as compared to the

Baseline. Simulated changes in Oroville release are expected to create the same change in Feather River flows below Oroville and Sacramento River flow from the confluence with the Feather into the Delta.

Figure 7. Change in Oroville Releases

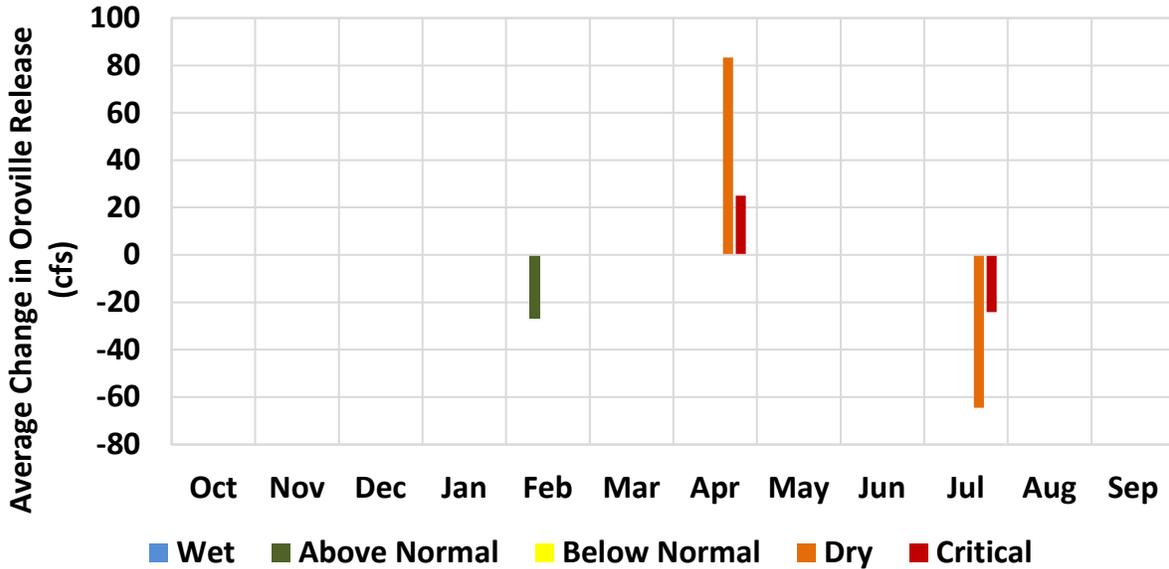


Figure 6 shows changes in Oroville Reservoir releases with the Project. Flows in the Feather River are higher under the Project conditions during April when Ecosystem Pulses are made from Oroville. The release of Ecosystem Pulses results in lower Oroville storage under the Project conditions after making Ecosystem Pulse releases. Storage in Oroville would be recovered in later months by reducing releases from Oroville when Feather River flows are in excess of the minimum instream flow requirements and Oroville is releasing water to support SWP Delta exports. Oroville Reservoir is typically releasing water to support Delta exports in the July through September period. Oroville releases are reduced in this period to compensate for the Ecosystem Pulses resulting in lower Feather River flows under the Project conditions to recover the volume of the Ecosystem Pulse. Analysis in the spreadsheet model attempts to recover the Ecosystem Pulse volume in Oroville in the same year as when the pulse is made, such that Oroville carryover storage is not affected.

Per MBK Engineers, in actual operations, it may be possible to develop an operational plan that would pre-deliver water into Oroville in other years, such that Oroville storage remains is increased, as compared to Baseline, prior to making the Ecosystem Pulse release.

Figure 8 shows changes in Delta outflows under the Project conditions. Delta outflows are greater during April of Dry and Critical years under the Project condition when Oroville is making Ecosystem Pulses. Ecosystem Pulses in April and May of Dry and Critical years are expected to increase Delta outflow because Delta exports are typically constrained in these months by regulatory requirements such as San Joaquin River inflow-to-export ratio or Old and Middle River flow requirements. Delta outflows can be lower in January through May of Below

Normal and wetter years when Delta outflow is diminished either due to capture of unallocated Article 21 surplus water for the Project or due to a reduction in Oroville releases.

Figure 8. Change in Delta Outflow

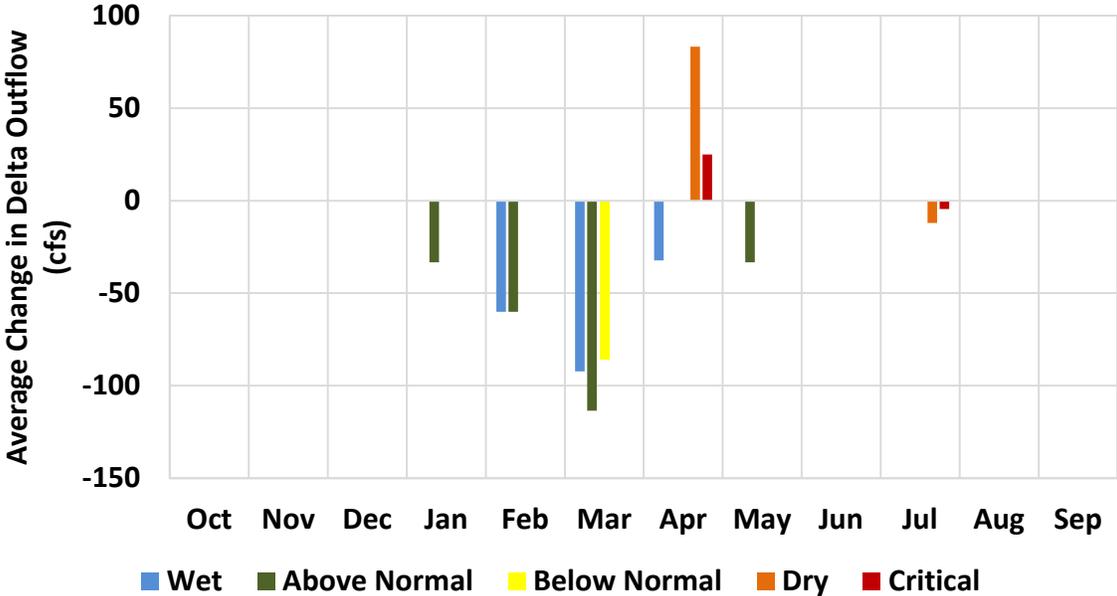


Figure 9 below presents a similar plot, showing change in SWP Delta exports under the Project conditions. SWP Delta exports are typically greater under Project conditions, as surplus flows are captured at the export pumps and delivered to the Project. SWP Delta exports show a reduction in Dry and Critical years as compared to the Baseline due to a reduction in Oroville releases.

Figure 9. Change in SWP Delta Exports

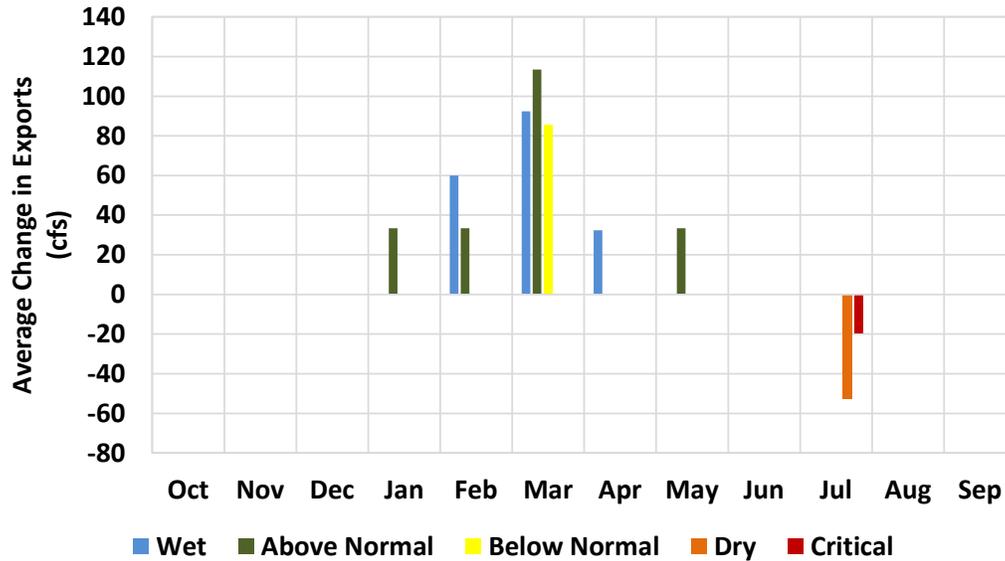


Table 1 presents a summary of the Project performance with the 2030 WSIP conditions from MBK Engineers. Of the 8 TAF available to the project diversion approximately 6.1 TAF is able to be conveyed to the Kern Fan Project for recharge. This water is stored and then later extracted to provide public and non-public benefits. Under 2030 conditions, the Project could provide six pulse releases from Oroville Reservoir over the 82-year period analyzed and provide an average annual ecosystem water supply of 1.3 TAF. Non-public water supply benefits are 4.5 TAF annually, with 2.0 TAF for IRWD and DRWD and 2.5 TAF for Rosedale.

Table 1: Summary of Project Performance (WSIP 2030), MBK Engineers

Year Type	Project Recharge (TAF)	Number of Pulses (Years)	Ecosystem Water Supply (TAF)	IRWD Water Supply (TAF)	Rosedale Water Supply (TAF)
Wet	11	0	0	0	0
Above Normal	13	0	0	1	0
Below Normal	5	0	0	4	6
Dry	0	5	5	4	6
Critical	0	1	2	2	1
All Years	6.1	6	1.3	2	2.5

MBK Engineers also simulated the project performance under other projected conditions: (1) 2070 climate change, (2) without the California WaterFix, and (3) with the California Water Fix. While the numbers vary, the conclusions generally remain the same – operation of the Project

and coordination with the SWP operation will support ecosystem pulse releases from Oroville Reservoir will yield a net increase in fishery benefits.

Operations for Incidental Wetland Habitat (Public Benefit - Ecosystem Priority 14)

The Kern Fan Project is expected to provide intermittent wetland habitat along the recharge basins-where marsh-like environments are established during recharge periods and create ideal habitat for waterfowl, shorebirds, raptors, and other native and migrating birds. These conditions will exist whenever recharge activity occurs on the Project sites.

The intermittent wetland habitat that will be provided by the Project will be approximately 1,200 acres in size which is the area of the recharge ponds located on both the Phase 1 and Phase 2 project sites. Water will be typically recharged at the Project sites during the winter months and will provide temporary habitat during wet, above normal, and below normal water years when recharge activity occurs. Under 2030 conditions during wet years when recharge activity occurs, the project can be expected to provide approximately 1.44 months of temporary habitat. Under these conditions during above normal years approximately 2 months of temporary habitat can be expected and during below normal years approximately 1 month of temporary habitat can be expected.

Over an 82 year simulation period using historical hydrology, the project is expected to have a total of 23 months of recharge under 2030 conditions. Using historical hydrology, it was determined that the project would have 1 to 3 months of temporary habitat during years in which recharge activity occurs depending on the year type. Duration of recharge was determined using the approximate area of recharge basins (1,200 acres), recharge rate of land (0.7 feet/day), and amount of water recharged per event.

Operations for Emergency Response-Extended Drought (Public Benefit):

A major benefit of the Project is that it will provide supplemental water to IRWD, Rosedale, and DRWD in the event of extreme drought, when other water resources are at their most expensive or may be limited. Groundwater stored as part of the project will be available to call on during a drought emergency or as an alternative supply in the case of a local supply outage. According to the WSIP Technical Guidance an emergency is defined as a critical year that occurs in the 3rd or later year of consecutive drought.

Per MBK's model, IRWD and Rosedale's accounts would receive 4,500 AF per year of water on an average annual basis under 2030 future conditions and 4,100 AF per year would be received on an average annual basis during 2070 future conditions. One-third of the water in the IRWD and Rosedale storage accounts will be dedicated to Emergency Response during extended droughts and two-thirds will be dedicated for water supply during other dry year conditions. The water used for Emergency Response purposes will be physically extracted from the Project utilizing the Phase 1 and Phase 2 recovery wells at the 3rd or later year of a multi-year drought. The Project recovery wells will have sufficient capacity to recover this emergency response drought water.

Operations for Emergency Response-Delta Failure (Public Benefit):

A separate emergency response benefit of the Project is the water supply that the Project could provide in the event of a levee failure in the Delta that curtails water project deliveries. The WSIP Technical Guidance explains that an emergency response to Delta Failure should be assumed to occur once, 30 years into the project operation period—2056 for this project.

According to MBK's analysis, under historical hydrologic conditions, the Project can provide Emergency Response benefits during a Delta levee failure by storing water south of the Delta that can be extracted and made available after a failure event. The probability of water being stored in the Project in any year is one measure of potential Emergency Response benefit. MBK found that the Project is likely to have 20,000 AF of water available for Emergency Response after 30 years of operation. MBK Engineering also explored how using the 20,000 acre-feet of water 30 years into the project life would affect other Project benefits. MBK found that the ecosystem pulse flows north of the Delta could be affected. To be conservative in the analysis of these effects, the availability of pulse flows north of the Delta were assumed to be reduced due to the need for water for Emergency Response.

Operations for Water Supply – Non-Public Benefit:

Water Supply benefits are non-public benefits that will accrue to IRWD, Rosedale, and DRWD, and their service area customers. Water stored in the IRWD, DRWD and Rosedale accounts will provide a water supply benefit to these agencies and their program partners during times of reduced water supply. The operations of the Project would be consistent with Rosedale's Conjunctive Use Program and IRWD's and Rosedale's existing water banking projects, including the Strand Ranch Integrated Banking Project and Stockdale Integrated Banking Project,

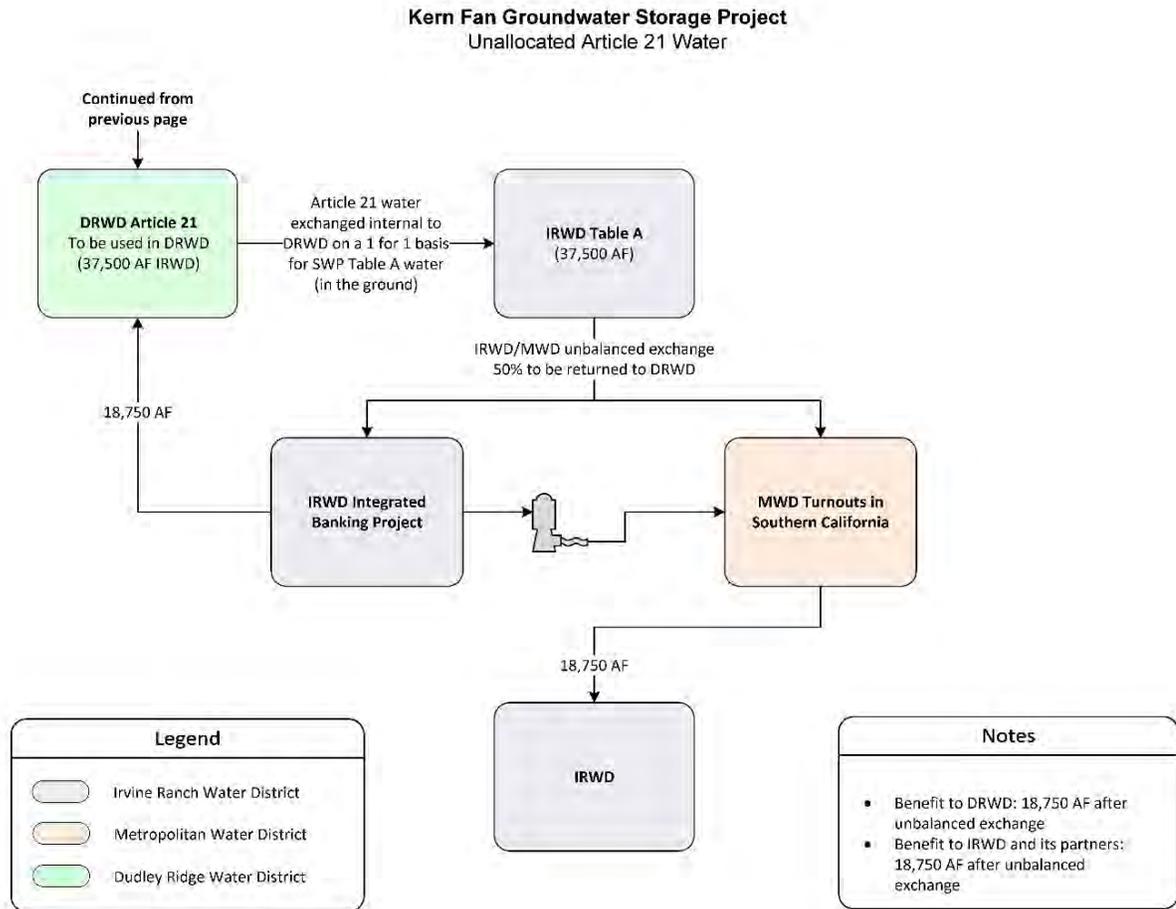
The Kern Fan Project will provide improved reliability and redundancy in supplies for Rosedale, IRWD and DRWD and their program partners. Recovery scenarios include Rosedale recovering water from the Project as needed to meet existing or future commitments under its Conjunctive Use Program. It is expected that IRWD and DRWD would receive water from the Project potentially during times when surface water and/or local supplies are interrupted or curtailed and likely in a dry or critical year.

According to modeling by MBK Engineers, the project will provide an annual expected additional supply of 4,500 acre-feet per year on an average annual basis under 2030 future conditions, and 4,100 acre-feet per year on an average annual basis under 2070 future conditions. IRWD and Rosedale will designate two-thirds of their water stored in their Project accounts for use as non-emergency water supply during below normal, dry, and critical water years.

As presented in Figure 10, the Article 21 water stored in the Project for IRWD as a land owner in DRWD would be exchanged for SWP Table A water on a 1-for-1 basis to IRWD. Under the terms of an unbalanced exchange, 50% of this water would be returned to DRWD and 50% to be recovered for used in IRWD's service area via existing canals, the California Aqueduct, and Metropolitan Water District of Southern California (MWD) facilities. The implementation of

this unbalanced exchange would require extension of existing agreements in accordance with the IRWD’s existing Coordinated, Operating, Water Storage, Exchange and Delivery Agreement that IRWD executed with MWD in April 2011.

Figure 10 IRWD and DRWD Water Supply Operations



Operations for Groundwater Benefit – Non-Public Benefit:

The Kern Fan Project would operate within the Rosedale service area overlying the Kern Fan area. Rosedale entered into two Memorandums of Understanding (MOUs) with adjoining entities in the Kern Fan area. The MOUs provide guidelines for operation and monitoring of Rosedale’s groundwater banking programs. The Kern Fan Project would be subject to and operated consistent with these MOUs. The MOUs guidelines help to avoid, eliminate or mitigate adverse impacts to the groundwater basin and to the operation of other groundwater banking programs in the Kern Fan area.

Among other things, the MOUs establishes loss factors for water that is recharged in the basin. Surface evaporation losses are assessed at 6%, migration losses are assessed at 4% and water recharged for out-of-County uses is assessed an additional 5%. Water recharged into Rosedale’s

account incurs a total 10% loss and IRWD water is assessed 15%. The modeling analysis (MBK Engineers, 2017) assumes water is simulated as stored in the Project in each of three “accounts”: public or ecosystem, IRWD, and Rosedale. Water stored in each account is subject to a loss percentage of 10% for Rosedale, 12.5% for Ecosystem, and 15% for IRWD. MBK’s model accounted for these losses, so that the estimated water stored in each “account” is net of these losses. These losses are assessed on all water recharged into the basin and except for the surface water loss which is considered evaporation, all other amounts are considered a benefit to the basin.

Uncertainties and Preliminary Adaptive Management Strategies

Project Uncertainties:

MBK performed uncertainty analyses related to the potential future (WSIP 2070) climate change, including Project performance during critical droughts and the California WaterFix. This uncertainty analysis is included in the MBK Engineers Technical Memorandum, August, 2017.

Climate Change:

MBK Engineers performed the climate change analysis using the WSIP 2070 dataset that reflects future climate and sea level conditions for a 30 year period centered at year 2070. As summarized in Table 2, the Project benefits diminish slightly due to a reduction in available water supply when the 2070 WSIP results are compared to the 2030 WSIP results. Average annual recharge is reduced by 0.4 TAF or approximately 7% as compared to 2030 conditions. The frequency of ecosystem pulses is reduced from six years under 2030 conditions, to five years under 2070 climate conditions. Water supply benefits also diminish slightly by approximately 0.3 TAF (7%) on an average annual basis. Though the Project performance is reduced with WISP 2070 climate conditions, they are similar to the WISP 2030 baseline.

California Water Fix:

MBK Engineers also performed analysis on the California WaterFix using the CalSim II model developed by DWR and Reclamation for the Biological Assessment for California WaterFix. The California WaterFix CalSim II model includes the 2025 Early Long Term climate change assumptions that are different from the WSIP 2030 climate change assumptions. Results, summarized in Table 2 below, indicate a substantial increase in Project yields with the California WaterFix when compared to without the California WaterFix. Average annual Project recharge is approximately 11 TAF with California WaterFix, nearly 6 TAF greater than DWR Early Long Term climate change without California WaterFix. Increases in the ability to recharge water with California WaterFix increase the frequency of ecosystem pulses from four years to seven and Project yields to IRWD and Rosedale are increased by approximately 4 TAF.

Table 2: Summary of Uncertainty Analysis

Model	Alternative	Project Recharge (TAF)	Number of Pulses (Years)	Ecosystem Water Supply (TAF)	IRWD Water Supply (TAF)	Rosedale Water Supply (TAF)
CalSim II (1)	WSIP 2030	6.1	6	1.3	2.0	2.5
CalSim II (1)	WSIP 2070	5.7	5	1.1	1.9	2.2
<i>CalSim II (1)</i>	<i>Change WISP 2070 - WISP 2030</i>	<i>0.4</i>	<i>1.0</i>	<i>0.2</i>	<i>0.1</i>	<i>0.3</i>
Calsim II ELT (2)	Without California Fix	5.2	4	0.9	1.8	1.9
Calsim II ELT (2)	With California Fix	10.7	7	1.5	3.9	3.9
Calsim II ELT (2)	<i>Change (With - Without California Fix)</i>	<i>5.5</i>	<i>3.0</i>	<i>0.6</i>	<i>2.1</i>	<i>2.0</i>
(1) Water Storage Investment Program (WSIP) CalSim II model (11/2/16)						
(2) Division of Water Resources and Bureau of Reclamation for Biological Assessment with 2025 Early Long Term climate change.						

Preliminary Adaptive Management Strategies:

Based on the MBK and CFS work, IRWD and Rosedale have prepared draft preliminary performance objectives for the Kern Fan Project and proposed draft methods for monitoring the operations to ensure public benefits are realized. The following presents draft strategies for each of the Ecosystem Priorities claimed by the project.

Ecosystem Priority 2:

Pursuant to information from CFS, the natural resource management entities (DWR, National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), U.S. Bureau of Reclamation (USBR)) regularly conduct survival studies on outmigration of juvenile Chinook salmon and steelhead. A relevant performance metric for the proposed Kern Fan Project would be an observed flow-survival relationships consistent with the predicted flow-survival relationships described by NMFS (2017) and were 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. CFS states that IRWD and Rosedale may participate in and support flow-survival studies relevant to evaluating performance of the flow pulses in achieving expected ecosystem benefits.

Ecosystem Priority 12:

Pursuant to information provided by CFS, natural resource management entities (DWR, NMFS, CDFW, USFWS, and USBR) conduct regular monitoring and special studies of adult green sturgeon passage and spawning success in the Feather River. As indicated in the CFS report, adult green sturgeon are expected to benefit from the proposed project, but insufficient information is currently available to quantify those expected benefits or to set performance measures associated with the action. Changes in the timing and magnitude of project flow pulses

to benefit green sturgeon will be considered as new information becomes available. IRWD and Rosedale may participate in and support monitoring programs which assess flow effects on green sturgeon passage on the Feather River.

Ecosystem Priority 14:

IRWD and Rosedale will work with the CDFW to develop an adaptive management and monitoring program that meets the requirements of the program regulations. In order to measure performance of the public benefit provided by the project, IRWD and Rosedale intend to conduct bird surveys during the years in which recharge activity occurs. In addition, IRWD and Rosedale may coordinate monitoring programs with local agencies near the project that manage wetland habitats