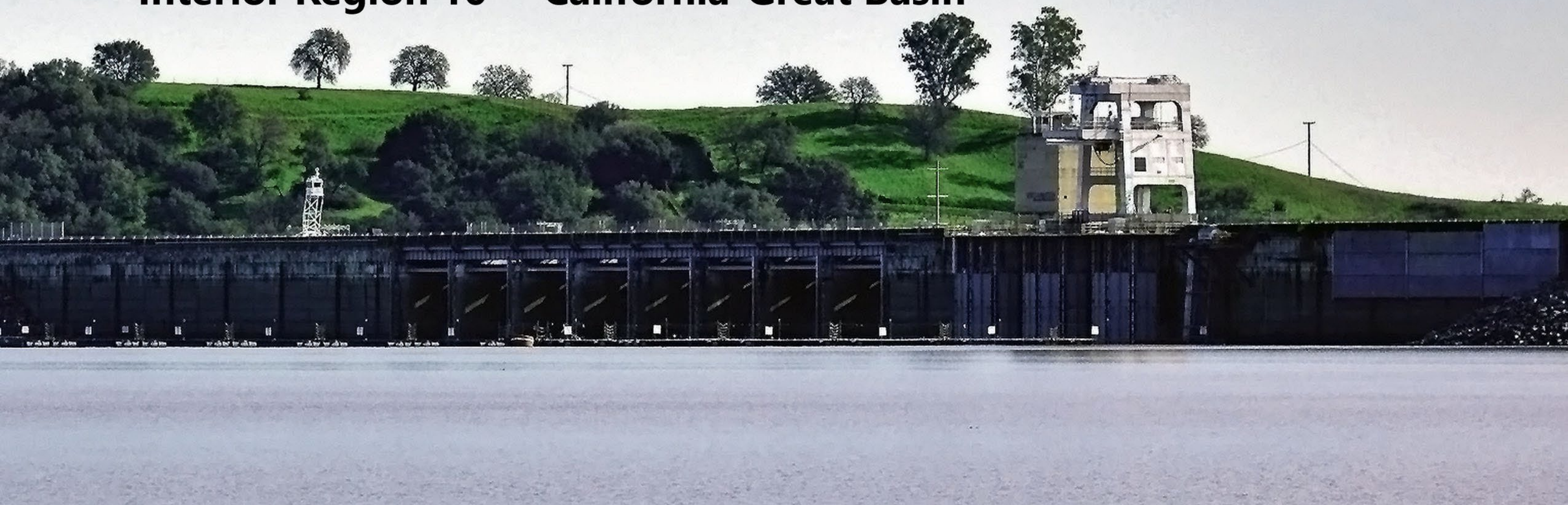
BUREAU OF RECLAMATION

Appendix F

Draft Description of Adaptation Portfolios

American River Basin Study
Interior Region 10 – California-Great Basin



Note: This appendix is a record of analysis for the ongoing study (2018 - 2022). The main report may have updated information that is not reflected in this appendix.

U.S. Department of the Interior

March 2022

Chapter 1 Alder Creek Storage and Conservation Project

This portfolio evaluates potential regional and system-wide (federal, state and local) benefits of a project concept for Alder Creek Dam Reservoir. The project representation used in this portfolio relies on information developed under previous studies, with the aim to assess and demonstrate the project concept potential to improve regional and system-wide adaptation to climate change effects. It should be noted that project concept formulated for this portfolio would likely be further refined under the future Alder Creek Dam and Reservoir Feasibility Study.

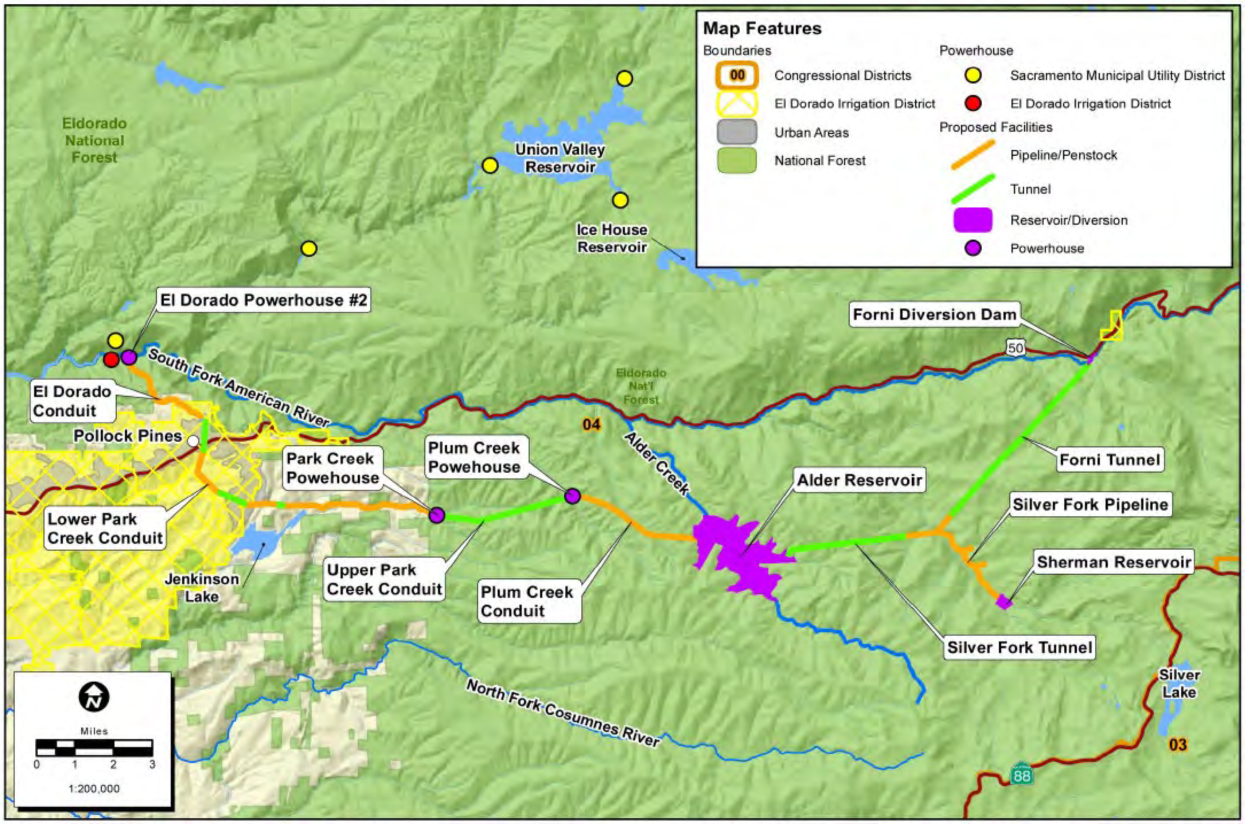
Description

The proposed Alder Creek Dam and Reservoir is located in the headwater catchment of Alder Creek, a tributary of the South Fork American River, 25 miles east of Placerville in El Dorado County, California at an elevation of 5,500 feet. A wide range of Alder Reservoir options have been studied over the last several decades: (1) 32,000 acre-foot (AF) water supply reservoir with a 10MW powerhouse and power generation of up to 56,000 MWh annually; (2) 60,000 AF water supply and seasonal pumped storage reservoir with a 14 MW powerhouse and power generation up to 81,000 MWh annually; and (3) a 175,000 AF reservoir with 110 MW capacity at 3 powerhouses and power generation up to 470,000 MWh annually. Option 3 is the focus of this Alder Creek Dam and Reservoir adaption portfolio. The project major facilities include:

- Alder Dam
- Two diversion dams upstream from Alder Dam
- Tunnels and pipelines for flow diversions and re-diversion for water supply operations and energy production
- Three powerhouses

The Alder Reservoir project, shown on Figure 1-1, would divert water from the South Fork American and Silver Fork to Alder Reservoir through approximately 6.6 miles of pipelines and 8.8 miles of tunnels. In an average water year these diversions would total about 180,000 AF. At Alder Reservoir, this water, along with local Alder Creek runoff (23,480 AF per year on average), would be stored and then released for water supply, renewable energy generation, and environmental purposes. Releases from Alder Reservoir would be conveyed through three powerhouses arranged in series, through approximately 18 miles of pipelines, tunnels and penstocks, with a total elevation drop of approximately 3,600 feet, back into the American River at the current site of the El Dorado Hydroelectric Project (FERC Project No. 184) El Dorado Powerhouse. To improve local supply reliability in dry years, water could be diverted from the project upstream of the El Dorado Powerhouse into Jenkinson Lake and/or at El Dorado Forebay and used to meet consumptive and irrigation demands.

The project would also allow for coordinated operations with Reclamation for releases at Folsom Reservoir, for enhanced water supply reliability, temperature management for anadromous fish in the Lower American River and for broader Central Valley Project and State Water Project (CVP/SWP) benefits including improvement to ecosystems, water quality, flood control, emergency response and recreation.



Potential Operations and Benefits

The proposed Alder Creek Reservoir could provide a wide range of benefits including:

- **Water Supply Benefits** – including direct local water supply benefits in El Dorado County to meet the buildout demand (urban and agricultural demand projection based on land carrying capacity and approved General Plan).
    - There are many potential permutations to provide for geographically distributed demands in the county subject to further coordination with other water suppliers in the county to determine the best use of all available sources of water for long-term reliability purposes.

- For local water supply benefits, potential federal interests may also apply to water supply to rural and disadvantaged communities and water supply to agricultural purposes.
- CVP water supply benefits and operation flexibility

- **Flood Damage Reduction Benefits –** from increased capacity in intercepting flood flow that would have reached Folsom Dam.
  - The reservoir size is relatively small in comparison with the storms of concern after the Joint Federal Project is completed to provide Sacramento a 200-year-level of flood protection. Currently, there is no dedicated flood space in project concept and there is no intention for inviting potential USACE's jurisdiction over the available reservoir space. Therefore, the benefits may be incidental if captured water is used for water supply purposes.
  - Alternatively, an intended flood benefit can be created if working with Sacramento Area Flood Control Agency (SAFCA) to establish a conditional flood storage that is tied to the forecast-based operation.
- **Hydropower Benefits –** are inherent with in-line generation facilities.
  - Depending on the facility ownership, the potential energy production can be integrated with Western Area Power Administration (WAPA) operation, or EID's project 184 to create greater collective benefits.
- **Recreation Benefits –** are possible around the reservoir areas, downstream areas and other amenities.

Additionally, there may be potential water temperature management benefits to augment Folsom Reservoir's current temperature management practice; however, this could be highly subjective to operation and hydrology.

Facilities

Reclamation and El Dorado County Water Agency (EDCWA) plan to initiate a federal feasibility study for Alder Creek Storage and Conservation Project soon. The following facilities are based on the description and formulation of a previous project, which is currently used for portfolio concept development purposes only. The detailed facilitation plan may be subject to change during the feasibility study.

Alder Creek Reservoir project (see Figure 1-2), includes the following major facilities:

(1) **Alder Dam –** The Alder Dam, located on Alder Creek, will form a 175,000 acre-feet capacity storage reservoir. The dam will be a rockfill structure with a crest elevation of 5485.5 feet. The embankment will have 1.4 horizontal to 1 vertical upstream and 1.5 horizontal to 1 vertical downstream slopes, and a concrete faced upstream slope and

parapet wall. The dam crest length will be approximately 3,700 ft. and the maximum height above stream-bed will be 352 ft. The spillway at Alder Dam will pass the PMF at Alder Reservoir, which has an inflow peak of 13,400 cfs, including 1,050 cfs from Forni and Sherman diversions, and an outflow peak of about 10,000 cfs when routed through the 175,000 acre-feet. reservoir.

(2) **Forni and Sherman Diversion Dams –** The two diversions dams are located upstream of Alder Creek Dam and Reservoir. Forni Diversion dam is located on the South Fork American River at Forni. The Sherman Diversion Dam is located on the Silver Fork at Sherman Canyon.

(3) **Flow Diversions into Alder Reservoir –** Flows from Forni Diversion Dam would pass through Forni Tunnel, and into Silver Fork Tunnel before discharging into Alder Reservoir. Flows from Sherman Diversion Dam and Reservoir would pass through Silver Fork pipeline before joining Silver Fork Tunnel and discharging into Alder Reservoir. Both the Forni Tunnel and Silver Fork pipeline would join into Sliver Fork Tunnel through the Silver Fork Siphon.

a. **Forni Tunnel** - A 27,900 feet long, 13x13 feet horseshoe rock tunnel, extending from Forni Diversion Darn to the Silver Fork near Girard Creek. The tunnel would extend in a southwesterly alignment to the Silver Fork.

b. **Silver Fork Siphon –** A 6,450 feet long, 9 feet and 11.5 feet diameter reinforced concrete pipe, would link the Forni Tunnel and the Silver Fork Pipeline to the Silver Fork Tunnel.

c. **Silver Fork Pipeline –** A 13,750 feet long, reinforced concrete pipe with diameters increasing from 8 feet. to 9 feet, would convey Sherman diversion flows in an almost due west direction along the north side of the Silver Fork to the junction with the Silver Fork Siphon.

d. **Silver Fork Tunnel –** An 18,000 feet 14.5 x 14.5 feet tunnel would be aligned almost due west beginning at the western bank of Girard Creek and extending to Alder Creek.

(4) **Plum Creek Conduit –** Flows from Alder Reservoir would be conveyed to the Plum Creek Powerhouse via the Plum Creek Conduit, which will be composed of Plum Creek Tunnel, Plum Creek Pipeline and Plum Creek Penstock. The conduit is aligned west from Alder Reservoir and then north-west to Plum Creek Powerhouse. The conduit is sized for a 450 cfs capacity, which is equivalent to a 60 percent plant capacity factor.

a. **Plum Creek Tunnel –** The tunnel will be approximately 7,000 feet. long with upstream and downstream invert elevations of 5,240 and 5,200 feet. respectively. The tunnel will connect with a buried 8 feet diameter, reinforced concrete Plum Creek Pipeline just above Mill Creek.

b. **Plum Creek pipeline –** The pipeline would be an 8 feet diameter reinforced concrete pipe that would generally follow Plum Creek Ridge for approximately 7,300 feet, and then connect with the penstock at elevation 5,144 feet.

c. **Plum Creek Penstock –** The penstock would be 6,000 feet steel pipe, with a diameter range of 8 to 6 feet.

(5) **Plum Creek Powerhouse –** The Plum Creek Powerhouse, to be located on the right bank of Plum Creek, would be the first of three powerhouses. The powerhouse will house a single 42.7 MW generating unit.

(6) **Upper Park Creek Conduit –** Discharge flows from Plum Creek Powerhouse would be conveyed via the Upper Park Creek Conduit to the Park Creek Powerhouse, at a maximum rate of 450 cfs. The Upper Conduit will consist of Park Creek Pipeline No. 1 and Park Creek Tunnel No. 1, both aligned in a westerly direction:

a. **The Park Creek Pipeline No. l**, approximately 500 ft. long, would link the Park Creek intake located in the Plum Creek Afterbay to the Park Creek Tunnel No. 1. The pipeline would be a buried 8.5 feet. diameter reinforced concrete pipe.

b. **Park Creek Tunnel No. 1** would be an 18,350 feet long, 9 feet diameter tunnel. The tunnel entrance invert elevation will be 4,067 feet. and the exit will be at 3,871.5 feet elevation.

(7) **Park Creek Powerhouse –** The Park Creek Powerhouse will be located on Park Creek, approximately 3.5 miles west of the Plum Creek Powerhouse, and it will house a single 6.9 MW generating unit.

(8) **Lower Park Creek Conduit –** Discharge flows from Park Creek Powerhouse would be conveyed via the Lower Park Creek Conduit to the El Dorado Powerhouse No.2, at a maximum rate of 450 cfs. The Lower Conduit would discharge into the existing El Dorado Forebay. The Lower Conduit would consist of Park Creek Pipelines No. 2, 3, and 4, and Park Creek Tunnels No. 2, 3, and 4. The conduit route would be generally west for the first 30,000 feet, and then north for the last 12 ,000 feet.

a. **Park Creek Pipelines No. 2, 3, and 4 –** The pipelines would be buried, 7.75 feet diameter, reinforced concrete pipes. They would be aligned parallel to existing roads wherever practical to minimize new construction roads.

b. **Park Creek Tunnels No. 2 –** Tunnel No. 2 would be 750 feet, 10x10 feet, with entrance and exit invert elevations at 3,800 feet.

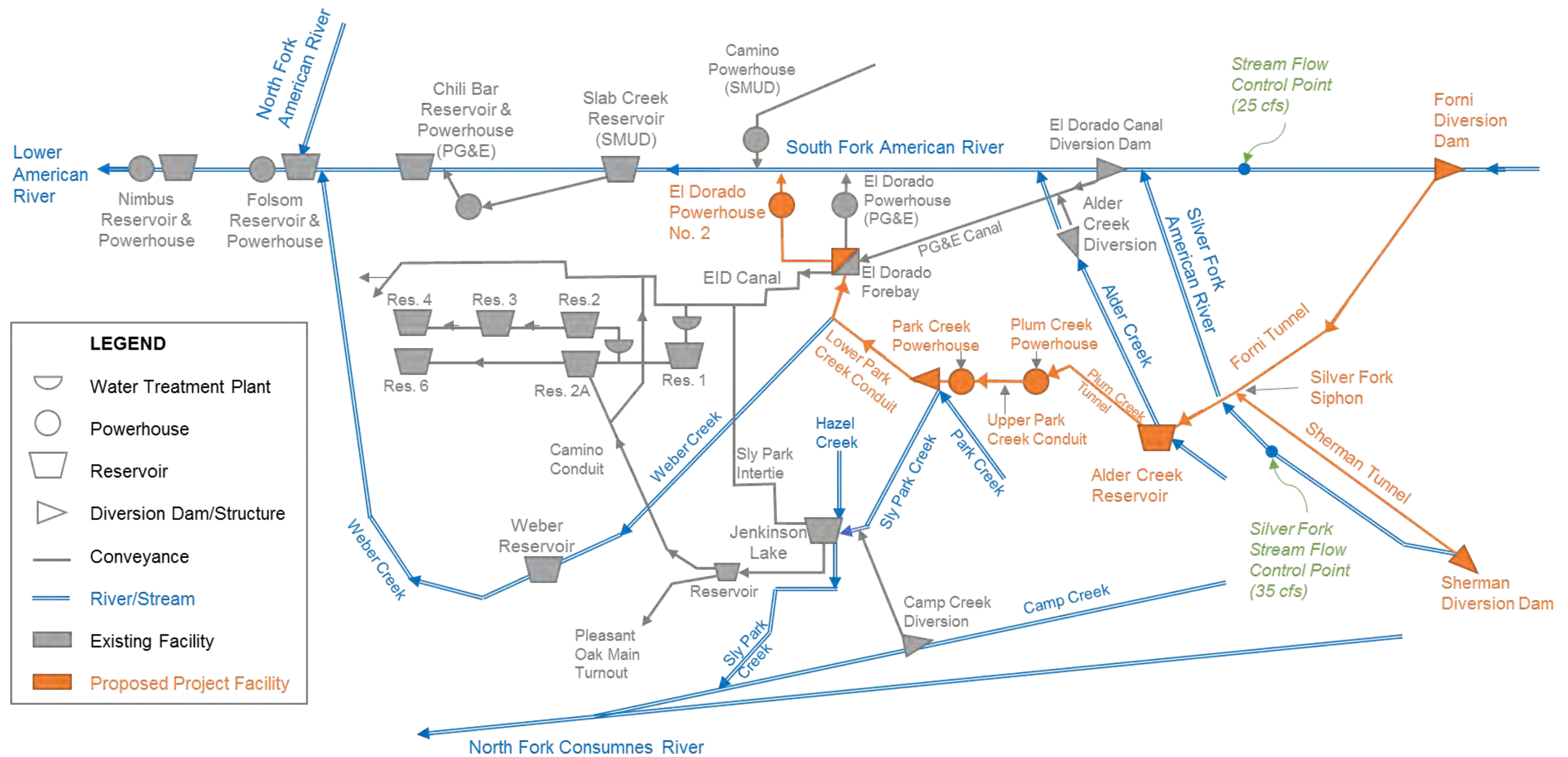
c. **Park Creek Tunnels No. 3 –** Tunnels No. 3 would be 3,275 feet long and 9 feet in diameter. The entrance and exit elevations will be 3,800 and 3,795 feet, respectively.

d. **Park Creek Tunnels No.4 –** Tunnel No. 4 would be 3,550 feet long and 9 feet diameter, passing under the community of Pollock Pines and discharging into El Dorado Forebay. The entrance and exit invert elevations for this tunnel will be 3,785 and 3,777 feet, respectively.

e. **Diversions to Jenkinson Lake –** The EID water supply would be diverted into Jenkinson Lake via Weber Creek through a turnout structure on Pipeline No.4 where it crosses the North Fork of Weber Creek.

(9) **El Dorado Forebay –** The El Dorado Forebay is an existing facility owned and operated by EID. Currently, Forebay waters are released through an outlet located in the left dam abutment to an EID water canal, and through a 5 feet diameter conduit located in the dam right abutment to the existing El Dorado pipeline and penstock. It is proposed that this forebay be a jointly operated facility for Alder and EID projects. Releases to the EID canal will continue according to the existing contract, and to El Dorado Powerhouse according to historic flow records. The additional flows from Lower Park Conduit would be released to the proposed El Dorado pipeline and penstock through two existing, but currently capped, 5 feet diameter conduits, which are located in the darn right abutment.

(10) **El Dorado Powerhouse No. 2 –** The powerhouse would be located near and east of the existing EID El Dorado Powerhouse. This powerhouse would house a single 60.8 MW generating unit.

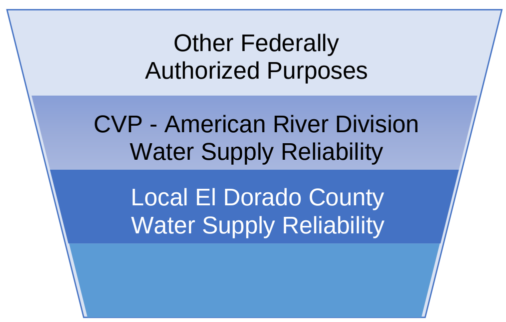


1-2. Schematic of Alder Creek Dam and Reservoir Project and Existing Related Facilities.

Portfolio Formulation to Represent Project Concept

Alder Creek Reservoir is selected to represent the concept of an upper watershed storage to replace some of the reduced snowpack and earlier snowmelt. There is an existing feasibility study authorization for the Alder Creek Water Storage and Conservation Project in Public Law 108-361, Title II, Section 202, dated October 2004. This portfolio evaluates the contribution of upper watershed storage to climate change adaptations.

Construction of Alder Reservoir provides approximately 180 TAF of additional storage upstream of Folsom Reservoir. Figure 1-3 shows a representative potential storage use to meet (1) local water supply reliability needs within El Dorado County, (2) regional water supply reliability needs for CVP American River Division, and (3) other system-wide Federally authorized purposes, include M&I and agricultural water supply reliability, flood protection, environmental flows, recreation, and hydropower generation.



(Not to scale and potential change from year to year)

Figure 1-3. Potential Uses of Alder Reservoir Storage.

Vulnerability pathways addressed by this portfolio are:

- **Primary:** Unreliable water supply in the foothills relying on only surface water without meaningful groundwater resources for supplemental/backup supply.

Key portfolio features include:

- **Water rights and facilities:**
    - Assumed water rights for EDCWA for 40 TAF per year with the assumed Points of Diversion at White Rock and Folsom Dam
    - Use of the storage in Sacramento Municipal Utility District (SMUD) facilities up to 40,000 AF of storage and up to 15,000 AF of carryover storage (inclusive) without interfering with SMUD energy generation, per the SMUD-El Dorado agreement.

  - Assumed 175 TAF Alder Creek Reservoir and associated water rights on Alder Creek
  - Assumed water rights to divert flood flows at Forni Diversion on the American River South Fork to the reservoir; the diversion would be allowed only during the time when Folsom Reservoir is spilling. Folsom spilling does not imply that the Delta is in excess (for in-basin and area-of-origin use, only the in-basin conditions are assessed).
  - Assumed available facilities and capacity to deliver water from the South Fork American River to Georgetown Divide Public Utilities District (GDPUD) via El Dorado Irrigation District's (EID) system separate conveyance along Highway 49. Note that it is possible to make the delivery through exchange with Placer County Water Agency (PCWA) for Middle Fork Project delivery at the American River Pump Station as we have assumed in the Baseline. This requires PCWA to reopen their water rights to include additional Place of Use, which could be challenging. For the portfolio modeling purposes, the assumption is made that water can be delivered from the South Fork American River to GDPUD without and exchange with PCWA, an option that would not make sense without the ability to provide water supply upstream reliably.
- **Water supply commitments:**
  - Assumed agreements among parties including Reclamation, EDCWA, EID, and GDPUD. The corresponding compensation and terms and conditions are not detailed for conceptual planning purposes.
    - EDCWA would enter into an operating agreement with Reclamation to provide water supply to EDCWA (Fazio contract) and EID in lieu of Reclamation's deliveries of CVP water at Folsom Dam.
    - EDCWA would have separate, concurrent and complementary agreements with EID and GDPUD for water supply up to 15.05 TAF and 7.5 TAF, respectively. Unlike their CVP water supply, EDCWA delivery would be only limited by hydrology without further discretionary cutback.
    - Neither EDCWA nor EID would void their existing CVP contract with Reclamation. Rather, these CVP contracts would be used as a backup supply (subject to its shortage policy) in events where Alder Reservoir supply is severely limited in drought conditions.
    - After the above-mentioned arrangement with Reclamation, if Alder Reservoir still has additional capacity to further assist Reclamation's burden in operating Folsom Reservoir, similar agreements would be structured among Reclamation, EDCWA, and City of Folsom for the 7 TAF CVP supply under the City of Folsom's CVP contract. This would be the maximum extent of firm commitments for the Alder Creek Reservoir portfolio.
    - Under these agreements, Reclamation would not need to include these CVP contracts in their contract allocation and operation planning and thus, create direct benefits to Reclamation.

        - **For modeling purposes:** The interception of flood flows should have limited impacts on Folsom operation. The primary benefits would be reflected in the EDC water supply reliability. The various agreements, when executed, means nearly shaving off Reclamation's burden in providing CVP contract delivery for about 30 TAF. This should translate to increase contract delivery and downstream flow conditions. The potential backup use of these CVP contracts would not be modeled explicitly.

- **Operational flexibility commitments:**
    - When feasible and without impacting the above water supply commitments and the water supply reliability in EDC, EDCWA can engage in surface water storage transfers directly with Reclamation under their long-term water transfer program. It is also possible to engage in transfers with party in the lower basin, contributing to the operation of federally recognized water bank. This added operational flexibility can develop shared benefits with Reclamation.
    - It is possible to engage the transfer through the Cosumnes River for environmental flow purposes. However, this does not create direct benefits to Reclamation in its operating Folsom Reservoir, which is the primary theme of the ARBS.
    - **For modeling purposes:** These operational flexibility commitments do not need to be modeled but discussed qualitatively in the assessment.

Chapter 2 Sacramento River Diversion Project

This portfolio evaluates potential regional and system-wide (local, state, and federal) benefits of a project concept for a new Sacramento River Diversion Project. The project representation used in this portfolio relies on information developed under previous and ongoing studies, with the aim to assess and demonstrate the project concept potential to improve regional and system-wide adaptation to climate change effects. It should be noted that project concept formulated for this portfolio would likely be further refined under ongoing studies.

Description

The Sacramento River Diversion Project represents a multi-agency partnership that would shift a portion of existing regional water diversions from Folsom Reservoir, the lower American River, and from the Sacramento River below the Sacramento/American River confluence, to a location upstream of the confluence of the two rivers. Specifically, the relocated diversions would take place through the existing Natomas Mutual Water Company (NMWC) intakes located upstream of the Sacramento and American Rivers confluence. A schematic comparison of current diversions versus the proposed Sacramento River Diversion Project diversions is shown on Figure 2-1.

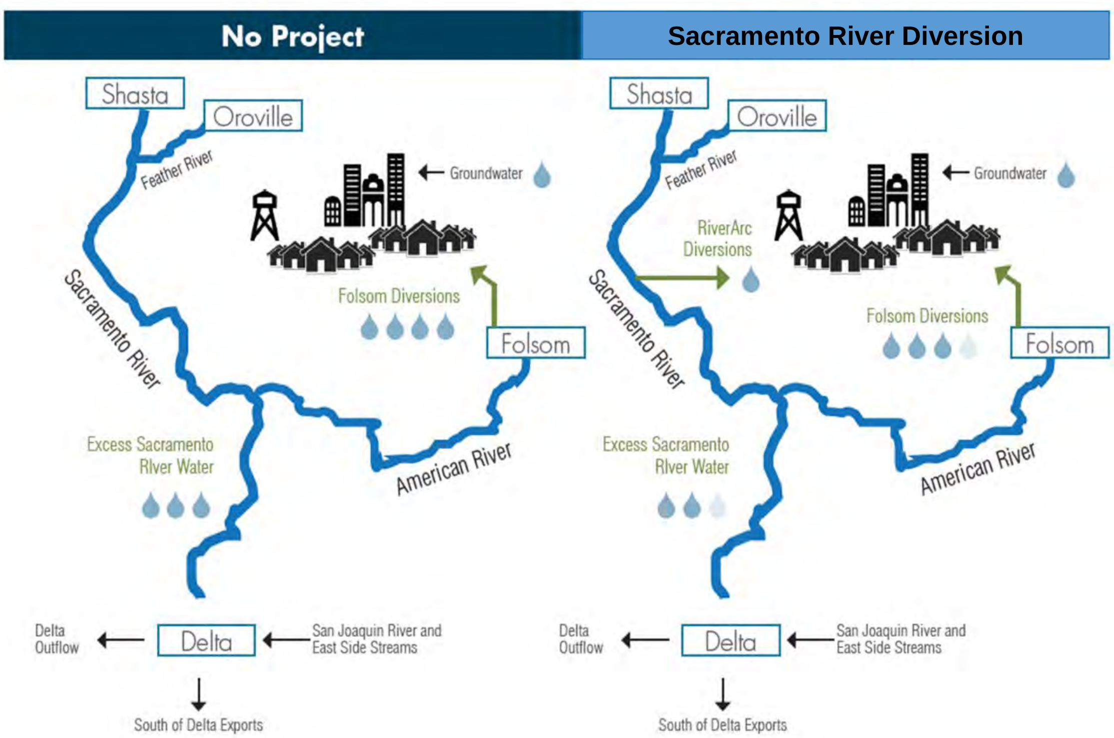


Figure 2-1. Schematic of Current Diversions versus Sacramento River Diversion Project Diversions.

The Sacramento River Diversion Project would potentially affect diversions to the City of Roseville, Sacramento Suburban Water District (Northridge), City of Sacramento and portions of Placer County Water Agency (PCWA). Under the No Project condition, these diversions are split between the American River, Folsom Reservoir, and a point downstream of the Sacramento and American River confluence. With the Sacramento River Diversion Project, a portion of these diversions would be shifted to the NMWC intakes. The increased volumes in the American River/Folsom Reservoir could be either stored in Folsom Reservoir or released to the American River, depending on whether the Delta is in excess or balanced conditions, and the availability of storage capacity in Folsom Reservoir.

By shifting diversions from the American River and Folsom Reservoir to the NMWC intakes, flows in the Lower American River could be increased by 53 TAF annually and end-of-September storage in Folsom Reservoir could be maximized to provide an increase in storage of as much as 20 TAF. These flow and storage increases would provide Reclamation with the flexibility to increase system-wide Central Valley Project (CVP) water supply, enhance Lower American River flows for fish habitat and spawning, and/or improve temperature management on both the American and Sacramento Rivers.

Potential Operations and Benefits

The Sacramento River Diversion Project is expected to enhance water supply reliability, increase the resiliency of regional groundwater supplies, increase system-wide supply for the CVP, enhance Lower American River flows for fish habitat and spawning, and improve temperature management on both the American and Sacramento Rivers. The project would also provide Reclamation flexibility in the operations of the CVP system in several different ways, depending on hydrologic conditions and operations.

The proposed operations could provide a wide range of benefits, including:

- **Regional Water Supply Benefits –** Shifting diversions from American River and Folsom Reservoir to the Sacramento River would enhance regional water supply reliability, especially during dry conditions, and increase the resiliency of regional groundwater supplies. In addition, new infrastructure would help meet the buildout urban demand in Western Placer County and Sacramento County.

- **South-of Delta Water Supply Benefits –** Shifting diversions from American River and Folsom Reservoir to the Sacramento River increases stored water supplies in Folsom Reservoir. During periods when South of Delta demand and export capacity are available, releasing stored water from Folsom Reservoir could enhance South of Delta exports.

- **Ecosystem Benefits on the Lower American River –** Flows that are currently diverted from the American River and Folsom Reservoir would be held in Folsom Reservoir to the maximum extent possible, thus enhancing cold water conditions in Folsom Reservoir and downstream in the American and Sacramento Rivers. Stored supplies can be released to maximize fall temperature benefits in the American and Sacramento Rivers for fish habitat and spawning.

Facilities

The Sacramento River Diversion Project includes the following major facilities:

(1) **Sacramento River Intakes –** NMWC owns and operates four diversion structures on the Sacramento River: Sankey, Pritchard Lake, Elkhorn, and Riverside (listed from upstream to down-stream). All intakes are identified in the CVP water right permits as diversion points.

a. **Sankey** intake is a flat plate screen, pier configuration intake located very close to the Natomas Cross Canal confluence with the Sacramento River. Sankey was constructed in 2013 to replace two older intakes.

b. **Pritchard Lake** is down river from Sankey and was constructed in 2015 to replace the existing structure.

c. **Elkhorn** Intake is unscreened diversion. Elkhorn is next downriver and is scheduled for upgrades in early 2020s.

d. **Riverside** Intake is the most southern intake and is also scheduled for upgrades in the mid-2020s.

(2) **Surface Water Treatment Plant:** The WTP location is east of the Sacramento International Airport.

(3) **Conveyance:** The raw and finished water pipelines will be constructed in phases. Raw water pipeline lengths would be 80,000 to 86,000 feet, and finished water pipeline lengths would be from 125,000 to 133,000 feet.

Chapter 3 Federally Recognized Groundwater Bank

This portfolio evaluates potential regional and system-wide (local, state, and federal) benefits of a project concept for a regional groundwater bank in the North and South American River groundwater basins. The project representation used in this portfolio relies on information developed as part of the Regional Water Authority's Regional Water Reliability Plan (2019), with the aim to assess and demonstrate the project concept potential to improve regional and system-wide adaptation to climate change effects. It should be noted that project concepts formulated for this portfolio will need to be further refined under subsequent studies.

Description

A regional groundwater bank is a multi-agency partnership that would allow participating local water agencies (termed Project Partners) to leverage available surface water and groundwater supplies to expand conjunctive use operations to improve statewide, regional, and individual agency long-term water supply reliability. The regional groundwater bank (Project) is a major climate change adaptation strategy for this region, which will build on the existing regional conjunctive use program.

The regional groundwater bank would maximize the regional conjunctive use practice in a sustainable manner to meet regional water supply reliability needs. The Project will provide an opportunity to integrate regional conjunctive use operations with the operation of Folsom Reservoir, providing system-wide operational flexibility. The Project will provide additional tools and capacities for Reclamation to improve the ecological health and water management in the Delta and Lower American River, as well as water supply benefits. Folsom Reservoir provides a critical function for managing temperature on the Lower American River and Delta water quality for the enhancement and protection of Delta fisheries and ecosystem. The Project will further expand the ability of Folsom Reservoir to perform these functions by fully integrating groundwater storage with surface water storage operations. The Project would also provide in-lieu water banking opportunities to improve statewide water management flexibility.

Project operations can be flexible and scalable using the combination of existing surface water and groundwater facilities. Operations may be adjusted with short notice, or in emergency conditions, making use of the facilities in place and integrated water management facilitated by the Project. In addition to water rights, many of the Project Partners are CVP contractors receiving deliveries from Folsom Reservoir. The North and South American Basins have nearly two million acre-feet (AF) of total storage that can be used to store surface water in wetter years for use when surface water supplies are more limited (RWA, 2019).

Potential Operations and Benefits

The proposed regional groundwater bank could provide a wide range of benefits including:

- **Regional Water Supply Benefits –** A regional groundwater bank would enhance water supply reliability through integrating the use of water rights and contract entitlements with groundwater resources. Expanded groundwater banking during wetter conditions would enhance groundwater sustainability. During dryer conditions, the region would use banked groundwater to make up for the reduction in surface water supplies made available to banking partners.

- **CVP Water Supply and Operational Flexibility Benefits –** A regional groundwater bank would provide CVP water supply benefits and operation flexibility. Banked CVP water supplies during wetter periods would be used by Project Partners, and equal amount of surface water would be made available at Folsom Reservoir for Reclamation to meet south-of-Delta CVP contractors' needs.

- **Delta Ecosystem and Water Quality Benefits –** During times when ecosystems or water quality conditions in the Delta are stressed, Project Partners may switch from surface diversions (including their CVP deliveries) to use of banked groundwater to change the timing of surface water availability in Folsom Reservoir for the operational needs of the Reclamation to meet Delta ecosystem and water quality targets.

- **Ecosystem Benefits on the Lower American River –** Project Partners may coordinate with Reclamation to switch from surface diversions (including their CVP deliveries) to use of banked groundwater to enhance cold water conditions in Folsom Reservoir and downstream in the American and Sacramento Rivers. Foregone deliveries stored in Folsom Reservoir can be released to maximize fall temperature benefits in the American River.

Facilities

The following physical facilities were used to determine the recharge and recovery potential of the Project:

- Capacity of Surface Water Treatment Plants – The amount of surface water in wetter years that is available to be recharged (either in lieu or ASR) is limited to the available capacity of surface water treatment plants.

- Capacity of Groundwater Wells – The amount of groundwater in drier years that is available to be recovered is limited to the available capacity of groundwater wells.

- Intra-District Water Distribution – The lack of cohesive intra-district infrastructure could limit the amount of water that could be delivered throughout a district. For example, certain areas may only be serviced by groundwater wells and are not hooked up to the larger distribution system, prohibiting those areas from receiving surface water even if available.

- Regional Water Transmission Pipelines – The lack of interties/transmission pipelines between districts limits the ability to transfer supplies. For example, an agency may have extra surface water in wet years to transfer to other agencies, but if it lacks interties with groundwater-using agencies, then the available surface water could not be transferred.

- Minimum Production Needs – Some facilities require a minimum amount of water to be produced/treated (e.g., minimum well production to meet agency policies or avoid physical damage to wells from shutting off/on). As such, the amount of water that can be recharged or recovered is limited to these minimum production needs of groundwater wells or surface water treatment plants.

Portfolio Formulation to Represent Concept

Expanding conjunctive use operations can further expand access to both surface water and groundwater, allowing more effective management through wet and dry periods. The Project will provide an opportunity to improve regional reliability and operational flexibility to Reclamation in drier years. Refer to the Regional Water Reliability Plan (RWA, 2019) for details on the assumptions used.[1]

Conjunctive Use Operations

Conjunctive use operations would enable the Project Partners to optimize use of available surface water when available (in lieu of groundwater). Thus, less groundwater will be used and is accounted as water stored in the groundwater bank. Then, when surface water is scare, groundwater can be extracted to minimize reliance on surface water supplies.

Recharge Operations

Recharge potential was analyzed using the assumptions listed in Table 3-1. The recharge capacity is limited to the in-lieu capacity which is defined as the average 2011 to 2013 groundwater use. The surface water available for recharge integrates information on surface water availability, available water treatment plant capacity, and available conveyance capacity. Note that while Roseville has ASR capacity, it was not included in this analysis as additional opportunity for recharge. That is because at the simulation year of 2070, Roseville will be using most, if not all, of its surface water supplies to meet existing demands, and hence only a limited amount would be available for direct recharge.

[1] Note that the recharge and recovery amounts shown in the tables may differ from those in the Regional Water Reliability Plan (RWA, 2019). Refer to Tables D-4 and D-5 for reasoning.

Table 3-1. Recharge Operations Assumptions

Agency Providing Surface Water	Agency that Surface Water is Delivered to In Lieu of Groundwater	Simulated surface water increase / groundwater decrease (TAF/yr)	Assumptions
San Juan WD (via Barton Road WTP)	California American WC - Antelope, California American WC - Lincoln Oaks	15.1	Assumes SCWA's CVP supply will be used to offset groundwater use. As SCWA's current CVP contract allows for CVP water to be used only within their contract-specific POU, this assumes SCWA would work with Reclamation to re-align its CVP contract to allow for use to these agencies.
	Citrus Heights Water District, Fair Oaks Water District	0.4	Assumes CVP water will be delivered to offset groundwater use.
Carmichael WD (via Bajamont WTP)	Sacramento Suburban WD - North	0.4	Assumes CWD's water right will be used to offset groundwater use.
	Golden State Water Company - Cordova	4.4	
SCWA (via Vineyard WTP)	EGWD - Service Area 2	1.5	Assumes SCWA's CVP supply will be used to offset groundwater use. As SCWA's current CVP contract allows for CVP water to be used only within their contract-specific POU, this assumes SCWA would work with Reclamation to re-align its CVP contract to allow for use to these agencies.
	CalAm - Rosemont Suburban	1.0	
City of Sacramento (via Fairbairn WTP)	CalAm - Rosemont Suburban, CalAm - Parkway	3.2	Assumes USBR Settlement Contract water will be delivered to offset groundwater use.
	Sacramento Suburban WD - South	10.6	
PCWA (via Foothills WTP)	City of Lincoln	0.2	Assumes CVP water will be delivered to offset groundwater use.
TOTAL		36.8	

Recovery Operations

Recovery potential was analyzed using assumptions listed in Table 3-2. The recovery potential is limited to surface water use that could be offset by groundwater and the available groundwater supplies. Existing surface water and groundwater use is based on the Year 2015 use because this was the most recent dry year condition and reflects a recent scenario when the region would undergo recovery operations.

1. Assumed groundwater available for conjunctive use to be equal to the groundwater production capacity less the 2015 actual groundwater usage.

2. For agencies that have groundwater production capacity, it was assumed that districts would offset their own surface water use with their own groundwater production.

3. If agencies still had remaining surface water use after any in-district groundwater recovery, it was assumed that either Sacramento Suburban WD, PCWA, or Roseville (based on proximity and consistent fluoridation practices) would provide groundwater to agencies to fully offset surface water use as conveyance and production capacity were available.

Table 3-2. Recovery Operations Assumptions

Agency Providing Groundwater	Agency that Receives Groundwater and Forgoes Surface Water	Simulated surface water decrease / groundwater increase (TAF/yr)
Citrus Heights Water District, Fair Oaks Water District	Citrus Heights Water District, Fair Oaks Water District	10.6
Sac Suburban North	Citrus Heights Water District, San Juan WD	5.8
Golden State WC - Cordova	Golden State WC - Cordova	7.2
Carmichael WD	Carmichael WD	2.4
City of Sacramento	City of Sacramento	31.8
Sac Suburban South	City of Sacramento	10.4
California American WC - Parkway, California American WC - Rosemont Suburban	California American WC - Parkway, California American WC - Rosemont Suburban	0.9
Sacramento County WA - Zone 40	Sacramento County WA - Zone 40	6.4
City of Lincoln	City of Lincoln	6.2
PCWA	City of Lincoln	0.6
City of Roseville	City of Roseville	11.4
City of Roseville	California American WC - West Placer	0.8
TOTAL		**94.5**

Water Bank Operations

To illustrate the potential quantitative benefits of conjunctive use, CalSim 3 was used to simulate longer-term recharge and recovery operations. The analysis used the following assumptions:

- **Recharge and Recovery Capacity –** The simulation included the recharge potential and recovery capacities listed in Tables 3-1 and 3-2 above.
- **Timing of Recharge –** While recharge could occur at any point when supplies are available, the model conservatively assumed recharge would only take place in Water Forum Agreement wet and average year types.[2]

[2] The Sacramento Water Forum Agreement defines wet years as when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 1.6 million acre-feet (maf).

- **Timing of Recovery –** Recovery occurs in dry and critical Sacramento River Index Year Types[3]. This index was selected because it represents a more realistic estimate of demand on the overall California market. Also, dry and critical Sacramento River Index Year Types have occurred more frequently in recent past than drier Water Forum Agreement Year Types.

- **One Bank for all Subbasins –** The water bank accounting combines both the North and South American subbasins, because several participating agencies overlie both basins and interties exist that can readily move water to both basins.

- **Positive Basin Storage Requirement –** Under normal banking operations, recharge must precede recovery and the cumulative banked water balance cannot run in the negative. If the cumulative banked balance reaches zero, then recovery operations cease until the cumulative banked balance is positive. These operational assumptions were included to ensure consistency with SGMA requirements.

- **Unrecoverable Losses –** When storing water in the water bank, an annual physical loss of 1 percent was assumed to occur to account for water flowing out of the basin and a one-time loss of 10 percent of what was recharged would occur as a basin mitigation factor (e.g., a contribution to the basin). Note that the annual loss and basin mitigation factor are hypothetical assumptions used for this analysis and do not commit any potential future water bank participants to this constraint. Should the region move forward with the development of a water bank, water loss factors through a detailed technical modeling analysis would be needed.

Institutional Considerations

Water supply commitments

Assumed agreements among parties including Reclamation and participating agencies. The corresponding compensation and terms and conditions are not detailed for conceptual planning purposes. An overview of the assumed commitments are as follows:

- CVP contractors (SJWD, PCWA, SCWA) would enter into an operating agreement with Reclamation to provide water supply to neighboring agencies who use groundwater in wet year (see Table 3-1) in lieu of Reclamation’s deliveries of CVP water at Folsom Dam, where possible.

- The CVP contractors would work with Reclamation to modify their contract-specific Place of Use, as needed, to enable delivery of CVP water to abovementioned agencies.

- SJWD, PCWA, and SCWA would have separate, concurrent and complementary agreements with groundwater-using agencies for water supply up to the amounts shown in Table 3-1, with the conditions consistent with the operating agreement with Reclamation. Unlike their CVP water supply, these agencies’ delivery would be only

[3] The Sacramento River Index Type defines years based on the unimpaired runoff from River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake. It factors in the current April to July runoff forecast, current October through March runoff, and the previous water year index. Unimpaired runoff in critical years is equal to or less than 5.4 maf, and dry years is greater than 5.4 maf, but equal to or less than 6.5 maf.

limited by hydrology without further discretionary cutback as additional benefits accrued in the region.

- Reclamation will continue to allocate CVP contract delivery based on their standard process and consideration, including the contracts with the American River Diverters because they would not void their existing CVP contract with Reclamation. Rather, Reclamation's deliveries from Folsom to the contract amount (subject to its shortage policy) would be a lower priority supply to these parties in drier conditions.

- Under these agreements, Reclamation would not need to fully include these CVP contracts in their contract allocation and operation planning and thus, create direct benefits to Reclamation.

- **For modeling purposes:** The various agreements, when executed, means lessening Reclamation's burden in providing CVP contract delivery for up to 90 TAF in dry years. This should translate to increase contract delivery and downstream flow conditions. The potential backup use of these CVP contracts would not be modeled explicitly.

Operational flexibility commitments

When feasible and without impacting the above water supply commitments and the water supply reliability in the region, the participating agencies can engage groundwater storage transfers directly with Reclamation by establishing agreements with Reclamation. It is also possible to engage transfer to a party in other downstream parts of the State. These are to create shared benefits with Reclamation.

For modeling purposes: These operational flexibility commitments are not modeled but discussed qualitatively in the assessment.

Supplemental Information

Table 3-3. Comparison of Recharge Potential between Regional Water Reliability Plan and this Project

Water source	Deliveries to	Surface water increase / ground water decrease (annual taf)		Difference	Primary limiting factors
		RWRP	ARBS		
San Juan WD	California American WC - Antelope, California American WC - Lincoln Oaks	18.1	15.1	-3.0	Existing groundwater pumping
	Citrus Heights Water District, Fair Oaks Water District	0.4	0.4	0.0	
Carmichael WD	Sacramento Suburban WD - North	4.4	0.4	-3.9	Water Forum limit on surface water diversions
	Citrus Heights Water District	0.4	0.0	-0.4	Water Forum limit on surface water diversions
	Golden State Water Company - Cordova	6.2	4.4	-1.8	Water Forum limit on surface water diversions
SCWA	EGWD - Service Area 2	1.5	1.5	0.0	
	CalAm - Rosemont Suburban	2.8	2.8	0.0	
City of Sacramento	CalAm - Rosemont Suburban, CalAm - Parkway	9.5	9.3	-0.2	Hodge criteria limit on surface water diversions
	Sacramento Suburban WD - South	11.6	10.8	-0.8	Hodge criteria limit on surface water diversions
PCWA	City of Lincoln	1.0	0.2	-0.8	Existing groundwater pumping
	Total	55.7	44.8	-10.9	

Table 3-4. Comparison of Recovery Potential between Regional Water Reliability Plan and this Project

Water source	Deliveries to	Surface water decrease / ground water increase (annual TAF)		Difference	Primary limiting factors
		RWRP	ARBS		
Citrus Heights Water District, Fair Oaks Water District	Citrus Heights Water District, Fair Oaks Water District	6.9	6.9	0.0	
Sac Suburban North	Citrus Heights Water District, San Juan WD	6.1	6.1	0.0	
Golden State WC - Cordova	Golden State WC - Cordova	7.2	4.7	-2.5	Existing surface water diversions
Carmichael WD	Carmichael WD	2.4	1.9	-0.5	Existing surface water diversions
City of Sacramento	City of Sacramento	8.7	8.6	-0.1	Existing surface water diversions
Sac Suburban South	City of Sacramento	11.4	11.3	-0.2	Existing surface water diversions
California American WC - Parkway, California American WC - Rosemont Suburban	California American WC - Parkway, California American WC - Rosemont Suburban	0.9	0.7	-0.1	
Sacramento County WA - Zone 40	Sacramento County WA - Zone 40	6.4	6.4	0.0	
City of Lincoln	City of Lincoln	0.8	0.8	0.0	
PCWA	City of Lincoln	1.9	1.9	0.0	
City of Roseville	City of Roseville	3.1	3.0	0.0	
City of Roseville	California American WC - West Placer	2.3	2.3	0.0	
	Total	58.1	54.6	-3.5	

Chapter 4 Folsom Dam Raise with Groundwater Banking

This portfolio is focused on increasing flood protection using Forecast Informed Reservoir Operations (FIRO) at Folsom Reservoir with conjunction with new flood space at upstream reservoirs. The increased water storage could be leveraged to further improve water supply conditions for Reclamation. Additionally, opportunities for pre-delivery of the flood releases for groundwater recharge in the South Basin, consistent with applicable water rights and permits, may be considered to create regional water supply and ecosystem benefits. This portfolio evaluates potential regional and system-wide (local, state, and federal) benefits of an authorized Folsom Dam raise together with groundwater banking in the South American River Basin. The project representation used in this portfolio relies on information developed under previous and ongoing studies, with the aim to assess and demonstrate the project concept potential to improve regional and system-wide adaptation to climate change effects. It should be noted that project concept formulated for this portfolio would likely be further refined under ongoing regional studies.

Description

The Sacramento Area Flood Control Agency (SAFCA) is investing resources in creating 500-year flood protection for the American River Basin. This includes working on a multi-objective, multi-component project in both the American River and Consumes River watersheds. This multi-objective project will occur over several years and will require extensive focus on flood institutional management, reservoir operations, water institutional management and exploration of public benefits. These elements are briefly described below:

1. Flood Institutional Management: The Placer County Water Agency (PCWA) and the Sacramento Area Flood Control Agency (SAFCA) are cooperating on reservoir improvements upstream of Folsom Reservoir that will lead to increased flood protection downstream throughout the American River. In addition, Reclamation and the U.S. Army Corps of Engineers (USACE) continue to work on improvements to Folsom Dam. Such improvements will require close coordination with Reclamation, PCWA, SAFCA, the USCOE and California Department of Water Resources (DWR).

2. Reservoir Operations: The infrastructure improvements and resulting additional storage space and flood protection will provide an opportunity to realize new reservoir operational opportunities that have the high potential to lead to a diverse set of system-wide benefits. These include the use of conditional storage under certain agreed upon conditions.

> NOTE: Numbers 1 and 2 above will ultimately require a USACE Water Control Manual update and new flood deviation processes to Folsom Reservoir operations.

3. Water Institutional Management: To take full system-wide advantage of the aspects associated with additional flood improvements and reservoir operational opportunities and to agree upon specific mechanisms to realize the full range of benefits, several agreements will be needed between and among the various water management agencies within the American River Basin. This includes, but is not limited to, the Regional Water Authority (RWA), PCWA, SAFCA, USACE, DWR, Consumes River water users and other water user groups. These agreements will address the responsibilities of each agency/organization, what benefits each agency will realize and other commitments of the signatories.

Key elements of this portfolio include:

- Folsom Dam Raise with limited allowable interim storage without increasing flood risk and infrastructure risk (facilitated by the new auxiliary spillway);
- Modifications of upstream reservoirs (Hell Hole, French Meadows, and Union Valley) for additional flood storage made available by prereleases enabled by 7- to 10-day forecast-based operations;
- Pre-release and limited storage releases through the Folsom South Canal for groundwater banking in the south basin (focusing on the rural areas); and
- Groundwater banking through rural area spreading grounds for water market opportunities, including Cosumnes River flow augmentation benefits.

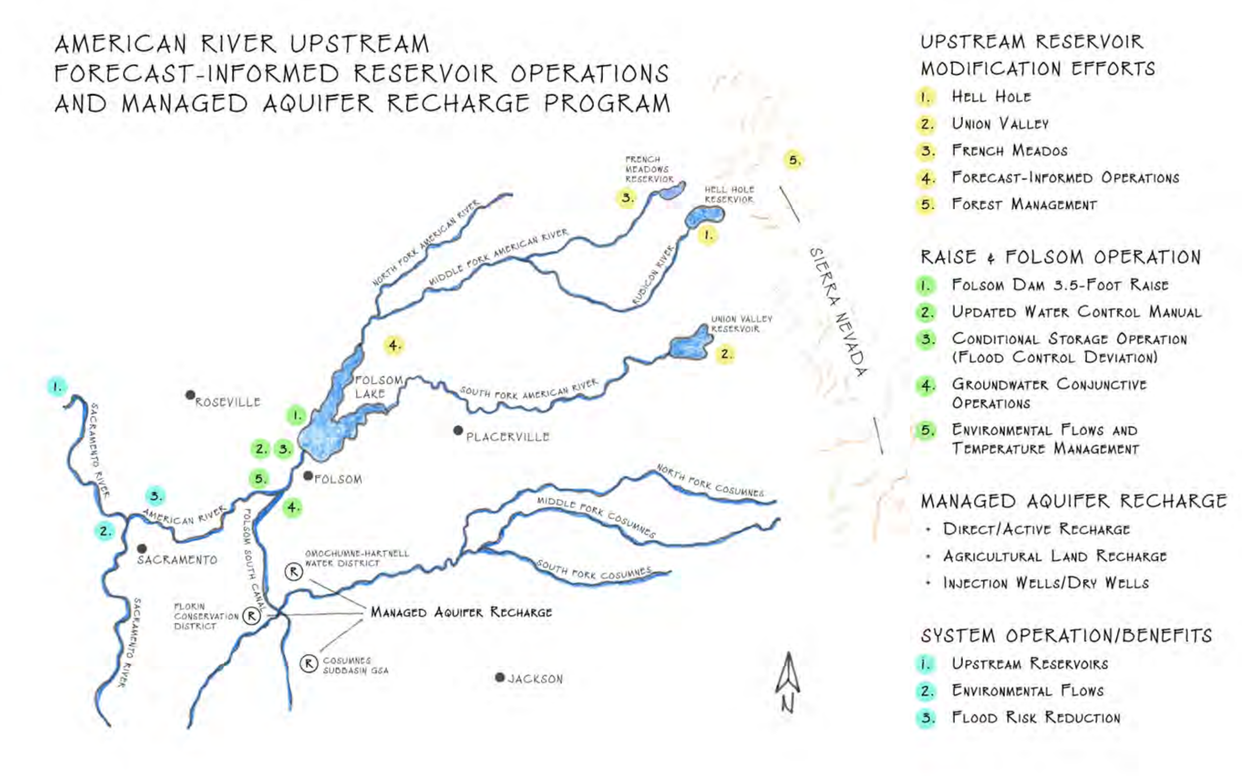
Potential Operations and Benefits

The proposed portfolio could provide a wide range of benefits including:

- **Flood Protection Benefits –** By coordinating pre-releases and limited storage releases upstream of Folsom Reservoir together with Folsom Reservoir operations, this portfolio would lead to increased flood protection downstream throughout the Lower American River. Additionally, raising Folsom Dam would provide additional storage that would improve operational flexibility for Folsom Reservoir operators.
- **Ecosystem Benefits on the Lower American River –** Project Partners may coordinate with Reclamation to switch from surface diversions (including their CVP deliveries) to use of banked groundwater to enhance cold water conditions in Folsom Reservoir and downstream in the American and Sacramento Rivers. Foregone deliveries stored in Folsom Reservoir can be released to maximize fall temperature benefits in the American River.
- **Regional Operational Flexibility Benefits –** Expanded groundwater banking during wetter conditions would enhance groundwater sustainability. During dryer conditions, the region would use banked groundwater to make up for the reduction in surface water supplies made available to banking partners.

- **CVP Water Supply and Operational Flexibility Benefits** – Regional groundwater banking would provide CVP water supply benefits and operation flexibility. Banked CVP water supplies during wetter periods could be used by Project Partners, and an equal amount of surface water would be made available at Folsom Reservoir for Reclamation to meet south-of-Delta CVP contractors' needs.

Figure 4-1 depicts the key elements and potential operations and benefits of the project.



4-1. Folsom Dam Raise with Groundwater Banking Portfolio Schematic.

Facilities

This portfolio includes the following major facilities:

(1) **Folsom Reservoir** – Folsom Reservoir is a multipurpose water project constructed by the Corps of Engineers and operated by the United States Bureau of Reclamation as part of the Central Valley Project (CVP). The reservoir has a normal full-pool storage capacity of 975,000 acre-feet with a minimum seasonally designated flood control storage space of 400,000 acre-feet. The reservoir provides flood protection for the Sacramento area; water supplies for irrigation, domestic, municipal, and industrial uses; and hydropower. It also provides extensive water-related recreational opportunities, water quality control in the Delta, and maintenance of flows stipulated to balance anadromous and resident

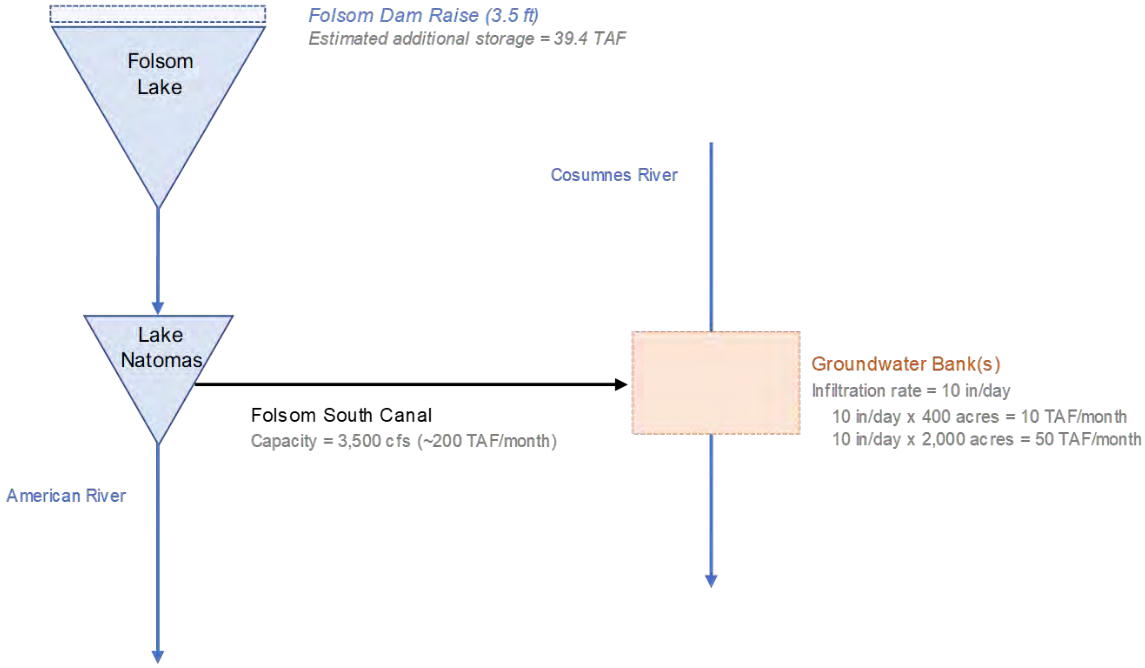
fisheries, wildlife, and recreational considerations in and along the lower American River.

a. **Folsom Dam –** Folsom Dam impounds Folsom Reservoir and regulates runoff from approximately 1,875 square miles of drainage area. The preferred alternative of the Final Environmental Impact Statement/Report for the Folsom Dam Raise Project includes a 3.5 foot dam raise for Folsom Dam, which is included in this portfolio's analysis.

b. Up to 300 TAF of additional flood space could be made available at French Meadows, Hell Hole, and Union Valley Reservoirs. This additional flood space would require agreements with reservoir owners and operators (PCWA and SMUD) and modifications to reservoir outlets to increase release capacity. This portfolio could effectively increase the existing flood control space on the American River from 400 to 600 TAF up to 700 to 900 TAF.

(2) **Folsom South Canal –** The Folsom South Canal (FSC) is an aqueduct that diverts water from the American River at Nimbus Dam and travels about 26.7 miles in a southerly direction, terminating near Clay, about 10 miles northeast of Lodi. The canal is operated by the U.S. Bureau of Reclamation, as part of the Auburn-Folsom South Unit of the Central Valley Project. It is contracted for irrigation, industrial and municipal water supply; formerly it provided cooling water for the Rancho Seco Nuclear Generating Station. It is also connected to the Mokelumne Aqueduct, which provides a large portion of the San Francisco Bay Area's water supply. The FSC has an operational capacity of 3,500 cubic feet per second.

(3) **South Basin Groundwater Banks –** managed aquifer recharge (MAR) efforts in the South American River Basin are underway currently and would benefit from this portfolio via additional recharge from the Folsom South Canal. Potential recharge methods could include direct/active recharge, agricultural land recharge, and/or injection wells/dry wells. Based on research from UC Davis, an infiltration rate of 10 in/day was analyzed for this portfolio over areas of 400 and 2,000 acres (equivalent to 10 TAF/month and 50 TAF/month of recharge capacity, respectively). Figure 4-2 shows a high-level schematic of how the groundwater bank recharge may be implemented.



4-2. Analysis Schematic of Potential Groundwater Banking Implementation.

Chapter 5 2019 BO Flow Management Standard

This portfolio evaluates potential regional and system-wide (local, state, and Federal) benefits of a modified flow management standard (FMS) for the lower American River. The application of the modified FMS developed by the Sacramento Water Forum relies on information developed under previous and ongoing studies, with the aim to assess and demonstrate the potential to improve regional and system-wide adaptation to climate change effects. The modified FMS aims at providing environmental and biological advantages along with an improved resiliency to the effects of climate change on the Lower American River flows. Note that these actions are currently being implemented as part of the NOAA Fisheries and USFWS 2019 Biological Opinions on Long-term Operation of the CVP and SWP. Therefore, this portfolio evaluates the benefit of such water management strategy for climate change adaptation.

Background

The Sacramento Water Forum has developed the Modified Flow Management Standard (Modified FMS) for the lower American River, that represents the best path forward for protecting local resources without re-directing negative impacts to other regions.

The 2006 FMS is a set of measures that includes minimum release requirements and water temperature objectives. Only the minimum release requirements are implemented in CalSim II. These requirements considerably affect the operations of Folsom reservoir and flows in the American River. The main differences between the 2006 FMS and the modified FMS are that the modified FMS (1) adjusts the curves for determining minimum release requirements, using only the Sacramento River Index (SRI) and American River Index (ARI) as indicators of water availability; (2) adds end-of-May and end-of-December storage targets which can be used to adjust the minimum release requirement; (3) adds protective adjustments relating to chinook salmon and steelhead redd dewatering; (4) provides spring pulse flows; and (5) removes the prescriptive and discretionary adjustments to the release requirement, and the conference year and off-ramp conditions, which were contained in the 2006 FMS.

Potential Project Operations and Benefits

The proposed portfolio could provide a wide range of benefits including:

- **Regional Water Supply Benefits –** The modified flow management standard for lower American River would provide for an improved storage in Folsom reservoir due to lower minimum release requirements (MRR) during dry years and higher MRRs during wet years. An increased storage would enhance water supply reliability. During drier conditions, the region would use the stored water to make up for the reduction of water supply deficit.

- **CVP Water Supply and Operational Flexibility Benefits –** Increased storage in Folsom reservoir would provide CVP water supply benefits and operation flexibility. The additional water available during wet periods could be used in lieu of the groundwater thus improving the groundwater storage in the region and providing additional operational flexibility.

- **Delta Ecosystem and Water Quality Benefits –** The modified MRRs for Folsom reservoir change the timing of surface water availability in Folsom Reservoir for the operational needs of the Reclamation to meet Delta ecosystem and water quality targets. The modified MRRs are based on unimpaired flows in Sacramento and American rivers, thus providing for a better protection for Delta Ecosystem and additional water quality benefits.

- **Ecosystem Benefits on the Lower American River –** The modified flow management standard provides for Redd dewatering protections and pulse flows for Chinook and Salmon emigration during times of low flows. The modified FMS is designed to avoid dewatering the eggs of anadromous salmonids in their spawning nests (“redds”). Minimum flows required for January and February are about 70% of December flows, which provides and additional protection to the ecosystem.

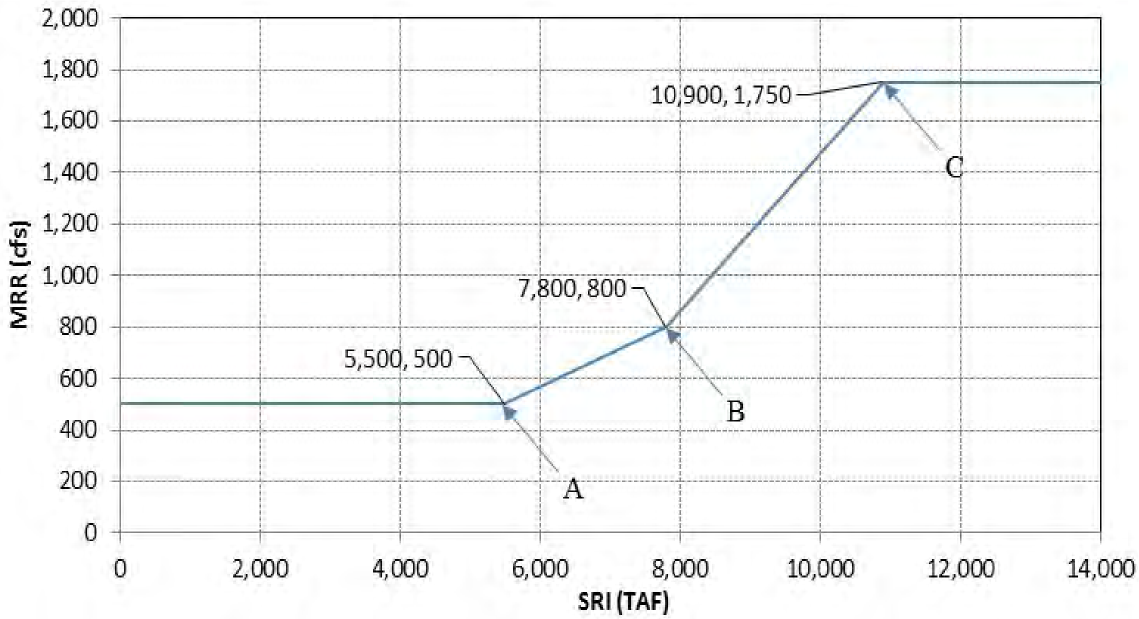
Implementation of the 2019 BO Flow Management Standard for Lower American River

The key assumptions implemented in the 2019 FMS are as follows:

1. **Use of American River Index (ARI) and Sacramento River Index (SRI)**: The minimum release requirements (MRR) from the Folsom reservoir are computed as a function of the American River Index (except for the minimum flow requirement in January, which is determined using the Sacramento River Index, SRI). The American River Index (ARI) is defined as the difference between forecasted unimpaired flow into the American River and the volume of Folsom reservoir spill till date. The volume of spill used for ARI computations is the cumulative year to date amount of discharge from the Folsom Dam Spillway and the Control Regulating Gates. The historical data for unimpaired flows into the American River was imported from CDEC website[4]. This data is thereafter used to compute the ARI and the minimum required flow. Use of hydrologic indices such as ARI and SRI allow for lower MRRs in drier years and higher MRRs in wetter years.

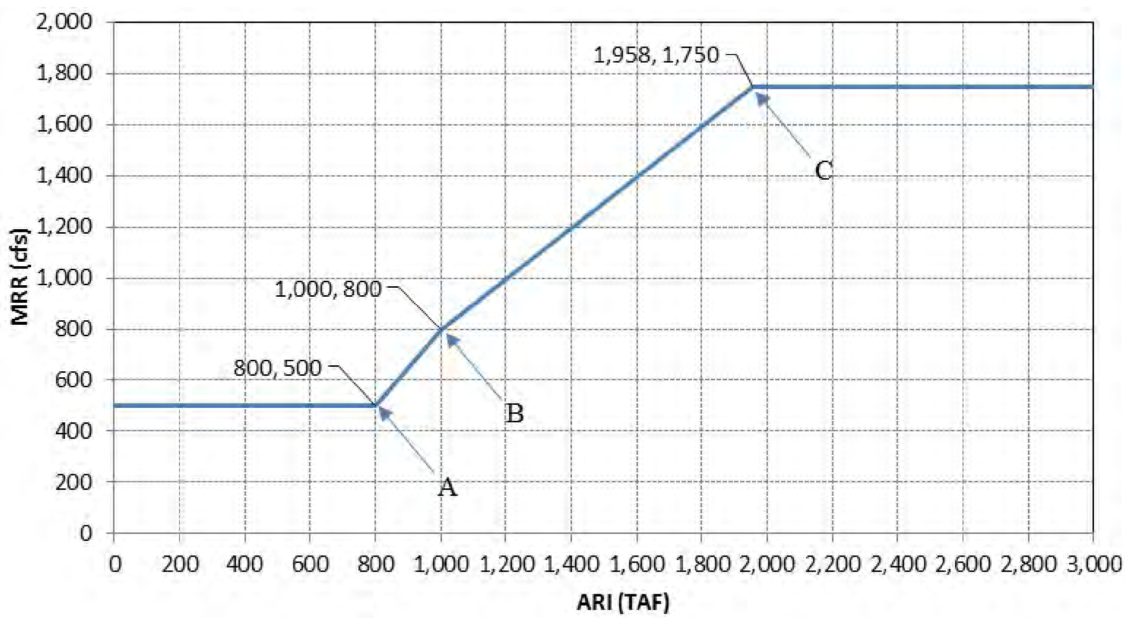
[4] http://cdec.water.ca.gov/dynamicapp/selectQuery?Stations=AMF&SensorNums=65&dur_code=M&Start=1921-10-01&End=2019-07-19

2. **MRR Curves**: The monthly MRRs are determined using SRI index values (for January) and ARI index values (for February through December). Figures 5-1 through 5-6 show the MRR values with respect to SRI for January and ARI values for different months during a year.



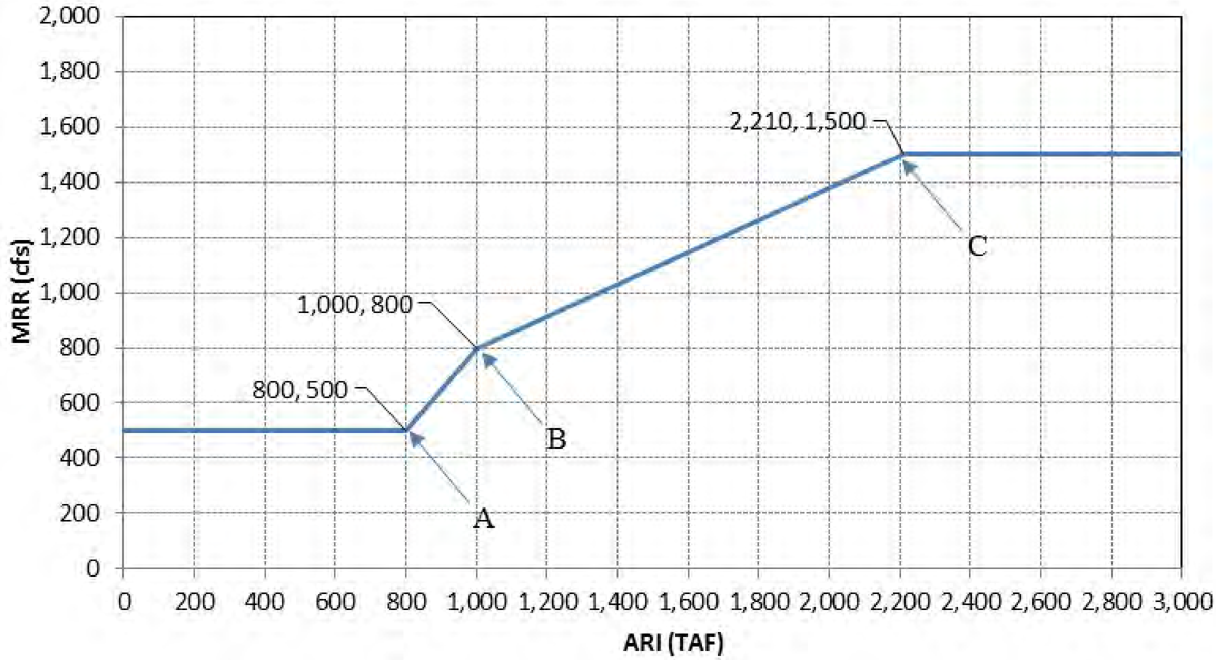
source: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-1. MRR values with respect to SRI (for January).



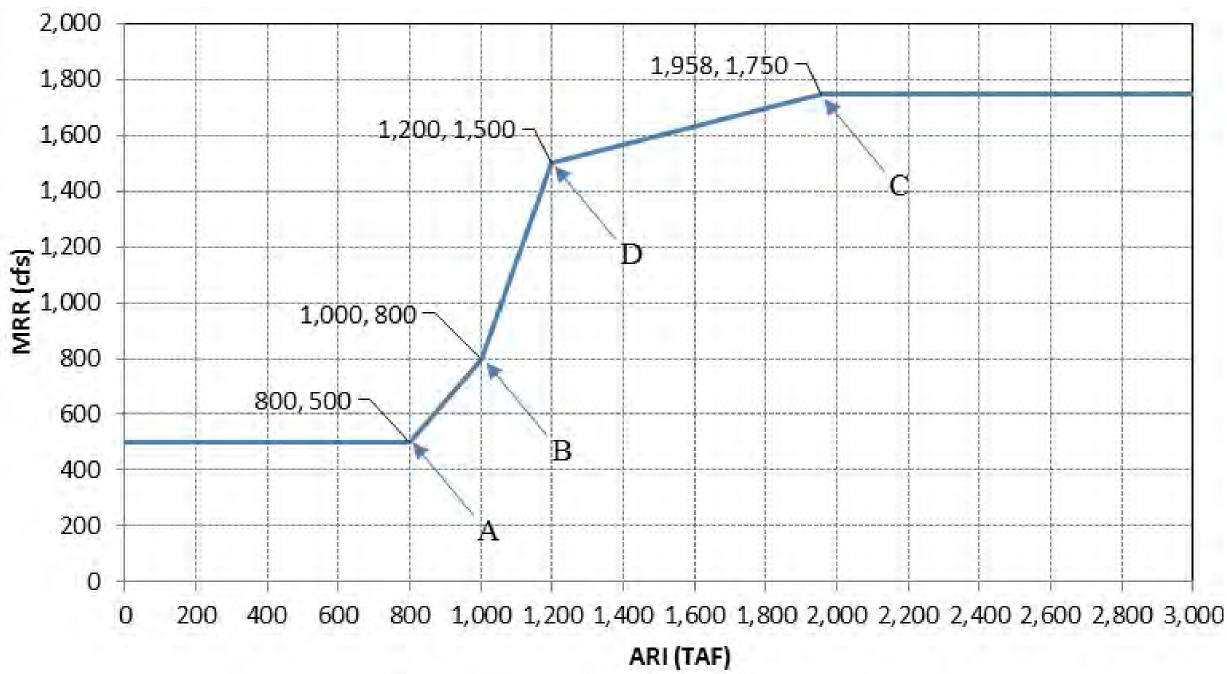
source:https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-2. MRR values with respect to ARI (February through March).



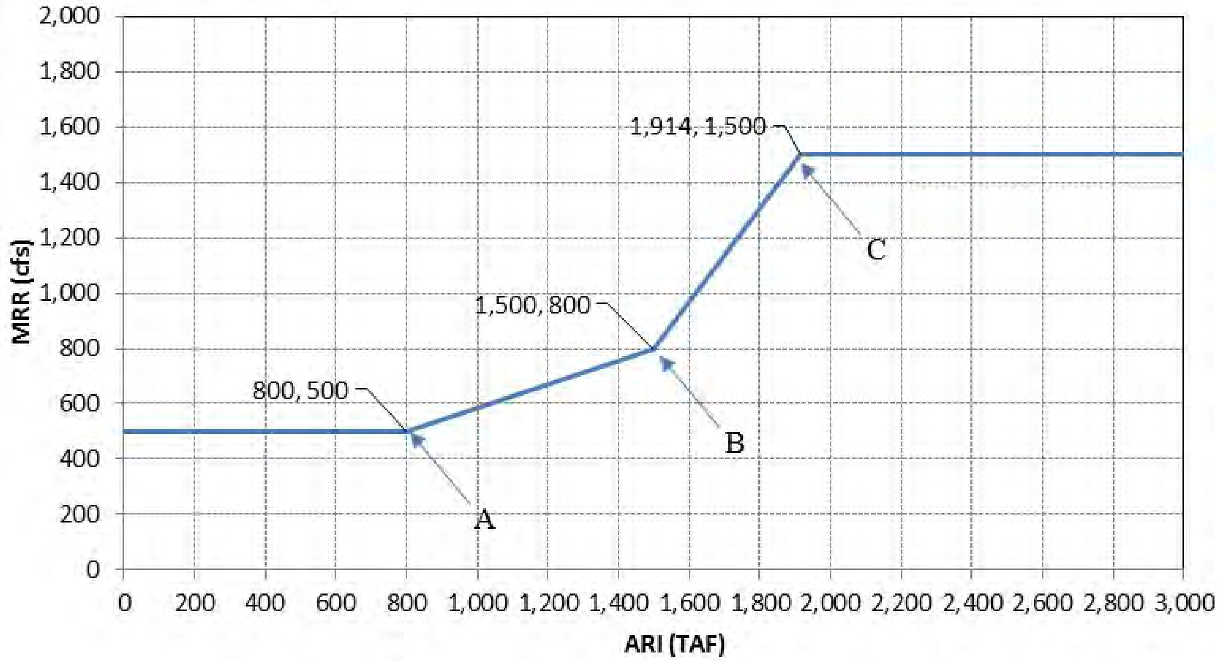
source: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-3. MRR values with respect to ARI (April through June).



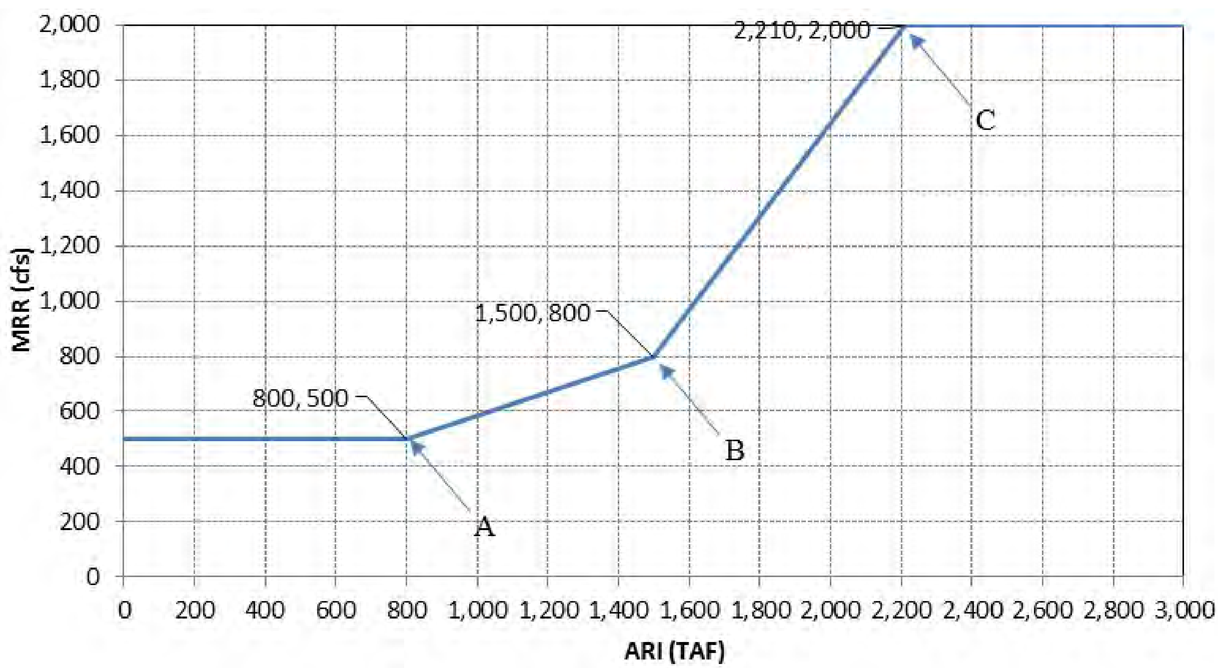
source: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-4. MRR values with respect to ARI (July through September).



source: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-5. MRR values with respect to ARI (October).



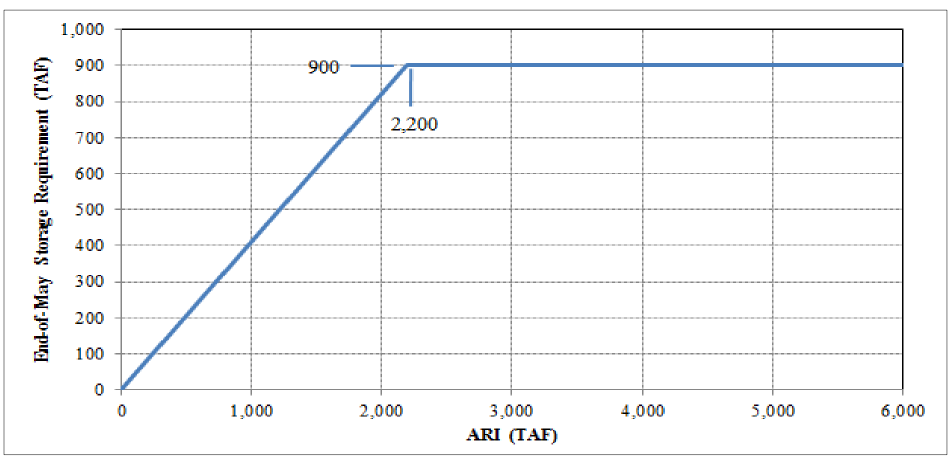
source: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-6. MRR values with respect to ARI (November and December).

These curves are implemented in CalSim 3 using lookup tables named MRR_Schedule.table. These tables were incorporated from the 'Proposed Action' study prepared by U.S. Department of the Interior, Bureau of Reclamation.
Note: The MRR tables provided in the 'Proposed Action' differ from the curves shown in Figure 5-1 for January and Figure 5-5 for October. The MRR tables for this study were incorporated from the 'Proposed Action' study and therefore have the same differences as compared to the curves shown in Figures F-1 and F-5.

3. **Redd dewatering protections**: The modified FMS is designed to avoid dewatering the eggs of anadromous salmonids in their spawning nests ("redds"). The protections in the modified FMS applied to the reservoir operations include that during January and February, the minimum release requirement (MRR) is limited at 70% of the December MRR. This is because of the inherent uncertainty of the SRI, upon which the January MRR is based. Thereafter, the greater of January or February MRR is chosen as the RDPA base flow for lake Natomas. The Redd dewatering protections are implemented through the FMStandard.wresl file. A lookup table named AmerSteelhead.table is used for setting limits on the minimum MRR to protect salmonids from dewatering.

4. **End of May (EOMay) and End of December (EODec) target for Folsom storage**: Target Storages in Folsom Reservoir are established for end of December and end of May as a part of the modified FMS and the Folsom reservoir is operated such that the MRR at Folsom meets the target at the end of December. A monthly carryover is computed to ensure that the end of December storage target is met assuming that the releases are only for MRR, evaporation and diversions as forecasted. The end-of-December storage target of 275 TAF was used for the USBR proposed study. This is different from the 300 TAF recommended in the ARWA report. **Figure 5-7** shows the relationship between the EOMay storage and ARI. The EOMay storage target is implemented in CalSim 3 using a lookup table named eomay_target.table.



source:
https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-602.pdf

Figure 5-7. EOMay Storage with respect to ARI.

5. **Spring Pulse Flow**: A spring flow is provided in the lower American River to provide an emigration cue to the fall-run Chinook salmon and Steelhead before relatively low flow conditions and associated unsuitable thermal conditions later in the spring in the river and downstream in the Sacramento River. The pulse flow is the maximum of the MRR, Steelhead protection requirements or the Chinook protection requirements. The pulse flow event should be provided only when the MRR from March 1 through March 31 ranged from 1,000 cfs to 1,500 cfs. This range of MRRs during this time period generally corresponds to dry and below normal water year types. The peak magnitude of the pulse flow should be three times the MRR base flows (pre-pulse flows), not to exceed a peak magnitude of 4,000 cfs. The pulse flow event should range in duration from 6 to 7.5 days, depending upon the initial MRR base flows (pre-pulse flows).