Public Draft

PULSE FLOWS COMPONENT OF THE WATER STORAGE INVESTMENT PROGRAM GROUNDWATER PROJECTS

Supplemental Environmental Impact Report

State Clearinghouse No. 2022080216

Prepared for
California Department of Water Resources

February 2024

Prepared by

ICF ESA

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Acronyms and Other Abbreviations

Abbreviation	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
2012 Plan	Greenhouse Gas Emissions Reduction Plan
2017 Scoping Plan	2017 Climate Change Scoping Plan
AB	Assembly Bill
af	acre-feet
AN	Above Normal
Authority	Groundwater Banking Joint Powers Authority
Banks Pumping Plant	Harvey O. Banks Delta Pumping Plant
Basin Plan	regional water quality control plan
Bay	San Francisco Bay
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin Delta
BiOp	biological opinion
BN	Below Normal
BP	Before Present
BVRMI	Buena Vista Rancheria of Me-Wuk Indians
CAA	Clean Air Act
CALFED	CALFED Bay-Delta Program
California Register	California Register of Historical Resources
CAISO	California Independent System Operator
CalSim II	California Simulation Model 2
CAP	Climate Action Plan
CAPB	Contract for Administration of Public Benefits
CARB	California Air Resources Board
C	Critically Dry
CDBWI	Cachil DeHe Band of Wintun Indians of the Colusa Indian Community
CDEC	California Data Exchange
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
Central Valley steelhead	California Central Valley steelhead Distinct Population Segment
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second

Abbreviation	Definition
Chino Basin	Chino Groundwater Basin
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CNRA	California Natural Resources Agency
CO_2e	carbon dioxide equivalent
CRPR	California Rare Plant Rank
CSD	Community Services District
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
CWC	California Water Commission
D	Dry
Delta	Sacramento–San Joaquin Delta
DPS	Distinct Population Segment
Draft SEIR	draft supplemental environmental impact report
DWR	California Department of Water Resources
DWR Water Operations	DWR Water Operations Branch
EIR	environmental impact report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
GHG	greenhouse gas
GSA	groundwater sustainability agency
GSP	groundwater sustainability plan
Harvest Water	Harvest Water Program
HCP	habitat conservation plan
HEC-RAS	Hydrologic Engineering Center–River Analysis System
IEUA	Inland Empire Utilities Agency
ITP	incidental take permit
Jones Pumping Plant	C. W. “Bill” Jones Pumping Plant
Kern Fan	Kern Fan Groundwater Storage Project
KVBM	Konkow Valley Band of Maidu
LSZ	low-salinity zone

Abbreviation	Definition
LTO ITP	long-term operation incidental take permit
LVE	Los Vaqueros Reservoir Expansion Project
maf	million acre-feet
MITCR	Mechoopda Indian Tribe of Chico Rancheria
mm	millimeters
MBTA	Migratory Bird Treaty Act
mmt	million metric tons
MRMI	Mooretown Rancheria of Maidu Indians
msl	mean sea level
NAHC	Native American Heritage Commission
National Register	National Register of Historic Places
NCCP	natural community conservation plan
NMFS	National Marine Fisheries Service
NOP	Notice of Preparation
OBMP	Optimum Basin Management Program
OWA	Oroville Wildlife Area
P-2100	Federal Energy Regulatory Commission Project No. 2100 (Oroville Facilities relicensing)
Pacheco	Pacheco Reservoir Expansion Project
PCB	polychlorinated biphenyl
PEIR	programmatic environmental impact report
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
PRC	Public Resources Code
psu	practical salinity units
Pulse Flows Component	Pulse Flows Component of the Water Storage Investment Program Groundwater Projects
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
Recovery Period	Lake Oroville Recovery Period
RM	River Mile
RWQCB	regional water quality control Board
SB	Senate Bill
SCH	State Clearinghouse
SEIR	supplemental environmental impact report
SGMA	Sustainable Groundwater Management Act
Sites	Sites Reservoir Project
SRFCP	Sacramento River Flood Control Project

Abbreviation	Definition
SSBMI	Shingle Springs Band of Miwok Indians
SSC	species of special concern
State Water Board	State Water Resources Control Board
Subsequent EIR	subsequent environmental impact report
SVI	Sacramento Valley Index
SWP	State Water Project
taf	thousand acre-feet
TBMI	Tuolumne Band of Me-Wuk Indians
TMDL	total maximum daily load
UAIC	United Auburn Indian Community of the Auburn Rancheria of California
Update 2020	Greenhouse Gas Emissions Reduction Plan Update 2020
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
W	Wet
Water Supply Contract	State Water Project Water Supply Contract
WCM	Water Control Manual
Willow Springs	Willow Springs Water Bank Project
WSIP	Water Storage Investment Program
YDWN	Yocha Dehe Wintun Nation

EXECUTIVE SUMMARY

ES.1 Introduction

This draft supplemental environmental impact report (Draft SEIR) has been prepared for the Pulse Flows Component of the Water Storage Investment Program (WSIP) Groundwater Projects (Pulse Flows Component). The Draft SEIR is a supplement to three certified environmental impact reports (EIRs) prepared pursuant to the California Environmental Quality Act (CEQA) for three independent WSIP projects (referred to herein as the “WSIP Groundwater Projects”): (1) the Chino Basin Program, (2) the Kern Fan Groundwater Storage Project (Kern Fan), and (3) the Willow Springs Water Bank Project (Willow Springs).[1]

The WSIP Groundwater Projects involve groundwater storage to improve local water supply and require an exchange of water (the WSIP Operational Exchange Process, as defined in Section 1.1.1) with the California Department of Water Resources (DWR) to provide ecosystem benefits through the release of pulse flows from Lake Oroville into the Low Flow Channel of the Feather River. A “pulse flow” refers to the planned release of a defined amount of water into the river system above all regulatory requirements, creating flow rates for a specified period that exceed those that otherwise would have occurred. A pulse flow release would be requested by the California Department of Fish and Wildlife (CDFW) and approved by DWR to benefit habitat for listed and non-listed native fish species and improve conditions for spawning and migration.

Each WSIP Groundwater Project EIR addressed the local storage and management of water that would be used to create the pulse flow, including, where applicable, the development, construction, and operation of the associated conveyance, recharge, and recovery facilities needed for groundwater banking. The three WSIP Groundwater Projects’ EIRs did not evaluate DWR actions that would be necessary to implement the projects, which include (1) release of the pulse flows from Lake Oroville, (2) implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases, and (3) diversion and conveyance of water to Kern Fan and Willow Springs that would be stored, in part, for ecosystem benefit.[2] Thus, this Draft SEIR supplements the three WSIP Groundwater Projects’ EIRs such that the environmental effects of DWR’s actions needed to implement the pulse flows can be evaluated.

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1 The Willow Springs Water Bank Project was formerly known as the Antelope Valley Water Bank Project.

2 This DWR action does not apply to the Chino Basin Program, as that project proposes to develop water by enhancing operations at an advanced water treatment facility. Water contributions to the pulse flow release from the Chino Basin Program would therefore come from the treated wastewater of surrounding local jurisdictions, as opposed to coming from the State Water Project. See Section 1.1.3, “WSIP Groundwater Projects,” for more details about how each WSIP Groundwater Project will develop water for ecosystem benefit. All other aspects of DWR’s actions to implement the WSIP Operational Exchange Process apply to all three WSIP Groundwater Projects.

ES.2 Objectives of the Pulse Flows Component

The objectives of the Pulse Flows Component include the following:

- Provide for the release of pulse flows from Lake Oroville (in addition to any flows needed to meet regulatory requirements).
- Improve habitat conditions for listed salmonids, primarily spring-run Chinook salmon, and improve conditions for spawning and migration of other listed and non-listed native fish species downstream of Lake Oroville, especially during drier water year types.
- Utilize contractual and operational mechanisms to avoid or minimize impacts on State Water Project (SWP) operations, SWP contractors, and water supplies that may result from pulse flow releases.

ES.3 Study Area

The Pulse Flows Component study area analyzed in this Draft SEIR extends approximately 575 miles from Lake Oroville in Northern California to the WSIP Groundwater Projects in the San Joaquin Valley and Southern California (**Figure ES-1**). For purposes of this Draft SEIR, the study area is divided into seven geographic areas as noted on **Figure ES-2**:

- Geographic Area 1: The Oroville Complex.
- Geographic Area 2: The Low Flow Channel of the Feather River, defined as the reach from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet.
- Geographic Area 3: The High Flow Channel of the Feather River, defined as the reach from the Thermalito Afterbay Outlet to the confluence with the Sacramento River, including the Lower Sutter Bypass.
- Geographic Area 4: The Sacramento River from the confluence with the Feather River to the Sacramento–San Joaquin Delta (Delta).
- Geographic Area 5: The Delta.
- Geographic Area 6: The Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant) and the California Aqueduct to the WSIP Groundwater Projects.
- Geographic Area 7: San Luis Reservoir.

ES.4 Summary of the Pulse Flows Component

The Pulse Flows Component is defined by the following DWR actions:

(1) Release of the pulse flows from Lake Oroville into the Low Flow Channel of the Feather River, with the goal of improving habitat conditions for listed salmonids, as well as improving spawning and migration conditions for other listed and non-listed native fish species.

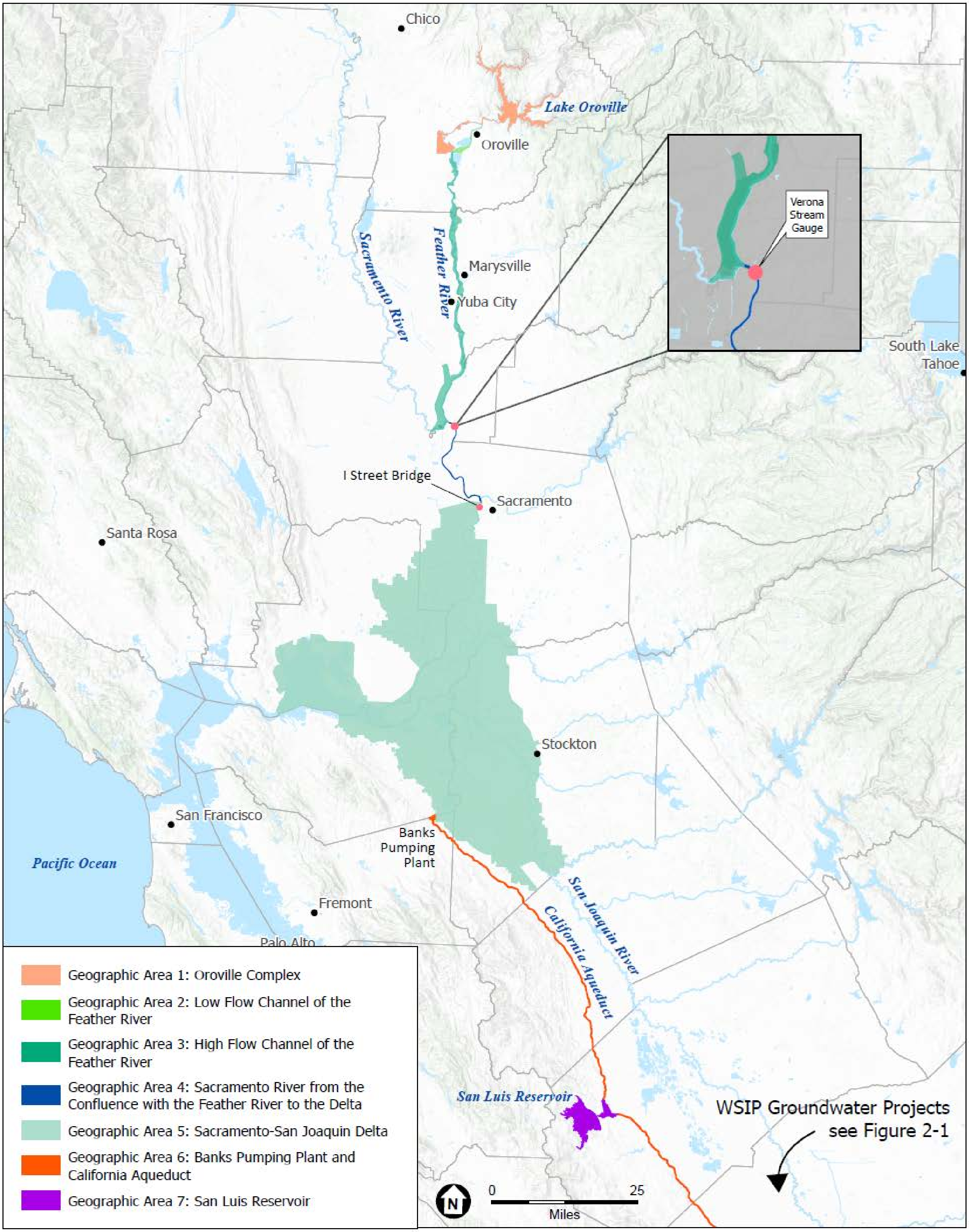
(2) Implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases.

(3) Diversion and conveyance of water to the Kern Fan and Willow Springs projects that would be stored, in part, for ecosystem benefit.

SOURCE: Esri, 2022; ESA, 2023

Figure 1-1
Pulse Flows Component Study Area

ESA



SOURCE: Esri, 2022; ESA, 2023

Figure ES-2
Pulse Flows Component Geographic Areas

Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases.

Pulse Flow Releases

Description of Potential Pulse Flow Releases

The three WSIP Groundwater Projects have identified a maximum volume of water to collectively contribute to a pulse flow in any one-year period of up to approximately 100,000 acre-feet (af). **Table ES-1** summarizes the maximum one-year volume of pulse flow water that would be made available by the three WSIP Groundwater Projects and the frequency of pulses. The frequency of pulses has been approximated because the temporal pattern over which pulses would be released is unknown at this time; the frequency and magnitude of pulse flow releases could vary substantially depending on the volume of water made available by the WSIP Groundwater Projects, the frequency with which the WSIP Groundwater Projects are able to dedicate an amount of water appropriate for a pulse flow, and on CDFW's request and DWR's approval of the pulse flow release.

TABLE ES-1
APPROXIMATE VOLUME AND FREQUENCY OF PULSE FLOW RELEASES FOR WSIP GROUNDWATER PROJECTS

WSIP Groundwater Project	Maximum Volume (af)[a]	Frequency of Pulses over a 25-Year Period (years)[b]	Frequency of Pulses over a 50-Year Period (years)
Kern Fan	18,000	3.5	7
Chino Basin[c]	50,000	7.5	–
Willow Springs	29,000	7.5	15

NOTE: af = acre-feet; Kern Fan = Kern Fan Groundwater Storage Project; Willow Springs = Willow Springs Water Bank Project; WSIP = Water Storage Investment Program.

a Values for Kern Fan and Chino Basin were derived from the applications for California Water Commission Proposition 1 funding, and values for Willow Springs were derived from a GEI technical memorandum to DWR (April 6, 2022).
b The frequencies of pulse flows were normalized to a 25-year period. As a conservative assumption, it is assumed that the California Department of Fish and Wildlife will request a pulse flow of the maximum volume (100,000 acre-feet).
c Chino Basin only occurs over a 25-year period.

Table ES-2 summarizes the potential magnitude and timing (based on water year) of pulse flow releases from Lake Oroville into the Low Flow Channel of the Feather River. In a given year, CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects, if available, and may request a maximum flow rate of 10,000 cfs. The requested flow rate would be derived by considering the base flow of the Low Flow Channel, which can be as low as 600 cfs, as specified by the 1983 DWR/CDFW Agreement[3] (California Department of Water Resources and California Department of Fish and Game 1983) and the 2004 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) (National Marine Fisheries Service 2004), plus additional water for the pulse flow, so the combined resultant flow does not exceed 10,000 cfs in the Low Flow Channel. Refer to Section 3.4,

[3] 1983 Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife (California Department of Water Resources and California Department of Fish and Game 1983).

"Hydrology and Water Quality," Section 3.4.3, "Regulatory Setting," for a more detailed description of the regulatory environment of the study area. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document (see Section 3.2.1, "Conservative Pulse Flow Release Scenario") to occur about once in three years but is likely to occur less frequently (see Table ES-1). Pulse flows of up to 100,000 af would be released from Lake Oroville with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to **Table ES-3**.

TABLE ES-2
POTENTIAL PULSE FLOW RELEASES FROM LAKE OROVILLE TO THE LOW FLOW CHANNEL

Month	Potential Range of Base Flow Release to Feather River Low Flow Channel		Potential Pulse Flow Volume[c]		Potential Maximum Flow Magnitude (Base Flow plus Pulse Flow Release)	Potential Water Year Types[d]
	Low[a] (cfs)	High (cfs)[b]	Low (af)	High (af)	cfs	
March	600	3,000	5,000	100,000	10,000	C, D, BN, AN
April	600	3,000	5,000	100,000	10,000	C, D, BN, AN
May	600	3,000	5,000	100,000	10,000	C, D, BN, AN
June	600	3,000	5,000	100,000	10,000	C, D, BN, AN

NOTES: af = acre-feet; cfs = cubic feet per second

a. Historically, flows as low as 550 cfs are on record. However, the current minimum instream flow requirement for the Low Flow Channel is 600 cfs.
b. Based on historical base flow ranges, the typical base flow in the Low Flow Channel does not exceed 3,000 cfs.
c. Water Storage Investment Program flows are in no way related to requests made under Section 5 of the 1983 CDFW Agreement.
d. Water Year Types: C = Critically Dry, D = Dry, BN = Below Normal, AN = Above Normal.

SOURCE: California Department of Fish and Wildlife 2022.

TABLE ES-3
LAKE OROVILLE LOW FLOW CHANNEL RAMP-DOWN RATES

Low Flow Channel of the Feather River Releases (cfs)[a]	Rate of Decrease (cfs)
3,500 to 5,000	1,000 per 24 hours
2,500 to 3,500	500 per 24 hours
<2,500	300 per 24 hours

NOTE: cfs = cubic feet per second.

a. Note that ramp-down rate of decrease requirements are not currently specified above 5,000 cfs in the Low Flow Channel.

SOURCE: National Marine Fisheries Service 2016.

The pulse flow releases would augment flows in the lower Feather River, in the Sacramento River, and through the Delta in drier years when there are typically lower flows (e.g., dry or below-normal water year types). For this analysis, depending on the availability of water from the WSIP Groundwater Projects, CDFW could request a pulse flow at any time in the spring months (March, April, May, and/or June) of critically dry, dry, below-normal, or above-normal water year types;[4] however, DWR would not likely accommodate pulse flows in critically dry years such as 2021 and 2022, given limitations in the SWP's overall water supply. In critically dry years, because DWR moves very little water from Lake Oroville through Banks Pumping Plant, there is little to no capacity to recover Lake Oroville storage via a reduction of summer releases. During these years, storage in Lake Oroville is low, with exports at minimum levels that cannot be further reduced. Note that the determination of water year type is not made until the end of the water year. It is possible that a pulse flow could be approved based on a projection of a certain water year type that varies from the ultimate determination.

After a pulse flow release, "recovery" of Lake Oroville storage would occur during the summer (July through September) Lake Oroville Recovery Period (Recovery Period). By the end of the Recovery Period, Lake Oroville storage is anticipated to reach a level equivalent to that which would have occurred without the pulse flow. The mechanism by which Lake Oroville storage would be recovered involves the WSIP Operational Exchange Process, detailed further in Section 2.5.2. Flow rates out of Lake Oroville during the Recovery Period would continue to meet minimum operational and regulatory flow and temperature requirements in both the Low Flow Channel (currently 600 cfs, see Section 2.3.2) and the High Flow Channel (1,000 cfs, see Section 2.3.3). Therefore, flows during the Recovery Period would remain within the typical range of existing operational variability experienced within the system.

Decision-Making Criteria and Constraints

DWR is developing an agreement with CDFW that will specify the decision-making criteria for DWR to consider a request for a pulse flow from CDFW (the "DWR/CDFW Agreement"). The timing, volume, peak flows, and duration requested are expected to vary, as CDFW will consider the amount of water available in the WSIP Exchange Storage Accounts, as well as biological and hydrologic conditions in the Feather River. DWR could deny or approve some or all requested pulse flows based on an informed analysis to ensure that implementation of a pulse flow would not negatively affect planned operations (including a key parameter: that Lake Oroville storage is 90 percent likely to be fully recovered in the same calendar year as the pulse flow release). The pulse flow releases would be coordinated with DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations, to ensure that flow releases are within required downstream parameters. Pulse flows shall not conflict with normal Oroville and Delta operations, including instream requirements, Delta outflow requirements, water quality, or other regulatory requirements.

WSIP Operational Exchange Process

Implementation of the Pulse Flows Component involves the following exchange of water: (1) the release of SWP water from Lake Oroville by DWR (i.e., the pulse flow release described in Section 2.4); and (2) the provision of In-Lieu Table A Water by the WSIP Groundwater Projects to their Partner Contractors that helps replenish SWP water used for a pulse flow release (i.e., one

[4] The five Sacramento Valley Index water year type classifications are Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critically Dry (C). The water year type is calculated based on measured and forecasted runoff from the Sacramento, Feather, Yuba, and American rivers. Prior water year calculations from 1901 to present are provided at: https://cdec.water.ca.gov/reportapp/javareports?name=wsihist.

component of the WSIP Operational Exchange Process described in this section). The transaction of In-Lieu Table A Water between each of the three WSIP Groundwater Projects storing water in their groundwater banks and their Partner Contractors (number (2) listed above) is a non-DWR action outside the scope of this SEIR.

Description of the WSIP Operational Exchange Process

The following steps describe the WSIP Operational Exchange Process to facilitate the pulse flow releases.

- **Step 1:** Article 21 water, advanced wastewater treatment water, or Pre-Positioning Yield water would be provided to, or developed by, the three WSIP Groundwater Projects. A portion of this water would be earmarked for ecosystem benefit and would be made available in each project's WSIP Exchange Storage Account.
- **Step 2:** If water in the WSIP Exchange Storage Account is determined to be available by the WSIP Groundwater Projects, pulse flows would be released from Lake Oroville into the Feather River during spring months (March through June) when requested by CDFW and approved by DWR, which would temporarily reduce the SWP supply in Lake Oroville. Flows would be dedicated to ecosystem benefits and protected from diversion by Water Code Section 1707.
- **Step 3:** Following a pulse flow release, Partner Contractors would receive WSIP In-Lieu Table A Water from the WSIP Exchange Storage Account in place of a portion of their Table A allocation. Note that the allocation of Table A water in the year of a pulse flow would need to be equivalent to or greater than the pulse flow volume. Water directly pumped at Banks Pumping Plant or stored in San Luis Reservoir that would have been delivered to Partner Contractors as part of a Table A allocation would remain in storage instead. San Luis Reservoir storage would increase as a result of reduced SWP deliveries to the Partner Contractors. From a water operations accounting perspective, this action would functionally (though not physically) move water stored in the WSIP Exchange Storage Account to San Luis Reservoir. The operations of Willow Springs could delay conditions when Article 21 water would be available to other SWP contractors. DWR would mitigate this impact by allowing SWP contractors to take Article 21 water before San Luis Reservoir spills to mimic conditions without Willow Springs.
- **Step 4:** In the summer months (July through September) after a pulse flow release, Lake Oroville Table A deliveries would be reduced equivalent to the amount of water released for the pulse flow, replenishing Lake Oroville storage. This period is referred to as the Recovery Period. Flow rates out of Lake Oroville during the Recovery Period would continue to meet minimum operational and regulatory flow and temperature requirements in the Low Flow and High Flow Channels. DWR would forecast the magnitude and duration of the reduced outflow related to the Recovery Period when considering approval of a request from CDFW for a pulse flow.
- **Step 5:** During the Recovery Period, pumping from Banks Pumping Plant would be reduced commensurate with the reduction in outflow from Lake Oroville, sending less water to San Luis Reservoir or for direct deliveries through the California Aqueduct. The WSIP Groundwater Projects would continue to deliver WSIP In-Lieu Table A Water (water made available from the WSIP Groundwater Projects in place of Table A water from the SWP, as further defined in Section 1.1.1) to Partner Contractors. Due to reduced pumping from Banks Pumping Plant, supplemental releases from San Luis Reservoir may be needed to meet SWP

water demands. Water operationally exchanged (see Step 3) that is stored in San Luis Reservoir storage would be used for the supplemental releases. San Luis Reservoir storage would continue to be replenished during the Recovery Period and through the fall months (October through December) as a result of reduced deliveries to Partner Contractors, as the WSIP Groundwater Projects continue to deliver WSIP In-Lieu Table A Water. The Recovery Period would be extended into a second year if necessary to allow minimum existing flow requirements and other requirements to be met.

With implementation of the WSIP Operational Exchange Process, Partner Contractors who voluntarily agree to contribute part of their Table A allocations for pulse flow releases would be made whole, over time, with WSIP In-Lieu Table A Water. San Luis Reservoir would be made whole from reduced Table A deliveries to the Partner Contractors. Lake Oroville would be made whole by reduced summer releases into the Feather River. Unforeseen circumstances could result in Lake Oroville not fully recovering storage at the end of the Recovery Period and San Luis Reservoir may not fully recover storage by the end of the calendar year. If this occurs, storage recovery would continue into the next year.

Efficiency Credit

Under existing conditions, Partner Contractors receive their Annual Table A Amount from Delta exports (i.e., water supply pumped directly from the Delta or pumped and temporarily stored). With the Pulse Flows Component, Partner Contractors would receive a portion of their annual Table A amount from a Project Proponent instead. To meet Delta water quality standards, Delta exports typically require additional volume of outflow from the SWP and the CVP. When changes in operations are made for a non-SWP party, such as for a water transfer, this additional volume is called “carriage water.” Carriage water represents the additional flow necessary to maintain water quality conditions in the Delta per increment of additional exported water. Carriage water requirements are commonly expressed as a percentage of additional inflows to the Delta. Under the Pulse Flows Component, an efficiency credit would be made available to a Project Proponent for providing WSIP In-Lieu Table A Water to a Partner Contractor, because no carriage water is required for the delivery.

Agreements and Contracts

DWR would implement the WSIP Operational Exchange Process through a series of agreements and Water Supply Contract amendments. DWR has not yet approved the WSIP Operational Exchange Process for any of the WSIP Groundwater Projects and part of the approval process is the environmental review contained in this document.

Water Diversion and Conveyance to WSIP Groundwater Projects

Water conveyance to the WSIP Groundwater Projects represents another DWR action evaluated in this Draft SEIR. Kern Fan would enhance water supply by constructing and operating a water bank[5] in Kern County that would store Article 21 water requested from DWR in years when

5 Environmental impacts associated with the construction and operation of the water bank are included in the 2020 Kern Fan Final EIR.

water is available. DWR's action would be to convey water from the Delta through the California Aqueduct to a new turnout (analyzed in the 2020 Kern Fan Final EIR) to Kern Fan.

Willow Springs would enhance water supply by pre-positioning SWP water in its groundwater bank[6] during the wet season in years there is not a low-point concern in San Luis Reservoir. A pre-positioning process would require DWR to convey SWP water from San Luis Reservoir to the Willow Springs Groundwater Bank via the California Aqueduct (through existing infrastructure) during the months of November through April. Pre-positioning the SWP water in the groundwater bank reduces the amount of water stored in San Luis Reservoir; therefore, water that otherwise would not be in the SWP system because of storage capacity limitations could be captured.

This DWR action does not apply to the Chino Basin Program, as this project proposes to develop water by enhancing operations of an existing advanced water treatment facility and constructing injection wells, extraction wells, groundwater treatment facilities, and distribution facilities. Water contributions to a pulse flow release from the Chino Basin Program would therefore come from the treated wastewater of surrounding local jurisdictions, as opposed to coming from the SWP.

ES.5 Alternatives to the Pulse Flows Component

Because the Pulse Flows Component would not result in any potentially significant impacts, only the No Project Alternative was identified for further evaluation in the Draft SEIR resulting from the alternatives development and screening process described above (as no other alternative was identified that would lessen a potentially significant adverse environmental effect).

Three alternatives were considered but rejected from further analysis because they would not avoid or substantially lessen significant environmental impacts, failed to meet the basic objectives, and/or were determined to be infeasible.

- Alternate Pulse Flow Release Magnitude
- Alternate Pulse Flow Release Frequency
- Alternate Pulse Flow Release and Recovery Period Timing

ES.6 Potential Areas of Controversy and Concern

In accordance with CEQA Guidelines Sections 15063 and 15082, the lead agencies prepared and published a Notice of Preparation (NOP) of an SEIR on August 10, 2022 (SCH No. 2022080216). To solicit comments on the Pulse Flows Component, DWR circulated the NOP to the public and to the federal, State, and local agencies and other interested parties through the State Clearinghouse. DWR also published the NOP in the Oroville Mercury Register on August 13, 2022; in the Sacramento Bee on August 15, 2022; and in the Los Angeles Times on August 12, 2022. The public comment period for the NOP closed on September 9, 2022. In addition to the public and agency comment period, a virtual public scoping meeting was held via remote teleconference on the Zoom platform on August 22, 2022, at 4:00 p.m.

[6] Environmental impacts associated with the construction and operation of the conjunctive use and reoperation of the reservoir are included in the 2006/2018 Willow Springs EIR.

Concerns raised in response to the NOP and oral comments received at the scoping meeting were considered during the preparation of this Draft SEIR. The NOP and scoping comments are included as **Appendix A** of the Draft SEIR.

ES.7 Draft Supplemental Environmental Impact Report

This Draft SEIR is available to federal, State, and local agencies, interested organizations, and individuals who may want to review and comment on the analysis in this document. Publication of the Draft SEIR marks the beginning of a 45-day public review period. The 45-day public review period extends from February 16, 2024, through April 1, 2024, ending at 5:00 p.m. During the public comment period, written comments should be delivered to:

Marianne Kirkland
California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Email: PulseFlowsComponent@water.ca.gov

If comments are provided via email, please include the project title in the subject line, attach comments in Microsoft Word format if possible, and include the commenter's U.S. Postal Service mailing address.

PLEASE NOTE: All comments received will be made available for public review in their entirety in the Final EIR, including the names and addresses of the respondents unless individual commenters request that DWR withhold their name and/or home addresses, etc. in the Final SEIR, which must be stated prominently at the beginning of their comments.

This Draft SEIR is available for public review on the following websites via the following links:

https://water.ca.gov/News/Public-Notices

California State Clearinghouse CEQAnet Web Portal (search by project name or SCH No. 2022080216):

https://ceqanet.opr.ca.gov/

A copy of the Draft SEIR is also available for review during normal business hours at the following locations:

California Department of Water Resources
Division of Operations and Maintenance,
Water Projects Planning and Management Branch
1516 9th Street, 2nd Floor
Sacramento, CA 95814

Sacramento Public Library, Central Branch
828 I Street
Sacramento, CA 95814

DWR will also conduct a virtual public meeting to receive oral comments on the adequacy of the analysis included in this Draft SEIR. The meeting will be held on:

Date: March 19, 2024
Time: 4:00 p.m.
Registration: https://us02web.zoom.us/webinar/register/WN_yvnN3OOxTEqM_EIY1_ilJg

After registering, you will receive a confirmation email containing information about joining the webinar. Registration will be open until the start of the meeting on March 19, 2024.

ES.8 Summary of Impacts

Table ES-4 presents a summary of the impacts and mitigation measures identified for the Pulse Flows Component evaluated in this Draft SEIR. The complete impact statements and mitigation measures are presented in Chapter 3, “Environmental Setting, Impacts, and Mitigation Measures,” and the alternatives are evaluated in Chapter 5, “Alternatives.” The level of significance for each impact was determined using thresholds of significance presented in each resource section of Chapter 3. Significant impacts are those adverse environmental impacts that meet or exceed the standards of significance; less-than-significant impacts would not exceed the standards of significance. For each impact identified, Table ES-4 presents the following information:

- The environmental impact.
- The level of significance before mitigation (LTS—Less than significant impact; NI—No Impact; PS—Potentially significant impact).
- For potentially significant impact, recommended mitigation measures.
- For potentially significant impacts, the level of significance after mitigation (LTSM—Less than significant impact after application of feasible mitigation measure(s))

TABLE ES-4
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation: Pulse Flows Component	Mitigation Measure	Significance After Mitigation: Pulse Flows Component
3.4 Hydrology and Water Quality			
3.4-1: Implementation of the Pulse Flows Component would substantially alter the existing drainage pattern of the site or area, including through the release of the pulse flow, in a manner which would result in substantial erosion or siltation; substantially increase the rate or amount of runoff in a manner which would result in flooding; create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows.	LTS	None Required	
3.4-2: Implementation of the Pulse Flows Component would violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality.	LTS	None Required	
3.4-3: I Implementation of the Pulse Flows Component would substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin.	LTS	None Required	
3.4-4: In flood hazard, tsunami, or seiche zones, implementation of the Pulse Flows Component would risk release of pollutants due to project inundation.	LTS	None Required	
3.4-5: Implementation of the Pulse Flows Component would conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan.	NI	None Required	
3.5 Biological Resources-Aquatic			
3.5-1: I Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NMFS, or USFWS.	LTS	None Required	
3.5-2: Implementation of the Pulse Flows Component would interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	LTS	None Required	
3.5-3: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources.	LTS	None Required	

NOTES: LTS—Less than significant; LTSM—Less than significant after application of feasible mitigation measure(s); NI—No Impact; PS—Potentially significant.

Impact	Significance Before Mitigation: Pulse Flows Component	Mitigation Measure	Significance After Mitigation: Pulse Flows Component
3.5-4: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan.	LTS	None Required	
3.6 Biological Resources-Terrestrial			
3.6-1: Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.	LTS	None Required	
3.6-2: Implementation of the Pulse Flows Component would have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.	LTS	None Required	
3.6-3: Implementation of the Pulse Flows Component would have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.	LTS	None Required	
3.6-4: Implementation of the Pulse Flows Component would Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	NI	None Required	
3.6-5: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.	NI	None Required	
3.6-6: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.	NI	None Required	
3.7 Cultural Resources			
3.7-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a historical resource pursuant to State CEQA Guidelines Section 15064.5.	LTS	None Required	
3.7-2: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5.	LTS	None Required	

NOTES: LTS—Less than significant; LTSM—Less than significant after application of feasible mitigation measure(s); NI—No Impact; PS—Potentially significant.

Impact	Significance Before Mitigation: Pulse Flows Component	Mitigation Measure	Significance After Mitigation: Pulse Flows Component
3.7-3: Implementation of the Pulse Flows Component could disturb human remains, including those interred outside of dedicated cemeteries.	LTS	None Required	
3.8 Tribal Cultural Resources			
3.8-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American Tribe, and that is: a) listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k), or b) a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American Tribe.	PS	**Mitigation Measure 3.8-1: Unanticipated Discovery/ Identification of Potential Tribal Cultural Resources that Could Be Affected by the Pulse Flows Component.** If potential tribal cultural resources that could be affected by the Pulse Flows Component are identified during ongoing consultation on the Pulse Flows Component or during pulse flows, DWR shall implement procedures to evaluate the resource for listing in the California Register. California Native American Tribes that are traditionally and culturally affiliated with the Pulse Flows Component's geographic area may have expertise concerning their tribal cultural resources; such Tribes shall be consulted concerning potential tribal cultural resources that may be affected by the Pulse Flows Component. Consultation shall focus on identifying measures to avoid or minimize impacts if DWR determines that a resource is a tribal cultural resource that could be affected. Should tribal cultural resources be identified that could be affected by the Pulse Flows Component, the following performance standards shall be implemented before the continuance of activities that may result in damage to or destruction of tribal cultural resources: Each identified tribal cultural resource shall be evaluated for California Register eligibility through application of established eligibility criteria (PRC Section 5024.1), in consultation with interested California Native American Tribes. If a tribal cultural resource is determined to be eligible for the California Register, the damaging effects shall be avoided in accordance with PRC Section 21084.3. Culturally appropriate mitigation capable of avoiding or substantially lessening potential significant impacts on the tribal cultural resource, or alternatives that would avoid significant impacts on the tribal cultural resource, shall be implemented. These measures may be considered to avoid or minimize significant adverse impacts and constitute the standard by which an impact conclusion of less than significant may be reached. Such measures include: • Treat the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:	LTSM

NOTES: LTS—Less than significant; LTSM—Less than significant after application of feasible mitigation measure(s); NI—No Impact; PS—Potentially significant.

Impact	Significance Before Mitigation: Pulse Flows Component	Mitigation Measure	Significance After Mitigation: Pulse Flows Component
3.8-1 (cont.)		– Protect the cultural character and integrity of the resource. – Protect the traditional use of the resource. – Protect the confidentiality of the resource. – Establish permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or using the resources or places.	
3.9 Energy and Greenhouse Gas Emissions			
3.9-1: Implementation of the Pulse Flows Component would result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project operation.	LTS	None Required	
3.9-2: Implementation of the Pulse Flows Component would conflict with or obstruct a State or local plan for renewable energy or energy efficiency.	NI	None Required	
3.9-3: Implementation of the Pulse Flows Component would generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.	LTS	None Required	
3.9-4: Implementation of the Pulse Flows Component would conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.	NI	None Required	
3.10 Recreation			
3.10-1: Implementation of the Pulse Flows Component would increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated.	LTS	None Required	
3.10-2: Implementation of the Pulse Flows Component would include recreational facilities or require the construction or expansion of recreational facilities which that might have an adverse physical effect on the environment.	NI	None Required	
3.11 Geology and Soils			
3.11-1: Implementation of the Pulse Flows Component would result in substantial soil erosion or the loss of topsoil.	LTS	None Required	
3.11-2: Implementation of the Pulse Flows Component would be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.	LTS	None Required	

NOTES: LTS—Less than significant; LTSM—Less than significant after application of feasible mitigation measure(s); NI—No Impact; PS—Potentially significant.

Impact	Significance Before Mitigation: Pulse Flows Component	Mitigation Measure	Significance After Mitigation: Pulse Flows Component
3.11-3: Implementation of the Pulse Flows Component would directly or indirectly cause potential substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslide.	NI	None Required	
3.11-4: Implementation of the Pulse Flows Component would be located on expansive soil creating substantial direct or indirect risks to life or property.	NI	None Required	
3.11-5: Implementation of the Pulse Flows Component would have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.	NI	None Required	
3.11-6: Implementation of the Pulse Flows Component would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.	LTS	None Required	
3.12 Agriculture and Forestry Resources			
3.12-1: Implementation of the Pulse Flows Component would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.	LTS	None Required	
3.12-2: Implementation of the Pulse Flows Component would conflict with existing zoning for agricultural use or a Williamson Act contract.	LTS	None Required	
3.12-3: Implementation of the Pulse Flows Component would conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220[g]), timberland (as defined by PRC Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104[g]).	LTS	None Required	
3.12-4: Implementation of the Pulse Flows Component would result in the loss of forest land or conversion of forest land to non-forest use.	LTS	None Required	
3.12-5: Implementation of the Pulse Flows Component would involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use.	LTS	None Required	

SOURCE: Data compiled by ESA in 2023

NOTES: LTS—Less than significant; LTSM—Less than significant after application of feasible mitigation measure(s); NI—No Impact; PS—Potentially significant.

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CHAPTER 1
Introduction

This draft supplemental environmental impact report (Draft SEIR) has been prepared for the Pulse Flows Component of the Water Storage Investment Program (WSIP) Groundwater Projects (Pulse Flows Component). The Draft SEIR is a supplement to three certified environmental impact reports (EIRs) prepared pursuant to the California Environmental Quality Act (CEQA) for three independent WSIP projects (referred to herein as the "WSIP Groundwater Projects"): (1) the Chino Basin Program, (2) the Kern Fan Groundwater Storage Project (Kern Fan), and (3) the Willow Springs Water Bank Project (Willow Springs).[1]

The WSIP Groundwater Projects involve groundwater storage to improve local water supply and require an exchange of water (the WSIP Operational Exchange Process, as defined in Section 1.1.1) with the California Department of Water Resources (DWR) to provide ecosystem benefits through the release of pulse flows from Lake Oroville into the Low Flow Channel of the Feather River. A "pulse flow" refers to the planned release of a defined amount of water into the river system above all regulatory requirements, creating flow rates for a specified period that exceed those that otherwise would have occurred. A pulse flow release would be requested by the California Department of Fish and Wildlife (CDFW) and approved by DWR to benefit habitat for listed and non-listed native fish species and improve conditions for spawning and migration.

Figure 1-1 presents an overview of the Pulse Flows Component Study Area. Refer to Chapter 2, "Description of the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects," for a detailed description of the Pulse Flows Component.

Each WSIP Groundwater Project EIR addressed the local storage and management of water that would be used to create the pulse flow, including, where applicable, the development, construction, and operation of the associated conveyance, recharge, and recovery facilities needed for groundwater banking. The three WSIP Groundwater Projects' EIRs did not evaluate DWR actions that would be necessary to implement the projects, which include (1) release of the pulse flows from Lake Oroville, (2) implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases, and (3) diversion and conveyance of water to Kern Fan and Willow Springs that would be stored, in part, for ecosystem benefit.[2] Thus, this Draft

[1] The Willow Springs Water Bank Project was formerly known as the Antelope Valley Water Bank Project.

[2] This DWR action does not apply to the Chino Basin Program, as that project proposes to develop water by enhancing operations at an advanced water treatment facility. Water contributions to the pulse flow release from the Chino Basin Program would therefore come from the treated wastewater of surrounding local jurisdictions, as opposed to coming from the State Water Project. See Section 1.1.3, "WSIP Groundwater Projects," for more details about how each WSIP Groundwater Project will develop water for ecosystem benefit. All other aspects of DWR's actions to implement the WSIP Operational Exchange Process apply to all three WSIP Groundwater Projects.

SOURCE: Esri, 2022; ESA, 2023

Figure 1-1
Pulse Flows Component Study Area

ESA

SEIR supplements the three WSIP Groundwater Projects' EIRs such that the environmental effects of DWR's actions needed to implement the pulse flows can be evaluated.

The Inland Empire Utilities Agency (IEUA) acted as CEQA lead agency in preparing and certifying the EIR for the Chino Basin Program. The Authority for the Groundwater Banking Joint Powers Authority (JPA) acted as CEQA lead agency in preparing and certifying the EIR for Kern Fan. The Rosamond Community Services District (CSD) acted as CEQA lead agency in preparing and certifying the EIR for Willow Springs. Pursuant to CEQA, the IEUA, Authority for the Groundwater Banking (JPA), and Rosamond CSD remain the lead agencies for the Pulse Flows Component, and DWR, the State Water Resources Control Board (State Water Board), the California Water Commission (CWC), and California Department of Fish and Wildlife (CDFW) are responsible agencies (and a trustee agency in the case of CDFW). DWR, as a responsible agency, has prepared this SEIR to supplement the three WSIP Groundwater Projects' EIRs and to provide CEQA coverage for DWR's actions.

1.1 Background

1.1.1 Key Terms

The following terms support this Draft SEIR. Terminology associated with the State Water Project (SWP) is listed first, generally followed by terminology specific to the Pulse Flows Component of the WSIP Groundwater Projects.

State Water Project

- **SWP Water Supply Contract (Water Supply Contract):** A long-term water supply contract between DWR and individual SWP contractors that details the terms of water supply to each contractor and related payments to DWR.
- **Annual Table A Amount:** An amount of SWP water defined in the Water Supply Contract, in a list format known as "Table A." The annual Table A amount sets forth the maximum amount of Table A water a particular SWP contractor may request for delivery on an annual basis.
- **Table A Allocation:** A portion or all of the annual Table A Amount requested by the SWP contractor and approved for delivery by DWR.
- **Table A Deliveries:** The actual deliveries to the SWP contractor to fulfill the Table A Allocation. Undelivered Table A water can be stored as carryover in San Luis Reservoir.
- **Article 21 Water:** A type of water available to SWP contractors on a short-term basis, as determined by DWR, when water is available after operational requirements for SWP water deliveries, water quality, and regulatory requirements are met. The availability of Article 21 water allows the SWP contractor to take delivery of water beyond the approved and scheduled Table A Amounts for the year. "Article 21" refers to the so-named article in each of the water supply contracts. Descriptions of both Kern Fan and Willow Springs refer to Article 21 water.
- **Regulatory Releases:** Required regulatory releases by DWR from Lake Oroville to comply with the San Francisco Bay/Sacramento–San Joaquin Delta water quality and flow standards set forth in the State Water Board's Water Rights Decision 1641, National Marine Fisheries Service and U.S. Fish and Wildlife Service biological opinions, CDFW's Incidental Take

Permit, and Federal Energy Regulatory Commission License No. P-2100 for operation of the Lake Oroville facilities and to comply with SWP water rights.

- **Discretionary Releases:** For the purposes of this SEIR, releases made at DWR's discretion to move water from Lake Oroville to the Harvey O. Banks Pumping Plant (Banks Pumping Plant) during the Lake Oroville Recovery Period (Recovery Period), defined as the months of July, August, and September, above Regulatory Releases and other contractual obligations to meet SWP contractors' deliveries and SWP operational needs.

WSIP Groundwater Projects

- **WSIP Groundwater Projects:** The Chino Basin Program, Kern Fan, and Willow Springs.
- **Project Proponent:** One of the entities that successfully submitted a proposal for WSIP Proposition 1 funding to the California Water Commission, or a representative successor, as in cases where a Joint Powers Authority was subsequently formed. The Project Proponent for the Chino Basin Program is the IEUA. The Project Proponent for Kern Fan is the Authority for the Groundwater Banking JPA. The Project Proponent for Willow Springs is the Southern California Water Bank Authority.
- **Partner Contractors:** Public agencies that have a Water Supply Contract with DWR and have agreed to participate in WSIP Groundwater Projects. Prospective Partner Contractors for the WSIP Operational Exchange are expected to be: the Metropolitan Water District of Southern California (Chino Basin Program); Dudley Ridge Water District and Kern County Water Agency (Kern Fan); and Antelope Valley–East Kern Water District (Willow Springs).
- **Contract for Administration of Public Benefits (CAPB):** Contracts for public benefits between the Project Proponent(s) and State agencies that specify requirements of the WSIP Groundwater Project(s) to provide public benefits over the term of the CAPB. For this SEIR, the applicable CAPB is the contract between the Project Proponent(s) and CDFW that includes the provision of pulse flows from Lake Oroville.
- **WSIP Operational Exchange Process:** Implementation of the Pulse Flows Component involves the following exchange of water: (1) the release of SWP water from Lake Oroville by DWR (see "WSIP Pulse Flow Release") and (2) an equivalent amount, less Efficiency Credit (defined below), of water released from the Project Proponent's groundwater bank to their Partner Contractors (see "WSIP In-Lieu Table A Water"). To replace the volume of SWP water reduced by a pulse flow release, DWR would reduce releases by an equivalent amount from Lake Oroville during the Recovery Period (July, August, and September), resulting in less pumping at the Banks Pumping Plant.
- **WSIP Pulse Flow Release (pulse flow release or pulse flows):** Releases made by DWR, in an amount that is greater than regulatory releases and other contractual obligations at that time, from Lake Oroville into the Low Flow Channel of the Feather River on behalf of the WSIP Groundwater Projects to provide fishery benefits. These releases would ultimately flow into San Francisco Bay.
- **WSIP In-Lieu Table A Water:** Water that is made available from the Project Proponent's groundwater bank in place of the Partner Contractor receiving Table A water from the SWP, as provided in the Water Supply Contract between the Partner Contractor and DWR. The amount of WSIP In-Lieu Table A Water that is provided to a Partner Contractor is the amount of its contribution of a WSIP Pulse Flow less the Efficiency Credit (defined below). The In-Lieu Table A Water delivery from a Project Proponent to a Partner Contractor is a non-DWR action and is not evaluated in this SEIR, because it is a local action covered by the

lead agency's environmental document. It is described here for readers' intuitive understanding of the WSIP Operational Exchange Process as a whole.

- **WSIP Exchange Storage Account:** A water storage account within the Project Proponent's groundwater bank to provide WSIP In-Lieu Table A Water.
- **Efficiency Credit:** A credit made available to a Project Proponent(s) for providing In-Lieu Table A Water to a Partner Contractor(s) receiving a portion of the Annual Table A Amount of water that otherwise would have been exported from the Sacramento–San Joaquin Delta. The efficiency credit may be up to 35 percent of the pulse flow release, depending on SWP and/or Central Valley Project (CVP) contribution. Refer to Section 2.5.3, "Efficiency Credit," for examples of how this applies to the WSIP Groundwater Projects.
- **Lake Oroville Recovery Period:** The time that releases are reduced from Lake Oroville to recover storage to what it would have been absent the pulse flow. The Recovery Period is analyzed in this document as the months of July, August, and September.
- **Advanced Wastewater Treatment:** As defined by the American Institute of Chemical Engineers, "any process that can reduce impurities in wastewater below [what is] attainable through conventional secondary or biological treatment" (American Institute of Chemical Engineers 2023). The Chino Basin Program would use advanced treatment on recycled water before storing it in the Chino Groundwater Basin.
- **Pre-Positioning Yield:** Additional water developed by a process proposed as part of Willow Springs, which would reduce the amount of water stored in San Luis Reservoir by depositing SWP water in the Willow Springs Groundwater Bank, thus increasing storage capacity in San Luis Reservoir to be filled during high-flow event periods. This would create additional water supply in the SWP system if the pre-positioning allows San Luis Reservoir to capture water that otherwise could not be stored.
- **DWR/CDFW Agreement**: An interagency agreement between DWR and CDFW for "Pulse Flow Releases from Lake Oroville to Assist in the Implementation of the WSIP" that provides for a decision-making process for the pulse flows.

1.1.2 Water Storage Investment Program

The WSIP is a $2.7 billion program for investments in water storage projects in California. It is part of the voter-approved Proposition 1 in 2014 and is administered by the California Water Commission (CWC). Water storage projects include expanding existing reservoirs, increasing groundwater storage capability, and building modern surface storage facilities. In addition to water storage benefits, the CWC-selected projects demonstrate an ability to provide additional public benefits related to flood control, ecosystem improvement, water quality improvement, recreation, and/or emergency response. Based on a rigorous review process by CWC, to date eight WSIP projects have been awarded conditional funding. Following one project's withdrawal, seven projects continue to proceed toward completing the remaining WSIP requirements. Once operational, these seven WSIP projects could increase California's water storage capacity by approximately 2.77 million acre-feet (af) over the 2021 baseline (California Water Commission 2023). Three of the seven WSIP projects are groundwater projects that include an ecosystem benefit component, referred to as the Pulse Flows Component, which is the subject of this Draft SEIR.

1.1.3 WSIP Groundwater Projects

The three WSIP Groundwater Projects involve the development of groundwater storage to improve local water supply in their immediate vicinities in the San Joaquin Valley and Southern California. As described in Section 1.1.2, CWC funding for the three WSIP Groundwater Projects was conditioned upon creation of an ecosystem benefit (among other public benefits); thus, the projects must reserve a certain quantity of stored water for this purpose. To provide an ecosystem benefit, the WSIP Groundwater Projects would operationally exchange stored water with DWR to facilitate the release of pulse flows into the Feather River, thus improving habitat and migratory capacity for listed and non-listed native fish species. The WSIP Operational Exchange Process to implement the pulse flow is described in Section 2.4.

The following subsections summarize the three WSIP Groundwater Projects, including a description of each project and a summary of previous environmental documents incorporated by reference. The environmental impacts of the construction and operations of WSIP Groundwater Projects are evaluated in the three WSIP Groundwater Projects' EIRs and are described here only for background context. The SEIR focuses on the portion of the WSIP Operational Exchange Process for which DWR takes actions and does not address the transaction between the WSIP Groundwater Projects and the Partner Contractors to deliver WSIP In-Lieu Table A Water.

Chino Basin Program

Description

Under the Chino Basin Program, the IEUA (the Project Proponent) would enhance the operations of an existing advanced water treatment facility and construct injection wells, extraction wells, groundwater treatment facilities, and distribution facilities in western San Bernardino County that would store up to 15,000 af per year of treated wastewater in the Chino Groundwater Basin (Chino Basin). During the first 25 years of operation of the Chino Basin Program, the existing Chino Basin would be operated to dedicate blocks of water stored in their WSIP Exchange Storage Account, assumed to be in increments of up to 50,000 af, to be used to provide pulse flows for ecosystem benefits.

Previous Environmental Documents

The Chino Basin Program was analyzed in a subsequent environmental impact report (Subsequent EIR) to the Optimum Basin Management Program Subsequent EIR (State Clearinghouse [SCH] No. 2020020183)[3] prepared for the IEUA and finalized in July 2020. An addendum to the Subsequent EIR was then prepared in February 2021 to address changes to the storage capacity of the proposed project. Due to these additional project changes and new information, the Chino Basin Program was not analyzed in its entirety in these prior CEQA documents, so the IEUA, as the CEQA lead agency, prepared a Program Environmental Impact Report (PEIR) (SCH No. 2021090310). The Chino Basin Program Final PEIR was certified May 6, 2022 (Inland Empire Utilities Agency 2022) and is referred to in this Draft SEIR as the "2022 Chino Basin Program Final PEIR." This Draft SEIR incorporates the 2022 Chino Basin

3 The original Optimum Basin Management Program EIR was certified in 2000 and the Peace II Subsequent EIR was certified in 2010. Copies of these documents can be accessed at the IEUA website: www.ieua.org/obmpu-ceqa.

Program Final PEIR by reference, which can be found in full at https://www.ieua.org/chino-basin-program-ceqa-documents/. This Draft SEIR adds to but does not modify the Mitigation Monitoring and Reporting Program adopted for the 2022 Chino Basin Program Final PEIR, which can be found starting on page 2,067 of the document linked above.

Kern Fan Groundwater Storage Project

Description

The Authority for the Groundwater Banking Joint Powers Authority (the Project Proponent) would construct and operate a regional water bank in Kern County, west of Bakersfield, that would store up to 100,000 af of Article 21 water and other available water supplies, including federal Central Valley Project Section 215 water.[4] Kern Fan would be operated so that in wet years, the Project Proponent (through its Partner Contractors) would request that DWR send Article 21 water through the California Aqueduct, to be diverted by the project for underground storage. Twenty-five percent of the stored water, or up to 25,000 af, would be stored in its WSIP Exchange Storage Account and would be dedicated for ecosystem benefits in blocks of water, approximately 18,000 af each. The remaining water would be stored by the Project Proponent for water supply reliability purposes.

Previous Environmental Documents

The Kern Fan Groundwater Storage Project EIR (SCH No. 2020049019) was prepared jointly by the Rosedale–Rio Bravo Water Storage District and Irvine Ranch Water District, which formed the Authority for the Groundwater Banking JPA that served as the lead agency. The Kern Fan Final EIR was certified December 28, 2020 (Irvine Ranch Water District and Rosedale–Rio Bravo Water Storage District 2020), and is referred to in this Draft SEIR as the "2020 Kern Fan Final EIR." This Draft SEIR incorporates the 2020 Kern Fan Final EIR by reference, which can be found in full at https://www.kernfanproject.com/environmental-review/. This Draft SEIR adds to but does not modify the Mitigation Monitoring and Reporting Program adopted for the 2020 Kern Fan Final EIR, which can be found in the 2020 Kern Fan Final EIR, Section 8.5, at the link above.

Willow Springs Water Bank Project

Description

The Southern California Water Bank Authority (the Project Proponent) would enhance the existing Willow Springs Water Bank located in southern Kern County, northwest of the city of Lancaster, in the adjudicated Antelope Valley Groundwater Basin. Willow Springs is a conjunctive use and reservoir reoperation project that would leverage 560,000 af of existing groundwater storage facilities at the Willow Springs Water Bank and High Desert Water Bank and operate conjunctively with the SWP. The Project Proponent would pre-position SWP water to the Willow Springs Water Bank between November and April in years when there is not a low-volume concern in San Luis Reservoir. This pre-positioned water would be classified as SWP

4 "Section 215" refers to a section in the Reclamation Reform Act of 1982 that defines temporary water supplies and allows non-storable water to be applied to lands otherwise ineligible to receive federal water.

water and used in SWP allocation calculations. Willow Springs would be operated to dedicate blocks of water, assumed to be in increments of 29,000 af, for ecosystem benefits.

Previous Environmental Documents

The Willow Springs Water Bank Project was originally known as the Antelope Valley Water Bank Project. The Antelope Valley Water Bank Project EIR (SCH No. 2005091117) was prepared by the Kern County Planning Department and Kern County served as the lead agency. The Antelope Valley Water Bank Project Final EIR was certified on September 12, 2006 (Kern County Planning Department 2006). An addendum to the EIR analyzing several project modifications was prepared by Rosamond CSD in 2018 (Rosamond Community Services District 2018), which changed the name of the project to the Willow Springs Water Bank Project. The addendum also designated Rosamond CSD as the appropriate CEQA lead agency, as "the agency responsible for authorizing construction of the improvements" analyzed in the addendum to the EIR, the most current document. This Draft SEIR incorporates both the Antelope Valley Water Bank Project Final EIR and the Willow Springs Water Bank Project EIR Addendum by reference, referred to as the "2006/2018 Willow Springs EIR." These documents can be found in full at https://aquiferpumpedhydro.com/eir. This Draft SEIR adds to but does not modify the Mitigation Monitoring and Reporting Program adopted for the 2006/2018 Willow Springs EIR, which can be found in full in the EIR Addendum, Appendix A (Memorandum of Understanding) available at the link above.

In-Lieu Table A Water Delivery

The WSIP Operational Exchange Process to replace water used for pulse flows with stored groundwater would require agreements between the WSIP Groundwater Project Proponents (i.e., the IEUA, Authority for the Groundwater Banking JPA, and Southern California Water Bank Authority) and SWP Partner Contractors. Partner Contractors are public agencies that have a Water Supply Contract with DWR and have agreed to participate in the WSIP Groundwater Projects. Partner Contractors would forgo the portion of their SWP Table A deliveries equivalent to the pulse flow amount (less the Efficiency Credit) in exchange for receiving an equivalent amount of WSIP In-Lieu Table A Water from their respective partner groundwater bank. Note that, for such an exchange to occur, the allocation of Table A water to Partner Contractors in the year of a pulse flow would need to be equivalent or greater than the requested pulse flow volume. Potential Partner Contractors are expected to include: the Metropolitan Water District of Southern California (for the Chino Basin Program); Dudley Ridge Water District and Kern County Water Agency (for Kern Fan); and Antelope Valley–East Kern Water District (for Willow Springs). As discussed, this transaction between the WSIP Groundwater Project Proponents and their Partner Contractors to deliver WSIP In-Lieu Table A Water is not a DWR action and is therefore not a part of the Pulse Flows Component analyzed in this SEIR.

1.2 Type of Environmental Impact Report

As explained in CEQA Guidelines Section 15163, an SEIR may be prepared when only minor additions or changes would be necessary to make the previously certified EIR adequately apply to the project in the changed situation. The SEIR needs to contain only the information necessary to make the previous CEQA documents adequate for the project as revised. Here, the changed situation is DWR refining the Pulse Flows Component originally proposed by the WSIP Groundwater Projects. The characteristics of the WSIP Groundwater Projects as described in the three WSIP Groundwater Projects' EIRs—the development, construction, and operation of the associated conveyance, recharge, and recovery facilities needed for groundwater banking—are not changed for the Pulse Flows Component.

Consistent with these requirements, this Draft SEIR supplements the previously certified 2022 Chino Basin Program Final PEIR, the 2020 Kern Fan Final EIR, and the 2006/2018 Willow Springs EIR, collectively referred to as the three WSIP Groundwater Projects' EIRs, and addresses the Pulse Flows Component not described in the prior environmental documents. This Draft SEIR provides additional information needed to make the three WSIP Groundwater Projects' EIRs, as supplemented, adequate to include the Pulse Flows Component. This Draft SEIR contains only the information needed to analyze the Pulse Flows Component, including changed circumstances and new information requiring additional environmental review. Information provided in the three WSIP Groundwater Projects' EIRs applicable to the Pulse Flows Component is incorporated by reference.

1.3 Intended Uses of This Supplemental Environmental Impact Report

As described in CEQA Guidelines Section 15121(a), an EIR is a public information and disclosure document that assesses potential environmental effects of a proposed project (i.e., the Pulse Flows Component) and identifies mitigation measures and alternatives to the proposed project that would reduce or avoid adverse environmental impacts. CEQA requires State and local government agencies to consider the environmental consequences of projects over which they have discretionary authority.

The IEUA, the Authority for the Groundwater Banking Joint Powers Authority, and Rosamond CSD are the lead agencies for complying with CEQA (Public Resources Code Section 21000 et seq., as amended) and the CEQA Guidelines (California Code of Regulations, Title 14). DWR has prepared this Draft SEIR to provide the public, as well as the CEQA lead, responsible, and trustee agencies, with information about the potential environmental effects of the Pulse Flows Component of the WSIP Groundwater Projects, as CEQA requires State and local government agencies to consider the environmental consequences of projects over which they have discretionary authority. When the CEQA lead agencies for the WSIP Groundwater Projects decide whether to make any discretionary approvals related to the WSIP Groundwater Projects, the decision-making bodies shall consider the previous CEQA documents and this SEIR.

DWR would use this Draft SEIR for CEQA compliance for any permits and approvals needed for the WSIP Groundwater Projects, including for any agreements, contract amendments, and water right changes needed for their implementation. Refer to Section 2.8, Anticipated Required Permits and Approvals.

1.4 Environmental Review and Approval Process

Preparation of an SEIR involves multiple steps, during which the public is provided the opportunity to review and comment on the content of the SEIR, the scope of the analyses, results and conclusions presented, and the overall adequacy of the document to meet the substantive requirements of CEQA and provide full disclosure of the potential environmental consequences of implementing the Pulse Flows Component and alternatives. The following discussion describes the major steps in the environmental review process that are applicable to this Draft SEIR.

1.4.1 Notice of Preparation

In accordance with CEQA Guidelines Sections 15063 and 15082, the lead agencies prepared and published a Notice of Preparation (NOP) of an SEIR on August 10, 2022 (SCH No. 2022080216). To solicit comments on the Pulse Flows Component, DWR circulated the NOP to the public and to the federal, State, and local agencies and other interested parties through the State Clearinghouse. DWR also published the NOP in the *Oroville Mercury Register* on August 13, 2022; in the *Sacramento Bee* on August 15, 2022; and in the *Los Angeles Times* on August 12, 2022. The public comment period for the NOP closed on September 9, 2022. In addition to the public and agency comment period, a virtual public scoping meeting was held via remote teleconference on the Zoom platform on August 22, 2022, at 4:00 p.m.

Concerns raised in response to the NOP and oral comments received at the scoping meeting were considered during the preparation of this Draft SEIR. The NOP and scoping comments are included as **Appendix A**.

1.4.2 Tribal Engagement

Ongoing Tribal consultation is described in Section 3.8, "Tribal Cultural Resources." In summary, in accordance with the California Natural Resources Agency's (CNRA's) Tribal Consultation Policy and DWR's Tribal Engagement Policy, DWR sent letters via certified mail in June 2022, and follow-up emails, to representatives from California Native American Tribes that had previously requested to DWR that they be notified of any DWR projects.

DWR has engaged 45 California Native American Tribes as well as the Butte Tribal Council to provide them with information on the Pulse Flows Component and request that they notify DWR if they have any concerns regarding the Pulse Flows Component and impacts on cultural resources and tribal cultural resources. DWR has received responses from ten of these Tribes, with six Tribes requesting consultation with DWR on the Pulse Flows Component, three Tribes requesting that DWR provide updates to them regarding the Pulse Flows Component, and one Tribe deferring to another. Consultation is ongoing between DWR and the Tribes that requested consultation with DWR on the Pulse Flows Components.

1.4.3 Draft Supplemental Environmental Impact Report

This Draft SEIR is available to federal, State, and local agencies, interested organizations, and individuals who may want to review and comment on the analysis in this document. Publication of the Draft SEIR marks the beginning of a 45-day public review period. The 45-day public review period extends from February 16, 2024, through April 1, 2024, ending at 5:00 p.m. During the public comment period, written comments should be delivered to:

Marianne Kirkland
California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Email: PulseFlowsComponent@water.ca.gov

If comments are provided via email, please include the project title in the subject line, attach comments in Microsoft Word format if possible, and include the commenter's U.S. Postal Service mailing address.

PLEASE NOTE: All comments received will be made available for public review in their entirety in the Final SEIR, including the names and addresses of the respondents, unless individual commenters request that DWR withhold their name and/or home addresses, etc., in the Final SEIR. If commenters wish for their names and/or home addresses to be withheld, this must be stated prominently at the beginning of their comments.

This Draft SEIR is available for public review on the following websites via the following links:

https://water.ca.gov/News/Public-Notices

California State Clearinghouse CEQAnet Web Portal (search by project name or SCH No. 2022080216):

https://ceqanet.opr.ca.gov/

A copy of the Draft SEIR is also available for review during normal business hours at the following locations:

California Department of Water Resources
Division of Operations and Maintenance, Water Projects Planning and Management Branch
1516 9th Street, 2nd Floor
Sacramento, CA 95814

Sacramento Public Library, Central Branch
828 I Street
Sacramento, CA 95814

DWR will also conduct a virtual public meeting to receive oral comments on the adequacy of the analysis included in this Draft SEIR. The meeting will be held on:

Date: March 19, 2024
Time: 4:00 p.m.
Registration: https://us02web.zoom.us/webinar/register/WN_yvnN3OOxTEqM_EIY1_ilJg

After registering, you will receive a confirmation email containing information about joining the webinar. Registration will be open until the start of the meeting on March 19, 2024

1.4.4 Final Supplemental Environmental Impact Report

DWR, as a responsible agency, will certify this SEIR to provide CEQA coverage for its actions to facilitate the Pulse Flows Component. The lead agencies may certify this SEIR to supplement the WSIP Groundwater Projects' EIRs to provide CEQA coverage for relevant discretionary actions on their part.

1.4.5 Mitigation Monitoring and Reporting Program

CEQA Section 21081.6(a) requires lead agencies to "adopt a reporting and mitigation monitoring program for the changes to the project which it has adopted or made a condition of project approval in order to mitigate or avoid significant effects on the environment." Mitigation measures identified in the Final SEIR for the Pulse Flows Component, if any, will be included in a Mitigation Monitoring and Reporting Program, which will identify all compliance measures and responsible parties.

1.5 Scope of This Supplemental Environmental Impact Report

1.5.1 Level of Review

According to CEQA Guidelines Section 15163, this Draft SEIR needs to contain only the information needed to analyze the Pulse Flows Component, including changed circumstances and new information requiring additional environmental review. Therefore, where existing information and analysis in the WSIP Groundwater Projects' EIRs are sufficient to evaluate the impacts of the Pulse Flows Component, no additional environmental review is warranted.

As discussed in Section 1.2, the proposed construction and operational aspects of the WSIP Groundwater Projects are described in the three WSIP Groundwater Projects' EIRs and are not changed for the Pulse Flows Component. However, the geographical boundary in those EIRs does not cover the Pulse Flows Component location that extends from Lake Oroville to the WSIP Groundwater Projects (see Figure 1-1), nor do the EIRs convey the following project-specific details related to DWR's proposed actions: (1) release of the pulse flows from Lake Oroville; (2) implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases from Lake Oroville; and (3) diversion and conveyance of water to Kern Fan and Willow Springs that would be stored, in part, for ecosystem benefit .

Therefore, this Draft SEIR contains only the information needed to analyze the Pulse Flows Component of the WSIP Groundwater Projects, including the Pulse Flows Component location and new environmental impact analyses for resource areas requiring additional review. As discussed in Section 1.1.3, the transaction between the WSIP Groundwater Project Proponents and their Partner Contractors to deliver WSIP In-Lieu Table A Water is not a DWR action and is therefore not a part of the Pulse Flows Component analyzed in this SEIR.

1.5.2 Summary of Issues Not Addressed Further

According to CEQA Guidelines Section 15163, this Draft SEIR needs to contain only the information necessary to analyze the Pulse Flows Component, including changed circumstances and new information requiring additional environmental review. Therefore, where existing information and analysis in the three WSIP Groundwater Projects' EIRs are sufficient to evaluate impacts associated with the Pulse Flows Component, no additional environmental review would be warranted.

For the following environmental issues, potential impacts of the Pulse Flows Component are adequately addressed in the WSIP Groundwater Projects' EIRs and/or no impact would occur and no further analysis is required: aesthetics, air quality, hazards and hazardous materials, land use, mineral resources, noise, population and housing, public safety, transportation, utilities and service systems, wildfire, and growth inducement. Refer to Section 3.2, "Environmental Issues Not Requiring Further Analysis," for additional discussion.

1.5.3 Summary of Issues Considered for Additional Impact Analysis

In light of the environmental issues not addressed further, the following CEQA resource areas are considered in greater detail in a revised impact analysis in this Draft SEIR: hydrology and water quality, biological resources (aquatic and terrestrial), cultural resources, Tribal cultural resources, energy and greenhouse gas emissions, recreation, geology and soils, and agriculture and forestry resources. An introduction to the CEQA impact analysis is provided in Section 3.3. For CEQA resource areas addressed in this Draft SEIR, Sections 3.4 through 3.12 include environmental setting information, regulatory background, identified thresholds of significance, an impact analysis, and applicable mitigation measures and significance conclusions. This Draft SEIR also includes an assessment of cumulative impacts and alternatives in Chapters 4 and 5, respectively, and other CEQA considerations in Chapter 6.

1.6 Incorporation by Reference

As described above, the following three WSIP Groundwater Projects' EIRs are incorporated by reference into this SEIR:

- Chino Basin Program Final PEIR (SCH No. 2021090310) (Inland Empire Utilities Agency 2022)
- Kern Fan Groundwater Storage Program Final EIR (SCH No. 2020049019) (Irvine Ranch Water District and Rosedale–Rio Bravo Water Storage District 2020)
- Antelope Valley Water Bank Project Final EIR (Kern County Planning Department 2006) and Willow Springs Water Bank Project EIR Addendum (SCH No. 2005091117) (Rosamond Community Services District 2018)

1.7 Supplemental Environmental Impact Report Organization

This Draft SEIR is organized as follows:

- **"Executive Summary."** This chapter presents a summary of the Pulse Flows Component, a description of the WSIP Groundwater Projects, and a summary of environmental impacts that would result from implementation of the Pulse Flows Component, including significant environmental impacts and mitigation measures proposed to reduce or eliminate those impacts.
- **Chapter 1, "Introduction."** Chapter 1 introduces the Pulse Flows Component and provides background context, including definitions of key terms, the WSIP, the three WSIP Groundwater Projects, and existing WSIP Groundwater Projects' EIRs. The chapter then describes the type of EIR, the intended uses of the SEIR, the environmental review and approval process, the scope of this SEIR, EIRs incorporated by reference, and document organization.
- **Chapter 2, "Description of the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects."** Chapter 2 describes the objectives of the Pulse Flows Component, defines the study area, and describes each of DWR's proposed actions (i.e., pulse flow releases, WSIP Operational Exchange Process, and diversion and conveyance of water to WSIP Groundwater Projects). The chapter concludes with a discussion of the Pulse Flows Component and climate change and anticipated required permits and approvals.
- **Chapter 3, "Environmental Setting, Impacts, and Mitigation Measures."** Chapter 3 describes the approach to evaluate impacts of the pulse flow releases, and summarizes environmental issues for which potential impacts of the Pulse Flows Component are adequately addressed in the three WSIP Groundwater Projects' EIRs and/or no impact would occur and no further analysis is required. This chapter also identifies resource area topics requiring additional CEQA analysis beyond the analysis presented in the three WSIP Groundwater Projects' EIRs, that include hydrology and water quality, aquatic biological resources, terrestrial biological resources, cultural resources, tribal cultural resources, energy and greenhouse gas emissions, recreation, geology and soils, and agriculture and forestry resources. The remaining sections of this chapter include a discussion of regulatory setting, environmental setting, and impact analysis and mitigation measures for each resource analyzed in the Draft SEIR.
- **Chapter 4, "Cumulative Impacts."** Chapter 4 describes the CEQA requirements for the cumulative analysis, geographic scope and time frame, existing conditions context for past activities, and related projects and plans, and presents the cumulative impact analysis.
- **Chapter 5, "Alternatives."** Chapter 5 describes the CEQA requirements for alternatives, description of alternatives to the Pulse Flows Component, alternatives eliminated from detailed analysis, comparative analysis of impacts from the alternatives to the Pulse Flows Component (greater than, equal to, or lesser than), and the environmentally superior alternative.
- **Chapter 6, "Other CEQA Considerations."** Chapter 6 describes the significant unavoidable impacts and significant irreversible environmental changes of the Pulse Flows Component, if applicable.

- **Chapter 7, "List of Preparers."** Chapter 7 provides the names of the Draft SEIR authors and consultants and the agencies or individuals consulted during preparation of this Draft SEIR.
- **Chapter 8, "References."** Chapter 8 lists all references cited in this Draft SEIR.
- **Appendices.** The appendices include materials that support the findings and conclusions presented in the text of this Draft SEIR.

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CHAPTER 2
Description of the Pulse Flows Component

2.1 Introduction

This section describes the Pulse Flows Component of the Water Storage Investment Program (WSIP) Groundwater Projects (Pulse Flows Component), which has been determined to require further analysis pursuant to the California Environmental Quality Act (CEQA), and thus is the subject of this draft supplemental environmental impact report (Draft SEIR). This SEIR supplements the environmental impact reports (EIRs) for the three WSIP Groundwater Projects such that the environmental effects of the California Department of Water Resources' (DWR's) actions needed to implement the pulse flows can be evaluated.

The Pulse Flows Component is defined by the following DWR actions:

(1) Release of the pulse flows from Lake Oroville into the Low Flow Channel of the Feather River, with the goal of improving habitat conditions for listed salmonids, as well as improving spawning and migration conditions for other listed and non-listed native fish species.

(2) Implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases.

(3) Diversion and conveyance of water to the Kern Fan Groundwater Storage Project (Kern Fan) and Willow Springs Water Bank Project (Willow Springs) that would be stored, in part, for ecosystem benefit.[1]

Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases.

The following sections describe the objectives of the Pulse Flows Component, the study area, and each of DWR's actions: the pulse flow releases, the WSIP Operational Exchange Process to implement the pulse flows, and diversion and conveyance of water to the WSIP Groundwater Projects.

[1] This DWR action does not apply to the Chino Basin Program, as that project proposes to develop water by enhancing operations at an advanced water treatment facility. Water contributions to the pulse flow release from the Chino Basin Program would therefore come from the treated wastewater of surrounding local jurisdictions, as opposed to coming from the State Water Project. See Section 1.1.3, "WSIP Groundwater Projects," for more details about how each WSIP Groundwater Project will develop water for ecosystem benefit.

2.2 Objectives of the Pulse Flows Component

The objectives of the Pulse Flows Component are as follows:

- Provide for the release of pulse flows from Lake Oroville (in addition to any flows needed to meet regulatory requirements).
- Improve habitat conditions for listed salmonids, primarily spring-run Chinook salmon, and improve conditions for spawning and migration of other listed and non-listed native fish species downstream of Lake Oroville, especially during drier water year types.
- Utilize contractual and operational mechanisms to avoid or minimize impacts on State Water Project (SWP) operations, SWP contractors, and water supplies that may result from pulse flow releases.

2.3 Study Area

The Pulse Flows Component study area analyzed in this Draft SEIR extends approximately 575 miles from Lake Oroville in Northern California to the WSIP Groundwater Projects in the San Joaquin Valley and Southern California (**Figure 2-1**). For purposes of this Draft SEIR, the study area is divided into seven geographic areas, as noted on **Figure 2-2**:

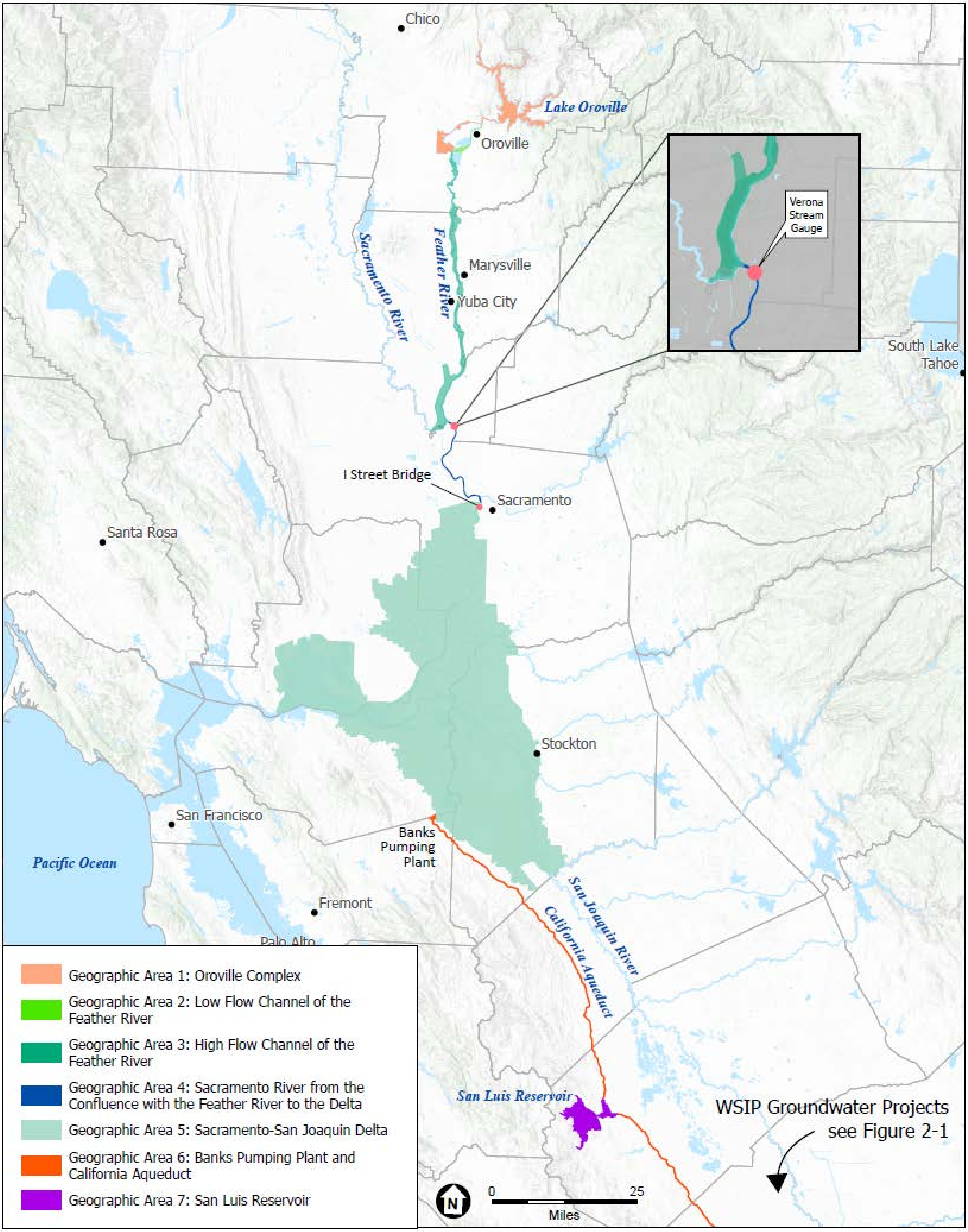
- Geographic Area 1: The Oroville Complex.
- Geographic Area 2: The Low Flow Channel of the Feather River, defined as the reach from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet.
- Geographic Area 3: The High Flow Channel of the Feather River, defined as the reach from the Thermalito Afterbay Outlet to the confluence with the Sacramento River, including the Lower Sutter Bypass.
- Geographic Area 4: The Sacramento River from the confluence with the Feather River to the Sacramento–San Joaquin Delta (Delta).
- Geographic Area 5: The Delta.
- Geographic Area 6: The Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant) and the California Aqueduct to the WSIP Groundwater Projects.
- Geographic Area 7: San Luis Reservoir.

Figure 2-3 presents features within the Oroville Complex and Low Flow Channel of the Feather River, and **Figure 2-4** presents key features within the High Flow Channel of the Feather River. Each of these geographic areas is described in more detail below, with specific details pertaining to the resources of interest provided in Chapter 3, “Environmental Settings, Impacts, and Mitigation Measures.”

SOURCE: Esri, 2022; ESA, 2023

Figure 2-1
Pulse Flows Component Study Area

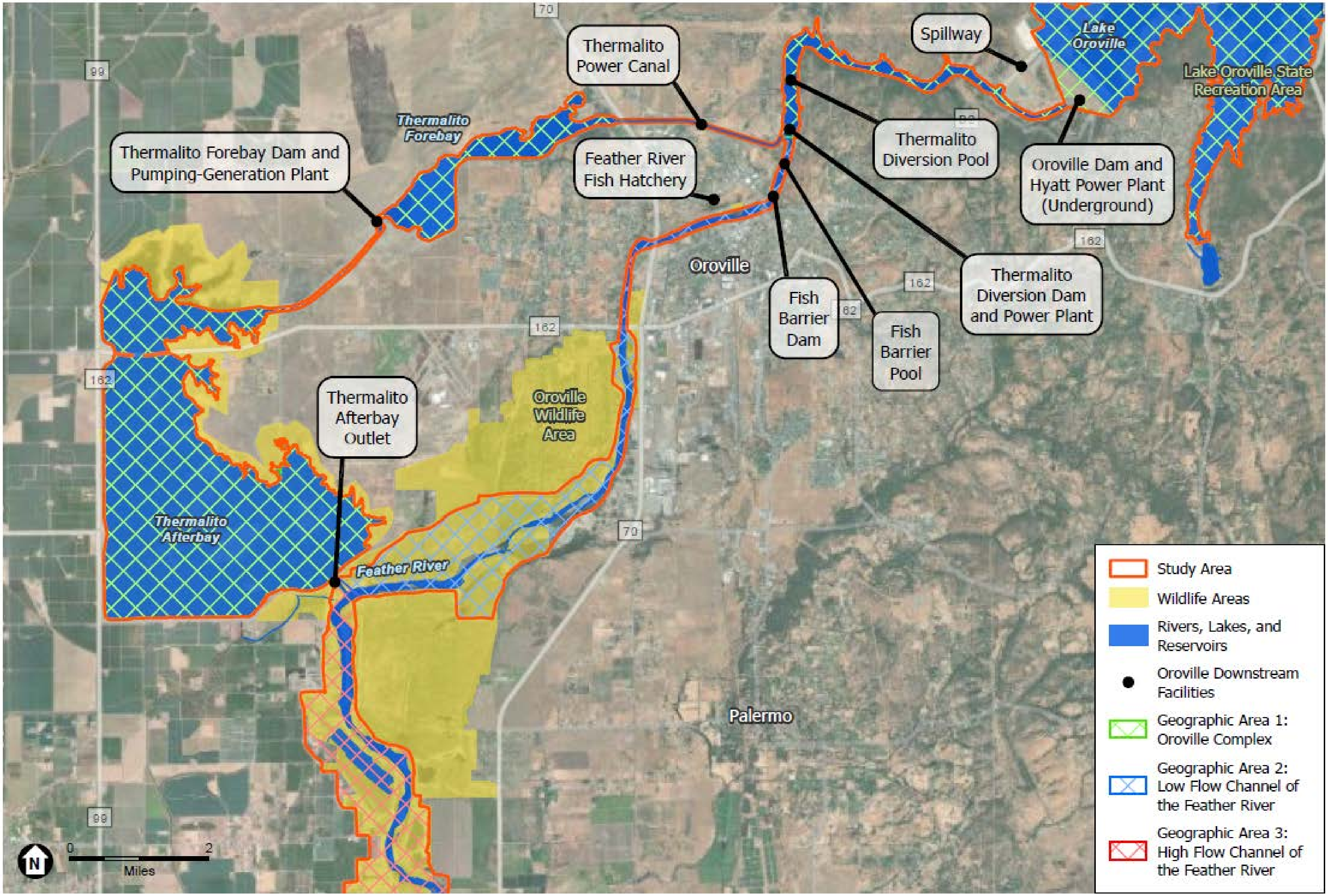
ESA



SOURCE: Esri, 2022; ESA, 2023

ESA

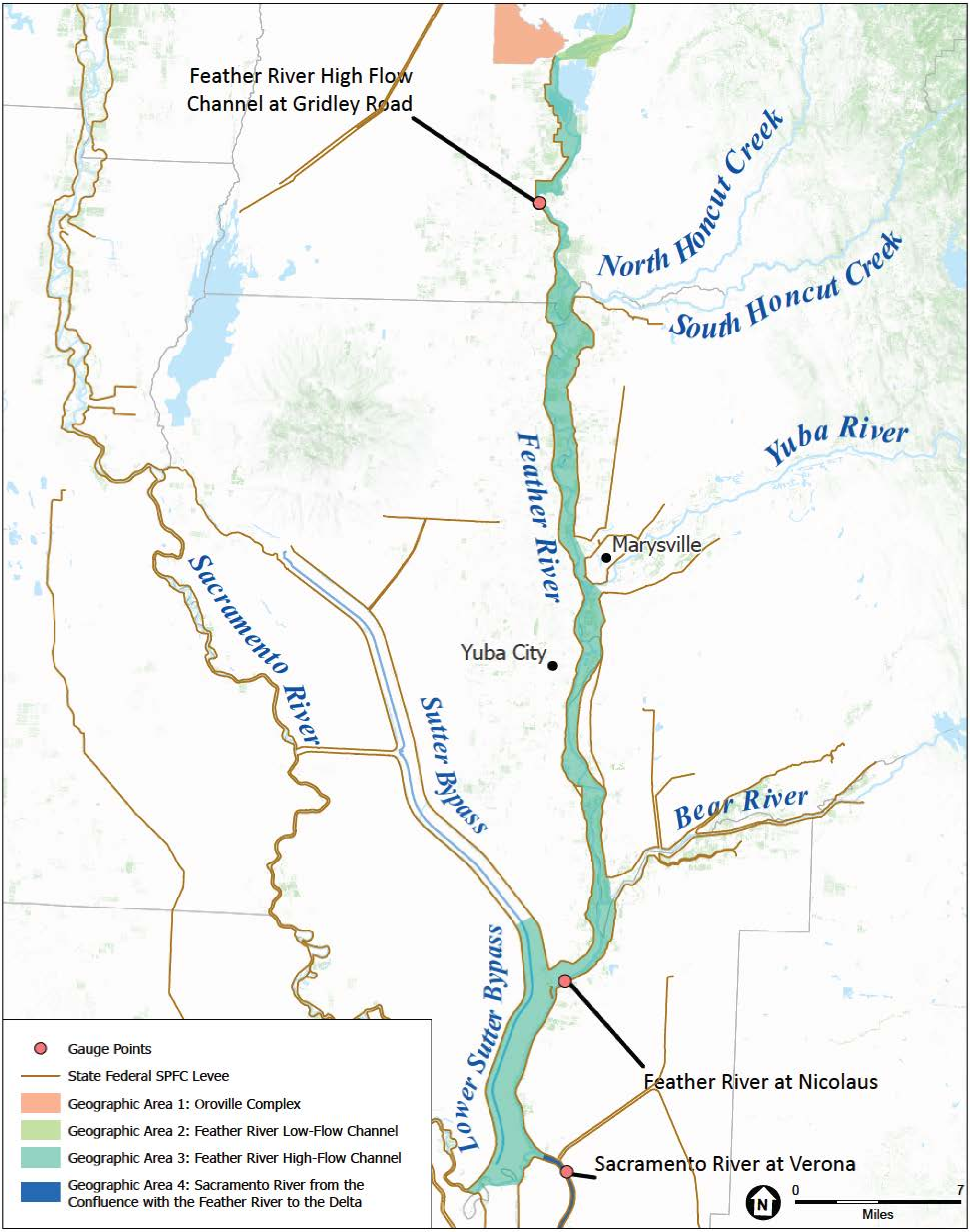
Figure 2-2
Pulse Flows Component Geographic Areas



SOURCE: ESA, 2023

ESA

Figure 2-3
Oroville Complex and Low and
High Flow Channels of the Feather River



SOURCE: Esri, 2022; ESA, 2023

Figure 2-4
High Flow Channel of the Feather River

2.3.1 Oroville Complex

The Oroville Complex (geographic area 1, Figures 2-2 and 2-3) is defined as Lake Oroville and the associated downstream Thermalito facilities including the Thermalito Diversion Pool, Thermalito Diversion Dam, Thermalito Power Canal, Thermalito Forebay, and Thermalito Afterbay. These facilities make up a system of impounded water bodies associated with the Oroville Complex's water delivery and hydroelectric power features.

The Feather River flows generally north to south from its origin near Lassen Peak to its mouth at the confluence with the Sacramento River near Verona. Water from the upper Feather River watershed drains to Lake Oroville, the largest water storage facility in the SWP. Lake Oroville is created by Oroville Dam and two small saddle dams. The lake has a storage capacity of 3.5 million acre-feet (maf), with a surface area of 15,810 acres at its normal maximum operating level of 900 feet above mean sea level (msl). Oroville Dam is 770 feet high from its base and has a crest length of 6,920 feet. Flows pass out of Lake Oroville in one of four ways: (1) through the underground Hyatt Pumping-Generating Plant, (2) through the main spillway, (3) through the low-level river outlet valve, or (4) over the emergency spillway.

Water is discharged from the Hyatt Pumping-Generating Plant to the lower Feather River through two tunnels within Oroville Dam. The plant has a generating capacity of 16,950 cubic feet per second (cfs) and a potential for pump-back flow capacity of 5,610 cfs (National Marine Fisheries Service 2016), though these "pump back" operations are not currently employed. With the exception of occasional intermittent use for maintenance, operations, testing, and exercising purposes, pump-back operations have not been used since 2004 and are not expected to resume in the near term. Water levels can change rapidly in Lake Oroville, especially during high-water events and at lower lake levels. Water levels at Lake Oroville can change by 1–2 feet on a daily basis. Weekly variations range from 2 to 6 feet and may be as great as 9–11 feet over a period of several weeks (Federal Energy Regulatory Commission 2007).

Lake Oroville is operated for water supply, flood control, power generation, Delta water quality and outflow, fisheries needs, and recreation. In the winter and spring, as much as 750 thousand acre-feet (taf) of storage space is available for flood protection during high-water events. Starting in mid-September, the maximum allowable storage limit decreases incrementally in preparation for a potentially wet season. From October through March, the maximum allowable storage limit varies from about 2.8 maf to 3.2 maf; from April through June, the maximum allowable storage limit increases incrementally as the potential for flooding decreases for the year. This allows the reservoir to capture the higher spring flows for use as water supply later in the year. Winter and spring runoff stored in Lake Oroville is released to the Feather River to meet downstream water demands and instream flow requirements. Since the 2017 spillway emergency, DWR has voluntarily operated to a more conservative flood curve than required by the governing U.S. Army Corps of Engineers (USACE) 1970 Water Control Manual (U.S. Army Corps of Engineers 1970).

Water released from Oroville Dam flows into the Thermalito Diversion Pool, which is impounded by the Thermalito Diversion Dam 4 miles downstream of Oroville Dam. The Thermalito Diversion Dam is a 143-foot-high structure with a crest length of 1,300 feet and a crest elevation of 233 feet above msl. Once reaching the Thermalito Diversion Dam, flows either are diverted into the Thermalito Power Canal or continue downstream into the Low Flow Channel of the Feather River and over the Fish Barrier Dam (described further in Section 2.3.2). Flows continue for 8.4 river miles, eventually joining flows released from the Thermalito Afterbay Outlet.

The Thermalito Power Canal is a 10,000-foot-long channel that conveys up to 16,900 cfs of generating flows to the Thermalito Forebay and can convey up to 9,000 cfs of pump-back flows in the opposite direction to the Thermalito Diversion Pool, though like the Hyatt Pumping-Generating Plant, these pump-back operations are not currently employed. With the exception of occasional intermittent use for maintenance, operations, testing, and exercising purposes, pump-back operations have not been used since 2004 and are not expected to resume in the near term. The Thermalito Forebay regulates flow between the Thermalito Diversion Pool and Thermalito Afterbay via the Thermalito Forebay Dam and Pumping-Generating Plant. Flows from the Thermalito Afterbay are released using the Thermalito Afterbay Outlet gates into the High Flow Channel of the Feather River, which continues to flow until it joins with the Sacramento River near Verona (see Figure 2-2).

The Thermalito Diversion Pool, Thermalito Power Canal, and Thermalito Forebay are all designed to share the same operating water level. The Thermalito Afterbay is operated to meet multiple requirements: regulating inflow from the Thermalito Pumping-Generating Plant, providing water for pump-back operations, releasing water through the Thermalito Afterbay Outlet to the Feather River for instream and downstream demands, and providing for diversions for the Feather River service area’s irrigation demands. Water surface elevations in the Thermalito Afterbay can range from approximately 124 to 136 feet msl throughout the year (Federal Energy Regulatory Commission 2007).

2.3.2 Low Flow Channel of the Feather River

The lower Feather River extends from Thermalito Diversion Dam to its mouth at its confluence with the Sacramento River and is divided into reaches: the Low Flow Channel downstream of the Thermalito Diversion Dam (geographic area 2) and the High Flow Channel downstream of the Thermalito Afterbay Outlet (geographic area 3).

In this Draft SEIR, the Low Flow Channel of the Feather River (geographic area 2) is defined as the reach that extends from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet (see Figure 2-3).[2] As mentioned above, water not diverted to the Thermalito facilities passes through the Thermalito Diversion Dam and Power Plant (or through the gates) and continues down the Low Flow Channel of the Feather River to the Fish Barrier Dam (see Figure 2-3). A pipeline at the Fish Barrier Dam provides water to the Feather River Fish Hatchery. The flow through the Fish Barrier Dam maintains fish habitat in the Low Flow Channel of the Feather River and provides attraction flow for the Feather River Fish Hatchery or helps with outmigration of

2 Some documents refer to the Low Flow Channel as only the reach downstream of the Fish Barrier Dam; however, the short upstream reach between the Thermalito Diversion Dam and the Fish Barrier Dam was included as part of geographic area 2 because flow rates are more similar to those in the channel immediately downstream (differing only by approximately 100 cfs typically passing through the Feather River Fish Hatchery facilities) than to the flow rates in the Thermalito Diversion Pool immediately upstream.

salmonids. The approximately 8-mile reach downstream of the Fish Barrier Dam contains spawning habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead (National Marine Fisheries Service 2016). See Section 3.5, "Biological Resources–Aquatic," for additional information regarding aquatic resources in the study area).

The Low Flow Channel has established flow and water temperature requirements regulated by: the 1983 *Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife* between DWR and the California Department of Fish and Wildlife (1983 DWR/CDFW Agreement) (California Department of Water Resources and California Department of Fish and Game 1983); the current Federal Energy Regulatory Commission (FERC) license for operation of Lake Oroville's hydropower facilities; the 2004 National Marine Fisheries Service Biological Opinion (2004 NMFS BiOp) associated with the FERC license (National Marine Fisheries Service 2004); and the 2016 NMFS BiOp (National Marine Fisheries Service 2016) associated with the anticipated FERC re-licensing for Oroville operations.

The minimum instream flow requirement in the Low Flow Channel is 600 cfs, as specified by the 1983 DWR/CDFW Agreement and the 2004 NMFS BiOp. DWR is currently waiting for an expected 50-year license from FERC for Oroville operations; when this occurs, the 2016 NMFS BiOp will take effect, which specifies a minimum flow of between 700 cfs and 800 cfs, depending on the time of year, to accommodate spawning. At this time, FERC has not issued the new license. Note that the ramping rates, defined as the rates at which flows are increased or decreased in a river, specified in the 2016 NMFS BiOp *are* currently being followed (see Table 2-3).

Flows in the Low Flow Channel tend to be higher during the summer months to comply with water temperature requirements (to combat warming river conditions) mandated by CDFW and NMFS. For compliance purposes, the flow in the Low Flow Channel equals the sum of the flow through the Fish Barrier Dam and the flow through the Feather River Fish Hatchery. Refer to Section 3.4, "Hydrology and Water Quality," Section 3.4.3, "Regulatory Setting," for a more detailed description of the regulatory environment of the Low Flow Channel.

2.3.3 High Flow Channel of the Feather River

The High Flow Channel extends from the Thermalito Afterbay Outlet to the Feather River's confluence with the Sacramento River near Verona (see Figure 2-4). This area (geographic area 3) includes the Lower Sutter Bypass parallel to the Feather River, from the Fremont Weir to approximately three miles north of the confluence with the Feather River. It is necessary to include this area because the Sutter Bypass absorbs flows from the Feather River when it is running higher than the Sutter Bypass, and the Lower Sutter Bypass is subject to inundation from backwater effects from the confluence of the Feather and Sacramento rivers (i.e., the volume of flows approaching the Sacramento River near Verona exceeds the capacity of the river at this location).

This reach is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley. Honcut Creek, the Yuba River, and the Bear River join the Feather River along this reach. In addition to these tributaries, flood flows are influenced by connection with the Sutter Bypass, which can bring Sacramento River flows through Butte Slough.

Like the Low Flow Channel, the High Flow Channel has established flow and water temperature requirements regulated by the 1983 DWR/CDFW Agreement, the current and anticipated FERC licenses, and the associated 2004 and 2016 NMFS BiOps; however, the 2016 NMFS BiOp sets instream flow requirements for the High Flow Channel consistent with the current flow requirements. The minimum instream flows in the High Flow Channel, supplemented by releases from the Thermalito Afterbay Outlet, range from 1,000 cfs to 1,700 cfs and are based on annual runoff. These minimum flows may be diminished under some circumstances due to low storage conditions at Lake Oroville, however, in no case shall the minimum flows be reduced by more than 25 percent (i.e., flows must not fall below 25 percent of 1,000 cfs, or 750 cfs). Ramping rates have been established to prevent rapid reductions in water levels that would have the potential to strand juvenile salmonids and other aquatic organisms (California Department of Water Resources and California Department of Fish and Game 1983; National Marine Fisheries Service 2014). Refer to Section 3.4, "Hydrology and Water Quality," Section 3.4.3, "Regulatory Setting," for a more detailed description of the regulatory environment of the High Flow Channel.

2.3.4 Sacramento River from the Confluence with Feather River to the Delta

The Sacramento River from the confluence with the Feather River to the I Street Bridge at the north end of the Delta defines another geographic area (geographic area 4; see Figure 2-2). Flows from the Sacramento River and the Feather River combine near Verona. The Sacramento River then flows 79 miles to the Delta, passing the city of Sacramento and the community of Freeport. The American River joins the Sacramento River in the city of Sacramento. The Yolo Bypass parallels the Sacramento River to the west. Georgiana Slough branches off from the mainstem of the Sacramento River, routing a portion of the Sacramento River into the central Delta. Flows in the Sacramento River generally peak in March and gradually decline through October before ramping back up again, and remain lower in the summer and fall months because of high demands and minimal precipitation.

When flood flows in the Sacramento River system are highest (greater than 55,000 cfs of combined flow), a portion of the flow diverts into the Yolo Bypass at the Fremont Weir, about 2 miles upstream of Verona. Overflow can also occur at the Sacramento Weir, about 3 miles upstream of the American River confluence near downtown Sacramento. At the downstream end of the Yolo Bypass, flows in the bypass reenter the Sacramento River near Rio Vista.

2.3.5 Sacramento–San Joaquin Delta

The Delta defines another geographic area (geographic area 5; see Figure 2-2). The Delta is a complex of channels and islands near the confluence of the Sacramento and San Joaquin rivers. Inflow to the Delta is primarily from the Sacramento River system, the San Joaquin River, and the eastside tributaries (the Mokelumne, Calaveras, and Cosumnes rivers), which flow directly into the Delta. About 77 percent of the water enters the Delta from the Sacramento River system, about 15 percent from the San Joaquin River system, and about 8 percent from the eastside tributaries (California Department of Water Resources 2019).

The SWP and the Central Valley Project (CVP) use the Delta to convey water to State and federal export facilities in the South Delta. Water in the South Delta flows toward the CVP's C.W. "Bill" Jones Pumping Plant (Jones Pumping Plant) and Clifton Court Forebay, which regulates stage going into the SWP's Banks Pumping Plant. Water flow paths in the Delta are influenced by inflows from the Sacramento River and the San Joaquin River and by ocean tides propagating inland. Flow paths are also affected by operation of the federal Delta Cross Channel gates, which divert flows from the Sacramento River to the lower Mokelumne River and through the central and South Delta to channels near the South Delta export facilities. The Delta Cross Channel gates are opened for both recreational and operational purposes. This reduces salinity in the Delta channels during the summer months with the transport of the comparatively low-salinity Sacramento River water to the central Delta. Operation of the South Delta export facilities can also influence the direction of flow in the interior of the Delta, from a westward direction to a southerly flow path. Flows in Delta channels also change direction as a result of continuous tidal exchange, ebbing, and flooding, with the two tides per day (California Department of Water Resources 2019).

When this water reaches the Delta, SWP water is either (1) pumped into the North Bay Aqueduct; (2) diverted for the use of Delta agricultural, municipal, and industrial users; (3) protected for the beneficial use of fish and wildlife in the Delta; or (4) diverted into the California Aqueduct via Clifton Court Forebay and the Banks Pumping Plant.

2.3.6 Banks Pumping Plant and California Aqueduct

The Banks Pumping Plant and the California Aqueduct to the locations of the WSIP Groundwater Projects define another geographic area (geographic area 6; see Figure 2-2). This portion of the study area consists of engineered facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures). The Clifton Court Forebay and Banks Pumping Plant are approximately 8 miles northwest of Tracy at the upstream end of the California Aqueduct. The shallow reservoir of Clifton Court Forebay buffers Banks Pumping Plant from the tides experienced in the Delta. The pumping plant consists of 11 pumps, with a total rated capacity of 10,300 cfs, that lift water 244 feet from Clifton Court Forebay to the California Aqueduct.

Diversion rates to Clifton Court Forebay are typically restricted to a 6,680-cfs, three-day-average inflow and a 6,993-cfs, one-day-average inflow. However, during the winter and spring, diversions can be increased by one-third of the San Joaquin River flows at Vernalis when flows are above 1,000 cfs. The SWP is also permitted to pump an additional 500 cfs between July 1 and September 30 to offset water costs associated with fisheries actions, effectively making the summer diversion limit an average of 7,180 cfs (California Department of Water Resources 2019).

Once water has been lifted from Banks Pumping Plant, the California Aqueduct and canals that lead from it convey the water to SWP service areas in the San Francisco Bay Area, the San Joaquin Valley, the central California coast, and Southern California. SWP operations are discussed further in Section 2.5.1.

2.3.7 San Luis Reservoir

San Luis Reservoir defines another geographic area (geographic area 7; see Figure 2-2). San Luis Reservoir is a joint-use facility (DWR/U.S. Bureau of Reclamation [Reclamation]) located adjacent to the California Aqueduct south of the Banks and Jones pumping plants. Situated at the base of the foothills on the western side of the San Joaquin Valley, this 2 maf off-stream reservoir provides storage for excess winter and spring flows diverted from the Delta. An “off-stream reservoir” is one that is not located on a streambed; water is supplied to such a reservoir by a pipeline, aqueduct, or other water source via pumping.

San Luis Reservoir regulates the SWP/CVP system, receiving any water pumped from the Banks and Jones pumping plants that exceeds SWP/CVP contractor direct deliveries. That water is released back to the California Aqueduct and the Delta Mendota Canal when pumping at the Banks and Jones pumping plants is insufficient to meet allocated water supply, such as in the summer when water use peaks. San Luis Reservoir usually reaches its low point in late August or early September. Once demands decline in September or early October, any extra water is pumped into San Luis Reservoir, optimally allowing the reservoir to fill before April of the following year. In drier years, San Luis Reservoir may not refill completely by spring.

2.4 Pulse Flow Releases

As described in Chapter 1, “Introduction,” the three WSIP Groundwater Projects involve the development of groundwater storage to improve local water supply in their immediate vicinities in the San Joaquin Valley and Southern California. The California Water Commission (CWC) provided planning funding to the WSIP Groundwater Projects and will consider awarding construction funding through WSIP on the basis that the projects create an ecosystem benefit. An ecosystem benefit would be accomplished through the WSIP Operational Exchange Process that facilitates the release of pulse flows from Lake Oroville into the Low Flow Channel of the Feather River, thus improving habitat and migratory capacity for listed and non-listed native fish species (described in more detail in Section 2.5, “WSIP Operational Exchange Process”). The pulse flows would eventually flow into the High Flow Channel of the Feather River, the Sacramento River, the Delta, and eventually San Francisco Bay. The CWC requires that the WSIP Groundwater Projects enter in Contracts for Administration of Public Benefits (CAPBs) with CDFW for the ecological public benefits from the pulse flows; as part of the CAPBs, the WSIP Groundwater Projects will be required to monitor and document public benefits provided and report to CDFW. CDFW will review monitoring of the pulse flows to ensure performance aligns with public benefit requirements of the WSIP (see Section 1.1.2, “Water Storage Investment Program”) and the objectives of the Pulse Flows Component related to improvement of habitat, spawning, and migration conditions for target native fish species (see Section 2.2, “Objectives of the Pulse Flows Component”).

The following sections describe the range of potential pulse flow releases that may be requested by CDFW and explain the decision-making criteria and constraints related to DWR’s approval of a pulse flow release.

2.4.1 Description of Potential Pulse Flow Releases

The three WSIP Groundwater Projects have identified a maximum volume of water to collectively contribute to a pulse flow in any one-year period of up to approximately 100,000 acre-feet (af). **Table 2-1** summarizes the maximum one-year volume of pulse flow water that would be made available by the three WSIP Groundwater Projects and the frequency of pulses. The frequency of pulses has been approximated because the temporal pattern over which pulses would be released is unknown at this time; the frequency and magnitude of pulse flow releases could vary substantially depending on the volume of water made available by the WSIP Groundwater Projects, the frequency with which the WSIP Groundwater Projects are able to dedicate an amount of water appropriate for a pulse flow, and on CDFW's request and DWR's approval of the pulse flow release.

TABLE 2-1
APPROXIMATE VOLUME AND FREQUENCY OF PULSE FLOW RELEASES FOR WSIP GROUNDWATER PROJECTS

WSIP Groundwater Project	Maximum Volume (af)[a]	Frequency of Pulses over a 25-Year Period (years)[b]	Frequency of Pulses over a 50-Year Period (years)
Kern Fan	18,000	3.5	7
Chino Basin[c]	50,000	7.5	–
Willow Springs	29,000	7.5	15

NOTE: af = acre-feet; Kern Fan = Kern Fan Groundwater Storage Project; Willow Springs = Willow Springs Water Bank Project; WSIP = Water Storage Investment Program.

a Values for Kern Fan and Chino Basin were derived from the applications for California Water Commission Proposition 1 funding, and values for Willow Springs were derived from a GEI technical memorandum to DWR (April 6, 2022).
b The frequencies of pulse flows were normalized to a 25-year period. As a conservative assumption, it is assumed that the California Department of Fish and Wildlife will request a pulse flow of the maximum volume (100,000 acre-feet).
c Chino Basin only occurs over a 25-year period.

Table 2-2 summarizes the potential magnitude and timing (based on water year) of pulse flow releases from Lake Oroville into the Low Flow Channel of the Feather River.

TABLE 2-2
POTENTIAL PULSE FLOW RELEASES FROM LAKE OROVILLE TO THE LOW FLOW CHANNEL

Month	Potential Range of Base Flow Release to Feather River Low Flow Channel		Potential Pulse Flow Volume[c]		Potential Maximum Flow Magnitude (Base Flow plus Pulse Flow Release)	Potential Water Year Types[d]
	Low[a] (cfs)	High (cfs)[b]	Low (af)	High (af)	cfs	
March	600	3,000	5,000	100,000	10,000	C, D, BN, AN
April	600	3,000	5,000	100,000	10,000	C, D, BN, AN
May	600	3,000	5,000	100,000	10,000	C, D, BN, AN
June	600	3,000	5,000	100,000	10,000	C, D, BN, AN

NOTES: af = acre-feet; cfs = cubic feet per second

a Historically, flows as low as 550 cfs are on record. However, the current minimum instream flow requirement for the Low Flow Channel is 600 cfs.
b Based on historical base flow ranges, the typical base flow in the Low Flow Channel does not exceed 3,000 cfs.
c Water Storage Investment Program flows are in no way related to requests made under Section 5 of the 1983 CDFW Agreement.
d Water Year Types: C = Critically Dry, D = Dry, BN = Below Normal, AN = Above Normal.

SOURCE: California Department of Fish and Wildlife 2022.

In a given year, CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects, if available, and may request a maximum flow rate of up to 10,000 cfs. The requested flow rate would be derived by considering the base flow of the Low Flow Channel, which can be as low as 600 cfs, as specified by the 1983 DWR/CDFW Agreement and the 2004 NMFS BiOp, plus additional water for the pulse flow, so the combined resultant flow does not exceed 10,000 cfs in the Low Flow Channel. Refer to Section 3.4, "Hydrology and Water Quality," Section 3.4.3, "Regulatory Setting," for a more detailed description of the regulatory environment of the study area. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document (see Section 3.2.1, "Conservative Pulse Flow Release Scenario") to occur about once in three years but is likely to occur less frequently (see Table 2-1). Pulse flows of up to 100,000 af would be released from Lake Oroville with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to **Table 2-3**.

TABLE 2-3
LAKE OROVILLE LOW FLOW CHANNEL RAMP-DOWN RATES

Low Flow Channel of the Feather River Releases (cfs)[a]	Rate of Decrease (cfs)
3,500 to 5,000	1,000 per 24 hours
2,500 to 3,500	500 per 24 hours
<2,500	300 per 24 hours

NOTE: cfs = cubic feet per second.

a. Note that ramp-down rate of decrease requirements are not currently specified above 5,000 cfs in the Low Flow Channel.

SOURCE: National Marine Fisheries Service 2016.

Figure 2-5 illustrates a plausible scenario for pulse flow releases that reach 100,000 af several times over a 50-year time period, assuming that all three WSIP Groundwater Projects are implemented. In this scenario, peaks are lower after the first 25 years, when Chino Basin would stop participating. As illustrated, the pulse flows occur every three to four years.

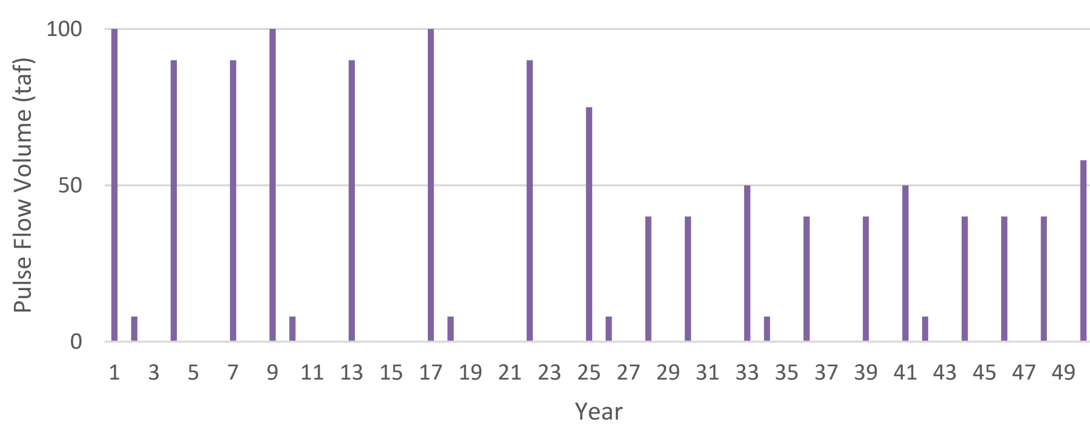


Figure 2-5
Example Pulse Flow Release Scenario

The pulse flow releases would augment flows in the lower Feather River, in the Sacramento River, and through the Delta in drier years when there are typically lower flows (e.g., dry or below-normal water year types). For this analysis, depending on the availability of water in the WSIP Exchange Storage Account, CDFW could request a pulse flow any time in the spring months (March, April, May, and/or June) of critically dry, dry, below-normal, or above-normal water year types[3]; however, DWR would not likely accommodate pulse flows in critically dry water year types such as 2021 and 2022, given limitations in the SWP's overall water supply. In critically dry years, because DWR moves very little water from Lake Oroville through Banks Pumping Plant, there is little to no capacity to recover Lake Oroville storage via a reduction in summer releases. During these years, storage in Lake Oroville is low, with exports at minimum levels that cannot be further reduced. Note that the determination of water year type is not made until the end of the water year; it is therefore possible that a pulse flow could be approved based on a projection of a certain water year type that varies from the ultimate determination.

After a pulse flow release, "recovery" of Lake Oroville storage would occur during the summer (July through September) Lake Oroville Recovery Period (Recovery Period). By the end of the Recovery Period, Lake Oroville storage is anticipated to reach a level equivalent to that which would have occurred without the pulse flow. The mechanism by which Lake Oroville storage would be recovered involves the WSIP Operational Exchange Process, detailed further in Section 2.5.2. Flow rates out of Lake Oroville during the Recovery Period would continue to meet minimum operational and regulatory flow and temperature requirements in both the Low Flow Channel (currently 600 cfs, see Section 2.3.2) and the High Flow Channel (1,000 cfs, see Section 2.3.3). Therefore, flows during the Recovery Period would remain within the typical range of existing operational variability experienced in the system.

2.4.2 Decision-Making Criteria and Constraints

DWR is developing an agreement with CDFW that will specify the decision-making criteria for DWR to consider a request for a pulse flow from CDFW (the "DWR/CDFW Agreement"). The timing, volume, peak flows, and duration requested are expected to vary, as CDFW will consider the amount of water available in the WSIP Exchange Storage Accounts, as well as biological and hydrologic conditions in the Feather River. DWR could deny or approve some or all requested pulse flows based on an informed analysis to ensure that implementation of a pulse flow would not negatively affect planned operations (including a key parameter: that Lake Oroville storage is 90 percent likely to be fully recovered in the same calendar year as the pulse flow release).

In summary, the decision to implement a pulse flow would be constrained by the following factors:

(1) The maximum amount of water in any given year available in the WSIP Exchange Storage Accounts for a pulse flow, as specified by the WSIP Groundwater Projects: Kern Fan, 18 taf; Chino Basin Program, 50 taf; Willow Springs, 29 taf. Note that the Chino Basin Program

[3] The five Sacramento Valley Index water year type classifications are Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critically Dry (C). The water year type is calculated based on measured and forecasted runoff from the Sacramento, Feather, Yuba, and American rivers. Prior water year calculations from 1901 to present are provided at: https://cdec.water.ca.gov/reportapp/javareports?name=wsihist.

estimates that it would provide pulse flows for 25 years and Kern Fan and Willow Springs estimate that they would provide pulse flows for 50 years (see Table 2-1).

(2) The rate of accumulation of water in the WSIP Exchange Storage Accounts. These have been modeled by the Project Proponents and are reflected in the maximum annual amounts specified above (see Table 2-1).

(3) A not-to-exceed flow rate of 10,000 cfs (pulse flow plus base flow) in the Low Flow Channel of the Feather River (see Table 2-2).

(4) A maximum annual pulse flow of 100,000 af (analyzed in this Draft SEIR) (see Table 2-2).

(5) Water year types defined as critically dry, dry, below normal, and above normal (see Table 2-2).

(6) Timing of a pulse flow release during the spring months of March, April, May, and/or June (see Table 2-2).

(7) The ability for Lake Oroville storage to recover the volume of the pulse flow release during the Recovery Period.

(8) The ability to meet instream flow and temperature requirements in the Feather River.

(9) Avoidance of inundation of Prime Farmland, Unique Farmland and Farmland of Statewide Importance (Important Farmland) such that it may be converted to non-agricultural use.

The DWR/CDFW Agreement will describe the decision-making criteria associated with the constraints outlined above used to reduce the risk of pulse flow releases. For example, the DWR/CDFW agreement would require that a CDFW-requested pulse flow would only be released if sufficient water supplies are made available for exchange with DWR by the WSIP Groundwater Projects, allowing DWR to determine (based on the water year type and other factors influencing SWP operations on a seasonal basis) whether a pulse flow can occur. Therefore, it is not reasonably foreseeable that the Pulse Flows Component would affect or impede water supply available to SWP contractors, water right holders, or other water suppliers in such a way that it would necessitate a change in water use or water management.

In addition, under certain conditions the pulse flow releases could cause inundation of certain areas of Important Farmland located within or adjacent to the study area, particularly in the Lower Sutter Bypass near its junction with the Sacramento River. As described in Section 3.2.2, "Modeling Approach," modeling has been done to predict if and when inundation is most likely to occur (see Appendix B). CDFW and DWR will jointly confer with landowners as needed in the Lower Sutter Bypass that may be impacted by or benefit from pulse flow releases, based on modeling conducted by DWR, prior to a pulse flow being released. This process would thereby avoid the risk that the Pulse Flows Component would convert such lands to non-agricultural use (see Section 3.12, "Agriculture and Forestry Resources," for further discussion of agricultural resources within the study area).

The pulse flows associated with the WSIP Groundwater Projects are separate from requirements associated with those provided in the California Endangered Species Act incidental take permit (No. 20812019-06600), which provides incidental take coverage to DWR for long-term operation of the SWP in the Delta (the "Long-Term Operations incidental take permit") or those required by the FERC license for Lake Oroville. Instead, these pulse flows would be in addition to flows required by State and federal regulatory permits. The pulse flow releases would be coordinated with DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations, to ensure that flow releases are within required downstream parameters. Pulse flows shall not conflict with normal Oroville and Delta operations, including instream requirements, Delta outflow requirements, or water quality or blocks of water identified within the Long-Term Operations incidental take permit.

When scheduled releases change, even by the relatively low magnitude of the Pulse Flows Component, DWR's Water Operations Branch reports them on the California Data Exchange web page at https://cdec.water.ca.gov/reservoir.html. DWR provides release notification when Feather River flows increase or decrease in both high-water and non-high-water events. DWR sends notifications within DWR, and to USACE, CDFW, Reclamation, and Yuba City representatives. When DWR transitions to flood operations, it is considered a high-water event (i.e., releases are greater than 10,000 cfs and/or there is encroachment into the flood space).

2.5 WSIP Operational Exchange Process

Implementation of the Pulse Flows Component involves the following exchange of water: (1) the release of SWP water from Lake Oroville by DWR (i.e., the pulse flow release described in Section 2.4); and (2) the provision of In-Lieu Table A Water by the WSIP Groundwater Projects to their Partner Contractors that helps replenish SWP water used for a pulse flow release (i.e., one component of the WSIP Operational Exchange Process described in this section). The transaction of In-Lieu Table A Water between each of the three WSIP Groundwater Projects storing water in their groundwater banks and their Partner Contractors (number (2) listed above) is a non-DWR action outside the scope of this SEIR.

The following sections describe current SWP operations, the WSIP Operational Exchange Process, the efficiency credit and its applicability to the WSIP Groundwater Projects, and the forthcoming agreements and contracts between DWR and the WSIP Groundwater Projects that will allow for implementation of the WSIP Operational Exchange Process.

2.5.1 Description of Current State Water Project Operations

The SWP provides a water supply for downstream urban, industrial, and agricultural uses if this water is available for export. The SWP's primary facilities associated with the Pulse Flows Component are the Oroville Complex, including Lake Oroville; Clifton Court Forebay and Banks Pumping Plant; San Luis Reservoir; and the California Aqueduct (see Figure 2-1). Water supplies captured and stored in Lake Oroville are released to meet the SWP's contractual obligations and regulatory requirements for downstream water use. When the water reaches the Delta, the water is either pumped into the North Bay Aqueduct, used for salinity control, used for fish and wildlife protection in the Delta, or diverted into the California Aqueduct to be delivered to the South Bay area, the San Joaquin Valley, the central California coast, and Southern California. The SWP also has water rights to unregulated flows in the Central Valley watershed. These flows and Lake Oroville releases provide the majority of the SWP's water supply.

DWR holds contracts with 29 public agencies for water supplies from the SWP. Under the Water Supply Contracts, DWR allocates Table A water on an annual basis that is made available for scheduled delivery throughout the year. The amount of Table A water listed in Water Supply Contracts compared to the water available for delivery varies from year to year depending on hydrologic conditions, current reservoir storage, and regulatory requirements. Total SWP Table A water is 4.173 maf, with more than 3 maf supplied to water users in the San Joaquin Valley and Southern California (California Department of Water Resources 2019).

To enable efficient deliveries, DWR and Reclamation coordinate on their operations daily. Some factors that DWR and Reclamation consider when coordinating their joint operations include required in-Delta flows, Delta outflow, water quality, fish species protections, schedules for the joint-use facilities (e.g., San Luis Reservoir), pumping/wheeling arrangements, and any facility capacity limitations. In addition, both the SWP and the CVP must meet the flood protection storage reservations of individual reservoirs. The Coordinated Operations Agreement governs DWR and Reclamation's contribution to meet the in-basin requirements. This has an effect on reservoir releases and diversions at the Delta export facilities.

"Balanced water conditions" are defined as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. During balanced water conditions, DWR and Reclamation share a responsibility to meet in-basin uses and maintain a daily water accounting of SWP and CVP obligations in conformance with the Coordinated Operations Agreement between the two projects. The duration of balanced water conditions varies from year to year.

"Excess water conditions" are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows exceed Sacramento Valley in-basin uses plus exports. During excess water conditions, sufficient water is available to meet all beneficial uses, and the SWP and CVP are not required to supplement the supply with water from reservoir storage. The SWP and CVP export water in excess conditions to fill their storage facilities and to make direct deliveries to their contractors. If additional water is available that the SWP and CVP cannot use, the "excess water" can be made available to individual SWP and CVP contractors. For the SWP, this water is called "Article 21 water." For the CVP, this water is "Section 215 water." As specified in the Coordinated Operations Agreement, DWR and Reclamation have the ability during excess water conditions to store and export as much water as possible within physical, legal, and contractual limits.

As defined in Section 1.1.1, "Key Terms," Article 21 water is a type of water available to SWP contractors on a short-term basis, as determined by DWR, when water is available after operational requirements for SWP water deliveries, water quality, and regulatory requirements are met. The availability of Article 21 water allows the SWP contractor to take delivery of water beyond the approved and scheduled Table A amounts for the year. Unlike Table A water, which is the maximum allocated annual supply made available for scheduled delivery throughout the year, Article 21 water is made available only under certain hydrologic conditions. As with all SWP water, Article 21 water is supplied under existing SWP water rights permits and is pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

Article 21 water is typically offered to SWP Contractors on a short-term (daily or weekly) basis when all of the following conditions exist:

(1) The SWP share of San Luis Reservoir is physically full or is projected to be physically full within approximately one week at permitted pumping rates or the conveyance capacity to fill the reservoir is maximized.

(2) Other SWP reservoirs south of the Delta are at their storage targets, or the conveyance capacity to fill these reservoirs is maximized.

(3) The Delta is in excess condition.

(4) Current Table A demand is being fully met.

(5) Banks Pumping Plant has export capacity beyond that which is needed to meet current Table A and other SWP operational demands.

2.5.2 Description of the WSIP Operational Exchange Process

The following steps describe the WSIP Operational Exchange Process to facilitate the pulse flow releases. Refer to Section 1.1.1 for a definition of key terms.

- **Step 1:** Article 21 water, advanced wastewater treatment water, or Pre-Positioning Yield water would be provided to, or developed by, the three WSIP Groundwater Projects. A portion of this water would be earmarked for ecosystem benefit and would be made available in each project's WSIP Exchange Storage Account.
- **Step 2:** If water in the WSIP Exchange Storage Account is determined to be available by the WSIP Groundwater Projects, pulse flows would be released from Lake Oroville into the Feather River during spring months (March through June) when requested by CDFW and approved by DWR, which would temporarily reduce the SWP supply in Lake Oroville. Flows would be dedicated to ecosystem benefits and protected from diversion by Water Code Section 1707.
- **Step 3:** Following a pulse flow release, Partner Contractors would receive WSIP In-Lieu Table A Water from the WSIP Exchange Storage Account in place of a portion of their Table A allocation. Note that the allocation of Table A water in the year of a pulse flow would need to be equivalent to or greater than the pulse flow volume. Water directly pumped at Banks Pumping Plant or stored in San Luis Reservoir that would have been delivered to Partner Contractors as part of a Table A allocation would remain in storage instead. San Luis Reservoir storage would increase as a result of reduced SWP deliveries to the Partner Contractors. From a water operations accounting perspective, this action would functionally (though not physically) move water stored in the WSIP Exchange Storage Account to San Luis Reservoir. The operations of Willow Springs could delay conditions when Article 21 water would be available to other SWP contractors. DWR would mitigate this impact by allowing SWP contractors to take Article 21 water before San Luis Reservoir spills to mimic conditions without Willow Springs.
- **Step 4:** In the summer months (July through September) after a pulse flow release, Lake Oroville Table A deliveries would be reduced equivalent to the amount of water released for the pulse flow, replenishing Lake Oroville storage. This period is referred to as the Recovery Period. Flow rates out of Lake Oroville during the Recovery Period would continue to meet minimum operational and regulatory flow and temperature requirements in the Low Flow and

High Flow Channels. DWR would forecast the magnitude and duration of the reduced outflow related to the Recovery Period when considering approval of a request from CDFW for a pulse flow.

- **Step 5:** During the Recovery Period, pumping from Banks Pumping Plant would be reduced commensurate with the reduction in outflow from Lake Oroville, sending less water to San Luis Reservoir or for direct deliveries through the California Aqueduct. The WSIP Groundwater Projects would continue to deliver WSIP In-Lieu Table A Water to Partner Contractors. Due to reduced pumping from Banks Pumping Plant, supplemental releases from San Luis Reservoir may be needed to meet SWP water demands. Water operationally exchanged (see Step 3) that is stored in San Luis Reservoir storage would be used for the supplemental releases. San Luis Reservoir storage would continue to be replenished during the Recovery Period and through the fall months (October through December) as a result of reduced deliveries to Partner Contractors, as the WSIP Groundwater Projects continue to deliver WSIP In-Lieu Table A Water. The Recovery Period would be extended into a second year if necessary to allow minimum existing flow requirements and other requirements to be met.

With implementation of the WSIP Operational Exchange Process, Partner Contractors who voluntarily agree to contribute part of their Table A allocations for pulse flow releases would be made whole, over time, with WSIP In-Lieu Table A Water. San Luis Reservoir would be made whole from reduced Table A deliveries to the Partner Contractors. Lake Oroville would be made whole by reduced summer releases into the Feather River. Unforeseen circumstances could result in Lake Oroville not fully recovering storage at the end of the Recovery Period and San Luis Reservoir may not fully recover storage by the end of the calendar year. If this occurs, storage recovery would continue into the next year.

Figure 2-6 shows how current operations would be modified to implement the timing of a pulse flow release and subsequent WSIP Operational Exchange Process necessary to facilitate a pulse flow release. As discussed in Section 2.4.1, there could be substantial variation in the number of pulse flows requested, the volume of water dedicated to each pulse flow, and/or the rate of each pulse flow release. Therefore, this is an approximation.

Figure 2-7 depicts the timing of a pulse flow release and the WSIP Operational Exchange Process, as shown in Figure 2-6; however, Figure 2-7 also conceptually presents how flow volume and storage would change at various points in the process. For a hypothetical pulse flow equal to 100 taf (i.e., 100 units of water), the change in water volume flowing through the system is depicted at various locations/facilities across spring, summer, and fall. The figure shows both changes in flow between features and changes in storage at Lake Oroville and at San Luis Reservoir. Lake Oroville is made whole by the end of the summer months, and San Luis Reservoir is made whole by the end of the calendar year. This example, for simplicity, does not include an Efficiency Credit (see Section 2.5.3) that would reduce the amount of WSIP In-Lieu Table A Water delivered to Partner Contractors.

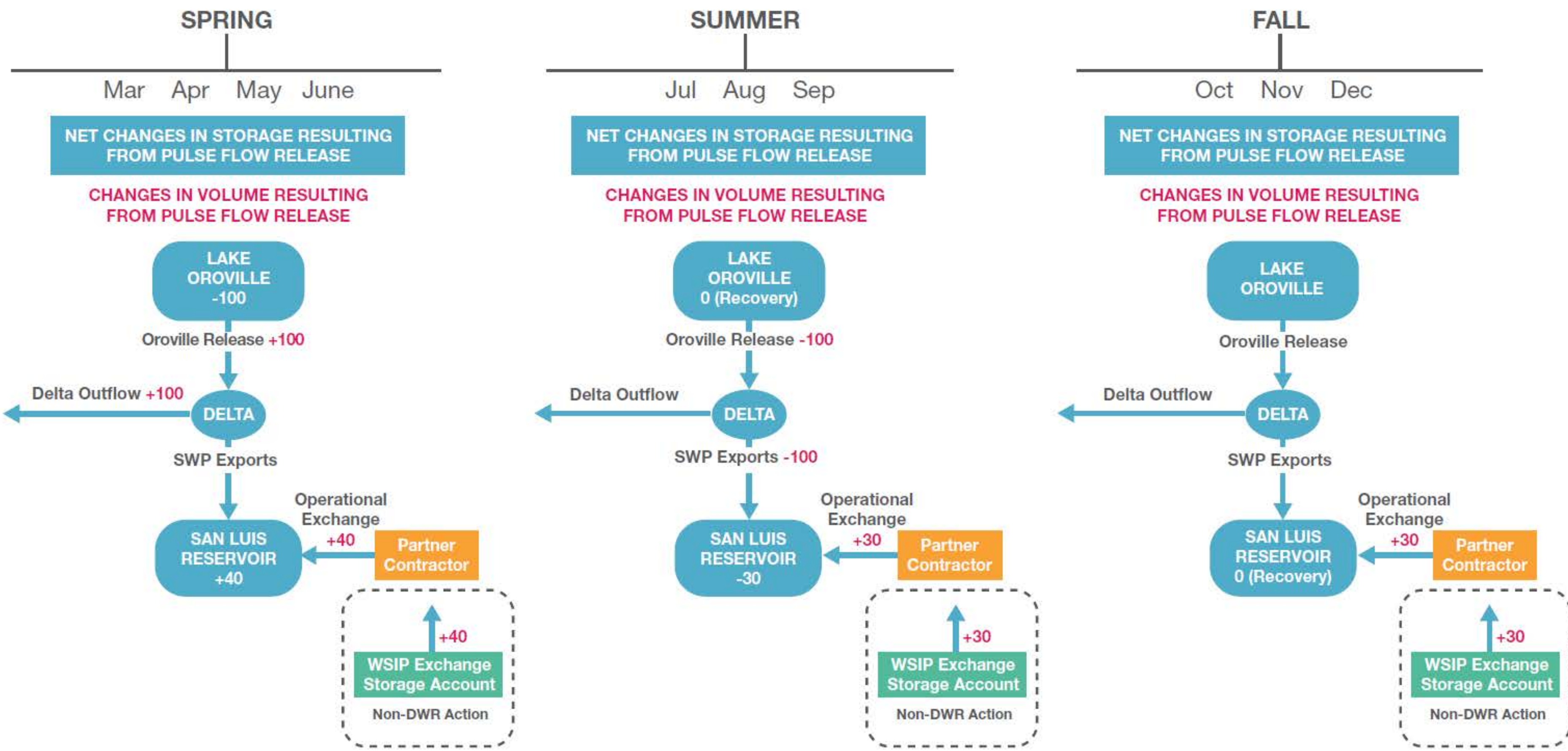
As shown in the first panel, during spring (March through June), a pulse flow release from Lake Oroville (+100 taf) flows downstream through the Delta (+100 taf). The pulse flow release initiates the provision of WSIP In-Lieu Table A Water to a Partner Contractor from the WSIP Exchange Storage Account (+40 taf), reducing the drawdown on San Luis Reservoir and, thereby

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lake Oroville			Pulse Flow Release - Releases Increased				Recovery Period - Releases Reduced					
			Storage Reduction				Storage Recovery					
Delta Outflow			Flow Increase				Flow Decrease					
Banks Pumping Plant							Pumping Reduction					
WSIP Groundwater Project			Banked Groundwater Provided to Partner Contractor In-Lieu of SWP Water									
Partner Contractor			Portion of Deliveries met by Banked Groundwater In-Lieu of SWP Water									
San Luis Reservoir			Storage Increase				Storage Reduction			Storage Recovery		

SOURCE: ESA, 2023

ESA

Figure 2-6
Example Pulse Flows Component Conceptual Schedule



Note: This example is simplified to illustrate the concept behind the WSIP Operational Exchange Process necessary to facilitate a pulse flow release from Lake Oroville, while minimizing impacts on State Water Project (SWP) operations, other SWP contractors, and water supplies. The numbers used are conceptual in nature and do not reflect actual SWP releases, outflow, exports, pulse flows, etc., nor do they depict the efficiency credit discussed in Section 2.5.3.

2019/D201901453.08 - PULSE-02/05 Graphics-GIS-Modeling/Illustrator

SOURCE: ESA, 2022

ESA

Figure 2-7
WSIP Groundwater Projects Operational Exchange Process:
Simplified Example Pulse Flow = 100 TAF
Efficiency Credit/Carriage Water Not Shown

increasing storage in San Luis Reservoir (+40 taf). A simplifying assumption in this illustration is that provision of WSIP In-Lieu Table A Water would be distributed equally (10 taf/month) from March through December.

As shown in the second panel, during summer (July through September), the amount of water released from Lake Oroville (for SWP exports) would be reduced (-100 taf) to recover storage in Lake Oroville. Pumping at Banks Pumping Plant would be commensurately reduced (-100 taf). This reduction in pumping would be reflected in a reduction in storage at San Luis Reservoir, where water operationally exchanged and stored in the summer months would be used to supplement diversions at Clifton Court and Banks Pumping Plant to meet SWP water demands. Concurrently during summer, the provision of WSIP In-Lieu Table A Water to a Partner Contractor from the WSIP Exchange Storage Account (+30 taf) would continue to occur, continuing the operational exchange of water and offsetting some of the reduction in storage at San Luis Reservoir.

As shown in the third panel, during the fall (October through December), the provision of WSIP In-Lieu Table A Water to a Partner Contractor from the WSIP Exchange Storage Account would continue to occur (+30 taf). This would enable San Luis Reservoir to fully recover by the end of the season.

2.5.3 Efficiency Credit

Under existing conditions, Partner Contractors receive their annual Table A amount from Delta exports (i.e. water supply pumped directly from the Delta or pumped and temporarily stored). With the Pulse Flows Component, Partner Contractors would receive a portion of their annual Table A amount from a Project Proponent instead. To meet Delta water quality standards, Delta exports typically require an additional volume of outflow from the SWP and the CVP. When changes in operations are made for a non-SWP party, such as for a water transfer, this additional volume is called “carriage water.” Carriage water represents the additional flow necessary to maintain water quality conditions in the Delta per increment of additional exported water. Carriage water requirements are commonly expressed as a percentage of additional inflows to the Delta. Under the Pulse Flows Component, an efficiency credit would be made available to a Project Proponent for providing WSIP In-Lieu Table A Water to a Partner Contractor, because no carriage water is required for the delivery.

The efficiency credit may be up to 35 percent of the total volume of water provided. For example, if a volume of 100 taf is released for a pulse flow, that would equate to a flow reduction of 548 cfs from Lake Oroville during the Recovery Period, assuming the pumping reduction is distributed evenly across July through September. Assuming a 35 percent carriage water assessment, this would result in 356 cfs of reduced Delta exports (i.e., 548 cfs * 65 percent = 356 cfs that would have otherwise been exported) and 192 cfs of reduced Delta outflows (i.e., 548 cfs * 35 percent = 192 cfs of carriage water that would have otherwise flowed through the Delta) as compared to a year where no pulse flow occurs. To place these numbers in terms of volume, a 356 cfs reduction in Delta exports equates to 65 taf and a 192 cfs reduction in Delta outflows equates to 35 taf. This reduction is because carriage water is not needed when there is no export of additional water from the Delta. Therefore, the average change in net Delta outflow (equivalent to the reduction in Carriage Water needed) is a reduction of 192 cfs.

To provide an example based on an individual Project Proponent, consider a 35 percent efficiency credit for the Chino Basin Program. If the Inland Empire Utilities Agency (or IEUA, the Project Proponent for Chino Basin) desires to provide 50 taf towards a pulse flow, they would provide only 32.5 taf of local water supplies from the WSIP Exchange Storage Account to Metropolitan Water District of Southern California (the Partner Contractor) as WSIP In-Lieu Table A Water (50 taf - (0.35*50) = 32.5 taf). The Partner Contractor's Table A deliveries would be reduced by 32.5 TAF, and IEUA would get credit for contributing 50 taf toward a pulse flow.

2.5.4 Agreements and Contracts

DWR would implement the WSIP Operational Exchange Process through a series of agreements and Water Supply Contract amendments. DWR has not yet approved the WSIP Operational Exchange Process for any of the WSIP Groundwater Projects and part of the approval process is the environmental review contained in this document.

The three WSIP Groundwater Projects are independent of each other, and the WSIP Operational Exchange Process would be employed for each of the three projects that proceed to implementation. The WSIP Operational Exchange Process would be managed by DWR, in accordance with forthcoming agreements and Water Supply Contract amendments with individual WSIP Groundwater Projects and SWP Partner Contractors. DWR agreements and amendments would be independently functional with any of the three WSIP Groundwater Projects that are implemented.

Additionally, CDFW will be entering into CAPBs with each WSIP Groundwater Project that will specify required actions to meet ecosystem public benefit requirements. The CAPB term can vary with each WSIP Groundwater Project and is tied to fulfilling pulse flow requirements specified in the CAPB with CDFW. The Chino Basin Program estimates that it can fulfill the CAPB requirements in 25 years. Willow Springs and Kern Fan estimate that they can fulfill CAPB requirements in 50 years. After the term of the CAPB, the WSIP Operational Exchange Process with the WSIP Groundwater Project and the associated pulse flow release would cease, and the WSIP Groundwater Project would be operated solely for local water supply benefits.

2.6 Water Diversion and Conveyance to WSIP Groundwater Projects

Water conveyance to the WSIP Groundwater Projects represents another DWR action evaluated in this Draft SEIR. As described in Chapter 1, Section 1.1.3, Kern Fan would enhance water supply by constructing and operating a water bank[4] in Kern County that would store Article 21 water requested from DWR in years when water is available. DWR's action would be to convey

[4] Environmental impacts associated with the construction and operation of the water bank are included in the 2020 Kern Fan Final EIR.

water from the Delta through the California Aqueduct to a new turnout (analyzed in the 2020 Kern Fan Final EIR) to Kern Fan.

Willow Springs would enhance water supply by pre-positioning SWP water in its groundwater bank[5] during the wet season in years there is not a low-point concern in San Luis Reservoir. A pre-positioning process would require DWR to convey SWP water from San Luis Reservoir to the Willow Springs Groundwater Bank via the California Aqueduct (through existing infrastructure), during the months of November through April. Pre-positioning the SWP water in the groundwater bank reduces the amount of water stored in San Luis Reservoir; therefore, water that otherwise would not be in the SWP system because of storage capacity limitations could be captured.

This DWR action does not apply to the Chino Basin Program, as this project proposes to develop water by enhancing operations of an existing advanced water treatment facility and constructing injection wells, extraction wells, groundwater treatment facilities, and distribution facilities. Water contributions to a pulse flow release from the Chino Basin Program would therefore come from the treated wastewater of surrounding local jurisdictions, as opposed to coming from the SWP.

2.7 Pulse Flows Component and Climate Change

Managing climate change and its impact on water supply is one of DWR's core values and objectives. DWR's climate change program implements climate mitigation and adaptation measures to ensure that Californians have an adequate water supply, reliable flood control, and healthy ecosystems, now and in the future (California Department of Water Resources 2022). As the climate changes, DWR and CDFW would structure the decision-making process for pulse flows to include the needed flexibility to adjust the timing and volume of flow in such a way that the ecosystem benefits could still be realized. The CDFW CAPBs are expected to address climate change by specifying how the individual WSIP Groundwater Projects could change their operations over time and still meet CAPB obligations while avoiding adverse effects on SWP water availability to SWP Contractors.

2.8 Anticipated Required Permits and Approvals

Various required permits and approvals are anticipated for the Pulse Flows Component of the WSIP Groundwater Projects. The following list may be revised or augmented before completion of the CEQA process and implementation of the Pulse Flows Component.

2.8.1 California Department of Water Resources

Required DWR approvals for implementation of the Pulse Flows Component include the following:

- DWR/CDFW Agreement for pulse flow operations (described in Section 2.4.2).

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5 Environmental impacts associated with the construction and operation of the conjunctive use and reoperation of the reservoir are included in the 2006/2018 Willow Springs EIR.

- DWR agreements with Project Proponents and Partner Contractors for the WSIP Operational Exchange to produce pulse flows (described in Section 2.5.4).
- Possible amendments to Water Supply Contracts with Partner Contractors (described in Section 2.5.4).

2.8.2 State Water Resources Control Board

Implementation of the Pulse Flows Component would involve discretionary approval from the State Water Resources Control Board (State Water Board) to ensure that pulse flow releases from Lake Oroville are not improperly diverted, specifically:

- DWR application to the State Water Board and State Water Board approval for a Water Code Section 1707 instream flow dedication for the pulse flows.

CHAPTER 3

Environmental Setting, Impacts, and Mitigation Measures

3.1 Introduction

The proposed construction and operational aspects of the Water Storage Investment Program (WSIP) Groundwater Projects are evaluated in the respective environmental impact reports (EIRs) for those projects. However, the geographical boundaries identified in these three specific EIRs do not cover the location of the Pulse Flows Component of the WSIP Groundwater Projects (Pulse Flows Component), which extends from Lake Oroville to the WSIP Groundwater Projects in the San Joaquin Valley and Southern California. In addition, the WSIP Groundwater Projects' EIRs do not convey the project-specific details of the California Department of Water Resources' (DWR's) actions that include the following (see Section 2.1):

- Release of the pulse flows from Lake Oroville (as described in Section 2.4, "Pulse Flow Releases").
- Implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases (as described in Section 2.5, "WSIP Operational Exchange Process").
- Diversion and conveyance of water to the WSIP Groundwater Projects (as described in Section 2.6, "Water Diversion and Conveyance to WSIP Groundwater Projects").

Therefore, this draft supplemental EIR (Draft SEIR) contains only the information needed to analyze the Pulse Flows Component of the WSIP Groundwater Projects: the location of the Pulse Flows Component and new environmental impact analyses for resource areas requiring additional review under the California Environmental Quality Act (CEQA).

This Draft SEIR evaluates only the first two DWR actions listed above include: (1) release of the pulse flows from Lake Oroville and (2) implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases. The third DWR action described above, "diversion and conveyance of water to the WSIP Groundwater Projects," would not result in any resource area impacts. Diversion and conveyance of water would occur through the California Aqueduct (a concrete-lined canal) and other existing and previously analyzed infrastructure. Diversion and conveyance to Project Proponents under the Pulse Flows Component would be similar to existing conditions and would fall within the typical range of hydrologic and operational variability experienced within the State Water Project (SWP) system. Because no change from existing conditions would result from this DWR action, the action is not described further in this Draft SEIR.

Section 3.2 describes the approach to evaluating impacts of the pulse flow release. It defines the conservative pulse flow release scenario, presents the modeling approach (described in greater detail in Appendix B), and summarizes model results. Section 3.3 provides an overview of the impact analysis that supplements the three WSIP Groundwater Projects' EIRs. This section presents a summary of the resource areas for which potential impacts of the Pulse Flows Component are adequately addressed in the WSIP Groundwater Projects' EIRs, and/or for which no impacts would occur and no further analysis is required. This section also presents resource areas requiring additional CEQA analysis to evaluate potential impacts of implementation of the Pulse Flows Component. Information on impact analysis and resource section format is also provided.

Sections 3.4 through 3.12 present the environmental and regulatory settings, impacts, and mitigation measures for the resource areas addressed in this Draft SEIR.

3.2 Approach to Evaluate Impacts of the Pulse Flow Releases

3.2.1 Conservative Pulse Flow Release Scenario

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," there could be substantial variation in the number of pulse flows requested, the volume of water dedicated to each pulse flow, and/or the rate of each pulse flow release. Therefore, the Draft SEIR evaluates potential effects of the conservative pulse flow release scenario (magnitude, duration, and frequency) for the impact analysis. The **conservative pulse flow release scenario** is defined as a maximum flow of 10,000 cubic feet per second (cfs) (base flow plus pulse flow released into the Low Flow Channel) over a short duration (approximately five days) in the spring months (March, April, May, or June) of critically dry or above normal water year types. Considering the critically dry and above-normal water year types provides a conservative baseline condition to evaluate potential impacts against the most extreme dry versus wet conditions under which pulse flow releases would be considered (discussed in more detail below). The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years but is likely to occur less frequently (see Table 2-1).

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," DWR would not likely approve a pulse flow release in a critically dry year given limitations on the SWP's overall water supply. However, when evaluating anticipated effects of the Pulse Flows Component, using a critically dry year provides for a conservative analysis of impacts across all dry water year types (i.e., critically dry, dry, and below-normal water years). This is because release of a pulse flow in a critically dry year would create the most noticeable change in hydraulic conditions (e.g., water levels, velocity, and inundation extent) and would necessitate the longest Lake Oroville Recovery Period (Recovery Period) as compared to existing "dry year" conditions.

Similarly, because the pulse flow releases are aimed at augmenting flows in the lower Feather River, Sacramento River, and through the Delta in drier years when there are typically lower flows, CDFW will not likely request a pulse flow in a wet year. However, as the determination of water year type is not made until the end of the water year, it is possible that a pulse flow could be approved based on a projection of a certain water yar type that varies from the ultimate determination. Therefore, evaluating anticipated effects of the Pulse Flows Component under above-normal water year conditions allows for a conservative evaluation in the event a pulse flow occurs in a year that becomes wetter than expected.

The modeling approach is summarized below and described in more detail in Appendix B.

3.2.2 Modeling Approach

The conservative pulse flow release scenario was simulated using a hydrodynamic Hydrologic Engineering Center–River Analysis System (HEC-RAS) model of the Feather and Sacramento rivers to quantify and contextualize how the pulse flow release conditions compare to existing conditions. Specifically, the model evaluated changes in hydraulic conditions—water levels (feet), velocity (feet per second), and inundation extent (percent)—from the pulse flow compared to existing conditions. Outputs of these simulations were then used to examine changes in geomorphic processes in the Feather and Sacramento rivers, specifically sediment transport and bank erosion, from the pulse flow compared to existing conditions. The modeling results informed the determination of whether the pulse flow releases would remain within the typical range of variability of the existing hydrologic system, and whether decreased flows during the recovery period would remain within the typical range of operations. Modeling results were used to identify potential impacts related to hydrology and water quality, aquatic and terrestrial biological resources, cultural resources, tribal cultural resources, recreation, geology and soils, and agriculture and forestry resources.

Hydraulic Impact Assessment

The HEC-RAS model of the Feather and Sacramento Rivers extending from Lake Oroville to Freeport, California, was calibrated using data from 2019 by comparing observed and simulated stage hydrographs for several stream gauges (refer to Appendix B for a detailed description of the model development and calibration). An average "base flow" condition was modeled using HEC-RAS steady flow simulations on the Feather and Sacramento rivers for above-normal and critically dry water years (1996–2021), using inputs of mean monthly flow data (March through June). Average depth, velocity, and inundation extent were calculated from the model output for specific reaches of the Feather and Sacramento River (from Lake Oroville to the I Street Bridge). The pulse flow condition hydrology was then modeled by increasing outflows from Lake Oroville to the Low Flow Channel of the Feather River, added on top of the modeled base flow condition, up to 10,000 cfs (base flow plus pulse flow release). Tributary inflows and other model parameters were not changed from the modeled base flow condition. Changes in mean monthly water level (feet), velocity (feet per second), and inundation extent (percent) were calculated by comparing the pulse flow condition hydrology to the base flow (see Table 3.4-8).

Flow Contextualization Analysis

A second set of simulations was run to contextualize the mean monthly hydraulic impact assessment results and determine whether pulse flow conditions fall within the range of existing hydrologic variability. As described in Appendix B, the purpose of the flow contextualization analysis was to test whether changes in water levels (depths) and velocities associated with the pulse flow releases fall within ranges experienced in the river system both spatially and temporally. HEC-RAS unsteady-flow simulations were performed for a representative period of water years 1996–2021 using mean daily flow data for the months March through September. The months of July through September were also included to assess the effect of late-season flow reductions (the Recovery Period) during years when pulse flows are implemented. Five water years were simulated – one of each water year type. The 2003, 2006, 2007, 2016, and 2021 water years were selected as representative of the typical hydrologic variability in the system (i.e., the existing conditions). Depths and velocities associated with the pulse flow condition hydrology were then compared with the existing-condition hydrology to determine whether changes in these parameters fall within the range of existing variability experienced in a given reach. Note that inundation extent under the pulse flow condition was not contextualized like water levels and velocity but was evaluated qualitatively to discern how changes in inundation compare to existing conditions.

Sediment Transport Impact Assessment

The sediment transport impact assessment was conducted by developing a sediment transport rating curve for the Feather River to determine the amount of sediment transported under base-flow and pulse flow condition hydrology for the period 1996–2021. The daily model outputs from the HEC-RAS simulations performed for the flow contextualization analysis were used to compare the amount of sediment transported in each reach on a monthly basis during base-flow and pulse flow conditions. Sediment sampling along the Feather River informed the delineation of the Feather River into four reaches based on bed material size and hydraulic parameters. Sediment transport rates were calculated for specific reaches using standard sediment transport formulas appropriate for the bed material size distribution (e.g., sand, gravel, mixture). These rates were then compared for the base-flow versus pulse flow condition.

Bank Erosion Impact Assessment

Riverbank erosion is controlled by a complex interaction of stresses and resisting forces that are a function of reach-scale hydraulics (velocity, shear stress[1]), geotechnical processes (slope stability), and bank material/geometry/vegetation (the resisting forces). The proposed pulse flow release has the potential to alter the stresses imposed on the banks by increasing velocity and applied shear stress. The daily model outputs from the HEC-RAS simulations performed for the flow contextualization analysis were also used to quantify the cumulative applied shear stress per site on a monthly basis under the base-flow and pulse flow conditions. The cumulative applied bank shear stresses calculated for the base-flow and pulse flow conditions were compared at selected sites along the Feather and Sacramento rivers with a history of bank erosion.

3.2.3 Summary of Modeling Results

The model results are presented in Section 3.4, “Hydrology and Water Quality,” and described in detail in Appendix B. Overall, modeling results demonstrate that the conservative pulse flow release scenario falls within the range of typical hydrologic and operational variability experienced in the system. Changes in hydraulic conditions, defined by changes in water level (feet), velocity (feet per second), and inundation extent (percent), associated with a maximum flow of 10,000 cfs in the Low Flow Channel during critically dry or above-normal water years fall within ranges historically experienced in any given reach. Note that, while inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Because the system has previously experienced changes in hydraulic conditions within these ranges, the Draft SEIR assumes that the system has also been operated to manage the range of flows. An analysis of the change in geomorphic processes, defined by changes in sediment transport and bank erosion, under the conservative pulse flow release scenario compared to existing conditions indicates that changes are minimal, considering the natural variability of these processes in the Feather and Sacramento rivers.

1 “Shear stress” is defined as the parallel force experienced by the bed of a channel due to the movement of water across its surface. Put simply, it is the force of water that is trying to drag the channel surface downstream with it.

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3.3 Impact Analysis

3.3.1 Environmental Issues Not Requiring Further Analysis

According to CEQA Guidelines Section 15163, this Draft SEIR needs to contain only the information necessary to analyze the Pulse Flows Component, including changed circumstances and new information requiring additional environmental review. Therefore, where existing information and analysis in the WSIP Groundwater Projects' EIRs are sufficient to evaluate the impacts of the Pulse Flows Component, no additional environmental review is warranted.

The following discussion summarizes environmental issues for which potential impacts of the Pulse Flows Component are adequately addressed in the certified EIRs for the WSIP Groundwater Projects and/or for which no impacts would occur considering the expanded geographical boundaries or changed circumstances of the Pulse Flows Component, and no further analysis is required.

Aesthetics

The location of the Pulse Flows Component extends from Lake Oroville to the three WSIP Groundwater Projects in the San Joaquin Valley and Southern California (Figure 2-1) and encompasses a wide array of visual settings. For example, Lake Oroville sits in a steep foothill ecosystem that includes both vegetated hillsides and concrete infrastructure associated with SWP facilities; the Feather and Sacramento rivers flow through urbanized areas, wildlife areas, and agricultural fields; the Sacramento–San Joaquin Delta (Delta) is characterized by flat topography with scattered stands of trees, extensive agriculture, and flood management infrastructure; and San Luis Reservoir and the California Aqueduct sit at and along the interface of the Diablo Range and Coast Ranges and the San Joaquin Valley's agricultural matrix.

However, because the Pulse Flows Component would not require any land disturbance or construction or modification of any facilities or infrastructure, no changes in land use type or direct or indirect changes to the visual environment are anticipated.

As described above, modeling results demonstrate that water levels, velocity, inundation extent, sediment transport, and bank erosion potential under the pulse flow releases fall within ranges historically experienced in any given reach. It is noted that inundation extent may be increased as compared to typical spring conditions, but the overall degree of inundation remains within the existing system's typical range of hydrologic variability. Also, the reduction in flows out of Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability experienced within the system. The proposed pulse flows would be a few days to weeks in duration and are estimated to occur about every three years, depending on water available in the WSIP Exchange Storage Accounts and the occurrence of drier years. Because flow rates during pulse flow releases and during the Recovery Period would remain within a typical range of hydrologic and operational variability experienced in the system, and because the frequency of releases would be limited by several factors, the Pulse Flows Component would not affect the existing visual environment created by existing hydrologic and operational patterns in the vicinity of the study area.

For the reasons described above, the Pulse Flows Component would not adversely affect a scenic vista, damage, or degrade scenic resources or existing visual character or quality, conflict with applicable regulations governing scenic quality, or create new sources of light or glare. The Pulse Flows Component would have **no impact** on aesthetic resources and this resource area is not discussed further.

Air Quality

The Pulse Flows Component does not involve any construction activities, land disturbance, or modification of any facilities or infrastructure, nor would it involve the development of new land uses or introduce new population, employment, or vehicle miles traveled in the region. Pulse flows would be released from existing facilities at Lake Oroville. Although SWP operations would be modified (to release the pulse flows and to implement the WSIP Operational Exchange Process), the modified SWP operations would not call for construction, expansion, or other modification of existing facilities or maintenance activities.

As described above, modeling results demonstrate that water levels, velocity, inundation extent, sediment transport, and bank erosion under the pulse flow releases fall within ranges historically experienced in any given reach. It is noted that inundation extent may be increased as compared to typical spring conditions, but the overall degree of inundation remains within the existing system's typical range of hydrologic variability. In addition, the reduction in flows out of Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability experienced within the system. Therefore, modified SWP operations necessary to implement the pulse flows would not exceed air pollutant emissions associated with existing operational flows (e.g., pumping of water). In addition, the pulse flows would be a few days to weeks in duration, are estimated to occur about every three years, and would comply with all applicable regulations and DWR operational procedures/guidelines.

Therefore, the Pulse Flows Component would not conflict with the assumptions used to develop the applicable air quality plans in the project area or obstruct implementation of such air quality plans. Operation of the Pulse Flows Component would not create a new source of air pollutant emissions or increase pollutant emissions beyond existing conditions, and thus would not result in a cumulatively considerable net increase of any criteria pollutant or toxic air contaminant emissions or lead to the release of emissions with odors that would affect a substantial number of people. Refer to Section 3.9, "Energy and Greenhouse Gas Emissions," for additional discussion of potential impacts of the Pulse Flows Component on greenhouse gas emissions.

The three WSIP Groundwater Projects' EIRs evaluated air quality impacts related to the construction and operation of the groundwater banks themselves (e.g., pumping water). For the reasons described above, the Pulse Flows Component of the WSIP Groundwater Projects would not adversely affect air quality. The Pulse Flows Component would have **no impact** on air quality resources and this resource is not discussed further.

Hazards and Hazardous Materials

The Pulse Flows Component does not involve any new construction of water facilities or infrastructure or any land disturbance, nor would it require installation or maintenance. Existing, ongoing DWR operations involve the storage, use, and transport of limited amounts of hazardous materials (e.g., fuel, lubricants, paint, pesticides), and the Pulse Flows Component would not materially change this aspect of DWR operations in the location of the project. The transport of hazardous materials on area roadways is regulated by numerous laws and regulations enforced by the California Highway Patrol and California Department of Transportation. The storage and use of these chemicals is regulated at the federal and State levels by numerous agencies, including the California Division of Occupational Safety and Health, California Environmental Protection Agency, California Department of Toxic Substances Control, and State Water Resources Control Board (State Water Board). As such, no construction or operation-related hazards would occur from routine transport, use, or disposal of hazardous materials, from accidental release of hazardous materials, or from accidental release of hazardous materials within 0.25 mile of a school.

The Pulse Flows Component does not involve any new construction of water facilities or infrastructure or any land disturbance, and modeling results demonstrate that water levels, velocity, inundation extent, sediment transport, and bank erosion potential under the pulse flow releases fall within ranges historically experienced in any given reach. It is noted that inundation extent may be increased as compared to typical spring conditions, but the overall degree of inundation remains within the existing system's typical range of hydrologic variability. In addition, reduction in flows out of Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability experienced within the system. Therefore, the Pulse Flows Component would not disturb any sites included on the California Department of Toxic Substances Control's Hazardous Waste and Substances Sites (Cortese) List;[2] place new structures or result in roadway closures that could impede emergency response or evacuation plans; or expose people or structures to a significant risk of loss, injury, or death involving wildland fires.

Portions of the Pulse Flows Component location may be within an airport land use plan or within two miles of a public or private airport; however, for the same reasons as described above, the Pulse Flows Component would not result in a safety hazard or excessive noise for people residing or working in the vicinity. The Pulse Flows Component would not increase the amount of bird habitat because the proposed pulse flows would be a few days to weeks in duration and are estimated to occur only once every three years; therefore, no project-related increase in aircraft collisions with birds (bird strike) would occur.

Therefore, the Pulse Flows Component would have **no impact** related to hazards and hazardous materials and this resource is not discussed further.

2 The Cortese List is a planning document used by the State, local agencies, and developers to comply with the CEQA requirements in providing information about the location of hazardous materials release sites.

Land Use

The location of the Pulse Flows Component extends from Lake Oroville to the three WSIP Groundwater Projects in the San Joaquin Valley and Southern California (Figure 2-1), crossing 16 counties: Alameda, Butte, Contra Costa, Fresno, Kern, Kings, Los Angeles, Riverside, Sacramento, San Bernardino, San Joaquin, Solano, Stanislaus, Sutter, Yolo, and Yuba. A wide range of land uses occurs in this large area—forestry, agriculture, water, urban (including industrial, commercial, and residential), rural residential, parks and recreation, and public open spaces. The counties and major communities in the study area maintain a variety of general plans, land use plans, zoning regulations, and other policies related to managing these land uses. In addition, a variety of State and regional policies apply within the study area, including those in the Delta Plan (adopted by the Delta Stewardship Council), the Land Use and Resource Management Plan (adopted by the Delta Protection Commission), and the Bay-Delta Water Quality Control Plan (enacted by the State Water Board).

The Pulse Flows Component would not require any land disturbance or construction of new or modified facilities or infrastructure, and no changes in land use type (i.e., conversion from agricultural land to nonagricultural land, as discussed in Section 3.12) are anticipated to result from the Pulse Flows Component. Pulse flows would be released from existing facilities at Lake Oroville. Although SWP operations would be modified (to release the pulse flows and to implement the WSIP Operational Exchange Process), the modified SWP operations would not call for construction, expansion, or other modification of existing facilities or maintenance activities. As described above, modeling results demonstrate that water levels, velocity, inundation extent, sediment transport, and bank erosion under the pulse flow releases fall within ranges historically experienced in any given reach. It is noted that inundation extent may be increased as compared to typical spring conditions, but the overall degree of inundation remains within the existing system's typical range of hydrologic variability. Also, the reduction in flows out of Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability experienced within the system. DWR would continue to operate the SWP in compliance with the terms and conditions contained in its water rights permits, licenses, and other regulatory requirements.

For the reasons described above, the Pulse Flows Component would not physically divide an established community and would not conflict with an applicable land use plan, policy, or regulation. The Pulse Flows Component would result in minor modification to SWP operations, but this would not conflict with applicable city or county general plans, the Delta Plan, or flow objectives established by the State Water Board's Bay-Delta Water Quality Control Plan. Therefore, the Pulse Flows Component would have **no impact** on land use and this resource is not discussed further.

Mineral Resources

The Pulse Flows Component does not involve any new construction of water facilities or infrastructure or any land disturbance, nor would it require installation or maintenance. Therefore, the Pulse Flows Component would not result in the loss of availability of economically valuable

State-designated mineral resource deposits. As described above, modeled parameters would fall within the typical range of hydrologic variability experienced within the existing system, and the reduction in flows out of Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements. Therefore, the increase in flow from the release of pulse flows would not be substantial enough to result in a loss of access to known mineral resource deposits in the study area or make access more difficult. Therefore, the Pulse Flows Component would have **no impact** on mineral resources and this resource is not discussed further.

Noise

The Pulse Flows Component would not involve any construction activities, introduce new land uses, or result in population increases in the study area. Noise levels from existing SWP facilities and operations would remain the same as under existing conditions. No new sources of noise would be introduced, nor would excessive vibration or groundborne noise be generated in the study area. Therefore, the Pulse Flows Component would not conflict with applicable general plan noise elements or noise ordinances for counties or cities in the study area. Because the project does not entail the construction or alteration of a private or public airport, it would not expose people residing or working in the study area to excessive noise associated with private or public use airports.

For the reasons described above, the Pulse Flows Component would not contribute to noise or vibration impacts and therefore would have **no impact** related to noise. This resource is not discussed further.

Population and Housing

The Pulse Flows Component would not involve construction of new or modified facilities and therefore would not require construction employees or result in the need for additional operations and maintenance employees. Additionally, the Pulse Flows Component would not require construction of any new residential facilities or housing, or conversion of land uses that would encourage or allow for an increase in the local population. In addition, there would be no increase in available water supply in areas currently served by the SWP with implementation of the Pulse Flows Component; water used for the pulse flows would be returned to the SWP via the WSIP Operational Exchange Process using water developed by the WSIP Groundwater Projects, but the overall amount of water in the SWP system would not increase or decrease as a result. Therefore, the Pulse Flows Component would not remove an impediment to growth or result in population beyond that planned by local jurisdictions.

For these reasons, the Pulse Flows Component would not result in substantial unplanned population growth in an area, either directly or indirectly, nor would it displace existing people or housing. Therefore, **no impact** related to population and housing would occur and this resource is not discussed further.

Public Services

The Pulse Flows Component would not involve construction of new facilities, housing, modified facilities or operations, or other land uses that could increase the local population and thus the demand for governmental facilities and services, such as fire protection, police protection, schools, or parks. As such, there would be no need for additional permanent staff due to increased demand for public services. Therefore, the Pulse Flows Component would not affect response times or other performance objectives for public services and would not require construction of new or altered facilities that could result in a significant environmental impact. For these reasons, **no impact** on public services would occur and this resource is not discussed further.

Transportation

The Pulse Flows Component would not involve construction of new or modified facilities that would require construction employees or result in the need for additional operations and maintenance employees. Project operations would not involve any additional staff who might use local or regional transportation facilities. In addition, the Pulse Flows Component would not include the construction of any housing or roadways that would conflict with CEQA Guidelines Section 15064.3(b)—which codifies a switch from level of service to vehicle miles traveled as the metric for transportation impact analysis—or include any change to roadway design in the area that would increase hazards or introduce incompatible uses. The Pulse Flows Component does not require any construction activities or changes in land uses that would affect emergency response access or response time. Therefore, **no impact** related to transportation would occur and this resource is not discussed further.

Utilities/Service Systems

The Pulse Flows Component would not require construction of any new facilities, housing, modified facilities or operations, or other land uses that could increase the local population and thus the demand for water, wastewater treatment, stormwater drainage, electrical power, natural gas, or telecommunication facilities. The Pulse Flows Component would not generate solid waste requiring compliance with federal, State, and local management and reduction statutes and regulations.

Although SWP operations would be modified (to release the pulse flows and to implement the WSIP Operational Exchange Process), the modified SWP operations would not call for construction, expansion, or other modification of existing facilities or maintenance activities. DWR is developing an agreement with CDFW (the DWR/CDFW Agreement discussed in Section 2.4.2) that will specify the criteria and process for DWR to consider a request for a pulse flow from CDFW, including water years for implementation. One of the objectives of the Pulse Flows Component is to minimize impacts on SWP operations and supplies; as such, a pulse flow would be released only if sufficient water supplies are made available for exchange with DWR by the WSIP Groundwater Projects, allowing DWR to determine (based on a variety of factors influencing SWP operations on a seasonal basis) whether a pulse flow could occur without affecting the SWP. Therefore, the Pulse Flows Component is not anticipated to affect or impede water supply available to the SWP Contractors, water right holders, or other water suppliers in such a way that it would necessitate a change in water use or water management.

For these reasons, the Pulse Flows Component would not require relocation or construction of new or expanded water, wastewater treatment, stormwater drainage, electrical power, natural gas, or telecommunication facilities; increase wastewater generation affecting the operational capacity of wastewater treatment providers in a given service area; or increase solid waste, necessitating an increase in solid waste collection or disposal services in a given service area. Therefore, **no impact** on utilities and service systems would occur and this resource is not discussed further.

Wildfire

The Pulse Flows Component would not involve any land disturbance or new construction of water facilities or infrastructure, nor would it require maintenance of such facilities. Thus, no new buildings or roadway closures would impede emergency response or evacuation plans. There would be no construction or modification of any facilities or similar activities that would increase the probability of wildland fire; thus, the Pulse Flows Component would not exacerbate wildfire risks or cause the uncontrolled spread of wildfire.

Additionally, the Pulse Flows Component would not introduce new land uses, involve development of buildings, or increase population in an area, thereby exposing people or structures to significant risks because of runoff, post-fire slope instability, or drainage causes. Therefore, the Pulse Flows Component would have **no impact** on wildfire risks and this resource is not discussed further.

Growth Inducement

CEQA Guidelines Section 15126.2I requires that an EIR discuss:

> [T]he way in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth (a major expansion of a wastewater treatment plant might, for example, allow for more construction in service areas). Increases in the population may tax existing community service facilities, requiring construction of new facilities that could cause significant environmental effects. Also discuss the characteristic of some projects which may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively. It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment.

The Pulse Flows Component would not directly induce growth because it does not involve the development of new housing or job centers that would attract an additional population. As described in Sections 3.3.1 through 3.3.12, the Pulse Flows Component would not require any land disturbance or construction of new or modified facilities or infrastructure or changes to existing maintenance activities, and no changes in land use type are anticipated to result. Because the Pulse Flows Component would not involve construction, it would not require construction employees to relocate to the area or result in the need for additional operations or maintenance employees, and it would not extend roads or include other infrastructure that could indirectly induce growth.

The Pulse Flows Component would not require construction of any new facilities, housing, or conversion of land uses that would otherwise directly or indirectly encourage or allow for an increase in the local population, nor would it require relocation or construction of new or expanded water, wastewater treatment, stormwater drainage, electrical power, natural gas, or telecommunication facilities. There would also be no increase in available water supply in areas currently served by the SWP with implementation of the Pulse Flows Component; water used for the pulse flows would be returned to the SWP via the WSIP Operational Exchange Process using water developed by the WSIP Groundwater Projects, but the overall amount of water in the SWP system would not increase or decrease as a result.

The three WSIP Groundwater Projects' EIRs evaluated the potential for growth inducement from the operation and maintenance of each respective groundwater bank. The Pulse Flows Component of the WSIP Groundwater Projects, for the reasons described above, would not remove an impediment to growth or result in direct or indirect population growth. Therefore, there would be **no impact** related to growth inducement from the Pulse Flows Component and this resource is not discussed further.

3.3.2 Resource Areas Addressed in this Draft SEIR

This Draft SEIR evaluates the physical environmental resources that have the potential to be affected by implementation of the Pulse Flows Component. As described in Chapter 2, "Description of the Pulse Flows Component," implementation of the Pulse Flows Component would not require construction of any new facilities. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analyses do not evaluate construction impacts, but rather focus on the short- and long-term direct and indirect operational impacts of the Pulse Flows Component compared to existing conditions.

The following CEQA resource areas are considered in greater detail in a revised impact analysis in this Draft SEIR:

- Section 3.4, "Hydrology and Water Quality"
- Section 3.5, "Biological Resources–Aquatic"
- Section 3.6, "Biological Resources–Terrestrial"
- Section 3.7, "Cultural Resources"
- Section 3.8, "Tribal Cultural Resources
- Section 3.9, "Energy and Greenhouse Gas Emissions"
- Section 3.10, "Recreation"
- Section 3.11, "Geology and Soils"
- Section 3.12, "Agriculture and Forestry Resources"

3.3.3 Impact Analysis Terms and Format

Impact Analysis Key Terms

This Draft SEIR uses a number of terms that have specific meaning under CEQA. Among the most important of the terms used are those that refer to the significance of environmental impacts. The following terms are used to describe environmental effects of the Pulse Flows Component:

- **Significance Criteria:** A set of criteria used by the lead agencies to determine the level or threshold at which an impact would be considered significant. Standards of significance used in this SEIR include those standards provided in Appendix G of the CEQA Guidelines. In determining the level of significance, the analysis assumes that the Pulse Flows Component would comply with relevant federal, State, and local regulations and ordinances.
- **Significant Impact:** The level of significance identified for an impact of the Pulse Flows Component that would result in a substantial adverse change in the physical conditions of the environment. Significant impacts are identified by comparing the evaluation of a project-related physical change to specified significance criteria. A significant impact is defined as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project [Pulse Flows Component] including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance" (CEQA Guidelines Section 15382).
- **Less-than-Significant Impact:** The level of significance identified when the physical change caused by the Pulse Flows Component would not exceed the applicable significance criterion.
- **Less-than-Significant Impact with Mitigation:** The level of significance identified when the physical change caused by the Pulse Flows Component, after implementation of identified mitigation measures, would not exceed the applicable significance criterion.
- **Significant and Unavoidable Impact:** The level of significance identified if the Pulse Flows Component would result in a substantial adverse physical change in the environment that could not be feasibly avoided or mitigated to a less-than-significant level.
- **Mitigation Measure:** An action that could be taken that would avoid or reduce the magnitude of a significant impact. CEQA Guidelines Section 15370 defines mitigation as:
  - Avoiding the impact altogether by not taking a certain action or parts of an action;
  - Minimizing impacts by limiting the degree of magnitude of the action and its implementation;
  - Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
  - Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
  - Compensating for the impact by replacing or providing substitute resources or environments.

Resource Section Format

After this section, the remainder of Chapter 3 is divided into technical sections (e.g., Section 3.4, "Hydrology and Water Quality") that present for each environmental resource issue area the physical environmental setting (existing conditions), regulatory setting, significance criteria, methodology and assumptions, and impacts on the environment. Where required, potentially feasible mitigation measures are identified to lessen or avoid significant impacts.

The technical resource sections each begin with a description of the **geographic areas analyzed within the overall study area of the Pulse Flows Component,** followed by a description of the Pulse Flows Component **environmental setting** and the **regulatory setting** as it pertains to a particular resource issue. The environmental setting discussion addresses existing conditions and provides a point of reference for assessing the environmental impacts of implementing the Pulse Flows Component. The environmental setting section provides a focused discussion of the applicable geographic area(s) within the study area as pertinent to the resource (see Figure 2-2). A general description of the study area, including each of the seven geographic areas, is presented in Section 2.3, "Study Area." The regulatory setting discussion presents relevant information about federal, State, regional, and/or local laws, regulations, plans, or policies that pertain to the environmental resources addressed in each section.

Each section then presents resource-specific **significance criteria**, which identify the standards used to determine the significance of effects of the Pulse Flows Component. The significance criteria used for this analysis were derived from Appendix G of the CEQA Guidelines.

A **methodology and assumptions** description in each section presents the analytical methods and key assumptions used in the evaluation of Pulse Flows Component effects and is followed by an **impacts and mitigation measures** discussion. The impacts and mitigation measures portion of each section includes impact statements, prefaced by a number in **boldfaced** type. An explanation of each impact is followed by an analysis of its significance. The subsection then includes a statement that the impact, following implementation of the mitigation measure(s) and/or the continuation of existing policies and regulations, would be reduced to a less-than-significant level or would be significant and unavoidable. Mitigation measures pertinent to each individual impact, if applicable, appear after the impact discussions. The reduction of an impact as a result of the mitigation and the potential effect of that reduction on the significance of the impact is also disclosed.

As required by CEQA Guidelines Section 15126.2(a), direct, indirect, short-term, long-term, on-site, and/or off-site impacts are addressed, as appropriate, for the environmental issue areas being analyzed. Under CEQA, economic or social changes by themselves are not considered significant impacts but may be considered in linking the implementation of a plan to a physical environmental change, or in determining whether an impact would be significant.

Where enforcement exists and compliance can be reasonably anticipated, this Draft SEIR assumes that the Pulse Flows Component would meet the requirements of applicable laws and other regulations described in Chapter 2, "Description of the Pulse Flows Component."

3.4 Hydrology and Water Quality

This section discusses the potential for the Pulse Flows Component to affect hydrology and water quality. The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

3.4.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on hydrology and water quality were not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

The following five remaining geographic areas were evaluated for impacts on hydrology and water quality:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

3.4.2 Environmental Setting

This environmental setting section provides a focused discussion of existing conditions in the five geographic areas analyzed for hydrology and water quality impacts (as identified above). A general description of each of the seven geographic areas composing the Pulse Flows Component study area is presented in Section 2.3.

Surface Water

The Feather River watershed provides the source water for the pulse flow releases. Major water bodies in the study area include Lake Oroville, the Feather River below Oroville Dam, the Sacramento River from the confluence with the Feather River to the Delta, the Delta, and San Luis Reservoir. Tributaries to the Feather and Sacramento rivers include Honcut Creek, the Yuba River, the Bear River, and the American River (**Figure 3.4-1**). The following sections present reservoir storage and/or typical flows at stream gauges from Lake Oroville to the Delta.

Oroville Complex

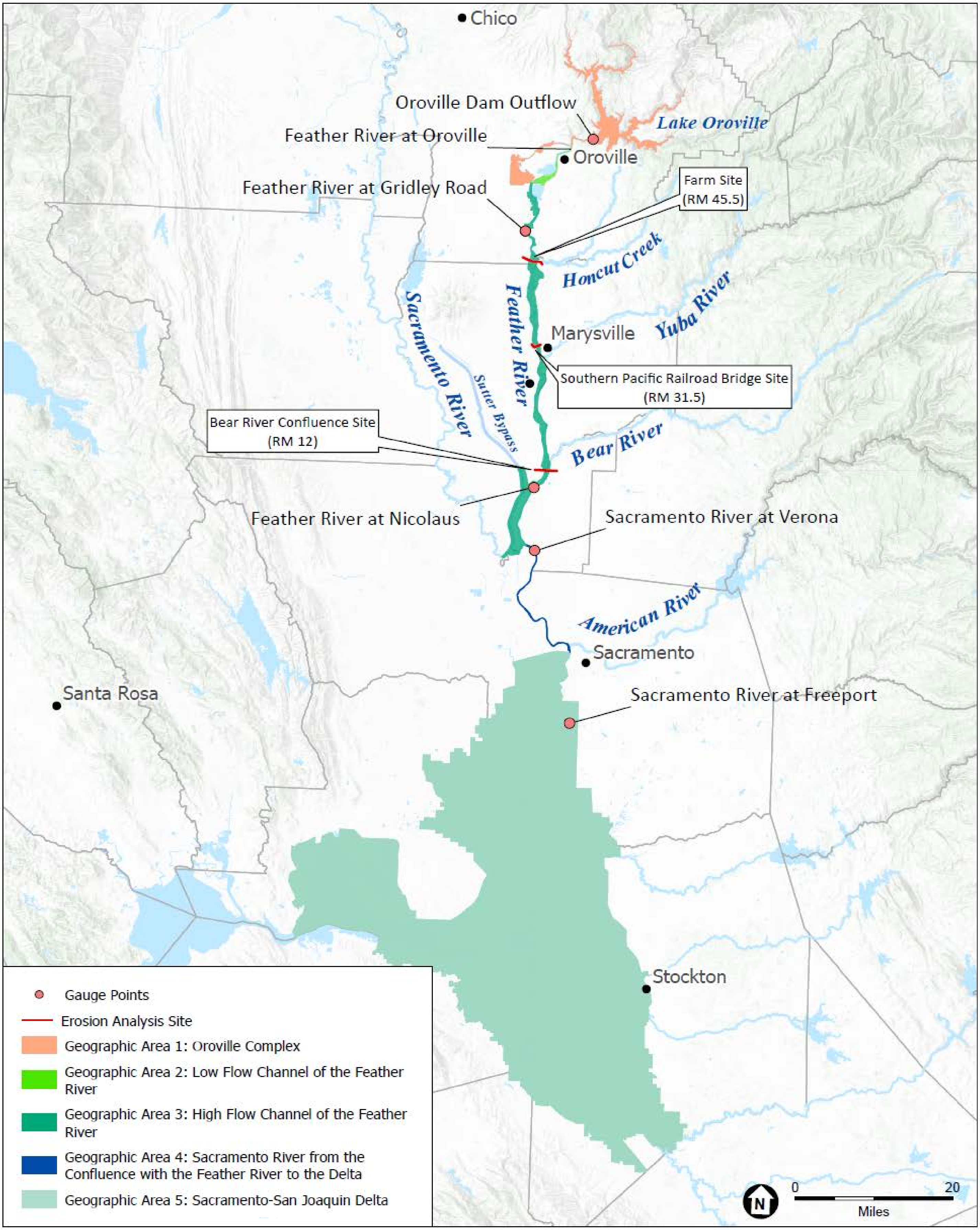
The Oroville Complex area is defined as Lake Oroville and the associated downstream Thermalito Facilities: Thermalito Diversion Pool, Thermalito Diversion Dam, Thermalito Power Canal, Thermalito Forebay, Thermalito Pumping-Generation Plant, and Thermalito Afterbay (Figure 2-3). These facilities make up a system of impounded water bodies associated with the Oroville Complex water supply and hydroelectric facilities.

Table 3.4-1 summarizes Oroville Dam's average net outflow by month and water year type (see Figure 3.4-1 for gauge location). **Figure 3.4-2** presents Lake Oroville reservoir storage (in thousand acre-feet [taf]) and water surface elevation (in feet) for water years 1996–2021.

TABLE 3.4-1
OROVILLE DAM OUTFLOW BY MONTH, WATER YEARS 1996–2021

Water Year Type	Outflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	4,062	3,546	7,390	11,583	16,508	12,004	12,138	10,395	7,596	8,363	7,517	5,607
Above Normal	3,887	3,450	3,485	2,351	4,425	4,159	2,202	4,677	6,394	9,661	7,824	4,808
Below Normal	3,538	3,626	3,497	1,921	2,172	2,527	3,056	4,046	5,851	9,572	8,415	5,557
Dry	3,715	3,445	2,685	2,077	1,480	1,816	2,893	4,659	5,969	7,805	5,921	3,473
Critical Dry	3,310	3,491	2,084	1,294	959	859	1,933	3,958	4,724	4,963	3,235	1,975
Average	3,745	3,518	4,288	4,866	6,476	5,211	5,524	6,126	6,293	8,092	6,698	4,521

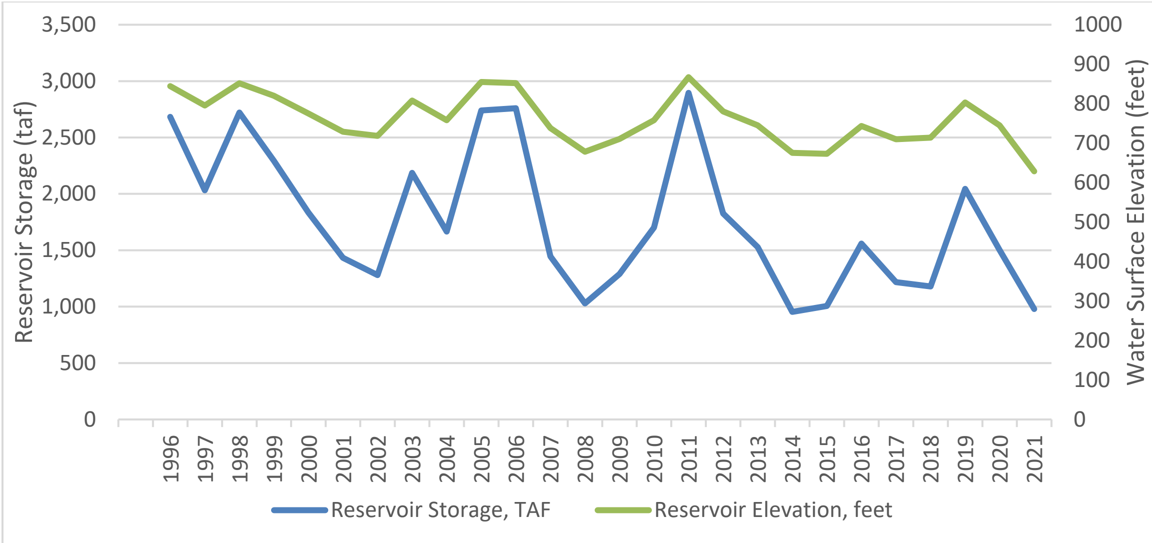
NOTE: cfs = cubic feet per second
SOURCE: California Data Exchange Center, 2023a. DWR Station ORO, Water Years 1996–2021.



SOURCE: Esri, 2022; ESA, 2023

Figure 3.4-1
Major Water Bodies and Tributaries in the Geographic Areas Analyzed for Hydrology and Water Quality Impacts

ESA



SOURCE: California Department of Water Resources 2023a, DWR Station ORO, Water Years 1996–2021.

Figure 3.4-2
Lake Oroville Reservoir Storage and Water Surface Elevation, Water Years 1996–2021

To generate as much energy from released water as feasible, water exceeding the minimum amount required in the Low Flow Channel of the Feather River is typically routed through the Thermalito Power Canal, which runs parallel to the Low Flow Channel. In this way, power can be generated both at the Hyatt Pumping-Generating Plant as the water is released from Oroville Dam and at the Thermalito Pumping-Generating Plant as it moves from Thermalito Forebay to Thermalito Afterbay. Energy resources in the study area are discussed further in Section 3.9, "Energy and Greenhouse Gas Emissions."

Low Flow Channel of the Feather River

The Low Flow Channel (river miles [RM] 67–59) is defined as the reach that extends from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet, near the Oroville Wildlife Area. It includes the Fish Barrier Pool, defined as the reach between the Thermalito Diversion Dam and the Fish Barrier Dam. The banks along the Low Flow Channel comprise coarse dredging material, some of which was used for the construction of Oroville Dam. The combination of reduced flow, levee obstruction, and bank armoring limits channel movement in this nearly straight reach. Near the Fish Barrier Dam, exposed bedrock lines the channel. Less than half a mile downstream of the Fish Barrier Dam, the bed consists mainly of coarse gravel and cobbles, resulting in erosion-resistant sediment. The coarse material requires substantial flow forces to transport it.

Table 3.4-2 presents measured flows in the Low Flow Channel of the Feather River downstream of the Thermalito Diversion Dam and upstream of the Fish Barrier Dam (see Figure 3.4-1 for the approximate gauge location). Typical flows in March through June of critically dry water years range from about 791 to 1,369 cubic feet per second (cfs), and typical flows in March through June of above-normal water years range from about 626 to 634 cfs.

TABLE 3.4-2
MEASURED FLOWS IN THE LOW FLOW CHANNEL OF THE FEATHER RIVER AT OROVILLE, WATER YEARS 1996–2021

Water Year Type	Flow (cfs)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Wet	892	988	2,043	5,770	8,931	4,165	4,347	2,518	1,381	935	1,127	737
Above Normal	637	635	626	632	635	634	626	634	633	685	667	633
Below Normal	751	807	788	808	825	808	1,060	895	1,472	1,651	1,272	752
Dry	684	748	905	866	821	866	857	735	831	1,071	1,072	741
Critical Dry	876	868	863	865	846	791	838	979	1,369	1,625	1,095	813
Average	768	809	1,045	1,788	2,412	1,453	1,545	1,152	1,137	1,193	1,047	735

NOTE: cfs = cubic feet per second
SOURCE: Appendix B, Table 3. DWR Gage A05191 Feather River at Oroville, Water Years 1996–2021.

High Flow Channel of the Feather River

The High Flow Channel extends from Thermalito Afterbay Outlet to the confluence with the Sacramento River at Verona. At the start of this reach, the Low Flow Channel joins water that has been diverted through the Thermalito facilities and released from the Thermalito Afterbay Outlet. Along the High Flow Channel, the Feather River is joined by several tributaries including Honcut Creek, the Yuba River, and the Bear River, resulting in increased contributing flows. To characterize differences in hydraulic conditions and geomorphic processes, the High Flow Channel was divided into five sub-reaches, described in more detail below.

Sub-reach 1: Thermalito Afterbay Outlet to Honcut Creek

From the Thermalito Afterbay Outlet to Honcut Creek (RM 59–47), the Feather River is bordered by levees on the west bank (river right) and historic dredge tailings material on the east bank (river left), the high points of which act similar to levees. The east floodplain is designated as the Oroville Wildlife Area. Linear spoil piles of gravel and cobble create split flows during low flows.

The bed sediments are coarse gravel and cobble. Remnant oxbow lakes, cutoff bends, and meander scars indicate channel avulsion, cutoff, and other fluvial processes. Sediment load derived from erosion in the river increases at the lower section of this reach, as the river rebounds from the sediment deficiency incurred by the upstream impoundments. Compared to the Low Flow Channel, this reach has increasing bank heights, bank erosion, and channel migration rates (see Appendix B). However, leveeing and armoring of the banks generally prevents channel erosion and migration.

Table 3.4-3 presents measured flows at the Feather River below the Thermalito Afterbay (see Figure 3.4-1 for the approximate gauge location). Typical flows from March through June of critically dry water years range from about 199 to 1,177 cfs, and typical flows from March through June of above-normal water years range from about 1,622 to 3,916 cfs.

TABLE 3.4-3
MEASURED FLOWS IN THE FEATHER RIVER BELOW THERMALITO AFTERBAY, WATER YEARS 1996–2021

Water Year Type	Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	2,210	1,268	4,028	6,067	7,885	7,937	7,399	5,880	4,018	4,670	4,199	4,240
Above Normal	1,942	1,509	1,621	1,437	3,853	3,916	1,622	2,072	3,267	6,152	4,768	3,324
Below Normal	1,908	1,215	1,722	818	1,527	1,883	1,963	1,014	1,788	4,947	5,044	4,338
Dry	2,044	1,283	990	757	976	1,226	1,379	1,339	2,249	3,933	2,810	2,118
Critical Dry	1,346	1,023	576	351	323	199	592	937	1,177	1,207	799	715
Average	1,890	1,260	1,787	1,886	2,913	3,032	2,591	2,249	2,500	4,182	3,524	2,947

NOTE: cfs = cubic feet per second
SOURCE: Appendix B, Table 3. DWR Gage A05975 Thermalito Afterbay, Water Years 1996–2021.

Table 3.4-4 presents measured flows in the High Flow Channel of the Feather River near Gridley Road, in the reach between the Thermalito Afterbay Outlet and Honcut Creek (see Figure 3.4-1 for gauge location). Typical flows from March through June in critically dry years range from about 732 to 2,421 cfs, and typical flows from March through June in above-normal water years range from about 2,020 to 3,962 cfs.

TABLE 3.4-4
MEASURED FLOWS IN THE FEATHER RIVER NEAR GRIDLEY ROAD, WATER YEARS 1996–2021

Water Year Type	Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	2,853	2,125	6,377	11,596	14,943	11,720	11,096	7,239	4,598	4,655	4,509	4,457
Above Normal	2,454	2,130	2,250	2,056	4,477	3,962	2,020	2,431	3,673	6,388	4,885	3,570
Below Normal	2,295	1,772	2,279	1,558	2,329	2,673	2,967	1,947	3,473	7,088	6,468	5,097
Dry	2,444	1,831	1,693	1,558	1,824	2,005	2,150	2,049	3,158	4,946	3,669	2,663
Critical Dry	2,020	1,693	1,257	972	932	732	1,193	1,836	2,421	2,879	1,803	1,430
Average	2,471	1,918	3,250	4,467	6,105	5,156	4,902	3,641	3,621	5,131	4,331	3,655

NOTE: cfs = cubic feet per second
SOURCE: California Data Exchange Center, 2023a. DWR Station GRL, Water Years 1996–2021.

Sub-reach 2: Honcut Creek to Yuba River

From Honcut Creek to the Yuba River (RM 47–29), the Feather River is bordered by levees and the channel is sinuous and active. The general channel pattern of active channel and slough flowing through loosely consolidated or unconsolidated soil continues downstream. Filled pits (ponds) and agricultural fields are present in this area; they are not immediately adjacent to the thalweg but lie within the State Plan of Flood Control levees, with the potential for inundation at higher flows.

This sub-reach is notable for its significant transition in bed sediment size from gravel and cobble to fine sands (although gravel and cobble are still present). The riverbed is typically gravel and cobble in the upper reaches, but it transitions to mixed sand and gravel bed in this reach, and by the time the Feather River meets the Yuba River, the bed material is mostly sand. Because median grain size transitions from gravel to sand, there is an increased volume of grains that can be mobilized. The high banks are erodible and susceptible to mass failure and lateral migration. There exist two historic active bank erosion sites in this sub-reach: the Farm Site (RM 45.5) and the Southern Pacific Railroad Site (RM 31.5) (see Figure 3.4-1 and Appendix B).

Sub-reach 3: Yuba River to Bear River

From the Yuba River to the Bear River (RM 29–14), bed material in the Feather River is coarse sand with considerable flow contributions from the Yuba River (ranging from approximately 500 to 5,000 cfs). Riverbed slope and sediment are relatively homogeneous downstream of the Yuba River confluence. The Feather River Wildlife Area begins south of Yuba City and runs to and past where the Bear River joins, with the units that constitute the wildlife area distributed along the river (Shanghai Bend, Abbott Lake, Star Bend, O'Connor Lakes, Lake of the Woods, Nelson Slough). A privately owned wild area, Bobelaine Audubon Sanctuary, lies between the Lake of the Woods and Nelson Slough units.

Sub-reach 4: Bear River to the Nicolaus Gauge

The relatively short sub-reach from the Bear River to the Nicolaus Gauge (RM 14–9) was delineated by the Bear River tributary and the transition from the Feather River to the Feather River and adjacent Sutter Bypass. During above normal water years, elevated water levels in the lower tributaries creates a backwater effect in the Feather River extending upstream towards the Nicolaus gage. Side channels along the base of the levee extend from the Bear River confluence down to the Nicolaus gage on river left and to the Sutter Bypass on river right (directions referenced are looking downstream). There exists one historic active bank erosion site in this sub-reach: the Bear River Confluence Site (RM 12) (see Figure 3.4-1 and Appendix B).

Sub-reach 5: Nicolaus Gauge to the Sacramento River Confluence at Verona

The sub-reach from the Nicolaus Gauge to the Sacramento River confluence at Verona (RM 9–0) runs along the portion of the Feather River directly adjacent to the Sutter Bypass, and includes the Lower Sutter Bypass. The river becomes much narrower and has an increased ability to convey sediment. Historic hydraulic mining deposits move downstream as sand sheets. Nelson Slough runs along the west levee of the Feather River and joins the Sutter Bypass as the East Canal within the Sutter Bypass. Nelson Slough allows water to enter the Sutter Bypass from Feather River near RM 8, before the agricultural levee overtops. The connection between the Feather River and the Sutter Bypass is controlled at lower flows, with a wide connection at high enough flows that the elevated dirt road (not a formal levee) delineating them is inundated. The Sutter Bypass and the Feather River both empty into the Sacramento River near Verona. This sub-reach includes the Lower Sutter Bypass parallel to the Feather River, from the Fremont Weir to approximately three miles north of the confluence with the Feather River. It is necessary to include this area because the Sutter Bypass absorbs high flows from the Feather River when it is running higher than the Sutter Bypass, and because the Lower Sutter Bypass is subject to inundation from backwater effects from the confluence of the Feather and Sacramento rivers (i.e., the volume of flows approaching the Sacramento River near Verona exceeds the capacity of the river at this location).

Sacramento River from Confluence with Feather River to the Delta

From the confluence with the Feather River to the Delta, the Sacramento River is contained between two federal levees with limited floodplain inside the levees. There are a few locations where tributary water joins (the Eastside Canal near Verona, the American River in Sacramento), but for the most part this segment of the Sacramento River resembles a single channel bounded by levees. Levees are slightly more widely spaced at Elkhorn Regional Park, and the Sacramento Weir provides a flood outlet to the Yolo Bypass as the Sacramento River continues south to be joined by the American River.

Table 3.4-5 summarizes measured flows in the Sacramento River at the upper end of this reach at Verona (see Figure 3.4-1 for gauge location). Typical flows from March through June of critically dry water years range from about 6,844 to 10,614 cfs, and typical flows from March through June of above-normal water years range from about 17,646 to 31,244 cfs.

TABLE 3.4-5
MEASURED FLOWS IN THE SACRAMENTO RIVER AT VERONA, WATER YEARS 1996–2021

Water Year Type	Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	10,916	12,009	29,237	43,458	51,108	48,848	41,450	28,887	23,276	16,865	17,065	16,642
Above Normal	9,794	10,645	18,492	32,422	34,035	31,244	19,347	28,014	17,646	17,916	15,908	14,258
Below Normal	10,316	9,660	14,044	23,061	21,801	29,213	20,427	10,685	12,197	14,992	15,795	14,919
Dry	9,820	10,227	19,816	17,527	16,890	16,689	11,250	10,367	11,096	14,748	14,074	12,070
Critical Dry	7,976	8,462	15,032	11,618	15,876	10,614	7,943	6,844	7,241	8,366	8,350	8,788
Average	9,966	10,443	20,716	27,380	30,148	29,737	22,733	17,621	15,218	14,830	14,656	13,917

NOTE: cfs = cubic feet per second
SOURCE: California Data Exchange Center, 2023a. USGS/DWR Station VON, Water Years 1996–2021.

Sacramento–San Joaquin Delta

The principal factors affecting Delta hydrodynamics are (1) inflow from the Sacramento River, San Joaquin River, and east side systems; (2) tidal inflow and outflow through San Francisco Bay; and (3) pumping from the South Delta, primarily through the Harvey O. Banks and C. W. "Bill" Jones pumping plants and Contra Costa Water District's Delta diversions. Local hydraulics can also be influenced by a multitude of agricultural, municipal, and industrial diversions in the Delta itself (U.S. Bureau of Reclamation 2014).

Delta channels are diverse: constructed or natural, leveed or not, armored or not, wide or narrow, or even open water from breached sunken islands. Land adjacent to the water is a patchwork of cultivated, uncultivated, and settled: with California's capital at the upstream end and multiple communities in and around the Delta.

Table 3.4-6 summarizes measured flows in the Sacramento River at Freeport, near the northern end of the Delta (see Figure 3.4-1 for gauge location). Typical flows from March through June of critically dry water years range from 7,032 to 11,501 cfs, and typical flows from March through June of above-normal water years range from 22,321 to 37,101 cfs.

TABLE 3.4-6
MEASURED FLOWS IN THE SACRAMENTO RIVER AT FREEPORT, WATER YEARS 1996–2021

Water Year Type	Flow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	13,028	14,583	36,325	51,119	61,449	57,678	50,480	36,768	29,686	20,303	19,676	19,194
Above Normal	11,371	12,410	20,939	36,492	41,096	37,101	23,200	33,681	22,321	21,237	18,581	16,133
Below Normal	11,722	10,810	15,631	24,766	23,973	32,795	24,513	13,322	14,995	18,564	17,715	15,866
Dry	10,690	11,447	22,137	19,975	18,626	18,636	12,769	11,578	12,581	16,900	15,397	12,656
Critical Dry	8,258	8,689	16,071	11,574	16,841	11,501	8,440	7,032	8,218	9,004	8,523	8,757
Average	11,300	11,878	23,930	31,338	35,015	33,922	26,882	21,669	18,600	17,386	16,306	15,236

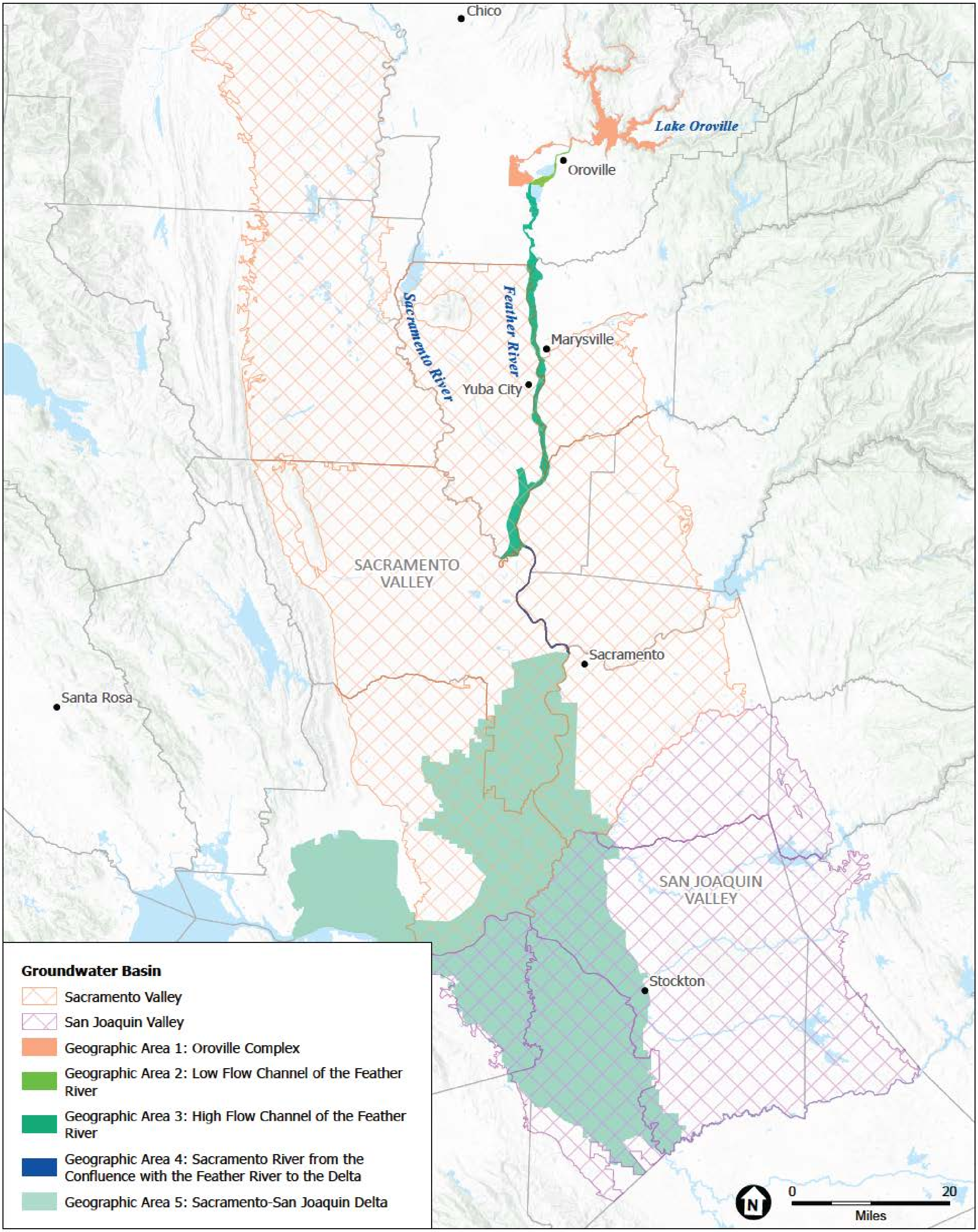
NOTE: cfs = cubic feet per second
SOURCE: California Data Exchange Center, 2023a. USGS Station FPT, Water Years 1996–2021.

Tidal flux at the downstream end of the Delta can be hundreds of thousands of cfs moving alternately upstream and downstream. The flow near Pittsburg during a typical tidal cycle can vary from 330,000 cfs upstream to 340,000 cfs downstream. The “net” summer Delta outflow is a smaller amount of the water movement. Delta outflow requirements as measured at Rio Vista are in the range of 3,000–4,500 cfs depending on year type and time of year. This requirement is based on minimum monthly average flow rate in cfs, with the seven-day running average not allowed to be less than 1,000 below the monthly objective (State Water Resources Control Board 2004).

Groundwater

Lake Oroville is underlain by relatively impermeable igneous and metamorphic bedrock that largely eliminates interaction between the surface water in Lake Oroville and local groundwater basins (Federal Energy Regulatory Commission 2007). The groundwater basins underlying the lower Feather River, lower Sacramento River, and Delta are the Sacramento Valley the San Joaquin Valley groundwater basins (**Figure 3.4-3**). The major groundwater subbasins in the Sacramento Valley Groundwater Basin are the Wyandotte Creek, Butte, North Yuba, South Yuba, Sutter, North American, South American, Yolo, and Solano subbasins.

Depth to groundwater ranges from about 60 feet below ground surface near Oroville to less than 10 feet in the Sacramento Valley area and above the Delta. In general, groundwater levels in the Sacramento River hydrologic region are on a declining trend. Most monitoring wells in the region showed a decreasing trend of up to 2.5 feet per year between 1998 and 2018, and approximately 20 percent of the wells displayed a stable or increasing trend. Land subsidence has also occurred in localized areas (California Department of Water Resources 2021).



SOURCE: Esri, 2022; ESA, 2023

Figure 3.4-3
Groundwater Basins in the Geographic Areas Analyzed for Hydrology and Water Quality Impacts

Flooding

The Federal Emergency Management Agency (FEMA) has mapped special flood hazard areas throughout the study area. According to the most recent Flood Insurance Rate Maps prepared for the National Flood Insurance Program, 100-year special flood hazard areas exist at Lake Oroville and the Thermalito facilities, along the lower Feather River and the Sacramento River and in the Delta, and at the bypasses (**Figure 3.4-4**).

The primary flood protection feature of the Feather River basin is Lake Oroville, which has a flood reservation volume of 375–750 taf required by the U.S. Army Corps of Engineers. This volume represents the range of flood reservation needed depending upon whether the basin is wet or dry: When the basin is wet, runoff increases, thus increasing the need for flood reservation; when the basin is drier, less flood reservation is necessary because low runoff is expected. During high-water events, Lake Oroville releases can increase flows in the Feather River. Levees line the Feather River from the city of Oroville to the confluence with the Sacramento River (U.S. Bureau of Reclamation 2014).

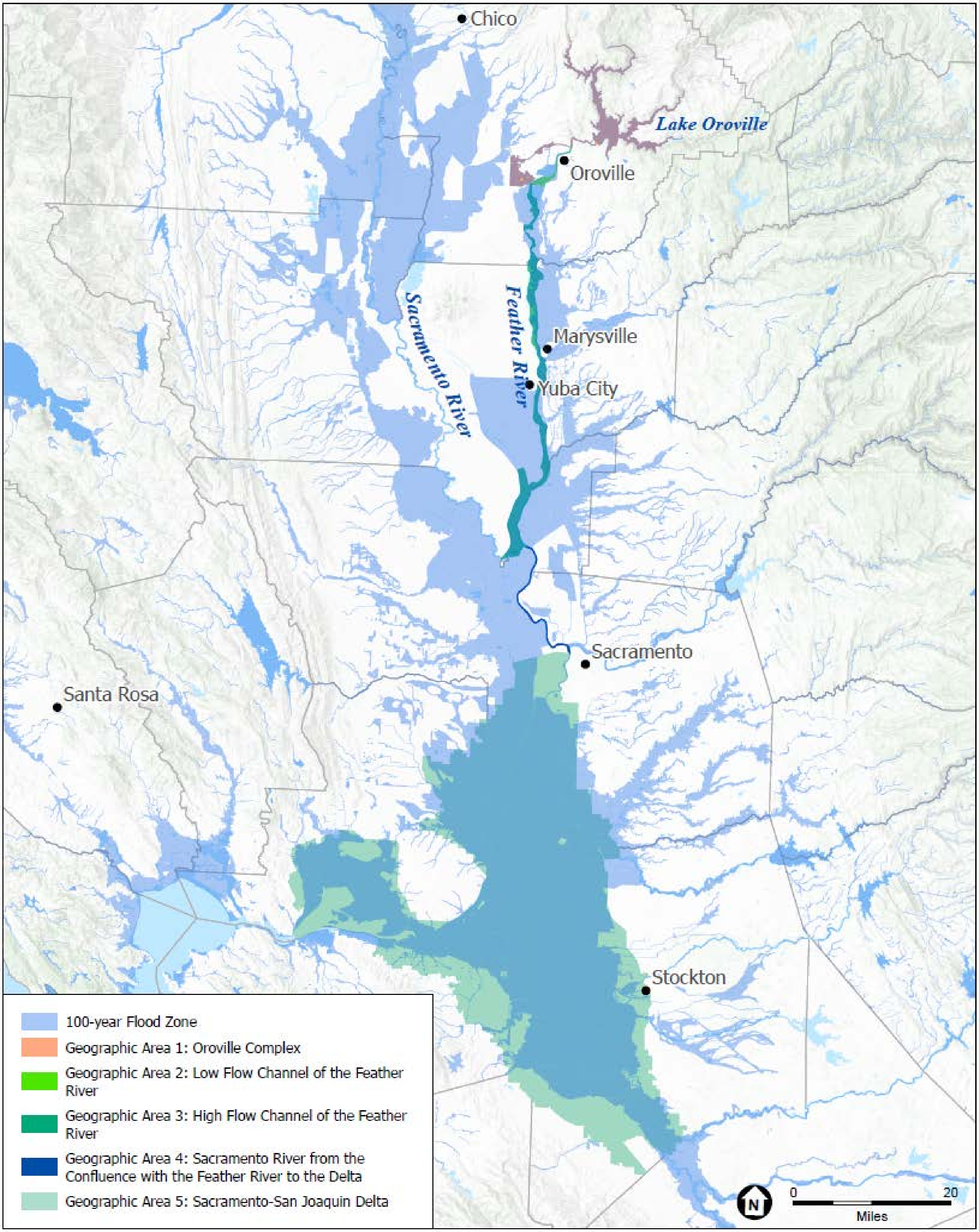
Flood management facilities along the Sacramento River and in the Delta include levees, weirs, and flood bypasses. The Sutter Bypass parallels the Feather River in the lower Sacramento Valley below its confluence with the Bear River and conveys flood flows from the Sacramento River through Butte Slough and Tisdale Weir. Feather River flows can enter the Sutter Bypass when the lower west levee of the Feather River is overtopped. Flow exits the Sutter Bypass and enters the Sacramento River or flows across the Sacramento River to enter the Yolo Bypass.

The Yolo Bypass parallels the Sacramento River to the west below Verona. Water enters the Yolo Bypass across Fremont Weir at the northern end, Sacramento Weir to the east, and from four tributaries to the west. It is also bounded by levees on either side and high ground for a distance along the southwest. The Yolo bypass conveys floodwaters from the Sacramento, Feather, and American rivers, as well as its western tributaries, away from Sacramento and West Sacramento.

Water Quality

In California, water quality standards are established in regional water quality control plans, which are referred to as “basin plans” because they cover specific areas defined by drainage basins. Basin plans designate beneficial uses for surface water and groundwater, establish water quality objectives to protect beneficial uses and prevent nuisance, and set forth implementation programs to achieve the water quality objectives. Beneficial uses, together with the water quality objectives contained in basin plans, constitute California’s water quality standards.

As provided in the Sacramento and San Joaquin River Basin Plan (Central Valley Regional Water Quality Control Board 2019), Lake Oroville’s existing beneficial uses consist of municipal and domestic supply; irrigation; hydropower generation; contact and noncontact water recreation; warm and cold freshwater habitat; spawning habitat suitable for reproduction and early development of fish in warm and cold ecosystems; and wildlife habitat. The Feather River from the Fish Barrier Dam to the Sacramento River also includes the beneficial use of aquatic species migration in warm and cold ecosystems. This reach does not support hydropower generation.



SOURCE: Esri, 2022; ESA, 2023

ESA

Figure 3.4-4
FEMA Flood Hazard Areas in the Geographic Areas Analyzed for Hydrology and Water Quality Impacts

Water quality at Lake Oroville and in the Low Flow Channel of the Feather River is generally good. In Lake Oroville, near-surface waters (known as the "epilimnion") begin to warm in the early spring, reach maximum temperatures approaching the mid-80s (degrees Fahrenheit [°F]) in late July, and then gradually cool to winter temperatures typically between 45° and 55°F. Temperatures in the deep waters (the "hypolimnion") remain as cool as 44°F year-round near the bottom of the reservoir. By late winter, relatively uniform temperatures, generally between 40° and 50°F, exist throughout the water column (Federal Energy Regulatory Commission 2007).

Flow releases into the Low Flow Channel are designed to meet temperature requirements suitable for salmon and steelhead spawning habitat. Temperatures often increase in the High Flow Channel because this area also includes releases from the Thermalito Afterbay. Other physical parameters such as dissolved oxygen, pH, and turbidity typically meet objectives. For example, dissolved oxygen concentrations at Lake Oroville and the lower Feather River are above 7 milligrams per liter, except in Lake Oroville when the reservoir is stratified in the summer or in the Feather River when decomposing salmon carcasses are present. Turbidity levels in Lake Oroville releases are generally low (generally less than 10 nephelometric turbidity units) because sediments mostly settle out in Lake Oroville before reaching the Feather River (Federal Energy Regulatory Commission 2018).

Table 3.4-7 shows the constituents of concern for Lake Oroville, the Thermalito Facilities, the Feather River, the Sacramento River, the Delta, and San Francisco Bay as reported in the State Water Resources Control Board (State Water Board) 2020–2022 Integrated Report (State Water Resources Control Board 2022a, 2022b). Of these listed pollutants, several have a required total maximum daily load (TMDL) for specific water bodies. Notably, water quality in the lower Feather River from Oroville Dam to the confluence with the Sacramento River has been influenced by agricultural and municipal land and water use in the watershed. The lower Feather River is listed on the Clean Water Act (CWA) Section 303(d) list of impaired water bodies for aluminum, chlorpyrifos, Group A pesticides, mercury, dissolved oxygen, polychlorinated biphenyls (PCBs), and toxicity. Metal concentrations are primarily the result of abandoned mining practices and development of municipal and industrial land uses, while agricultural activities in the area have resulted in elevated levels of pesticides.

TABLE 3.4-7
WATER QUALITY–LIMITED SURFACE WATERS/303(D)-LISTED WATER BODIES

Water Body Name	Listed Pollutants	Listed Pollutants with a Required Total Maximum Daily Load
Lake Oroville	Mercury, PCBs	Mercury, PCBs
Lower Feather River (Oroville Dam to confluence with Sacramento River)	Aluminum, Chlorpyrifos, Group A Pesticides, Mercury, Dissolved Oxygen, PCBs, Toxicity	Aluminum, Group A Pesticides, Mercury Dissolve Oxygen, PCBs, Toxicity
Thermalito Forebay	PCBs	PCBs
Thermalito Afterbay	Mercury, PCBs	Mercury, PCBs
Sutter Bypass	Mercury, Dissolved Oxygen	Mercury, Dissolved Oxygen
Sacramento River (Knights Landing to the Delta)	Chlordane, DDT, Dieldrin, Mercury, PCBs, Water Temperature, Toxicity	Chlordane, DDT, Dieldrin, Mercury, PCBs, Water Temperature, Toxicity
Delta Waterways (northern portion)	Chlordane, Chlorpyrifos, DDT, Diazinon, Dieldrin, Group A Pesticides, Invasive Species, Mercury, PCBs, Toxicity	Chlordane, DDT, Dieldrin, Group A Pesticides, Invasive Species, PCBs, Toxicity
Delta Waterways (central portion)	Chlorpyrifos, DDT, Diazinon, Group A Pesticides, Invasive Species, Mercury, Toxicity	DDT, Group A Pesticides, Invasive Species, Toxicity
Delta Waterways (southern portion)	Chlorpyrifos, DDT, Diazinon, Electrical Conductivity, Group A Pesticides, Invasive Species, Mercury, Toxicity	DDT, Electrical Conductivity, Group A Pesticides, Invasive Species, Toxicity
Delta Waterways (western portion)	Arsenic, Chlordane, Chlorpyrifos, DDT, Diazinon, Dieldrin, Electrical Conductivity, Group A Pesticides, Invasive Species, Mercury, PAHs, PCBs, Total DDT, Toxicity	Arsenic, Chlordane, DDT, Dieldrin, Electrical Conductivity, Group A Pesticides, Invasive Species, PAHs, PCBs, Total DDT, Toxicity
Sacramento–San Joaquin Delta	Chlordane, DDT, Dieldrin, Dioxin Compounds, Furan Compounds, Invasive Species, Mercury, PCBs, PCBs (dioxin-like), Selenium	Chlordane, DDT, Dieldrin, Dioxin Compounds, Furan Compounds, Invasive Species

NOTES: DDD = dichlorodiphenyldichloroethane; DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane; Delta = Sacramento–San Joaquin Delta; PAHs = polycyclic aromatic hydrocarbons; PCBs = polychlorinated biphenyls

Dioxin compounds include 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

SOURCE: State Water Resources Control Board 2022b.

3.4.3 Regulatory Setting

The following federal, State, regional, and local regulations apply to the Pulse Flows Component. Only those regulations directly applicable to hydrology and water quality impact analyses as required under CEQA are included.

Federal

Clean Water Act

The Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act or CWA, established the institutional structure for the U.S. Environmental Protection Agency (EPA) to regulate discharges of pollutants into waters of the United States, establish water quality standards, conduct planning studies, and provide funding for specific grant projects. Congress has amended the CWA several times since 1972.

EPA has delegated to most states the authority to administer many provisions of the CWA. In California, the State Water Board has been designated by EPA to develop and enforce water quality objectives and implementation plans.

Section 303

Section 303 of the CWA requires states to adopt water quality standards for all surface waters of the United States. The three major components of water quality standards are designated users, water quality criteria, and antidegradation policy. CWA Section 303(d) requires states and authorized Native American tribes to develop a list of water quality–impaired segments of waterways. The list includes waters that do not meet water quality standards necessary to support the beneficial uses of a waterway, even after point sources of pollution have installed the minimum required levels of pollution control technology. The list includes only waters impaired by "pollutants" (clean sediments, nutrients such as nitrogen and phosphorus, pathogens, acids/ bases, temperature, metals, cyanide, and synthetic organic chemicals [U.S. Environmental Protection Agency 2022]), not those impaired by other types of change (e.g., altered flow, channel modification).

CWA Section 303(d) also requires states to maintain a list of impaired water bodies so that a total maximum daily load, or TMDL, can be established. A TMDL is a plan to restore the beneficial uses of a stream, or to otherwise correct impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH, temperature) for a water body, thereby providing the basis for establishing water quality–based controls. The calculation for establishing TMDLs for each water body must include a margin of safety to ensure that the water body can be used for the purposes designated by the state. The calculation also must account for seasonal variations in water quality (U.S. Environmental Protection Agency 2022).

Water quality criteria are designed to protect beneficial uses. Ambient surface water quality may be judged against national and state water quality criteria and specific numeric objectives.

Federal Antidegradation Policy

The Secretary of the Interior established the first antidegradation policy in 1968. In 1975, EPA included the antidegradation requirements in the Water Quality Standards Regulation (Code of Federal Regulations [CFR] Title 40, Section 130.17 [40 CFR 130.17] and 40 CFR 55340–55341). The requirements were included in the 1987 CWA amendment in Section 303(d)(4)(B). The federal antidegradation policy requires states to develop regulations to allow an increase in pollutant loadings or changes in surface water quality only in the following cases:

- Existing surface water uses are maintained and protected, and established water quality requirements are met.
- If a project cannot maintain water quality requirements, water quality is maintained to fully protect "fishable/swimmable" uses and other existing uses.
- In Outstanding National Resource Waters, "States may allow some limited activities which result in temporary and short-term changes in water quality" (Water Quality Standards Regulations) but would not affect existing uses or special use that makes the water an Outstanding National Resource Water.

Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of energy (electricity, natural gas, and oil). FERC also reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines, and for licensing of hydropower projects (Federal Energy Regulatory Commission 2022).

Relicensing of FERC Project No. 2100 (Oroville Facilities)

On February 11, 1957, DWR was issued a 50-year license to construct and operate the Oroville facilities, also known as FERC Project No. 2100 or P-2100. The original license expired on January 31, 2007, and P-2100 is currently operating under an annual license that automatically renews each year until a new license is issued. During relicensing, a diverse group of agencies and stakeholders scoped issues, designed a $27 million suite of studies, reviewed reports, proposed measures, and discussed potential solutions for SWP impacts. Using relevant information from this effort, DWR filed an Application for New License with supporting environmental documentation on January 26, 2005. On March 21, 2006, DWR and an overwhelming majority of stakeholders successfully concluded negotiations and signed a Settlement Agreement that has been estimated to provide approximately $1 billion in environmental, recreational, cultural, and other benefits over a proposed 50-year new license term (California Department of Water Resources 2023b).

The Settlement Agreement resolves all relicensing issues that had been raised by the signatories or that may arise in the issuance of permits necessary for relicensing. Key activities and documents from relicensing, that define existing operations of the Oroville Complex, are presented below (California Department of Water Resources 2023b).

- February 1, 2007—FERC issued a notice authorizing continued project operations.
- May 18, 2007—FERC issued the final environmental impact statement with recommended alternatives accepting most of the Settlement Agreement proposals.
- April 9, 2007—The U.S. Fish and Wildlife Service issued the terrestrial biological opinion (BiOp) in anticipation of the new FERC license. The 2007 BiOp included a five-year interim period to cover the expected time period before the new license was issued. DWR has been operating in conformance with the interim-period requirements pending issuance of a new license.
- November 20, 2007—This was the effective date for the DWR and Pacific Gas and Electric Company Habitat Expansion Agreement.
- May 2007—DWR issued the final EIR.
- December 15, 2010—The State Water Board issued the water quality certification pursuant to CWA Section 401.
- December 5, 2016—The National Marine Fisheries Service (NMFS) issued the aquatic BiOp for anadromous fish. The 2016 BiOp will become effective when the new FERC license is issued. NMFS's current aquatic BiOp was issued in 2004.

DWR is waiting for an expected 50-year license from FERC for Oroville operations. At this time, FERC has not issued the new license. Until FERC issues a new license, DWR will continue to operate the Oroville Facilities (e.g., to meet minimum flows and other requirements in the Low

Flow and High Flow channels of the Feather River) according to the regulatory requirements established in the 2004 NMFS BiOp and the 1983 Agreement[1] between DWR and CDFW ("the 1983 DWR/CDFW Agreement").

Biological Opinions for Oroville Operations

Minimum flows in the Feather River are required by the 1983 DWR/CDFW Agreement (California Department of Water Resources and California Department of Fish and Game 1983), the 2004 and 2016 NMFS BiOps (National Marine Fisheries Service 2004; 2016), and the current and future FERC license for Oroville operations. The 2016 NMFS BiOp is effective when the renewed FERC license is issued. Note that the ramping rates specified in the 2016 BiOp are currently being followed.

For the Low Flow Channel, the 1983 DWR/CDFW Agreement specifies a minimum release of 600 cfs from the Thermalito Diversion Dam into the Low Flow Channel for fisheries purposes. When the renewed FERC license is issued and the 2016 NMFS BiOp (National Marine Fisheries Service 2016) becomes effective, the minimum flow will increase to 700 cfs. The minimum flow will be increased to 800 cfs from September 9 to March 31 of each year to accommodate spawning, unless NMFS, USFWS and CDFW provide a written notice that a flow between 700 and 800 cfs will substantially meet the needs of anadromous fish (in which event, DWR may release that lower flow). Note that these 2016 BiOp requirements will not become effective until the new FERC license is issued.

DWR manages flows in the Feather River in a manner that reduces the potential for stranding of fish and dewatering of redds (i.e., salmonid nests). Ramping rates, defined as the rates at which flows are increased or decreased in a river, are specified in the 2016 NMFS BiOp (see Chapter 2, "Description of the Pulse Flows Component", Table 2-3). Ramping rates are important because decreasing flows too quickly may cause fish to become stranded (National Marine Fisheries Service 2016).

There is a temperature requirement at Robinson Riffle (RM 61.6), downstream of the Feather River Fish Hatchery in the Low Flow Channel. With the 2004 NMFS BiOp, DWR has targeted a mean daily water temperature objective of less than or equal to 65 degrees Fahrenheit (°F) from June 1 through September 30 to protect over-summering steelhead. During these summer months, the Robinson Riffle temperature requirement governs temperature management in the Low Flow Channel due to warming in the river prior to this compliance point.

For the High Flow Channel, the 1983 DWR/CDFW Agreement and the current FERC license stipulate instream flow requirements for fisheries purposes. The 2016 NMFS BiOp also sets a minimum instream flow requirement for the High Flow Channel consistent with the current FERC license and the 1983 DWR/CDFW Agreement, resulting in no change to the flow requirements for the High Flow Channel. The minimum instream flows range from 1,000 cfs to 1,700 cfs and are based on annual runoff. If the April 1 runoff forecast in a given water year indicates that, under normal operation of the SWP, Lake Oroville will be drawn down to 733 feet

1 1983 Agreement Concerning the Operation of Oroville Division of the State Water Project for Management of Fish and Wildlife (California Department of Water Resources and California Department of Fish and Game 1983).

in elevation, minimum flows in the High Flow Channel may be diminished on a monthly average basis, in the same proportion as the respective monthly deficiencies imposed upon deliveries from the SWP; however, in no case shall the minimum flows be reduced by more than 25 percent (i.e., 25 percent of 1,000 cfs, or 750 cfs) (National Marine Fisheries Service 2016).

After issuance of the new FERC license, DWR is expected to implement Facilities Modifications to increase the flexibility to release more cold water from Lake Oroville to meet new temperature objectives in the 2016 NMFS BiOp. The new temperature objectives for the High Flow Channel range from 56 to 64 degrees Fahrenheit (National Marine Fisheries Service 2016).

Coordinated Operations Agreement

The SWP and Central Valley Project (CVP) use a common water supply in the Delta. The State Water Board places conditions on the SWP's and CVP's associated water rights individually and jointly to protect the beneficial uses of water in the Sacramento Valley and the Delta estuary. The Coordinated Operations Agreement (Public Law 99-546), signed in 1986 and with an addendum incorporated in 2018, defines the SWP and CVP facilities and their water supplies; sets forth procedures for coordinating operations; identifies formulas for joint responsibilities for meeting in-basin use; sets up a framework for the exchange of water and services between the SWP and CVP; and provides for periodic review of the agreement.

Biological Opinions on the Long-Term Operations of the Central Valley Project and State Water Project

USFWS and NMFS released BiOps on the coordinated long-term operation of the CVP and SWP in 2008 and 2009, respectively (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009). The 2008 USFWS BiOp and 2009 NMFS BiOp included Reasonable and Prudent Alternatives to avoid jeopardy to fish species. The Reasonable and Prudent Alternatives included conditions for revised water operations, habitat restoration and enhancement actions, and fish passage actions.

Court actions were brought challenging the 2008 USFWS BiOp and 2009 NMFS BiOp under the federal Endangered Species Act (ESA) and the Administrative Procedure Act concerning the effects of the CVP and SWP on endangered fish species. The 2008 and 2009 BiOps issued by the agencies were upheld by the Ninth Circuit Court of Appeals, and at that time contained the most recent estimate of potential changes in water operations that could occur in the near future.

On August 2, 2016, the U.S. Bureau of Reclamation (Reclamation), the lead federal agency, and DWR, the applicant, jointly requested the re-initiation of ESA consultation on the coordinated long-term operation of the CVP and SWP. USFWS accepted the re-initiation request on August 3, 2016, and NMFS accepted the re-initiation request on August 17, 2016. On January 31, 2019, Reclamation transmitted its biological assessment to USFWS and NMFS. Both USFWS and NMFS finalized their BiOps on the coordinated long-term operation of the CVP and SWP on October 21, 2019 (U.S. Bureau of Reclamation 2019).

In February 2019, State agencies announced that they would for the first time pursue a separate State incidental take permit to ensure the SWP's compliance with the California Endangered

Species Act. Pursuing a separate permit enables the State to avoid relying on federal permits and provides the opportunity to use transparent, science-based guidelines to establish rules to protect endangered fish. After a public comment period, DWR developed and submitted an application for an incidental take permit to CDFW in December 2019. DWR certified its final environmental document on March 27, 2020, and CDFW issued the incidental take permit on March 31, 2020.

On September 30, 2021, Reclamation, after coordination with DWR and CDFW, requested re-initiation of consultation on the Long-Term Operation of the CVP and SWP. Pursuant to 50 CFR 402.16, re-initiation is warranted based on anticipated modifications to the Proposed Action that may cause effects on listed species or designated critical habitats not analyzed in the 2019 USFWS and NMFS BiOps.

Implementation of the CALFED Bay-Delta Record of Decision

In the CALFED Bay-Delta Program (CALFED) Record of Decision issued August 28, 2000, Reclamation and other federal and State agencies committed to implementing a long-term plan to restore the San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta) estuary (CALFED Bay-Delta Program 2000). This plan consists of many elements: storage, conveyance, ecosystem restoration, levee integrity, watersheds, water supply reliability, water use efficiency, water quality, water transfers, and science. The Implementation Memorandum of Understanding, also signed August 28, 2000, continued the operational decision-making process that had evolved through the CALFED process. The record of decision identified numerous programs, including the Environmental Water Account to protect fish in the Bay-Delta estuary through environmentally beneficial changes to SWP and CVP operations at no loss of uncompensated water costs to SWP and CVP water users. This project expired in 2009; however, specific provisions may be considered in future operations.

State

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) established the State Water Board and divided the state into nine regions, each overseen by a regional water quality control board (RWQCB). The nine RWQCBs have primary responsibility for the coordination and control of water quality within their respective jurisdictional boundaries. Under the Porter-Cologne Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the protection of beneficial uses.

The Porter-Cologne Act requires the RWQCBs to establish water quality objectives while acknowledging that water quality may be changed to some degree without unreasonably affecting beneficial uses. Designated beneficial uses, together with the corresponding water quality objectives, and an antidegradation policy also constitute water quality standards under the federal CWA. The water quality objectives provide requirements for water quality control. These water quality objectives are often site-specific and are described in more detail in the region's basin plan. Depending on the region, objectives may exist for bacteria, bioaccumulation, biostimulatory substances, color, dissolved oxygen, floating material, oil and grease, population and community ecology, pH, radioactivity, salinity, sediment, settleable materials, suspended materials, sulfides, tastes and odors, toxicity, turbidity, and un-ionized ammonia.

Water Quality Control Plans

Under the Porter-Cologne Act, waters of the state fall under the jurisdiction of the State Water Board and the nine RWQCBs. "Waters of the state" means any surface water or groundwater, including saline waters, within the boundaries of the state (Water Code Section 13050[e]). The State Water Board and RWQCBs have been delegated federal authority to implement the requirements of the CWA in California, including issuing National Pollutant Discharge Elimination System permits, under the Porter-Cologne Act. However, the requirements of the Porter-Cologne Act are even broader than those of the CWA. The Porter-Cologne Act requires the RWQCBs to prepare and periodically update their regional water quality control plans, also known as basin plans. Each basin plan establishes water quality objectives sufficient to ensure that the designated beneficial uses of surface water and groundwater are reasonably protected; it also identifies actions to control nonpoint and point sources of pollution.

Any person who discharges or proposes to discharge any waste that could affect the quality of the waters of the state must file a "report of waste discharge" with the appropriate RWQCB. "Waste" includes any and all waste substances associated with human habitation, of human or animal origin, or from any producing, manufacturing, or processing operation (Water Code Section 13050[d]). Upon receipt of a report of waste discharge, the RWQCB may issue "waste discharge requirements" designed to ensure compliance with applicable water quality objectives and other requirements of the basin plan.

A public review process must be conducted every three years to identify and prioritize the actions needed to address water quality concerns and maintain the effectiveness of the basin plan. Amendments to basin plans may include site-specific water quality objectives for a single constituent, basin-wide control programs for a suite of potential pollutants, and/or policy recommendations and strategies for addressing emerging contaminants and/or climate change. Applicable basin plans are described below.

Water Quality Control Plan for Sacramento and San Joaquin River Basins

The Sacramento–San Joaquin River Basin Plan covers the entire Sacramento and San Joaquin River basins (Central Valley Regional Water Quality Control Board 2019). The plan provides water quality objectives for reasonable protection of beneficial uses (municipal and industrial, agricultural, and fish and wildlife). These include compliance with various salinity and flow objectives. The Sacramento–San Joaquin River Basin Plan was originally adopted in 1975 and is now in its third edition since the fully approved May 2018 amendment.

Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

This plan, referred to as the "Bay-Delta Plan," provides water quality objectives for reasonable protection of beneficial uses (municipal and industrial, agricultural, and fish and wildlife). These include compliance with various salinity and flow objectives, for example. The Bay-Delta Plan was originally adopted in 1995, was updated in 2006, and is currently undergoing consideration of amendments, including amendments focused on the Sacramento River and its tributaries.

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA) was enacted in September 2014. The SGMA establishes a new structure for locally managing California's groundwater in addition to the existing groundwater management provisions established by Assembly Bill (AB) 3030 (1992), Senate Bill (SB) 1938 (2002), and AB 359 (2011), as well as SBX7 6 (2009). The SGMA includes the following key elements:

- Provides for the establishment of a groundwater sustainability agency (GSA) by one or more local agencies overlying a designated groundwater basin or subbasin identified in DWR Bulletin 118-03.
- Requires the preparation of groundwater sustainability plans (GSPs) for all DWR Bulletin 118 groundwater basins found to be of "high" or "medium" priority.
- Provides for proposed revisions, by local agencies, to the boundaries of a DWR Bulletin 118 basin, including the establishment of new subbasins.
- Authorizes DWR to adopt regulations for the development of GSPs and review the GSPs for compliance every five years.
- Requires DWR to establish best management practices and technical measures for GSAs to develop and implement GSPs.
- Provides regulatory authority to the State Water Board for developing and implementing interim GSPs under certain circumstances (such as lack of compliance with development of GSPs by GSAs).

The SGMA defines "sustainable groundwater management" as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." "Undesirable results" are defined as any of the following effects:

- Chronic lowering of groundwater levels.
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

Based on the basin priority definitions included in DWR's California Statewide Groundwater Elevation Monitoring program in June 2014 and confirmed in January 2015, the SGMA required that GSPs be formed by 2020 or 2022. GSPs were required by 2020 for medium- and high-priority basins identified as subject to critical overdraft conditions, and by 2022 for all other high- and medium-priority basins. Sustainable groundwater operations must be achieved within 20 years after completion of the GSPs.

Assembly Bill 3030: Groundwater Management Act (2002)

The Groundwater Management Act (Water Code Sections 10750–10756; AB 3030) provides a systematic procedure for an existing local agency to develop a groundwater management plan. This law provides agencies with the powers of a water replenishment district to raise revenue to pay for facilities to manage the basin (extraction, recharge, conveyance, quality).

Many agencies have adopted groundwater management plans in accordance with AB 3030. AB 3030 allows certain defined existing local agencies to develop a groundwater management plan for groundwater basins.

Central Valley Flood Protection Board

The Central Valley Flood Protection Board (CVFPB), previously known as The Reclamation Board, was created in 1911. Its purpose is to help manage flood risks in the Central Valley on a systemwide basis through the development and implementation of a comprehensive flood control plan for the Sacramento and San Joaquin rivers, and to act as the nonfederal sponsor for federal flood control projects in the Central Valley. The CVFPB has jurisdiction throughout the Sacramento and San Joaquin valleys, which is synonymous with the drainage basins of the Central Valley and includes the Sacramento–San Joaquin Drainage District.

An encroachment permit from the CVFPB is required for every proposal or plan of work that:

(1) Is located between or in the vicinity of any project levees.

(2) Is located within a CVFPB easement.

(3) Is located within a designated floodway that has been adopted by the CVFPB.

(4) Is located within 30 feet of a non-leveed regulated stream listed in California Code of Regulations Title 23, Division 1, Article 8, Table 8.1.

(5) May have a negative effect on any adopted plan of flood control.

California Code of Regulations Title 23 and the Water Code provide guidance to DWR and the CVFPB on enforcement of appropriate standards for flood control projects in the Central Valley. These codes authorize DWR and the CVFPB to enforce standards for erecting, maintaining, and operating levees, channels, and other flood control works within their jurisdictions.

California Water Rights

California has a dual system for water rights: Both the riparian doctrine and the prior-appropriation doctrine apply. Riparian rights result from the ownership of land bordering a surface water source and are normally senior in priority to most appropriative rights. Owners with riparian water rights may use natural flows directly for beneficial purposes on adjoining lands without a permit from the State Water Board.

The State Water Board oversees water rights and water quality functions in California. It issues permits and licenses for appropriating water from surface and subterranean streams flowing through known and definite channels. The California courts have jurisdiction over the use of infiltrating groundwater, riparian use of surface waters, and the appropriative use of surface waters from diversions begun before 1914.

Regional and Local

As described in Section 3.4.1, the geographic areas analyzed for impacts on hydrology and water quality include the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba counties. Each county and each city has local regulations and general plans with policies related to hydrology and water quality. These may include goals and policies related to surface water and groundwater resources, stormwater, and water quality.

3.4.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form, with slight project-specific modifications, to determine whether implementation of the Pulse Flows Component would result in a significant impact. A hydrology and water quality impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Substantially alter the existing drainage pattern of the site or area, including through the release of the pulse flows, in a manner which would:
  - Result in substantial erosion or siltation.
  - Substantially increase the rate or amount of runoff in a manner which would result in flooding.
  - Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
  - Impede or redirect flood flows.
- Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality.
- Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the Pulse Flows Component may impede sustainable groundwater management of the basin.
- In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation.
- Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.4.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts, but rather focuses on short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases," to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. Specifically, the model evaluated changes in hydraulic conditions including water levels (feet), velocity (feet per second), and inundation extent (percent) from the pulse flow compared to existing conditions. Outputs of these simulations were then used to examine changes in geomorphic processes including sediment transport and bank erosion in the Feather and Sacramento rivers from the pulse flow compared to existing conditions. The modeling results were used to determine whether the pulse flow releases would remain within the typical range of variability of the existing hydrologic system, and whether decreased flows during the Lake Oroville Recovery Period (Recovery Period) would remain within the typical range of operations. Model results are summarized below and detailed in Appendix B.

Impacts and Mitigation Measures

Table 3.4-8 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.4-8
SUMMARY OF IMPACT CONCLUSIONS—HYDROLOGY AND WATER QUALITY

Impact Statement	Operations and Maintenance
3.4-1: Implementation of the Pulse Flows Component would substantially alter the existing drainage pattern of the site or area, including through the release of the pulse flow, in a manner which would result in substantial erosion or siltation; substantially increase the rate or amount of runoff in a manner which would result in flooding; create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows.	LTS
3.4-2: Implementation of the Pulse Flows Component would violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality.	LTS
3.4-3: Implementation of the Pulse Flows Component would substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin.	LTS
3.4-4: In flood hazard, tsunami, or seiche zones, implementation of the Pulse Flows Component would risk release of pollutants due to project inundation.	LTS
3.4-5: Implementation of the Pulse Flows Component would conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan.	NI

NOTES: NI = No Impact; LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2023.

Impact 3.4-1: Implementation of the Pulse Flows Component would substantially alter the existing drainage pattern of the site or area, including through release of the pulse flows, in a manner which would result in substantial erosion or siltation; substantially increase the rate or amount of runoff in a manner which would result in flooding; create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows.

Summary of the Pulse Flows Component

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations.

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, and above-normal water year types, with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. As described in Section 3.2.1, "Conservative Pulse Flow Release Scenario," this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May or June) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would continue to meet flow and temperature requirements for the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations).

The spring pulse flow release (March through June) and the corresponding reduction in flows associated with the Recovery Period (July through September) could potentially alter the existing drainage pattern in the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta. The implications of DWR's actions (i.e., pulse flow releases and WSIP Operational Exchange Process) on the existing drainage pattern in these areas are discussed below.

Implications of the Conservative Pulse Flow Release Scenario

Oroville Complex

Pulse flow releases would alter Lake Oroville reservoir storage and water surface elevation. Streamflow changes would also occur through the Thermalito Complex (the Thermalito Diversion Pool, Thermalito Diversion Dam, Thermalito Power Canal, Thermalito Forebay, and

Thermalito Afterbay). Flow releases of 10,000 cfs and higher from Lake Oroville have occurred historically for flood control purposes. Therefore, the conservative pulse flow release scenario is consistent with releases that have occurred historically in Lake Oroville, particularly during wetter water year types, and fall within the range of existing hydrologic conditions. Because releases of this magnitude and duration have occurred (e.g., flows at or above 10,000 cfs), the pulse flow releases would not substantially affect the existing drainage pattern in the Oroville Complex, and thus would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

Summary of Hydraulic Modeling Results Downstream of the Oroville Complex

Table 3.4-9 presents anticipated changes in hydraulic conditions (i.e., water levels [feet], velocity [feet per second], and inundation extent [percent]) downstream of the Oroville Complex under the conservative pulse flow release scenario. Results for the Low Flow Channel, High Flow Channel, and Sacramento River from Verona to the Delta are discussed in greater detail the subsections below.

TABLE 3.4-9
CHANGE IN HYDRAULIC CONDITIONS UNDER THE CONSERVATIVE PULSE FLOW RELEASE SCENARIO

Geographic Area/ Reach	Sub-reach	Critically Dry Water Year			Above Normal Water Year		
		Change in Median Water Level (feet)	Change in Median Velocity (feet per second)	Change in Inundation Extent (percent)	Change in Median Water Level (feet)	Change in Median Velocity (feet per second)	Change in Inundation Extent (percent)
Low Flow Channel of the Feather River	Oroville Dam to Thermalito Afterbay	5 to 6	2.0 to 2.5	46–58	5 to 6	2.0 to 2.5	61
High Flow Channel of the Feather River	Thermalito Afterbay to Honcut Creek	4.5 to 5.5	2	60	4.5 to 5.5	2	60
	Honcut Creek to Yuba River	6 to 7	1.5 to 2	30–40	6 to 7	1.5 to 2	30–40
	Yuba River to Bear River	4 to 5	1 to 2	30–35	4 to 5	1 to 2	30–35
	Bear River to Nicolaus	4 to 5	0.5 to 1	35–50	4 to 5	>0.5 to 1	35–50
	Nicolaus Gauge to Verona Gauge	4.5 to 5.5	1.5 to 1.75	13	3.5 to 4.5	1.0 to 1.25	9–104[a]
Sacramento River from Verona to the Delta	Verona Gauge to American River	3 to 4	0.5 to 1.0	3–4	3 to 4	0.5 to 1.0	3–4
	American River to Freeport Gauge	1.5 to 2.5	0.4 to 0.8	2–3	1.5 to 2.5	0.4 to 0.8	2–3

NOTES

a. Under the above-normal condition, flows in the Feather River are higher and lead to greater increases in inundation extents due to the backwater effect from the Sacramento River. During the above-normal June simulation, flows in the Sutter Bypass are quite low. However, the backing up of water caused by the increased stages of the pulse flow allow the small channel along the west levee to surpass bank full and expand quickly outward. Despite the high percentage change (104 percent), the water depths across this low-gradient floodplain are relatively shallow (approximately 1 foot).

SOURCE: Data compiled by ESA in 2023 based on modeling results presented in Appendix B.

Low Flow Channel of the Feather River

Hydraulic Conditions: During the pulse flow releases, water levels and velocity would increase in the Low Flow Channel more than in other reaches of the river (see Table 3.4-9). As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions; this reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June).

Under the conservative pulse flow release scenario, the pulse flow would temporarily increase inundation by 46–61 percent in the spring months (see Table 3.4-9). The Low Flow Channel is sensitive to changes in inundation extent, as the magnitude of flow would be nearly 10 times greater with pulse flow conditions than during the base flow (10,000 versus 1,000 cfs). However, a flow of 10,000 cfs would be fully contained within the Low Flow Channel and would not result in inundation of adjacent infrastructure (see Appendix B). While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions in the Low Flow Channel would fall within the range of existing hydrologic variability.

Geomorphic Processes: As discussed in Section 3.4.2, the bed of the Low Flow Channel is dominated by cobble and gravel. The coarse material would require high discharge rates to move sediment in this area. The banks comprise coarse material (like the bed of the river), and thus are erosion resistant. As detailed in Appendix B, under the conservative pulse flow release scenario, at a 10,000 cfs flow rate over five days, the change in sediment transport rates in the Low Flow Channel would be low (0.3 percent)[2] and no bank erosion is expected.

Summary: Because water releases from Lake Oroville have occurred in the Low Flow Channel at similar magnitudes and durations to the pulse flow releases, the conservative pulse flow release scenario would not substantially affect the existing drainage pattern in the Low Flow Channel, and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

High Flow Channel of the Feather River

In the High Flow Channel, the Low Flow Channel joins water that has been diverted through the Thermalito Facilities at the Thermalito Afterbay Outlet. During the pulse flow releases, hydraulic conditions in the High Flow Channel would change, but less than in the Low Flow Channel, given contributing tributary flows from Honcut Creek, the Yuba River, and the Bear River. Changes in hydraulic conditions and geomorphic processes under the conservative pulse flow

[2] These findings are consistent with results presented in the Draft Initial Study/Proposed Mitigated Negative Declaration for the Feather River Salmonid Habitat Improvement Project. Hydraulic modeling conducted for the 2014 gravel augmentation project in the Low Flow Channel indicated that the gravel would begin to mobilize at flows between 7,000 and 14,000 cfs, indicating that travel would mobilize on the ascending limb of flood flow and would have a negligible effect on water surface elevation (California Department of Water Resources 2022b).

release scenario were evaluated across several sub-reaches of the High Flow Channel and are discussed in the following sections. **Table 3.4-9** presents changes in hydraulic conditions under the conservative pulse flow release scenario across five sub-reaches.

Sub-reach 1: Thermalito Afterbay Outlet to Honcut Creek

Hydraulic Conditions: As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions from the Thermalito Afterbay Outlet to Honcut Creek; this sub-reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June). Much of the variability in water level can be explained by the variations in flow contributions from the Thermalito Afterbay Outlet.

Baseflow inundation extents in this sub-reach are generally larger than in the Low Flow Channel given the additional flow from the Thermalito Afterbay Outlet. The pulse flow would temporarily increase inundation by approximately 60 percent (see Table 3.4-9), as many side channels are activated under the pulse flow condition. While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions would fall within the range of existing hydrologic variability.

Geomorphic Processes: As described in Section 3.4.2, this reach of the High Flow Channel also features very coarse gravel and cobble materials, and erosion-resistant sediment. As detailed in Appendix B, limited/minimal sediment transport is expected in the reach from the Thermalito Afterbay Outlet to Honcut Creek. Therefore, under the conservative pulse flow release scenario, at a 10,000 cfs flow rate over five days, the change in sediment transport rates would be low and no bank erosion is expected.

Sub-reach 2: Honcut Creek to Yuba River

Hydraulic Conditions: As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions from Honcut Creek to the Yuba River; this sub-reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June). As the river transitions from a dynamic gravel bed reach with multiple/wider channels to a single deeper channel, increases in flow are accommodated. The resulting changes in inundation extent are less than the upstream reach from the Thermalito Afterbay Outlet to Honcut Creek.

In sub-reach 2, adding the pulse flow to the base flow would temporarily increase inundation by 30-40 percent (see Table 3.4-9). While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions would fall within the range of existing hydrologic variability.

Geomorphic Processes: As described in Section 3.4.2, between Honcut Creek and the Yuba River, the riverbed transitions from gravel and cobble to gravel and sand, which leads to an increased volume of grains that can be mobilized. To provide for a conservative analysis, sediment transport in this sub-reach was analyzed using only sand, as coarser material is less sensitive to changes associated with the pulse flows (as discussed above). This sub-reach is more active for bank erosion than the upstream reaches that comprise coarser bank material and tall, fine-grained banks that allow the river to migrate laterally and more rapidly. As detailed in Appendix B, under the conservative pulse flow release scenario, at a 10,000 cfs flow rate over five days, the change in sediment transport rates would be minimal (approximately 0.5 percent). Bank erosion in this sub-reach under the pulse flow condition would also be minimal, ranging from 0.8 to 1.1 percent.

Sub-reach 3: Yuba River to Bear River

Hydraulic Conditions: As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions in the Yuba River to Bear River sub-reach; this sub-reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June). Flow contributions from the Yuba River diminish the influence of the pulse flow release.

In sub-reach 3, adding the pulse flow to the base flow would temporarily increase inundation by 30-35 percent (see Table 3.4-9). While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions would fall within the range of existing hydrologic variability.

Geomorphic Processes: As described in Section 3.4.2, this sub-reach is a coarse sand bed reach. Flows from the Yuba River increase flow rates; however, once the river corridor fills from levee to levee and the floodwater is fully activated, transport rates do not increase rapidly with increased discharge. Downstream of the Yuba River, bank erosion is present but at a lower frequency than the reach immediately upstream. As detailed in Appendix B, under the conservative pulse flow release scenario, at a 10,000 cfs flow rate over five days, the change in sediment transport rates and bank erosion would be minimal (approximately 0.5 percent and less than 1 percent, respectively).

Sub-reach 4: Bear River to the Nicolaus Gauge

Hydraulic Conditions: As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions from the Bear River to the Nicolaus gauge; this sub-reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June). In above-normal water years, the velocity is lower because of elevated water levels downstream including in the Sutter Bypass, Sacramento River, and American River that create a backwater effect extending upstream towards the Nicolaus gauge.

Compared to existing conditions, inundation extents under the pulse flow condition are greater than in the previous reach, as side channels along the base of the levee extend from the Bear River down to the Nicolaus gauge on the east bank (river left) and extend to the Sutter Bypass on the west bank (river right). As these channels receive more water under the pulse flows, adding the pulse flow to the base flow results in inundation extents increasing 35–50 percent (see Table 3.4-9). While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions would fall within the range of existing hydrologic variability.

Geomorphic Processes: As described in Section 3.4.2, the narrower channel and increased sand deposits in this sub-reach lead to increased sediment transport. As detailed in Appendix B, under the conservative pulse flow release scenario, at a 10,000 cfs flow rate over five days, geomorphic processes under the pulse flow condition resemble those in the upstream reach (Yuba River to Bear River). That is, the change in sediment transport rates and bank erosion would be minimal (approximately 0.5 percent and less than 1 percent, respectively).

Sub-reach 5: Nicolaus Gauge to the Sacramento River Confluence at Verona

Hydraulic Conditions: As described in Section 3.4.2, this sub-reach of the Feather River runs parallel to the Sutter Bypass (see Figure 3.4-1). The river channel is bordered on its east bank (river left) by a federal levee and by agricultural levees on the west bank (river right). Since the agricultural levee is lower than the federal levee, under higher Feather River flows that agricultural levee can be overtopped and flow into the Sutter Bypass. As described above (Section 3.4.2), the Lower Sutter Bypass is subject to inundation from backwater effects from the confluence of the Feather and Sacramento rivers (i.e., the volume of flows approaching the Sacramento River near Verona exceeds the capacity of the river at this location).

As detailed in Appendix B, water level and velocity profiles during the 10,000 cfs pulse flow condition fall within the range of existing conditions; this sub-reach of the Feather River experiences depths and velocities similar to or greater than the pulse flows during the spring release period (March through June). Modeling results suggest that when pulse flows are released, the greatest water level and velocity differences are observed when Sacramento River flows are their lowest, thereby limiting the backwater influence.

Higher releases from the Thermalito Afterbay Outlet also tend to reduce the relative magnitude of the peak pulse contribution to additional inundation. Under the conservative pulse flow release scenario, pulse flows would not overflow the natural banks of the Feather River. The majority of the inundation associated with the pulse flows is within the Sutter Bypass. Under the critically dry year pulse flow release scenario, there are limited inundation extent increases in the spring months (approximately 13 percent, inclusive of both the Feather River and the Sutter Bypass; see Table 3.4-9). Under the above-normal year pulse flow release scenario, flows in the Feather River are higher, and lead to greater increases in inundation extents caused by the backwater effect from the Sacramento River through the Sutter Bypass (up to approximately 104 percent; see Table 3.4-9). The most notable increase is during the above-normal June simulation, where flows in the Sutter Bypass are low; however, the backing up of water resulting from the pulse flow's increased stages allows the small channel along the west levee of Sutter Bypass to surpass bank full and expand quickly outward. On these low-gradient floodplains, small increases in water surface elevation lead to significant increases in inundation extent. Although the largest percent increase in inundation extent occurs in the above-normal June simulation, the water depths at that time are relatively shallow (approximately 1 foot). As discussed, while inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system. Therefore, under the conservative pulse flow release scenario, changes in hydraulic conditions would fall within the range of existing hydrologic variability.

Geomorphic Processes: Although this reach was not explicitly evaluated for changes in geomorphic processes, based on the results of the Bear River to Nicolaus gauge sub-reach, changes in sediment transport and bank erosion would remain within the range of existing variability.

Summary for High Flow Channel

The High Flow Channel of the Feather River was evaluated at the sub-reach scale. As presented above, from the Thermalito Afterbay Outlet to the Sacramento River confluence at Verona, changes in water level, velocity, and inundation extent under the pulse flow conditions fall within the typical range of hydrologic variability experienced in the system. The magnitude of the percent changes in inundation extent due to the pulse flow release decreases from upstream to downstream as flow contributions from tributaries (Honcut Creek, Yuba River, Bear River) and increasing channel size (width and depth) dampen differences in the hydraulic conditions resulting from the pulse flow release (see Table 3.4-9). While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability experienced in the system.

Despite transitions from coarse gravel to finer sands from upstream to downstream, mobilization of sediment remains within the range of existing conditions. Under the conservative pulse flow release scenario, sediment transport rates in the Feather River would be minimal compared to existing conditions (increase by less than 0.3 percent in the gravel-bed reaches and less than 0.9 percent in the sand-bed reaches). Changes in bank erosion along the High Flow Channel would also remain within the range of existing conditions, even within the most active reach (Honcut Creek to Yuba River) where changes would be minimal (less than 1 percent).

For the reasons described above, the conservative pulse flow release scenario would not substantially affect the existing drainage pattern in the High Flow Channel and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

Sacramento River from the Confluence with the Feather River to the Delta

Hydraulic Conditions: As described in Section 3.4.2, this reach of the Sacramento River is contained between two federal levees with limited floodplain inside the levees. From the Sacramento River confluence with the Feather River to the Delta, the pulse flows represent a smaller percentage of the total flows and fall within the range of existing hydrologic variability. As detailed in Appendix B, changes in water level, velocity, and inundation extent under the conservative pulse flow release scenario would be minimal (see Table 3.4-9) and would fall within the range of existing hydrologic variability.

Geomorphic Processes: As detailed in Appendix B, changes in sediment transport and bank erosion under the conservative pulse flow release scenario would fall within the range of existing variability.

Summary: For the reasons described above, the conservative pulse flow release scenario would not substantially affect the existing drainage pattern in the Sacramento River from the confluence with the Feather River to the Delta, and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

Delta

In the Delta, changes in flow rates and water surface elevation as a result of the pulse flow releases would also be minimal compared to the total volume of the Delta and the scale of tidal flux. For this reason, the conservative pulse flow release scenario would not substantially affect the existing drainage pattern in the Delta, and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

Implications of WSIP Operational Exchange Process

All Geographic Areas

The WSIP Operational Exchange Process allows for recovery of the pulse flow release amounts through a reduction in Feather River flows by reducing flows from Lake Oroville during the Recovery Period (between July and September) to allow Lake Oroville storage to replenish.

The reduction in releases from Lake Oroville and flows through the Low and High Flow Channels would fall within the typical range of operational flows as described in the 2016 BiOp and other DWR agreements and would therefore remain within the typical range of existing operational variability experienced within the system. Releases during the Recovery Period would meet flow and temperature requirements for the Low and High Flow Channels of the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations).

Therefore, the WSIP Operational Exchange Process would not substantially affect the existing drainage patterns of the geographic areas analyzed, and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow.

Summary

The impact analysis presented in this section evaluates the potential for implementation of the Pulse Flows Component—defined by DWR's actions of the pulse flow releases and WSIP

Operational Exchange Process—to substantially alter the existing drainage pattern of the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to Verona, and the Delta. As presented above and detailed in Appendix B, changes in hydraulic conditions and geomorphic processes would occur primarily in the Low and High Flow Channels of the Feather River. Once flows reach the Sacramento River confluence and continue to the Delta, changes in these parameters would be minimal relative to inputs from tributary creeks and the scale of tidal flux. Modeling of the conservative pulse flow release scenario indicates that changes in hydraulic conditions and geomorphic processes resulting from the pulse flow releases would fall within the typical range of hydrologic variability experienced in the system.

Additionally, releases from Lake Oroville during the Recovery Period would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability.

For these reasons, the Pulse Flows Component would not substantially affect the existing drainage patterns of the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to Verona, and the Delta, and therefore would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow. Impacts would be **less than significant.**

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to existing drainage patterns of the study area are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.4-2: Implementation of the Pulse Flows Component would violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality.

As described above, the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (August through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

The Pulse Flows Component would alter the timing of flows, reservoir storage, and lake elevation levels, which could alter water quality. For example, during the Recovery Period, there would be a corresponding reduction in Discretionary Releases from Lake Oroville that would reduce river flows later in the year, from July through September, when compared to existing conditions.

However, all DWR actions would be coordinated through DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations, to help ensure that flow releases are within required downstream parameters, including water quality standards (e.g., Low and High Flow Channel water temperature targets as presented in the 2016 BiOps) and waste discharge requirements.

The Pulse Flows Component would be operated in a manner consistent with overall SWP operational constraints. Reductions in Discretionary Releases within required downstream parameters would not violate water quality standards or waste discharge requirements, or otherwise degrade water quality. Source water for the Kern Fan and Willow Springs projects that are supplied by SWP water (i.e., Article 21 water) would be provided under existing SWP water rights permits and/or pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

As presented in Impact 3.4-1 and detailed in Appendix B, changes in hydraulic conditions and geomorphic processes under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. Reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, implementation of the Pulse Flows Component would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality, and impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to violation of any water quality standards or waste discharge requirements that would substantially degrade surface or ground water quality are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.4-3: Implementation of the Pulse Flows Component would substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin.

As described above, the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (August through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As presented in Impact 3.4-1 and detailed in Appendix B, changes in hydraulic conditions during pulse flow releases would remain within the typical range of hydrologic variability experienced in the system. Reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Because the total volume of water would not substantially change compared to existing conditions, changing the timing of the flows would not substantially interfere with annual groundwater recharge or impede sustainable groundwater management of the basin. In addition, because of the limited frequency of pulse flows and the relatively limited reduction in flows in the Feather River during the subsequent Recovery Period, the Pulse Flows Component would have a limited potential to substantially alter groundwater recharge in the Pulse Flows Component location compared to existing conditions.

The Pulse Flows Component would not require groundwater as a water supply source (and thus would not necessitate groundwater pumping), as the water would be supplied by the SWP. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to sustainable groundwater management are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.4-4: In flood hazard, tsunami, or seiche zones, implementation of the Pulse Flows Component would risk release of pollutants due to project inundation.

Several of the major water bodies and SWP facilities within the Pulse Flows Component study area are in special flood hazard areas mapped by FEMA, including Lake Oroville, the Thermalito Facilities, the lower Feather River, the Sacramento River, the Delta, and associated flood bypass systems (Figure 3.8-5). The Pulse Flows Component location is not in a tsunami zone, but given its presence over geologic faults, it may be present in a seismic seiche zone.[3]

Although the Pulse Flows Component would not require construction of new facilities, implementation of the pulse flow releases would result in increased flood flow conditions at existing facilities. However, as discussed in Impact 3.4-1 and detailed in Appendix B, changes in hydraulic conditions during the conservative pulse flow release scenario would remain within the typical range of variability of the existing hydrologic system. Existing facilities at Lake Oroville would be used to manage flood flows, with operations at those facilities modified to support the pulse flow releases and to facilitate the WSIP Operational Exchange Process to return water used for pulse flows back to the SWP. Because the Pulse Flows Component would not construct new facilities or result in flow rates or water surface elevation outside the typical range of variability of the existing hydrologic system, implementation would not risk the release of pollutants due to inundation. Therefore, impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component

3 "Seismic seiches" are standing waves set up on rivers, reservoirs, ponds, and lakes when seismic waves from an earthquake pass through the area (U.S. Geological Survey 1994).

related to release of pollutants due to project inundation in a flood hazard or seismic seiche zone are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.4-5: Implementation of the Pulse Flows Component would conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan.

As described in Impact 3.4-2, implementation of the Pulse Flows Component would not violate any water quality standards that would otherwise degrade surface or groundwater quality. The Pulse Flows Component would be coordinated with DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations, to ensure that flow changes would be within required downstream parameters (i.e., minimum flow and temperature requirements for the Feather River). This includes operational constraints for fish and wildlife protection and water quality as described in relevant water quality control plans (i.e., basin plans), as well as other environmental and legal restrictions. Water from pulse flows would be supplied under existing SWP water rights permits and source water for the WSIP Groundwater Projects (i.e., water banks) would be pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies. Accordingly, the Pulse Flows Component would be operated in a manner consistent with existing salinity control and fish and wildlife protection measures in the Delta and would avoid conflicts with existing basin plans. DWR's actions would be coordinated with DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations. Therefore, the Pulse Flows Component would not conflict with or obstruct implementation of the applicable water quality control plans (basin plans). **No impact** would occur.

As discussed in Impact 3.4-3, implementation of the Pulse Flows Component would not impede the sustainable groundwater management of the basin. The Pulse Flows Component would not require groundwater as a water supply source. Changing the timing of the flows would not substantially interfere with annual groundwater recharge or impede sustainable groundwater management of the basin, because the total volume of water would not substantially change compared to existing conditions. Therefore, the Pulse Flows Component would not conflict with or obstruct implementation of a sustainable groundwater management plan. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conflicts with, or obstruction of implementation of a water quality control plan or sustainable groundwater management plan are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

3.5 Biological Resources–Aquatic

This section discusses the potential for the Pulse Flows Component to affect aquatic biological resources. This section is limited in scope to special-status fish species. For analysis of effects on wetlands, terrestrial wildlife, and special-status plants, see Section 3.6, "Biological Resources–Terrestrial." The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and the Willow Springs Water Bank Project.

Recall that the objectives of the Pulse Flows Component include to improve habitat conditions for listed salmonids, and to improve conditions for spawning and migration conditions for other listed and non-listed native fish species.

3.5.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (Figure 2-2).

Impacts on aquatic biological resources were not evaluated for several geographic areas. The Pulse Flows Component would not affect special-status aquatic resources upstream of Oroville Dam, for two reasons:

(1) The change in water surface elevation/water level from the release of pulse flows in the spring and the subsequent Recovery Period would not substantially alter littoral habitat for recreationally important special-status species occurring in Lake Oroville (e.g., non-native black bass species).

(2) The release of pulse flows during the spring and the subsequent Recovery Period would not affect tributary flows.

Under existing conditions, Oroville Dam, its associated facilities, and the operation of these facilities result in effects on fish species and their habitat. The Oroville Facilities impose a total barrier to fish migration at the Fish Barrier Dam, located downstream of Oroville Dam. Operation of the facilities produces thermographs and hydrographs that differ from the historical (pre-dam) condition of the Feather River. Oroville Dam retains sediment and large woody material that would otherwise continue downstream and replenish spawning and rearing habitat (National Marine Fisheries Service 2016).

The Harvey O. Banks Pumping Plant (Banks Pumping Plant) and California Aqueduct portion of the Pulse Flows Component study area (i.e., from the Banks Pumping Plant to the WSIP Groundwater Projects) consists of engineered facilities (pumping plants, pipes, concrete-lined canals, and turnout structures). The water flows in the California Aqueduct are highly regulated by pump stations and check structures (e.g., small dams) and physically segregated from the Central Valley range of special-status fish species populations. Changes in the physicochemical characteristics of California Aqueduct water from flow changes caused by the pulse flow projects would be minimal, given that additional State Water Project (SWP) exports to fill the WSIP Groundwater Projects would be two orders of magnitude lower than exports occurring for other uses. (See further discussion in the "South Delta Exports at Banks Pumping Plant" section below.) Note that entrainment risk caused by differences in South Sacramento–San Joaquin Delta (Delta) exports at the Banks Pumping Plant is discussed in the impact analysis for the Delta (geographic area 5).

San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Because the source of water in the reservoir is the California Aqueduct, San Luis Reservoir is physically segregated from the Central Valley range of special-status fish species populations so the changes in the physicochemical characteristics of aqueduct water from flow changes from the Pulse Flows Component would be minimal. Therefore, impacts on aquatic biological resources were not evaluated for the following geographic areas:

- Geographic Area 1: Oroville Complex
- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

The four remaining geographic areas contain focal fish species. Changes in flow rates, water levels, and other parameters resulting from the pulse flow releases and WSIP Operational Exchange Process are anticipated to occur primarily in the Low and High Flow channels of the Feather River. Based on the analysis in Section 3.4, "Hydrology and Water Quality," impacts of the pulse flow releases from Lake Oroville diminish considerably at the point where the Feather River meets the Sacramento River because the pulse flows make up an increasingly smaller proportion of overall flows in the waterways (see also Appendix B). Therefore, the analysis is more detailed for the Feather River. Because the pulse flows would be dedicated to instream beneficial uses and would be protected from diversion (California Water Code Section 1707), the pulse flows would enter and pass through the Delta (i.e., past Chipps Island).

Therefore, impacts on aquatic biological resources were evaluated for the following geographic areas:

- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

3.5.2 Environmental Setting

This environmental setting section provides a focused discussion of existing conditions in the geographic areas analyzed for aquatic biological resource impacts (as identified above). A general description of each of the seven geographic areas composing the Pulse Flows Component study area is presented in Section 2.3.

Feather River

The Feather River is the largest tributary to the Sacramento River downstream of Shasta Dam. The Feather River's drainage area covers 3,607 square miles on the east side of the Sacramento Valley, and its two largest tributaries are the Yuba and Bear rivers (U.S. Bureau of Reclamation 2019). The Feather River has undergone many anthropogenic changes from its historical condition. These changes began in earnest with the California Gold Rush and continued with the development of human-made dams and other structures to control the flow, storage, and transport of water, and the development of hydroelectric power.

The "lower Feather River" is generally considered to be the portion of the Feather River and its watershed that lies downstream of Oroville Dam, extending to the confluence with the Sacramento River at Verona (see Figure 2-3). As described in Section 2.3, the lower Feather River is commonly divided into the Low Flow Channel and the High Flow Channel. The transition is at the Thermalito Afterbay Outlet, through which most of the outflow from Lake Oroville is routed. The lower Feather River watershed encompasses about 803 square miles. The river flows approximately 68 miles north to south before entering the Sacramento River at Verona. The river is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley (National Marine Fisheries Service 2016).

The National Marine Fisheries Service (NMFS) identified a number of factors that affect fish habitat in the lower Feather River below the Fish Barrier Dam (National Marine Fisheries Service 2016):

- Blocked habitat.
- Altered river flow.
- Altered river temperatures.
- Impaired recruitment of large woody material and sediment.
- Susceptibility to disease.
- Water quality.
- Bank modification and loss of riparian habitat.
- Water diversions.
- Water management.
- Flood control.
- Recreational fishing.

Many of these factors would not be influenced by the Pulse Flows Component and are not discussed further. Three factors identified by NMFS (National Marine Fisheries Service 2016) that influence fish habitat quality in the lower Feather River could be affected by the Pulse Flows Component: altered river flow, altered temperature, and disease. Those factors are discussed further below.

Past and current operations of the Oroville Facilities create a hydrograph that is markedly different from the historical condition, which includes a consistent pattern of decreased springtime flows and increased summer flows across all water year types. NMFS suggested (National Marine Fisheries Service 2016) that anadromous fishes are sensitive to changes in streamflow, timing their life-cycle movements according to local discharge regimes. For fish species such as steelhead (*Oncorhynchus mykiss*), Chinook salmon (*O. tshawytscha*), and green sturgeon (*Acipenser medirostris*), which evolved in conditions of elevated springtime flows, such an altered hydrograph may have negative effects; but under some conditions, such as drought, the altered hydrograph may be beneficial (National Marine Fisheries Service 2016).

Flow and temperature requirements for the Feather River are discussed in Section 3.5.3 below.

Although flows are managed to protect fish and fish eggs, there may be some unintended negative biological consequences. The modified flow regime has reduced the frequency of channel-forming flows; this change, along with the presence of levees, has reduced the lateral movement of the Feather River. The result has been a more channelized river with reduced sinuosity, which reduces the amount of some types of habitats that are productive for salmonids. Flood management has also reduced the frequency of inundation of floodplains, which are areas that are generally very productive for salmonids when inundated. The alteration of flows may also be affecting downstream migration and survival because decreased flows increase travel time (National Marine Fisheries Service 2016).

Past and current operations of Oroville Dam and associated facilities affect water temperature in the Feather River below Oroville Dam. Water temperatures may be colder or warmer than historic norms in the river depending on a number of parameters: (1) the large, naturally occurring variability in Feather River hydrology (unimpaired Feather River flow has varied from 1 million acre-feet (maf) to nearly 10 maf over the roughly 100-year gauge record); (2) operation of dams farther upstream; and (3) a variety of operations conducted at Oroville Dam, a majority of which are not elective for DWR, such as flood control and riparian water right deliveries.

Since 2004, DWR has targeted a mean daily water temperature objective of less than or equal to 65 degrees Fahrenheit (°F) (18.3 degrees Celsius [°C]) from June 1 through September 30 at Robinson Riffle on the lower Feather River (River Mile [RM] 61.6). Water can be drawn from a variety of depths within Lake Oroville by adding or removing shutters on the Hyatt Power Plant intakes. Because deeper water tends to be colder, this type of manipulation is effective, up to a point, at regulating the temperature of the water released from Oroville Dam. Also, the dam structure has a River Valve Outlet System that allows deep, cold water to be released if desired. Typically as water flows downstream of Oroville Dam, most of the water is diverted into the Thermalito Facilities.

As described in Chapter 2, “Description of the Pulse Flows Component,” the Thermalito Afterbay is operated to meet multiple requirements, including regulating inflow from the Thermalito Pumping-Generating Plant, releasing water through the Thermalito Afterbay Outlet to the Feather River for instream and downstream demands, and providing for diversions for the Feather River service area’s irrigation demands. Water’s residence in the broad, shallow lake-type area of the afterbay tends to warm the water, which then flows back into the Feather River at the Thermalito Afterbay Outlet. The diversion of water through the Thermalito Facilities can warm water as much as 6°F and can significantly reduce the amount of coldwater habitat available in the Feather River. Pump-back operations can also contribute to the artificial warming of river water, although pump-back operations have not been used since 2004 and are not expected to resume in the near term (National Marine Fisheries Service 2016: 23).

Water temperatures downstream of Oroville Dam have been significantly altered by the presence of the Oroville Facilities, resulting in water temperatures that are now warmer in the winter and cooler in the summer (National Marine Fisheries Service 2016: 182). It is unclear how the cooler water temperatures compare to the spawning, incubation, and rearing habitat to which native species occurring in the Feather River were adapted before construction of the dams on the Feather River (National Marine Fisheries Service 2016: 182).

Studies in the lower Feather River have shown that there is a relatively high rate of infection of juvenile Chinook salmon with the myxozoan parasite *Ceratonova shasta*. Adult Chinook salmon carcasses from the Low Flow Channel produce billions of myxospores annually that move downriver over the winter, and are then consumed by the alternative polychaete worm host *Manayunkia occidentalis,* from which waterborne actinospores capable of infecting juvenile Chinook salmon are released (Foott et al. 2023). A five-year study demonstrated that the prevalence of infection is considerably greater in the High Flow Channel than in the Low Flow Channel. The study found that there is an infectious zone beginning at the Thermalito Afterbay Outlet, with initial infection of fry and detection of the actinospore stage in river water beginning in late January or early February, and overt, lethal disease occurring in March (Foott et al. 2023). The High Flow Channel itself appears to be the primary source of actinospore production, as opposed to the Thermalito Afterbay (Foott et al. 2023). Foott et al. (2023) observed that ≥85 percent of the natural fry population has migrated past their High Flow Channel trapping location when disease severity increases in March, with disease progression occurring if exposure within the High Flow Channel is five days or more.

Additional surveys are required to elucidate whether disease progresses in fry chronically exposed to low actinospore concentrations during downstream river migration in January and February (Foott et al. 2023). Despite high flows in 2017 and relatively low spore concentrations in 2018, most fish sampled in 2018 were assessed to be diseased. Foott et al. (2023) noted that after their first study year (2015), the infectious zone has since enlarged to include reaches of the Feather River below the Yuba River confluence. Foott et al. (2023) noted that the high flows of 2017, followed by increasing levels of infection in 2018 and 2019, suggest that some portion of the alternative host polychaete population is associated with stable habitat such as the lee side of boulders and riprap and can recolonize within a year.

Sacramento River

As distinct from where the Sacramento River flows through the Delta, the portion of the lower Sacramento River that could be more affected by Pulse Flows Component flows extends approximately 20.4 miles, from its confluence with the Feather River near Verona (RM 79.8) to the northern boundary of the legal Delta at the I Street Bridge in the city of Sacramento (RM

59.4) (see Figure 2-2). Along with its tributaries, the lower Sacramento River provides migratory, spawning, rearing, and other habitat for a variety of fish species (see the "Special-Status Fish Species" section, below).

The Sacramento River between the confluence with the Feather River and the boundary of the legal Delta has a wide range of aquatic habitat characteristics. Some physical parameters of habitat for this river reach (for example, discharge, water temperature, and water quality) have been monitored for long periods of time. Other parameters that are also important to fish, such as substrate, instream structure, and overhead shaded riparian canopy, have not been well characterized.

There have been substantial geomorphic changes to the Sacramento River channel from its native state. This segment of the river is currently a single-thread, narrowly confined, leveed channel that has been extensively hardened with large rock revetment, arresting the channel erosion and channel meandering that once occurred. The levees at the channel margin have blocked the river's access to historical wetlands and seasonally inundated floodplains. The levees and revetment have resulted in relatively uniform fish habitat.

Agriculture is the primary land use along the Sacramento River upstream of the cities of Sacramento and West Sacramento, at which point the urban landscape prevails. Urbanization in the form of private residences has occurred along long distances of the river reach; this has resulted in the addition of more than 170 private boat docks, with their supporting facilities, to the aquatic environment.

Numerous water diversion facilities are present along the Sacramento River. Herren and Kawasaki (2001) documented as many as 431 diversions from the Sacramento River between Shasta Dam and the city of Sacramento as of April 1997. The exact number of agricultural diversions along the Sacramento River between Verona and the I Street Bridge is unknown, but they are believed to be numerous, with various types, capacities, and timing of use. Most are unscreened. The two largest diversions to the Natomas Basin (Sankey and Pritchard Lake) are operated by the Natomas Central Mutual Water Company and have been screened in recent years to reduce entrainment of juvenile salmonids.

Also added to the riverscape in this reach are marinas, boat launching ramps, irrigation and stormwater return flow facilities, bridges, wing-dikes, sunken boats and other structures, and numerous instream structures of unknown current purpose. This list does not include numerous upstream facilities that influence the environmental conditions encountered by fish in this river reach. Although the habitat in this reach of the Sacramento River is uniform and degraded relative to historical habitat conditions, there are no fish passage issues in the Sacramento River reach from Verona to the I Street Bridge (see Figure 3.4-1).

On the mainstem Sacramento River, relatively high rates of predation have been suggested to occur at diversion facilities (Vogel 2013) and areas where rock revetment has replaced natural riverbank vegetation (National Marine Fisheries Service 2009). Species such as Chinook salmon fry, juveniles, and smolts are more susceptible to predation at these locations because native and non-native predators occur at relatively high density near structures and riprapped areas that provide refuge to ambush predators (Williams 2006; Tucker et al. 2003; Sabal et al. 2016).

Tidal influence extends up the Sacramento River to Verona, with greater tidal variations occurring downstream during low river stages.

Delta

Ecologically, the Delta consists of three major landscapes and geographic regions:

- The North Delta freshwater flood basins, composed primarily of freshwater inflow from the Sacramento River system.
- The South Delta distributary channels, composed of predominantly San Joaquin River system inflow, and within the interior, reflecting the hydraulic influence of the SWP and Central Valley Project (CVP) South Delta pumping facilities.
- The central Delta tidal islands landscape, wherein flows from the Sacramento River, San Joaquin River, and eastside tributary flows converge, and tidal influences from San Francisco Bay are greater.

The pulse flows from the Pulse Flows Component would be dedicated to instream beneficial uses, and they would be protected from diversion by an instream flow dedication from the State Water Resources Control Board (State Water Board) under California Water Code Section 1707 (DWR is currently pursuing this dedication). Therefore, the pulse flows would remain in the Sacramento River through the Delta (i.e., past Chipps Island) and would not be diverted by the SWP's Banks Pumping Plant in the South Delta, for example.

Flow management in the Delta altered the aquatic habitat in the following ways:

- Changed aspects of the historical flow regime (timing, magnitude, and duration) that supported the life-history traits of native species.
- Limited access to habitat and reduced the quality of habitat.
- Contributed to conditions better suited to invasive, non-native species (reduced spring flows, increased summer inflows and exports, and low and less-variable interior Delta salinity [Moyle and Bennett 2008]).
- Caused net reverse flows in channels, which led to the potential for project export facilities to entrain fish (Mount et al. 2012).

Species native to the Delta are adapted to and depend on variable flow conditions at multiple scales, which are influenced by the region's wide-ranging seasonal and interannual climatic variation. In particular, most native fishes evolved reproductive or outmigration timing associated with historical peak flows during spring (Moyle 2002).

Water temperatures in the Delta follow a seasonal pattern of winter coldwater conditions and summer warmwater conditions. This is largely because of the region's Mediterranean climate, with its alternating cool-wet and hot-dry seasons. The most notable recent changes in water temperatures in the Delta have been in the form of increased summer water temperatures over large areas because of high summer ambient air temperatures.

Landscape-scale changes resulting from flood management infrastructure, along with flow modification, have eliminated most of the historical hydrologic connectivity of floodplains and aquatic ecosystems in the Delta and its tributaries, thereby degrading and diminishing Delta habitat for native plant and animal communities (Mount et al. 2012). Large-scale reclamation of tidal wetlands has also contributed to the degradation and reduction of habitat for Delta fishes. The large reduction of hydrologic variability and landscape complexity, coupled with degradation of water quality, has supported invasive aquatic species that have further degraded conditions for native species.

Because of the combination of these factors, the Delta appears to have undergone an ecological regime shift unfavorable to many native species (Baxter et al. 2010), including delta smelt, longfin smelt, Sacramento splittail, green sturgeon and white sturgeon, and juvenile Chinook salmon (Jassby et al. 1995; Kimmerer 2002a; Rosenfield and Baxter 2007; Kimmerer et al. 2009; Fish 2010; Perry et al. 2012; Thomson et al. 2010; Feyrer et al. 2010; Loboschefsky et al. 2012; Mount et al. 2012; Heublein et al. 2017). A shift has also occurred in the littoral fish assemblage of the Delta since the mid-1990s, largely driven by increases in the presence of non-native fish species such as centrarchids and Mississippi silversides (Mahardja et al. 2017).

Salinity is a critical factor influencing the distribution of plant and animal communities in the Delta. Although estuarine fish species are generally tolerant of a range of salinity levels, this tolerance varies by species and life stage. A measure of the spatial geography of salinity in the western Delta is X2, which is the distance in kilometers from the Golden Gate Bridge to the point where the salinity on the bottom is 2 parts per thousand. X2 has been used to help define the extent of habitat available for oligohaline pelagic organisms and their prey. It has been correlated with the abundance of some species and the amount of suitable habitat for delta smelt in fall (Feyrer et al. 2007, 2010; U.S. Fish and Wildlife Service 2008).

Based on an analysis of historical monitoring data, Feyrer et al. (2007) defined the abiotic habitat of delta smelt as a specific envelope of salinity and turbidity that changes over the course of the species' life cycle. However, Murphy and Weiland (2019) suggest that the low-salinity zone (LSZ) is not a reliable indicator of delta smelt habitat—and by extension, the distribution of the species in the Delta—given that the species frequently occurs outside the zone, or that large parts of the zone do not have delta smelt detections in regular monitoring. In recent decades, it has been suggested that during the fall, lower outflows have tended to shift X2 farther upstream, out of the wide expanse of Suisun Bay into the much narrower channels near the confluence of the Sacramento and San Joaquin rivers (near Collinsville), thereby reducing the spatial extent of low-salinity habitat believed to be important for some species such as delta smelt (U.S. Fish and Wildlife Service 2008, 2011; Kimmerer et al. 2009; Baxter et al. 2010).

More recent studies comparing Delta outflow during pre-project and post-project time periods do not support the conclusion that project operations have significantly moved X2 more upstream in September, October, and November, relative to pre-project conditions (Hutton et al. 2016).

Summer-fall habitat for delta smelt is managed as part of the implementation of current regulations governing SWP and CVP operations. Investigations are ongoing regarding the effects of Delta outflow on delta smelt and its habitat (Schultz 2019, 2021).

Feyrer et al. (2007, 2010) concluded that an overall negative trend in habitat quality has occurred for delta smelt and striped bass (and potentially other fish species), as measured by water quality attributes and midwater trawl catch data since 1967. Thomson et al. (2010) found that X2 in spring had a strong negative relationship with longfin smelt, spring calanoids, and mysids, but none of the other Pelagic Organism Decline species; by contrast, X2 in fall was negatively related only to striped bass abundance.

The abundance of several taxa has been correlated with X2 (Jassby et al. 1995; Kimmerer 2002a, 2002b), suggesting that the quantity or suitability of estuarine habitat may increase when outflows are high. However, further analyses by Kimmerer et al. (2009, 2013) generally indicated that changes in the area or volume of low-salinity water (habitat) did not tend to be consistent with the abundance relationships, suggesting that X2 may be indexing other environmental variables or processes rather than simple extent of habitat.

Special-Status Fish Species

Many fish species use the Feather River, Sacramento River, and Delta during all or some portion of their lives. The California Natural Diversity Database and previous environmental documents (e.g., California Department of Water Resources 2020; U.S. Bureau of Reclamation 2019; Sites Project Authority and U.S. Bureau of Reclamation 2017, 2021) were reviewed to identify special-status and commercially or recreationally important species that could occur in these water bodies. Certain fish species were selected to be the focus of the evaluation in this Draft SEIR section based on their use of the Feather River, the Sacramento River to the Delta, and the Delta, and on their potential to be affected by implementation of the Pulse Flows Component. Fish species of focal evaluation include those species that could be affected by the Pulse Flows Component that fall within any of the following categories:

- Species listed by the federal or State government as threatened or endangered.
- Species identified by CDFW as species of special concern (classified as critical, high, or moderate status based on Moyle et al. 2015) and species designated by California statute as fully protected (i.e., California Fish and Game Code Section 5515 [fish]).
- Species considered by USFWS or NMFS as Species of Concern.
- Species that are of tribal, recreational, or commercial importance.

Based on these categories, 19 fish species of focal evaluation were identified as having the potential to occur at locations that could be directly or indirectly affected by implementation of the Pulse Flows Component. **Table 3.5-1** identifies these species and their protected status; their tribal, recreational, or economic importance; and the species' occurrence in the area of analysis.[1]

[1] For the reason noted in the "Geographic Regions Analyzed" section above, impacts on aquatic biological resources have not been evaluated for the California Aqueduct portion of the Pulse Flows Component location (i.e., from Banks Pumping Plant to the WSIP Groundwater Projects, including San Luis Reservoir).

The species in the table are generally identified in the following order: (1) State-listed or federally listed species that occur in the Feather River; (2) State species of special concern or federal species of concern that occur in the Feather River; (3) State-listed or federally listed species that occur in the Delta; and (4) recreationally or commercially important species, regardless of distribution. Spring-run Chinook salmon have the greatest potential to be affected by implementation of the Pulse Flows Component and therefore are discussed first, with Central Valley steelhead and green sturgeon also having potential for effect but to a lesser extent.

TABLE 3.5-1
SPECIAL-STATUS FISH SPECIES WITH POTENTIAL TO BE AFFECTED BY THE PULSE FLOWS COMPONENT

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Tribal, Recreational, or Economic Importance[2]	Occurrence within Area of Analysis[3]
Chinook salmon, Central Valley spring-run ESU	*Oncorhynchus tshawytscha*	FT	ST	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Steelhead, Central Valley DPS	*Oncorhynchus mykiss irideus*	FT	–	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Green sturgeon, southern DPS	*Acipenser medirostris*	FT	SSC	Y	Feather River,[4,5] Sacramento River,[4,5] Delta[5]
Chinook salmon, Sacramento River winter-run ESU	*Oncorhynchus tshawytscha*	FE	SE	Y	Feather River,[5] Sacramento River,[5] Delta[5],
Chinook salmon, Central Valley fall-run and late fall-run ESU	*Oncorhynchus tshawytscha*	SC	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Pacific lamprey	*Entosphenus tridentatus*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Western river lamprey	*Lampetra ayresi*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
White sturgeon	*Acipenser transmontanus*	–	SSC	Y	Feather River,[4,5] Sacramento River,[4,5] Delta[5]
Sacramento splittail	*Pogonichthys macrolepidotus*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Hardhead	*Mylopharodon conocephalus*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Sacramento hitch	*Lavinia exilicauda*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Central California roach	*Lavinia symmetricus*	–	SSC	Y	Feather River,[4,5] Sacramento River,[5] Delta[5]
Longfin smelt	*Spirinchus thaleichthys*	FC	ST	Y	Delta[4,5]
Delta smelt	*Hypomesus transpacificus*	FT	SE	Y	Delta[6]
Striped bass	*Morone saxatilis*	–	–	Y	Feather River,[4,5] Sacramento River,[4,5] Delta[5]
American shad	*Alosa sapidissima*	–	–	Y	Feather River,[4,5] Sacramento River,[4,5] Delta[5]

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Tribal, Recreational, or Economic Importance[2]	Occurrence within Area of Analysis[3]
Largemouth bass	*Micropterus salmoides*	–	–	Y	Feather River,[6] Sacramento River,[6] Delta[6]
Smallmouth bass	*Micropterus dolomieu*	–	–	Y	Feather River,[6] Sacramento River,[6] Delta[6]
Spotted bass	*Micropterus punctulatus*	–	–	Y	Feather River,[6] Sacramento River,[6] Delta[6]

NOTES: Delta = Sacramento–San Joaquin Delta; DPS = distinct population segment; ESU = evolutionarily significant unit

Species are identified in the following general order: (1) State-listed or federally listed and occur in the Feather River; (2) State species of special concern or federal species of concern and occur in the Feather River; (3) State-listed or federally listed and occur in the Delta; and (4) recreationally or commercially important regardless of distribution.

1 Status: FC = federal candidate for listing under the Endangered Species Act; FE = federally listed as endangered under the Endangered Species Act; FT = federally listed as threatened under the Endangered Species Act; SC = federal species of concern; SE = State-listed as endangered under the California Endangered Species Act; SSC = State species of special concern; ST = State-listed as threatened under the California Endangered Species Act.
2 Species of importance because of existing regulatory management that limits commercial or recreational harvesting.
3 The “area of analysis” for special-status fish species refers only to those areas affected by pulse flows within the species’ range and includes the Feather River from the Fish Barrier Dam downstream to the Delta.
4 Species uses the river/Delta for spawning.
5 Species uses the river/Delta for rearing and migration.
6 Species uses the river/Delta year-round for all life stages.

SOURCES: California Department of Fish and Wildlife 2019; Moyle et al. 2015; Shilling et al. 2014:15–46.

Spring-Run Chinook Salmon

Historically, the Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU) in the Sacramento River Basin was found in the upper and middle reaches (1,000–6,000 feet in elevation) of the American, Yuba, Feather, Sacramento, McCloud, and Pit rivers, as well as in smaller tributaries of the upper Sacramento River below Shasta Dam (National Marine Fisheries Service 2009). Naturally spawning populations of spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, the Yuba River, and the Feather River. With the exception of the Feather River spawning areas, these other riverine reaches used for spawning would not be affected by the Pulse Flows Component. However, all spring-run Chinook salmon migratory life stages must pass through the Delta and the lower Sacramento River to the Feather River confluence.

Juvenile spring-run Chinook salmon rear in natal tributaries, the Sacramento River mainstem, and non-natal tributaries to the Sacramento River. Spring-run Chinook salmon may migrate downstream as young-of-year, juveniles, or yearlings. Juvenile emigration from the Feather River generally occurs from mid-November through June, with peak emigration occurring from January through March. Rotary screw trap data for 1998–2000 documented emigration of Central Valley spring-run Chinook salmon from the Feather River peaking in December, followed by another pulse of juvenile young-of-year emigrants at Live Oak in April and May (National Marine Fisheries Service 2016). Migratory cues—such as increased flows, increasing turbidity from runoff, changes in day length, or intraspecific competition from other fish in their natal streams—may spur outmigration of juveniles from the upper Sacramento River Basin when they have reached the appropriate stage of maturation (National Marine Fisheries Service 2009). Recent research has found that the majority of spring-run adults returning to Mill Creek and Deer Creek emigrated as yearlings, even though yearlings constitute a relatively small portion of the juvenile population (Cordoleani et al. 2021).

Spring-run Chinook salmon returning to spawn in the Sacramento River system enter the San Francisco Estuary from the ocean in January to late February and move through the Delta before entering the Sacramento River. Adult Central Valley spring-run Chinook salmon enter the Feather River as immature adults from March to June and spawn in the fall, during September and October (National Marine Fisheries Service 2016).

Central Valley Steelhead

Existing stocks of wild California Central Valley steelhead Distinct Population Segment (DPS) (Central Valley steelhead) in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in other tributaries, and a few naturally spawning steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). Historical accounts rarely mention the distribution and abundance of California Central Valley steelhead in the Feather River Basin (National Marine Fisheries Service 2016).

Adult steelhead migrate upstream past the Fremont Weir between August and March, and primarily from August through October; they migrate upstream past the Red Bluff Diversion Dam (RBDD) during all months of the year, but primarily during September and October (National Marine Fisheries Service 2009). The primary spawning area used by steelhead in the Sacramento River is well upstream of the confluence with the Feather River. Steelhead spawn in the Feather River between December and March, with peak spawning occurring in late January. Most of the natural steelhead spawning in the Feather River occurs in the Low Flow Channel, particularly in its upper reaches near the Hatchery Side Channel, a side channel between RM 66 and RM 67. Limited spawning has also been observed below the Thermalito Afterbay Outlet (National Marine Fisheries Service 2016).

Unlike salmon, steelhead may live to spawn more than once, and they generally rear in freshwater streams for two to four years before migrating to the ocean. Both spawning areas and migratory corridors are used by juvenile steelhead for rearing before outmigration. Feather River steelhead generally emigrate from about February through September, with peak emigration occurring from March through mid-April. However, empirical and observational data show that juvenile Central Valley steelhead potentially emigrate from the Feather River during all months of the year (National Marine Fisheries Service 2016).

The segment of the Sacramento River between the Delta and the confluence with the Feather River functions primarily as a migration channel. Limited rearing habitat may exist in areas of setback levees, although these areas are primarily upstream of Colusa (National Marine Fisheries Service 2009).

Juvenile steelhead migrate through the Delta from October through July. Chipps Island catch data indicate a difference in the outmigration timing between wild and hatchery-reared steelhead smolts from the Sacramento River and eastside tributaries. Hatchery fish are typically recovered at Chipps Island from January through March, with a peak in February and March, corresponding to the schedule of hatchery releases of steelhead smolts from the Central Valley hatcheries (Nobriga and Cadrett 2001; U.S. Bureau of Reclamation 2008). Outmigration by wild (unmarked) steelhead occurs over approximately six months, with the highest levels occurring in February through June (Aasen 2011, 2012).

Green Sturgeon

The Sacramento River provides habitat for green sturgeon spawning, adult holding, foraging, and juvenile rearing. Suitable spawning temperatures and spawning substrate exist for green sturgeon in the Sacramento River upstream and downstream of the RBDD (U.S. Bureau of Reclamation 2008). Based on the distribution of sturgeon eggs, larvae, and juveniles, spawning occurs in the Sacramento River upstream of Hamilton City (Brown 2007; Poytress et al. 2013). The Feather River contains at least two known green sturgeon spawning areas: the Thermalito Afterbay Outlet (Seesholtz et al. 2015) and below the Fish Barrier Dam in the Low Flow Channel (Heublein et al. 2017:8). The Feather River also provides a migratory corridor for the species to access the Yuba River, where spawning also occurs (National Marine Fisheries Service 2016; California Department of Fish and Wildlife 2018, 2019).

The timing of migration and spawning varies by individual and from year to year. In general, however, green sturgeon leave the ocean and enter the San Francisco Bay–Delta and estuary in late winter/early spring (generally February through April), then arrive at holding and spawning locations between April and July, with most spawning activity concentrated from mid-April through mid-June (Heublein 2006; Kelly et al. 2007; National Marine Fisheries Service 2016). After their initial spawning run upriver, adults may hold in the upper river for a few weeks to several months before moving back downstream, which occurs from fall into winter (Vogel 2008; Heublein et al. 2009; Miller et al. 2020), or they may migrate immediately back downstream. Radio-tagged adult green sturgeon have been tracked moving downstream past Knights Landing during the summer and fall, typically in association with pulses of flow in the river (Heublein et al. 2009). Recent information indicates that adult green sturgeon may hold for extended periods of time in the river and may be present year-round, despite their anadromous life history (Miller et al. 2020).

Larval green sturgeon hatch in the late spring or summer (May through August) and move downstream toward the Delta and estuary, rearing into juveniles (National Marine Fisheries Service 2016). Young green sturgeon appear to rear for the first one to two months near spawning areas (Heublein et al. 2017). After hatching, larvae and juveniles migrate downstream toward the Delta in the late fall or early winter, usually with a flow increase from a rain event. Juveniles are believed to use the Delta for rearing for the first one to three years of their lives before moving out to the ocean; they are likely to be found in the main channels of the Delta and the larger interconnecting sloughs and waterways, especially in the central Delta and Suisun Marsh and Bay (U.S. Bureau of Reclamation 2019).

Adult and juvenile green sturgeon use the Sacramento River downstream of the Feather River as a migratory pathway. Adult and juvenile green sturgeon use the Delta as a migration corridor and are known to reside in the Delta for extended periods of time (Heublein et al. 2017).

Winter-Run Chinook Salmon

Adult Sacramento River winter-run Chinook salmon ESU fish return to fresh water during the winter but delay spawning until spring and summer. Adults enter fresh water in an immature reproductive state, then hold in the cool waters downstream of Keswick Dam for an extended period before spawning. Adults first enter San Francisco Bay from November through June, then migrate up the Sacramento River, past RBDD, from mid-December through early August (National Marine Fisheries Service 2016).

Holding and spawning activities take place in the Sacramento River well upstream of the Feather River confluence (National Marine Fisheries Service 2019). The majority of the run passes RBDD from January through May, with the peak of passage occurring in mid-March (National Marine Fisheries Service 2016). Spawning occurs from May through July, peaking in June and July. Fry emergence occurs from mid-June through mid-October, and fry disperse to areas downstream of the spawning grounds for rearing. Outmigration from the upper Sacramento River to the Delta occurs primarily from December through April. Most juvenile winter-run Chinook salmon outmigrate past Chipps Island by the end of March (National Marine Fisheries Service 2019).

Juvenile winter-run Chinook salmon may remain and rear in the Delta until they are 5–10 months of age (based on scale analysis) (Fisher 1994; Myers et al. 1998). Although the duration of residence in the Delta is not precisely known, Del Rosario et al. (2013) suggested that it can be up to several months, including in the Sacramento River (National Marine Fisheries Service 2009).

Sampling at Chipps Island in the west Delta suggests that winter-run Chinook salmon exit the Delta as early as December and as late as May, with a peak in March (Brandes and McLain 2001; Del Rosario et al. 2013).

The Feather River supports some non-natal rearing of winter-run Chinook salmon in the lowermost reaches of the river, as suggested by otolith microchemistry (Phillis et al. 2018). From downstream of the Feather River confluence to Chipps Island, the Sacramento River serves as a migratory corridor for both adult and outmigrant juvenile winter-run Chinook salmon; the Delta serves as a rearing area for juveniles, and juveniles and adults migrate through the Delta. Most rearing appears to occur in the Sacramento River, and sizable proportions of juveniles also rear in the American River and several creeks originating on the slopes of Mount Lassen (Battle Creek, Mill Creek, and Deer Creek; Phillis et al. 2018).

Fall-Run and Late Fall-Run Chinook Salmon

The Central Valley fall/late fall-run Chinook salmon ESU includes both fall-run Chinook salmon and late fall-run Chinook salmon, even though some of their life history characteristics differ. Fall-run Chinook salmon are an ocean-maturing type of salmon adapted for spawning in lowland reaches of big rivers, including the mainstem Sacramento River, Feather River, and Yuba River. Late fall-run Chinook salmon are mostly a stream-maturing type (Moyle 2002). Adult late fall-run Chinook salmon typically hold in the river for one to three months before spawning, while fall-run Chinook salmon generally spawn shortly after entering fresh water. The majority of young fall-run Chinook salmon migrate to the ocean during the first few months after their emergence, although some may remain in fresh water and migrate as yearlings. Late fall-run juveniles typically enter the ocean after 7–13 months of rearing in freshwater, at 150–170 millimeters (mm) in fork length, which is considerably larger and older than fall-run Chinook salmon entering the ocean (Moyle 2002).

The primary Sacramento River spawning area used by fall-run and late fall-run Chinook salmon is well upstream of the Feather River confluence, with the highest density for each run located in the reach between Keswick Dam and RBDD. Fall-run Chinook salmon migrate into the Feather River from the Sacramento River and spawn in both the Feather and Yuba rivers.

Central Valley fall-run and late fall-run Chinook salmon pass through the Delta as adults migrating upstream and juveniles out-migrating downstream. Adult fall-run Chinook salmon migrate through the Delta and into Central Valley rivers, including the Feather River, from June through December. Adult late fall-run Chinook salmon migrate through the Delta and into the Sacramento River from October through April.

Most fall-run Chinook salmon fry rear in fresh water from December through June, with outmigration as smolts occurring primarily from January through June. Late fall-run Chinook salmon rear in fresh water from April through the following April and outmigrate as smolts from October through February (Snider and Titus 2000).

From downstream of the Feather River confluence to Chipps Island, the Sacramento River serves as a migration corridor for both adult and outmigrant juvenile fall-run and late fall-run Chinook salmon. Some fry and juvenile fall-run and late fall-run Chinook salmon use the Delta for rearing.

Pacific Lamprey

Pacific lamprey are anadromous, rearing in fresh water before migrating to the ocean, where they grow to full size before returning to their natal streams to spawn. They are culturally important to indigenous people throughout their range and play a vital role in the ecosystem as food for mammals, fish, and birds; as nutrient cycling and storage; and as a prey buffer for other species (Goodman and Reid 2012).

Data from midwater trawls in Suisun Bay and the lower Sacramento River indicate that Pacific lamprey adults likely migrate into the Sacramento River and its tributaries from late fall (November) through early summer (June) (Hanni et al. 2006). Hannon and Deason (2008) documented Pacific lamprey spawning in the American River between early January and late May, with peak spawning typically occurring in early April. Pacific lamprey ammocoetes rear in parts of the Sacramento River for all or part of their five- to seven-year freshwater residence. Data from rotary screw trapping at sites on the mainstem Sacramento River indicate that outmigration of Pacific lamprey peaks from early winter through early summer, but some outmigration is observed year-round at both RBDD and the Glenn-Colusa Irrigation District diversion dam (Hanni et al. 2006).

From downstream of the Feather River confluence to Chipps Island, the Sacramento River serves as a migration corridor for both adult and outmigrant Pacific lamprey. The Feather River supports spawning and rearing. Some Pacific lamprey ammocoetes rear in the Delta (Goertler et al. 2020).

Western River Lamprey

Western river lamprey are found in large coastal streams from just north of Juneau, Alaska, to San Francisco Bay (Vladykov and Follett 1985). The Sacramento and San Joaquin basins are at the southern edge of their range (Moyle et al. 2009). Western river lamprey seem to be associated primarily with the lower portions of certain large river systems, and most records for the state are from the lower Sacramento–San Joaquin system, especially the Stanislaus and Tuolumne rivers (Moyle 2002). In the Sacramento River, they have been documented upstream to at least RBDD (Hanni et al. 2006). Western river lamprey have also been collected in the Sacramento River as far upstream as RBDD, the Feather River, the American River, and Mill and Cache creeks (Vladykov and Follett 1985; Hanni et al. 2006; Moyle et al. 2009).

The life history of Western river lamprey is poorly known, especially in California (Moyle et al. 2015). Adults migrate from the ocean to spawning areas during the fall and late winter (Beamish 1980). Spawning is believed to occur from February through May in small tributary streams (Moyle 2002). Presumably, like adults of other lamprey species, adult Western river lampreys need clean, gravelly riffles in permanent streams for spawning; larvae (ammocoetes) require sandy to silty backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 25°C (77°F) (Moyle et al. 2015). After the larvae emerge, they drift downstream and burrow into sediments in pools or side channels, where they rear. After several years, the larvae metamorphose in late July, and the juveniles (macropthalmia) migrate downstream in the following year from May to July (Moyle 2002).

From downstream of the Feather River confluence to Chipps Island, the Sacramento River serves as a migration corridor for both adult and outmigrant Western river lamprey. The Feather River supports spawning and rearing.

White Sturgeon

In California, white sturgeon are most abundant in the Delta region, but the population spawns mainly in the Sacramento River, the Feather River, and the San Joaquin River (Moyle 2002; Jackson 2013; Jackson et al. 2016). White sturgeon are found in the Sacramento River primarily downstream of the RBDD site (Tehama-Colusa Canal Authority 2008), and most spawning and embryo development occurs between Knights Landing and Colusa (Schaffter 1997; Moyle 2002; Israel and Klimley 2008).

Spawning-stage adults generally move from estuarine and ocean habitats into the lower reaches of the Sacramento River during winter before spawning, then migrate upstream in response to higher flows to spawn from February to early June (Schaffter 1997; McCabe and Tracy 1994). Most spawning in the Sacramento River occurs in April and May (Kohlhorst 1976). Young-of-year white sturgeon make an active downstream migration that disperses them widely to rearing habitat throughout the lower Sacramento River and Delta (McCabe and Tracy 1994; Israel and Klimley 2008).

White sturgeon migrate, spawn, and rear in the Feather River. They use the Sacramento River from the Feather River confluence to Chipps Island as a migratory pathway. Adult and juvenile white sturgeon use the Delta as a migration corridor and are known to reside in the Delta for extended periods of time (Heublein et al. 2017).

Sacramento Splittail

Historically, Sacramento splittail were widespread in the Sacramento River from Redding to the Delta (Moyle et al. 2004). Adult Sacramento splittail migrate upstream in the lower Sacramento River to above the mouth of the Feather River, and into the Sutter and Yolo bypasses (Sommer et al. 1997; Feyrer et al. 2005; Sommer, Baxter et al. 2007).

Non-reproductive adult Sacramento splittail are most abundant in moderately shallow, brackish areas, but can be found in freshwater areas with tidal or riverine flow (Moyle et al. 2004). Adults typically migrate upstream from brackish areas in January and February and spawn in fresh water on inundated floodplains in March and April (Moyle et al. 2004; Sommer, Baxter et al. 2007). In the Sacramento River drainage, the most important spawning areas appear to be the Yolo and Sutter bypasses; however, some spawning occurs almost every year along the river edges and backwaters created by small increases in flow. Splittail spawn in the Sacramento River from Colusa to Knights Landing in most years (Feyrer et al. 2005).

Most juvenile splittail move from upstream areas downstream into the Delta from April through August (Meng and Moyle 1995; Sommer, Baxter, et al. 2007). The production of young-of-year Sacramento splittail is largely influenced by the extent and period of inundation of floodplain spawning habitats, with abundance peaking after wet years and declining after dry years (Sommer et al. 1997; Moyle et al. 2004; Feyrer et al. 2006).

Although juvenile Sacramento splittail are known to rear in upstream areas for a year or more (Baxter 1999), most move to the Delta after only a few weeks or months of rearing in floodplain habitats along the rivers (Feyrer et al. 2006). Juveniles move downstream into the Delta from April to August (Meng and Moyle 1995; Feyrer et al. 2005).

Sacramento splittail use the Feather River for spawning and rearing. From the Feather River confluence to Chipps Island, the Sacramento River serves as a migratory corridor for Sacramento splittail to spawning areas upstream. There also may be some local splittail spawning and rearing in this reach of the river, depending on flow conditions.

Hardhead

Hardhead are widely distributed in streams at low to mid-elevations in the Sacramento–San Joaquin and Russian River drainages (Leidy 1984; Moyle 2002). They exist throughout the Sacramento–San Joaquin River Basin and are fairly common in the Sacramento River and in the lower reaches of the American and Feather rivers; in other parts of their range, populations have declined or have become increasingly isolated (Moyle 2002).

Hardhead mature after their second year and spawn in the spring, mainly in April and May (Reeves 1964), judging by the upstream migrations of adults into smaller tributary streams during this time of the year (Moyle 2002). They migrate upstream and into tributary streams as far as 45 miles to spawning sites. This species' spawning behavior has not been documented, but it is assumed to be similar to that of the pikeminnow, which deposits eggs over gravel-bottomed riffles, runs, and at the head of pools (Moyle et al. 1995).

Hardhead are considered a resident fish in the Feather River and in the Sacramento River downstream of the Feather River confluence. Hardhead are present only in very low abundance in the San Francisco Estuary and Delta, as reflected by electrofishing in the 1980s and 2000s (Brown and Michniuk 2007) and the collection of very few individuals at the SWP/CVP South Delta fish salvage facilities (California Department of Water Resources 2020:4-62).

Sacramento Hitch

Sacramento hitch historically occurred in low-elevation streams throughout the Sacramento and San Joaquin valleys and in the Delta but are now extirpated from the San Joaquin River and tributaries between Friant Dam and the Merced River (Moyle et al. 2015). In the vicinity of the San Francisco Estuary and Delta, there are historical records for Sacramento hitch (pre-dating 1950s water development) in Coyote Creek and Alameda Creek. However, the species may have been introduced to Arroyo Valle through water transfers from the Central Valley. Furthermore, it is unknown whether populations in these streams are reproducing or are sustained by reservoir or historical stream populations (Leidy 2007).

This species occurs in some urban streams and may tolerate highly altered habitats. Sacramento hitch face continued threats from population fragmentation (e.g., dams), agriculture (e.g., flow alteration and pollution), estuary alteration, and non-native species. The species appears to be in long-term decline and consists mainly of small populations scattered over a broad area. However, there is only moderate concern for the overall extinction of the Sacramento hitch, in part because of the species' fairly secure establishment in some areas (Moyle et al. 2015).

Moyle et al. (2015:2) summarized the habitat and distribution of the Sacramento hitch: Spawning takes place mainly in riffles of streams tributary to lakes, rivers, and sloughs after flows increase in response to spring rains, but spawning requirements need to be documented further. Moyle et al. (2015:2) indicate that young-of-year hitch spend the next two months after they hatch shoaling in shallow water or staying close to aquatic plants before moving out into more open water at around 50 mm fork length. The species is distributed in the Sacramento River Basin, including the Feather River (Seesholtz et al. 2004), but is no longer in the San Joaquin River Basin and in some locations in the North Delta (Moyle et al. 2015:2–3).

Central California Roach

Central California roach are found in tributaries to the Sacramento and San Joaquin rivers and tributaries to San Francisco Bay. Roach are most abundant in mid-elevation streams in the Sierra Nevada foothills and in lower reaches of some Bay streams, but they may also be found in the main channels of some rivers (Moyle 2002).

In lower mainstem stream channels, roach occur as part of a predominantly native fish assemblage that, depending on location, is characterized by combinations of native fishes (Leidy

2007). Central California roach cannot coexist with large populations of alien fishes, especially centrarchids such as sunfish and black basses (*Micropterus* spp.). Central California roach may reside in the Feather River and the lower Sacramento River between the Delta and the confluence with the Feather River year-round, and they spawn in these reaches during March through June, when water temperatures become suitable.

Delta Smelt

Delta smelt are endemic to the Delta and Suisun Marsh (Moyle et al. 1992; Bennett 2005). Delta smelt complete their entire life cycle in the LSZ of the upper estuary or in the tidal freshwater region of the Cache Slough Complex, or they move between the two regions of fresh water and low salinity (Bennett 2005; Sommer and Mejia 2013; Hobbs et al. 2019).

Studies conducted to synthesize available information about delta smelt indicate that they have been documented throughout their geographic range during much of the year (Merz et al. 2011; Sommer and Mejia 2013; Brown et al. 2014). Studies indicate that in fall, before spawning, delta smelt are found in the Delta and Suisun and San Pablo bays; at the Sacramento River/San Joaquin River confluence; in Cache Slough; and in the lower Sacramento River (Murphy and Hamilton 2013). By spring, they move to freshwater areas of the Delta region, including the Sacramento River/San Joaquin River confluence, and Cache Slough (Brown et al. 2014; Murphy and Hamilton 2013). There is also a freshwater resident life-history type (Bush 2017; Hobbs et al. 2019), occurring primarily in the Cache Slough region year-round (Sommer et al. 2011).

Sommer et al. (2011) described adult delta smelt initiating upstream spawning migrations during winter in association with “first flush” freshets. After arriving in freshwater staging habitats, adult delta smelt hold until the late winter and spring, when spawning begins during favorable water temperatures (Bennett 2005; Grimaldo et al. 2009; Sommer et al. 2011). Water temperatures suitable for spawning occur most frequently from March to May, but ripe female delta smelt have been observed as early as January, and larvae have been collected as late as July (Damon et al. 2016).

Delta smelt appear to have one spawning season for each generation, which makes the timing and duration of the spawning season important every year. Spawning locations can vary with the water year. During higher flows, spawning may be centered downstream of the Delta; during drier years, spawning is centered in the Delta. The length of the spawning season varies with variation in water temperature (Bennett 2005).

Although adult delta smelt can spawn more than once, most adults senesce by May (Polansky et al. 2018). The egg stage averages about 10 days before the embryos hatch into larvae (Bennett 2005). The larval stage averages about 30 days. Metamorphosing post-larvae appear in monitoring surveys from April into July of most years (Bennett 2005). By July, most delta smelt have reached the juvenile life stage. Delta smelt collected during the fall are considered sub-adults, and they are considered adults by January 1.

The distribution of the delta smelt population varies with life stage, season, and environmental conditions (Bennett 2005; Sommer et al. 2011; Hobbs et al. 2019). Sub-adult and adult delta smelt typically make landward movements soon after first-flush periods, when turbidities are elevated (Grimaldo et al. 2009). Larval delta smelt can be broadly distributed, depending on the freshwater flow during March and April. During wet years, larval delta smelt are generally distributed seaward. In contrast, during drier years, larval delta smelt are concentrated in the Delta. The distribution of juvenile delta smelt is generally centered in the North Delta Arc, which extends from Cache Slough to Suisun Bay and the Suisun Marsh. During and after larval rearing in fresh water, many young Delta smelt move with river and tidal currents to remain in favorable rearing habitats, often moving increasingly into the LSZ to avoid the seasonally warm and highly transparent waters that typify many areas in the central Delta (Interagency Ecological Program Management, Analysis and Synthesis Team 2015).

During the summer and fall, many juvenile Delta smelt continue to grow and rear in the LSZ until they mature during the following winter (Bennett 2005). Some delta smelt also rear in upstream areas such as the Cache Slough Complex and the Sacramento Deep Water Ship Channel, depending on habitat conditions (Sommer and Mejia 2013).

The Interagency Ecological Program Management Analysis and Synthesis Team report found a relationship between Delta outflow and spring delta smelt recruitment (spring to summer) for the post–Pelagic Organism Decline era (Sommer, Armor et al. 2007). However, the mechanisms underlying this relationship are unknown and warrant further investigation (Interagency Ecological Program Management, Analysis and Synthesis Team 2015).

During the late summer and fall, Delta outflow affects the distribution of low-salinity habitat in the upper estuary landscape. Higher Delta outflows (or low X2) expand the LSZ, and lower outflows constrict the extent of low-salinity habitat (Feyrer et al. 2011; Bever et al. 2016). It has been hypothesized that environmental conditions improve for delta smelt during the summer and fall, as X2 moves seaward and the LSZ expands habitat area (Interagency Ecological Program Management, Analysis and Synthesis Team 2015), although the importance of outflow during this time period is the subject of ongoing investigation (Schultz 2019, 2021).

Summer (June–August) outflow is positively related to survival of juvenile delta smelt (Polansky et al. 2021; Smith et al. 2021). Recent work suggests that increased Delta outflow during the summer and fall can increase the zooplankton prey *Pseudodiaptomus forbesi* subsidy from the Delta to the LSZ (Kimmerer et al. 2019; although see also Hamilton et al. 2020), and that greater spring outflow increases copepod prey density in much of the Delta (Hamilton et al. 2020).

Delta smelt use the Delta region during all life stages.

Longfin Smelt

Longfin smelt populations occur along the Pacific coast of North America, and the San Francisco Estuary represents the southernmost population (Garwood 2017). Longfin smelt generally occur in the Delta; Suisun, San Pablo, and San Francisco bays; and the Gulf of the Farallones, just outside San Francisco Bay.

Longfin smelt are anadromous and spawn in fresh or low-salinity water in the San Francisco Bay–Delta (Grimaldo et al. 2017), generally at two years of age (Moyle 2002). They migrate upstream to spawn during the late fall through winter, with most spawning from November through April (California Department of Fish and Wildlife 2020). Previous studies suggested that spawning in the Sacramento River occurs from just downstream of the confluence of the Sacramento and San Joaquin rivers, upstream to about Rio Vista (Moyle 2002). More recent studies suggest that hatching and early rearing occur in a much broader region and higher salinity (2–12 parts per thousand) than previously recognized (Grimaldo et al. 2017). Spawning likely also occurs in the Suisun Marsh and the Napa River (California Department of Fish and Wildlife 2020), and in other tributaries to San Francisco Bay, such as in the Coyote Creek watershed and nearby marsh areas (Lewis et al. 2020).

Longfin smelt larvae usually are most abundant in the water column from January through April (U.S. Bureau of Reclamation 2008).

Longfin smelt in the San Francisco Estuary are broadly distributed in both time and space, and interannual distribution patterns are relatively consistent (Rosenfield and Baxter 2007). Seasonal patterns in abundance and occurrence in the nearshore ocean suggest that the population is at least partially anadromous (Rosenfield and Baxter 2007; Garwood 2017). During the late summer and early fall, juvenile and adult longfin smelt are more common throughout San Francisco Bay than in other areas (Rosenfield and Baxter 2007; MacWilliams et al. 2016). During the spawning period in late fall and early winter, adults are more commonly found in San Francisco Bay tributaries and marshes (Lewis et al. 2020), Suisun Bay, and the Delta (Rosenfield and Baxter 2007). Larval longfin smelt are broadly distributed throughout San Francisco Bay and its associated tributaries during wet years (MacWilliams et al. 2016; Lewis et al. 2020; Parker et al. 2017). Merz et al. (2013) found that larvae were detected in the Delta more frequently in drier years than in wet years, but overall, more than 50 percent of the measured larval abundance in any given year occurred in Suisun Bay and the Suisun Marsh (Grimaldo et al. 2017).

Newly hatched larvae have been observed in salinities up to 12 practical salinity units (psu), with peak observations occurring between 2 and 4 psu (Grimaldo et al. 2017). Early juvenile longfin smelt (20–40 mm standard length) are found in salinities up to 30 psu, but most are found in salinities between 2 and 18 psu (MacWilliams et al. 2016). By late summer, late juveniles can tolerate full seawater.

Habitat for longfin smelt is open water, largely away from shorelines and vegetated inshore areas, except during spawning. This includes all of the large embayments in the estuary and the deeper areas of many of the larger channels in the western Delta. Indices of longfin smelt abundance are positively correlated with Delta outflow and negatively correlated with winter-spring X2 (Jassby et al. 1995; Kimmerer 2002b; Kimmerer et al. 2009; Baxter et al. 2010; MacNally et al. 2010; Thomson et al. 2010; Mount et al. 2013; Nobriga and Rosenfield 2016), or positively correlated with general indicators of hydrological conditions (e.g., watershed runoff) (Maunder et al. 2015). Because longfin smelt abundance indices have been correlated with Delta outflow, it is thought that habitat suitability in these areas for longfin smelt is somehow influenced by variation in freshwater flow, although the mechanism remains unknown (Jassby et al. 1995; Bennett and Moyle 1996; Kimmerer 2004; Kimmerer et al. 2009).

Longfin smelt use the Delta during all life stages; in recent years, those found in the Delta are found predominantly in the western Delta.

Striped Bass

The striped bass is anadromous and non-native. Adult striped bass are distributed mainly in the lower bays and ocean during the summer and in the Delta during the fall and winter. Spawning takes place in the spring, from April to mid-June (Leet et al. 2001), at which time striped bass swim upstream to their spawning grounds. Striped bass are not believed to spawn or rear in the Sacramento River upstream of RBDD (Tehama-Colusa Canal Authority 2008). Most striped bass spawning occurs in the lower Sacramento River between Colusa and the confluence of the Sacramento and Feather rivers (Moyle 2002). After spawning, most adult striped bass move downstream into brackish water and saltwater for the summer and fall.

The striped bass is an important seasonal sport fish in the Feather River. Striped bass are frequently observed from the Thermalito Afterbay Outlet to the confluence with the Sacramento River and are infrequently observed from Steep Riffle to the Thermalito Afterbay Outlet. Striped bass are present in the Feather River during adult immigration and spawning, which generally extends from April through June, with peak spawning occurring in May (California Department of Water Resources 2003).

Eggs are free-floating and negatively buoyant. The eggs hatch as they drift downstream, and larvae occur in shallow and open waters of the lower reaches of the Sacramento and San Joaquin rivers, the Delta, Suisun Bay, Montezuma Slough, and the Carquinez Strait.

Striped bass use the Feather River for spawning. Between the confluence with the Feather River and Chipps Island, the Sacramento River functions primarily as a migration corridor for both adults and drifting eggs and larvae.

American Shad

The American shad is a recreationally important anadromous species introduced into the Sacramento–San Joaquin River Basin in the 1870s (Moyle 2002). American shad spend most of their adult lives at sea and the species may make extensive migrations along the coast (U.S. Bureau of Reclamation 2019). American shad become sexually mature while in the ocean and migrate through the Delta to spawning areas in the Sacramento, Feather, American, and Yuba rivers. Spawning migration may begin as early as February, but most adults migrate into the Delta in March and early April (Skinner 1962). Migrating adults generally take two to three months to pass through the Sacramento–San Joaquin estuary (Painter et al. 1979). Fertilized eggs are slightly negatively buoyant, are not adhesive, and drift in the current. Newly hatched larvae are found downstream of spawning areas and can be rapidly transported downstream by river currents because of their small size. Juvenile shad rear in the Sacramento River below Knights Landing, in the Feather River below Yuba City, and in the Delta (Painter et al. 1979). Some juvenile shad may rear in the Delta for up to a year before migrating to the ocean (U.S. Fish and Wildlife Service 1995). Outmigration from the Delta begins in late June and continues through November (Painter et al. 1979).

Seasonally, adult American shad are important sport fish in the Feather River and in the reach of the Sacramento River from the Feather River confluence to Chipps Island. American shad use the Delta for upstream migration as adults and for downstream migration and rearing as juveniles.

Non-native Black Bass Species

The Delta is ranked among the 10 best black bass fishing locations in the United States. Black bass (a collective term for the genus *Micropterus*) have a long history in California. Three species—largemouth bass, smallmouth bass, and spotted bass—are highly regarded from a recreational perspective. All three species are commonly found in the Feather and Sacramento rivers. These fish are all resident in this reach, although they may move widely. Typically, as ambush predators on salmonids and other fishes, they use instream structures (boat docks, pilings, and rock piles) from which to hunt prey. Spawning occurs in the spring, with largemouth bass (the most commonly identified black bass species captured in the Feather River by Seesholtz et al. 2015) having an April–June spawning period (Moyle 2002).

3.5.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to the aquatic impact analyses as required under CEQA have been included.

Federal

Federal Energy Regulatory Commission

See Section 3.4.3 in Section 3.4, “Hydrology and Water Quality,” for a description of the Federal Energy Regulatory Commission (FERC) regulations for the Oroville Facilities and associated requirements related to the 1983 DWR/CDFW Agreement (California Department of Water Resources and California Department of Fish and Game 1983), the 2004 and 2016 NMFS Biological Opinions (BiOps) (National Marine Fisheries Service 2004; 2016), and the current and future FERC license for Oroville operations.

Federal Endangered Species Act

The federal Endangered Species Act (ESA) requires that both USFWS and NMFS maintain lists of threatened and endangered species and designates critical habitat for listed species. ESA Section 7(a)(2) requires all federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. If an activity proposed by a federal agency would result in the take of a federally listed species, the consulting agency will issue a BiOp analyzing the effects of the proposed action on listed species and an incidental take statement if appropriate. Where a federal agency is not authorizing, funding, or carrying out a project, take that is incidental to the lawful operation of a project may be permitted pursuant to ESA Section 10(a) through approval of a habitat conservation plan (HCP) and issuance of an incidental take permit (ITP). Operations of the Pulse Flows Component would be consistent with the existing BiOp for the Oroville Facilities (National Marine Fisheries Service 2016).

There are several species recovery plans for fish species listed under the ESA: Sacramento River winter-run and Central Valley spring-run Chinook salmon and Central Valley steelhead (National Marine Fisheries Service 2014), Delta native fish (including delta smelt, longfin smelt, and Sacramento splittail among the special-status fish species within the area of the aquatic biological resources analysis) (U.S. Fish and Wildlife Service 1996), and the southern DPS of North American green sturgeon.

Magnuson-Stevens Fisheries Conservation and Management Act

Section 305(b) of the Magnuson-Stevens Fisheries Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), requires federal agencies to consult with NMFS on activities that may adversely affect essential fish habitat for species that are managed under federal fishery management plans in United States waters. The statutory definition of "essential fish habitat" includes "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity," which encompasses all physical, chemical, and biological habitat features necessary to support the entire life cycle of the species in question.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act grants the U.S. Secretary of the Interior the authority to aid federal, state, public, or private agencies in developing, protecting, rearing, or stocking all wildlife, wildlife resources, and their habitats (U.S. Code Title 16, Section 661). Under the Fish and Wildlife Coordination Act, whenever waters of any stream or other water body are proposed to be impounded, diverted, or otherwise modified by any public or private agency under federal permit, that agency must consult with USFWS and, in California, CDFW (United States Code Title 16, Sections 661–667e, March 10, 1934, as amended in 1946, 1958, 1978, and 1995).

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA) authorized the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes of the CVP having equal priority with irrigation and domestic uses of CVP water, and elevated fish and wildlife enhancement to a level having equal purpose with power generation. Dedication of CVPIA Section 3406(b)(2) water occurs when the U.S. Bureau of Reclamation takes a fish and wildlife habitat restoration action based on the recommendations of USFWS (and in consultation with NMFS and CDFW), pursuant to Section 3406(b)(2). Water exports at the CVP pumping facilities have been reduced using Section 3406(b)(2) water to decrease the risk of fish entrainment at the South Delta export facilities and to augment river flows. The CVPIA directs the Secretary of the Interior to develop and implement the Anadromous Fish Restoration Program to restore natural populations and ensure the sustainability of anadromous fish (e.g., Chinook salmon, steelhead, green sturgeon, white sturgeon, American shad, and striped bass) in Central Valley rivers and streams.

State

California Endangered Species Act

The California Endangered Species Act (CESA) (Fish and Game Code Sections 2050–2089) establishes various requirements and protections regarding species listed as threatened or endangered under State law. The California Fish and Game Commission is responsible for maintaining lists of threatened and endangered species under CESA. CESA prohibits the take of listed species and candidate species (those that are petitioned to be listed) (Fish and Game Code Section 2080). In accordance with Section 2081 of the California Fish and Game Code, a permit from CDFW is required for projects "that could result in the incidental take of a wildlife species state-listed as threatened or endangered."

California Fish and Game Code Section 5937

Under California Fish and Game Code Section 5937, "The owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or through the dam to keep good condition any fish that may be planted or exist below the dam."

Salmon, Steelhead Trout, and Anadromous Fisheries Program Act

The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act states that it is the policy of the State of California to increase the state's salmon and steelhead resources and directs CDFW to develop a plan and program that strives to double California's salmon and steelhead resources (Fish and Game Code Section 6902[a]). It is also the policy of the State that existing natural salmon and steelhead habitat shall not be diminished further without offsetting the impacts of lost habitat (Fish and Game Code Section 6902[c]).

Porter-Cologne Water Quality Control Act and Water Quality Control Plans

See Section 3.4.3 in Section 3.4, "Hydrology and Water Quality," for a description of the Porter-Cologne Water Quality Control Act and the Water Quality Control Plans for the Sacramento and San Joaquin River Basins and the San Francisco Bay/Sacramento–San Joaquin Delta Estuary.

Regional and Local

As described in Section 3.5.1, the geographic areas analyzed for impacts on aquatic biological resources include the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba counties. Each county and city has local regulations and general plans with policies related to aquatic biological resources. These may include goals and policies such as preservation and reestablishment of special-status fish species and coordination with federal, State, and local resource agencies to protect special-status fish species.

3.5.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. An aquatic biological resources impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NMFS, or USFWS.
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
- Conflict with any local policies or ordinances protecting biological resources.
- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan.
- Result in cumulatively considerable impacts on biological resources.

As described previously, this section addresses potential impacts on special-status fish species. For an analysis of effects on wetlands, terrestrial wildlife, and special-status plants, see Section 3.5, "Biological Resources–Terrestrial."

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.5.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts and rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases," to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B were considered in addition to available relevant information including historical flow data and information regarding special-status fish species (see Table 3.5-1) and their habitat, as described in the following impact discussions.

Impacts and Mitigation Measures

Table 3.5-2 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.5-2
SUMMARY OF IMPACT CONCLUSIONS—AQUATIC BIOLOGICAL RESOURCES

Impact Statement	Impact Conclusion
3.5-1: Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NMFS, or USFWS.	LTS
3.5-2: Implementation of the Pulse Flows Component would interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	LTS
3.5-3: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources.	LTS
3.5-4: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan.	LTS

NOTES: LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates and ICF in 2024.

Impact 3.5-1: Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NMFS, or USFWS.

Summary of the Pulse Flows Component

As described in Chapter 2, “Description of the Pulse Flows Component,” the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations.

As described in Section 2.4.1, “Description of Potential Pulse Flow Releases,” CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, and above-normal water year types, with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. The DWR/CDFW Agreement for pulse flow operations will provide for decision making on the pulse flows that includes specifying the criteria for the timing and volume of the pulse flow releases (see Section 2.4.2, “Decision-Making Criteria and Constraints”). An instream flow dedication from the State Water Board (Water Code Section 1707) is being pursued for the pulse flows to ensure that pulse flows are not improperly diverted.

As described in Section 3.2.1, “Conservative Pulse Flow Release Scenario,” this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May, or June) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would meet flow and temperature requirements for the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations).

The spring pulse flows would travel though the Low Flow and High Flow Channels of the lower Feather River, the lower Sacramento River (below Verona), and the Delta, increasing riverine flows and net outflow to San Francisco Bay. Table 2-2 in Chapter 2, "Description of the Pulse Flows Component," illustrates the range of the volume and timing of pulse flow releases from Lake Oroville. Pulse flow amounts increasing total river flow up to 10,000 cfs would be released from Lake Oroville. Flow releases would be shaped to mimic natural hydrology, with an initial high pulse of flow that subsequently ramps down, thus facilitating outmigration by anadromous fish, providing cues for anadromous fish immigration, and minimizing the potential for stranding. Established ramping rates would be used to prevent rapid reductions in water levels that could cause stranding of juvenile salmonids and other aquatic organisms. The pulse flow releases would be coordinated with DWR's Water Operations Branch in compliance with all applicable guidelines, regulations, and other requirements, to help ensure that flow releases are within existing approved operations parameters.

The pulse flow releases under the Pulse Flows Component would result in a reduction of the SWP storage in Lake Oroville. The reduced SWP storage would be recovered through the WSIP Operational Exchange Process, illustrated in Figure 2-7. There would be no direct physical transfer of the additional WSIP water supplies into Lake Oroville; instead, an exchange of water supplies would occur where WSIP In-Lieu Table A Water would be distributed to SWP Partner Contractors in place of Table A Water that would have been delivered from Lake Oroville. There will be a reduction in Lake Oroville releases in July through September (the Lake Oroville Recovery Period [Recovery Period]) when contractor demands would otherwise have been met with SWP supplies from Lake Oroville (see Figure 2-6, which presents a conceptual diagram of the schedule associated with the Pulse Flows Component).

Because of the reduction in summer releases from Lake Oroville, there would be a corresponding reduction in summer flows in the lower Feather River and lower Sacramento River during years with pulse flows. Delta outflow would not directly correlate with the reduction in summer releases from Lake Oroville because flow releases that would have occurred in the absence of the Recovery Period would otherwise have been in some part exported at the SWP Banks Pumping Plant.

The reduction in Lake Oroville summer releases for a 100 taf pulse flow release would equate to approximately 548 cfs, assuming the pumping reduction is distributed evenly across the July through September Recovery Period. However, there would be somewhat less Delta outflow, because carriage water (as described in Section 2.5.3, "Efficiency Credit") associated with South Delta exports would not be released.

Following a spring pulse flow, the reduction of releases from Lake Oroville would result in reduced inflow into the Delta, and reduced exports from the Delta, during the Recovery Period.

In the example described above where a 100 taf pulse flow is released, there would be a subsequent reduction of 548 cfs from Lake Oroville during the Recovery Period. Assuming a 35 percent carriage water assessment, this would result in 356 cfs of reduced Delta exports (i.e., 548 cfs * 65 percent = 356 cfs that would have otherwise been exported) and 192 cfs of reduced Delta outflows (i.e., 548 cfs * 35 percent = 192 cfs of carriage water that would have otherwise flowed through the Delta) as compared to a year where no pulse flow occurs. This is because carriage water is not needed when there is no export of additional water from the Delta. Therefore, the average change in net Delta outflow (equivalent to the reduction in Carriage Water needed) is a reduction of 192 cfs.

A conservative (high) estimate of the relative potential change in net outflow can be derived as follows. The minimum allowable monthly average Delta outflow in July through September ranges from 3,000 cfs in a critically dry water year to 8,000 cfs in an above-normal or wet water year[2]. Selecting the minimum (3,000 cfs) value for use in calculating percent change in Delta outflow is a conservative assumption. Given a carriage water flow of 192 cfs (the conservative, 35 percent assumption), resulting in a reduction in net Delta outflow of 192 cfs, the outflow change would be about 6 percent (192 cfs/3,192 cfs). This represents an infrequent upper bound, featuring both the maximum Recovery Period reduction in Oroville release, combined with the minimum allowable Delta outflow. Note that all Delta requirements would still be met.

As described in Section 2.4.2, "Decision-Making Criteria and Constraints," DWR would forecast the magnitude and duration of the reduced outflow during the Recovery Period (July–September) when coordinating with CDFW regarding planned pulse flow releases.

Both the Low Flow and the High Flow Channels of the Feather River have flow and temperature requirements that would continue to be met as described in Section 3.4.3, "Regulatory Settings" under the subheading Biological Opinions for Oroville Operations. For the Low Flow Channel, the 1983 DWR/CDFW Agreement specifies a minimum release of 600 cfs from the Thermalito Diversion Dam into the Low Flow Channel for fisheries purposes. When the renewed FERC license is issued and the 2016 NMFS BiOp (National Marine Fisheries Service 2016) becomes effective, the minimum flow will increase to 700 cfs. The minimum flow will be increased to 800 cfs from September 9 to March 31 of each year to accommodate spawning, unless NMFS, USFWS and CDFW provide a written notice that a flow between 700 and 800 cfs will substantially meet the needs of anadromous fish (in which event, DWR may release that lower flow). Note that these 2016 BiOp requirements will not become effective until the new FERC license is issued. DWR manages flows in the Feather River in a manner that reduces the potential for stranding of fish and dewatering of redds (i.e., salmonid nests). Ramping rates, defined as the rates at which flows are increased or decreased in a river, are specified in the 2016 NMFS BiOp (see Chapter 2, "Description of the Pulse Flows Component", Table 2-3). Ramping rates are

2 The minimum allowable Delta outflow in July is 8,000 cfs (wet and above-ormal water years), 6,500 cfs (below-normal water years), 5,000 cfs (dry water years) and 4,000 cfs (critically dry water years); in August the minimum allowable is 4,000 cfs (wet, above-normal, and below-normal water years), 3,500 cfs (dry water years), and 3,000 cfs (critically dry water years); and in September the minimum allowable is 3,000 cfs in all water years (State Water Resources Control Board 2006, p.15).

important because decreasing flows too quickly may cause fish to become stranded (National Marine Fisheries Service 2016).

There is a temperature requirement at Robinson Riffle (RM 61.6), downstream of the Feather River Fish Hatchery in the Low Flow Channel. With the 2004 NMFS BiOp, DWR has targeted a mean daily water temperature objective of less than or equal to 65 degrees Fahrenheit (°F) from June 1 through September 30 to protect over-summering steelhead. During these summer months, the Robinson Riffle temperature requirement governs temperature management in the Low Flow Channel due to warming in the river prior to this compliance point.

For the High Flow Channel, the 1983 DWR/CDFW Agreement and the current FERC license stipulate instream flow requirements for fisheries purposes. The 2016 NMFS BiOp also sets a minimum instream flow requirement for the High Flow Channel consistent with the current FERC license and the 1983 DWR/CDFW Agreement, resulting in no change to the flow requirements for the High Flow Channel. The minimum instream flows range from 1,000 cfs to 1,700 cfs and are based on annual runoff. If the April 1 runoff forecast in a given water year indicates that, under normal operation of the SWP, Lake Oroville will be drawn down to 733 feet in elevation, minimum flows in the High Flow Channel may be diminished on a monthly average basis, in the same proportion as the respective monthly deficiencies imposed upon deliveries from the SWP; however, in no case shall the minimum flows be reduced by more than 25 percent (i.e., 25 percent of 1,000 cfs, or 750 cfs) (National Marine Fisheries Service 2016). Only Discretionary Releases would be reduced, and minimum flows of at least 750 cfs would be maintained in the Feather River below the Thermalito Afterbay Outlet in the summer of years with pulse flows. The Recovery Period would be extended into a second year if necessary to allow minimum existing flow requirements and other requirements to be met.

After issuance of the new FERC license, DWR is expected to implement Facilities Modifications to increase the flexibility to release more cold water from Lake Oroville to meet new temperature objectives in the 2016 NMFS BiOp. The new temperature objectives for the High Flow Channel range from 56 to 64 degrees Fahrenheit (National Marine Fisheries Service 2016).

The Pulse Flows Component would be operated in a manner consistent with applicable SWP operational requirements, including operational constraints for fish and wildlife protection and water quality, as well as other environmental and legal restrictions. Summer flows would not be reduced below those required for salinity control in the Delta and for fish and wildlife protection. As noted previously, Delta outflow would not be significantly reduced relative to existing conditions, because during the summer months of years when the pulse flows are expected, Delta regulatory requirements are met regardless of exports.

Implications of the Conservative Pulse Flow Release Scenario

Pulse Flow Aquatic Impacts in the Low Flow Channel

The Low Flow Channel of the Feather River is used for spawning and rearing by anadromous salmonid and lamprey species and serves as habitat for resident native minnows. Green sturgeon have been confirmed to spawn and have been observed in the Low Flow Channel (Heublein et al. 2017:8). During the period when pulse flows occur, fish species including steelhead, Pacific lamprey, Western river lamprey, and hardhead could be spawning and rearing. It is unknown at this time whether sturgeon would be attracted into the Low Flow Channel by flow pulses, although increases in flow are generally hypothesized to increase the attraction of sturgeon to spawning areas (Fish 2010; Heublein et al. 2017:27).

As described previously, pulse flows of up to approximately 100,000 af could occur every several years between March and June. For the conservative pulse flow release scenario, the maximum flow of 10,000 cfs is expected to occur about every three years, and a critically dry year and an above-normal year provide for a conservative analysis (see Section 3.2.1). Pulse flows would be released directly into the Low Flow Channel of the Feather River, and they would be dedicated for protection as a beneficial use for fish migration by California Water Code Section 1707 as they move downstream.

Pulse flow releases of the magnitude described in the conservative pulse flow scenario would result in a severalfold increase in flow relative to mean flows observed in critically dry water years (Table 3.4-2 in Section 3.4).[3] As described in Section 3.4 (Impact 3.4-1) and detailed in Appendix B, changes in hydraulic conditions (water levels, velocity, inundation extent) and geomorphic processes (sediment transport and bank erosion) under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system, so that the existing aquatic biological resource environment of the Low Flow Channel would not be substantially affected by the Pulse Flows Component.

Generally, pulse flows have the potential to affect flow-dependent physical habitat characteristics such as wetted area, depth, and velocity; turbidity and associated biological responses such as predation risk; migration cues for juvenile and adult anadromous fishes; water temperature; and biotic habitat characteristics such as the prevalence of the myxozoan parasite *Ceratonova shasta* (which infects freshwater salmonid fishes). The intent of the pulse flows is to affect these habitats in a beneficial way.

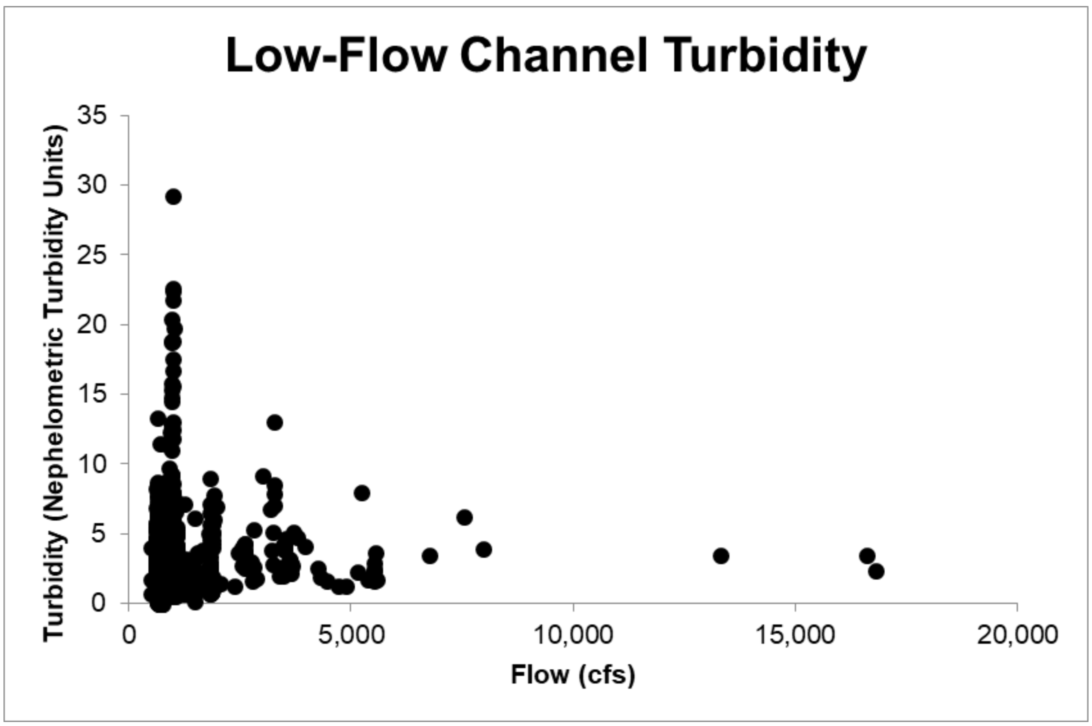
The increase in water volume associated with the pulse flows could increase the amount of suitable spawning habitat for Central Valley steelhead, when the water surface elevation of the Feather River increases and inundates areas along margins that were previously dry or too shallow. This increase in usable wetted areas may encourage spawning in areas that would dry out after the pulse flow, which would result in the dewatering and desiccation of redds (nests constructed in the gravel substrate) and may also result in pre-spawn mortality from unproductive energy expenditure by adult steelhead. However, the peak of steelhead spawning occurs during January and February (National Marine Fisheries Service 2016:302), before the projected pulse flow period. The relatively short duration (a few days) of the maximum possible (10,000 cfs) pulse flows would make the use of areas at risk for dewatering less likely, although some fish could spawn during the short period of time of higher inundation.

Pulse flows would also provide access to margin habitat by juvenile salmonids and other fish for feeding. Reductions in water surface elevation and wetted area as pulse flows recede would

[3] Increases up to 10,000 cfs total flow in the Low Flow Channel would require pulse flow releases of approximately 8,800–9,200 cfs based on mean critically dry year base flows of approximately 800–1,200 cfs (Table 3.4-2).

increase the potential for juvenile stranding. However, established ramping rates described in Chapter 2 would be implemented during pulse flow operations, which would minimize the risk of juvenile stranding.

Based on typical patterns observed in freshwater systems wherein flows are positively related to turbidity (e.g., Cloern et al. 2011), pulse flow releases could increase turbidity. This could benefit juvenile salmonids and other species by reducing visibility, thereby reducing predation risk by both avian and aquatic predators (Gregory and Levings 1998). It is not expected that turbidity would be substantially increased directly below the Fish Barrier Dam, at the upstream end of the Low Flow Channel, because suspended sediment levels in the released water would be low and because of the influence of the dam. Higher turbidity levels, should they occur, would be more likely to occur farther downstream in the Low Flow Channel as a result of sediment mobilization processes after the initial release of pulse flows. Moderate levels of turbidity are not expected to negatively affect aquatic species, but higher levels may cause direct harm by causing gill trauma and indirect harm by reducing foraging efficiency (Newcombe and Jensen 1996). Data collected at a DWR rotary screw trap near the downstream end of the Low Flow Channel show no statistically significant relationship between flow and turbidity (**Figure 3.5-1**). Therefore, based on the data collected by DWR, pulse flow releases would not be expected to substantially increase turbidity.



NOTE: Includes data for 2009–2022 at Gateway Riffle (River Mile 59.5; GPS coordinates 39.457160°, -121.623443), Eye Riffle (River Mile 60.2; GPS coordinates 39.456317°, -121.614745°), and Steep Riffle (River Mile 61; GPS coordinates, 39.462058°, -121.604404°). Turbidity is recorded during daily visits to rotary screw traps and flow is the mean on the same day.

SOURCE: Hickey pers. comm.

Figure 3.5-1
Relationship between Flow and Turbidity in the Feather River Low Flow Channel

An increased volume of water flowing down the Low Flow Channel is expected to benefit the downstream passage of juvenile anadromous salmonid and lamprey species by triggering a response to initiate downstream migration. As with juveniles, the increased rate of flow has the potential to enhance migratory cues for adult spring-run Chinook salmon that could be holding in the mainstem Sacramento River and lamprey species migrating to spawning and holding sites in the Low Flow Channel. An increased volume of water may also provide benefits to juvenile salmonids by providing a "flush" and decreasing the density of *Ceratonova shasta* or the alternative host polychaete population, although there is relatively little *Ceratonova shasta* in the Low Flow Channel (Foott et al. 2023), as discussed in Section 3.5.1, "Environmental Setting"; see further discussion below regarding the High Flow Channel.

Increased velocity could provide passage benefits to emigrating juvenile salmonids by reducing travel time and predation risk, based on patterns observed elsewhere in the Sacramento River Basin (Perry et al. 2018; Notch et al. 2020; Michel et al. 2021). However, flow/survival relationships in the Feather River have not been clearly established. This topic is discussed further below in the sections assessing potential effects in the Feather River High Flow Channel and Delta. The increase in velocity could also help to move juveniles downstream passively while requiring less energy output. Downstream migration by lamprey could also benefit from pulse flows if migration increases en masse, as has been observed for Pacific lamprey juveniles in the upper Sacramento River after rain-driven flow pulses (Goodman et al. 2015). There are no quantitative flow/survival relationships to inform the extent of potential benefits, however.

Water depth would increase during the pulse flow events (see Table 3.4-9 for changes in water levels, velocity, and inundation extent under the conservative pulse flow release scenario). However, as presented in Section 3.4 (Impact 3.4-1) and detailed in Appendix B, these changes would fall within the range of variability of the existing hydrologic system. Increased water levels in the Low Flow Channel could aid rearing juveniles by reducing the potential for predation from avian and terrestrial predators. Additionally, areas along margins could become inundated and increase forage opportunities for juveniles. Increased margin habitat could also benefit emigrating juveniles because they would have increased access to areas where instream shelter and cover are more prevalent. Increased depth also could aid adult passage opportunities by increasing the amount of flow over shallow-water obstacles, although as discussed further in the analysis below of flow decreases during the Recovery Period, passage limitations generally have not been found (National Marine Fisheries Service 2016:255). See also the discussion below regarding pulse flow effects in the Feather River High Flow Channel.

Water temperatures in the Feather River Low Flow Channel may decrease during the pulse flow events, although the extent of the change relative to existing conditions is unknown at this time. Decreases in water temperature during the pulse flow events would increase the extent of suitable habitat by extending the area of suitable water temperatures farther downstream than would otherwise occur. However, with favorable conditions farther downstream, adult spring-run Chinook salmon may not be incentivized to migrate to holding areas in the upper reaches of the High Flow Channel or the Low Flow Channel. A delay in upstream migration by adult spring-run Chinook salmon has the potential to cause individuals to migrate to holding areas during warmer conditions after the pulse flow events, when water temperatures would be less favorable and increase thermal stress on individuals. Conversely, this increased extent of colder water could reduce thermal stress on migrating adult spring-run Chinook salmon and would have the potential to reduce pre-spawn mortality of Central Valley steelhead (i.e., reduced in-vivo egg mortality or adult mortality). Additionally, reduced water temperatures could reduce sub-lethal stress on migrating or holding salmonids by decreasing metabolic requirements.

Colder water temperatures could improve rearing and emigration conditions for juvenile salmonid and lamprey species. The relative change in water temperatures may not provide large benefits over existing conditions in the upper reaches of the Low Flow Channel but could extend colder water temperatures farther downstream. Lower water temperatures benefit juveniles by decreasing stress during rearing and emigration as they move farther downstream. Pulse flows could also benefit hatchery-origin spring-run Chinook salmon, both juveniles (by aiding hatchery releases, if occurring at the same time) and adults (by cuing entry into the Low Flow Channel and thence the Feather River hatchery). The magnitude of these potential benefits is not estimable.

Colder water temperatures may also benefit juveniles by decreasing the risk of *Ceratonova shasta*–related infection; see further discussion below regarding the High Flow Channel.

Pulse Flow Aquatic Impacts in the High Flow Channel

The upper portion of the High Flow Channel is used by anadromous salmonids, lamprey, and sturgeon for spawning and rearing. The High Flow Channel also serves as year-round habitat for native minnows and non-native black bass species. During the period when pulse flows occur, steelhead, sturgeon, Pacific lamprey, Western river lamprey, and native minnows could be spawning, rearing, and migrating through the High Flow Channel.

As summarized in Table 3.4-4 in Section 3.4, “Hydrology and Water Quality,” during the critically dry water years of 1996–2021, mean daily flows in the High Flow Channel (Feather River near Gridley; California Data Exchange Center GRL gauge, see Figure 3.4-1 for gauge location) were 732 cfs in March, 1,193 cfs in April, 1,836 cfs in May, and 2,421 cfs in June. Releases from the Thermalito Afterbay Outlet are variable and depend on several factors: reservoir levels, downstream demand (e.g., water deliveries), pump-back operations, and regulatory requirements. Releases could fluctuate throughout a pulse flow event, so this analysis uses average daily flows by month as a basis of comparison relative to the pulse flows (i.e., as the existing condition) to identify the magnitude of flow changes that could occur under the Pulse Flows Component.

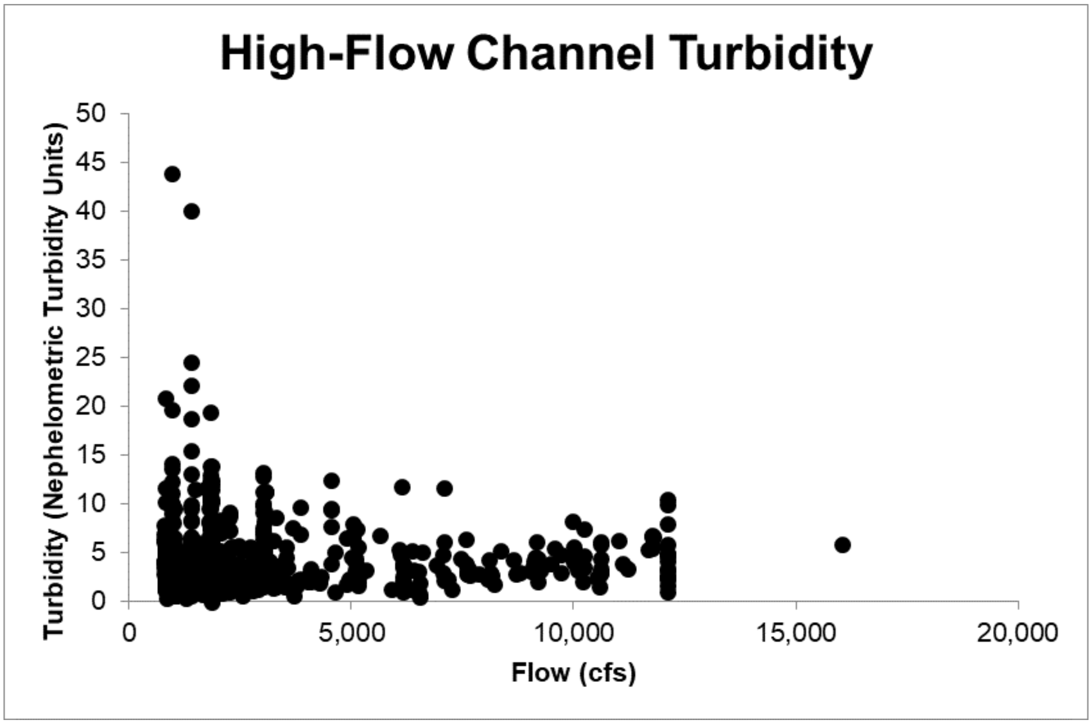
Compared to the historical mean values (see Table 3.4-4), an additional pulse flow release resulting in total Low Flow Channel flow of 10,000 cfs for several days would result in flow increases of one to two orders of magnitude, depending on the month. (See Table 3.4-9 for changes in water levels, velocity, and inundation extent under the conservative pulse flow release scenario; see also Appendix B.) The pulse flows could provide benefits to salmonid migration and rearing in the High Flow Channel.

Generally, pulse flows would affect special-status fish species and their habitat in the High Flow Channel similarly to the effects identified for the Low Flow Channel. However, the effects generally would be less substantial than those occurring in the Low Flow Channel because the pulse flow would represent a smaller proportion of the High Flow Channel's overall flow. Additionally, the habitat for anadromous salmonids and lamprey provided by the High Flow Channel is not of as high quality as the habitat provided by the Low Flow Channel. The High Flow Channel is warmer, less complex (i.e., more homogenous and dominated by deep runs and pools), and more channelized, with less riparian and side-channel habitat. Therefore, increases in flows generally would be less beneficial for the spawning and rearing life stages of anadromous salmonid species. Nonetheless, pulse flows could provide some short-term benefit where suitable rearing habitat exists.

In contrast to the spawning and rearing life stages, the potential beneficial effects of pulse flows on emigration of juvenile salmonids in the High Flow Channel would be similar to or greater than those in the Low Flow Channel. Emigration cues associated with increased flow would likely be similar to those for the Low Flow channel. However, because aquatic habitat in the High Flow Channel is not as complex and is generally warmer than in the Low Flow Channel, increased turbidity and velocity would reduce predation potential and transit time through the High Flow Channel. This would improve the likelihood that emigrating juveniles would survive and reach higher quality rearing habitat downstream (e.g., within restored habitats of the North Delta).

Pulse flow releases could increase turbidity, which could provide benefits to juvenile salmonids and sturgeon by reducing visibility and, in turn, reducing the potential for predation by both avian and aquatic predators. Turbidity is expected to be higher in the High Flow Channel than in the Low Flow Channel because fine sediments mobilized in the Low Flow Channel would continue into the High Flow Channel. As with the Low Flow Channel, the available data do not show a statistically significant relationship between flow and turbidity in the High Flow Channel (**Figure 3.5-2**). Therefore, based on data collected by DWR, pulse flow releases would not be expected to increase turbidity substantially.

Increased flow and velocity have the potential to affect juveniles by reducing predation in areas such as the Thermalito Afterbay Outlet, where significant numbers of predators reportedly exist (National Marine Fisheries Service 2014). Increased flow from the Pulse Flows Component could disrupt predation behavior and decrease transit times for emigrating juveniles, which would reduce the time spent in areas with high numbers of predators. Available studies of flow effects on juvenile salmonid emigration in the Feather River (e.g., Kindopp 2003; White et al. 2013) have not yielded flow/survival relationships such as those observed elsewhere in the Sacramento River Basin (e.g., Perry et al. 2018; Notch et al. 2020; Michel et al. 2021). To some extent, this likely reflects relatively limited variability in historical flow conditions from which to infer effects. Thus, it is challenging to ascertain the extent to which pulse flows would provide a positive effect on emigrating juvenile salmonids.



NOTE: Includes data for 2009–2022 at the Sunset Pumps (River Mile 38; GPS coordinates 39.247545°, -121.636040°) and Herringer Riffle (River Mile 45.7; GPS coordinates 39.315861°, -121.624510°). Turbidity is recorded during daily visits to rotary screw traps and flow is the mean on the same day.

SOURCE: Hickey pers. comm.

Figure 3.5-2
Relationship between Flow and Turbidity in the Feather River High Flow Channel

Similar to the effect discussed for the Low Flow Channel, increased water depth in the High Flow Channel could aid rearing juveniles by reducing the potential for predation from avian and terrestrial predators. Additionally, with overall greater depths, areas along margins could become inundated and increase foraging opportunities for juveniles. Increased margin habitat could also benefit emigrating juveniles because they would have access to areas where instream shelter and cover are more prevalent. However, juveniles occupying these margin areas have the potential to become stranded during the descending hydrograph of a pulse flow event, although such potential would be limited by ramping at rates required under the NMFS BiOp for the Oroville Facilities (National Marine Fisheries Service 2016). Although pulse flows would increase inundation of the Lower Sutter Bypass (see discussion in Section 3.4.4), the increases in inundated area would be infrequent and of insufficiently long duration to provide positive effects on juvenile salmonids from increases in rearing habitat.

Similar to the effect on juveniles, pulse flows may enhance migratory cues for adult salmonids, lamprey, and sturgeon by attracting the fish to higher quality spawning and holding areas in the upper reaches of the Feather River High Flow Channel. Higher flows have been shown to reduce the risk of straying by adult Feather River spring-run Chinook salmon to the Yuba River (Yuba Accord River Management Team 2013; Luis and Pasternack 2023), albeit in the fall rather than during the spring period that would be subject to higher flows as a result of the Pulse Flows

Component. Increased depth also could aid adult passage opportunities by increasing the amount of flow over shallow-water obstacles, including the primary passage obstruction created by the boulder weir at the Sunset Pumps in the High Flow Channel at Live Oak (National Marine Fisheries Service 2018; Seesholtz pers. comm.). This weir creates a partial barrier to the only confirmed spawning location of green sturgeon in the Feather River (Seesholtz et al. 2015). USFWS indicates that the boulder weir is a barrier to upstream passage of green sturgeon when Feather River flow is less than 6,000 cfs (U.S. Fish and Wildlife Service 2016). The recovery plan for the southern DPS of green sturgeon lists removal or modification of the Sunset Pumps boulder weir as a high-priority recovery action (National Marine Fisheries Service 2018), but it is not clear when such measures would be implemented (Seesholtz pers. comm.).

Based on the hydrologic data summarized above, pulse flows increasing the High Flow Channel's total flow up to 10,000 cfs could provide short-term passage opportunities at the Sunset Pumps for green sturgeon above the 6,000-cfs threshold suggested by USFWS (U.S. Fish and Wildlife Service 2016). Adult salmonids are able to pass above the Sunset Pumps weir at 1,500 cfs or less (Kindopp pers. comm.); therefore, changes related to pulse flows would not be expected to greatly increase passage opportunities, given the prevailing hydrologic conditions typical of March–May in below-normal or dry water years (i.e., flows at or above 2,000 cfs; see the summary above).

Water temperatures in the upper portion of the High Flow Channel could decrease, although the extent of the change relative to existing conditions is likely small and is unknown at this time. This decrease in water temperature is expected to be less than that of the reaches closest to Oroville Dam in the Low Flow Channel. Decreases in water temperature during the pulse flow events would increase the extent of suitable habitat by extending the area of suitable water temperatures farther downstream than would otherwise occur. This increased extent could temporarily reduce the potential for thermal stress on migrating juvenile and adult salmonids and lamprey. It also would have the potential to reduce pre-spawn mortality (i.e., reduced in-vivo egg mortality or adult mortality) in holding spring-run Chinook salmon.

The risk of infection with *Ceratonova shasta* for juvenile salmonids increases with increasing temperature (Lehman et al. 2020). Laboratory studies have shown that water velocity is inversely related to transmission of *C. shasta* to salmonids, up to a threshold of approximately 0.67 to 1 foot per second, above which transmission is very unlikely (Ray and Bartholomew 2013). Simulation studies in the Klamath River suggest that flushing flows of greater than 6,000 cfs for 72 hours reduce *C. shasta* peak spore density by 90 percent (Robinson et al 2022). As described in Section 3.5.1, "Environmental Setting," *C. shasta* infection in Chinook salmon fry within the Feather River High Flow Channel begins in late January or early February, with lethal disease occurring in March (Foott et al. 2023). Additional surveys are required to elucidate whether disease progresses in fry chronically exposed to low actinospore concentrations during downstream river migration in January and February (Foott et al. 2023).

Therefore, although spring pulse flows from the Pulse Flows Component would reduce the likelihood of *C. shasta* infection to some extent by increasing velocity, flushing spores from the river, and decreasing water temperature, the potential overall population-level effect is uncertain.

High velocity associated with the Pulse Flows Component could disturb the habitat for the alternative polychaete host of *C. shasta.* However, the high flows of 2017, followed by increasing levels of infection in 2018 and 2019, suggest that some portion of the alternative host polychaete population is associated with stable habitat such the lee side of boulders and riprap and can recolonize within a year (see Section 3.5.1, “Environmental Setting”). This would limit the potential for decreasing the probability of *Ceratonova shasta* infection.

Special-status native minnows that reside in the Feather River include hardhead, Sacramento splittail, and Sacramento hitch (Seesholtz et al. 2004); Central California roach are also likely present but were not collected by Seesholtz et al. (2004). Hardhead is the only one of these species considered common in the river. All are largely restricted to the High Flow Channel (Seesholtz et al. 2004). All four native minnow species spawn during the spring period, when pulse flows would result in increased Feather River flows. However, roach, hardhead, and hitch spawn primarily in tributaries, which would not be affected by the pulse flows. As they develop, the larvae and juveniles rear in wetted habitat on the river margins in the mainstem, which could be inundated more by pulse flows.

Sacramento splittail typically migrate upstream from the Delta in late winter and spawn on inundated floodplains and side channels during March and April (Sommer et al. 1997; Moyle et al. 2004; Sommer et al. 2008). Adult splittail require a rising hydrograph for upstream migration and spawning (Moyle et al. 2015), and pulse flows stimulate splittail upstream migration and spawning (Feyrer et al. 2006). Pulse flows of up to 10,000 cfs would only last a few days before ramping down begins. Splittail eggs hatch in about four days and exogenous feeding begins about six days post-hatch (Deng et al. 2012). Therefore, pulse flows continuing for a few days would not be long enough for the early splittail life stages to develop sufficiently for successful emigration from the spawning habitat to the Delta. Most of the splittail larvae spawning in additional inundated areas could be at risk of stranding. The pulse flows have the potential to negatively affect local splittail production; however, little splittail spawning generally occurs in the Feather River, so any such effect would be unlikely to substantially affect overall splittail production, which is driven by large-scale inundation of floodplains (Sommer et al. 1997). Although pulse flows would increase inundation of the Lower Sutter Bypass (see discussion in Section 3.4.4), the increases in inundated area would be infrequent and of insufficiently long duration to increase splittail spawning and early rearing habitat.

Pulse flows are not likely to affect resident non-native black bass species substantially. Increased velocity during the pulse flows could displace adults and juveniles or reduce their feeding efficiency and would have the potential to disrupt spawning behavior. However, these effects would occur for a short duration and would not substantially affect the populations of these species. Black bass spawning is water temperature–dependent, and if spawning were to occur before a pulse flow, nests could be scoured by the increased velocity, which could reduce hatching success. Black bass are widespread and spawn over multiple years, so any such effects would be expected to be limited. Spring pulse flows have been shown not to have significant effects on the persistence of black bass in the lower reaches of Putah Creek (Kiernan et al. 2012), which are somewhat analogous to the Feather River High Flow Channel (e.g., warmer temperatures compared to upstream reaches; Seesholtz et al. 2004).

Striped bass and American shad are broadcast spawners that release eggs into the water column. The increase in flow and velocity associated with the pulse flows could be beneficial to eggs and larvae in the water column by keeping them suspended in the water column and promoting downstream movement. This would reduce the amount of time spent by eggs and larvae in the riverine environment and accelerate their dispersal to productive rearing areas in the Delta. As described further below under "Pulse Flow Aquatic Impacts in the Delta," there are positive relationships between spring flow (or correlates with flow, such as X2) and abundance indices of juvenile striped bass and American shad (e.g., Kimmerer et al. 2009).

Pulse Flow Aquatic Impacts in the Sacramento River

The Sacramento River between the Delta and the confluence with the Feather River is used as a migration corridor for anadromous salmonids, lamprey, sturgeon, striped bass, and American shad. This reach also serves as year-round habitat for native minnows and non-native black bass species.

During critically dry water years between 1996 and 2021, mean daily flows during March–June in the Sacramento River near Verona (U.S. Geological Survey gauge 11425500), downstream of the Feather River confluence, were around 6,800–10,600 cfs. (See Figure 3.4-1 for gauge location; see also Table 3.4-5 in Section 3.4, "Hydrology and Water Quality.") A pulse flow resulting in 10,000 cfs total flow coming out of the Feather River Low Flow Channel (i.e., around 8,800–9,200 cfs of additional flow, based on the discussion for the Low Flow Channel above) would result in an approximate doubling of flow.

The pulse flows could provide benefits to migration in the Sacramento River, although these benefits may not be realized to the same extent as in the Feather River Low Flow and High Flow Channels.

Generally, the effect of pulse flows on special-status anadromous fish species and their habitat in the Sacramento River would be similar to the effects identified for the Feather River Low Flow and High Flow channels. However, the effect would be less pronounced in the Sacramento River because the pulse flows would represent a smaller proportion of the overall flows. Additionally, this reach of the Sacramento River does not provide high-quality complex habitat for anadromous salmonids, lamprey, and sturgeon. Therefore, increased flows in the Sacramento River would be less beneficial for anadromous species because such flows would have less of an effect on physical habitat variables (e.g., depth and velocity) than identified for the Low Flow and High Flow channels of the Feather River.

Pulse flows would have the potential to increase turbidity, velocity, and depth in the Sacramento River downstream of the Feather River confluence. However, pulse flows would be unlikely to influence water temperatures in the Sacramento River, because the coldwater releases would occur approximately 68 river miles from the confluence of the Sacramento and Feather rivers, and local environmental conditions would likely have a stronger influence on water temperatures than release-water temperatures far from the point of coldwater releases.

Although increases in turbidity are expected, they would likely be small because the average daily flow in the Sacramento River during March–June is relatively high and the river is already generally turbid. Therefore, slight turbidity increases likely would neither benefit migrating and rearing fishes nor cause adverse impacts.

An increased volume of water in the Sacramento River may benefit downstream juvenile passage, by triggering a response to continue downstream migration to higher quality rearing habitats in the Delta. As with juveniles, the increased flow magnitude may enhance migratory cues for adult salmonids, lampreys, sturgeons, striped bass, and American shad migrating to spawning and holding areas. The increase in flows from the Feather River could reduce straying risk for Feather River adult salmonids by increasing the strength of migration cues originating from the Feather River. However, increased flow from the Feather River could also increase the straying potential of other adult salmonid populations from upper Sacramento River tributaries. Increased straying by Sacramento River tributary populations, should it occur, has the potential to reduce the fitness of Feather River stocks by causing hybridization and increased pre-spawn mortality of the Sacramento River tributary populations through wasted energy expenditure and delayed migration to natal waters.

There are few quantitative data with which to infer the straying impact that a 10,000-cfs pulse flow from the Feather River would have on upstream-migrating adult fish in the Sacramento River. Straying rates are relatively low for adult hatchery-origin Chinook salmon released as juveniles upstream of the Delta near natal streams in the Sacramento River Basin, in contrast with the relatively high straying rates of San Joaquin River Basin fish released upstream of the Delta (Marston et al. 2012). This difference likely reflects the typically very small percentage of water in the Delta contributed by San Joaquin River Basin water; the straying rate decreases as the magnitude of the San Joaquin River's water flow increases (Marston et al. 2012). Relatively high rates of straying of Mokelumne River Chinook salmon (75 percent) were estimated to have occurred in October 2008 when the Delta Cross Channel gates were open (Setka 2018), causing natal Mokelumne River flow to compose only 3–6 percent of flow in the Mokelumne River.[4] This addition of Delta Cross Channel flow to Mokelumne River flow far exceeds the magnitude of the flow increase that would result from implementation of the Pulse Flows Component, which, as shown above, would result in an approximate doubling of flow relative to mean flows in critically dry years.

Velocity also would increase in the Sacramento River downstream of the Feather River confluence. As with turbidity, the likely increase in velocity would be small and would be greatest at the confluence, diminishing downstream. Although velocity may not increase substantially, the increase could provide some passage benefits to juvenile emigrating salmonids, lampreys, and sturgeons by reducing travel times, for the reasons discussed above under "Pulse Flow Aquatic Impacts in the Feather River High Flow Channel." Hance et al. (2022) found a flow/survival relationship for juvenile winter-run Chinook salmon for the Sacramento River between the Feather River confluence and Sacramento. The gradient of the flow/survival slope is

[4] Estimates were based on data for the Delta Cross Channel (from https://nwis.waterdata.usgs.gov/ca/nwis/uv/?cb_72137=on&format=rdb&site_no=11336600&period=&begin_date=2008-10-01&end_date=2008-10-31) and the Mokelumne River (from Dayflow; California Natural Resources Agency 2022).

relatively flat (i.e., relatively limited variability in survival across the range of flows). Given the uncertainty interval around the line (Hance et al. 2022: Figure 5), this finding suggests that flow/ survival effects of the pulse flows released under the Pulse Flows Component may be modest and difficult to detect statistically, if the relationship is generally representative of the types of relationships that exist for juvenile salmonids in this reach.

Depths could increase as a result of the pulse flow releases but are not expected to substantially alter available habitat. With increased depth from the pulse flows, additional margin habitat could become inundated and available for species to occupy. However, it is not anticipated that such additional inundated habitat would be substantial or productive, given the low sinuosity and stable channelization of the Sacramento River and the short duration of pulse flows. The additional inundated habitat would likely be composed largely of riprap, although recent restoration efforts have constructed habitat benches on some of the levees in this river reach that are designed to be inundated by slightly elevated flows (Hellmair et al. 2018). The potential inundation of these habitat restoration sites by the pulse flows would temporarily improve migration and rearing habitat relative to the situation that would exist without the pulse flows, but only for short durations—a few days—based on the conservative flow scenario that is the focus of the present analysis.

The pulse flows would be unlikely to influence water temperatures in the Sacramento River, given the distance from Oroville Dam, where cold water is released. Water temperature is influenced by several factors as the water flows the approximately 68 miles from Oroville Dam to the confluence of the Feather River. Ambient conditions, water diversions, and inflows from the Thermalito Afterbay Outlet and major tributaries like the Bear and Yuba rivers all affect water temperatures in the Feather River. The influence of these factors on the water temperature increases with distance from the source water. These factors ultimately have a stronger influence on water temperatures in the Sacramento River than the temperatures of water released from Oroville Dam. Therefore, pulse flows are likely to have a limited effect, if any, on water temperatures in the Sacramento River.

Pulse Flow Aquatic Impacts in the Delta

The Sacramento River between the beginning of the legal Delta (Sacramento River at I Street Bridge) and the confluence with the Feather River is used as a migration corridor for anadromous salmonids, lampreys, sturgeons, striped bass, and American shad. This reach also serves as year-round habitat for native minnows and non-native bass species.

During critically dry water years between 1996 and 2021, mean daily flows by month in the Sacramento River near Freeport (near the upstream limit of the legal Delta), were approximately 7,000–11,500 cfs (Table 3.4-6 in Section 3.4, “Hydrology and Water Quality”). A pulse flow resulting in 10,000 cfs total flow coming out of the Feather River Low Flow Channel (i.e., around 8,800–9,200 cfs of additional flow, based on the discussion for the Low Flow Channel above) would result in an approximate doubling of flow.

As in the reach of the Sacramento River upstream of the Delta, pulse flows would have the potential to increase turbidity, velocity, and depth in the more riverine portions of the Sacramento River in the Delta. The effects of these changes would be similar to those identified above under

"Pulse Flow Aquatic Impacts in the Sacramento River." Generally, however, effects would be less substantial, because the distance from the pulse flow releases would be greater and the percentage of flow represented by the pulse flow would be smaller, particularly as additional inflows from sources such as the American River join the system. Consequently, effects on migrating anadromous fishes and resident minnow and black bass species generally may be less than those identified for the Sacramento River upstream of the Delta. Additionally, pulse flows would be unlikely to influence water temperatures in the Delta, because environmental conditions would have a stronger influence on water temperatures in the Delta than release-water temperatures (see also Wagner et al. 2011).

Although effects of pulse flows in the Delta generally may be less than in the Sacramento River upstream of the Delta, pulse flows may have a larger effect in the North Delta channel reaches where riverine and tidal flows interact. At these locations, the extent of riverine inflow influences the frequency and location of tidal flow reversals, migration pathways, and through-Delta survival of juvenile migrating salmonids (Cavallo et al. 2015; Perry et al. 2018; Hance et al. 2020).

For example, Perry et al. (2018) identified a relationship between Freeport flow and the probability of through-Delta survival of Chinook salmon smolts. This relationship can be applied to compare predicted smolt survival under historical mean March–June Freeport flows (see the summary above) against survival under historical mean Freeport flows plus pulse flows of approximately 9,000 cfs (i.e., the increase in the Feather River low channel in a critically dry year), for the conservative pulse flows scenario of up to 10,000 cfs total Feather River flow. Applying this flow-survival relationship (Perry et al. 2018), the maximum pulse flows in a critically dry year increase the probability of survival from 0.35–0.40 to 0.45–0.49 (i.e., a relative increase of approximately 20–28 percent).

The overall population-level effect on salmonids is uncertain but is likely lower than these estimates, given variability around the factors involved:

- Flow/survival relationships (see Perry et al. 2018; Hance et al. 2020).
- The frequency of pulse flows. (The maximum of 10,000 cfs total flow out of the Feather River would occur no more than once in three years.)
- The magnitude of pulse flows. (The example calculations pertain to the maximum flow release possible.)
- The duration of pulse flows not covering the full migration period of juvenile salmonids (with the maximum of 10,000 cfs total flow lasting only a few days).

Positive effects on longfin smelt could occur from pulse flows, although such effects would likely be limited. The causal mechanism is unknown, but indices of longfin smelt abundance are positively correlated with winter-spring Delta outflow (Jassby et al. 1995; Kimmerer 2002b; Kimmerer et al. 2009; Baxter et al. 2010; MacNally et al. 2010; Thomson et al. 2010; Mount et al. 2013; Nobriga and Rosenfield 2016; see also Maunder et al. 2015). In other words, when spring outflow is relatively high, the subsequent abundance index from the longfin smelt fall midwater trawl (i.e., mostly juveniles) generally is also relatively high, although this is also dependent on other factors, including the abundance of adult longfin smelt. Implementing pulse flows would have a proportionally larger effect on total Delta outflow during a critically dry water year than during a below-normal water year. This finding suggests that the potential for a larger proportional effect on longfin smelt abundance could be greater in critically dry water years.

However, a pulse flow of up to 100,000 af would make a relatively small contribution to total spring Delta outflow. Recent analyses by DWR of potential effects of Delta outflow on longfin smelt (California Department of Water Resources 2022: Appendix 12B, p. 12B-199) used both December–May and March–May Delta outflow periods, reflecting uncertainty about which period within winter-spring is of greatest importance. (See, for example, discussion by Mount et al. 2013 and Nobriga and Rosenfield 2016.) Based on historical estimates of Delta outflow for 1996–2021 from the Dayflow database (California Natural Resources Agency 2022), a flow pulse of 100,000 af would contribute the following additional increments to Delta outflow in critically dry water years:

- December–May: 0.66 percent.
- March–May, critically dry water years: 1.75 percent.

These relatively small increments would be unlikely to result in a measurable effect on longfin smelt abundance. For delta smelt, a positive correlation exists between the density of the important larval and juvenile zooplankton prey *Eurytemora affinis* in the LSZ and Delta outflow (as indexed by X2) during the spring (March–May) (Kimmerer 2002b; Greenwood 2018). Other analyses have also found positive correlations between outflow and the delta smelt's calanoid copepod prey in spring (Hamilton et al. 2020). Some other analyses have not found statistically significant relationships between spring outflow and biomass per unit of sampling effort for other delta smelt prey (*Limnoithona tetraspina* and *Pseudodiaptomus forbesi*) (California Department of Water Resources and U.S. Bureau of Reclamation 2021:2-11).

Based on statistical relationships between calanoid copepod biomass and flow in the Delta, Hamilton and Murphy (2020) investigated the potential effects of adding 1,000 cfs[5] of flow in April and May in drier than average years. They estimated that calanoid copepod biomass in areas with relatively high abundance of delta smelt would have varying responses to such a pulse, depending on location. The 1,000-cfs additional flow (in the Sacramento River at Rio Vista) in April was estimated to result in 12 percent less biomass near Decker Island but 9 percent greater biomass in the lower Sacramento River; in May, the additional flow resulted in 1–6 percent estimated increases in biomass at these locations. Of the locations with relatively high delta smelt abundance that were assessed for effects of increasing Delta outflow incrementally by 1,000 cfs, the estimated biomass increase in April was 8 percent at Chipps Island and 15 percent at Montezuma Slough, whereas in May, the estimated increase was 11 percent at Montezuma Slough. Overall, this illustrates the potential for a modest increase in delta smelt prey biomass in critically dry water years as a result of pulse flows implemented under the Pulse Flows Component, although there is uncertainty given the variability in the statistical relationships.

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[5] This is equivalent to approximately 60,000 af additional flow per month for the months of April and May. Note that the study by Hamilton et al. (2020) assumed that the 1,000 cfs flow was added to each of various locations in the Delta: the Sacramento River at Rio Vista, Delta outflow, and the lower San Joaquin River near Jersey Point (termed QWEST in Dayflow).

Among the other special-status fish species considered herein, white sturgeon, striped bass, and American shad have been shown to have statistically significant correlations between spring Delta outflow (or X2) and indices of abundance (Fish 2010; Kimmerer et al. 2009; California Department of Water Resources 2022:12B-206). As noted above for longfin smelt, the incremental increase in overall spring Delta outflow as a result of the pulse flows released under the Pulse Flows Component would be small, and thus would be unlikely to result in a measurable difference, given the variability in the statistical relationships. (See, for example, ranges of predictions for white sturgeon year-class strength as functions of April–May and March–July Delta outflow [California Department of Water Resources 2022:12B-208].)

Implications of the WSIP Operational Exchange Process

Recovery Period Aquatic Impacts in the Low Flow Channel

Recovery of the volume of water released during pulse flows in Lake Oroville would not result in reduced flows in the Feather River Low Flow Channel compared to existing conditions because the flow reduction would occur in the Thermalito Facilities, resulting in less flow being released into the High Flow Channel from the Thermalito Afterbay Outlet. Flows in the Low Flow Channel would meet flow requirements described in the FERC license and other regulatory requirements and would be the same as would occur under existing conditions, so there would be no change in the potential for effects on special-status fish species.

Recovery Period Aquatic Impacts in the High Flow Channel

Under the Pulse Flows Component, decreases in summer flow in the High Flow Channel relative to existing conditions would occur after a spring pulse—during July, August, and September of the same year (Figure 2-2 in Chapter 2). Regulatory requirements are such that this summer period is when the SWP typically releases water from storage in Lake Oroville for delivery south of the Delta. Releases above minimum Feather River and Delta requirements are made at the discretion of the SWP, based on water management decisions such as preserving storage in Lake Oroville for future years or conveying that water south of the Delta for deliveries or storage in San Luis Reservoir. Any decision whether to decrease releases to recover pulse flow volumes would be made within the existing regulatory environment that controls SWP operations. The reduced releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would remain within the typical range of operational flows, so that the existing aquatic biological environment of the Low Flow Channel would not be substantially affected by the Pulse Flows Component.

For an example of the hydraulic changes caused by reduced releases, based on the assumption that the Recovery Period would occur in the same year, daily flows into the High Flow Channel could average approximately 548 cfs per day less than under existing conditions, when calculated across the Recovery Period (see "Summary of the Pulse Flows Component" above). When occurring in the critically dry year used for the conservative pulse flow release scenario, such a decrease would result in flows at or greater than the minimum allowable flow of 750 cfs.

During the Recovery Period, when flow reductions would occur to facilitate recovery of the pulse flow volume in Lake Oroville, adult spring-run Chinook salmon could be holding or spawning; adult fall-run Chinook salmon could be immigrating and spawning; adult green sturgeon could be spawning or holding; adult lampreys could be emigrating downstream; and juvenile steelhead, spring-run Chinook salmon, and sturgeon could be emigrating and rearing. Winter-run Chinook salmon emigrating down the Sacramento River could rear in the lower portion of the High Flow Channel. The High Flow Channel is also year-round habitat for resident native minnows and non-native black bass species, which have relatively broad environmental tolerance levels and thus would be unlikely to experience negative effects from changes in flow during the Recovery Period.

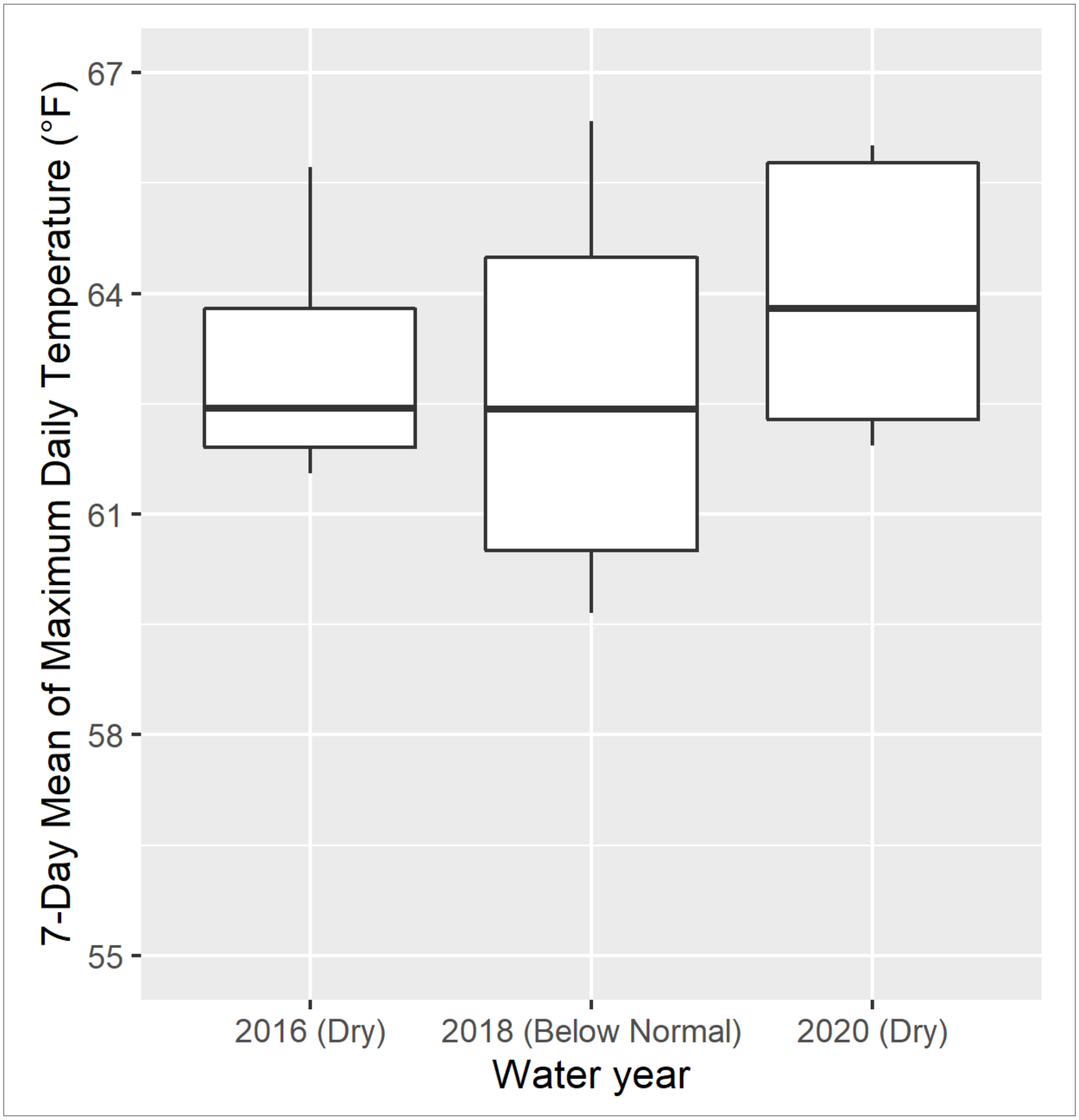
Based on their preference for spawning in the upper reaches of tributaries, most spring-run Chinook salmon likely spawn in the Low Flow Channel. Indeed, NMFS's analysis in the Oroville Facilities BiOp (National Marine Fisheries Service 2016:246–252) considered only the Low Flow Channel for potential effects on spawning. Some spring-run Chinook salmon could spawn in the High Flow Channel during September if water temperatures are suitable. Additionally, fall-run Chinook salmon spawn in the High Flow Channel when water temperatures are suitable. However, available temperature data for September of recent years in the upper High Flow Channel suggest that the High Flow Channel's water temperature is typically too high for spawning in these year types (**Figure 3.5-3**), based on thresholds of 55–56°F (National Marine Fisheries Service 2016:241).

Because flows in the High Flow Channel would be reduced under the Pulse Flows Component during the warmest months of the year, water temperatures may be higher than under existing conditions. If the temperature were below the threshold for spawning but were raised above the threshold by lower flows during the Recovery Period, the potential would exist for a negative effect on spring-run Chinook salmon. In such a scenario, increased water temperatures in the High Flow Channel could increase the concentration of spawning in the Low Flow Channel, where water temperatures are more suitable. Higher concentrations of spawning Chinook salmon in the Low Flow Channel could result in increased hybridization between spring-run and fall-run Chinook salmon. These higher concentrations also could cause increased redd superimposition (i.e., construction of redds in the same location as previous redds), which would have the potential to increase in-gravel egg mortality and reduce the ability of the fish to survive to later life stages.

Reductions in flow during the beginning of the Recovery Period could negatively affect spawning by green sturgeon, as the spawning period may extend into July based on observations from the Sacramento River (although most spawning occurred in May/June; Poytress et al. 2015). However, no spawning was observed in the Feather River in July (Seesholtz et al. 2015).

Sturgeon generally spawn in the deeper portions of rivers (e.g., mean depths of 21 feet in the Sacramento River [Poytress et al. 2015] and 12.5 feet in the Feather River [Seesholtz et al. 2015]). The decrease in water volume may reduce some available habitat in the High Flow Channel, given the observations of eggs in water as shallow as 2 feet in the Sacramento River (Heublein et al. 2017). However, observations of green sturgeon spawning in the Feather River were made in the Thermalito Afterbay Outlet pool, which is a relatively deep area; the minimum observed egg depth at this location was 5.2 feet (Seesholtz et al. 2015), so the eggs would be unlikely to be affected by changes in water depth.

The extent of available rearing habitat for juvenile salmonids in the High Flow Channel could be decreased slightly during the Recovery Period. However, such effects would be limited. A 550-cfs reduction in flow below historical mean monthly flows would not result in large differences based on available weighted usable area curves, as exemplified for fry and juvenile steelhead (National Marine Fisheries Service 2016:313–314). Most steelhead early rearing occurs in the Low Flow Channel (National Marine Fisheries Service 2016:314).



NOTE: The horizontal lines within the boxes represent the median, the boxes represent the 25th and 75th percentiles, and the whiskers represent ±1.5 times the interquartile range (which includes the minima and maxima for each year). Station is located at Latitude 39.40250 Longitude -121.61940, approximately 4 river miles downstream of the Thermalito Afterbay Outlet.

SOURCE: California Data Exchange Center, https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=FOW; California Department of Water Resources 2021.

Figure 3.5-3
Box Plots of September Water Temperature in the Feather River at the Oroville Wildlife Area's Southern Boundary (California Data Exchange Center Station FOW) during Recent Dry and Below-Normal Water Years

Decreases in water depth because of flow reductions could increase predation potential by reducing the availability of depth refugia near channel margins, where juveniles would otherwise be able to avoid avian and terrestrial predators. Reductions in wetted habitat on the river margins also could reduce habitat and survival for lamprey ammocoetes (larvae) that are rearing in muddy substrates, if rearing substrates are dewatered, although no quantitative information is available to assess this risk. Hardhead and hitch juveniles move into pools as they age, making them less likely than young salmonids or lamprey to be much affected by the Recovery Period reductions in flow (Moyle et al. 2015). Most splittail have emigrated to the Delta by July (Feyrer et al. 2005).

Decreases in flow during the Recovery Period could affect migration cues and increase the potential for immigrating adult spring-run and fall-run Chinook salmon and Central Valley steelhead to stray, given observed fall relationships of straying from the Feather River to the Yuba River with relatively lower Feather River flow (Yuba Accord River Management Team 2013; Luis and Pasternack 2023). However, the difference is very small compared to the extent of flow changes observed to cause straying issues elsewhere in the Central Valley, and the ratio of Yuba River to Feather River flows would remain low relative to the higher ratios observed to have caused straying issues in prior studies (Yuba Accord River Management Team 2013:6-20). (See the discussion of the San Joaquin River Basin/Delta and the Mokelumne River/Delta Cross Channel above under "Pulse Flow Aquatic Impacts in the Sacramento River.") Flow decreases could also affect migration cues for post-spawn, emigrating adult green sturgeon, although this is uncertain and no quantitative thresholds are known.

Upstream migration by adult fall-run Chinook salmon would occur during the Recovery Period. Most Central Valley steelhead migrate upstream between August and March. Decreases in flow may also expose potential barriers not evident at higher flows or may reduce depths over shallow riffles, increasing the potential for passage delay or causing immigrating fish to expend more energy to traverse these shallow riffles. However, NMFS noted, "Extensive evaluations of critical riffles have not revealed any passage limitations at riffles; therefore, the proposed flows [for FERC relicensing and analyzed in NMFS's Oroville Facilities BiOp] are expected to provide adequate depths and velocities for upstream migration" (National Marine Fisheries Service 2016:255). The Recovery-Period flows would meet the requirements of the FERC license and the NMFS BiOp (National Marine Fisheries Service 2016).

A reduction in flow during the Recovery Period relative to existing conditions could negatively affect anadromous species, possibly with the greatest potential to affect juvenile Chinook salmon and steelhead rearing in the Feather River. For spring-run Chinook salmon, NMFS noted that although year-round rearing in the High Flow Channel is possible, the species generally occurs from November through May, and thus its presence would not generally overlap the Recovery Period (National Marine Fisheries Service 2016:251).

The reduction in flow could cause water temperatures in the High Flow Channel to increase, thus leading to increased stress, reduced ability to avoid predators, and increased disease, and would have the potential to preclude rearing in the High Flow Channel altogether. However, such effects would be limited because flows would still meet the requirements of the FERC license and the NMFS BiOp for the Oroville Facilities (National Marine Fisheries Service 2016).

Additionally, CDFW could consider any impacts from the Recovery Period when requesting a pulse flow. CDFW could adjust their requests to DWR for a pulse flow to maximize beneficial effects and to minimize any adverse effects from the pulse flows.

Recovery Period Aquatic Impacts in the Sacramento River

As shown in the discussion of the representative pulse flow and Recovery Period for the Pulse Flows Component (Chapter 2, Table 2-2), decreases in flow in the Sacramento River from the confluence with the Feather River to the Delta would occur in July, August, and September of the same year as a pulse flow event, leading to approximately 548 cfs less inflow in these months. Based on historical flows in the Sacramento River at Verona (Table 3.4-5 in Section 3.4, "Hydrology and Water Quality"), this would represent approximately 6–7 percent less flow during critically dry years.

During the Recovery Period, when flow reductions would occur to facilitate recovery of the pulse flow volume in Lake Oroville, adult fall-run Chinook salmon and steelhead could be immigrating; adult sturgeon could be emigrating; adult lampreys could be emigrating; and juvenile steelhead, spring-run Chinook salmon, winter-run Chinook salmon, lampreys, and sturgeon could be emigrating and rearing. This reach of the Sacramento River also serves as year-round habitat for native minnows and non-native black bass species.

No Chinook salmon or sturgeon spawning or holding is known to occur in this reach of the Sacramento River, so these life stages would not be affected in this reach by reduced flows during the Recovery Period.

Decreases in flow could affect migration cues for fall-run Chinook salmon and steelhead, and as a result, could increase straying. However, the flow reductions in this reach would be relatively small and would not be expected to substantially increase straying by Feather River fish into the American River, or to cause a substantial number of fish to continue migrating in the Sacramento River upstream of the Feather River. The relative difference is very small compared to the extent of flow changes observed to cause straying issues elsewhere in the Central Valley. (See the discussion of the San Joaquin River Basin/Delta and Mokelumne River/Delta Cross Channel above under "Pulse Flow Aquatic Impacts in the Sacramento River.")

Available rearing habitat in the Sacramento River could be reduced during the Recovery Period because flow reductions would decrease the amount of available usable wetted margin habitat preferred by juvenile salmonids. However, this reach is not considered prime rearing habitat, given its lack of channel complexity, reduced sinuosity, and channelization. Reductions in wetted habitat on the river margins likely would not affect lamprey ammocoetes (larvae) that are rearing in muddy substrates, because the reach has very little margin habitat that is suitable for long-term lamprey rearing. The lower portions of this reach are tidally influenced, and the tidal range is likely to have a greater influence on channel margin depths and velocities than the small reduction in river flow associated with the Recovery Period.

The reduction in flow could increase passage time for some migrating juveniles, such as early-migrating winter-run Chinook salmon or yearling spring-run Chinook salmon, although

September is earlier than the time when migration is typically observed in the general area (Brandes et al. 2021) and few individuals would be expected to be affected. As described above under "Pulse Flow Aquatic Impacts in the Sacramento River," the flow/survival relationship established by Hance et al. (2022) for juvenile winter-run Chinook salmon for the Sacramento River is relatively flat, so any impacts in this reach would be expected to be limited and difficult to statistically detect.

Reductions in flow during the Recovery Period would not be likely to influence water temperatures in the Sacramento River, for reasons similar to those described above under "Pulse Flow Aquatic Impacts in the High Flow Channel."

Recovery Period Aquatic Impacts in the Delta

As shown in the discussion of the representative pulse flow and Recovery Period for the Pulse Flows Component (Chapter 2, Table 2-2) and the summary provided above in "Summary of the Pulse Flows Component", decreases in Sacramento River flow entering the Delta would occur in July, August, and September of the same year as a pulse flow event, leading to approximately 548 cfs less flow in these months based on recovery of up to 100,000 af of storage. Based on historical flows in the Sacramento River at Freeport (Table 3.4-6 in Section 3.4, "Hydrology and Water Quality"), this would represent approximately 6 percent less flow during critically dry water years. As noted above under "Summary of the Pulse Flows Component," Delta outflow would not be significantly reduced relative to existing conditions during the Recovery Period (i.e., a maximum reduction of about 6 percent, assuming both the maximum Recovery Period reduction in Oroville release combined with the minimum allowable Delta outflow).

During the Recovery Period, when flow reductions would occur to facilitate recovery of the pulse flow volume in Lake Oroville, adult fall-run Chinook salmon and steelhead could be immigrating; adult sturgeon could be emigrating; adult lampreys could be emigrating; and juvenile steelhead, spring-run Chinook salmon, winter-run Chinook salmon, lampreys, and sturgeon could be emigrating and rearing. Additionally, delta smelt would be rearing in the North Delta and Sacramento River near Rio Vista, which would experience reductions similar to those identified at Freeport. The Delta also serves as year-round habitat for native minnows and non-native black bass species. No Chinook salmon or sturgeon spawning is known to occur in the Delta, so these life stages would not be affected in this reach. Adult and sub-adult green sturgeon and white sturgeon use the Delta extensively and would likely be present in the Delta during the recovery period.

Decreases in flow could affect migration cues for fall-run Chinook salmon and steelhead to some small degree. The flow reductions would be relatively small and would not be expected to substantially increase the risk of straying for these species within the Sacramento River system, given the very low rates of straying observed for fall-run Chinook salmon across a broad range of hydrological conditions (Marston et al. 2012:Methods appendix, page 10).

Available rearing habitat could be reduced slightly in the more riverine portions of the North Delta during the Recovery Period because flow reductions could cause a decrease in the amount of available wetted margin habitat preferred by juvenile salmonids. Such effects would be expected to be limited given the relatively small reduction in flow. Based on existing flow/survival relationships, less flow in the Sacramento River could result in lower through-Delta survival for juvenile salmonids.

For example, Perry et al. (2018) identified a relationship between Freeport flow and the probability of through-Delta survival of Chinook salmon smolts. This relationship can be applied to compare predicted smolt survival under historical mean September Freeport flows (see the summary above) against survival under historical mean Freeport flows minus 548 cfs flow to account for the Recovery Period. Applying this flow/survival relationship (Perry et al. 2018), subtracting the 548 cfs flow reduces the probability of survival from 0.26 to 0.25 (i.e., a relative decrease of 4 percent) in critically dry years. However, very few juvenile salmonids would be expected to experience such effects, given that the main migration period is winter-spring.

Reductions in flow during the Recovery Period compared to existing conditions would not result in a reduction of Delta outflow or effects on delta smelt habitat outside the range specified by various regulatory processes existing to protect the species: State Water Board Water Right Decision 1641, the USFWS and NMFS BiOps on the Long-Term Operation of the CVP and SWP, and the CESA ITP for the Long-Term Operation of the SWP in the Delta (ITP No. 2081-2019-066-00). For example, ITP Condition of Approval 9.1.3, "Delta Smelt Summer-Fall Habitat Action in CESA ITP No. 2081-2019-066-00," includes actions to be implemented by DWR in several water year types to benefit delta smelt food supply and, in turn, contribute to the recruitment, growth, and survival of delta smelt. Although there is no action in critically dry years, the other existing criteria would apply and would not be affected by reduced flows during the Recovery Period because DWR would implement measures at Lake Oroville or at the Banks Pumping Plant in the Delta to ensure that Delta outflow and delta smelt habitat requirements are met.

Reductions in flow during the Recovery Period would not be likely to influence water temperatures in the Delta, for reasons similar to those described above under "Pulse Flows Impacts in the Sacramento River."

Summary of Impacts on Special-Status Fish Species

The pulse flows would be implemented at the request of CDFW and approved operationally by DWR in accordance with the DWR/CDFW Agreement (see Section 2.4.2). CDFW is expected to confer with the Feather River Operations Group (FROG). The agencies with required FROG participation are: DWR, NMFS, USFWS, and CDFW. The FROG provides recommendations for coordination of Feather River flows, flows with fish releases, flows for green sturgeon, and provides input on research to identify effects of flow management on fish migrations. Additionally, the FROG will gather and analyze information and make recommendations regarding adjustments to water operations, including flows for the Feather River High Flow Channel, within the range of flexibility prescribed in the anticipated Oroville Facilities FERC license and the Terms and Conditions of the 2016 BiOp (National Marine Fisheries Service 2016).

As discussed in Section 2.4, "Pulse Flow Releases," as part of the CAPBs with the WSIP Groundwater Projects, CDFW will review monitoring of the pulse flows to ensure performance aligns with public benefit requirements of the WSIP (see Section 1.1.2, "Water Storage

Investment Program”) and the objectives of the Pulse Flows Component related to improvement of habitat, spawning, and migration conditions for target native fish species (see Section 2.2, “Objectives of the Pulse Flows Component”). In addition, the DWR/CDFW Agreement (Section 2.4.2) will constrain implementation of pulse flows based on the ability to meet instream flow and temperature requirements in the Feather River.

Salmonids

The flow-dependent habitat changes expected to occur with implementation of the pulse flows have the potential to benefit anadromous salmonids. The resulting flow-related changes could benefit habitat conditions by altering physical factors such as depth and velocity. The largest potential for effects would be in the Feather River Low Flow Channel, with effects decreasing in the High Flow Channel, and generally decreasing further in the Sacramento River and Delta as the pulse flow volume becomes a smaller proportion of the flow.

Increases in water volume, depth, and velocity and decreases in water temperature could all provide benefits. Decreased flows during the Recovery Period have the potential to negatively affect salmonids, although these potential negative effects would be less pronounced than the pulse flow effects because of less spatiotemporal overlap and a lower proportional change in flow. As described in Appendix B, changes in hydraulic conditions and geomorphic processes under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. The reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, the Pulse Flows Component would not substantially adversely affect the existing aquatic biological resources environment.

Rearing conditions for anadromous salmonids during the pulse flows are expected to improve through an increase in water volume, depth, and velocity and a decrease in water temperatures. However, such changes would be limited for very high flow releases, occurring for only a few days, which would be more likely to benefit emigration of juvenile salmonids. In the Feather River, these changes could benefit spring-run Chinook salmon, fall and late fall-run Chinook salmon, and steelhead, including fall-run and spring-run hatchery releases. The changes could also benefit incidentally rearing winter-run Chinook salmon in the lower reaches of the Feather River. Adult Feather River spring-run Chinook salmon could benefit from pulse flows by being provided larger migration cues.

The increase in the volume of flows could also reduce the potential for straying by these fish, although the magnitude of change is within the range of typical hydrological conditions, in which straying rates within the Sacramento River Basin have been observed to be low. Higher flows may also provide easier access over partial fish barriers that require more energy to traverse in lower flows, although passage barriers in shallow areas have not been noted to be a major impediment to salmonids in the Feather River. Additionally, decreased water temperatures would decrease metabolic requirements for migrating adults, leaving more energy available for reproduction.

Increased water volume and depths during the pulse flows could provide additional wetted areas for Central Valley steelhead spawning in the Feather River Low Flow and High Flow channels. Such increases in usable area may encourage spawning in areas that could dry out after a pulse flow, which would result in the dewatering and desiccation of any redds in such areas. After a pulse flow, Central Valley steelhead redds could become dewatered and desiccated when flows recede in areas that had been inundated by the pulse flow. However, not many salmonids would be likely to spawn in newly wetted areas that would be at risk of desiccation during receding flows, given the relatively short time period of peak pulse flows. Central Valley steelhead would be the species most likely to be affected by these changes in spawning conditions, because they spawn in the Feather River from December through April and the proposed pulse flows could occur as early as March, depending on CDFW requests regarding the timing of pulse flow releases. (The peak of spawning is in January–February, before the pulse flow period.)

Decreased releases during the Recovery Period have the potential to affect spawning by spring-run and fall-run Chinook salmon by decreasing their available spawning habitat. This effect would occur mainly (1) toward the end of the Recovery Period in late August and September, when both spring-run and fall-run Chinook salmon are known to spawn in the Feather River; and (2) if less flow under the Recovery Period were to increase water temperature in the High Flow Channel, thus increasing the number of spring-run and fall-run overlapping in the Low Flow Channel relative to existing conditions. Negative effects that could arise would be greater potential hydridization and redd superimposition, leading to greater potential for in-gravel egg mortality. However, temperature data for below-normal and dry water years suggest that water temperature in the High Flow Channel is above the range suitable for spawning in any case, so the effects of increasing water temperature in the High Flow Channel would likely be limited.

With the exception of water temperature effects, potential flow-related positive effects would also be realized for these species in the Sacramento River and Delta. However, the positive effects would generally occur there at a less pronounced level than in the Feather River, because the magnitude of pulse flows accounts for a lower percentage of the overall flow in these areas. Increased volumes and depths would benefit rearing salmonids by reducing the potential for predation and causing an increase in access to margin habitats that provide foraging opportunities and instream cover.

The increased volume of water in the Feather River may also provide benefits to salmonids through a “flushing” process in which concentrations of parasites such as *Ceratonova shasta* could be decreased. The pulse flow could also reduce the abundance of the alternative polychaete host of *C. shasta*, thereby also decreasing *C. shasta*, albeit temporarily. Decreases in water temperatures could provide benefits by reducing metabolic requirements during rearing and emigration. After the pulse flows, the potential would exist for receding water levels to strand juveniles, although ramping rates are in place to minimize this effect.

Decreased releases during the Recovery Period have the potential to affect rearing juvenile salmonids by reducing habitat and increasing water temperatures downstream of the Low Flow Channel, because the flows released from the Thermalito Afterbay Outlet would be reduced. A decrease in releases could reduce the amount of margin habitat available for rearing. It also could increase predation risk from avian and terrestrial predators by reducing depth refugia near channel margins where juveniles would otherwise be able to avoid these predators. Water temperatures likely would warm more quickly and would warm to a higher daily maximum water temperature in the lower portion of the High Flow Channel, which could increase stress and increase susceptibility to disease and predation. However, effects would be limited because flows would meet the requirements of the FERC license and the NMFS BiOp (National Marine Fisheries Service 2016).

During the pulse flows, increases in flow rate could provide more pronounced migration cues for juveniles to initiate downstream emigration. Additionally, increased velocity would reduce travel times downstream, potentially increasing survival based on flow/survival relationships; such relationships have been found for the Sacramento River and North Delta, but not for the Feather River, so there is some uncertainty as to the magnitude of the effect. Decreased water temperatures in the Feather River Low Flow Channel and the upper portion of the High Flow Channel could also benefit emigrating salmonids by decreasing metabolic requirements.

During the Recovery Period, decreased releases could affect emigrating and rearing salmonids by reducing margin habitat and resulting in slower travel times. Limited potential would exist for temporal overlap of decreased releases with most juvenile salmonid migrants, but there could be some overlap with early-migrating winter-run Chinook salmon and yearling steelhead. Available quantitative flow/survival relationships suggest that any such effects would be limited.

Reduced flows during the Recovery Period could affect migration cues and increase the risk for straying by adult fall-run Chinook salmon returning to the Feather River. However, flows are low throughout the Sacramento River system during this time period, and straying has been historically observed to be low across a broad range of hydrological conditions; therefore, increased straying would likely be minimal. Within the High Flow Channel, the decrease in volume associated with the Recovery Period is not likely to increase the risk of passage delay at shallow areas.

Overall, for the reasons described above, the pulse flows could benefit anadromous salmonids by improving juvenile emigration and survival, and the Recovery Period could have some negative effects because of reduced flows. In consideration of the positive and negative effects of the pulse flows and Recovery Period—including the magnitude, duration, and seasonal timing of the physical changes, relative to the life stages present in the rivers and their habitat use—and continued management under the requirements of the FERC license, the DWR/CDFW Agreement for pulse flow operations, the CAPBs with CDFW, and NMFS BiOps (National Marine Fisheries Service 2016), the impact of the Pulse Flows Component on spring-run Chinook salmon, winter-run Chinook salmon, fall and late-fall-run Chinook salmon, and steelhead would be **less than significant**.

Green Sturgeon and White Sturgeon

Sturgeon could benefit from many of the same flow-related changes as salmonids during the pulse flow period. Changes in habitat variables associated with increased flow such as depth and velocity would be greatest in the Low Flow Channel, with smaller changes occurring in the High

Flow Channel, and still smaller changes occurring in the Sacramento River and Delta. Increased water depth, velocity, and lower water temperature during the pulse flow period could benefit spawning, rearing, and emigration in the Feather River, and may benefit rearing and emigration in the Sacramento River and Delta. White sturgeon year-class strength is positively correlated with spring Delta outflow, which would be increased during pulse flows; however, the magnitude of the potential effect is uncertain, given the variability in the statistical relationship, and would be unlikely to result in a measurable difference in year-class strength.

Decreased flows and increased water temperatures in the downstream reaches of the Feather River High Flow Channel during the Recovery Period could result in negative effects on rearing and emigrating juveniles. There likely would be limited overlap of the Recovery Period with green sturgeon spawning, which has not been observed to occur in July in the Feather River.

Overall, the pulse flows could benefit sturgeon, and the Recovery Period could result in some negative effects. In consideration of the positive and negative effects of the pulse flows and recovery period, and continued management under the requirements of the FERC license, the DWR/CDFW Agreement for pulse flow operations, the CAPBs with CDFW, and the NMFS BiOps (National Marine Fisheries Service 2016), the impact of the Pulse Flows Component on green sturgeon and white sturgeon would be **less than significant**.

Pacific Lamprey and Western River Lamprey

Lamprey could benefit from spring pulse flows in a manner similar to that described previously for salmonids and sturgeon (e.g., greater flow enhancing cues for juvenile emigration and reductions in water temperature). Decreased flow could have negative effects such as greater water temperature and less inundation of habitat for ammocoete rearing. However, effects would be expected to be limited, given management of flow under the requirements of the FERC license, the DWR/CDFW Agreement for pulse flow operations, the CAPBs with CDFW, and the NMFS BiOps (National Marine Fisheries Service 2016) for other species. Therefore, the impact would be **less than significant**.

Native Minnows

Native minnows (Sacramento splittail, hardhead, Sacramento hitch, and Central California roach) could experience minor positive effects from increased inundation of habitat in the High Flow Channel during pulse flows. For Sacramento splittail, negative effects could occur if adults spawn in newly inundated areas and larvae are stranded because of the relatively short duration of inundation relative to development time. However, such effects would be limited, given that the primary driver of population dynamics is the inundation of large areas of floodplain such as the Yolo Bypass.

Potential negative effects during the period of reduced flows in the Recovery Period would be limited because of the relatively broad environmental tolerance of native minnows. Flow management under the requirements of the FERC license, the DWR/CDFW Agreement for pulse flow operations, the CAPBs with CDFW, and the NMFS BiOps (National Marine Fisheries Service 2016) for other species would also limit the potential for negative effects. The impact would be **less than significant**.

Delta Smelt and Longfin Smelt

Pulse flows would increase spring Delta outflow. Positive effects on longfin smelt could occur as a result of these pulse flows, but the relatively small incremental increase in Delta outflow would be unlikely to result in a measurable effect on longfin smelt abundance indices. Given observed positive correlations between spring Delta outflow and delta smelt prey, positive effects on delta smelt could occur through greater abundance of prey. Again, however, these effects are uncertain given the variability in the statistical relationships.

Potential negative effects on delta smelt during the Recovery Period would be limited because Delta outflow would not be substantially reduced as a result of less carriage water, as exports of released water would not occur and existing regulations would continue. The impact would be **less than significant**.

Other Special-Status Fish Species

Striped bass and American shad could benefit from greater dispersal of early life stages by pulse flows (e.g., striped bass eggs). Statistically significant negative relationships between spring X2 and indices of abundance for striped bass and American shad indicate the potential for greater spring Delta outflow to have a positive effect on these species, although the incremental increase in flow would be relatively small and of short duration and thus unlikely to result in a measurable difference in the abundance indices. Striped bass, American shad, and non-native black bass species have relatively broad environmental tolerances and thus would be expected to have limited effects from positive or negative flow changes resulting from implementation of the Pulse Flows Component. The impact would be **less than significant**.

South Delta Exports at Banks Pumping Plant Impacts

As described above, under the Pulse Flows Component, Delta outflow during the Recovery Period would remain approximately the same (except for the carriage water component) because water that otherwise would have been released from Lake Oroville for export would no longer be exported at the Banks Pumping Plant.

With respect to additional South Delta exports at the Banks Pumping Plant to fill the WSIP Groundwater Projects that facilitate the Pulse Flows Component, the additional rates of winter-spring diversion from the SWP Banks Pumping Plant would be very small: two orders of magnitude smaller than the level of Banks Pumping Plant exports under baseline conditions. The small incremental increases in pumping that would occur to fill the WSIP Groundwater Projects would be subject to the existing restrictive criteria set by CDFW's SWP ITP (California Department of Fish and Wildlife 2020) to limit the potential for take by entrainment of CESA-listed fish species (winter-run Chinook salmon, spring-run Chinook salmon, delta smelt, and longfin smelt). The impact would be **less than significant.**

Conclusion for Impact 3.5-1

The Pulse Flows Component would not result in significant impacts on special-status fish species. The impact would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to substantial adverse effects, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NMFS or USFWS movement of any native resident or migratory fish are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.5-2: Implementation of the Pulse Flows Component would interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

The Pulse Flows Component is not expected to substantially interfere with the movement of any native resident or migratory fish. Overall, the Pulse Flows Component could provide benefits to anadromous fish migration during the pulse flow events in March, April, May, or June. The Recovery Period is not expected to substantially interfere with the migration of resident or anadromous fish, but flow reductions from July through September could have a minor effect on early-migrating fall-run Chinook salmon and steelhead and on post-spawn, emigrating green sturgeon. These effects are not expected to be substantial because the reductions in flow would not restrict access to spawning and holding areas in the Feather River. Although reductions in flow might have the potential to increase straying risk for adult spring-run and fall-run Chinook salmon and Central Valley steelhead, the available information suggests that any increase in risk would be minimal, as discussed further in Impact 3.5-1. As also discussed in Impact 3.5-1, potential negative effects on downstream-migrating juvenile salmonids during the Recovery Period would be small and limited to a small proportion of individuals. Therefore, the impact would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to movement of any native resident or migratory fish are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.5-3: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources.

As described in the "Regional and Local" discussion within Section 3.5.2, "Regulatory Setting," cities and counties typically include goals and policies such as preservation and reestablishment of special-status fish species and coordination with federal, State, and local resource agencies to protect special-status fish species. As shown in the analysis of potential impacts of the Pulse Flows Component described in Impact 3.5-1, there would not be a significant impact on special-status fish species. Therefore, the Pulse Flows Component would not conflict with local policies or ordinances protecting special-status fish species. The impact would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conflicts with local policies or ordinances protecting aquatic biological resources are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.5-4: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan.

Three adopted HCPs/natural community conservation plans (NCCPs) are implemented in the general vicinity of the areas potentially affected by the Pulse Flows Component: the Yolo County NCCP/HCP; Placer County Conservation Plan Phase I NCCP/HCP; and the East Contra Costa County NCCP/HCP. None of these plans include special-status fish species as covered species; therefore, the Pulse Flows Component would not conflict with the provisions of these plans. The impact would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conflicts with the provisions of an adopted HCP, NCCP, or other approved local, regional, or State HCP are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

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3.6 Biological Resources–Terrestrial

This section discusses the potential for the Pulse Flows Component to affect terrestrial biological resources, which include special-status species and their habitats, riparian habitat, and other sensitive natural communities. This section is limited in scope to wetlands, terrestrial wildlife, and special-status plants; for analysis regarding special-status fish species, refer to Section 3.5, "Biological Resources–Aquatic." The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and the Willow Springs Water Bank Project.

3.6.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (Figure 2-2).

Areas downstream of the Delta include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir, a joint use facility between DWR and USBR, is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct and Delta Mendota Canal. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system. These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations.

Furthermore, the California Aqueduct consists of pumping plants, pipes and concrete lined canals that are physically separated from the Central Valley range of terrestrial populations and does not function as habitat for terrestrial species. Therefore, impacts on terrestrial biological resources were also not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

As presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B, changes in hydraulic conditions and geomorphic processes resulting from the pulse flow releases (as indicated through modeling of the conservative pulse flow release scenario) and WSIP

Operational Exchange Process would be minimal in the Sacramento River relative to inputs from the Sutter Bypass and other tributary creeks and rivers; hence the effects of the pulse flow releases on habitats for terrestrial species would likewise be relatively imperceptible. For the Sacramento–San Joaquin Delta (Delta), the influence of the pulse flows would be minimal compared to the scale of tidal flux and inputs from tributary rivers that include the San Joaquin, Cosumnes, and Mokelumne. Therefore, impacts on terrestrial biological resources were not evaluated for the following geographic areas:

- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

Changes in flow rates, water levels, and other parameters resulting from the pulse flow releases and WSIP Operational Exchange Process are anticipated to occur primarily in the Low and High Flow Channels of the Feather River. Terrestrial species within these areas are generally associated with the riparian zone along rivers whose flows would be changed by pulse flow releases. Lacustrine riparian habitats in these areas could also be affected by drawdowns associated with pulse flow releases. Therefore, impacts on terrestrial biological resources were evaluated for the following geographic areas:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River

3.6.2 Environmental Setting

This environmental setting section provides a focused discussion of existing conditions in the geographic areas analyzed for impacts on terrestrial biological resources (as identified above). A general description of each of the seven geographic areas composing the Pulse Flows Component study area is presented in Section 2.3. For detailed descriptions of the predominant geographic, historic, and hydrologic contexts of these regions, refer to Chapter 2, “Description of the Pulse Flows Component,” and Sections 3.4 and 3.5, “Hydrology and Water Quality” and “Biological Resources–Aquatic,” respectively.

Existing Terrestrial Habitat Types

Habitat types are typically characterized by dominant plant species (e.g., oak trees or grasses), with varying combinations of other plant species that provide resources for use by wildlife and facilitate suitable conditions for associated special-status plant species. The dominant vegetation community in a habitat type is governed by a combination of site-specific factors, including soil type, slope, aspect, elevation, microclimate, and hydrologic regime. Structural and species diversity of habitats in the study area vary widely due to its large geographic area, from broad floodplains and/or riparian corridors; to narrow, sparsely vegetated channelized banks.

Sensitive Natural Communities

Sensitive habitats in the study area include areas of special concern to resource agencies, areas protected under CEQA, areas designated as sensitive natural communities by the California Department of Fish and Wildlife (CDFW), areas outlined in Section 1600 of the California Fish and Game Code, areas regulated under Section 404 of the federal Clean Water Act, and areas protected under local regulations and policies. California natural communities are defined by CDFW and partner organizations based on vegetation type classification and are ranked using the same system the California Natural Diversity Database (CNDDB) uses to assign global and State rarity ranks for plant and animal species. Natural communities that are ranked S1 through S3 are considered sensitive natural communities by CDFW and are to be addressed in the environmental review process.

Riparian habitat in the study area includes several sensitive natural communities as well as other, non-sensitive vegetation communities, including barren and developed areas that overlap waterways and may be subject to regulation by CDFW under Section 1602 of the California Fish and Game Code, such as riprapped levees, ruderal grasslands, and blackberry thickets. The pulse flow releases could change the water levels and wetted area of waterways, particularly the Low and High Flow channels of the Feather River, affecting this riparian habitat.

Riparian trees are used for nesting, foraging, and protective cover by many bird species, and riparian canopies provide roosting habitat for bats and foraging habitat for a variety of mammals. Understory shrubs provide cover for ground-nesting birds that forage among the vegetation and leaf litter. Reptiles and amphibians use upland riparian areas for winter hibernation and estivation habitat; some reptiles, like the western pond turtle, may also use this habitat for nesting. Willow and elderberry shrub thickets provide habitat for a wide range of wildlife species, including special-status species like the yellow warbler (*Setophaga petechia*) and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

Wildlife inhabiting the Pulse Flows Component location are dependent on the trees associated with riparian habitats for vegetation diversity, microclimate conditions, and the availability of water, food, and cover. Several species of raptors, including Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperii*), and great horned owl (*Bubo virginianus*), nest in cottonwood (*Populus* spp.), valley oak (*Quercus lobata*), and other large trees that currently exist on both the landside and waterside of the Feather River and Sacramento River levees and in the project area. Natural cavities and woodpecker holes provide nesting sites for cavity-nesting species, including wood duck (*Aix sponsa*), common merganser (*Mergus merganser*), American kestrel (*Falco sparverius*), tree swallow (*Tachycineta bicolor*), and western screech owl (*Megascops kennicottii*). Riparian scrub supports large numbers of mammals, reptiles, amphibians, and insects and attracts passerine birds, including several species of warblers and hummingbirds.

The nearshore aquatic area, referred to as "shaded riverine aquatic habitat," occurs at the interface between a river and adjacent woody riparian habitat and is regulated by the U.S. Fish and Wildlife Service (USFWS). Shaded riverine aquatic habitat is generally represented by overhead canopy cover and is thus part of the overall riparian habitat in the project area. The principal attributes of shaded riverine aquatic habitats include (1) adjacent bank being composed of natural, eroding substrates that support riparian vegetation that either overhangs or protrudes into the water; and (2) water containing variable amounts of woody debris such as leaves, logs, branches, and roots, as well as variable depths, velocities, and currents (U.S. Fish and Wildlife Service 1992). Overhanging vegetation over aquatic habitat provides shade coverage important to the survival of many aquatic organisms, including fish, by moderating water temperatures. Vegetation provides food, habitat, and cover for terrestrial and aquatic invertebrates as well as several native fish species.

Oroville Complex

Vegetation around Lake Oroville consists of mixed oak woodlands, foothill pine/mixed oak woodlands, and oak/pine woodlands within a mosaic of chaparral and annual grassland (Federal Energy Regulatory Commission 2018). Serpentine and gabbro soils are common along the shoreline of the lake in its northern and southern reaches, respectively (California Department of Water Resources 2004a). Both soil types are associated with unique assemblages of plant species, many of which are special status. Limited native riparian vegetation is restricted to narrow strips along tributaries in the upper reaches of the lake. Seeps and springs above the high-water line are characterized by perennial wetland vegetation; otherwise, the lacustrine shoreline is composed of upland vegetation or is barren. Emergent wetlands generally are absent in the drawdown zone of Lake Oroville but do exist along the edges of the Thermalito Forebay (Federal Energy Regulatory Commission 2018). A thin strip of mixed riparian vegetation with an understory of emergent wetland vegetation also occurs around the northern shore of the Thermalito Forebay (Federal Energy Regulatory Commission 2007).

Both the Thermalito Forebay and Thermalito Afterbay are surrounded by valley grassland habitats in upland areas that are dotted with vernal pools and swale complexes (California Department of Water Resources 2004a). In contrast to the drawdown area around the margin of Lake Oroville and the Thermalito Forebay, the drawdown zone of Thermalito Afterbay is shallower, with lower slopes that support a richer wildlife community and greater habitat diversity. Exposed mudflats in the Thermalito Afterbay seasonally provide habitat for a variety of migratory waterbirds (Federal Energy Regulatory Commission 2007). The Thermalito Afterbay also contains numerous waterfowl brood ponds constructed in inlets, protected by berms to support emergent vegetation and nesting waterfowl, which also provide a refuge for giant garter snakes during periods of afterbay drawdown (California Department of Water Resources 2004b).

Low Flow Channel of the Feather River

The Low Flow Channel of the Feather River, downstream of the Thermalito Diversion Dam and above the Thermalito Afterbay Outlet, has been mined for gravel in the past and is now characterized by dredge tailings along its bed and banks (California Department of Water Resources 2004c). The channel is restricted by levees, with the eastern side consisting of limited riparian vegetation and adjacent urban development. Along the western side of the Low Flow Channel is the Oroville Wildlife Area which contains a broad corridor of riparian woodland habitat. Above the Thermalito Diversion Dam, the Thermalito Diversion Pool channel consists of bedrock material covered by cobbles and boulders, with riparian vegetation restricted to banks.

High Flow Channel of the Feather River

Below the Thermalito Afterbay Outlet, the High Flow Channel of the lower Feather River consists mostly of barren gravel and cobble piles, with little riparian vegetation. For 6 miles downstream of the Thermalito Afterbay Outlet, cottonwood riparian forest extends to the east; numerous old dredge ponds vegetated by varying amounts of cottonwood and willow trees occur to the west and southwest of the river channel (California Department of Water Resources 2004c).

Farther downstream, the river channel features mixed riparian forests bordered mostly by agricultural fields. Large setback levees varying from 100 feet to nearly 1 mile wide are common and feature complex mixed herbaceous fields, riparian forest, and shrub vegetation communities, as well as areas of agriculture (orchards) and urban/disturbed lands. Several wide meander bends persist along portions of the Feather River south of Yuba City to its confluence with the Sacramento River at Verona Marina, such as Abbott Lake and O'Connor Lake near the Lake of the Woods State Recreation Area and the Bobelaine Audubon Sanctuary.

Special-Status Plants and Wildlife

For this analysis, special-status terrestrial species are defined as plants and wildlife that fall within any of the following categories:

- Species listed by the federal government as threatened or endangered
- Species listed by the State as threatened, endangered, or rare (rare status is for plants only)
- Species that are formally proposed for federal listing or are candidates for federal listing as threatened or endangered
- Species that are candidates for State listing as threatened or endangered
- Species identified by CDFW as species of special concern
- Species designated by California statute as fully protected (e.g., California Fish and Game Code Sections 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians])
- Species, subspecies, and varieties of plants considered by CDFW and the California Native Plant Society (CNPS) to be rare, threatened, or endangered in California.

The CNPS Inventory of Rare and Endangered Plants of California assigns California Rare Plant Rank (CRPR) categories for plant species of concern:

- CRPR 1A—Plants presumed to be extinct in California
- CRPR 1B—Plants that are rare, threatened, or endangered in California and elsewhere
- CRPR 2A—Plants that are presumed extirpated in California but more common elsewhere
- CRPR 2B—Plants that are rare, threatened, or endangered in California but more common elsewhere
- CRPR 3—Plants for which more information is needed, a review list
- CRPR 4—Plants of limited distribution, a watch list

- CRPR Threat Rank Extensions:
  - .1 = Seriously endangered in California (>80 percent of occurrences are threatened and/or high degree and immediacy of threat)
  - .2 = Fairly endangered in California (20 to 80 percent of occurrences are threatened/moderate degree and immediacy of threat)
  - .3 = Not very threatened in California (less than 20 percent of occurrences threatened/low degree and immediacy of threat)

Table 3.6-1 and **Table 3.6-2** list the special-status plant and special-status terrestrial wildlife, respectively, that have been documented or have a moderate to high potential to occur in the geographic areas considered and may be directly or indirectly affected by the Pulse Flows Component. Special-status plant and wildlife species were included in the analysis if they potentially could be directly or indirectly affected because of:

- Potential changes to wildlife and plant habitat in the riparian zone as a result of changes in flows that could affect plants and wildlife along stream and reservoir banks; or
- Potential changes to existing riparian or upland areas in the riparian zone and associated special-status species due to spring inundation that may result in a loss of habitat.

Special-status species with little to no likelihood of occurring in geographic areas considered for terrestrial biological resources, or whose life history or habitat use would not be affected due to the nature of the Pulse Flows Component, were not included in this analysis. The species list in **Appendix C** includes all special-status species with records of occurrence in the geographic areas analyzed (see Section 3.6.1), and was developed based on review of available background reports; previous studies conducted in or near the geographic areas considered; a list obtained from the USFWS Information for Planning and Consultation system; and CNDDB and CNPS Inventory records of previously documented occurrences of special-status species in the Oroville Dam, Oroville, Shippee, Biggs, Palermo, Gridley, Honcut, Sutter, Yuba City, Olivehurst, Nicolaus, and Verona U.S. Geological Survey 7.5-minute quadrangles.

TABLE 3.6-1
SPECIAL-STATUS PLANT SPECIES CONSIDERED IN THE PROJECT AREA

Common Name ***Scientific Name***	**Federal Status**	**State Status**	**CRPR Status**	**Habitat Requirements**	**Identification/ Survey Period**
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	--	--	1B.2	Vernal pool margins	Mar-May
Ahart's paronychia *Paronychia ahartii*	--	--	1B.1	Well-drained rocky outcrops and rocky soils within volcanic uplands; often on vernal pool edges, higher ground around vernal pools, nearly barren clay of vernal swales, or other vernally moist sites with thin soils	Feb-Jun
Bidwell's knotweed *Polygonum bidwelliae*	--	--	4.3	Chaparral, cismontane woodland, and valley and foothill grassland	Apr-Jul
Bolander's water-hemlock *Cicuta maculata* var. *bolanderi*	--	--	2B.1	Marshes, edges of ponds, streambanks and ditches	Jul-Sep
Brandegee's clarkia *Clarkia biloba* ssp. *brandegeeae*	--	--	4.2	Chaparral, cismontane woodland, and lower montane coniferous forest	May-Jul
brassy bryum *Bryum chryseum*	--	--	4.3	Chaparral (openings), cismontane woodland, valley and foothill grassland	N/A
Brazilian watermeal *Wolffia brasiliensis*	--	--	2B.3	Marshes and swamps (shallow freshwater)	Apr-Dec
bristly leptosiphon *Leptosiphon acicularis*	--	--	4.2	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland	Apr-Jul
Butte County calycadenia *Calycadenia oppositifolia*	--	--	4.2	Dry meadows, grassy to brushy openings, and road cuts within a variety of plant communities, including Valley and Foothill/Basalt Grassland, Chaparral, Foothill/Cismontane Woodland, and Yellow Pine Forest; volcanic, granitic, or serpentine substrates; often on hillsides	Apr-Jul
Butte County fritillary *Fritillaria eastwoodiae*	--	--	3.2	Chaparral, cismontane woodland, lower montane coniferous forest (openings)	Mar-Jun
Butte County meadowfoam *Limnanthes floccosa* var. *californica*	FE	CE	1B.1	Valley and foothill grassland (mesic), vernal pools	Mar-May
crownscale *Atriplex coronata* var. *coronata*	--	--	4.2	Chenopod scrub, valley and foothill grassland, vernal pools	Mar-Oct
Delta mudwort *Limosella australis*	--	--	2B.1	Marshes and swamps (brackish, freshwater), riparian scrub	May-Aug

Common Name *Scientific Name*	**Federal Status**	**State Status**	**CRPR Status**	**Habitat Requirements**	**Identification/ Survey Period**
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	--	--	1B.2	Marshes and swamps (brackish, freshwater)	May-Jul (Aug-Sep)
depauperate milk-vetch *Astragalus pauperculus*	--	--	4.3	Chaparral, cismontane woodland, valley and foothill grassland	Mar-Jun
English Peak greenbrier *Smilax jamesii*	--	--	4.2	Broadleafed upland forest. lower montane coniferous forest, marshes and swamps, North Coast coniferous forest, upper montane coniferous forest	May-Jul (Aug-Oct)
Greene's tuctoria *Tuctoria greenei*	FE	CR	1B.1	Vernal pools	May-Jul (Sep)
hairy Orcutt grass *Orcuttia pilosa*	FE	CE	1B.1	Vernal pools	May-Sep
Hartweg's golden sunburst *Pseudobahia bahiifolia*	FE	CE	1B.1	Cismontane woodland, valley and foothill grassland	Mar-Apr
hogwallow starfish *Hesperevax caulescens*	--	--	4.2	Valley and foothill grassland (mesic clay), vernal pools (shallow)	Mar-Jun
Hoover's spurge Euphorbia hooveri	FT	--	--	Vernal pools	Jul-Sep (Oct)
Humboldt lily *Lilium humboldtii* ssp. *humboldtii*	--	--	4.2	Chaparral, cismontane woodland, lower montane coniferous forest	May-Jul (Aug)
Layne's ragwort *Packera layneae*	FT	CR	1B.2	Chaparral, cismontane woodland	Apr-Aug
Lewis Rose's groundsel *Packera eurycephala* var. *lewisrosei*	--	--	1B.2	Chaparral, cismontane woodland, lower montane coniferous forest	Mar-Jul (Aug-Sep)
Mason's liliaeopsis *Lilaeopsis masonii*	--	--	1B.1	Marshes and swamps (brackish, freshwater), riparian scrub	Apr-Nov
Mexican mosquito fern *Azolla microphylla*	--	--	4.2	Marshes and swamps (ponds, slow water)	Aug
Mosquin's clarkia *Clarkia mosquinii*	--	--	1B.1	Cismontane woodland, lower montane coniferous forest	May-Jul (Sep)
Parry's rough tarplant *Centromadia parryi* ssp. *rudis*	--	--	4.2	Valley and foothill grassland, vernal pools	May-Oct

Common Name ***Scientific Name***	**Federal Status**	**State Status**	**CRPR Status**	**Habitat Requirements**	**Identification/ Survey Period**
red-stemmed cryptantha *Cryptantha rostellata*	--	--	4.2	Cismontane woodland, valley and foothill grassland	Apr-Jun
Sanford's arrowhead *Sagittaria sanfordii*	--	--	1B.2	Marshes and swamps (shallow freshwater)	May-Oct (Nov)
shield-bracted monkeyflower *Erythranthe glaucescens*	--	--	4.3	Chaparral, cismontane woodland, lower montane coniferous forest, valley and foothill grassland	Feb-Aug (Sep)
Sierra Foothills brodiaea *Brodiaea sierrae*	--	--	4.3	Chaparral, cismontane woodland, lower montane coniferous forest	May-Aug
slender Orcutt grass *Orcuttia tenuis*	FT	CE	1B.1	Vernal pools	May-Sep (Oct)
small spikerush *Eleocharis parvula*	--	--	4.3	Marshes and swamps	(Apr) Jun-Aug (Sep)
Stinkbells *Fritillaria agrestis*	--	--	4.2	Chaparral, cismontane woodland, Pinyon and juniper woodland, valley and foothill grassland	Mar-Jun
Suisun Marsh aster *Symphyotrichum lentum*	--	--	1B.2	Marshes and swamps (brackish, freshwater)	(Apr)May-Nov
sylvan microseris *Microseris sylvatica*	--	--	4.2	Chaparral, cismontane woodland, Great Basin scrub, Pinyon and juniper woodland, valley and foothill grassland	Mar-Jun
Tehama navarretia *Navarretia heterandra*	--	--	4.3	Valley and foothill grassland (mesic), vernal pools	Apr-Jun
thread-leaved beakseed *Bulbostylis capillaris*	--	--	4.2	Lower montane coniferous forest, meadows and seeps, upper montane coniferous forest	Jun-Aug
valley brodiaea *Brodiaea rosea* ssp. *vallicola*	--	--	4.2	Valley and foothill grassland, vernal pools	Apr-May (Jun)
white-stemmed clarkia *Clarkia gracilis* ssp. *albicaulis*	--	--	1B.2	Chaparral, cismontane woodland. serpentinite (sometimes)	May-Jul
wine-colored tufa *Plagiobryoides vinosula*	--	--	4.2	Cismontane woodland. Mojavean desert scrub, meadows and seeps, Pinyon and juniper woodland. riparian woodland	N/A
woolly meadowfoam *Limnanthes floccosa* ssp. *floccosa*	--	--	4.2	Chaparral, cismontane woodland, valley and foothill grassland, vernal pools	Mar-May (Jun)

Common Name ***Scientific Name***	**Federal Status**	**State Status**	**CRPR Status**	**Habitat Requirements**	**Identification/ Survey Period**
woolly rose-mallow *Hibiscus lasiocarpos* var. *occidentalis*	--	--	1B.2	Marshes and swamps; often in riprap on sides of levees	Jun-Sep

KEY TO STATUS CODES:

Federal

FE = federal endangered
FT = federal threatened
FC = candidate
PT = proposed threatened
FPD = proposed for delisting
FD = delisted

California

CE = California State endangered
CT = California State threatened
CR = California State rare
SSC = California species of special concern
CCT = California State threatened candidate
CFP = California fully protected

CNPS

Rank Categories:

1A = Plants presumed extirpated in California and either rare or extinct elsewhere
1B = Plants Rare, Threatened, or Endangered in California and elsewhere
2A = Plants presumed extirpated in California, but more common elsewhere
2B = Plants Rare, Threatened, or Endangered in California, but more common elsewhere
3 = Plants about which more information is needed - A Review List
4 = Plants of limited distribution - A Watch List

Code Extensions:

.1 = Seriously endangered in California (over 80% of occurrences threatened/high degree and immediacy of threat)
.2 = Fairly endangered in California (20–80% occurrences threatened)
.3 = Not very endangered in California (less than 20% of occurrences threatened or no current threats known)

Sources: California Department of Fish and Wildlife 2022; California Native Plant Society 2022; U.S. Fish and Wildlife Service 2022.

TABLE 3.6-2
SPECIAL-STATUS TERRESTRIAL WILDLIFE SPECIES CONSIDERED IN THE PROJECT AREA

Type	Common Name Scientific Name	Federal Status	State Status	Habitat Requirements
Invertebrate	Conservancy fairy shrimp *Branchinecta conservatio*	FE	--	Vernal pools and swales.
Invertebrate	Crotch bumble bee *Bombus crotchii*	--	CCT	Found in open grassland and scrub; can persist in semi-natural habitats surrounded by intensely modified landscapes; food plants include *Asclepias*, *Chaenactis*, *Lupinus*, *Medicago*, *Phacelia*, and *Salvia.*
Invertebrate	monarch butterfly–California overwintering population *Danaus plexippus* pop. 1	FC	--	This subspecies requires milkweeds as caterpillars, but as adults they feed on nectar from a variety of flowers. Monarchs roost in trees near water. Overwintering in California occurs in gum, pine, cypress, and sycamore trees.
Invertebrate	valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	--	Elderberry shrubs, typically in riparian habitats.
Invertebrate	vernal pool fairy shrimp *Branchinecta lynchi*	FT	--	Vernal pools and other seasonal wetlands.
Invertebrate	vernal pool tadpole shrimp *Lepidurus packardi*	FE	--	Vernal pools, swales, and other ephemeral wetlands.
Amphibian	western spadefoot toad *Spea hammondii*	--	SSC	In winter, breeds in vernal pools and seasonal wetlands with a minimum 3-week inundation period; in summer, aestivates in grassland habitat, in soil crevices and rodent burrows.
Reptile	giant garter snake *Thamnophis gigas*	FT	CT	Forages in slow-moving streams, sloughs, ponds, marshes, inundated floodplains, rice fields, and irrigation and drainage canals; also requires upland refugia not subject to flooding during the snake's inactive season.
Reptile	western pond turtle *Emys marmorata*	--	SSC	Forages in ponds, marshes, slow-moving streams, sloughs, and irrigation ditches; nests in nearby uplands with low, sparse vegetation.
Bird	American peregrine falcon *Falco peregrinus anatum*	FD	CD	When not breeding, occurs in areas where prey concentrate, including farmlands, marshes, lakeshores, river mouths, tidal flats, dunes and beaches, broad river valleys, cities, and airports. Often nests on ledge or hole on face of rocky cliff or crag.
Bird	bald eagle *Haliaeetus leucocephalus*	FD	CE	Forages primarily in large inland fish-bearing waters with adjacent large trees or snags, and occasionally in uplands with abundant rabbits, other small mammals, or carrion.
Bird	bank swallow *Riparia riparia*	--	CT	Nests in vertical banks or bluffs, typically adjacent to water, devoid of vegetation, and with friable, eroding soils; forages in a wide variety of habitats.
Bird	burrowing owl *Athene cunicularia*	--	SSC	Nests and forages in grasslands, agricultural fields, and low scrub habitats, especially where ground squirrel burrows are present; occasionally inhabits artificial structures and small patches of disturbed habitat.

Type	Common Name Scientific Name	Federal Status	State Status	Habitat Requirements
Bird	California black rail *Laterallus jamaicensis coturniculus*	--	CT/CFP	Nests and forages in saline, freshwater, or brackish emergent marshes with gently grading slopes and upland refugia with vegetative cover beyond the high-water line.
Bird	golden eagle *Aquila chrysaetos*	--	CFP	Nests and forages in a variety of open habitats, including grassland, shrubland, and cropland; most common in foothill habitats; rare foothill breeder; nests in cliffs, rock outcrops, and large trees.
Bird	greater sandhill crane *Antigone canadensis tabida*	--	CT/CFP	Forages primarily in croplands with waste grain; also frequents grasslands and emergent wetlands.
Bird	loggerhead shrike *Lanius ludovicianus*	--	SSC	Nests in isolated shrubs and trees and woodland edges of open habitats; forages in grasslands, agricultural fields, and low scrub habitats.
Bird	northern harrier *Circus hudsonius*	--	SSC	Nests on the ground among herbaceous vegetation, such as grasses or cattails; forages in grasslands, agricultural fields, and marshes.
Bird	purple martin *Progne subis*	--	SSC	Nests in tree cavities, bridges, utility poles, lava tubes, and buildings; forages in foothill and low montane oak and riparian woodlands, and less frequently in coniferous forests and open or developed habitats.
Bird	saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	--	SSC	Primarily brackish marsh with dense and continuous wetland or riparian vegetation down to the water surface; however, to a lesser degree, also uses woody swamp and freshwater marsh; often found in rush, tall grass, and willow-dominated communities.
Bird	short-eared owl *Asio flammeus*	--	SSC	Nests on the ground among herbaceous vegetation, such as grasses or cattails; forages in grasslands, agricultural fields, and marshes.
Bird	song sparrow “Modesto” population *Melospiza melodia*	--	SSC	Nests and forages primarily in emergent marsh, riparian scrub, and early successional riparian forest habitats, and infrequently in mature riparian forest and sparsely vegetated ditches and levees.
Bird	Suisun song sparrow *Melospiza melodia maxillaris*	--	SSC	Nests and forages in brackish water marshes dominated by cattails, tules, and pickleweed.
Bird	Swainson’s hawk *Buteo swainsoni*	--	CT	Nests in isolated trees, open woodlands, and woodland margins; forages in grasslands and agricultural fields.
Bird	tricolored blackbird *Agelaius tricolor*	--	CT	Nests colonially in large, dense stands of freshwater marsh, riparian scrub, and other shrubs and herbs; forages in grasslands and agricultural fields.
Bird	western yellow-billed cuckoo *Coccyzus americanus occidentalis*	FT	CE	Nests in valley, foothill, and desert riparian forest with densely foliaged deciduous trees and shrubs, especially willows; other associated vegetation includes cottonwood trees, blackberry, nettle, and wild grape.
Bird	white-tailed kite *Elanus leucurus*	--	CFP	Forages in ponds, marshes, slow-moving streams, sloughs, and irrigation ditches; nests in nearby uplands with low, sparse vegetation.
Bird	yellow-breasted chat *Icteria virens*	--	SSC	Nests and forages in riparian thickets of willow and other brushy tangles near water and thick understory in riparian woodland.

Type	Common Name Scientific Name	Federal Status	State Status	Habitat Requirements
Bird	yellow warbler *Setophaga petechia*	--	SSC	Habitat includes open scrub, second-growth woodland, thickets, farmlands, and gardens, especially near water; riparian woodlands, especially of willows, are typical habitat.
Mammal	Ringtail *Bassariscus astutus*	--	CFP	Typically found in rocky areas with cliffs or crevices for daytime shelter; desert scrub, chaparral, pine-oak and conifer woodland. Usually found within 0.5 mile of water. Dens usually in rock shelter; also in tree hollow, under tree roots, in burrow dug by other animal, in remote building, under brush pile.
Mammal	salt marsh harvest mouse *Reithrodontomys raviventris*	FE	E/CFP	Saline emergent marshes with low, dense cover of vegetation (especially pickleweed) and higher elevation refugia.
Mammal	Townsend's big-eared bat *Corynorhinus townsendii*	--	SSC	Typically roosts in caves; however, colonies of fewer than 100 individuals occasionally nest in buildings or bridges; forages in all habitats except alpine and subalpine, although most commonly in mesic forests and woodlands.
Mammal	western mastiff bat *Eumops perotis californicus*	--	SSC	Roosts in trees, rock crevices, and buildings in small colonies of fewer than 100 individuals; forages in a variety of grassland, shrub, and wooded habitats, including riparian and urban areas, although most commonly in open, arid lands.
Mammal	western red bat *Lasiurus blossevillii*	--	SSC	Roosts primarily in tree foliage, occasionally shrubs; roosts in small family groups rather than large colonies as other bats; prefers habitat edges and mosaics with trees that are protected from above and open below with open areas for foraging, including grasslands, shrublands, and open woodlands.

KEY TO STATUS CODES:

Federal

FE = federal endangered
FT = federal threatened
FC = candidate
PT = proposed threatened
FPD = proposed for delisting
FD = delisted
FSC = federal species of concern (U.S. Fish and Wildlife Service or National Marine Fisheries Service)
FU = Under Review for Listing
EFH = Essential Fish Habitat

California

CE = California State endangered
CT = California State threatened
CR = California State rare
SSC = California species of special concern
CCT = California State threatened candidate
CFP = California fully protected
CD = delisted

SOURCES: California Department of Fish and Wildlife 2022; California Native Plant Society 2022; U.S. Fish and Wildlife Service 2022.

Existing SWP Operations Affecting Terrestrial Species and Habitat

Existing SWP operations affecting terrestrial species and habitat at the Oroville Complex and at the Low and High Flow channels of the Feather River are discussed briefly below for each geographic area considered (see Section 3.6.1).

Oroville Complex

As described in Section 2.3, water levels can change in Lake Oroville, especially during high-water events and at lower lake levels. During a "normal" year, the water levels of Lake Oroville fluctuate more than 100 feet, with the lowest water levels occurring in the fall. Similarly, the Thermalito Facilities experience regular water level changes as a result of SWP operations. Water levels in the Thermalito Diversion Pool, Thermalito Power Canal, and Thermalito Forebay vary by about 2 feet, 4–6 feet, and 3.5 feet, respectively, on a weekly basis. In contrast, the Thermalito Afterbay, which is operated as a temporary storage pool for pump-back operations, experiences more dramatic weekly fluctuations in water levels, from 8 feet up to 12 feet (California Department of Water Resources 2004c). The brood ponds along the edges of the Thermalito Afterbay are contained by small earthen dams to maintain a stable water surface elevation relative to water level changes in other portions of the Thermalito Facilities, allowing for the establishment of persistent emergent vegetation and enhanced waterfowl production. DWR maintains water levels in the Oroville Complex in the ranges specified by existing applicable regulations (see Section 3.6.2).

Low and High Flow Channels of the Feather River

DWR manages flows in the Low and High Flow Channels of the Feather River for fisheries purposes, based on Federal and state requirements in BiOps and regulatory agreements. Refer to Section 3.4.3, under the subheading Biological Opinions for Oroville Operations, for a detailed description of the regulatory environment of the Feather River. Although flows are managed to protect fish and fish eggs, the modified flow regime has reduced the frequency of channel-forming flows. This, along with levees, has reduced the lateral movement of the Feather River. The modified flow regime and construction of levees has resulted in a more channelized river, with reduced sinuosity, reducing the amount of adjacent riparian terrestrial habitats. Flood management has also reduced the frequency of the inundation of floodplains, and levee construction has isolated floodplains from the river.

3.6.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to the terrestrial biological resource impact analyses as required under CEQA have been included.

Federal

Endangered Species Act of 1973, as Amended

The federal Endangered Species Act (ESA) and subsequent amendments (United States Code Title 16, Sections 1531–1543 [16 USC 1531–1543]) provide guidance for the conservation of endangered and threatened species and the ecosystems upon which they depend. In addition, the

ESA defines species as threatened or endangered and provides regulatory protection for listed species. The ESA also provides a program for the conservation and recovery of threatened and endangered species as well as the conservation of designated critical habitat that USFWS determines is required for the survival and recovery of these listed species.

Section 9 of the act lists those actions that are prohibited under the ESA. The definition of "take" includes to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Although unauthorized take of a listed species is prohibited, take may be allowed when it is incidental to an otherwise legal activity. Section 9 prohibits take of listed species of fish, wildlife, and plants without special exemption. The definition of "harm" includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns related to breeding, feeding, or shelter. "Harass" is defined as actions that create the likelihood of injury to listed species by disrupting normal behavioral patterns related to breeding, feeding, and shelter significantly.

Section 10 provides a means whereby a nonfederal action with the potential to result in take of a listed species can be allowed under an incidental take permit.

For additional information on the USFWS and National Marine Fisheries Service biological opinions on the Long-Term Operations of the Central Valley Project and SWP, see Section 3.4.3.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 USC 703–711) is the domestic law that affirms and implements a commitment by the United States to four international conventions (with Canada, Mexico, Japan, and Russia) for the protection of a shared migratory bird resource. Unless and except as permitted by regulations, the Migratory Bird Treaty Act makes it unlawful at any time, by any means, or in any manner to intentionally pursue, hunt, take, capture, or kill migratory birds anywhere in the United States. The law also applies to disturbance and removal of nests occupied by migratory birds or their eggs during the breeding season, whether intentional or incidental.

Bald and Golden Eagle Protection Act of 1940

The federal Bald and Golden Eagle Protection Act of 1940 (16 USC 668) protects bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) by prohibiting the taking, possession, and commerce of such birds and establishes civil penalties for violation of this act. Take of bald and golden eagles includes to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" (16 USC 668c). "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle; (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior (*Federal Register* Title 72, page 31132, June 5, 2007; Code of Federal Regulations Title 50, Section 22.3).

State

California Endangered Species Act

The California Endangered Species Act (CESA) (Fish and Game Code Section 2050 et seq.) establishes State policy to conserve, protect, restore, and enhance threatened or endangered species and their habitats. The CESA mandates that State agencies should not approve projects that would jeopardize the continued existence of threatened or endangered species if reasonable and prudent alternatives are available that would avoid jeopardy. For projects that would affect a listed species under both the CESA and the ESA, compliance with the ESA would satisfy the CESA if CDFW determines that the federal incidental take authorization is "consistent" with the CESA under Fish and Game Code Section 2080.1. Before a project results in take of a species listed under the CESA, a take permit must be issued under Section 2081(b).

The Incidental Take Permit for the Long-Term Operations of the SWP in the Sacramento–San Joaquin Delta (2081-2019-066-00) was issued in 2020 and authorizes changed SWP operations from existing conditions and provides take coverage for four fish species listed under the CESA. CDFW is authorized to issue incidental take permits for the taking of listed species under the CESA if the taking is incidental to carrying out an otherwise lawful activity.

Fish and Game Code Sections 2080 and 2081

Section 2080 of the Fish and Game Code states:

> No person shall import into this state [California], export out of this state, or take, possess, purchase, or sell within this state, any species, or any part or product thereof, that the [State Fish and Game] Commission determines to be an endangered species or threatened species, or attempt any of those acts, except as otherwise provided in this chapter, or the Native Plant Protection Act, or the California Desert Native Plants Act.

Pursuant to Section 2081, CDFW may authorize individuals or public agencies to import, export, take, or possess State-listed endangered, threatened, or candidate species. These otherwise prohibited acts may be authorized through permits or memoranda of understanding if the take is incidental to an otherwise lawful activity, impacts of the authorized take are minimized and fully mitigated, the permit is consistent with any regulations adopted pursuant to any recovery plan for the species, and the project operator ensures adequate funding to implement the measures required by CDFW. CDFW makes this determination based on available scientific information and considers the ability of the species to survive and reproduce.

Fish and Game Code Sections 3503, 3503.5, and 3513

Under these sections of the Fish and Game Code, a project operator is not allowed to conduct activities that would result in the take, possession, or destruction of any birds of prey; the take or possession of any migratory nongame bird; the take, possession, or needless destruction of the nest or eggs of any raptors or nongame birds; or the take of any nongame bird pursuant to Fish and Game Code Section 3800, whether intentional or incidental.

Fish and Game Code Sections 1600–1616 (Lake or Streambed Alteration Agreement Program)

Under the Lake or Streambed Alteration Agreement Program, CDFW regulates activities that would interfere with the natural flow of, or substantially alter, the channel, bed, or bank of a lake, river, or stream. CDFW jurisdiction under this program includes riparian habitat, which is defined in the context of Section 1600 of the California Fish and Game Code. According to guidance provided in *A Field Guide to Lake and Streambed Alteration Agreements: Section 1600–1607, California Fish and Game Code* (California Department of Fish and Game 1994), the outer edge of riparian vegetation is a reasonable and identifiable boundary for the lateral extent of a stream, the protection of which should result in preservation of the fish and wildlife at risk in a stream or drainage, and therefore may constitute the limits of CDFW authority along waterways.

Section 1602 requires that CDFW be notified of lake or stream alteration activities. If, after notification is complete, CDFW determines that the activity may substantially adversely affect an existing fish and wildlife resource, CDFW has authority to issue a streambed alteration agreement under Section 1603 of the California Fish and Game Code.

Requirements to protect the integrity of biological resources and water quality are often conditions of streambed alteration agreements. These requirements may include avoiding or minimizing the use of heavy equipment in stream zones; limiting work periods to avoid impacts on wildlife and fisheries resources; and implementing measures to restore degraded sites or compensate for permanent habitat losses.

Fully Protected Species

Certain species are considered fully protected, meaning that the California Fish and Game Code explicitly prohibits all take of individuals of these species except for scientific research. Section 5050 lists fully protected amphibians and reptiles, Section 5515 lists fully protected fish, Section 3511 lists fully protected birds, and Section 4700 lists fully protected mammals. A species can be protected under the California Fish and Game Code but not be fully protected. For instance, mountain lion (*Puma concolor*) is protected under Section 4800 et seq. but is not a fully protected species. In 2023, the California legislature passed Senate Bill 147 which authorizes CDFW through 2033 to issue a permit that would allow take of a fully protected species for particular types of projects if certain key conditions are satisfied. The projects or categories of projects covered by this bill include maintenance, repair, and improvements related to the State Water Project undertaken by DWR; projects related to maintenance, repair, and improvements of critical regional and local water agency infrastructure; certain transportation projects provided they do not increase highway or street capacity for vehicle traffic; and certain types of wind and solar energy projects. Senate Bill 147 also requires CDFW to develop a plan by July 1, 2024 to assess the population status of each fully protected species. The bill also explicitly removed American peregrine falcon, brown pelican, and thicktail chub as fully protected species.

Species of Special Concern

CDFW maintains lists of candidate-endangered species and candidate-threatened species. California candidate species are afforded the same level of protection as listed species. California also designates “species of special concern,” which are species of limited distribution, declining populations, diminishing habitat, or unusual scientific, recreational, or educational value. These species do not have the same legal protection as listed species or fully protected species but may be added to official lists in the future. CDFW intends the species of special concern list to be a management tool for consideration in future land use decisions.

Native Plant Protection Act

California’s Native Plant Protection Act (Fish and Game Code Sections 1900–1913) requires all State agencies to use their authority to carry out programs to conserve endangered and rare native plants. Provisions of the Native Plant Protection Act prohibit taking endangered or rare plants from the wild and require that CDFW be notified at least 10 days in advance of any change in land use in areas that support listed plants.

California Rare Plant Ranking System

CDFW works in collaboration with CNPS to maintain a list of plant species native to California that have low numbers or limited distribution, or that are otherwise threatened with extinction. These species are categorized by rarity in the CRPR. This information is published in the Inventory of Rare and Endangered Vascular Plants of California. Potential impacts on populations of CRPR species may receive consideration under CEQA review. The system ranks rare plants using the following definitions:

- **Rank 1A:** Plants presumed extirpated in California and either rare or extinct elsewhere.
- **Rank 1B:** Plants rare, threatened, or endangered in California and elsewhere.
- **Rank 2A:** Plants presumed extirpated in California, but more common elsewhere.
- **Rank 2B:** Plants rare, threatened, or endangered in California, but more common elsewhere.
- **Rank 3:** Plants about which more information is needed—a review list.
- **Rank 4:** Plants of limited distribution—a watch list.

In general, plants with CRPR 1A, 1B, or 2 are considered to meet the criteria of CEQA Guidelines Section 15380 (discussed above). Some CRPR 3 and 4 plants may fall under the Section 15380 criteria as well. In addition, plants with CRPR Rank 1A, 1B, or 2 meet the definitions of California Fish and Game Code Section 1901, Chapter 10 (Native Plant Protection Act) and Sections 2062 and 2067 (CESA).

Regional and Local

As described in Section 3.6.1, the geographic areas analyzed for impact on terrestrial biological resources include the Oroville Complex and the Low and High Flow channels of Feather River. This portion of the study area for the Pulse Flows Component crosses Butte, Sutter, and Yuba counties. Each county and each city has local regulations and a general plan with policies related to terrestrial biological resources. These may include goals and policies such as preservation of trees and protection and reestablishment of habitat areas that can support special-status plants and wildlife.

3.6.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. A terrestrial biological resources impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW or USFWS.
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by CDFW or USFWS.
- Have a substantial adverse effect on State or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
- Conflict with the provisions of an adopted habitat conservation plan (HCP), natural community conservation plan, or other approved local, regional, or State HCP.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.6.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts, but rather focuses on short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases," to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B were considered in addition to available relevant information regarding terrestrial special-status species and their habitats, riparian habitat, and other sensitive natural communities (see Tables 3.6-1 and 3.6-2), as described in the following impact discussions.

Impacts and Mitigation Measures

Table 3.6-3 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.6-3
SUMMARY OF IMPACT CONCLUSIONS—BIOLOGICAL RESOURCES (TERRESTRIAL)

Impact Statement	Impact Conclusion
3.6-1: Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.	LTS
3.6-2: Implementation of the Pulse Flows Component would have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.	LTS
3.6-3: Implementation of the Pulse Flows Component would have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.	LTS
3.6-4: Implementation of the Pulse Flows Component would Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	NI
3.6-5: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.	NI
3.6-6: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan.	NI

NOTES: NI = No Impact; LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2022.

Impact 3.6-1: Implementation of the Pulse Flows Component would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.

As described in Chapter 2, “Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. As described in Section 2.4.1, “Description of Potential Pulse Flow Releases,” CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, or above-normal water year types, with a ramp-down rate estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. As described in Section 3.2.1, “Conservative Pulse Flow Release Scenario,” this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May orJune) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would continue to comply with flow and temperature requirements for the Feather River (See Section 3.5.3 for requirements).

Large fluctuations in water levels are a part of the existing conditions of Lake Oroville and the Thermalito Facilities as well as the Low and High Flow channels of the Feather River, resulting from natural causes (i.e., precipitation events) and managed reservoir releases from Lake Oroville. As a result of hydropower operations, the water levels in Lake Oroville and the Thermalito Facilities experience regular and dramatic changes (California Department of Water Resources 2004c). Changes in water levels along riparian shorelines could cause temporary shifts in vegetation and wildlife usage patterns that could affect special-status species.

Impacts on Special-Status Plants

The analysis considered the potential for impacts on special-status plant species and their habitats to result from implementation of the Pulse Flows Component, as increased flow releases change water levels in habitats suitable for special-status plants occurring along the riparian zone of Lake Oroville, the Thermalito Facilities, or the Feather River. Those special-status plant species that could occur within the geographic areas considered, their respective listing statuses, and their habitat requirements are summarized in Table 3.6-1.

Oroville Complex

As described in Section 3.4, “Hydrology and Water Quality,” and detailed in Appendix B, hydraulic conditions (i.e., water levels, velocity, and inundation extent) and geomorphic processes (sediment transport and bank erosion) would remain within the typical range of hydrologic variability experienced in the system, such that the Pulse Flows Component would not substantially affect the existing riparian habitat conditions. Special-status plants found along the slopes of Lake Oroville are all associated with steep, remote, upland habitats that are above the drawdown zone of the lake and thus are not expected to be affected by water level changes in the lake associated with the pulse flows. The reduced releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would also reverse the temporary drawdown in lake water levels associated with the release of the pulse flows.

The brood ponds along the Thermalito Afterbay within which Sanford’s arrowhead is found are bermed and are actively managed to maintain consistent water levels for waterfowl nesting; therefore, they are buffered from water level changes. Because pulse flows would be released directly into the Low Flow Channel, bypassing the Thermalito Facilities, a total of 100,000 acre-feet of water would not be moved through the Thermalito Facilities in the summer during pulse-flow years. This would result in some changes to water levels along shorelines, but those changes would be within the typical range of water level changes seen in the Thermalito Facilities, which vary from 2 to 12 feet weekly as a result of hydropower operations, and would have no substantial effect on existing populations of special-status plants adjacent to the Thermalito Facilities (California Department of Water Resources 2004c). Furthermore, as described previously, DWR would maintain water levels at the Themalito Facilities consistent with applicable regulatory standards.

Low Flow Channel of the Feather River

Pulse flow releases from Lake Oroville would increase vertical water levels by 5–6 feet in the Low Flow Channel of the Feather River (see Table 3.4-9 for changes in water levels, velocity, and inundation extent under the conservative pulse flow release scenario; see also Appendix B). Higher water levels in the Low Flow Channel during pulse flows may result in recruitment of riparian woody vegetation due to sediment deposition along channel banks, which would increase the likelihood of seedling establishment. The wetland- and riparian-dependent special-status plant species found within the geographic areas considered are accustomed to intra-annual fluctuations in hydrology. Water levels and velocity within the Low Flow Channel would increase to a greater extent than in other reaches of the Feather River; however, these flows would be within the range of existing hydrologic variability associated with the Low Flow Channel (Appendix B).

Given that changes in hydraulic conditions within the Low Flow Channel during pulse flow releases would be within the bounds of existing conditions, effects on special-status plants are expected to be minimal, as riparian and wetland-dependent plant species would have been accustomed to the level of flow volumes and water levels. For example, Brazilian watermeal and Mexican mosquito fern would not be affected by water level increases because they are both floating plants. Other special-status plants expected to occur in the geographic areas considered are associated with riparian and wetland habitats that experience seasonal fluctuations in water levels and are adapted to increases in hydrology during the spring, when pulse flows would be released into the system. Pulse flows may temporarily inundate special-status wetland plants but are not expected to suffocate these species, because pulse flows would not persist for more than a few days to a few weeks at a time. In fact, because pulse flows are proposed for drier hydrologic years, when base flows would likely be below normal, the flows could benefit the hydrophytic special-status plants in the riparian zone during their growing season.

High Flow Channel of the Feather River

Changes to water levels in the Feather River downstream of the Thermalito Afterbay Outlet as a result of pulse flow releases may result in increases ranging from 3.5 to 7 feet along vertical banks (see Table 3.4-9 and Appendix B). The change in the High Flow Channel would be less than the change in the Low Flow Channel, considering the contribution of tributary inputs from Honcut Creek, the Yuba River, and the Bear River. The pulse flows could benefit the hydrophytic special-status plants in the riparian zone by providing enhanced hydrology during their spring growing season. After the spring pulse flow release, there would be reduced summer flow releases in the Feather River as part of the Recovery Period to replenish SWP water stored in Lake Oroville. The summer flows during this Recovery Period would continue to meet flow and temperature requirements for the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations). The hydrologic conditions during the summer Recovery Period would thus be consistent with conditions that have occurred historically—to which special-status plants within the riparian zone along the Feather River have become adapted.

Impacts on Special-Status Wildlife

The analysis considered the potential for impacts on special-status wildlife species to result from implementation of the Pulse Flows Component as water levels change within the geographic areas considered (see Section 3.6.1)—the riparian zone of Lake Oroville, the Thermalito Facilities, or the Feather River. Those special-status wildlife species that could occur, their respective listing statuses, and their habitat requirements are summarized in Table 3.6-2. The following analysis groups special-status wildlife into the following categories: terrestrial invertebrates, vernal pool crustaceans, amphibians, reptiles, birds, and mammals.

Terrestrial Invertebrates

The monarch butterfly and valley elderberry longhorn beetle depend on host plants—milkweed and elderberry shrubs, respectively—to complete their life cycle. The Crotch bumble bee relies upon a suite of different flowering plants including *Asclepias*, *Chaenactis*, *Lupinus*, *Medicago*, *Phacelia*, and *Salvia*. Both milkweed and elderberry are often associated with riparian habitats and commonly grow along riverbanks in the geographic areas considered. The Crotch bumble bee also relies on many plants that are found in upland areas, such as annual grasslands. The plants on which these special-status insects depend are not associated with wetland habitats and are therefore not generally tolerant of flooding or prolonged inundation. Milkweed and elderberry are found on upper banks or in floodplains and grassland/savanna habitats outside of the water fluctuation zone of large river systems. As discussed previously, the Low Flow Channel of the Feather River would likely experience the greatest overall changes in hydraulic conditions during pulse flow releases. No milkweed plants are mapped in the Low Flow Channel; the only milkweed population mapped in the Feather River system is from upland grasslands in the Lake of the Woods State Wildlife Area (Western Monarch Milkweed Mapper 2021). No elderberry shrubs were found in the Low Flow Channel during relicensing surveys (California Department of Water Resources 2004b).[1]

Valley elderberry longhorn beetles were found farther downstream in the High Flow Channel (see Appendix C), where the influence of the pulse flows is expected to be much more muted, given the influence of tributary inputs. Pulse flows would tend to be released in drier hydrologic years, when background flow rates are expected to be in the lower range (e.g. 1,000 cfs), with pulse flows increasing vertical water levels by 5–6 feet in the Low Flow Channel and by 3.5 to 7 feet in the portion of the High Flow Channel just downstream of the Thermalito Afterbay Outlet (see Appendix B). As a result, there would be no substantial change in hydrology along upper banks and adjacent uplands and floodplains where suitable habitats for the special-status Crotch bumble bee, monarch butterfly, or valley elderberry longhorn beetle occur.

Vernal Pool Invertebrates

Three vernal pool crustacean species that are endemic to vernal pool habitats are known to occur in vernal pool and swale habitats surrounding the Thermalito Facilities: conservancy fairy shrimp,

1 A search of the CNDDB records in August 2023 did not find any documented occurrences of elderberry shrubs along the Low Flow Channel.

vernal pool fairy shrimp, and vernal pool tadpole shrimp. Potential water level changes in the Thermalito Facilities related to pulse flow releases from Lake Oroville would fall within the range of the background of regular, dramatic water level changes related to hydropower operations, which range from 2 to 12 feet on a weekly basis. No vernal pools or upland habitats surrounding the Thermalito Facilities would be affected by pulse flows, given that reduced water levels into this system related to pulse flow releases would be within normal ranges. Because pulse flows would result in up to 100,000 acre-feet of water being routed directly to the Low Flow Channel of the Feather River and not being moved through the Thermalito Facilities, the Pulse Flows Component would not flood upland or vernal pool habitats surrounding the Thermalito Facilities.

During the Recovery Period, there would be a corresponding reduction in Discretionary Releases from Lake Oroville, from July through September, when compared to existing conditions. Reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. No substantial change in water levels within the Thermalito Facilities would result from the pulse flow operations, because DWR would continue to maintain water levels in the ranges specified by existing or then-applicable regulations. Such DWR actions would be coordinated with DWR's Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations. Therefore, special-status species associated with vernal pool habitats (i.e., conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp) would be minimal, given that hydrologic conditions within suitable habitat for these species during any spring pulse flow and the subsequent summer Recovery Period would be maintained in accordance with the range of existing water management conditions.

Amphibians

The western spadefoot is endemic to vernal pool and swale habitats and can utilize such habitat in the areas surrounding the Thermalito Facilities. No vernal pools or upland habitats surrounding the Thermalito Facilities would be affected by pulse flows, given that reduced water levels into this system related to pulse flow releases would be within normal ranges. The Pulse Flows Component would not affect upland habitat conditions for spadefoot toad as it does not involve any ground disturbance or the conversion or creation of new upland habitat. DWR would continue to maintain water levels within the Thermalito Facilities in the ranges specified by existing or then-applicable regulations. Given these considerations, the effects of Pulse Flow Component on western spadefoot would be minimal because upland habitat would remain unaffected and hydrologic conditions within suitable aquatic habitat during any spring pulse flow and the subsequent summer Recovery Period would be maintained in accordance within the range of existing water management conditions.

Reptiles

The giant garter snake has also been recorded in suitable emergent wetland habitats in the Thermalito Afterbay and brood ponds (California Department of Fish and Wildlife 2022); however, the presence of non-native predatory fish in the Thermalito Facilities reduces the likelihood of the persistence of giant garter snake in the Thermalito Facilities. Predatory fish in the flowing portions of larger river systems, such as the Feather and Sacramento rivers, preclude the presence of the giant garter snake from much of the riverine habitat within the study area

(California Department of Water Resources 2004b). Giant garter snakes could occupy backwater/ channel margin areas of the main river channels where flow velocities are reduced and where emergent aquatic vegetation can provide them suitable refugia from predators. Giant garter snakes could also occupy adjacent rice fields and canals and use upland habitats in the riparian zones of the lower Feather River and the Sacramento River in the study area, if suitable burrows exist that individuals could use as winter refugia from November through April. Changes in water levels within all reaches evaluated in the geographic areas considered would be well within the range of expected hydrologic variability. Therefore, the Pulse Flows Component would not be expected to negatively affect aquatic or upland brumation habitat for giant garter snake. This species evolved in the Central Valley and adapted to withstand some flooding of habitats (U.S. Fish and Wildlife Service 2017). Furthermore, giant garter snakes typically do not overwinter where flooding occurs in channels with rapidly moving water (U.S. Fish and Wildlife Service 2017). Therefore, giant garter snakes are not likely to be adversely affected by pulse flows.

Western pond turtles could occupy all aquatic habitats in the study area, and nest in upland habitats up to 1,300 feet from aquatic habitats, but usually within 3–150 feet from the water's edge (Ashton et al. 1997; U.S. Geological Survey 2006). Females tend to seek out open areas with a low slope angle (i.e., 25 degrees or less) (Ashton et al. 1997). The western pond turtle nesting season extends from April through August. Past observational records of the species in the study area are from ponds, irrigation canals, ditches, and sloughs in the riparian zone outside of main river channels (California Department of Fish and Wildlife 2022). For this reason, it is expected that most pond turtles would nest in uplands outside of river channels. As detailed in Appendix B, changes in hydraulic conditions would fall within the range of existing variability of the hydrologic system. As such, the effects of the Pulse Flow Component on western pond turtle would be minimal, given that hydrologic conditions would be within the range of existing conditions.

Birds

Nesting birds are expected to be found throughout the study area from the Oroville Complex to the Delta. As described in Appendix B, because water levels during pulse flow releases would remain within the typical range of hydrologic variability experienced in the system, the existing riparian habitat conditions would not be substantially affected by the Pulse Flows Component.

Many bird species that nest within riparian areas nest high enough to reduce the risk of nest predation by certain ground-based predators (e.g., certain mammals and snakes); for this reason, they would not be expected to be affected by the temporary increases in vertical water levels of around 5–6 feet in the Low Flow Channel and 3.5 to 7 feet in the portion of the High Flow Channel just downstream of the Thermalito Facilities (see Table 3.4-9). Some special-status bird species more commonly utilize vegetation low enough that they are more likely to be affected by temporary changes in water surface levels. These species include California black rail (*Laterallus jamaicensis coturniculus*), yellow warbler, yellow-breasted chat (*Icteria virens*), and song sparrow "Modesto population" (*Melospiza melodia*), which nest and/or roost in dense emergent vegetation or shrub thickets in river floodplains and along riverbanks.Additionally, bank swallows (*Riparia riparia*) nest in burrows along vertical eroded banks in the study area that could be affected by pulse flow releases.

Shallow, stable marsh or flooded grassy vegetation suitable for nesting California black rail occurs in the study area only along the edges of the Thermalito Afterbay; therefore, the species is not expected to nest in or near the main river channels and would not be affected by pulse flows.

Yellow warbler, yellow-breasted chat, and song sparrow were identified as the bird species most likely to be affected by changes in water levels from the pulse flow releases. Changes in water levels and inundation extent (i.e., how far laterally water extends within the channel) under the conservative pulse flow release scenario would vary based on location (see Appendix B). A brief and irregular change in water levels and/or inundation extent is not anticipated to meaningfully alter the vegetative structure in or adjacent to the channel, because while changes in inundation extent resulting from a pulse flow are generally most prominent in the Low Flow Channel of the Feather River (e.g., on the order of around 50 to 60 percent increase compared to baseline), the hydraulic modeling suggests that, aside from limited situations where several backwater channels would become activated, increased flows would be fully contained within the mainstem channel of this reach (see Appendix B). Therefore, nesting habitat for these bird species is not anticipated to be directly affected. Some birds nesting immediately proximate to a channel during a pulse flow event could experience adverse effects. Birds nesting closest to the ground or water surface may experience a temporary increase in predation risk due to higher water surface levels under a nest, allowing access by swimming predators; reduced foraging opportunities due to changes in inundation extent and resulting insect availability adjacent to a nest; or direct effects due to flooding of a nest. However, changes due to pulse flows would only occur over a few days to a few weeks every few years, and would have to coincide with a given nesting attempt to result in adverse effects. Should they occur, such effects would be short in duration. Effects on nests for yellow warbler, yellow-breasted chat, or song sparrow “Modesto” would be minimal.

Bank swallow nests are built mostly in the upper third of banks, where they are less susceptible to many predators. The heights of vertical banks at nesting colonies average 10.8 feet in California (Garrison and Turner 2020). An increase in water levels at a location where bank swallows are actively nesting could result in a temporary increase in predation risk due to increased access to burrows by swimming predators. However, many of this species’ predators are not aquatic. Further, changes due to pulse flows would only occur over a few days to a few weeks every few years, and would have to coincide with an active nesting colony to result in adverse effects. Should they occur, any incremental increase in predation risk to bank swallow nesting colonies resulting from higher water surface elevations during a pulse flow release would be short in duration. As presented in Section 3.4, “Hydrology and Water Quality” (Impact 3.4-1) and as detailed in Appendix B, bank erosion during pulse flow releases would remain within the typical range of hydrologic variability experienced in the system. Therefore, it is expected that the bank swallow nests would generally be above the water fluctuation zone during pulse flow periods. As such, the Pulse Flow Component would not result in substantial effects on bank swallow.

Mammals

Bats can use riparian trees for roosting. Bat roosts are located off the ground in tree canopies or cavities to help them avoid predators. Because the water levels during pulse flow releases would remain within the typical range of hydrologic variability experienced in the system, there is not expected to be an effect on special-status bats.

Conclusion for Impact 3.6-1

As described above and detailed in Appendix B, changes in water levels, velocity, sediment transport, and bank erosion resulting from the pulse flow releases would remain within the typical range of hydrologic variability experienced in the system and, while inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability as well. Additionally, releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would continue to meet minimum operational and regulatory flow and temperature requirements in the Feather River and would therefore remain within the typical range of existing operational variability experienced within the system. Therefore, the Pulse Flows Component would not result in any substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species. The impact would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to special-status species are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.6-2: Implementation of the Pulse Flows Component would have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.

As presented above, the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

Fast-growing pioneer species of riparian habitats, such as Fremont cottonwood and willow trees, are physiologically adapted to the highly variable hydrologic and geomorphic regimes of alluvial river floodplain systems. Adaptations include fast root growth to follow seasonal groundwater decline, clonal growth in response to flooding and scouring, and floating seeds. In California, where natural hydrology is driven by winter storms and spring runoff, river flows are highly variable and result in high-energy water pulses through the system, with scouring common along main river channels. Levees that constrain flows to a relatively narrow conveyance further contribute to localized high-energy flows. Consequently, mature riparian forests in river systems are usually found in protected areas, such as oxbow lakes and secondary stream channels, and wide depositional floodplains are populated by young seedlings and saplings of fast-growing tree and shrub species.

The Low and High Flow Channels of the Feather River experience limited recruitment of new riparian trees, which indicates that current project operations, which move flows through the Thermalito Facilities and into the lower Feather River at the Thermalito Afterbay Outlet south of the Low Flow Channel, largely prevent initial seedling survival and/or long-term establishment of seedlings (California Department of Water Resources 2004c). The Low Flow Channel consists of a cobble substrate that is not suitable for seed germination. However, based on studies of cottonwood seedling establishment along the Feather River, flow augmentation during the late spring and gradual ramping down of flow, as is planned under the Pulse Flows Component, could support cottonwood seed dissemination and seedling establishment along the entire waterway (California Department of Water Resources 2004c). Similarly, pulse flows could provide an influx of nutrients and water on an incrementally more frequent basis, which would benefit riparian vegetation establishment throughout the lower Feather River and riparian systems downstream.

As summarized above, the changes in water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system and, while inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability as well. Additionally, reduced releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would continue to meet minimum operational and regulatory flow and temperature requirements and would therefore remain within the typical range of existing operational variability experienced within the system (see Appendix B). The pulse flow releases would be temporary, would ramp down gradually in accordance with current operations and existing regulations, and would drain rapidly from cobble and gravel substrates of the Low Flow Channel and upper High Flow Channel below the Thermalito Afterbay Outlet. Although the pulse flows may temporarily inundate some riparian vegetation, flow rates would not be strong enough to scour banks or rip tree roots from riverbanks, because water level increases along shorelines would be temporary and would fall within the range of normal springtime flows (U.S. Geological Survey 2021). In fact, because they are proposed in drier years when base flows would likely be below normal, pulse flows could benefit riparian trees and plants during the spring growing season. Therefore, implementation of the Pulse Flows Component would not have a substantial adverse effect on any riparian habitat or other sensitive natural community. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to riparian and sensitive natural communities are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.6-3: Implementation of the Pulse Flows Component would have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.

Historically, the Feather River and Sacramento River systems were bordered by floodplains that supported riparian forests and associated wetlands (Whipple et al. 2012). Widespread land-use changes related to mining, urban and agricultural development, construction of levees, and flood control and water supply functions of dams have acted to remove, alter, and reduce functioning floodplains and the associated riparian and wetland habitats throughout the region. Remaining wetlands in the geographic areas considered include low-lying areas adjacent to lakes and rivers that could periodically flood from both rainfall events and high-water levels in the adjacent main water body. Both natural and constructed wetlands such as marshes, lagoons, and the brood ponds around the Thermalito Afterbay are present in the geographic areas considered. Isolated wetlands include ponds, impoundments created by dredge tailings, and vernal pools and seasonal wetlands.

The Pulse Flows Component could result in some inundation of fringe wetlands within riparian areas that would provide an influx of nutrients and potentially benefit wetland vegetation establishment and the local food web in these areas. For example, during pulse flow years, higher flows in the spring as compared to existing conditions could potentially result in flooding and sediment deposition in low-lying adjacent wetlands, especially in the Low Flow Channel and upper reaches of the High Flow Channel of the Feather River.

As summarized above and detailed in Appendix B, the changes in water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system and, while inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability as well (see Appendix B). The proposed pulse flows would be well within the range of flows released into the Low Flow Channel over the past 25 years, and the demonstrated capacity of the Low Flow Channel exceeds the proposed pulse flow rates (U.S. Geological Survey 2021). Furthermore, pulse flows would be temporary, would be ramped down over several days, and would drain rapidly from the cobble and gravel substrates of the Low and High Flow channels. Reduced releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would continue to meet minimum operational and regulatory flow and temperature requirements and would therefore remain within the typical range of existing operational variability experienced within the system (see Appendix B). Therefore, implementation of the Pulse Flows Component would not have a substantial adverse effect on state or federally protected wetlands. The impact would be less than significant.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to wetlands are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.6-4: Implementation of the Pulse Flows Component would interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

The Pulse Flows Component would not involve construction of water facilities or infrastructure, nor would it require a change to existing maintenance needs, a change in land use, or other projects that may affect terrestrial wildlife movement or nursery sites. The Pulse Flows Component would therefore not result in alterations in habitat that would interfere with terrestrial wildlife movement and migratory wildlife corridors, or impede the use of native wildlife nursery sites. (For analysis of how the Pulse Flows Component would affect migratory conditions for special-status fish, refer to Section 3.4, "Biological Resources–Aquatic.") Therefore, **no impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to terrestrial wildlife movement and native wildlife nursery sites are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.6-5: Implementation of the Pulse Flows Component would conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

State agencies such as DWR are not subject to local ordinances and policies. To the extent feasible, implementation of the Pulse Flows Component would comply with applicable adopted ordinances and local policies protecting biological resources, if they are consistent with DWR's internal environmental policies. Therefore, **no impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to local policies protecting biological resources are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.6-6: Implementation of the Pulse Flows Component would conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan.

The geographic areas considered for impacts on terrestrial biological resources are overlapped by the Butte Regional Conservation Plan, which overlaps the Thermalito Facilities and the Feather

River above Yuba City. As discussed in Impacts 3.6-1 through 3.6-4, the Pulse Flows Component would not have a substantial adverse effect on special-status species, sensitive habitats, natural communities, or wetlands, nor would it interfere with wildlife movement or native wildlife nurseries. The Pulse Flows Component would therefore not conflict with the provisions of these or any other adopted HCP, natural community conservation plan, or other approved local, regional, or State HCP protecting special-status plants and wildlife or sensitive natural communities. Therefore, **no impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to local or regional HCPs are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

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3.7 Cultural Resources

This section discusses the potential for the Pulse Flows Component to affect cultural resources. Tribal cultural resources are discussed separately in Section 3.8, “Tribal Cultural Resources.” The Pulse Flows Component analyzed in this section is defined by DWR’s action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR’s action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

For the purposes of this analysis, the term “cultural resource” is defined as follows:

> Native American, and non–Native American historic-era, sites, structures, districts, and landscapes, or other evidence associated with human activity considered important to a culture, a subculture, or a community for scientific, traditional, religious, or other reason. These resources include the following types of CEQA-defined resources: historical resources, archaeological resources, and human remains.

This section includes the following key terms:

- **Architectural Resource.** This resource type includes historic-era buildings, structures (e.g., bridges, canals, roads, utility lines, railroads), objects (e.g., monuments, boundary markers), and districts. Residences, cabins, barns, lighthouses, military-related features, industrial buildings, and bridges are some examples of architectural resources.
- **Archaeological Resource.** This resource type consists of pre-contact and historic-era Native American archaeological resources, as well as non–Native American archaeological resources from the historic era:
  - *Native American archaeological resources* consist of village sites, temporary camps, lithic scatters, roasting pits/hearths, milling features, petroglyphs, rock features, and burials. Associated artifacts include obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or toolmaking debris; anthropogenic soil (midden) containing heat-affected rocks, artifacts, or shellfish remains; and stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs).
  - *Non–Native American historic-era archaeological resources* consist of townsites, homesteads, agricultural or ranching features, mining-related features, refuse concentrations, and features or artifacts associated with early military and industrial land uses. Associated artifacts include stone, concrete, or adobe footings and walls; artifact-filled wells or privies; and deposits of metal, glass, and/or ceramic refuse.

  If a resource is considered a ruin (e.g., building lacking structural elements, structure lacking a historic configuration), it is classified as an archaeological resource.

3.7.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (see Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on cultural resources were not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

The following five remaining geographic areas were evaluated for impacts on cultural resources:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

Note that this Draft SEIR covers the Pulse Flows Component and does not include any cultural resources within the project areas for the three WSIP Groundwater Projects.

3.7.2 Environmental Setting

Some of the background context, notably the ethnographic setting, used for the analysis of potential impacts on cultural resources is similar to that used for the analysis of potential impacts on tribal cultural resources. As a result, the ethnographic setting applicable to the current section is presented in the tribal cultural resources section (Section 3.8, “Tribal Cultural Resources”).

Pre-contact Setting

This section describes, in general terms, broad patterns in the prehistory of the Central Valley, focusing on major environmental, technological, and adaptive changes evident in the archaeological record of this region. Categorizing the pre-contact period into cultural stages allows researchers to describe a broad range of archaeological resources with similar cultural patterns and components during a given time frame, thereby creating a regional chronology. Rosenthal et al. (2007) provide a framework for the interpretation of the Central Valley's pre-contact archaeological record and have divided human history in the region into three basic periods: *Paleo-Indian* (13,550 to 10,550 years Before Present [BP]), *Archaic* (10,550 to 900 BP), and *Emergent* (900 to 300 BP). The Archaic period is subdivided into three sub-periods: *Lower Archaic* (10,550 to 7550 BP), *Middle Archaic* (7550 to 2550 BP), and *Upper Archaic* (2550 to 900 BP) (Rosenthal et al. 2007). Economic patterns, stylistic aspects, and regional phases further subdivide cultural patterns into shorter phases.

This scheme uses economic and technological types, socio-politics, trade networks, population density, and variations of artifact types to differentiate between cultural periods. The following summary of the region's prehistory is derived principally from Rosenthal et al. (2007) and Moratto (1984 [2004]).

Paleo-Indian Period (13,550 to 10,550 BP)

Humans first entered the Central Valley sometime before 13,000 years ago. At that time, Pleistocene glaciers had receded to the mountain crests, leaving conifer forests on the mid- and upper elevations of the Sierra Nevada and a nearly contiguous confer forest on the Coast Ranges. The Central Valley was covered with extensive grasslands and riparian forests. The Delta system of Central California had not yet developed. The Central Valley was home to a diverse community of large mammals, which soon became extinct. People were likely focused on large game hunting, although evidence remains scant, as does understanding of lifeways during this period.

Lower Archaic Period (10,550 to 7550 BP)

The Paleo-Indian Period was followed by the Lower Archaic Period. During this period, the ancient lakes, which had been the subsistence base during the Paleo-Indian Period, began to dry up as a result of climate change. This led to a rapid expansion of oak woodland and grassland prairies across the Central Valley. After 10,550 BP, a significant period of soil deposition ensued in the valley, capping the older Pleistocene formation. This was followed around 7000 BP by a second period of substantial soil deposition in the valley.

It was during this period that the first evidence of milling stone technology appeared, indicating an increased reliance on processing plants for food. This period is often termed the "Milling Stone Horizon" in California. The appearance of milling technology may also indicate less emphasis on hunting as individuals became more familiar with the local plant resources. Milling stones include handstones and milling slabs and are frequently associated with a diverse tool assemblage including cobble-based pounding, chopping, and scraping tools. Milling tools were used for processing seeds and nuts. The Lower Archaic also saw the development of well-made bifaces used for projectile points and cutting tools, commonly formed from meta-volcanic greenstone and volcanic basalts. Most artifacts during this period were manufactured of local materials and trade was limited. The primary social unit remained the extended family (Fredrickson 1992).

Middle Archaic Period (7550 to 2550 BP)

After about 7550 BP, California experienced a change in the climate, with warmer and drier conditions. Oak woodland expanded upslope in the Coast Ranges and conifer forest moved into the alpine zone in the Sierra Nevada. Rising sea levels led to the formation of the Delta and associated marshlands. An initial period of upland erosion and lowland deposition was followed by a long period of stabilization of landforms. Scant evidence of human occupation from this period has been found in the Sacramento Valley or the adjacent Coast Ranges. Most evidence comes from the Sierra Nevada foothills in Calaveras and Tuolumne counties.

Upper Archaic Period (2550 to 900 BP)

Evidence for Upper Archaic human occupation in the Central Valley is much more extensive than for earlier periods. The development of the Holocene landscape buried older deposits, resulting in the identification of more sites from the Upper Archaic than from older periods of development. Alluvial deposition was partially interrupted by two consecutive droughts, known as the "Medieval Climatic Anomaly."

Two fundamental adaptations developed side by side during the Upper Archaic period, evidenced by a diversification in settlement patterns. Populations in the Central Valley tended toward large, high-density, permanent settlements. These villages were used as hubs from which the populace roamed to collect resources, utilizing a wide range of technologies. The populations in the foothills and mountains lived in less dense settlements, moving with the seasons to maximize resource returns. Tools tended to be expedient and multipurpose for use in a wide variety of activities. Village sites show extended occupation as evidenced by well-developed midden, and also frequently contain hundreds of burials, storage pits, structural remains, hearths, ash dumps, and extensive floral and faunal remains.

Emergent Period (900 to 300 BP)

A major shift in material culture occurred around 900 BP, marking the beginning of the Emergent Period. Particularly notable was the introduction of the bow and arrow. The adoption of the bow occurred at slightly different times in various parts of the Sacramento Valley, but by 750 BP, it was in use in the Delta region. The bow was accompanied by the Stockton Serrated point, an invention seemingly developed by people in the area, distinctive from point types used in other parts of the state.

Another key element of material culture from this period is the big-head effigy ornaments made from *Haliotis* shell and thought to be associated with the Kuksu religious movement. In areas where stone was scarce, baked clay balls are found, presumably for cooking in baskets. Other diagnostic items from this period are bone tubes, stone pipes, and ear spools. Along rivers, villages are frequently associated with fish weirs, with fishing taking on an increasing level of importance in the diet of the local populace.

Historic Setting

Early European Exploration and Settlement of the Sacramento Valley

The earliest recorded European explorations of the area around the mouth of the Sacramento and San Joaquin rivers occurred in 1806 and 1808. Two expeditions, one led by Alferez Gabriel Moraga and the other by Father Pedro Muñoz, passed through the general region in search of suitable mission sites (Beck and Haase 1974:18). In general, these early expeditions to the interior lands were peaceful, although by 1813 some explorations took on a more belligerent course, in part through their pursuit and capture of indigenous people s who escaped from the coastal missions. Other early Euro-American contact with the native populations began in the late 1820s, when trapper Jedediah Smith traveled into the San Joaquin Valley. Also, around this time, Peter Ogden of the Hudson's Bay Company scouted the Sacramento Valley as far south as Stockton. Although expeditions were carried out into the interior along the major rivers, including the Sacramento, no missions were established, apparently because seasonal inundation was viewed as a hindrance to the establishment of settlements. In contrast to land ownership by Spain, later rule by Mexico stressed individual ownership of the land; after Mexican secularization of the missions, vast tracts of mission lands were granted to individuals.

Captain John Sutter was granted his "New Helvetia" ranch at present-day Sacramento in 1839. In 1841, Sutter acquired additional lands in what is now Yuba County. It was from Sutter's Mill, near present-day Coloma in El Dorado County, that John Marshall discovered gold in 1848, resulting in the Gold Rush and an influx of settlers and explorers into California.

At the outset of the Gold Rush in 1848, huge numbers of prospectors arrived in Sacramento to mine for gold in the Sierra Nevada foothills. The Delta, which was still in its natural state and was not a desirable destination for farmers or those in search of gold, provided numerous waterways to transport mining-related machinery and tools throughout the region. Many people who arrived ultimately decided not to mine for gold because they deemed it too difficult or dangerous, and they instead turned to subsistence farming and agricultural pursuits. Farms and ranches developed along the Feather and Sacramento rivers and throughout the Delta, and shipping food and other supplies to the mining camps proved to be highly lucrative for these farmers. With the end of the Mexican-American War in 1848, California became a territory of the United States; two years later, on September 9, 1850, California was admitted into the Union as the 31st state.

Historic-era settlements in and near the Pulse Flows Component location were situated primarily on naturally formed levees, which were created by sediment deposition on flatter surfaces from flood events. For the most part, these early settlements consisted of single-family farm residences or farm labor camps. Those who did not fare well in the gold fields turned to farming. The tule marshes provided forage for cattle during summer and were burned in fall to promote new growth in spring after the floodwaters receded. Several of the islands in the Delta bear the names of these early settlers, such as Brannan Island, presumably named for the Mormon leader and entrepreneur Sam Brannan. Nearby Mandeville Island was named for a United States surveyor, and Ryer Island was named for a pioneer doctor.

River Transportation

At the start of Euro-American exploration of the area, river traffic consisted primarily of expeditions that charted the water courses. However, it was the Gold Rush that contributed to a rapid rise in river traffic, with the Sacramento and San Joaquin rivers providing the major routes of transportation to mines for prospectors arriving at San Francisco and traveling on to the mining gateways of Sacramento and Stockton. Later, from 1867 until the turn of the 20th century, small steamboats that could navigate sloughs and backwaters between San Francisco Bay, through the Delta, and into the Central Valley and the western Sierra Nevada foothills were instrumental in opening up the agricultural market and bringing merchandise and news to settlers in California's interior (California State Lands Commission 1988). Shipwrecks and explosions on board steamers were a constant threat due to submerged natural obstacles and faulty materials and operation of boilers, respectively.

Mining and Early Agriculture

Throughout the mid-1800s, the combination of mining, population growth, and development led to dramatic changes to waterways in the Sacramento Valley (Mount 1995:190). Agriculture emerged as a leading industry in California during the 1850s and 1860s as Gold Rush boomtowns busted, and would-be miners turned to industries that supplied the incoming wave of emigrants. The rich soils of the Central Valley were swiftly cultivated into fields of grain and wheat (Kelley 1998:61). Although they were profitable, the new settlements were situated on floodplains, and growing farms and towns inevitably faced inundations. In 1850, the fledgling city of Sacramento flooded when the American and Sacramento rivers crested simultaneously. During most of the month of January, witnesses reported widespread transportation by boat and buildings being swept from their foundations (Willis 1913:160). Despite this devastating flood in Sacramento and the surrounding farmland, the city continued to grow and was subject to many more floods into the 1910s.

The growth of farms and cities in the floodplains of the Sacramento Valley marked a flood-prone pattern of settlement that would continue to be sited along riverbanks. Sustained growth in chronically flooded areas may appear counterintuitive from the modern perspective, but this pattern reflected a common mid-19th-century emphasis on "reclaimed" land and development popular on the political stage. According to this post-industrial mindset, floodplains and wetlands were considered inherently unproductive, and by draining these "swamplands" through human-made infrastructure, the lands could and should be profitably developed.

Throughout the mid-1800s, Congress passed a series of laws called the Swamp Land Acts, which transferred titles to swamp and overflow lands from the federal government to the states. The intent of the legislation was to put swamplands in the hands of private landowners who would drain inundated areas through human-made infrastructure and develop the land for agricultural or other commercial use. Following the Swamp Land Act of 1850, much of the land in the Central Valley was sold at $1.00 for 320 acres to private parties, with the condition that the landowner would "reclaim" the land through cultivation and flood management. By the 1870s, most of the floodplains of the Sacramento Valley had become privately owned farmland.

Individual landowners who were tasked with cultivating and draining swampland built primitive levees to protect farms and property. Early levees were not particularly well constructed. The unsystematic nature of levee construction along property lines rather than geographic features ultimately intensified flooding in the valley (Mount 1995:206). Throughout the 1850s, the rise of cities and agriculture in the Sacramento Valley diminished floodplains that had previously absorbed inundations from the banks of the Sacramento and American rivers, further intensifying flooding. During the 1860s, the already deteriorating natural system of flood protection in the Sacramento Valley was additionally stressed by hydraulic mining upstream in the Sierra Nevada, where the buildup of debris resulted in one of the most dramatic disruptions to the waterways of the Sacramento Valley (Mount 1995:190).

Hydraulic mining, introduced in the Sierra Nevada gold fields in 1853, was an industrialized strategy that used a system of reservoirs, dams, and high-powered hoses to wash away entire hillsides to access deeply buried gold deposits (Isenberg 2005:24). Unlike the small-scale placer mining methods used by the first wave of gold seekers, hydraulic mining produced an enormous amount of debris that washed into local waterways (Mount 1995:190). By the 1860s and 1870s, debris from hydraulic mining clogged tributaries and eventually the Sacramento and San Joaquin rivers. The debris resulted in navigation challenges and severe flooding in the low-lying and increasingly agricultural Central Valley (Mount 1995:192).

Implementation of the Sacramento River Flood Control Project

Effective water management infrastructure was not implemented until the Sacramento River Flood Control Project (SRFCP) of 1911. However, the hydrological studies that informed the final design of the SRFCP were sponsored by local, State, and federal government agencies starting in the late 1860s. Following a severe flood in 1907, the federally appointed California Debris Commission commissioned a study of the hydrology of the Sacramento Valley. Thomas H. Jackson, the primary author of the study, proposed a centrally managed system of bypasses and levees that would serve waterways and communities across the Sacramento Valley. Jackson's report, completed in 1910, presented the flood control system that would come to be known as the SRFCP (United States 1911).

The California Legislature approved the SRFCP when the California Flood Control Act of 1911 adopted the infrastructure proposed in the Jackson Report. The 1911 legislation also created the California Reclamation Board, a State authority with the ability to regulate reclamation districts and infrastructure along the Sacramento River. The subsequent Flood Control Act of 1913 expanded the authority of the California Reclamation Board to the Central Valley. Within the first few years of the Flood Control Act of 1911, State-funded water management infrastructure was built across the valley. Using floating mechanical dredges to extract material from the riverbed, crews completed the massive levees of the Sutter Bypass and the Yolo Bypass by 1923 (Garone 2011:113).

In 1911, when the State of California began to implement the infrastructure of the Jackson Report, federal funding could not be allocated to State flood control efforts, such as the SRFCP. This changed when devastating floods on the Mississippi River in 1913 and 1914 brought national attention to the issue of flooding. Congress enacted the Flood Control Act of 1917, and funds were appropriated to projects along the Sacramento, Ohio, and Mississippi rivers (Arnold 1988:14). Congress stipulated that upon receiving federal funding, local governments would contribute one dollar for every two federal dollars spent; would be responsible for obtaining right-of-way for water management infrastructure; and would take responsibility for maintaining the infrastructure once it was in place. Administration of the funding and the construction effort was left largely to the U.S. Army Corps of Engineers (USACE). The War Department and Chief of Engineers were responsible for dispensation of the funding. The act also authorized USACE to conduct studies of the watersheds in question, now known as "feasibility studies," to determine whether it was advisable for the federal government to take part in proposed projects (Arnold 1988:14–15). This pattern of construction by USACE, followed by management by local entities, continues to be the model for the SRFCP. During the 1950s, USACE improved the existing levees throughout the region, bringing them to federal construction standards, with many of the newly improved “project levees” then transferred to the state.

Post–New Deal Construction, 1935–1961

The Great Depression era ushered in a period of appropriations for large infrastructure projects under the New Deal (Mount 1995:196). Many of the civil works projects in the Sacramento Valley were designed to enhance flood control and reclamation throughout California, while also stimulating the economy.

Legislation of the 1930s paved the way for large, federally funded reclamation projects in the Sacramento Valley, for both the U.S. Bureau of Reclamation (Reclamation) and USACE. Under the Flood Control Act of 1936, USACE adopted flood control as a leading mission. Instead of acting with a nonfederal sponsor, USACE was given the authority to build infrastructure, including dams and levees, to protect citizens and property in flood zones (Mount 1995:196). Three objectives under the Rivers and Harbors Act of 1937 were tailored to the missions of both Reclamation and USACE:

(1) Regulate rivers and improve flood control and navigation (USACE).

(2) Provide water for irrigation and domestic use (Reclamation).

(3) Generate power (Reclamation) (U.S. Bureau of Reclamation 2020).

Construction on the SRFCP continued to expand throughout the valley. By 1944, 980 miles of levees had been added to the SRFCP, and the system was considered nearly 90 percent complete (Kelley 1998:309). The Flood Control Act of 1944 expanded on the 1936 Flood Control Act to designate the responsibilities of flood control and navigation to USACE. The low-lying, flood-prone, agricultural Central Valley continued to be a major focus for USACE and Reclamation (U.S. Army Corps of Engineers 2020). Large-scale federal reclamation and flood control projects tapered in the late 1960s, and USACE and Reclamation shifted staff and resources toward managing existing projects rather than constructing new ones (U.S. Bureau of Reclamation 2020). In 1961, the infrastructure of the SRFCP was deemed complete and USACE turned toward managing the existing system.

Beginning in 1961, annual inspections of the SRFCP levees were conducted by USACE, the California Reclamation Board, and DWR. At a national level, policy changes in the early 1960s also led to new approaches to federal flood protection in the United States. In 1966, the Federal Task Force on Flood Control Policy observed that the purpose of federal flood control projects had shifted from providing flood relief to existing communities, to paving the way for property development (Elfring et al. 1995:165). Concurrently, a 1966 report by the National Resources Planning Board promoted flood management alternatives, including wetland conservation, planned land use, and evacuation systems. Many of these nonstructural measures were adopted in the National Flood Insurance Act of 1968 (Elfring et al. 1995:22). As a result of these policy changes, modifications and maintenance of large flood control projects, such as the SRFCP, were driven by structural deterioration from the 1960s forward. The levees of the SRFCP, in particular those along the Feather and Sacramento rivers, have required substantial repairs after major flooding in 1986 and 1997; additional measures were taken to identify and repair weaknesses in the system after Hurricane Katrina brought renewed national attention to levee safety in 2005.

3.7.3 Regulatory Setting

No federal regulations are applicable to cultural resources within the Pulse Flows Component location. The following State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to the cultural resource impact analyses as required under CEQA have been included.

State

California Code of Regulations, Title 14, Section 15064.5

The CEQA Guidelines recognize that "historical resources" include all of the following:

(1) A resource in the California Register of Historical Resources (California Register).

(2) A resource included in a local register of historical resources, as defined in Public Resources Code (PRC) Section 5020.1(k) or identified as significant in a historical resource survey meeting the requirements of PRC Section 5024.1(g).

(3) Any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California by the lead agency, provided the lead agency's determination is supported by substantial evidence in light of the whole record.

If a lead agency determines that an archaeological site is a historical resource, the provisions of PRC Section 21084.1 and California Code of Regulations Title 14, Section 15064.5 apply. If an archaeological site does not meet the criteria for a historical resource contained in the CEQA Guidelines, then the site may be treated in accordance with the provisions of PRC Section 21083.2, pertaining to unique archaeological resources.

California Public Resources Code Section 21083.2

As defined in PRC Section 21083.2, a "unique archaeological resource" is an archaeological artifact, object, or site, about which it can be clearly demonstrated that without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and there is a demonstrable public interest in that information.
- Has a special and particular quality such as being the oldest of its type or the best available example of its type.
- Is directly associated with a scientifically recognized important prehistoric or historic event or person.

The CEQA Guidelines note that if an archaeological resource is not a unique archaeological, historical, or tribal cultural resource, the effects of the project on those cultural resources shall not be considered a significant effect on the environment (California Code of Regulations Title 14, Section 15064.5[c][4]).

California Register of Historical Resources

The California Register is "an authoritative listing and guide to be used by State and local agencies, private groups, and citizens in identifying the existing historical resources of the State and to indicate which resources deserve to be protected, to the extent prudent and feasible, from substantial adverse change" (PRC Section 5024.1[a]). The criteria for eligibility for the California Register are based upon the criteria for listing in the National Register of Historic Places (National Register) (PRC Section 5024.1[b]). Certain resources are determined by the statute to be automatically included in the California Register, including California properties formally determined eligible for, or listed in, the National Register.

To be eligible for the California Register, a cultural resource must be significant at the local, State, and/or federal level under one or more of the following four criteria:

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

A resource eligible for the California Register must be of sufficient age and retain enough of its historic character or appearance (integrity) to convey the reason for its significance. Additionally, the California Register consists of resources that are listed automatically and those that must be nominated through an application and public hearing process. The California Register automatically includes the following:

- California properties listed in the National Register (and those formally Determined Eligible for the National Register).
- California Registered Historical Landmarks from No. 770 onward.
- Those California Points of Historical Interest that have been evaluated by the California Office of Historic Preservation and have been recommended to the State Historical Commission for inclusion in the California Register.

The following other resources may be nominated to the California Register:

- Historical resources with a significance rating of Category 3 through 5 (those properties identified as eligible for listing in the National Register, the California Register, and/or a local jurisdiction register).
- Individual historic resources.

- Historic resources contributing to historic districts.
- Historic resources designated or listed as local landmarks, or designated under any local ordinance, such as an historic preservation overlay zone.

Also, pursuant to PRC Section 21074, tribal cultural resources may be included or determined to be eligible for inclusion in the California Register.

California Public Resources Code Section 5097

PRC Section 5097.99, as amended, states that no person shall obtain or possess any Native American artifacts or human remains that are taken from a Native American grave or cairn. Any person who knowingly or willfully obtains or possesses any Native American artifacts or human remains is guilty of a felony punishable by imprisonment. Any person who removes, without authority of law, any such items with an intent to sell or dissect, or with malice or wantonness, is also guilty of a felony punishable by imprisonment.

California Native American Historic Resources Protection Act

The California Native American Historic Resources Protection Act of 2002 imposes civil penalties, including imprisonment and fines up to $50,000 per violation, for persons who unlawfully and maliciously excavate upon, remove, destroy, injure, or deface a Native American historic, cultural, or sacred site that is listed or may be listed in the California Register.

California Health and Safety Code Section 7050.5

Section 7050.5 of the California Health and Safety Code protects human remains by prohibiting the disinterment, disturbance, or removal of human remains from any location other than a dedicated cemetery. PRC Section 5097.98 (reiterated in CEQA Guidelines Section 15064.5 [e]) also identifies steps to follow in the event of the accidental discovery or recognition of any human remains in any location other than a dedicated cemetery.

Shipwrecks and Submerged Cultural Resources

The title to all abandoned shipwrecks and other (submerged) cultural resources on or in the tide and submerged lands of California is vested in the State and under the jurisdiction of the California State Lands Commission (PRC Section 6313[a]). Also, according to PRC Section 6313(c), any submerged cultural resource remaining in State waters for more than 50 years is presumed to be archaeologically or historically significant.

Regional and Local

As described in Section 3.7.1, the geographic areas analyzed for impacts on cultural resources include the Oroville Complex, Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba counties. Each county and city has local regulations and general plans with policies related to cultural resources. These may include goals and policies related to the following:

- Identification of cultural resources.

- Consultation with California Native American Tribes and the California Historical Resources Information System.
- Listing of cultural resources for the National Register of Historic Places, the California Register, and local historic registers.
- Preference for avoidance of impacts on cultural resources.
- Development and implementation of protocols to avoid or mitigate impacts on cultural resources.
- Promotion of public education regarding cultural resources.

3.7.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. A cultural resources impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Cause a substantial adverse change in the significance of a historical resource pursuant to State CEQA Guidelines Section 15064.5.
- Cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5.
- Disturb any human remains, including those interred outside of formal cemeteries.

The following analysis describes archaeological resources, both as historical resources according to CEQA Guidelines Section 15064.5, and as unique archaeological resources as defined in PRC Section 21083.2(g).

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR’s action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.7.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects’ EIRs. Existing facilities would be used, with operations modified to support the pulse flow release. Therefore, the impact analysis does not evaluate construction impacts and rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions. This impact analysis incorporates the approach described in Section 3.2, “Approach to Evaluate Impacts of the Pulse Flow Releases,” to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, “Hydrology and Water Quality,” and detailed in Appendix B were also considered.

Historical Resources

Impacts on historical resources are assessed by identifying any activities that would affect them, such as new construction, demolition, or substantial alteration. Individual properties and districts identified as historical resources under CEQA include those that are significant because of their association with important events, people, or architectural styles or master architects, or for their informational value (California Register Criteria 1, 2, 3, and 4) and that retain sufficient historic integrity to convey their significance. Criterion 4 is typically applied to the evaluation of archaeological resources and not to architectural resources. Historical resources may include architectural resources and archaeological resources.

Once a resource has been identified as significant, it must be determined whether the impacts of the project would "cause a substantial adverse change in the significance" of the resource (CEQA Guidelines Section 15064.5[b]). A "substantial adverse change in the significance" of a historical resource means "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of [the] historical resource would be materially impaired" (CEQA Guidelines Section 15064.5[b][1]). A historical resource is materially impaired through the demolition or alteration of the resource's physical characteristics that convey its historical significance and that justify its inclusion in (or eligibility for inclusion in) the California Register or a qualified local register (CEQA Guidelines Section 15064.5[b][2]). Therefore, material impairment of historical resources constitutes a significant impact.

Archaeological Resources

The significance of most pre-contact and historic-era archaeological sites is typically assessed relative to California Register Criterion 4. This criterion stresses the importance of the information potential contained within an archaeological site, rather than the significance of the site as a surviving example of a type or its association with an important person or event. Archaeological resources may qualify as historical resources under the definition provided in CEQA Guidelines Section 15064.5(a). Alternatively, they may be assessed under CEQA as unique archaeological resources. "Unique archaeological resources" are defined as archaeological artifacts, objects, or sites that contain information needed to answer important scientific research questions (PRC Section 21083.2).

A substantial adverse change in the significance of an archaeological resource is assessed similarly to such changes to other historical resources; that is, a "substantial adverse change in significance" means "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of [the] historical resource would be materially impaired" (CEQA Guidelines Section 15064.5[b][1]). As stated previously, a historical resource is materially impaired when a project demolishes or materially alters the resource's physical characteristics that convey its historical significance and that justify its inclusion (or eligibility for inclusion) in the California Register or a qualified local register (CEQA Guidelines Section 15064.5[b][2]). Therefore, material impairment of archaeological resources that are considered historical resources or unique archaeological resources would be a significant impact.

Human Remains

Human remains, including those buried outside of formal cemeteries, are protected under several State laws, including PRC Section 5097.98 and California Health and Safety Code Section 7050.5. For the purposes of this analysis, intentional disturbance, mutilation, or removal of interred human remains without following the notification and consultation procedures outlined in PRC Section 5097.89 and California Health and Safety Code Section 7050.5 would be a significant impact.

Impacts and Mitigation Measures

Table 3.7-1 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.7-1
SUMMARY OF IMPACT CONCLUSIONS—CULTURAL RESOURCES

Impact Statement	Operations and Maintenance
3.7-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a historical resource pursuant to State CEQA Guidelines Section 15064.5.	LTS
3.7-2: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5.	LTS
3.7-3: Implementation of the Pulse Flows Component could disturb human remains, including those interred outside of dedicated cemeteries.	LTS

NOTES: LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2022.

Impact 3.7-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a historical resource pursuant to State CEQA Guidelines Section 15064.5.

Evaluations of California Register eligibility have previously occurred for many architectural resources in the Pulse Flows Component location, although numerous other architectural resources present in the area have not been evaluated for California Register eligibility. As a result, for the purposes of this analysis, all architectural resources in the Pulse Flows Component location that have not been previously evaluated as ineligible for the California Register are treated as potentially eligible for the California Register, and therefore, as potential historical resources.

As presented in Section 3.4, “Hydrology and Water Quality” (Impact 3.4-1), and as detailed in Appendix B, water levels and velocity under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability. Additionally, reduced releases from Lake Oroville during the Lake Oroville Recovery Period (Recovery Period) would remain within the typical range of operational flows. Finally, no new construction is proposed for the Pulse Flows Component. As a result, there is a very low potential for the Pulse Flows Component to result in impacts on historical resources.

Therefore, the Pulse Flows Component is not anticipated to substantially affect existing conditions as they pertain to historical resources; thus, the Pulse Flows Component would not result in a substantial adverse change in the significance of a historical resource pursuant to CEQA Guidelines Section 15064.5. The Pulse Flows Component would result in a **less-than-significant** impact on historical resources. No mitigation associated with historical resources is required.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to historical resources are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.7-2: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5.

This analysis describes archaeological resources, both as historical resources according to CEQA Guidelines Section 15064.5 and as unique archaeological resources as defined in PRC Section 21083.2(g), under Question b.

Evaluations of California Register eligibility have previously occurred for many archaeological resources in the location of the Pulse Flows Component, although numerous other archaeological resources present in the area have not been evaluated for California Register eligibility. As a result, for the purposes of this analysis, all archaeological resources in the Pulse Flows Component location that have not been previously evaluated as ineligible for the California Register are treated as potentially California Register eligible, and therefore, as potential archaeological resources pursuant to CEQA Guidelines Section 15064.5.

As stated above, water levels and velocity under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Finally, no new construction is proposed for the Pulse Flows Component. As a result, there is a very low potential for the Pulse Flows Component to result in impacts on archaeological resources, including any submerged cultural resources.

Therefore, the Pulse Flows Component would not result in a substantial adverse change in the significance of an archaeological resource pursuant to CEQA Guidelines Section 15064.5, and the Pulse Flows Component would result in a **less-than-significant** impact on archaeological resources. No mitigation associated with archaeological resources is required.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to archaeological resources are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.7-3: Implementation of the Pulse Flows Component could disturb human remains, including those interred outside of dedicated cemeteries.

As stated above, water levels and velocity under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the typical range of hydrologic variability. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Finally, no new construction is proposed for the Pulse Flows Component. As a result, there is a very low potential for the Pulse Flows Component to result in impacts on human remains (associated with archaeological resources).

Therefore, the Pulse Flows Component would not disturb human remains, including those interred outside of dedicated cemeteries, and the Pulse Flows Component would result in a **less-than-significant** impact on human remains. No mitigation associated with archaeological resources is required.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to disturbance of human remains are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

3.8 Tribal Cultural Resources

This section discusses the potential for the Pulse Flows Component to affect tribal cultural resources. Cultural resources are discussed separately in Section 3.7, "Cultural Resources." The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

For the purposes of this analysis, the term "tribal cultural resource" is defined as follows (based on Public Resources Code [PRC] Section 21074a):

> Sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are listed, or determined to be eligible for listing, in the California Register [California Register of Historical Resources], or a local register of historical resources.

3.8.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component study area was divided into seven geographic areas (see Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on tribal cultural resources were not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

The following five remaining geographic areas were evaluated for impacts on tribal cultural resources:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

Note that this Draft SEIR covers the Pulse Flows Component and does not include any tribal cultural resources within the project areas for the three WSIP Groundwater Projects.

3.8.2 Environmental Setting

Some of the background context, notably the pre-contact setting, used for the analysis of potential impacts on tribal cultural resources is similar to that used for the analysis of potential impacts on cultural resources. As a result, the pre-contact setting applicable to the current section is presented in the cultural resources section (Section 3.7, "Cultural Resources").

Ethnographic Setting

Beginning in the early 16th century, but primarily during the late 19th and early 20th centuries, Native American lifeways and languages (i.e., ethnographic data) were documented throughout California. Whether provided by professional ethnographers or archaeologists, by field personnel from government agencies such as the Bureau of Indian Affairs, or by soldiers, merchants, settlers, or travelers, ethnographic accounts partly illuminate the traditions, beliefs, and cultures of Native American groups during specific points in time.

Synthesized narratives such as the *Handbook of North American Indians,* Volume 8: *California* (Heizer 1978) categorize Native traditions and practices documented at the time in California; however, the complexity of regional diversity should not be overlooked. Traditional anthropological literature portrays native peoples as having static cultures and boundaries, but many variations of culture and ideology existed within and between villages. Although these static descriptions of separations between native cultures of California make it easier for ethnographers to describe past behaviors and ascribe people to a particular geographic locale, this approach masks Native adaptability and self-identity. Most of California's Native Americans never saw themselves as members of larger cultural groups, as described by anthropologists. Instead, they saw themselves as members of specific village communities, perhaps related to others by marriage or kinship ties, but viewing the village as the primary identifier of their origins.

In short, all tribal group boundaries should be viewed as permeable and approximate. The location of the Pulse Flows Component is within the traditional lands of the following Indigenous groups: Cahuilla, Chumash, Konkow, Nisenan, Northern Valley Yokuts, Patwin, Plains Miwok, Serrano, Southern Valley Yokuts, Tataviam, and Tongva (Heizer 1978).

At least six primary language families exist in California, and there may be more than 300 different dialects of approximately 100 languages. The “geolinguistic mosaic of the ethnographic period, with a startling diversity of languages and language families” indicates numerous major population shifts and migrations (Golla 2007:71). Ethnographers have also quantified at least 60 greater Indian cultures and as many as 250 specific tribes throughout the state.

Similarities between California’s native populations crossed geographic, climatic, and cultural boundaries. Acorns, where available, were a staple throughout California. Native populations relied on deer, elk, small mammals, birds, and fish, and they used resources to their fullest extent, with little to no waste product. Ethnographically documented communities were generally focused on a central tribe with smaller satellite tribelets, although this characteristic varied by region. In general, Native American settlement locations depended primarily on elevation, exposure, and proximity to water and other resources. Permanent villages were usually situated on low rises along major watercourses. Village sizes ranged from a few houses up to 50 or more. Houses were usually conical or domed structures covered with earth and tule or grass, measuring up to 5 meters or more in diameter. Brush shelters were often used in summer and at temporary camps during food-gathering rounds. Larger villages commonly had semi-subterranean dance houses that were covered in earth and tule or brush. Another common village structure was a granary used for storing acorns (Kroeber 1976; Johnson 1978; Levy 1978; Riddell 1978; Wilson and Towne 1978).

Shamanism and ceremonialism played important roles in the lives of most California Native Americans; the specific religious traditions themselves differed between groups. Basketry was widespread, and some southern tribes also manufactured pottery. Hunting, trapping, and fishing technologies were shared across tribal and cultural boundaries but varied depending on environmental conditions.

Native American fishing techniques along inland waterways included constructing fish weirs or dams across rivers to trap anadromous fish during upstream migration. Weirs were constructed of wood poles, logs, and small stakes to obstruct fish passage up a waterway. Some fish weirs were built and used by small groups, mainly individual families, but communal constructions were also common (Gould 1975). Organized labor teams from many surrounding villages worked cooperatively to collect logs for the construction of a communal fish weir, catch fish, gather firewood, and process the catch. The dam would be in place for approximately 10 days before the group would tear it down. Other methods of fishing included net traps, harpoons, spears, platforms, and clubs (Kroeber and Barrett 1960). Tule balsa canoes and dugout canoes were also used for fishing (Wilson and Towne 1978). Among the other important riverine subsistence species were steelhead, candlefish, lamprey, eel, and trout.

Trade was well developed in California. The use of shell beads as currency was an important economic and cultural practice for many tribes. Food, ornaments, household items, clothing, industrial materials such as obsidian, finished items including canoes, pottery, basketry, and tobacco were used for trade items. Trade networks were well established, and although it appears that there were not professional traders, central villages served as focal points for trading (Heizer 1978).

Regional differences in Native American beliefs are significant, yet there is a common identity and relationship with the environment. California Native peoples believe that nature is interrelated and imbued with sacred power. Most California Tribes have creation histories that often explain the origins of the earth, human existence, and individual cultural attributes. These histories have often taught morality or defined the establishment of elements. Modern Native American beliefs are rooted in their ancestral land and traditions.

As with other California Native American groups, the Gold Rush of 1849 had a devastating effect on the Native Americans who inhabited the Pulse Flows Component location and vicinity. The flood of miners who came to the area in search of gold brought with them diseases that decimated tribal populations. Those who survived were subjected to violence and prejudice at the hands of the miners, and the Native Americans were eventually pushed out of their ancestral territories. Although this contact with settlers had a profound negative impact on the Native American populations through disease and violent actions, these groups survived and have maintained strong communities and action-oriented organizations to this day. These groups have continued to protect their cultural heritage and identity and maintain their languages and traditions.

The 2000 U.S. Census recorded 220,657 American Indians in California (excluding Alaska Natives and Native Hawaiians) for those designating only one race. Of that number, some come from Tribes outside the current boundaries of California. Currently, there are 109 federally recognized Tribes in California and approximately 40 groups seeking to gain federal recognition.

Today, Tribes are reinvesting in their traditions. Tribes are growing and thriving communities that are actively involved in defining their role as stewards of their ancestors' sites, including the identification of tribal cultural resources. Tribal cultural resources provide the backdrop to religious understanding; traditional stories; knowledge of resources such as varying landscapes, bodies of water, animals and plants; and self-identity. Knowledge of place is central to the continuation and persistence of culture, though many former tribal occupants live removed from their traditional homeland. Tribes view these interconnected sites and places as living entities; their associations and feeling persist and connect with descendant communities.

Native American Consultation

DWR contacted the Native American Heritage Commission (NAHC) in June 2022 requesting a search of the NAHC's Sacred Lands File and a list of Native American representatives who may have interest in the Pulse Flows Component. The request focused on the portion of the study area north of the California Aqueduct (see Section 3.8.1). The NAHC replied in July 2022, stating that the Sacred Lands File has records of sacred sites in the Pulse Flows Component location; the reply also included a list of Native American representatives to contact who may be interested in the Pulse Flows Component.

In accordance with the California Natural Resources Agency's (CNRA's*)* Tribal Consultation Policy and DWR's Tribal Engagement Policy, DWR sent letters via certified mail in June 2022, and follow-up emails, to representatives from the following nine California Native American

Tribes that had previously requested to DWR that they be notified of any DWR projects pursuant to Assembly Bill (AB) 52:

- Buena Vista Rancheria of Me-Wuk Indians (BVRMI).
- Ione Band of Miwok Indians.
- Konkow Valley Band of Maidu (KVBM).
- Mechoopda Indian Tribe of Chico Rancheria (MITCR).
- North Valley Yokuts.
- Shingle Springs Band of Miwok Indians (SSBMI).
- United Auburn Indian Community of the Auburn Rancheria of California (UAIC).
- Wilton Rancheria.
- Yocha Dehe Wintun Nation (YDWN).

These letters and emails provided information on the Pulse Flows Component and requested that the recipients notify DWR if they had any concerns regarding potential Pulse Flows Component impacts on cultural resources and tribal cultural resources. Additionally, the letters and emails invited the California Native American Tribes that had been identified at that time to attend an informational video conference about the Pulse Flows Component. DWR held the informational video conference on July 22, 2022, with the representatives from the following four Tribes participating: BVRMI, MITCR, UAIC, and Wilton Rancheria. Of the Tribes notified above, DWR received formal responses from the following five Tribes requesting to consult with DWR on the Pulse Flows Component: BVRMI, KVBM, SSBMI, UAIC, and YDWN. DWR is actively consulting with these five Tribes on the Pulse Flows Component. DWR received responses from MITCR and Wilton Rancheria stating that they would like to be provided with updates on the Pulse Flows Component.

On August 22, 2022, DWR emailed the Notice of Preparation (NOP) to representatives from the five California Native American Tribes that had requested to consult with DWR on the Pulse Flows Component (BVRMI, KVBM, SSBMI, UAIC, YDWN) as well as the two Tribes that had requested that DWR provide them with updates on the Pulse Flows Component (MITCR and Wilton Rancheria). Although responsibility for Assembly Bill (AB) 52 compliance falls to the individual Lead Agencies of the individual WSIP Groundwater Projects, DWR used its AB 52 list as an initial reference to comply with DWR’s Tribal Engagement Policy and CNRA’s Tribal Engagement Policy. As soon as practicable, DWR expanded outreach to other Tribes to assess their interest as well.

In accordance with the CNRA’s Tribal Consultation Policy and DWR’s Tribal Engagement Policy, DWR also sent letters via certified mail and follow-up emails, to representatives from the following additional 36 California Native American Tribes by August 2022 (as soon as practicable after Tribal contact information was obtained):

- Amah Mutsun Tribal Band of Mission San Juan Bautista.
- Berry Creek Rancheria of Maidu Indians.

- Big Valley Rancheria of Pomo Indians.
- Cachil DeHe Band of Wintun Indians of the Colusa Indian Community (CDBWI).
- Calaveras Band of Mi-Wuk Indians.
- California Valley Miwok Tribe.
- Chicken Ranch Rancheria of Me-Wuk Indians.
- Colfax–Todds Valley Consolidated Tribe.
- Cortina Rancheria–Kletsel Dehe Band of Wintun Indians.
- Costanoan Rumsen Carmel Tribe.
- Elem Indian Colony Pomo Tribe.
- Estom Yumeka Maidu Tribe of the Enterprise Rancheria.
- Greenville Rancheria.
- Guidiville Indian Rancheria.
- Habematolel Pomo of Upper Lake.
- Indian Canyon Mutsun Band of Costanoan.
- Koi Nation of Northern California.
- Middletown Rancheria of Pomo Indians.
- Mishewal-Wappo Tribe of Alexander Valley.
- Mooretown Rancheria of Maidu Indians (MRMI).
- Muwekma Ohlone Indian Tribe of the San Francisco Bay Area.
- Nashville Enterprise Miwok-Maidu-Nishinam Tribe.
- Nevada City Rancheria Nisenan Tribe.
- Pakan'yani Maidu of Strawberry Valley Rancheria.
- Pinoleville Pomo Nation.
- Robinson Rancheria of Pomo Indians.
- Scotts Valley Band of Pomo.
- Southern Sierra Miwuk Nation.
- Tamien Nation.
- The Confederated Villages of Lisjan.
- The Ohlone Indian Tribe.
- Tsi Akim Maidu.
- Tule River Indian Tribe.
- Tuolumne Band of Me-Wuk Indians (TBMI).
- Washoe Tribe of Nevada and California.
- Wuksache Indian Tribe/Eshom Valley Band.

In addition, in June 2022, DWR sent a letter to the Butte Tribal Council via certified mail.

These letters and emails provided information on the Pulse Flows Component and requested that the recipients notify DWR if they had any concerns regarding potential Pulse Flows Component impacts on cultural resources and tribal cultural resources. DWR received responses from the following three Tribes notified as listed above: CDBWI, MRMI, and TBMI. MRMI's response requested consultation with DWR on the Pulse Flows Component. DWR is actively consulting with MRMI on the Pulse Flows Component. TBMI's response requested that the Tribe be provided with updates on the Pulse Flows Component. CDBWI's response deferred consultation on the Pulse Flows Component to YDWN. On August 22, 2022 and September 21, 2022 respectively, DWR emailed the NOP to representatives from MRMI and TBMI, as they had either requested to consult with DWR on the Pulse Flows Component (MRMI) or had requested that DWR provide them with updates on the Pulse Flows Component (TBMI).

In summary, DWR has engaged 45 California Native American Tribes as well as the Butte Tribal Council to provide information on the Pulse Flows Component and request that they notify DWR if they have any concerns regarding the Pulse Flows Component and impacts on cultural resources and tribal cultural resources. DWR has received responses from ten of these Tribes, with six Tribes requesting consultation with DWR on the Pulse Flows Component, three Tribes requesting that DWR provide updates to them regarding the Pulse Flows Component, and one Tribe deferring to another. Consultation is ongoing between DWR and the six Tribes that requested consultation with DWR on the Pulse Flows Components.

3.8.3 Regulatory Setting

No federal regulations are applicable to tribal cultural resources within the Pulse Flows Component location. The following State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to the tribal cultural resource impact analyses as required under CEQA have been included.

State

California Natural Resources Agency Tribal Consultation Policy

The CNRA's Final Tribal Consultation Policy, adopted November 12, 2012, was developed in response to Governor Edmund G. Brown Jr.'s Executive Order B-10-11 (September 19, 2011), which states, "[t]he purpose of this policy is to ensure effective government-to-government consultation between the Natural Resources Agency, its Departments…and Indian Tribes…to provide meaningful input into the development of regulations, rules, policies, programs, projects, plans, property decisions, and activities that may affect tribal communities."

California Department of Water Resources Tribal Engagement Policy

DWR adopted the Tribal Engagement Policy, effective March 8, 2016, to strengthen DWR's commitment to improving communication, collaboration, and consultation with California Native American Tribes. This policy is consistent with Executive Order B-10-11, the CNRA's Tribal Consultation Policy, and AB 52, and includes principles that facilitate early and meaningful tribal engagement with California Native American Tribes.

Assembly Bill 52

AB 52, enacted in September 2014, recognizes that California Native American Tribes have expertise with regard to their tribal history and practices. AB 52 established a new category of cultural resources in CEQA, "tribal cultural resources," to consider tribal cultural values when determining the impacts of projects on cultural resources (PRC Sections 21080.3.1, 21084.2, and 21084.3). The law also requires that CEQA lead agencies consult with California Native American Tribes to identify, evaluate, and assess potential project impacts on tribal cultural resources (PRC Sections 21080.3.1, 21080.3.2, and 21082.3).

PRC Section 21074(a) defines a tribal cultural resource as any of the following:

- Sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American Tribe that are either of the following:
  - Included or determined to be eligible for inclusion in the California Register.
  - Included in a local register of historical resources, as defined in PRC Section 5020.1(k).
- A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying these criteria, the lead agency would consider the significance of the resource to a California Native American Tribe.

A cultural landscape that meets the criteria of PRC Section 21074(a) is also a tribal cultural resource if the landscape is geographically defined in terms of the size and scope. A historical resource as described in PRC Section 21084.1, a unique archaeological resource as defined in PRC Section 21083.2, or a non-unique archaeological resource as defined in PRC Section 21083.2 may also be a tribal cultural resource under CEQA if it meets the criteria identified in PRC Section 21074(a).

AB 52 requires CEQA lead agencies to analyze the impacts of projects on tribal cultural resources separately from impacts on archaeological resources (PRC Sections 21074 and 21083.09) because tribal cultural resources that are also archaeological resources may also have cultural values beyond their ability to yield data important to prehistory or history. The provisions of AB 52 apply to projects for which an NOP or a notice of negative declaration/mitigated negative declaration was filed on or after July 1, 2015.

Each of the WSIP Groundwater Projects has a different CEQA process and timeline, so AB 52 may apply to some and not to others. The AB 52 responsibility for each WSIP Groundwater Project lies with the CEQA lead agency for that individual project.

Because DWR is not the CEQA lead agency for any of the WSIP Groundwater Projects, under AB 52, DWR did not formally notice any Tribes under AB 52. However, as a responsible agency, DWR has invited Tribes to consult under its Tribal Engagement Policy and the CNRA's Tribal Consultation Policy.

The net results of tribal engagement under the DWR and CNRA policies are to be virtually identical: a good-faith effort to understand and address concerns. The difference in this case is that AB 52 does not constrain DWR's timeline for consultation with Tribes.

California Register of Historical Resources

See Section 3.7.3, "Regulatory Setting," in Section 3.7, "Cultural Resources," for a description of the California Register.

California Public Resources Code Section 5097

See Section 3.7.3, "Regulatory Setting," in Section 3.7, "Cultural Resources," for a description of this regulation.

California Native American Historic Resources Protection Act

See Section 3.7.3, "Regulatory Setting," in Section 3.7, "Cultural Resources," for a description of this regulation.

California Health and Safety Code Section 7050.5

See Section 3.7.3, "Regulatory Setting," in Section 3.7, "Cultural Resources," for a description of this regulation.

Regional and Local

As described in Section 3.8.1, the geographic areas analyzed for impacts on tribal cultural resources include the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba counties. Each county and city has local regulations and general plans with policies related to cultural resources, and many of these have additional regulations and policies related to tribal cultural resources. These may include goals and policies related to the following:

- Identification of tribal cultural resources.
- Consultation with California Native American Tribes and the California Historical Resources Information System.
- Listing of cultural resources for the National Register of Historic Places, the California Register, and local historic registers.
- Preference for avoidance of impacts on cultural resources and tribal cultural resources.
- Development and implementation of protocols to avoid or mitigate impacts on cultural resources and tribal cultural resources.
- Promotion of public education regarding cultural resources.

3.8.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. A tribal cultural resources impact is considered significant if implementation of the Pulse Flows Component would:

- Cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American Tribe, and that is:
  - Listed or eligible for listing in the California Register, or in a local register of historical resources as defined in PRC Section 5020.1(k); or
  - A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American Tribe.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR’s action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.7.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects’ EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts, but rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, “Approach to Evaluate Impacts of the Pulse Flow Releases,” to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, “Hydrology and Water Quality,” and detailed in Appendix B were also considered. CEQA requires that a project’s impacts on tribal cultural resources be considered as part of the overall analysis of project impacts (PRC Sections 21080.3.1[a], 21084.2, and 21084.3). The significance of a resource as a tribal cultural resource is assessed by evaluating all of the following:

- Its eligibility for listing in the California Register.
- Its eligibility as a unique archaeological resource pursuant to PRC Section 21083.2.
- Its listing status in the NAHC’s Sacred Lands File.

In addition, a lead agency can independently determine a resource to be a tribal cultural resource.

California Native American Tribes are considered experts with respect to tribal cultural resources. Thus, the analysis of whether project impacts may result in a substantial adverse change to the significance of a tribal cultural resource depends heavily on consultation between the lead agency and culturally affiliated California Native American Tribes during the CEQA process.

Impacts and Mitigation Measures

Table 3.8-1 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.8-1
SUMMARY OF IMPACT CONCLUSIONS—TRIBAL CULTURAL RESOURCES

Impact Statement	Operations and Maintenance
3.8-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American Tribe, and that is: a) listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k), or b) a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American Tribe.	LTSM

NOTES: LTSM = Less than Significant with Mitigation
SOURCE: Data compiled by Environmental Science Associates in 2022.

Impact 3.8-1: Implementation of the Pulse Flows Component could cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American Tribe, and that is:

a) listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k), or

b) a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American Tribe.

DWR has engaged 45 California Native American Tribes plus one Tribal Council to provide information on the Pulse Flows Component and request that they notify DWR if they have any concerns regarding potential impacts of the Pulse Flows Component on cultural resources and tribal cultural resources. DWR has received responses from a number of these Tribes, with six Tribes requesting consultation with DWR on the Pulse Flows Component. Consultation with these six Tribes is ongoing.

To date, none of the Tribes consulting with DWR on the Pulse Flows Component have identified a specific tribal cultural resource that they feel could be affected by the Pulse Flows Component.

However, because DWR's tribal consultation process is ongoing, the potential remains for a tribal cultural resource to be identified that could be affected by the Pulse Flows Component. Any impacts of the Pulse Flows Component on tribal cultural resources, as defined in PRC Section 21074, would be potentially significant. This potentially significant impact would be reduced to **less than significant** with implementation of **Mitigation Measure 3.8-1**.

Mitigation Measure 3.8-1: Unanticipated Discovery/Identification of Potential Tribal Cultural Resources That Could Be Affected by the Pulse Flows Component.

If potential tribal cultural resources that could be affected by the Pulse Flows Component are identified during ongoing consultation on the Pulse Flows Component or during pulse flows, DWR shall implement procedures to evaluate the resource for listing in the California Register.

California Native American Tribes that are traditionally and culturally affiliated with the Pulse Flows Component's geographic area may have expertise concerning their tribal cultural resources; such Tribes shall be consulted with concerning potential tribal cultural resources that may be affected by the Pulse Flows Component. Consultation shall focus on identifying measures to avoid or minimize impacts if DWR determines that a resource is a tribal cultural resource that could be affected. Should tribal cultural resources be identified that could be affected by the Pulse Flows Component, the following performance standards shall be implemented before the continuance of activities that may result in damage to or destruction of tribal cultural resources:

- Each identified tribal cultural resource shall be evaluated for California Register eligibility through application of established eligibility criteria (PRC Section 5024.1), in consultation with interested California Native American Tribes.
- If a tribal cultural resource is determined to be eligible for the California Register, the damaging effects shall be avoided in accordance with PRC Section 21084.3. Culturally appropriate mitigation capable of avoiding or substantially lessening potential significant impacts on the tribal cultural resource, or alternatives that would avoid significant impacts on the tribal cultural resource, shall be implemented. These measures may be considered to avoid or minimize significant adverse impacts and constitute the standard by which an impact conclusion of less than significant may be reached. Such measures include:
  - Treat the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:
    - Protect the cultural character and integrity of the resource.
    - Protect the traditional use of the resource.
    - Protect the confidentiality of the resource.
    - Establish permanent conservation easements or other interests in real property, with culturally appropriate management criteria for the purposes of preserving or using the resources or places.

Significance after Mitigation: Less than significant.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to tribal cultural resources are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to tribal cultural resources, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

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3.9 Energy and Greenhouse Gas Emissions

This section discusses the potential for the Pulse Flows Component to affect energy and greenhouse gas (GHG) emissions. The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project (Kern Fan) and Willow Springs Water Bank Project (Willow Springs).

3.9.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (see Figure 2-2).

Several geographic areas within the study area do not include energy-generating facilities applicable to the Pulse Flows Component. Therefore, impacts on energy resources and GHG emissions were not evaluated for the following geographic areas:

- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

The following three remaining geographic areas were evaluated for impacts on energy resources and GHG emissions:

- Geographic Area 1: Oroville Complex
- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

3.9.2 Environmental Setting

The environmental setting section provides a focused discussion of existing conditions with the geographic areas analyzed for energy resources and GHG emissions (as outlined above).
A general description of the Pulse Flows Component study area, including the seven geographic areas, is presented in Section 2.3.

Energy Resources

In the context of energy resources, the Oroville Complex is the primary energy-generating facility in the study area. There is also energy use associated with the Harvey O. Banks Pumping Plant (Banks Pumping Plant) that lifts water from the Sacramento–San Joaquin Delta (Delta) into the California Aqueduct, and the William R. Gianelli Pumping-Generating Plant at San Luis Reservoir. Each of these facilities is described in more detail below.

Oroville Complex

The Oroville Complex, or Oroville-Thermalito Complex, is the primary energy facility in the study area. The Oroville facilities are also known as Federal Energy Regulatory Commission (FERC) Project No. 2100, or P-2100 (refer to Section 3.4.2 for additional information on FERC relicensing of P-2100). The Oroville Complex plays an important part in meeting DWR's resource adequacy requirements and is a significant power resource for the State of California and for the California Independent System Operator (CAISO). The hydroelectric facilities of P-2100 have a combined license capacity of approximately 762 megawatts, which produce an average of 2.2 billion kilowatt-hours of electricity each year. (The relicensing of P-2100 is discussed further in Section 3.9.3.) Oroville Complex operations are planned and scheduled in concert with other State Water Project (SWP) and U.S. Bureau of Reclamation Central Valley Project water storage, pumping, and conveyance facilities.

Facilities involved in storage and pumping operation of the Feather River include Lake Oroville; three power plants (the Hyatt Powerplant, Thermalito Diversion Dam Powerplant, and Thermalito Pumping-Generating Plant); and a forebay and afterbay. As water leaves this region, it flows down the Feather River and Sacramento River channels to the Delta (California Department of Water Resources 2023). Select facilities are described in more detail below.

Lake Oroville stores winter and spring runoff that is released into the Feather River to meet the SWP's needs. It also provides 750,000 acre-feet of flood control storage, recreation, and freshwater releases to control salinity intrusion in the Delta and for fish and wildlife enhancement. At 770 feet tall, Oroville Dam is the tallest earth-fill dam in the United States. Construction first began in 1957 and was completed in 1967 (California Department of Water Resources 2023).

The Thermalito Pumping-Generating Plant is a principal feature of the Thermalito Facilities. Construction on the plant began in 1964 and was completed in 1969, with operations starting in 1968. This facility is operated in tandem with the Hyatt Powerplant and Thermalito Diversion Dam Powerplant to produce power. The Hyatt Powerplant and Thermalito Pumping-Generating Plant have the physical capability to pump water back into their upstream reservoirs to maximize power benefits, although these "pump-back" operations are not currently employed. With the exception of occasional intermittent use for maintenance, operations, testing, and exercising purposes, pump-back operations have not been used since 2004 and are not expected to resume in the near term.

Constructed between 1965 and 1968, the Thermalito Forebay is an offstream reservoir contained by Thermalito Forebay Dam on the south and east and by Campbell Hills on the north and west. It is located about four miles west of the city of Oroville. The forebay conveys generating and pumping flows between the Thermalito Power Canal and Thermalito Pumping-Generating Plant, provides regulatory storage and surge damping for the Thermalito Facilities power facilities, and serves as a recreational site. Located about six miles southwest of the city of Oroville, the Thermalito Afterbay is an offstream reservoir. The afterbay provides storage for the water, helps regulate the power system, produces controlled flow in the Feather River downstream from the

Oroville Complex, and provides recreation. The facility was constructed from 1965 to 1968 (California Department of Water Resources 2023).

The SWP generates hydropower at facilities such as those in the Oroville Complex, selling it to the larger grid, and uses energy at its pumping plants, sourcing that energy from the larger grid near the specific facilities. With consideration of regulatory flow and temperature requirements, the Oroville Complex is operated to maintain generation during the peak energy demand. In recent years, this contribution has been helpful during CAISO's Summer Readiness program to provide reliability to the larger grid during peak-load days.

Overall, the SWP uses more energy than it produces. In a normal year, SWP generation facilities supply about two-thirds of the SWP's necessary operating power (California Department of Water Resources 2019). For example, in 2016, the SWP used 6,600 gigawatt-hours of energy, approximately 2,600 gigawatt-hours of which were purchased by DWR (California Department of Water Resources 2019). Therefore, DWR uses a portfolio of energy resources to make up the difference in energy between the electricity that SWP facilities generate, and the amount of electricity needed to run the SWP. The composition of the SWP power portfolio varies throughout the year and from year to year depending on water year type, but the SWP power portfolio's electricity sources generally can be categorized as generation from large hydroelectric facilities, renewable energy facilities, natural gas, and purchased energy (California Department of Water Resources 2020). Even with all of the electricity the SWP uses, it accounts for only about 3 percent of statewide electricity use (California Department of Water Resources 2021).

Banks Pumping Plant and California Aqueduct

The Banks Pumping Plant and California Aqueduct consist of engineered facilities, including pumping plants, pipes, concrete-lined canals, San Luis Reservoir (described below), and turnout structures. The Clifton Court Forebay is a part of the SWP and serves as the starting point of the California Aqueduct, which delivers water to the San Francisco Bay Area, the San Joaquin Valley, the central coast, and Southern California. SWP water flows through the Delta channels until it reaches the Banks Pumping Plant at Clifton Court Forebay just south of Stockton. Constructed between 1963 and 1969, the Banks Pumping Plant can pump up to 10,300 cubic feet per second (cfs), although operation at that level has occurred for only limited periods of time (Water Education Foundation 2023).

San Luis Reservoir

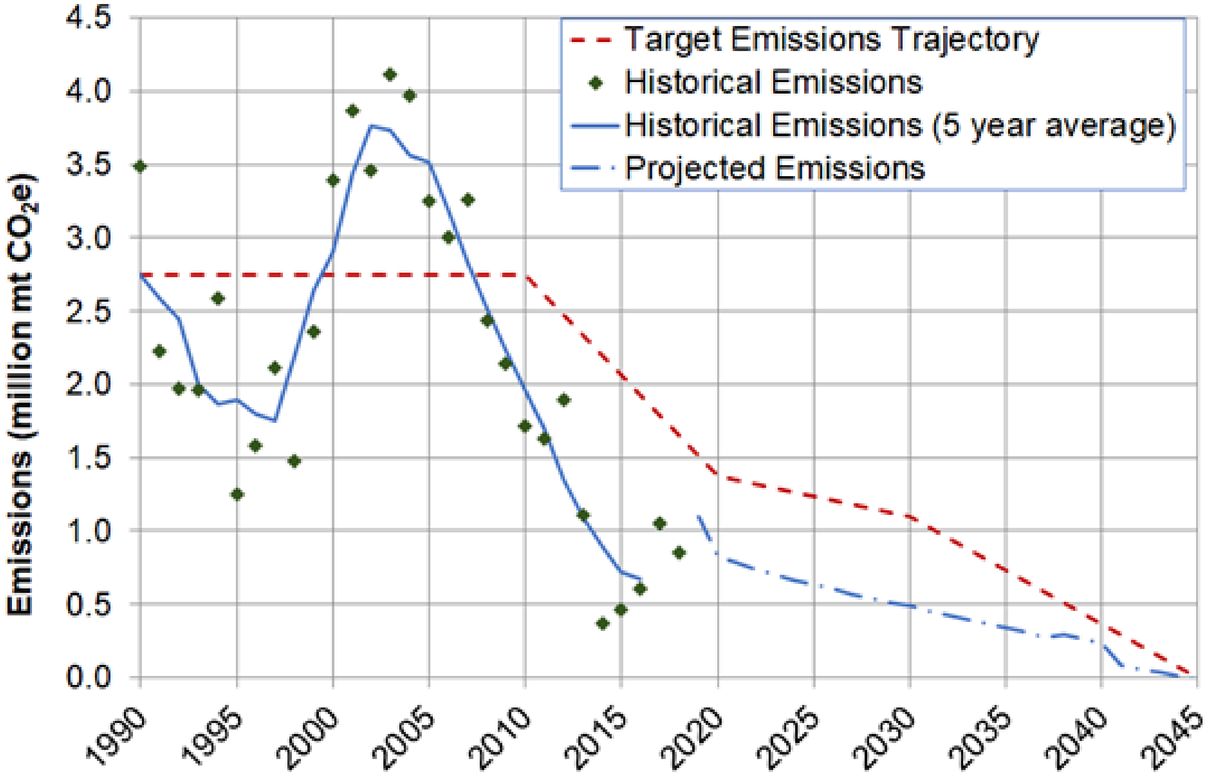
The William R. Gianelli Pumping-Generating Plant (Gianelli Power Plant), located at the base of San Luis Dam, is owned by the U.S. Bureau of Reclamation and operated by DWR. This joint federal-State facility, located at San Luis Dam, lifts water via pump turbines from the O`Neill Forebay into San Luis Reservoir. During the irrigation season, water is released from San Luis Reservoir back through the pump turbines to the forebay and energy is reclaimed. Each of the eight pumping-generating units has a capacity of 63,000 horsepower as a motor and 53,000 kilowatts as a generator. As a pumping station to fill San Luis Reservoir, each unit lifts 1,375 cfs at 290 feet total head. As a generating plant, each unit passes 1,640 cfs at the same head (U.S. Bureau of Reclamation 2023).

Greenhouse Gas Emissions

The sources of energy used to power the facilities described above are directly linked to the volume of associated GHG emissions. However, GHG emissions and their climate-related impacts are not limited to one geographic area, but rather occur on global or regional scales. Whereas many pollutants with localized air quality effects have relatively short atmospheric lifetimes of one or several days, GHGs have long atmospheric lifetimes and may persist for years. GHG emissions contribute cumulatively to the overall heat-trapping capability of the atmosphere, and the effects of global warming—also known as climate change—are manifested in different ways across the globe. Therefore, from the standpoint of CEQA, the impacts of GHG emissions on global climate change are inherently cumulative.

Increases in GHG concentrations in the Earth's atmosphere are thought to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the release of solar radiation that is reflected back into space after hitting Earth. Some GHGs occur naturally and are necessary for keeping the earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase in the average global temperature (Intergovernmental Panel on Climate Change 2022).

The GHGs widely accepted as the principal contributors to human-induced global climate change are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (California Air Resources Board 2017). The California Air Resources Board (CARB) performs an annual GHG inventory for emissions and sinks of the six major GHGs. California produced 418.2 million metric tons (MMT) of carbon dioxide equivalents (CO_2e) in 2019 (California Air Resources Board 2021). Combustion of fossil fuels in the transportation category was the single largest source of California's GHG emissions, accounting for approximately 39.7 percent of total GHG emissions. It was followed by the industrial and electric power (including in-state and out-of-state sources) categories at 21.1 percent and 14.1 percent of the total, respectively (California Air Resources Board 2021). **Figure 3.9-1** shows DWR's historical emissions, target emissions trajectory, and projected emissions.



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SOURCE: DWR 2022

Figure 3.9-1
DWR GHG Emissions

ESA

3.9.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to the energy and GHG emissions impact analyses as required under CEQA have been included.

Federal

Federal Energy Regulatory Commission

FERC is an independent agency that regulates the interstate transmission of energy (electricity, natural gas, and oil). FERC also reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines, and for licensing of hydropower projects (Federal Energy Regulatory Commission 2022a).

Federal Energy Regulatory Commission Order Numbers 888 and 889

California's energy market is regulated by FERC Order Nos. 888 and 889. These orders, issued in 1996 and 1997, respectively, apply to public utilities that own, control, or operate facilities for transmitting electricity in interstate commerce. Under Order No. 888, the affected public utilities must offer open-access, nondiscriminatory transmission tariffs with minimum terms and conditions of service. The utilities may seek to recover the justifiable stranded costs (the potential losses to electric power utilities as their industry is deregulated [Congressional Budget Office 1998]) of providing open-access transmission services (Federal Energy Regulatory Commission 2020a).

FERC Order No. 889 requires public utilities to participate in the Open Access Same-Time Information System. This participation is intended to inform current and potential open-access transmission customers regarding available transmission capacity, prices, and other relevant data (Federal Energy Regulatory Commission 2020b).

Federal Power Act

The Federal Power Act (United States Code Title 16, Section 4[e] [16 USC 4(e)]) grants FERC the authority to issue licenses for hydropower projects of any size that fall into any of the following categories:

- Located on navigable waters.
- Located on non-navigable waters that are under the jurisdiction of Congress under the Commerce Clause, were constructed after 1935, and affect the interests of interstate or foreign commerce.
- Located on public lands or reservations of the United States.
- Using surplus water or water power from a federal dam.

There are multiple hydropower projects in California pending relicense by FERC (Federal Energy Regulatory Commission 2022b). Relicensing projects typically incur increased costs for environmental protection and project enhancement, which in turn can increase the costs of power generation. As a result, the power generation and operational flexibility of relicensed projects often decreases. For these reasons, future relicensing efforts have the potential to change the number of operating hydroelectric facilities.

Federal National Energy Conservation Policy Act

The National Energy Conservation Policy Act serves as the underlying authority for federal energy management goals and requirements. Signed into law in 1978, the National Energy Conservation Policy Act has been regularly updated and amended by subsequent laws and regulations. This law is the foundation of most federal energy requirements. The National Energy Conservation Policy Act established energy-efficiency standards for consumer products and includes a residential program for low-income weatherization assistance, grants and loan guarantees for energy conservation in schools and hospitals, and energy-efficiency standards for new construction. Initiatives in these areas continue today.

Clean Air Act

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for implementing the Clean Air Act (CAA) and its amendments. The U.S. Supreme Court ruled on April 2, 2007, that carbon dioxide is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs. Based on the ruling in this case, EPA took steps to regulate GHG emissions and lent its support to state and local agencies' efforts to reduce GHG emissions.

The 1963 CAA was the first federal legislation regarding air pollution control and has been amended numerous times in subsequent years, with the most recent amendments occurring in 1990. At the federal level, EPA is responsible for implementation of certain portions of the CAA, including mobile-source requirements.

In *Massachusetts v. Environmental Protection Agency* 549 U.S. 497 (2007), 12 states and cities, including California, together with several environmental organizations, sued to require EPA to regulate GHGs as pollutants under the CAA. The U.S. Supreme Court ruled that GHGs fit within the CAA's definition of a pollutant and that EPA had the authority to regulate GHGs.

On December 7, 2009, the EPA Administrator signed two distinct findings regarding GHGs under CAA Section 202(a):

- *Endangerment Finding:* The current and projected concentrations of the six key GHGs—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—in the atmosphere threaten the public health and welfare of current and future generations.
- *Cause or Contribute Finding:* The combined emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution that threatens public health and welfare.

These findings did not, by themselves, impose any requirements on industry or other entities. However, these actions were a prerequisite for implementing GHG emissions standards for motor vehicles.

State

California Energy Efficiency Action Plan

The California Energy Commission (CEC) is responsible for preparing the California Energy Efficiency Action Plan, which covers issues, opportunities, and savings estimates related to energy efficiency in California's building, industrial, and agricultural sectors. The 2019 California Energy Efficiency Action Plan focuses on the following three goals:

- Double energy efficiency savings by 2030 (Senate Bill [SB] 350).
- Remove and reduce barriers to energy efficiency in low-income and disadvantaged communities.
- Reduce GHG emissions from the building sector.

The plan offers several recommendations to advance these goals:

- Expand funding sources for energy efficiency programs beyond ratepayer portfolios.
- Improve energy efficiency data.
- Integrate energy efficiency into long-term utility planning.
- Enhance the energy efficiency workforce.
- Improve demand flexibility.
- Expand building decarbonization.

Senate Bill 1389, California Integrated Energy Policy

In 2002, the California Legislature enacted SB 1389. The legislation reconstituted the State's responsibility to develop an integrated energy plan for electricity, natural gas, and transportation fuels. The CEC adopts and transmits to the Governor and Legislature a report of findings biannually. Reports have been prepared since 2002.

Most recently, the CEC published the 2021 Integrated Energy Policy Report. The report assesses major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors. The report also provides policy recommendations to conserve resources, protect the environment, ensure reliable, secure, and diverse energy supplies; enhance the state's economy; and protect public health and safety. The report covers such topics as decarbonization of buildings, integration of renewables, energy efficiency, energy equity, integration of renewable energy, updates on Southern California electricity reliability, climate adaptation activities for the energy sector, natural gas assessment, transportation energy demand forecast, and the California energy demand forecast (California Energy Commission 2022).

Assembly Bill 32, The California Global Warming Solutions Act of 2006

Assembly Bill (AB) 32 requires California to reduce its GHG emissions to 1990 levels by 2020—a reduction of approximately 15 percent below emissions expected under a "business as usual" scenario. AB 32 directs CARB to be the lead agency to implement the law. The Climate Action Team, made up of relevant State agencies, is charged with helping to direct State efforts on the reduction of GHG emissions and engaging State agencies. AB 32 requires CARB to develop a scoping plan that lays out California's strategy for meeting the goals. The scoping plan must be updated every five years.

In December 2008, CARB adopted its Climate Change Scoping Plan, which contains the main strategies California will implement to reduce CO_2e emissions by approximately 118 MMT, or approximately 21.7 percent from the State's projected 2020 emissions level of 545 MMT CO_2e under a business-as-usual scenario. (This is a reduction of 47 MMT CO_2e, or almost 10 percent, from 2008 emissions.)

CARB released the First Update to the Climate Change Scoping Plan in May 2014 and subsequently adopted the plan, which identifies the next steps to reaching the goals of AB 32 and evaluates the progress made between 2000 and 2012 (California Air Resources Board 2014). The update stated that California was on track to meet the near-term 2020 GHG limit and is well positioned to maintain and continue reductions beyond 2020 (California Air Resources Board 2014). The update also reported trends in GHG emissions from various emissions sectors (e.g., transportation, building energy, agriculture).

On December 14, 2017, CARB adopted the 2017 Climate Change Scoping Plan (2017 Scoping Plan) (California Air Resources Board 2017), which presents the framework for achieving the 2030 reductions established in more recent legislation.[1] The 2017 Scoping Plan identifies the GHG reductions needed by each emissions sector to achieve a statewide emissions level before 2030 that is 40 percent below the 1990 level.

The 2017 Scoping Plan also identifies how GHGs from proposed projects could be evaluated under CEQA. Specifically, it states that achieving "no net increase" in GHG emissions is the correct overall objective for projects evaluated under CEQA if the projects cannot be shown to conform with applicable local GHG reduction plans. CARB recognizes that it may not be appropriate or feasible for every development project to mitigate its GHG emissions to no net increase, and that this may not necessarily imply a substantial contribution to the cumulatively significant environmental impact of climate change.

Assembly Bill 1279, the Climate Crisis Act

AB 1279, approved in 2022, declares the policy of the State to both (1) achieve net zero GHG emissions as soon as possible but no later than 2045, and achieve and maintain net negative GHG emissions thereafter; and (2) ensure that by 2045, statewide anthropogenic GHG emissions are reduced to at least 85 percent below the 1990 levels. It requires CARB to work with relevant State agencies to ensure that updates to the 2017 Scoping Plan identify and recommend measures to achieve these policy goals and to identify and implement a variety of policies and strategies that enable carbon dioxide removal solutions and carbon capture, utilization, and storage technologies in California, as specified. AB 1279 requires CARB to submit an annual report, as specified.

[1] CARB released the Draft 2022 Scoping Plan Update May 10, 2022 (California Air Resources Board 2022).

Senate Bill 350, the Clean Energy and Pollution Reduction Act of 2015

SB 350 requires the California Public Utilities Commission to focus its energy procurement decisions on reducing GHG emissions by 40 percent by 2030, including through efforts to procure at least 50 percent renewable energy, double energy efficiency, and promote electrification of transportation.

Senate Bill 100, California Renewables Portfolio Standard Program: Emissions of Greenhouse Gases

SB 100 requires that California's renewable-energy and zero-carbon resources supply 100 percent of electric retail sales to end-use customers, and 100 percent of the electricity procured for State agencies, by December 31, 2045. The policy specifies that the transition to a zero-carbon electric system must not cause or contribute to increases of GHG emissions elsewhere in the western electricity grid.

SB 100 also requires the CEC, California Public Utilities Commission, and CARB to complete a joint agency report to the Legislature evaluating the 100 percent zero-carbon electricity policy. The report will be developed using a public process and qualitative and quantitative analyses to address the requirements and intent of the statute.

In consultation with all California balancing authorities and as part of a public process, the three agencies issued the 2021 SB 100 Joint Agency Report to the Legislature by January 1, 2021, and will issue updated reports at least every four years afterward.

Senate Bill 1020, Clean Energy, Jobs, and Affordability Act of 2022

Under previous law, it was the policy of the State that eligible renewable energy resources and zero-carbon resources supply 100 percent of all retail sales of electricity to California end-use customers and 100 percent of electricity procured to serve all State agencies by December 31, 2045. SB 1020 revised that State policy to instead provide that eligible renewable energy resources and zero-carbon resources supply 90 percent of all retail sales of electricity to California end-use customers by December 31, 2035, increasing to 95 percent by December 31, 2040, and to 100 percent by December 31, 2045; and supply 100 percent of electricity procured to serve all State agencies by December 31, 2035, as specified.

State Water Project Energy Roadmap

In 2022, DWR released the State Water Project Energy Roadmap, which identifies short-, mid- and long-term opportunities and challenges for SWP energy investments and strategies that would position the SWP to be in the lead in maintaining an efficient and effective power portfolio and serve DWR and the 29 State Water Contractors in achieving their water supply reliability and clean energy goals (California Department of Water Resources 2022a).

California Department of Water Resources—Climate Change Guidance

In 2012, DWR developed the Greenhouse Gas Emissions Reduction Plan (GGERP) as the first phase (Phase 1) of the Climate Action Plan (CAP) to guide decision-making related to energy use and GHG emissions. This plan lays out DWR's GHG emissions reduction goals and strategies for both the near term (present to 2020) and long term (2050). In 2020, DWR developed its GGERP Update 2020 (Update 2020) to review its GHG reductions since publication of the 2012 plan and to update strategies for further reduction consistent with legislative changes, including the GHG emissions reduction targets established in SB 32 (2016), SB 100 (2018), Executive Order B-18-12 (2012), Executive Order B-30-15 (2015), and Executive Order B-55-18 (2018) (California Department of Water Resources 2020).

DWR's near-term goal in the 2012 GGERP was to reduce its emissions to 50 percent below 1990 emissions level by 2020. DWR achieved this goal five years early. For the GGERP Update 2020, DWR established the following goals beyond 2020:

- *Mid-Term Goal:* By 2030, reduce GHG emissions to at least 60 percent below the 1990 level.
- *Long-Term Goal:* By 2045, supply 100 percent of electricity load with zero-carbon resources and achieve carbon neutrality.

The CAP identifies 11 GHG emissions reduction measures to meet near-term and long-term goals, which include:

- Making efficiency improvements to DWR's existing facilities.
- Purchasing and developing renewable and high-efficiency electricity supplies.
- Making comprehensive improvements to DWR's construction practices.
- Making improvements to DWR's business activities that will reduce GHG emissions.

In total, these measures will reduce annual GHG emissions in 2030 by more than 2.3 MMT of CO_2e[2] per year and by more than 2.7 MMT of CO_2e per year in 2045 (California Department of Water Resources 2021).

DWR also uses Phase 1 of the 2012 GGERP, as revised pursuant to the GGERP Update 2020, to streamline the CEQA cumulative impact analysis of GHG emissions for current and future DWR projects pursuant to CEQA Guidelines Sections 15064(h)(3), 15064.4(b)(3), 15130(d), and 15183.5. Because global climate change, by its very nature, is a global cumulative impact, an individual project's compliance with a qualifying GHG reduction plan (such as the GGERP Update 2020) may suffice to mitigate the project's incremental contribution to that cumulative impact to a level that is not cumulatively considerable (CEQA Guidelines Section 15064[h][3]). As described in the GGERP Update 2020, later project-specific environmental documents for DWR projects that are covered by the GGERP Update 2020 may rely on its analysis and conclusions for the purposes of cumulative analysis of a project's GHG emissions (California Department of Water Resources 2020).

To show that the current or future project is consistent with the GGERP Update 2020 and that the cumulative impact analysis of DWR GHG emissions conducted for the GGERP Update 2020 analyzes and addresses the emissions for the project, GGERP Update 2020 identifies the

[2] CO_2e is a metric used to quantify carbon dioxide and other GHGs as an equivalent of carbon dioxide.

following steps that each DWR project must take to demonstrate consistency (California Department of Water Resources 2020):

(1) Analysis of the GHG emissions from the proposed project.

(2) Determination that the construction emissions from the proposed project do not exceed the Extraordinary Construction Project thresholds.

(3) Incorporation of DWR's project-level GHG emissions reduction strategies into the design or implementation plan for the proposed project or an explanation of why measures that have not been incorporated do not apply to the project.

(4) Determination that the proposed project does not conflict with DWR's ability to implement any of the specific project GHG emissions reductions measures in Chapter VI, GHG Emissions Reduction Measures.

(5) Determination that project would not result in additional demands on the SWP system of 15 gigawatt-hours per year or greater, or written confirmation from the DWR SWP Power and Risk Office stating that the Renewable Power Procurement Plan will be updated to accommodate the additional load resulting from the proposed project at such time as the proposed project is ultimately implemented.

Consistent with the GGERP Update 2020 requirements, these steps are discussed below, in evaluating the Pulse Flows Components GHG emissions to ensure that they are addressed by the environmental analysis in the Update 2020 and entitled to streamlined review.

Other phases of DWR's CAP include:

- *Phase 2: Climate Change Analysis Guide*—This phase of planning develops a framework and guidance for consistent incorporation and alignment of analyses for climate change impacts on DWR's project and program planning activities (California Department of Water Resources 2018).
- *Phase 3: Climate Change Vulnerability Assessment and Adaptation Plan*—The Vulnerability Assessment will describe, evaluate, and quantify the vulnerabilities of DWR's assets and business to potential climate change impacts. The Adaptation Plan will prioritize and address the vulnerabilities to DWR–owned and operated facilities and activities throughout the state and establish comprehensive DWR policies and procedures to guide climate change adaptation.

Refer to Section 2.7, "Pulse Flows Component and Climate Change," for a discussion of climate change and the Pulse Flows Component.

Regional and Local

As described in Section 3.9.1, the geographic areas analyzed for impacts on energy and GHG emissions include the Oroville Complex, the Banks Pumping Plant and California Aqueduct, and San Luis Reservoir. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Fresno, Kern, Kings, Los Angeles, Merced, Riverside, San Bernardino, San Joaquin, and Stanislaus counties. Each county and city has local regulations and general plans with policies related to energy and GHG emissions. These may include goals and policies related to promotion of alternative energy resources, energy conservation, renewable energy production, and reduction of GHG emissions.

3.9.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. An energy or GHG emissions impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

Energy

- Result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation.
- Conflict with or obstruct a State or local plan for renewable energy or energy efficiency.

Greenhouse Gas Emissions

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.9.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts, but rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions.

The impact analysis focuses on whether the Pulse Flows Component would result in wasteful, inefficient, or unnecessary consumption of energy or would conflict with relevant renewable energy or energy efficiency plans. The physical environmental impact of wasteful, inefficient, or unnecessary consumption of energy resources is the increased emission of GHGs and the associated impacts on the environment as a result of emissions-driven climate change. The potential impacts related to GHG emissions associated with the Pulse Flows Component are also discussed in this section.

Impacts and Mitigation Measures

Table 3.9-1 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.9-1
SUMMARY OF IMPACT CONCLUSIONS—ENERGY AND GREENHOUSE GAS EMISSIONS

Impact Statement	Operations and Maintenance
3.9-1: Implementation of the Pulse Flows Component would result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project operation.	LTS
3.9-2: Implementation of the Pulse Flows Component would conflict with or obstruct a State or local plan for renewable energy or energy efficiency.	NI
3.9-3: Implementation of the Pulse Flows Component would generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.	LTS
3.9-4: Implementation of the Pulse Flows Component would conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.	NI

NOTES: NI = No Impact; LTS = Less than Significant.

SOURCE: Data compiled by Environmental Science Associates in 2022.

Impact 3.9-1: Implementation of the Pulse Flows Component would result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project operation.

Implementation of the Pulse Flow Component would result in a change in operations of the SWP, including the Oroville Complex, the Banks Pumping Plant, San Luis Reservoir and the California Aqueduct with an associated change in hydropower generation and energy use. The following describes these changes:

(1) The release of the pulse flows would bypass the Thermalito Pumping-Generating Plant because the flow would be routed directly to the Low Flow Channel of the Feather River, resulting in a reduction in SWP power generation. DWR estimated the power generation loss of a pulse of 98 taf using the year 2020 as an example. The analysis shows that there would be a reduction in 8,900 megawatt-hours (MWh). This is compared to the average hydropower generation of 2.2 million MWh for the Oroville Complex (California Department of Water Resources 2022b).

(2) The spring pulse flow release would result in a shift of power generation at the Hyatt Powerplant from summer to spring. This action would not significantly change the amount of energy generated but has the potential to reduce power generation during peak summer demand periods. The amount of Hyatt Powerplant generation during the pulse flow is approximately 50,000 MWh for the 2020 scenario (California Department of Water Resources 2022b).

(3) The spring pulse flow release would reduce the coldwater pool in Lake Oroville, which could cause the river valves at the base of Oroville Dam to be used for coldwater management in the Feather River. The use of the river valves in the dam would bypass the Hyatt Powerplant generation units. The need to use the river valves is dependent on the need to provide additional cold water to meet temperature requirements in the Feather River. The use of the river valves is unpredictable and they are not used every year.

(4) There would be a reduction in Banks Pumping Plant pumping and California Aqueduct pumping, due to Table A water effectively being delivered to the Partner Contractors from the three WSIP Groundwater Projects instead of the SWP. There would be an increase in

Banks Pumping Plant pumping and California Aqueduct pumping during wet years when Article 21 water is delivered to the Kern Fan. There would be an increase in pumping along the California Aqueduct when water from San Luis Reservoir is delivered to Willow Springs. These actions would likely offset each other and would be within the range of normal SWP operations.

(5) For Willow Springs, there would be some additional power changes. Willow Springs develops water for its WSIP Exchange Storage Account through a "pre-positioning" process (a maximum of 60 taf annually) from San Luis Reservoir. As a result, the available storage capacity of San Luis Reservoir would increase. This additional storage capacity at San Luis Reservoir would be used to increase water storage during wet periods. Moving water into the reservoir would require additional pumping. This additional energy demand would be partially offset with the subsequent release of this water from San Luis Reservoir when this water is delivered to Willow Springs. Electricity consumption and generation would remain within the historical range of energy used and generated by the SWP at San Luis Reservoir.

(6) San Luis Reservoir storage would change due to the WSIP Operational Exchange Process. Changes in reservoir water surface elevation change power generation and power use at San Luis Reservoir. During the year when there is a pulse flow release, there would be reduced releases from San Luis Reservoir (with a corresponding loss in power generation) as SWP water is provided to the Partner Contractors from the WSIP Groundwater Projects rather than from releases from San Luis Reservoir. During the Lake Oroville Recovery Period (July through September), San Luis Reservoir releases would be increased (with a corresponding gain in power generation) to supplement California Aqueduct flows due to reduced Delta pumping that correspond to reduced Lake Oroville releases to replenish storage from the release of the spring pulse flow. Because the volumes of reduced and increased releases are planned to be equivalent, and the changes would be small in the context of the amount of energy that DWR produces and uses, there would not be a significant change in power generation.

These types of operational changes occur in the SWP for multiple reasons. A voluntary action, such as releasing the pulse flows for the purpose of environmental enhancement, is consistent with one of the purposes of the SWP: to operate the SWP to be protective of the environment. These operational changes fall within the range of existing hydrologic and operational variability of the SWP.

DWR uses a portfolio of purchased energy resources to make up the difference between the SWP's energy generation and its demand. Given the historic fluctuations in SWP energy demand, the relatively large amount of purchased power, and intermittent (on average every three years) minor pulse flow release volumes and associated energy loss relative to the overall average annual deliveries from Lake Oroville, the Pulse Flows Component would result in a negligible change to used, generated, and purchased power.

As described in Chapter 2, "Description of the Pulse Flows Component," the pulse flow releases and WSIP Operational Exchange Process would be managed by DWR in accordance with existing regulations and forthcoming agreements with the WSIP Groundwater Projects to ensure that the pulse flow releases do not detrimentally affect operation of the SWP, including water supply, energy generation, and energy consumption. To the extent that the Pulse Flows Component would result in a relatively small net increase in energy consumption, the overall objectives of the Pulse Flows Component—to provide ecosystem benefits and utilize contractual and operational mechanisms to minimize impacts on SWP operations, SWP contractors, and water supplies that may result from pulse flow releases—are not considered a wasteful or inefficient use of energy. Therefore, the Pulse Flows Component would not result in wasteful, inefficient, or unnecessary consumption of energy resources that would potentially result in substantial environmental impacts. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to wasteful, inefficient, or unnecessary consumption of energy resources that would potentially result in substantial environmental impacts are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.9-2: Implementation of the Pulse Flows Component would conflict with or obstruct a State or local plan for renewable energy or energy efficiency.

As discussed in Impact 3.9-1, SWP electricity consumption and generation would remain within the historical ranges under the Pulse Flows Component. DWR would continue to operate the SWP in compliance with the terms and conditions contained in its water rights permits and licenses issued by the State Water Resources Control Board (State Water Board), including any flow criteria imposed by the State Water Board under those permits and licenses. The Pulse Flows Component would result in minor modified operations; however, the minor modifications would continue to implement energy efficiency and measures in accordance with applicable State and local plans, including California's Integrated Energy Policy and DWR's SWP Energy Roadmap and CAP (see Section 3.9.3). As discussed further under the GHG analysis (Impact 3.9-3), these plans are consistent with State and local plans for renewable energy and energy efficiency; therefore, the Pulse Flows Component would not conflict with or obstruct a State or local plan for renewable energy or energy efficiency. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to consistency with State and local plans for renewable energy and energy efficiency are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.9-3: Implementation of the Pulse Flows Component would generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

As discussed under Impacts 3.9-1 and 3.9-2, modifications to the SWP's operations would result in minor changes to power generation due to the Pulse Flow Component As described in Section 3.9.2, "Environmental Setting," SWP generation facilities only supply about two-thirds of the

SWP's necessary operating power. Therefore, DWR uses a portfolio of energy resources to make up the difference in energy between the electricity that SWP facilities generate and the amount of electricity needed to run the SWP. The portfolio sources can be generally categorized as generation from large hydroelectric facilities, renewable energy facilities, and natural gas, as well as purchased energy (California Department of Water Resources 2020).

For example, although energy generation at the Thermalito Pumping-Generating Plant may be reduced during the pulse flow releases, the difference in energy generation would not result in a substantial increase in GHG emissions, given DWR's diverse power portfolio (including renewable energy sources). In addition, because of the intermittent nature of the pulse flow releases (on average every three years) and the overall dynamic relationship between energy generation and energy consumption of the SWP system, the pulse flow releases are not anticipated to substantially alter the SWP's overall energy requirements and result in a substantial increase in GHG emissions. Furthermore, emissions associated with the SWP system, including the effects of the pulse flow releases, would vary on an annual basis because of fluctuations in hydrologic conditions, water demands, regulatory constraints, and electricity market characteristics (California Department of Water Resources 2020).

Given the limited changes in energy generation and consumption, the Pulse Flows Component would result in a negligible change to the SWP's energy-related GHG emissions (Step 1 of determining consistency with the GHG Reduction Plan). For example, the largest impact of the Pulse Flows Component is the bypassing of the Thermalito Pumping-Generation Plant resulting in a loss of 8,900 MWh of power generation. This reduction in generation is orders of magnitude less than the SWP system of 15 gigawatt-hours per year or greater (Step 5 of determining consistency with the GHG Reduction Plan). The Pulse Flows Component would also not construct new facilities or physically alter existing facilities; thus, there would be no new construction-related emissions. Therefore, the Pulse Flows Component would not exceed the Extraordinary Construction Project thresholds identified in the GGERP Update 2020, and DWR's project-level GHG emission reduction strategies would not be applicable (Steps 2 and 3 of determining consistency with the GHG Reduction Plan).

Over time, the sources of energy used to power the SWP will become more renewable (California Department of Water Resources 2022a). GHG emissions associated with energy consumption will decrease in compliance with DWR-adopted plans and policies, as well as legislative mandates requiring increased reliance on renewable resources and energy efficiency. For example, the GGERP Update 2020 notes that DWR has implemented or will implement specific project GHG emission reduction measures, such as increasing the use of renewable energy to operate the SWP, increasing the efficiency of SWP pumps and generators, replacing low-emission energy with zero-carbon energy, developing renewable energy projects, and purchasing renewable energy from local utilities' retail energy programs. The Pulse Flows Component would not conflict with DWR's ability to implement any of the specific project GHG emission reduction measures (Step 4 of determining consistency with the GGERP). Therefore, based on the analysis provided in the GGERP Update 2020 and the Assessment Form for Consistency with GGERP, any impact associated with implementation of the Pulse Flows Component would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to GHG emissions are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.9-4: Implementation of the Pulse Flows Component would conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.

The Pulse Flows Component would result in limited modifications to existing SWP operations; however, SWP operations with implementation of the Pulse Flows Component would continue to adhere to energy efficiency strategies and measures in accordance with the SWP Energy Roadmap and DWR's CAP. Specifically, the CAP and Update 2020 were developed to establish strategies and measures consistent with statewide GHG emissions reductions targets, including SB 32 (2016), SB 100 (2018), Executive Order B-18-12 (2012), Executive Order B-30-15 (2015), and Executive Order B-55-18 (2018) (California Department of Water Resources 2020). Therefore, the measures and goals in the CAP are consistent with statewide regulations adopted for reducing GHG emissions. As discussed in Impact 3.9-2, the Pulse Flows Component would not conflict with the applicable State or local plans for renewable energy or energy efficiency (e.g., California's Integrated Energy Policy, the DWR CAP, and the GGERP Update 2020).

Furthermore, the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. As described in Section 3.4, "Hydrology and Water Quality," the Pulse Flows Component would convey surface water through pulse flow releases from Lake Oroville. The WSIP Groundwater Projects would increase groundwater storage in the San Joaquin Valley and Southern California. These outcomes are consistent with the goal in CARB's 2017 Scoping Plan Update to develop and support more reliable water supplies for people, agriculture, and the environment, provided by a more resilient, diversified, and sustainably managed water resources system (California Air Resources Board 2017). Therefore, the Pulse Flows Component would not conflict with any adopted plan, policy, or regulation adopted for the purpose of reducing GHG emissions. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to a conflict with any adopted plan, policy, or regulation adopted for the purpose of reducing GHG emissions are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

3.10 Recreation

This section discusses the potential for the Pulse Flows Component to affect recreation resources. The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

3.10.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on recreational resources were not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

As presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B, once flows reach the Sacramento River confluence and continue to the Delta, changes to these parameters would be minimal relative to inputs from tributary creeks and rivers and the scale of tidal flux. During the Lake Oroville Recovery Period (Recovery Period), flow rates out of Lake Oroville would not fall below existing minimum operational and regulatory flow requirements and would therefore remain with the typical range of operational variability experienced within the system. Further, pulse flows would be released only if sufficient water supplies are made available for exchange by the WSIP Groundwater Projects, allowing DWR to determine (based on reservoir storage, forecasted hydrology, and other factors influencing SWP operations on a seasonal basis) whether a pulse flow can occur without affecting SWP operations, SWP Contractors, or other water right holders.

Therefore, the Pulse Flows Component is not anticipated to affect or impede supply available to water-dependent recreation facilities (e.g., managed wetlands for waterfowl) in such a way that it would necessitate a change in water use or water management. Nominal, temporary changes to water levels and flow would have a negligible impact on recreational opportunities; therefore, despite the presence of popular formal and informal recreational resources (e.g., marinas, docks, shoreline fishing, parks) along the Sacramento River and throughout the Delta, impacts related to recreational resources are also not evaluated further for:

- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

The following three remaining geographic areas were evaluated for impacts on recreational resources:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River

3.10.2 Environmental Setting

This environmental setting section provides a focused discussion of existing conditions in the geographic areas analyzed for recreational resource impacts (as identified above). A general description of each of the seven geographic areas composing the Pulse Flows Component study area is presented in Section 2.3.

Oroville Complex

Lake Oroville is one of the largest reservoirs in California, with more than 15,810 surface acres and 167 miles of shoreline at a maximum pool elevation of 900 feet mean sea level (Federal Energy Regulatory Commission 2007). Recreational facilities at Lake Oroville are primarily in the Lake Oroville State Recreation Area, which surrounds the lake and is managed by the California Department of Parks and Recreation. There are boat-in campsites, day use areas, beaches, full-service marinas, boat ramps, car-top boat ramps, floating campsites, floating restrooms, hundreds of campsites, and a visitor center around Lake Oroville (California Department of Water Resources 2006). Boat ramp access is dependent on reservoir levels, with the number of available ramps reduced as water levels decrease. The Lake Oroville State Recreation Area includes all of the recreation facilities at Lake Oroville, as well as those at the Thermalito Diversion Pool and Thermalito Forebay, both of which are impounded water bodies associated with the Oroville facilities hydroelectric project.

Recreation also occurs at the Thermalito Afterbay (another impounded water body associated with the hydroelectric project) and the Oroville Wildlife Area (OWA), managed by the California

Department of Fish and Wildlife. Note that the OWA spans geographic areas 1, 2, and 3 of the geographic regions described in this SEIR, with habitat along the edge of the Thermalito Afterbay, the Low Flow Channel, and the High Flow Channel of the Feather River. Recreation opportunities at Lake Oroville and the associated facilities include camping, fishing, picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, and hunting (California Department of Water Resources 2006). See **Figure 3.10-1** for the locations of relevant recreation facilities discussed in this section.

Low Flow Channel of the Feather River

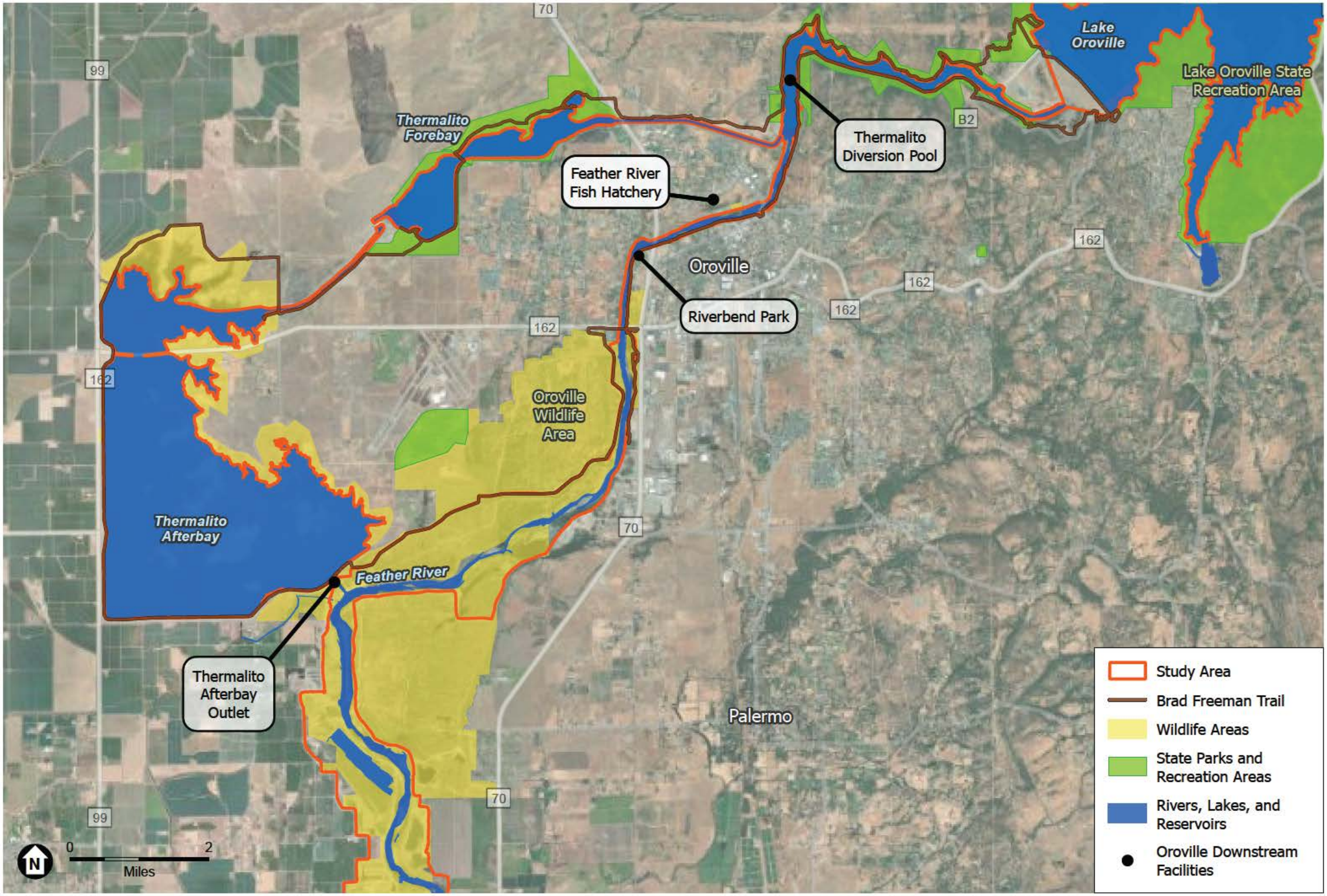
Below the Thermalito Diversion Pool is the Low Flow Channel of the Feather River. The Brad Freeman Trail runs along this section of the river (as well as along the Thermalito Diversion Pool and Thermalito Forebay and Afterbay), and the Feather River Fish Hatchery is toward the upstream end of the channel. Approximately 1.3 miles downstream of the fish hatchery is Riverbend Park, a 210-acre urban park offering multi-use fields, paved trails, play structures, restrooms, a beach and boat launch along the river, and an adjacent dog park. The Feather River Bike Trail is a 3-mile-long, paved, Class I bike path that runs along the west side of Riverbend Park and beyond, hugging the river's eastern edge between its crossings with State Route 70 and State Route 162.

As noted above, the OWA encompasses a portion of the Low Flow Channel of the Feather River as well as surrounding and below the Thermalito Afterbay Outlet, where the flows diverted to the Thermalito Forebay and Afterbay return to the river. There are restrooms and unimproved boat launches that provide access to the Feather River in the Feather River portion of the OWA (Federal Energy Regulatory Commission 2007), as well as a shooting range (California Department of Fish and Wildlife 2021). Recreation opportunities in the OWA include fishing, wildlife viewing, hunting, camping, and shooting.

High Flow Channel of the Feather River

The High Flow Channel downstream of the Thermalito Afterbay Outlet runs through the OWA and the communities of Gridley, Live Oak, Yuba City, and Marysville before joining the Sacramento River approximately 70 miles below Lake Oroville at Verona. Recreation activities along the lower Feather River include fishing, boating, hunting, camping, swimming, wildlife viewing, and picnicking. Recreation facilities along this stretch of the Feather River include public and private launch ramps, day-use facilities, camping sites, and trails.

The Feather River State Wildlife Area is also distributed along the High Flow Channel of the Feather River. It offers 2,522 acres of dense riparian forest on both sides of the Feather River, bounded in the north by Shanghai Garden Park and Boat Ramp and Abbott Lake area (opposite Plumas Lake) and in the south by the Sutter Bypass (opposite Nicolaus). The main access point is the Star Bend Park and Boat Ramp on Feather River Boulevard just west of Plumas Lake. Some areas of the Feather River State Wildlife Area can only be reached by boat but are good for fishing (LocalWiki 2023). Other recreational opportunities include wildlife viewing, birdwatching, and seasonal hunting (California Department of Fish and Wildlife 2023). Bobelaine Audubon Sanctuary also lies along the lower Feather River and is popular with birdwatchers (Sacramento Audubon Society 2023).



SOURCE: CDFW, 2022; ESA, 2023

Figure 3.10-1
Lake Oroville and Downstream Recreation Facilities

ESA

3.10.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to recreation resource impact analyses as required under CEQA have been included.

Federal

Federal Water Project Recreation Act

Under the Federal Water Project Recreation Act (U.S. Code Title 16, Sections 460[L][12] through 460[L][21]), recreation and fish and wildlife enhancement are to be given full consideration as purposes of federal water development projects if nonfederal public bodies agree to do all of the following:

- Bear no less than half the separable costs allocated for recreational purposes or 25 percent of the cost for fish and wildlife enhancement.
- Administer project land and water areas devoted to these purposes.
- Bear all costs of operation, maintenance, and replacement.

Where federal lands or authorized federal programs for fish and wildlife conservation are involved, cost-sharing is not required.

The Federal Water Project Recreation Act also authorizes using federal water project funds for land acquisition to establish refuges for migratory waterfowl when recommended by the Secretary of the Interior. The law further authorizes the Secretary to provide facilities for outdoor recreation and fish and wildlife at all reservoirs under the jurisdiction of the U.S. Department of the Interior, except within national wildlife refuges.

Federal Land and Water Conservation Fund Act

The Land and Water Conservation Fund, created by Congress in 1964, provides money to federal, state, and local governments to purchase land, water, and wetlands for the benefit of all Americans. Lands and waters purchased through the Land and Water Conservation Fund do all the following:

- Provide recreational opportunities.
- Provide clean water.
- Preserve wildlife habitat.
- Enhance scenic vistas.
- Protect archaeological and historical sites.
- Maintain the pristine nature of wilderness areas.

State

State Lands Commission

The California State Lands Commission was established in 1938 and provides stewardship of the lands and waterways of California (California State Lands Commission 2022). The State of California owns nearly 4 million acres of "sovereign lands," which include the beds of navigable rivers, lakes, and streams, tidal waterways, and tidelands up to the ordinary high-water mark and submerged lands along the coastline extending from the shoreline out to 3 miles offshore. The California State Lands Commission may lease sovereign lands for any public trust purpose, including recreation, navigation, fisheries, commerce, and open space. For instance, a public or private entity must lease sites for marinas and recreational piers that fall within sovereign lands. In addition, the California State Lands Commission issues permits for dredging lands that fall under its jurisdiction.

California Division of Boating and Waterways

The California Division of Boating and Waterways, part of the California Department of Parks and Recreation, has a mission to provide safe and convenient public access to California's waterways and leadership in promoting the public's right to safe, enjoyable, and environmentally sound recreational boating. The California Division of Boating and Waterways endorses boating safety and education, assists local boating law enforcement agencies, ensures uniformity in boating regulations, and licenses boat operators and brokers. The division is also responsible for reviewing, updating, and adopting state boating regulations to reflect changes in federal and State boating laws, and planning and designing State boating facilities. The California Division of Boating and Waterways is the lead agency for controlling water hyacinth (*Eichhornia crassipes*) and other invasive floating aquatic vegetation species under the Floating Aquatic Vegetation Control Program (California Department of Parks and Recreation 2022).

California Department of Parks and Recreation

The mission of the California Department of Parks and Recreation is to provide for the health, inspiration, and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation. In addition to the lands it directly owns, the California Department of Parks and Recreation has certain jurisdiction over granted or ungranted tidelands or submerged lands abutting State Park System lands (Public Resources Code Section 5003.5).

State Public Park Preservation Act

The State Public Park Preservation Act of 1971 is the primary instrument for protecting and preserving parkland in California. Under Public Resources Code Section 5400 et seq., cities and counties may not acquire any real property that is in use as a public park for any nonpark use unless compensation, land, or both, are provided to replace the parkland acquired. This provides no net loss of parkland and facilities.

Regional and Local

As described in Section 3.10.1, the geographic areas analyzed for impacts on recreational resources include the Oroville Complex and the Low and High Flow Channels of the Feather River. This portion of the study area for the Pulse Flows Component crosses Butte, Sutter, and Yuba counties. Each county and each city has local regulations and general plans with policies related to recreation. These may include goals and policies involving land use decisions related to recreation lands, restoring or enhancing recreation facilities, and improving connectivity of recreation infrastructure.

3.10.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementing the Pulse Flows Component would result in a significant impact. A recreation impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated.
- Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed in this section (see Section 3.10.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, the impact analysis does not evaluate construction impacts, but rather focuses on short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases," to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B were also considered.

Impacts and Mitigation Measures

Table 3.10-1 summarizes the impact conclusions presented in this section for ease of reference.

TABLE 3.10-1
SUMMARY OF IMPACT CONCLUSIONS—RECREATION

Impact Statement	Operations and Maintenance
3.10-1: Implementation of the Pulse Flows Component would increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated.	LTS
3.10-2: Implementation of the Pulse Flows Component would include recreational facilities or require the construction or expansion of recreational facilities which that might have an adverse physical effect on the environment.	NI

NOTES: NI = No Impact; LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2022.

Impact 3.10-1: Implementation of the Pulse Flows Component would increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated.

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, or above-normal water year types, with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. As described in Section 3.2.1, "Conservative Pulse Flow Release Scenario," this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May, or June) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would continue to meet flow and temperature requirements for the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations).

Changes in water levels, velocity, and inundation extent resulting from the pulse flow releases and the Recovery Period would occur primarily in the Low and High Flow channels of the Feather River (see Appendix B). Both the increased water levels during the pulse flows and the reduced water levels during the Recovery Period have the potential to affect recreational resources within and adjacent to the river. These impacts could include inundation of beaches (e.g., Riverbend Park) or trails (e.g., Brad Freeman Trail, Feather River Bike Trail), or slightly higher (spring) or lower (summer) water levels and velocities that could affect boating and/or fishing.

The conservative pulse flow release scenario was simulated using a hydrodynamic HEC-RAS model of the Feather and Sacramento rivers to contextualize how the pulse flow release conditions compare to existing conditions. As presented in Section 3.4, "Hydrology and Water

Quality" (Impact 3.4-1) and detailed in Appendix B, the modeling results demonstrate that water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would remain within the typical range of variability of the existing hydrologic system. While modeling of inundation extent shows that, under certain conditions, release of a spring pulse flow has the potential to increase inundation in some parts of the study area as compared to typical spring conditions, the overall degree of inundation remains within the existing system's typical range of hydrologic variability as well. In addition, flow and temperature requirements in the Low Flow and High Flow Channels of the Feather River would continue to be met; only discretionary releases would be reduced to recover water levels at Lake Oroville.
The Pulse Flows Component would be operated in a manner consistent with applicable SWP operational requirements, including operational constraints for fish and wildlife protection and water quality, as well as other environmental and legal restrictions. Therefore, the reduction of SWP water supply in Lake Oroville and other Oroville Complex facilities, and in flows out of Lake Oroville, during the Recovery Period would remain within the typical range of existing operational variability experienced within the system.

Further, the Pulse Flows Component would not involve construction of new or modified facilities, new housing, or conversion of land use that would require construction employees or additional operations and maintenance employees, or otherwise draw new residents to the area. There would be no increase in available water supply in areas currently served by the SWP; water used for the pulse flows would be returned to the SWP via the WSIP Operational Exchange Process using water developed by the WSIP Groundwater Projects, but the overall amount of water in the system would not increase or decrease as a result. Therefore, the Pulse Flows Component would not directly or indirectly increase the local population or demand for recreation facilities, nor would it increase the use of existing regional recreation facilities.

The proposed pulse flows would be a few days to weeks in duration and are estimated to occur about every three years, depending on water available in the WSIP Exchange Storage Accounts and the occurrence of drier years. The inundation of beaches or trails, or slightly higher (spring) or lower (summer) water surface elevations and velocities that could affect boating and/or fishing resulting from reservoir levels and flow rates during pulse flow releases and during the Recovery Period, would remain within a typical range of hydrologic and operational variability experiencing in the existing system, as described above. As such, the existing recreational environment at the Oroville Complex and downstream of Lake Oroville would not be substantially deteriorated by the Pulse Flows Component, nor would the Pulse Flows Component increase the local population size or displace recreationists such that surrounding recreational facilities would experience increased use or degradation. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to physical deterioration of recreational facilities are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.10-2: Implementation of the Pulse Flows Component would include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment.

The Pulse Flows Component would not involve construction of new recreation facilities or expansion of existing recreational facilities. In addition, the Pulse Flows Component would not increase the population in the study area by introducing new housing or employment opportunities. As described under Impact 3.10-1, existing recreational facilities would not be substantively altered or deteriorated by the Pulse Flows Component, requiring construction of replacement facilities. Therefore, additional recreation facilities or the expansion of recreation facilities would not be necessary, and there would be **no impact** from construction of new or expanded recreational facilities.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to the construction or expansion of recreational facilities are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

3.11 Geology and Soils

This section discusses the potential for the Pulse Flows Component to affect geology and soils. The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

3.11.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (see Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on geology and soils were not evaluated for the remaining geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

The following five remaining geographic areas were evaluated for impacts on geology and soils:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River
- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento–San Joaquin Delta

3.11.2 Environmental Setting

The environmental setting section provides a focused discussion of existing conditions within the geographic areas analyzed for geology and soils (as outlined above). A general description of the Pulse Flows Component study area, including each of the seven geographic areas, is presented in Section 2.3.

Geology

The Sacramento Valley region considered for this analysis extends from Lake Oroville to the Delta and includes the Sacramento and Feather Rivers. The igneous and metamorphic rocks of the Sierra Nevada extend westward beneath the eastern Sacramento Valley. The eastern valley floor is an alluvial plain, composed of late Mesozoic- and Cenozoic-era sediments, deposited by wind and rivers flowing out of the Sierra Nevada.

The Delta is a flat-lying river delta that evolved at the inland margin of the San Francisco Bay Estuary as two overlapping and coalescing geomorphic units: the Sacramento River Delta to the north and the San Joaquin River Delta to the south. During large river-flood events, silts and sands were deposited adjacent to the river channel, which formed as a tidal marsh with few natural levees and was dominated by tidal flows, allowing landward accumulation of sediment behind the bedrock barrier at the Carquinez Strait. The sediment formed marshlands, which consisted of numerous islands that were surrounded by hundreds of miles of channels. Tule marshes became established on peat and organic soils in many portions of the Delta, including Suisun Marsh. Additional peat and other organic soils continue to form from repeated inundation and accumulation of sediment and marsh vegetation.

Geographic Area–Specific Soils and Geology

Table 3.11-1 presents a description of geological resources and paleontological sensitivity of the geographic areas analyzed.

Oroville Complex

The Oroville Complex encompasses Lake Oroville and Southwest of Lake Oroville, as indicated in Figure 2-3. The Oroville Complex is located near the Foothills fault system. The Foothills fault system is a large fault system, that is the dominant structural feature of the western Sierra Nevada. The faulted Paleozoic and Mesozoic rocks are overlapped by unfaulted younger rocks, and the total extent of the fault system is not known (U.S. Geological Survey 1960). A low-level of seismicity has occurred in the area.

Soils in the foothills of the Table Mountains around Lake Oroville are shallow and generally reflect volcanic and metamorphic origins, have lower fertility, and consist primarily of grasslands. Foothill soils include serpentines; sedimentary sandstones; shales; conglomerates; and sandy loam, loam, and clay loam soils above bedrock. Southwest of Lake Oroville includes soils from the terrace lands. Terrace lands include brownish loam, silt loam, and/or clayey loam soils. Along the eastern boundary of the Sacramento Valley, the terraces are primarily red silica-iron-cemented hardpan and clays, sometimes with calcium carbonate (U.S. Bureau of Reclamation 2019).

TABLE 3.11-1
DESCRIPTION OF GEOLOGICAL AREAS AND PALEONTOLOGICAL SENSITIVITY

Study Area	Geologic Description	Paleontological Sensitivity
Sacramento Valley Region		
Lake Oroville	Pliocene volcanic rocks (andesite, basalt, cinder cones), Tuscan Formation (Pliocene interbedded lahars, volcanic conglomerate, volcanic sandstone, siltstone, and pumiceous tuff), Feather River Peridotite Belt (Triassic metamorphic rocks consisting of quartz, mica, and hornblende schists), Smartville Complex (Jurassic volcanic rocks consisting of pyroclastic rocks and flows and undifferentiated volcanic rocks), and Bald Rock Pluton (Mesozoic quartz diorite, tonalite, trondhemite, quartz monzonite)	Low
Southwest of Lake Oroville	Lovejoy Basalt (Miocene extrusive, fine-grained volcanic rocks), Tuscan Formation (Pliocene interbedded lahars, volcanic conglomerate, volcanic sandstone, siltstone, and pumiceous tuff), Laguna Formation (Pliocene interbedded alluvial gravel, sand, and silt), Holocene alluvial deposits, and Historic dredge and mine tailings	Low
	Chico Formation (Cretaceous marine sandstone and minor siltstone), Ione Formation (Eocene light-colored conglomerate, sandstone, and claystone), Riverbank Formation (Pleistocene weathered reddish gravel, sand, and silt forming alluvial terrace and fan deposits), and Modesto Formation (Pleistocene unconsolidated, unweathered gravel, sand, silt, and clay)	High
Feather River	Holocene alluvial deposits (clay, silt, sand, gravel, cobbles, and boulders in various layers and mixtures), slickens (fine, clay-rich, light yellow-brown powdery residue from hydraulic mining), Historic dredge tailings, and Historic floodplain deposits	Low
	Modesto Formation	High
Sacramento River	Holocene alluvial deposits, Holocene basin deposits, Holocene stream channel deposits, Historic dredge tailings, and Historic floodplain deposits	Low
Delta Region		
Sacramento–San Joaquin Delta	Merritt Sand (Pleistocene beach and dune sand deposits); Holocene peat and organic soils, alluvium, and levee and channel deposits; and Holocene Bay Mud	Low
	Pleistocene alluvium (weakly to moderately consolidated, poorly sorted, interbedded clay, stilt, sand, and gravel)	High
Suisun Marsh	Holocene intertidal deposits composed of Bay Mud and medium-grained alluvium	Low

SOURCES: Dundas et al. 1996; Gutierrez 2011; Helley and Harwood 1985; Helley et. al 1979; Saucedo and Wagner 1992; The Paleontology Portal n.d.; University of California Museum of Paleontology 2021; Jefferson 1991a, 1991b; Wagner et al. 1991.

Low Flow and High Flow Channel of the Feather River

Both the Low Flow Channel of the Feather River and the High Flow Channel are in the Sacramento Valley. The Sacramento Valley comprises the northern half of the Central Valley, which is one of the most productive agricultural areas in the world; more than half of the fruits, vegetables, and nuts grown in the United States come from the Central Valley. Surface soils of the Sacramento Valley include alluvial and aeolian soils. The alluvial soils include calcic brown and noncalcic brown alluvial soils on deep alluvial fans and floodplains. The calcic brown soil primarily is made of calcium carbonate and is alkaline (also known as “calcareous” soils). The noncalcic brown soils do not contain calcium carbonate and are either slightly acidic or neutral in chemical properties. Aeolian soils (i.e., sand and silt-sized particles) are more susceptible to wind erosion than alluvial soils. Non-irrigated soils that have been disturbed by cultivation or other activities throughout the Central Valley are more susceptible to wind erosion and subsequent blowing dust than soils with more soil moisture (Reclamation). The Sacramento Valley generally experiences low seismicity.

The banks of the Feather River are composed entirely of either hydraulic mining debris or Modesto Formation outcrop. The hydraulic mining-derived sediments consist of a basal section of fine-grained silts and clays (slickens), which are overlain by unconsolidated, non-cohesive, quartz-rich sands. Consequently, whereas the lower bank of the Feather River, which is composed of slickens, is cohesive and thereby moderately resistant to erosion, the sandy mid-bank is prone to rapid erosion by fluvial entrainment and dry ravel. Bank stratigraphy along the Feather River is capped by fine-grained vertical accretion sediments; erosion of the sandy mid-bank commonly results in cantilever failure of the upper bank (U.S. Army Corps of Engineers 1990). Extensive flow control has been exerted on the system. Infrequent flows can mobilize the coarse material, and downstream, the debris is sand-dominated and mobile over a large percentage of the flow duration curve. Consequently, the lower reaches have degraded (Water Engineering & Technology, Inc. 1991).

Future trends of bank erosion on the Feather River are dependent on stratigraphy. As the river has incised into the hydraulic mining stratigraphy, various stratigraphic horizons have comprised the bank toe through time. Presently, the study reach of the river has incised into the slickens, contributing significant stability to the channel planform. Upstream, on the lower Yuba River, the lower banks are composed of coarse sands and gravels and bank erosion rates are relatively high as a result.

Sacramento River from confluence with Feather River to the Delta

Soils found in the Sacramento Valley are consistent with the Sacramento River from the confluence with the Feather River to the Delta and are discussed above. Soils in the Delta are high in organic matter. These soils are typically dark, acidic, and generally include peat or clay. They are poorly drained and consist of clays, clay loams, silty clay loams, and muck. Silty soils composed of fine-grained alluvial deposits are also present, along with well-drained Merritt Sand soils (U.S. Bureau of Reclamation 2019).

Seismicity

Seismicity in Northern California primarily is controlled by the San Andreas Fault Zone—which runs 150 miles from the Gulf of California through the Coast Ranges and ends offshore, north of Point Reyes—and the Cascadia subduction zone. The Cascadia subduction zone runs from Vancouver Island in Canada to Cape Mendocino in Northern California. The Pacific, North American, and Gorda tectonic plates meet at the Mendocino Triple Junction, in the Pacific Ocean just west of Cape Mendocino. Along the Cascadia subduction zone, the Gorda Plate is being actively subducted (overridden) and driven underneath the North American Plate. The San

Andreas Fault Zone is along portions of the active tectonic plate boundary (described above) and the historic tectonic plate boundary where the Farallon Plate became subducted underneath the North American Plate millions of years ago.

Over time, as subduction continues to occur, more of the Pacific Plate comes into contact with the North American Plate, resulting in strain along the rock strata. In some cases, this strain is relieved by very slow movement of the rocks past one another (known as fault creep). Periodically, the strain buildup becomes great enough that an earthquake occurs. In recent years, scientists with the California Geological Survey (CGS) and USGS have determined that many of the faults along the Northern California coast that were once thought to operate independently of one another actually are interconnected strands of the San Andreas Fault Zone (Field and the 2014 Working Group on California Earthquake Probabilities 2015).

Surface fault rupture is fault movement that breaks to the surface of the Earth, either suddenly during earthquakes or slowly because of fault creep, and is from tectonic movement that originates deep in the Earth. "Active" or "Holocene-active" faults (i.e., faults showing evidence of displacement during the last 11,700 years) are more likely to result in both surface fault rupture and strong seismic ground shaking than pre-Holocene faults. Surface fault rupture and strong seismic ground shaking can severely damage buildings, roads, bridges, and underground pipelines. Strong seismic ground shaking also can trigger potentially damaging landslides (in areas of steep or unstable slopes) and liquefaction (in areas composed of young, unconsolidated, water-saturated sediments such as Bay Mud).

Northern California's active faults are along the west coast because of ongoing strain from the interaction of the Pacific and North American continental plates. The Delta and Suisun Marsh are near several major fault systems, including the San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, and Greenville Faults (Jennings and Bryant 2010). As a result, the western portion of the Delta is subject to seismic hazards. Active faults in the Sierra Nevada, on the other hand, are less common, primarily because most of the strain of tectonic plate movement today is relieved by faults in the Coast Ranges, which are closer to the boundary where the tectonic plates make contact with one another. With the exception of the 1975 earthquake (magnitude 5.7) along the Cleveland Hill Fault south Lake Oroville (California Department of Water Resources 1979), the Sacramento Valley generally does not contain active faults (Jennings and Bryant 2010), and therefore is subject to a very low level of seismic activity. Therefore, most of the Sacramento Valley is generally not subject to seismic hazards.

Paleontological Resources

In its standard guidelines for assessment and mitigation of adverse impacts on paleontological resources, the Society of Vertebrate Paleontology (SVP) established four categories of sensitivity for paleontological resources: high, low, no, and undetermined (Society of Vertebrate Paleontology 2010). Areas where fossils have been found previously are considered to have a high sensitivity and a high potential to produce fossils. Areas that are not sedimentary in origin and have not been known to produce fossils in the past typically are considered to have low sensitivity. Areas consisting of high-grade metamorphic rocks (e.g., gneisses and schists) and plutonic igneous rocks (e.g., granites and diorites) are considered to have no sensitivity. Areas that have not had any previous paleontological resource surveys or fossil finds are considered to be of undetermined sensitivity until surveys and mapping are performed to determine their sensitivity. In keeping with the SVP significance criteria, all vertebrate fossils generally are categorized as being of potentially significant scientific value.

An individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and if it meets one of the following criteria:

- A type specimen (i.e., the individual from which a species or subspecies has been described).
- A member of a rare species.
- A species that is part of a diverse assemblage (i.e., a site where more than one fossil has been discovered) wherein other species are also identifiable, and important information regarding life history of individuals can be drawn.
- A skeletal element different from, or a specimen more complete than, those now available for its species.
- A complete specimen (i.e., all or substantially all of the entire skeleton is present).

The value or importance of different fossil groups varies, depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they already have been identified and documented, and the ability to recover similar materials under more controlled conditions (e.g., for a research project). Marine invertebrates generally are common; the fossil record is well developed and well documented, and they generally are not considered to be a unique paleontological resource. Identifiable vertebrate marine and terrestrial fossils generally are considered scientifically important because they are relatively rare.

In general, mountainous areas that are composed of bedrock (which formed from magma deep below the earth’s surface) and rocks formed from volcanic activity on the Earth’s surface do not contain fossils. Metamorphic rocks, which have been altered from their original condition by conditions of high temperature and pressure, contain few fossils. Most fossils are found in sedimentary deposits. Fossils become a part of sedimentary rocks when sediments such as mud, clay, silt, sand, and pebbles cover plant and animal organisms and preserve their characteristics through time. The surface of the Sacramento Valley and, in some places, extending to depths of more than 2,000 feet below the surface, is composed of sedimentary deposits. Many of the rock formations that fill the Sacramento Valley are known to have produced numerous vertebrate fossils (e.g., Turlock Lake, Riverbank, and Modesto Formations) or large numbers of plant assemblages (e.g., Ione Formation), and therefore are considered to be of high paleontological sensitivity. Geologic units that are of Holocene age (i.e., 11,700 years Before Present to Present Day) contain only the remains of extant, modern taxa (if any fossil resources are present), which are not considered “unique” paleontological resources.

Geologic Features

Unique geologic features consist of outstanding natural landforms such as mountain peaks, lakes, rivers, deep scenic canyons and gorges, scenic rock formations, and large waterfalls. Lake

Oroville, the main stem Feather and Sacramento River channels, and the sloughs and channels in the Delta, are considered unique geologic features.

3.11.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to geology and soils resource impact analyses as required under CEQA have been included.

Federal

U.S. Geological Survey Quaternary Faults

The U.S. Geological Survey (USGS) maintains a database of Quaternary fault and fold parameters. The database is periodically updated to reflect the latest data available and current understanding of fault behaviors. These fault parameters were used to develop the National Seismic Hazard Maps.

U.S. Geological Survey National Seismic Hazard Maps

The USGS provides probabilistic seismic hazard maps for the 48 conterminous states. These maps depict contour plots of peak ground acceleration and spectral accelerations at selected frequencies for various ground motion return periods. As noted previously, the maps were developed for a reference site condition with an average shear-wave velocity of about 2,500 feet per second in the top 100 feet. The USGS National Seismic Hazard Maps are updated periodically and have been adopted by many building and highway codes as the minimum design requirements.

U.S. Geological Survey Landslide Hazard Program

The USGS provides information regarding the causes of ground failure and mitigation strategies to reduce long-term losses from landslide hazards. The information is useful for understanding the nature and scope of ground failures and for improving the mitigation strategies.

National Earthquake Hazards Reduction Act (U.S. Code Title 42 Section 7704)

In 1977, the U.S. Congress enacted the Earthquake Hazards Reduction Act of 1977 (Public Law 95-124) to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program." The National Earthquake Hazards Reduction Program was also enacted in 1977, to accomplish the goals of the act. The Earthquake Hazards Reduction Act and National Earthquake Hazards Reduction Program were amended in 1990 to refine the description of agencies' responsibilities, program goals, and objectives. The Earthquake Hazards Reduction Act was amended as the National Earthquake Hazards Reduction Program Act. The four general goals of the National Earthquake Hazards Reduction Program are:

- Develop effective practices and policies to reduce losses of life and property from earthquakes and accelerate their implementation.
- Improve techniques for reducing seismic vulnerabilities of facilities and systems.
- Improve earthquake hazards identification and risk assessment methods, and their use.

- Improve the understanding of earthquakes and their effects.

The National Earthquake Hazards Reduction Program Act designates the Federal Emergency Management Agency as the program's lead agency. Other supporting agencies include the National Institutes of Standards and Technology, the National Science Foundation, and USGS.

State

Liquefaction and Landslide Hazard Maps (Seismic Hazards Mapping Act)

The Seismic Hazards Mapping Act of 1990 (Public Resources Code [PRC] Sections 2690 to 2699.6) was enacted following the Loma Prieta earthquake to reduce threats to public health and safety by identifying and mapping known seismic hazard zones in California. The act directs the California Geological Survey (formerly known as the California Division of Mines and Geology) to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The maps assist cities and counties in fulfilling their responsibilities for protecting public health and safety.

As of April 2019, more than 100 official seismic hazard zone maps showing areas prone to liquefaction and landslides had been published in California, and more maps are scheduled for publication. Most mapping has been performed in Southern California and the San Francisco Bay Area.

A development permit review is required for sites in the mapped seismic hazard zones. Site-specific geologic investigations and evaluations are carried out to identify the extent of hazards, and appropriate mitigation measures are incorporated in the development plans to reduce potential damage.

Alquist-Priolo Earthquake Fault Zones

The Alquist-Priolo Earthquake Fault Zoning Act (then called the Alquist-Priolo State Special Studies Zone Act) was enacted in 1972 (PRC Section 2621 et seq.). Similar to the Seismic Hazards Mapping Act, the Alquist-Priolo Act's main purposes are to identify known active faults in California and to prevent the construction of buildings for human occupancy on the surface trace of active faults.

California Geological Survey

The California Geological Survey assists in the identification of fault locations and other geological hazards.

Regional and Local

As described in Section 3.11.1, the geographic areas analyzed for impacts on geology and soils include the Oroville Complex, Low and High Flow channels of the Feather River, the Sacramento River from the Confluence with the Feather River to the Delta, and the Delta. This portion of the study area for the Pulse Flows Component crosses Alameda, Butte, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo, and Yuba counties. Each county and city have local regulations and a general plan with policies related to geology and soils. These may include goals and policies related to geologic resources, soils, and paleontological resources.

3.11.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementation of the Pulse Flows Component would result in a significant impact. A geology and soils impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Directly or indirectly cause potential substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslides.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.
- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed (see Section 3.11.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow release and WSIP Operational Exchange Process. Therefore, the impact analysis does not evaluate construction impacts and rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases" to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, "Hydrology and Water Quality," and detailed in Appendix B were also considered.

Impacts and Mitigation Measures

Table 3.11-2 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.11-2
SUMMARY OF IMPACT CONCLUSIONS—GEOLOGY AND SOILS

Impact Statement	Operations and Maintenance
3.11-1: Implementation of the Pulse Flows Component would result in substantial soil erosion or the loss of topsoil.	LTS
3.11-2: Implementation of the Pulse Flows Component would be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.	LTS
3.11-3: Implementation of the Pulse Flows Component would directly or indirectly cause potential substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslide.	NI
3.11-4: Implementation of the Pulse Flows Component would be located on expansive soil creating substantial direct or indirect risks to life or property.	NI
3.11-5: Implementation of the Pulse Flows Component would have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.	NI
3.11-6: Implementation of the Pulse Flows Component would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.	LTS

NOTES: NI = No Impact; LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2023.

Impact 3.11-1: Implementation of the Pulse Flows Component would result in substantial soil erosion or the loss of topsoil.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations.

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, and above-normal water year types, with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. As described in Section 3.2.1, "Conservative Pulse Flow Release Scenario," this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May, or June) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would continue to meet flow and temperature requirements for the Feather River (described in detail in Section 3.4, "Hydrology and Water Quality," Section 3.4.3, "Regulatory Setting," under the subheading Biological Opinions for Oroville Operations).

The Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses that would result in substantial soil erosion or the loss of topsoil. However, the spring pulse flow release (March through June) and the corresponding reduction in flows associated with the summer Recovery Period (July through September) could potentially result in soil erosion or loss of topsoil along the banks in the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta.

As described in Section 3.11.2, soils vary by geographic area, with certain soils being susceptible to erosion. With regards to the bank material in the Feather River, and its susceptibility to erosion as a result of the Pulse Flows Component, the lower bank of the Feather River, which is composed of slickens, is cohesive and thereby moderately resistant to erosion. The sandy mid-bank is prone to rapid erosion by fluvial entrainment and dry ravel. The banks of Feather River are capped by fine-grained vertical accretion sediments; erosion of the sandy mid-bank commonly results in cantilever failure of the upper bank.

As presented in Section 3.4, "Hydrology and Water Quality" (Impact 3.4-1) and detailed in Appendix B, changes in water levels, velocity and inundation extent under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability. Changes in geomorphic processes (e.g., sediment transport and bank erosion) would also remain within the range of existing conditions. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows.

Therefore, the Pulse Flows Component would not result in substantial soil erosion or the loss of topsoil in the Oroville Complex, the Feather River Low and High Flow channels, the Sacramento River from the confluence with the Feather River to Verona, and the Delta. Impacts would be **less than significant.**

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to substantial soil erosion or the loss of topsoil are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.11-2: Implementation of the Pulse Flows Component would be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

As described in Section 3.11.2, unstable geologic units or unstable soil are present in the geographic areas analyzed. However, the Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses. Therefore, unstable geologic units and unstable soil would not change from the existing conditions and thus would not result in damages to any facilities as a result of the Pulse Flows Component.

As presented above, water levels, velocity and inundation extent under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability. Changes in geomorphic processes (e.g., sediment transport and bank erosion) would also remain within the range of existing conditions. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, there would not be an increased potential for on- or off-site landslide, lateral spreading, subsidence, liquefication, or collapse. Impacts would be **less than significant.**

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse as a result of the project being located on a geologic unit or soil that is unstable are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.11-3: Implementation of the Pulse Flows Component would directly or indirectly cause potential substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslide.

The Pulse Flows Component does not involve any new construction of water facilities or infrastructure or any land disturbance, nor would it require installation or maintenance. As presented above, water levels, velocity and inundation extent under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability. Changes in geomorphic processes (e.g., sediment transport and bank erosion) would also remain within the range of existing conditions. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows.

Therefore, the Pulse Flows Component would not directly or indirectly cause potential substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslides. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to substantial adverse effects, including the risk of loss from surface fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslide. Are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.11-4: Implementation of the Pulse Flows Component would be located on expansive soil creating substantial direct or indirect risks to life or property.

As described in Section 3.11.2, expansive soils are present in the geographic areas analyzed. However, the Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses. Therefore, expansive soil would not result in damage to any facilities. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to substantial direct or indirect risks to life or property as a result of being located on expansive soil are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.11-5: Implementation of the Pulse Flows Component would have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of waste water.

The Pulse Flows Component does not require the use of septic tanks or alternative wastewater disposal systems. Therefore, the soil capability in the study area was not evaluated to determine whether septic systems and alternative wastewater disposal systems would be adequately supported. **No impact** would occur.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to the use of septic tanks or alternative wastewater disposal systems are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.11-6: Implementation of the Pulse Flows Component would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

As described in Section 3.11.2, geologic areas within the geographic areas analyzed for geology and soils present a range of paleontological sensitivity (see Table 3.11-1). There also exist unique geologic features within the geographic areas analyzed. For example, Lake Oroville, the main stem Feather and Sacramento River channels, and the sloughs and channels in the Delta, are considered unique geologic features.

The Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses. However, the spring pulse flow release (March through June) and the corresponding reduction in flows associated with the summer Recovery Period (July through September) could potentially expose unique paleontological resources or sites or alter unique geologic features along the banks in the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta.

As presented above, water levels, velocity and inundation extent under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability. Changes in geomorphic processes (e.g., sediment transport and bank erosion) would also remain within the range of existing conditions. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, the Pulse Flows Component would not directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to direct or indirect destruction of a unique paleontological resource or site or unique geologic feature are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

3.12 Agriculture and Forestry Resources

This section discusses the potential for the Pulse Flows Component to affect agriculture and forestry resources. The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows, as well as implementation of the Water Storage Investment Program (WSIP) Operational Exchange Process that develops water used for the pulse flow releases. For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan Groundwater Storage Project and Willow Springs Water Bank Project.

3.12.1 Geographic Areas Analyzed

As described in Section 2.3, the study area for the Pulse Flows Component was divided into seven geographic areas (see Figure 2-2).

Areas downstream of the Sacramento–San Joaquin Delta (Delta) include engineered State Water Project (SWP) facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and delivery schedules. San Luis Reservoir is an off-stream reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP system.

These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations. Therefore, impacts on agriculture and forestry resources were not evaluated for the following geographic areas:

- Geographic Area 6: Banks Pumping Plant and California Aqueduct
- Geographic Area 7: San Luis Reservoir

As presented in Section 3.4, "Hydrology and Water Quality" and detailed in Appendix B, once flows reach the Sacramento River confluence and continue to the Sacramento–San Joaquin Delta (Delta), changes to these parameters would be minimal relative to inputs from tributary creeks and rivers and the scale of tidal flux. During the Recovery Period, flow rates out of Lake Oroville would not fall below existing minimum operational and regulatory flow requirements and would therefore remain with the typical range of operational variability experienced within the system. Further, pulse flows would only be released if sufficient water supplies are made available for exchange by the WSIP Groundwater Projects, allowing DWR to determine (based on reservoir storage, forecasted hydrology, and other factors influencing SWP operations on a seasonal basis) whether a pulse flow can occur without affecting SWP operations, SWP Contractors, or other water right holders. Nominal, temporary changes to water levels and flow would have a negligible impact related to agriculture and forestry resources; therefore, despite the presence of agriculture and forestry resources along the Sacramento River and throughout the Delta, impacts related to these resources are also not evaluated further for:

- Geographic Area 4: Sacramento River from the Confluence with the Feather River to the Delta
- Geographic Area 5: Sacramento-San Joaquin Delta

The following three remaining geographic areas were evaluated for impacts on agriculture and forestry resources:

- Geographic Area 1: Oroville Complex
- Geographic Area 2: Low Flow Channel of the Feather River
- Geographic Area 3: High Flow Channel of the Feather River

3.12.2 Environmental Setting

The environmental setting section provides a focused discussion of existing conditions within the geographic areas analyzed for agriculture and forestry resources (as outlined above). A general description of the Pulse Flows Component study area, including each of the seven geographic areas, is presented in Section 2.3.

Agricultural Resources

California leads the nation in agricultural production, with crops valued at over $38 billion annually, and more than three fifths of that value comes from the Central Valley (Butte County General Plan 2040). As described above, the geographic areas analyzed for impacts on agricultural resources include the Oroville Complex and the Low and High Flow Channels of the Feather River (geographic areas 1 through 3). This portion of the study area for the Pulse Flows Component extends from Lake Oroville across a large area of the Sacramento Valley, located in the northern Central Valley of California; consequently, agricultural land uses are numerous and varied.

The Pulse Flows Component flows through the southwest portion of Butte County and then runs along the border of Sutter and Yuba counties (with Sutter County to the west and Yuba County to the east). These counties are major producers of a wide variety of farm products, ranked 20th, 22nd, and 32nd, respectively in terms of gross value of agricultural production among California's 58 counties (California Department of Food and Agriculture 2018). The majority of farmland in these counties is aggregated in the floodplain of the Sacramento Valley, which provides high quality soils and a temperate climate supporting a variety of crops, including fruits and nuts, rice and other field crops, seed crops, vegetable crops, and livestock (Butte County 2023, Sutter County 2011, Yuba County 2011).

Areas near the Feather River and Sacramento River are characterized by deep, rich soils. The natural levees that border the Sacramento-Feather River system create backwater basins of heavy clay soils that help sustain agricultural uses (U.S. Department of Agriculture 2021). The existing SWP plays an important role in California's agriculture, with approximately 30 percent of SWP water used to irrigate approximately 750,000 acres of farmland (Water Education Foundation 2021).

Mapped Farmland

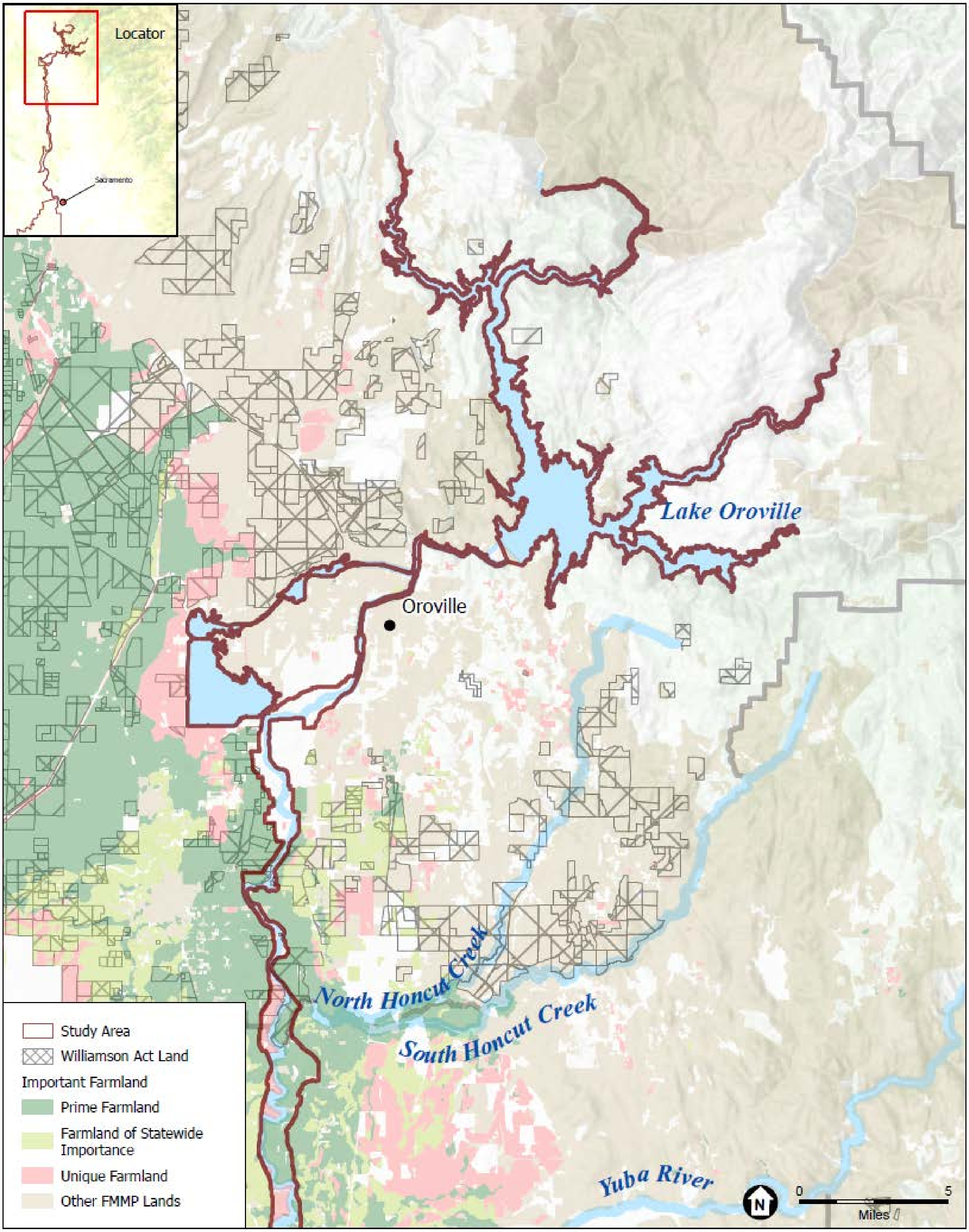
The Farmland Mapping and Monitoring Program (FMMP) (California Department of Conservation 2021) was established by the State of California in 1982 to continue the Important Farmland mapping efforts started in 1975 by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The intent of NRCS (then named the Soil Conservation Service) was to produce agricultural resource maps based on soil quality and land use across the nation. The California Department of Conservation (CDOC) sponsors the FMMP and is also responsible for establishing agricultural easements in accordance with Public Resources Code sections 10250–10255.

As part of the nationwide effort to map agricultural land uses, NRCS uses a series of definitions known as Land Inventory and Monitoring (LIM) criteria. The LIM criteria classify the land's suitability for agricultural production. "Suitability" relates to the physical and chemical characteristics of soils, as well as the actual land use. Maps of Important Farmland are derived from the NRCS soil survey maps using the LIM criteria and are available by county.

The maps prepared by NRCS and used by the FMMP classify land into water and seven other categories: Prime Farmland, Unique Farmland, Farmland of Statewide Importance, Farmland of Local Importance, Grazing Land, Other Lands, and Urban and Built-Up Lands. Prime Farmland, Farmland of Statewide Importance, and Unique Farmland are collectively termed "Farmland" in CEQA Appendix G and are defined as follows:

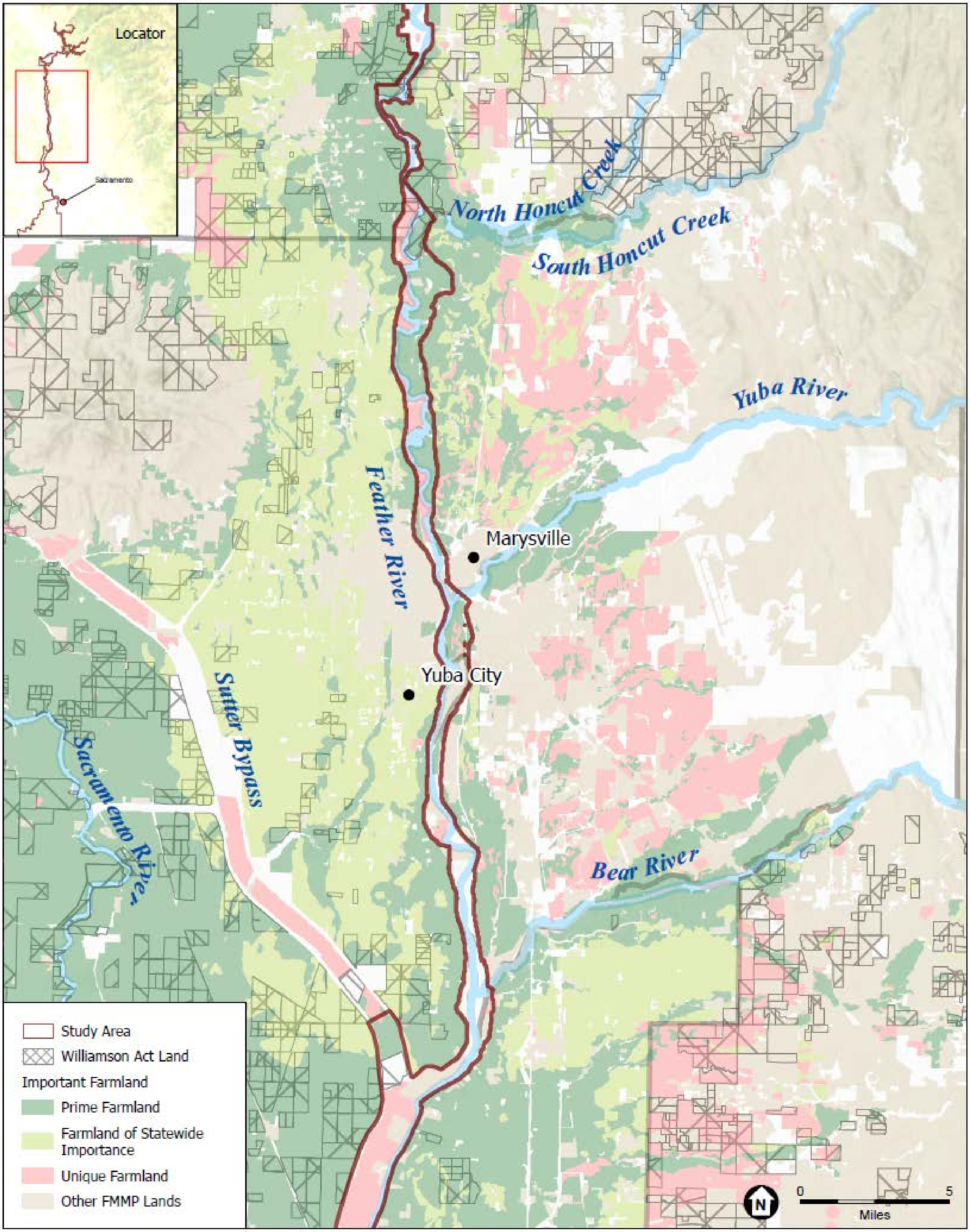
- **Prime Farmland**—Land that has the best combination of features for producing agricultural crops. Prime Farmland must have been used for production of irrigated crops at some time during the four years prior to the FMMP's mapping date.
- **Unique Farmland—**Land that has been used to produce specific crops with high economic value but does not meet the criteria for Prime Farmland or Farmland of Statewide Importance. These lands usually are irrigated, but they may include non-irrigated orchards or vineyards found in some climatic zones. Unique Farmland must have been used for crops at some time during the four years prior to the mapping date.
- **Farmland of Statewide Importance**—Land, other than Prime Farmland, with a good combination of physical and chemical characteristics for producing crops. Farmland of Statewide Importance must have been used for production of irrigated crops at some time during the four years prior to the mapping date.

The portion of the Pulse Flows Component study area analyzed for impacts on agricultural resources includes the Oroville Complex and the Low and High Flow Channels of the Feather River, which collectively contain approximately 4,818 acres of Prime Farmland; 6,710 acres of Unique Farmland; and 11 acres of Farmland of Statewide Importance (**Figure 3.12-1**).



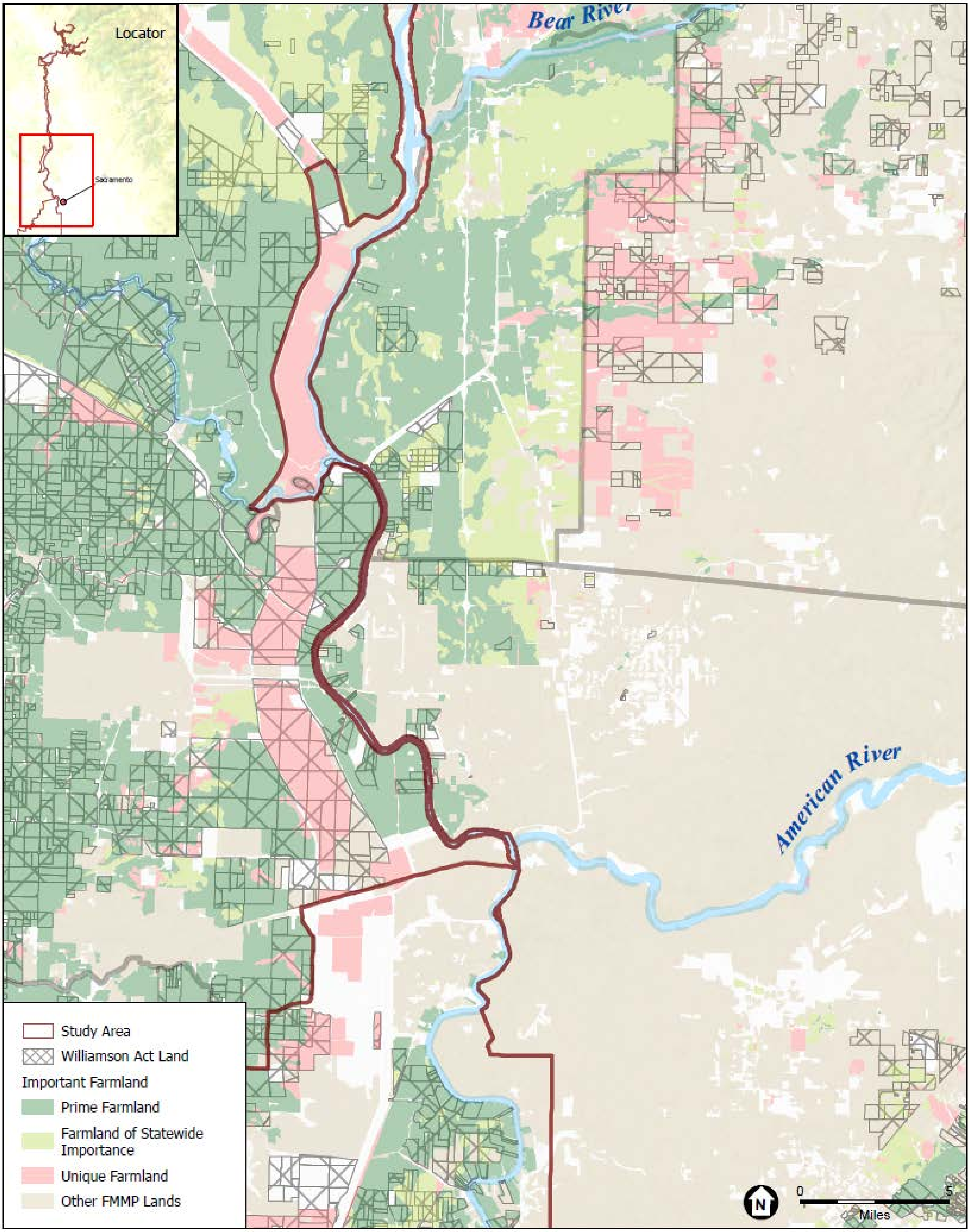
SOURCE: Esri, 2022; ESA, 2023

Figure 3.12-1
Mapped Farmland



SOURCE: Esri, 2022; ESA, 2023

Figure 3.12-1
Mapped Farmland



SOURCE: Esri, 2022; ESA, 2023

Figure 3.12-1
Mapped Farmland

Forestry Resources

Forestland is defined by Section 12220[g] of the California PRC as land that can support 10 percent native tree cover and woodland vegetation of any species, including hardwoods, under natural conditions; and that allows management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation, and/or other public benefits. Nearly one third of California's total land, approximately 32 million acres, is forested. Forest land is present throughout California, mostly found in mountainous areas, including the North Coast, Cascade Range, and the Sierra Nevada (U.S. Department of Agriculture 2020).

Timberland is defined as forestland that is producing or capable of producing more than 20 cubic feet per acre per year of wood, but excludes reserved forestland (areas permanently reserved from wood products use through statute or administrative designation). In California, timberlands account for approximately 52 percent of California's total forestland area. The timberlands with the greatest standing volume include Douglas fir, white fir, ponderosa pine, and redwoods. Reserved forestland, consisting of areas permanently reserved from wood products use through statute or administrative designation, makes up approximately 20 percent of forestland area in California. Reserved forestland includes national forest wilderness areas, national parks, and monuments (U.S. Department of Agriculture 2020).

The geographic areas analyzed for impacts on forestry resources include the Oroville Complex and the Low and High Flow Channels of the Feather River (geographic areas 1 through 3). This portion of the study area for the Pulse Flows Component extends from Lake Oroville across a large area of the Sacramento Valley and covers a broad area of the Sacramento Valley with numerous and diverse forestry resources. The Plumas National Forest is adjacent to Lake Oroville to the north and east, and there are parcels zoned as forestland, timberland, and Timberland Production Zone adjacent to Lake Oroville in the study area.

3.12.3 Regulatory Setting

The following federal, State, regional, and local regulations would apply to the Pulse Flows Component. Only those regulations directly applicable to agriculture and forestry resources impact analyses as required under CEQA have been included.

Federal

Noxious Weed Act of 1974

The Noxious Weed Act (7 U.S.C. § 2801 et seq.) was authorized to control and manage the spread of nonnative plant species that may have adverse effects on agriculture, commerce wildlife resources, or public health. It inhibits the transport, trade, or sales of noxious plant species in the U.S. and gave the Secretary of Agriculture authority to determine noxious plant species, and to establish measures to control them. As amended, the Act requires all Federal agencies to establish a management plan to control the spread of noxious plant species in their jurisdiction.

Central Valley Project Improvement Act

The U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and the U.S. Bureau of Land Management, in coordination with the State of California, participating CALFED Bay-Delta Program agencies, and other partners, have implemented numerous programs, projects, and actions to meet the goals of the Central Valley Project Improvement Act (CVPIA), many of which have affected land use and agriculture throughout the Central Valley, especially in the Sacramento–San Joaquin Delta watershed.

To achieve the CVPIA's purposes and the identified goals and objectives, numerous provisions for agriculture were incorporated into the statute. Specific programs, measures, and operational and management directives address water, habitat, and land management. Among these are directives for the retirement of drainage-impaired farmlands through the Land Retirement Program and implementation of an Agricultural Waterfowl Incentives Program. The goal of the Land Retirement Program is to retire 15,000 acres of agricultural lands characterized by low productivity and poor drainage through a willing seller program. In the Agricultural Waterfowl Incentives Program, farmers are paid to keep private agricultural fields flooded during the winter months when doing so would increase the amount of habitat and the availability of food for waterfowl.

State

California Farmland Conservancy Program

CDOC's California Farmland Conservancy Program was established in 1996 to encourage the permanent conservation of productive agricultural lands in collaboration with local entities. In creating this program, the California Legislature recognized the important contribution made by farmland to the state's food supply and the additional benefits of farmland: conserving wildlife habitat, protecting wetlands, and preserving scenic open space.

The California Farmland Conservancy Program supports local efforts to conserve farmland by providing grant funds for the purchase of agricultural conservation easements. These easements are deed restrictions intended to ensure that a given piece of agricultural land can never be used for purposes that would interfere with farming, leaving farmers free to make all ongoing agricultural management decisions on their land.

California Farmland Mapping and Monitoring Program

In 1980, CDOC started a system of mapping and monitoring important farmland in California based on soil and climatic characteristics, the Farmland Mapping and Monitoring Program (FMMP). CEQA lead agencies are required to evaluate agricultural resources in environmental assessments based at least in part on the FMMP. The State's system was designed to document the amount of agricultural land in California that was being converted to non-agricultural land or transferred into Williamson Act contracts. FMMP lands within the Pulse Flows Component Study Area can be seen in Figure 3.12-1.

California Land Conservation Act of 1965 (Williamson Act)

The California Land Conservation Act of 1965, commonly known as the Williamson Act (Government Code Section 51200 et seq.), enables local governments to enter into contracts with private landowners to promote the continued use of the relevant land in agricultural or related open space use. In return, landowners receive property tax assessments that are based on farming and open space uses instead of full market value. Local governments receive an annual subvention (subsidy) of forgone property tax revenues from the state via the Open Space Subvention Act of 1971. State payments were significantly reduced several years ago and were halted when the state stopped subvention in the 2009–2010 fiscal year because of the state's budget problems.

The Williamson Act empowers local governments to establish "agricultural preserves" consisting of lands devoted to agricultural uses and other compatible uses. Upon establishment of such preserves, the locality may offer to owners of included agricultural land the opportunity to enter into annually renewable contracts that restrict the land to agricultural use for at least 10 years (i.e., the contract continues to run for 10 years following the first date upon which the contract is not renewed). In return, the landowner is guaranteed a relatively stable tax rate, based on the value of the land for agricultural/open space use only and unaffected by its development potential. There are financial consequences to the landowner for early cancellation of a Williamson Act contract, and cancellations must go through a rigorous approval process. Williamson Act lands within the Pulse Flows Component Study Area can be seen in Figure 3.12-1.

Amendments to the Williamson Act resulted in the opportunity to create Farmland Security Zone (FSZ) lands. A county board of supervisors creates an FSZ upon request by a landowner or group of landowners. It is an enforceable contract between a private landowner and a county that restricts land to agricultural or open space uses. The minimum initial term is 20 years. Like a Williamson Act contract, FSZ contracts self-renew annually; thus, unless either party files a notice of nonrenewal, the contract is automatically renewed each year for an additional year. FSZs offer landowners greater property tax reduction. Land restricted by an FSZ contract is valued for property assessment purposes at 65 percent of its Williamson Act valuation or 65 percent of its Proposition 13 valuation, whichever is lower.

California Department of Forestry and Fire Protection (CAL FIRE)

The Board of Forestry and Fire Protection is a government-appointed body within CAL FIRE. The Board is responsible for developing the general forest policy of the state, for determining the guidance policies of CAL FIRE and for representing the state's interest in federal forestland in California. Together, the Board and CAL FIRE work to carry out the California Legislature's mandate to protect and enhance the state's unique forest and wildland resources. The Board is charged with protecting the forest resources of all the wildland areas of California that are not under federal jurisdiction. The forest resources include: major commercial and non-commercial stands of timber; areas reserved for parks and recreation; the woodland, brush-range watersheds; and all such lands in private and state ownership that contribute to California's forest resource wealth.

Under various statutes, the Board is authorized to adopt regulations to implement specified programs. Currently, the Board has regulations in the following areas: forest practices (14 CCR 895.1- 1111.8), hazardous fire areas and conditions (14 CCR 1200 et seq.), fire protection (14 CCR 1220 et seq.), state forest use and sales (14 CCR 1400 et seq.), forest improvement (14 CCR 1525 et seq.), urban forestry (14 CCR 1550 et seq.), chaparral management (14 CCR

1560 et seq.), Professional Forester Registration (14 CCR 1601 et seq.), and policy for administration of the Department (14 CCR 1655).

Regional and Local

As described in Section 3.12.1, the geographic areas analyzed for impacts on agriculture and forestry resources include the Oroville Complex, and the Low and High Flow Channels of the Feather River. This portion of the study area for the Pulse Flows Component crosses Butte, Sutter, and Yuba counties. Each county and city have local regulations and general plans with policies related to agriculture and forestry resources. These may include goals and policies that address the conservation and protection of agricultural and forestry resources.

3.12.4 Impact Analysis and Mitigation Measures

Significance Criteria

For the purpose of this analysis, the relevant standards of significance were based on the current CEQA Appendix G Environmental Checklist Form to determine whether implementation of the Pulse Flows Component would result in a significant impact. An agricultural and forest resources impact is considered significant if implementation of the Pulse Flows Component would do any of the following:

- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use
- Conflict with existing zoning for agricultural use or a Williamson Act contract
- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))
- Result in the loss of forest land or conversion of forest land to non-forest use
- Involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use

Methodology and Assumptions

The following impact analysis considers the potential impacts of implementation of the Pulse Flows Component (defined by DWR's action to release the pulse flows and implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases) for the geographic areas analyzed (see Section 3.12.1). Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow release and WSIP Operational Exchange Process. Therefore, the impact analysis does not evaluate construction impacts and rather focuses on the short- and long-term direct and indirect operational impacts compared to existing conditions.

This impact analysis incorporates the approach described in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases" to discern reasonably foreseeable changes in existing conditions attributable to implementation of the Pulse Flows Component. The modeling results presented in Section 3.4, "Hydrology and Water Quality" and detailed in Appendix B were also considered.

Impacts and Mitigation Measures

Table 3.12-1 summarizes the impact conclusions presented in this section for easy reference.

TABLE 3.12-1
SUMMARY OF IMPACT CONCLUSIONS—AGRICULTURE AND FORESTRY RESOURCES

Impact Statement	Operations and Maintenance
3.12-1: Implementation of the Pulse Flows Component would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.	LTS
3.12-2: Implementation of the Pulse Flows Component would conflict with existing zoning for agricultural use or a Williamson Act contract.	LTS
3.12-3: Implementation of the Pulse Flows Component would conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220[g]), timberland (as defined by PRC Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104[g]).	LTS
3.12-4: Implementation of the Pulse Flows Component would result in the loss of forest land or conversion of forest land to non-forest use.	LTS
3.12-5: Implementation of the Pulse Flows Component would involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use	LTS

NOTES: LTS = Less than Significant.
SOURCE: Data compiled by Environmental Science Associates in 2023.

Impact 3.12-1: Implementation of the Pulse Flows Component would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.

As described in Section 2.4.1, "Description of Potential Pulse Flow Releases," CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects. Pulse flows would be released from Lake Oroville in March, April, May, and/or June in critically dry, dry, below-normal, or above-normal water year types, with a ramp-down estimated to occur over a period of several days to several weeks such that flow in the river (base flow plus pulse flow) conforms to Table 2-3. As described in Section 3.2.1, "Conservative Pulse Flow Release Scenario," this Draft SEIR analyzes a conservative pulse flow release scenario defined by a maximum flow of 10,000 cfs released over a short duration in spring (a few days in March, April, May, or June) of critically dry or above normal water years. The maximum pulse flow of 10,000 cfs is conservatively analyzed in this document to occur about once in three years.

The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release. Releases during the Recovery Period would continue to meet flow and temperature requirements for the Feather River (described in detail in Section 3.4.3, under the subheading Biological Opinions for Oroville Operations).

The Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses that would directly or indirectly convert Farmland to non-agricultural uses. However, the Oroville Complex and the Low and High Flow Channels of the Feather River collectively contain approximately 4,818 acres of Prime Farmland; 6,710 acres of Unique Farmland; and 11 acres of Farmland of Statewide Importance. The proposed project could result in changes in water levels, velocity, and inundation extent along the Feather River and therefore has the potential to indirectly affect these existing Farmlands.

The conservative pulse flow release scenario was simulated using a hydrodynamic HEC-RAS model of the Feather and Sacramento rivers to contextualize how the pulse flow release conditions compare to existing conditions. As presented in Section 3.4, "Hydrology and Water Quality" (Impact 3.4-1) and detailed in Appendix B, the modeling results demonstrate that water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability in the system. Modeling of inundation extent shows that, under certain conditions, the release of a spring pulse flow has the potential to increase inundation of Farmland located within or adjacent to the study area, particularly in the Lower Sutter Bypass near its junction with the Sacramento River, as compared to typical spring conditions. While this degree of inundation remains within the existing system's typical range of hydrologic variability, spring planting is time-sensitive and a potential delay in planting of certain spring crops during a pulse flow year could cause an indirect conversion of these Farmlands to non-agricultural use over time. However, to control and minimize potential inundation of Farmland, the DWR/CDFW Agreement (see Section 2.4.2) will require CDFW and DWR to jointly confer with affected landowners in the Lower Sutter Bypass that may be impacted by or benefit from pulse flow releases, based on modeling conducted by DWR, prior to a pulse flow being released. In addition, DWR and CDFW have met with River Partners, a landowner of Farmlands in the Lower Sutter Bypass that are particularly susceptible to inundation from a pulse flow release based on preliminary modeling (see Appendix B). River Partners plans to convert the existing leased rice farming land to habitat, which would benefit from the increased inundation. The conversion is anticipated to occur in phases, beginning in 2026 and to be completed by 2034 (Mike Davis [River Partners Senior Restoration Ecologist], personal communication, 12/07/2023). Therefore, it is not anticipated that Farmland adjacent to riparian areas or waterways within the study area would be impacted by increased inundation or erosion due to a pulse flow release such that a conversion to non-agricultural use would occur.

Further, reduced flows out of Lake Oroville during the Recovery Period would not be expected to reduce water deliveries to agricultural lands currently served by the SWP. As described in Section 2.2, "Objectives of the Pulse Flows Component," one of DWR's objectives in implementing the Pulse Flows Component would be to minimize impacts on SWP operations, SWP contractors, and water supply; as such, the DWR/CDFW Agreement (see Section 2.4.2) would require that a pulse flow only be released if sufficient water supplies are made available for exchange by the WSIP Groundwater Projects, allowing DWR to determine (based on reservoir storage, forecasted hydrology, and other factors influencing SWP operations on a seasonal basis) that a pulse flow can occur without affecting the SWP. In addition, The Pulse Flows Component would be operated in a manner consistent with all existing SWP operational requirements, including operational constraints for fish and wildlife protection and water quality, as well as other environmental and legal restrictions. Therefore, the reduction of SWP water supply out of Lake Oroville during the Recovery Period would remain within the typical range of existing operational variability experienced within the system and would not affect or impede water supply or quality for SWP Contractors, water right holders, or other water suppliers in such a way that it would necessitate a change in water use or water management. Water deliveries for Farmland and other agricultural uses under the Pulse Flows Component would be consistent with historic deliveries, which fluctuate depending on water year type, water demands, and cropping patterns.

As outlined above, hydraulic conditions and geomorphic processes (water levels, velocity, sediment transport, and bank erosion under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability, and potential inundation of Farmland would be controlled and minimized by the requirements of the DWR/CDFW Agreement. The conservative pulse flow release scenario would therefore not reduce, alter, or indirectly convert adjacent Farmland to non-agricultural use. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of existing operational variability and would not affect water supply or quality for agricultural water users; no change in water use or water management would be required. As such, Farmlands and other agricultural lands adjacent to riparian areas or waterways along the Low and High Flow Channels of the Feather River would not experience significant changes from the Pulse Flows Component as compared to existing conditions. Therefore, the Pulse Flows Component would not substantially alter existing agricultural uses to a level that would indirectly result in the conversion of Farmland to non-agricultural use. Impacts would be **less than significant.**

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conversion of Farmland to non-agricultural uses are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.12-2: Implementation of the Pulse Flows Component would conflict with existing zoning for agricultural use or a Williamson Act contract.

As described under Impact 3.12-1, the Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses that would conflict with existing agricultural zoning or a Williamson Act contract. Hydraulic conditions and geomorphic processes including water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability, and potential inundation of Farmland would be controlled and minimized by the requirements of the DWR/CDFW Agreement such that no direct or indirect conversion to non-agricultural use would occur. Additionally, reduced releases from Lake Oroville during the Recovery Period would not affect water supply or quality for agricultural water users; no change in water use or water management would be required. Therefore, the Pulse Flows Component would not affect existing Farmland zoning or lands under a Williamson Act contract. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conflicts with existing zoning for agricultural use or a Williamson Act contract are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.12-3: Implementation of the Pulse Flows Component would conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220[g]), timberland (as defined by PRC Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104[g]).

As described under Impact 3.12-1, the Pulse Flows Component would not require any land disturbance, construction, or modification of any facilities, infrastructure, or other land uses that would conflict with existing zoning of forest land or timberland. Hydraulic conditions and geomorphic processes including water levels, velocity, sediment transport, and bank erosion potential under the conservative pulse flow release scenario would remain within the typical range of variability of the existing hydrologic system and, while inundation extent may be increased as compared to typical spring conditions, the overall degree of inundation remains within the existing system's typical range of hydrologic variability as well. As such, adjacent forest lands would not be impacted. Additionally, reduced releases from Lake Oroville during the Recovery Period would not affect water supply or quality and no change in water use or water management would be required. Therefore, the Pulse Flows Component would not affect existing zoning of forest land or timberland. Impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to conflicts with existing zoning for forest land, timberland, or timberland zoned Timberland Production are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.12-4: Implementation of the Pulse Flows Component would result in the loss of forest land or conversion of forest land to non-forest use.

For the reasons outlined under Impact 3.12-3, the Pulse Flows Component would not remove forest land or permanently convert forest land to non-forest uses and impacts would be **less than significant**.

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to loss of forest land or conversion of forest land to non-forest use are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

Impact 3.12-5: Implementation of the Pulse Flows Component would involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use.

As outlined under Impact 3.12-1, water levels, velocity, sediment transport, and bank erosion under the conservative pulse flow release scenario would fall within the range of existing hydrologic variability. Modeling of inundation extent shows that, under certain conditions, the release of a spring pulse flow has the potential to increase inundation of Farmland located within or adjacent to the study area, particularly in the Lower Sutter Bypass, as compared to typical spring conditions, which could cause changes to planting patterns and indirectly convert Farmlands to non-agricultural use. However, to control and minimize potential inundation of Farmlands, the DWR/CDFW Agreement (see Section 2.4.2) will require CDFW to confer with affected landowners in the Lower Sutter Bypass that could potentially be impacted by or benefit from the pulse flows, based on modeling conducted by DWR, prior to a pulse flow being released. Therefore, it is not anticipated that Farmlands or forest lands within the study area would be impacted by increased inundation or erosion such that they would be altered or indirectly converted. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of existing operational variability and would not affect water supply or quality for agricultural or forestry water users; no change in water use or water management would be required. As such, agricultural and forest lands adjacent to riparian areas or waterways along the Low and High Flow Channels of the Feather River would not experience significant changes from the Pulse Flows Component as compared to existing conditions. Therefore, the Pulse Flows Component would not substantially alter existing agricultural or forestry uses to a level that would directly or indirectly result in the conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use. Impacts would be **less than significant.**

With the addition of the new information and analysis in this section to the information presented in the original WSIP Groundwater Projects' EIRs, the impacts of the Pulse Flows Component related to other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use are adequately addressed. The Pulse Flows Component does not introduce new significant effects related to this impact threshold, nor does it substantially increase the severity of effects that were identified in the prior EIRs.

Mitigation: None required.

CHAPTER 4
Cumulative Impacts

4.1 Introduction

This chapter describes the CEQA requirements for the analysis of cumulative impacts, the geographic scope and time frame for cumulative analysis, existing-conditions context for past activities, related projects, and the potential cumulative impacts of the Pulse Flows Component.

The proposed construction and operational aspects of the WSIP Groundwater Projects are evaluated in the respective EIRs for those projects. However, the geographical boundaries identified in these EIRs do not cover the location of the Pulse Flows Component, nor do they convey the project-specific details of DWR's actions (see Section 2.1) that include:

(1) Release of the pulse flows from Lake Oroville into the Low Flow Channel of the Feather River, with the goal of improving habitat conditions for listed salmonids, as well as improving spawning and migration conditions for other listed and non-listed native fish species.

(2) Implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases.

(3) Diversion and conveyance of water to the Kern Fan Groundwater Storage Project (Kern Fan) and Willow Springs Water Bank Project (Willow Springs) that would be stored, in part, for ecosystem benefit.[1]

The Pulse Flows Component analyzed in this section is defined by DWR's action to release the pulse flows (detailed in Section 2.4), as well as implementation of the WSIP Operational Exchange Process that develops water used for the pulse flow releases (detailed in Section 2.5). For the reasons presented in Section 3.1, this analysis does not discuss DWR's action to divert and convey water to the Kern Fan and Willow Springs (detailed in Section 2.6).

Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, no associated construction impacts would occur and the impact analyses focus on the operational impacts of the Pulse Flows Component as compared to existing conditions.

[1] This facet of the DWR action does not apply to the Chino Basin Program, as this project proposes to develop water by constructing a new advanced water treatment facility, injection wells, extraction wells, groundwater treatment facilities, and distribution facilities. Water inputs for this project would come from wastewater of surrounding local jurisdictions and would not come from the State Water Project.

The CEQA Guidelines require that an EIR assess the cumulative environmental impacts of a project when the project's incremental effect is "cumulatively considerable." An EIR must assess the cumulative impacts of a project with respect to past, current, and probable future projects in the region. CEQA Guidelines Section 15355 defines "cumulative effects" as "two or more individual effects that, when considered together, are considerable or which compound or increase other environmental impacts." According to CEQA Guidelines Section 15130(b), the purpose of the cumulative impacts discussion is to reflect "the severity of the impacts and their likelihood of occurrence," and the discussion shall "be guided by the standards of practicality and reasonableness." The CEQA Guidelines further indicate that the discussion of cumulative impacts should include all of the following information:

- Either (a) a list of past, present, and probable future projects producing related cumulative impacts or (b) a summary of projections in an adopted general plan or similar document, or an adopted or certified environmental document, that described or evaluated conditions contributing to a cumulative impact.
- A discussion of the geographic scope of the area affected by the cumulative effect.
- A summary of the environmental effects expected to be produced by these projects.
- Reasonable, feasible options for mitigating or avoiding the project's contribution to any significant cumulative effects.

The cumulative analysis in this chapter provides additional information needed to make the three WSIP Groundwater Projects' EIRs, as supplemented, adequate to include the Pulse Flows Component.

4.2 Cumulative Context and Approach

4.2.1 Geographic Scope

The cumulative context considers both the geographic scope and the timing of projects related to the Pulse Flows Component. To evaluate the cumulative impacts of the Pulse Flows Component, the geographic scope is defined as the study area described in Chapter 2, "Description of the Pulse Flows Component," and shown in Figure 2-1. The study area extends approximately 575 miles from Lake Oroville in Northern California to the WSIP Groundwater Projects in Southern California (see Figure 2-1). The study area is constrained by the levees, or banks, that parallel waterways in the study area.

The study area is divided into seven geographic areas (Figure 2-2):

1. The Oroville Complex.
2. The Feather River Low Flow Channel, defined as the reach from the Thermalito Diversion Dam to the Thermalito Afterbay Outlet.
3. The Feather River High Flow Channel, defined as the reach from the Thermalito Afterbay Outlet to the confluence with the Sacramento River.
4. The Sacramento River from the confluence with the Feather River to the Sacramento–San Joaquin Delta (Delta).

5. The Delta.
6. The Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant) and the California Aqueduct to the WSIP Groundwater Projects.
7. San Luis Reservoir.

The evaluation of cumulative impacts considers the locations of impacts of the Pulse Flows Component relative to the geographic extent of other projects with which it may be combined.

4.2.2 Criteria for Identifying Related Projects in the Study Area

Projects were considered for inclusion in the cumulative impact analysis based on whether they could affect resources in the study area that the Pulse Flows Component could also affect. A list of such past, present, and reasonably foreseeable future projects was developed based on the following criteria:

(1) The project would affect a portion of the physical environment that could also be affected by the Pulse Flows Component (i.e., could interact with the Pulse Flows Component on a cumulative basis).

(2) Sufficiently detailed information about the project is available to allow meaningful analysis without undue speculation.

(3) The project meets all the following criteria:
   - The project is actively under development (i.e., an identified sponsor is actively pursuing project development or construction).
   - A notice of preparation or notice of intent has been released and/or environmental clearance documentation has been completed, or substantial progress has been made toward completion.
   - The project is "reasonably foreseeable" given other considerations, such as site suitability, funding availability and economic viability, and regulatory limitations (e.g., the project has required regulatory permits).

(4) The project is not considered part of the proposed project (i.e., part of the Pulse Flows Component or part of the three WSIP Groundwater Projects).

This cumulative impact discussion considers projects and plans identified under existing conditions (which include the current effects of past projects) and reasonably foreseeable and probable future projects. The criterion used by this draft supplemental EIR (Draft SEIR) analysis for considering whether a project is reasonably foreseeable and probable is whether the project has been defined in adequate detail to assess potential impacts, through the completion of either publicly available preliminary evaluations, feasibility studies, or draft environmental and engineering documents.

The availability of funding and regulatory permits are also considerations for whether a project is reasonably foreseeable. Projects that were only in the development phase without detailed descriptions, operations criteria, or general locations, or that were not funded or permitted at the time that this cumulative impact assessment was written, are considered speculative. Thus, those projects are not considered further in this evaluation.

4.3 Cumulative Projects

Table 4-1 summarizes the projects determined to meet the four criteria listed in Section 4.4 for past, present, and reasonably foreseeable future projects and were selected for inclusion in the cumulative impact analysis. Each project is described in more detail below.

TABLE 4-1
PROJECTS INCLUDED IN THE CUMULATIVE IMPACT ANALYSIS

Name	Location	Type
Harvest Water Program[a]	Sacramento County	Water Management
Los Vaqueros Reservoir Expansion Project[a]	Contra Costa County	Water Management
Sites Project[a]	Colusa County	Water Management
Pacheco Reservoir Expansion Project[a]	Santa Clara County	Water Management
Oroville Federal Energy Regulatory Commission Relicensing Implementation	Butte County	Energy
Voluntary Agreements Related to State Water Board Efforts to Update and Implement the Bay-Delta Plan	Bay-Delta	Multi-benefit
Delta Conveyance Project	Delta	Water Management

NOTES:
Bay-Delta = San Francisco Bay/Sacramento–San Joaquin Delta; Bay-Delta Plan = *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary*; State Water Board = State Water Resources Control Board
a. This project is one of the Water Storage Investment Program projects.
SOURCE: Data compiled by Environmental Science Associates in 2023.

4.3.1 Harvest Water Program

The Harvest Water Program (Harvest Water) is a conjunctive-use project located in Sacramento County. Harvest Water would store and manage groundwater via in-lieu recharge during the irrigation season and passive recharge by applying recycled water to sandhill crane habitat in the winter while improving streamflow, enhancing groundwater-dependent riparian habitats, sustaining prime agricultural lands, and improving regional water supply reliability. Sources of water would be up to 50 thousand acre-feet (taf) per year of tertiary-treated recycled water produced by the Sacramento Regional County Sanitation District and diverted from discharge into the Sacramento River. Water produced from Harvest Water would be used to irrigate up to 16,000 acres of agriculture and habitat lands in Sacramento County near the lower Cosumnes River and Stone Lakes National Wildlife Refuge. Harvest Water is one of seven WSIP projects. The California Water Commission has awarded construction funding for this project and construction has started. Additional information related to Harvest Water can be found at https://www.regionalsan.com/harvest-water.

4.3.2 Los Vaqueros Reservoir Expansion Project

The Los Vaqueros Reservoir Expansion Project (LVE) is a surface storage project located in southeastern Contra Costa County. The project would enlarge the capacity of an existing off-stream reservoir by 115 taf (from 160 taf to 275 taf), upgrade existing conveyance facilities, construct new conveyance, and reoperate existing facilities to develop water supplies for ecosystem benefits and increased water supply reliability. LVE would divert water from the Delta at Rock Slough, Old River, and Middle River intakes (operated by Contra Costa Water District), divert water from the Sacramento River at the Freeport Intake, and deliver water to project participants within Contra Costa Water District's service area, the San Francisco Bay Area, the Delta, neighboring regions, and south-of-Delta wildlife refuges. LVE is one of seven WSIP projects. Additional information related to LVE can be found at https://www.ccwater.com/706/Los-Vaqueros-Studies.

4.3.3 Sites Reservoir Project

The Sites Reservoir Project (Sites) proposes a new surface storage reservoir located in Colusa County in the Sacramento Valley west of the town of Maxwell. Sites would be an off-stream 1.5-million-acre-foot reservoir that would impound Funks Creek and Stone Coral Creek and provide storage capacity for Sacramento River diversions. Diversions would occur during excess conditions and would range from an average of 61 to 406 taf per year, depending on water year type, the availability of Sacramento River water, and diversion and conveyance facility capacities. Sites also includes conveyance using the existing Tehama Colusa Canal and Glenn-Colusa Irrigation District Canal diversion and conveyance facilities. Sites Reservoir would be operated in cooperation with the operations of existing Central Valley Project (CVP) and State Water Project (SWP) system facilities. A new Dunnigan Pipeline would allow water in the Tehama Colusa Canal to flow into the Colusa Basin Drain and ultimately back into the Sacramento River. Using these facilities, Sites water would be delivered to participants within neighboring areas, to SWP and CVP contractors, to the Yolo Bypass, and to north- and south-of-Delta wildlife refuges. The project also includes exchanges with upstream reservoirs to preserve coldwater releases for fishery benefits. Sites is one of seven WSIP projects. Additional information related to Sites can be found at https://sitesproject.org/.

4.3.4 Pacheco Reservoir Expansion Project

The Pacheco Reservoir Expansion Project (Pacheco) is a surface storage project located in southeast Santa Clara County that proposes to enlarge an existing reservoir by 136 taf (from 6 taf to 142 taf), construct new conveyance infrastructure to the CVP San Felipe Division in Santa Clara County, and deliver water supply to up to eight south-of-Delta wildlife refuges in Merced County. Pacheco benefits include increased delivery of water to south-of-Delta wildlife refuges, improved local habitat for threatened south-central California coast steelhead, and emergency water storage. The primary water sources to fill the expanded reservoir would be natural inflows from the North and East forks of Pacheco Creek and imported water from San Luis Reservoir. Supplemental flows to the expanded reservoir would arrive from Santa Clara Valley Water District's and San Benito County Water District's share of contracted CVP and SWP pumped water from San Luis Reservoir as well as water from excess condition diversions, when available. Pacheco is one of seven WSIP projects. Additional information related to Pacheco can be found at https://www.valleywater.org/project-updates/a1-pacheco-reservoir-expansion-project.

4.3.5 Oroville Federal Energy Regulatory Commission Relicensing Implementation

The Oroville Federal Emergency Regulatory Commission (FERC) Relicensing Implementation involves the implementation of relicensing of the Oroville Facilities, also known as FERC Project No. 2100 or P-2100 (refer to Section 3.4.3). The principal features of P-2100 include the Oroville Dam and Reservoir, as well as the Edward Hyatt Powerplant, the Thermalito Facilities, the Feather River Fish Hatchery, and associated recreational and fish and wildlife preservation and enhancement facilities. The hydroelectric facilities of P-2100 have a combined license capacity of approximately 762 megawatts, which produce an average of 2.2 billion kilowatt-hours of electricity each year.

The 50-year license to construct and operate P-2100 was issued to DWR in 1957 and expired in 2007. Under relicensing, DWR would implement six programs designed to enhance habitats for coldwater fisheries to benefit the threatened and endangered Central Valley spring-run Chinook salmon and Central Valley steelhead in the Feather River, and warmwater fisheries in Lake Oroville. Relicensing also includes a comprehensive program to monitor water quality and bacteria levels, wildlife enhancements through proposed measures to manage the Oroville Wildlife Area, recreational enhancements, and implementation of a historical properties management plan to address conflicts between recreation use and the protection of cultural resources. The new license has not been issued and DWR has been operating under the original license terms. Additional information related to the Oroville FERC Relicensing Implementation can be found at https://water.ca.gov/Programs/State-Water-Project/SWP-Facilities/Oroville/HLPCO-Oroville-Facilities-Project-2100.

4.3.6 Voluntary Agreements Related to State Water Board Efforts to Update and Implement the Bay-Delta Plan

Protecting the San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta) watershed and its many beneficial uses is one of the State Water Resources Control Board's (State Water Board's) primary responsibilities and top priorities. The State Water Board is responsible for adopting and updating the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta Plan), which establishes water quality control measures and flow requirements needed to provide reasonable protection of beneficial uses in the watershed. The State Water Board is now engaged in urgent efforts to address prolonged and precipitous declines of native aquatic species in the Bay-Delta and the ecosystem upon which these species depend. The California Natural Resources Agency and water users in the Bay-Delta watershed have made efforts toward the establishment of Voluntary Agreements related to the State Water Board's efforts to update and implement the Bay-Delta Plan. These efforts include a memorandum of understanding signed by the State Water Board and other parties on March 29, 2022. Additional information related to the proposals for voluntary agreements can be found at https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/proposed_voluntary_agreements.html. Additional information related to the State Water Board's Bay-Delta Plan update processes can be found at https://waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/.

4.3.7 Delta Conveyance Project

The Delta Conveyance Project proposes to modernize aging SWP infrastructure in the Delta to restore and protect the reliability of SWP water deliveries in a cost-effective manner, consistent with the State's Water Resilience Portfolio. The SWP infrastructure is owned and operated by DWR and includes the vast network of waterways composing the Delta that collects and moves water to homes, farms, and businesses throughout major regions of the state from the San Francisco Bay Area to Southern California. The Delta Conveyance Project will also allow DWR to address sea level rise and climate change, minimize water supply disruption caused by seismic risk, and provide operational flexibility to improve aquatic conditions in the Delta. Additional information related to the Delta Conveyance Project can be found at https://water.ca.gov/deltaconveyance. The Draft and Final EIRs for the Delta Conveyance Project can be found at https://www.deltaconveyanceproject.com/.

4.4 Approach to the Cumulative Impact Analysis

To determine the significance of the Pulse Flows Component's cumulative impacts, a three-step process has been followed:

- First, the extent of the cumulative impacts without the Pulse Flows Component has been evaluated to determine whether a significant cumulative impact on a resource would exist in the future. To do so, the combined effects of past, present, and probable future projects listed in Table 4-1 have been evaluated to determine whether there is a significant cumulative impact.
- Second, a determination has been made regarding whether the Pulse Flows Component's incremental contribution to any significant cumulative impact is cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past, current, and probable future projects (CEQA Guidelines Section 21083).
- Third, a determination has been made as to whether mitigation measures are required to reduce the Pulse Flows Component's contribution to the cumulative impact to a less-than-considerable level, thereby resulting in a less-than-significant cumulative impact. If not, then the cumulative impact would remain significant and unavoidable.

4.5 Cumulative Impact Analysis

The cumulative impact analysis is presented by resource section and in the same order as the technical resource sections in Chapter 3, "Environmental Settings, Impacts, and Mitigation Measures." All impacts of the Pulse Flows Component discussed in this chapter are described in detail in Chapter 3, Sections 3.4 through 3.11. For each issue area addressed in this Draft SEIR, the criteria applied to evaluate the significance of the overall cumulative effect are the same criteria used to evaluate direct and indirect impacts for that issue area. The cumulative impact analysis considers the geographic areas (see Figure 2-2) analyzed in each of the resource areas, described in more detail below.

4.5.1 Hydrology and Water Quality

The study area includes surface water and groundwater resources within the geographic areas analyzed for impacts on hydrology and water quality (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or alter existing operations that could alter existing drainage patterns in a manner which would result in substantial erosion or siltation, increase the rate or amount of surface runoff, create or contribute runoff water, or impede or redirect flood flows; violate surface and groundwater quality standards that would otherwise degrade surface or groundwater quality; substantially decrease groundwater supplies or interfere with groundwater recharge; risk releases of pollutants due to project inundation; or conflict with or obstruct implementation of a water quality control and/or sustainable groundwater management plan. This could result in cumulatively significant impacts.

As described in Chapter 2, “Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.4, “Hydrology and Water Quality,” and detailed in Appendix B, changes in water levels, velocity, inundation extent, sediment transport, and bank erosion under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. Further, reduced releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would not fall below existing minimum operational and regulatory flow requirements and would thus remain within the typical range of operational flows. Therefore, the Pulse Flows Component would not substantially affect the existing drainage patterns of the Oroville Complex, the Feather River Low and High Flow Channels, the Sacramento River from the confluence with the Feather River to Verona, and the Delta, and thus would not result in substantial erosion or siltation, increase runoff that would result in flooding or exceed the capacity of existing or planned stormwater drainage systems, or impede or redirect flood flow. Because DWR’s actions to implement the Pulse Flows Component would not construct new facilities or result in changes to hydraulic properties or geomorphic processes outside the typical range of hydrologic variability experienced in the system, implementation would not risk the release of pollutants due to inundation.

The Pulse Flows Component would be operated in a manner consistent with overall SWP operational constraints; all DWR actions would be coordinated with DWR’s Water Operations Branch, in compliance with all applicable procedures, guidelines, and regulations, to help ensure that flow releases are within required downstream parameters, including water quality standards (e.g., Low and High Flow Channel water flow and temperature targets as presented in the 2016 biological opinions) and waste discharge requirements. Therefore, the Pulse Flows Component would not violate water quality standards or waste discharge requirements, or otherwise degrade surface or groundwater quality. Additionally, the Pulse Flows Component would not require groundwater as a water supply source (and thus would not necessitate groundwater pumping), as the water would be supplied by the SWP. Therefore, the Pulse Flows Component would not conflict with or obstruct implementation of a water quality control plan or a sustainable groundwater management plan**.** The Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.2 Biological Resources–Aquatic

The study area includes aquatic biological resources (e.g., special-status fish species and their habitats) within the geographic areas analyzed for impacts on aquatic biological resources (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). Within these areas, 19 fish species of focal evaluation were identified as having the potential to occur. Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or alter existing operations that could affect special-status fish and other aquatic organisms, resulting in potentially significant cumulative impacts on those aquatic biological resources.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.5, "Biological Resources–Aquatic," and detailed in Appendix B, water levels, velocity, inundation extent, sediment transport, and bank erosion under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. The Pulse Flows Component would be operated in a manner consistent with applicable SWP operational requirements, including operational constraints for fish and wildlife protection and water quality, as well as other environmental and legal restrictions. Summer flows would not be reduced below those required for salinity control in the Delta and for fish and wildlife protection.

Overall, the Pulse Flows Component could provide benefits to anadromous fish migration during the pulse flow events in March, April, May, or June. The Recovery Period is not expected to substantially interfere with the migration of resident or anadromous fish, but flow reductions from July through September could have a minor effect on early-migrating fall-run Chinook salmon and steelhead and on post-spawn, emigrating green sturgeon. Therefore, the Pulse Flows Component would not result in significant impacts on special-status fish species, substantially interfere with the movement of any native resident or migratory fish, or conflict with local policies or ordinances protecting special-status fish species. The Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.3 Biological Resources–Terrestrial

The study area includes terrestrial biological resources (wetlands, terrestrial wildlife, and special-status plants) within the geographic areas analyzed for impacts on terrestrial biological resources (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). Within these areas, there exist diverse terrestrial habitats, sensitive natural communities (e.g., riparian areas), and special-status plants and wildlife. Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or alter existing operations that could affect sensitive habitats and special-status plant and wildlife species, resulting in potentially significant cumulative impacts on those terrestrial biological resources.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.6, "Biological Resources–Terrestrial," and detailed in Appendix B, water levels, velocity, inundation extent, sediment transport, and bank erosion under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system. Reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, the Pulse Flows Component would not result in any substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species; on any riparian habitat or other sensitive natural community; or on State or federally protected wetlands. The Pulse Flows Component would therefore not conflict with the provisions of these or any other adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan protecting special-status plants and wildlife or sensitive natural communities. Additionally, the Pulse Flows Component would not result in alterations in habitat that would interfere with terrestrial wildlife movement and migratory wildlife corridors, or impede the use of native wildlife nursery sites.

State agencies such as DWR are not subject to local ordinances and policies; however, to the extent feasible, implementation of the Pulse Flows Component would comply with relevant adopted ordinances and local policies protecting biological resources, if they are consistent with DWR's internal environmental policies. The Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.4 Cultural Resources

The study area includes historical (i.e., architectural) and archaeological resources, considering the traditional territory of the local Native American community within the geographic areas analyzed for impacts on cultural resources (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). Continued development in the region runs the inherent risk of damaging or destroying unknown significant cultural resources that could yield information important to history or prehistory or previously unidentified human remains, resulting in a significant cumulative impact. Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or modified operations that could potentially affect architectural resources that qualify as historical resources and/or archaeological resources, as defined in CEQA Guidelines Section 15064.5, or disturb or damage any human remains. This could result in a potentially cumulatively significant impact.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.7, "Cultural Resources," water levels, velocity, and inundation extent under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system (see Appendix B). Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. As a result, there is a very low potential for the Pulse Flows Component to result in impacts on historical resources, archaeological resources (including any submerged cultural resources), or human remains.

Implementation of the Pulse Flows Component would not substantially affect existing conditions as they pertain to historical and archaeological resources, and, thus, it does not appear that the Pulse Flows Component would result in a substantial adverse change in the significance of a historical or archaeological resource, pursuant to CEQA Guidelines Section 15064.5, or that it would disturb or damage any human remains. Therefore, the Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.5 Tribal Cultural Resources

The study area includes the traditional territory of the local Native American community within the geographic areas analyzed for impacts on tribal cultural resources (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). The study area may contain previously undocumented archaeological resources that have value independent of the scientific information they can provide and that may qualify as tribal cultural resources. Therefore, the potential exists for construction and operation of ongoing and future projects in the study area and vicinity, including the projects listed in Table 4-1, to disturb landscapes and archeological resources that may qualify as tribal cultural resources, as defined in Public Resources Code Section 21074. This would result in a potentially significant cumulative impact on those tribal cultural resources.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.8, "Tribal Cultural Resources," DWR has engaged 45 California Native American Tribes as well as one Tribal Council to provide them with information on the Pulse Flows Component and request that they notify DWR if they have any concerns regarding potential impacts of the Pulse Flows Component on cultural resources and tribal cultural resources. DWR has received responses from a number of these Tribes. To date, none of the Tribes consulting with DWR on the Pulse Flows Component have identified a specific tribal cultural resource that they feel could be affected by the Pulse Flows Component. However, because DWR's Tribal consultation process is ongoing, the potential remains for a tribal cultural resource to be identified that could be affected by the Pulse Flows Component. Any impacts of the Pulse Flows Component on tribal cultural resources, as defined in Public Resources Code Section 21074, would be a considerable contribution to the potential significant cumulative impact.

Implementation of Mitigation Measure 3.8-1 would require DWR to implement procedures to evaluate potential tribal cultural resources identified during ongoing consultation on the Pulse

Flows Component or during pulse flows for listing in the California Register of Historical Resources, and would reduce the Pulse Flows Component's contribution to cumulative impacts on tribal cultural resources. Therefore, implementing this mitigation measure would reduce the contribution of the Pulse Flows Component to cumulative impacts on tribal cultural resources to less than cumulatively considerable, and the cumulative impact would be **less than significant.**

4.5.6 Energy and Greenhouse Gas Emissions

Energy

The study area includes energy facilities within the geographic areas analyzed for impacts related to energy resources and greenhouse gas (GHG) emissions (i.e., the Oroville Complex, Banks Pumping Plant and California Aqueduct, and San Luis Reservoir). Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or alter existing operations that could require direct and indirect energy use. These effects could be both temporary (construction-related) and long-term or permanent (new structures), and could result in wasteful, inefficient, or unnecessary consumption of energy resources, or conflict with or obstruct State and local plans for renewable energy or energy efficiency. This could result in a cumulatively significant impact.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.9, "Energy and Greenhouse Gas Emissions," the pulse flow release and WSIP Operational Exchange Process would be managed by DWR in accordance with existing regulations and forthcoming agreements with the WSIP Groundwater Projects to ensure that pulse flow releases do not detrimentally affect operation of the SWP, including water supply, energy generation, and energy consumption. To the extent that the Pulse Flows Component would result in a net increase in energy consumption, the overall objectives of the Pulse Flows Component to provide ecosystem benefits and increase the reliability of SWP operations are not considered a wasteful or inefficient use of energy. Minor operational modifications under the Pulse Flows Component would continue to implement energy efficiency and measures in accordance with applicable State and local plans for renewable energy and energy efficiency (e.g., DWR's SWP Energy Roadmap and Climate Action Plan; see Section 3.9.3).

The Pulse Flows Component would not result in wasteful, inefficient, or unnecessary consumption of energy resources that would potentially result in substantial environmental impacts or conflict with or obstruct a State or local plan for renewable energy or energy efficiency. Therefore, the Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

Greenhouse Gas Emissions

Climate change is a global problem and the effects of GHG emissions are experienced globally. Therefore, in the context of CEQA, impacts of GHG emissions on global climate change are inherently cumulative. No single project could generate enough GHG emissions to contribute noticeably to a change in the global average temperature. However, GHG emissions from present and future projects, including those listed in Table 4-1, combine to contribute substantially to the phenomenon of global climate change and its associated environmental impacts.

As described in Chapter 2, "Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.8, "Energy and Greenhouse Gas Emissions," implementation of the Pulse Flows Component is not anticipated to substantially alter the SWP's overall energy requirements and result in a substantial increase in GHG emissions. Because of the limited changes in energy generation and consumption, the Pulse Flows Component would result in a negligible change to the SWP's energy-related GHG emissions. Over time, the sources of energy used to power the SWP will become more renewable (California Department of Water Resources 2022). The Pulse Flows Component would not generate substantial GHG emissions or conflict with the applicable GHG plan, policy, or regulation, or GHG reduction goals (e.g., DWR's Greenhouse Gas Emissions Reduction Plan Update 2020; see Section 3.9.3). Therefore, the Pulse Flows Component's contribution to the global cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.7 Recreation

The study area includes recreational facilities within the geographic areas analyzed for impacts on recreational resources (i.e., the Oroville Complex and the Low and High Flow Channels of the Feather River). Construction and operation of the projects listed in Table 4-1 would introduce new structures and features and/or alter existing operations that could result in increased use of existing neighborhood and regional parks or other recreational facilities, or include recreational facilities or require the construction or expansion of recreational facilities. This could result in a cumulatively significant impact.

As described in Chapter 2, “Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The request for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.10, “Recreation,” water levels, velocity, and inundation extent under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system (see Appendix B). Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Because the Pulse Flows Component would not affect existing recreational facilities, it would not displace recreationists or cause an increase in the use of other nearby recreational facilities such that the substantial physical deterioration of the facility would occur or be accelerated. Additionally, the Pulse Flows Component would not involve construction of new recreation facilities or expansion of existing recreational facilities and no impact would occur. Therefore, the Pulse Flows Component contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.8 Geology and Soils

There exists a range of geologic features, soils, and paleontological resources within the geographic areas analyzed for impacts on geology and soils (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River, the Sacramento River from the confluence with the Feather River to the Delta, and the Delta). These areas have a variety of soil types, with certain soils and bank material being susceptible to erosion, and a very low level of seismic activity. Construction and operation of the projects listed in Table 4-1 would introduce new structures and features that could result in substantial soil erosion or the loss of topsoil; result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse in unstable soils; or directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. This could result in a cumulatively significant impact.

As described in Chapter 2, “Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in a reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.10, “Geology and Soils,” water levels, velocity, inundation extent, sediment transport, and bank erosion under the conservative pulse flow release scenario would remain within the typical range of hydrologic variability experienced in the system (see Appendix B). Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows. Therefore, the Pulse Flows Component would not result in substantial soil erosion or the loss of topsoil; increased potential for on- or off-site landslide, lateral spreading, subsidence, liquefication, or collapse; or directly or indirectly destroy a unique paleontological resources or site or unique geologic feature. Given the very low level of seismic activity in the study area, any impacts related to the risk of loss, injury, or death due to fault rupture, strong seismic ground shaking, seismic-related ground failure, or landslides would not be significant. Therefore, the Pulse Flows Component’s contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

4.5.9 Agriculture and Forestry Resources

Numerous and diverse agricultural and forestry resources exist within the geographic areas analyzed for impacts on agriculture and forestry resources (i.e., the Oroville Complex, the Low and High Flow Channels of the Feather River). The natural levees that border the Sacramento–Feather River system create backwater basins of heavy clay soils that help sustain agricultural uses. Construction and operation of the projects listed in Table 4-1 would introduce new structures and features that could result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to non-agricultural use, or forest land to non-forest use; or conflict with existing zoning for agricultural (e.g., Williamson Act contract) or forest land or timberland. This could result in a cumulatively significant impact.

As described in Chapter 2, “Description of the Pulse Flows Component," the Pulse Flows Component would provide ecosystem benefits on behalf of the WSIP Groundwater Projects that would improve habitat and migratory capacity for several native fish species through the release of pulse flows from Lake Oroville. DWR would make each pulse flow release, in an amount that is greater than regulatory releases and other contractual obligations. The requests for pulse flow releases could be made any time in the March, April, May, and/or June period of critically dry, dry, below-normal, or above-normal water year types and are expected to occur about every three years. The WSIP Groundwater Projects would develop water for the spring pulse flow release, resulting in reduced summer flow (July through September) from Lake Oroville, known as the Recovery Period, to replace the volume of SWP water reduced by a pulse flow release.

As described in Section 3.12, “Agriculture and Forestry Resources,” water levels, velocity, sediment transport, and bank erosion under the conservative pulse flow release scenario would remain within the typical range of variability of the existing hydrologic system (see Appendix B). Modeling of inundation extent shows that, under certain conditions, the release of a spring pulse flow has the potential to increase inundation of Farmland located within or adjacent to the study area, particularly in the Lower Sutter Bypass near its junction with the Sacramento River, as compared to typical spring conditions. While this degree of inundation remains within the existing system's typical range of hydrologic variability, spring planting is time-sensitive and a potential delay in planting during a pulse flow year could cause indirect conversion of Farmlands to non-agricultural use over time. However, this potential inundation of Farmland would be controlled and minimized by the requirements of the DWR/CDFW Agreement (see Section 2.4.2) such that no direct or indirect conversion to non-agricultural use would occur. Additionally, reduced releases from Lake Oroville during the Recovery Period would remain within the typical range of operational flows and would not be expected to reduce water deliveries to agricultural lands currently served by the SWP or otherwise affect or impede water supply in such a way that it would necessitate a change in water use or water management. The Pulse Flows Component would not result in the conversion of Farmland to non-agricultural use, or forest land to non-forest use; or conflict with existing zoning for agricultural (e.g., Williamson Act contract) or forest land or timberland. Therefore, the Pulse Flows Component's contribution to this potentially significant cumulative impact would not be considerable and this would be a **less-than-significant** cumulative impact.

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CHAPTER 5
Alternatives

5.1 Introduction

This chapter presents the CEQA alternatives analysis for the Pulse Flows Component. CEQA Guidelines Section 15126.6(a) states that an EIR must describe and evaluate a reasonable range of alternatives to the project that would feasibly attain most of the project's basic objectives and would avoid or substantially lessen any identified significant adverse environmental effects of the project. Specifically, CEQA Guidelines Section 15126.6 specifies that an EIR must do all the following:

- Describe a reasonable range of potentially feasible alternatives to the project that could feasibly attain most of the basic objectives of the project.
- Consider alternatives that could reduce or eliminate any significant environmental impacts of the proposed project (in this case, the Pulse Flows Component of the Water Storage Investment Program [WSIP] Groundwater Projects [Pulse Flows Component]), including alternatives that may be costlier or could otherwise impede the project's objectives.
- Evaluate the comparative merits of the alternatives.

The focus and definition of the alternatives evaluated in this Draft SEIR are governed by the "rule of reason," in accordance with CEQA Guidelines Section 15126.6(f). CEQA Guidelines Section 15126.6 requires that an EIR evaluate at least one "No-Project Alternative," evaluate a reasonable range of alternatives to the project, identify alternatives that were considered during the scoping process but eliminated from detailed consideration, and identify the "environmentally superior alternative."

Although CEQA Guidelines Section 15126.6[d] requires that alternatives be evaluated, it permits the evaluation to be conducted in less detail than for the proposed project (i.e., Pulse Flows Component).

According to CEQA Guidelines Section 15163, this Draft SEIR needs to contain only the information necessary to analyze the Pulse Flows Component, including changed circumstances and new information requiring additional environmental review. Although the WSIP Groundwater Projects' EIRs addressed alternatives to their respective projects, alternatives to the Pulse Flows Component were not described in the prior environmental documents. Therefore, consistent with CEQA Guidelines Section 15126.6(d), the information provided in this Draft SEIR is sufficient to allow for a meaningful evaluation, analysis, and comparison of the alternatives with the Pulse Flows Component.

Section 5.2 describes the alternatives selection process and the objectives of the Pulse Flows Component, summarizes the significant impacts of the Pulse Flows Component, and describes the alternatives that were considered but rejected from further analysis. Section 5.3 identifies the alternatives selected for detailed analysis, compares the environmental impacts of the alternatives to those of the Pulse Flows Component, and identifies the environmentally superior alternative.

5.2 Alternatives Development

5.2.1 Approach to Alternatives Selection

CEQA requires that an EIR describe and evaluate a range of reasonable alternatives to a project or to the location of a project that would feasibly attain most of the basic project objectives and avoid or substantially lessen significant project impacts. The alternatives selection process for the Pulse Flows Component was guided by the magnitude and severity of the impacts identified, and by the range of operational actions within DWR's control (e.g., discretion around water year type, flow rate, volume, timing, duration, frequency) while meeting the basic objectives of the Pulse Flows Component. The alternatives to the Pulse Flows Component considered in this Draft SEIR were developed based on information gathered during development of the range of potential pulse flow releases from Lake Oroville that may be requested by the California Department of Fish and Wildlife (CDFW).

Potential alternatives were screened based on their ability to feasibly attain the basic project objectives, their feasibility within the limits of the lead agencies' jurisdiction, and their ability to reduce or eliminate any significant environmental impacts of the implementation of the Pulse Flows Component.

- **Meeting project objectives—**The objectives of the Pulse Flows Component are introduced in Section 2.2 and presented below (Section 5.2.2). The CEQA Guidelines state that alternatives must feasibly attain most of the basic objectives of the project. Alternatives that did not meet the majority of the objectives for the Pulse Flows Component were screened out and not carried forward for further evaluation in the EIR.
- **Feasibility—**Alternatives that do not meet the requirements of applicable laws and regulations were not carried forward for further evaluation in the EIR.
- **Avoiding or lessening any potentially adverse environmental effect of the Pulse Flows Component—**Consistent with the CEQA Guidelines, alternatives should avoid or substantially lessen one or more of the significant environmental effects of implementation of the Pulse Flows Component. Alternatives that would not lessen or avoid a potentially significant environmental impact may be eliminated from detailed evaluation in the Draft SEIR.

5.2.2 Objectives

As presented in Chapter 2, "Description of the Pulse Flows Component," the objectives of the Pulse Flows Component are to:

- Provide for the release of pulse flows from Lake Oroville (in addition to any flows needed to meet by regulatory requirements).

- Improve habitat conditions for listed salmonids, primarily spring-run Chinook salmon, and improve conditions for spawning and migration of other listed and non-listed native fish species downstream of Lake Oroville, especially during drier water year types.
- Utilize contractual and operational mechanisms to avoid or minimize impacts on State Water Project (SWP) operations, SWP contractors, and water supplies that may result from pulse flow releases.

5.2.3 Significant Environmental Impacts

This section summarizes the significant impacts of the Pulse Flows Component, as analyzed in Chapter 3, "Environmental Setting, Impacts, and Mitigation Measures."

Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases; therefore, the impact analysis does not evaluate construction impacts.

Further, the third DWR action described in Chapter 2, "Description of the Pulse Flows Component," that discusses "conveyance and diversion of water to the WSIP Groundwater Projects" would not result in any resource area impacts. Diversion and conveyance of water would occur through the California Aqueduct (a concrete-lined canal) and would mimic existing conditions and fall within the typical range of hydrologic and operational variability experienced within the SWP system. Because no change from existing conditions would result from this DWR action, the action to divert and convey water to the Kern Fan Groundwater Storage Project (Kern Fan) and Willow Springs Water Bank Project (Willow Springs) was not evaluated in this Draft SEIR.

For similar reasons, the Harvey O. Banks Pumping Plant (Banks Pumping Plant) and California Aqueduct (geographic area 6) and San Luis Reservoir (geographic area 7) as described in Section 2.3, "Study Area," and depicted on Figure 2-2, were not analyzed in this Draft SEIR. These areas include SWP facilities (pumping plants, pipes, concrete lined canals, San Luis Reservoir, and turnout structures) that operate and control flow rates and water levels based on regulatory requirements and contracts.

San Luis Reservoir, owned by the United States Bureau of Reclamation and operated by the DWR, is an off-stream shared reservoir into which water is pumped and released seasonally. Water in the reservoir is sourced from the California Aqueduct and the Delta Mendota Canal. Fluctuations in reservoir storage and water surface elevations as part of the WSIP Operational Exchange Process are anticipated, which could increase the wetted area of habitats and other lands along the banks of San Luis Reservoir in spring months of a pulse flow year and decrease the wetted area in summer months. However, these fluctuations would be expected to normalize through the fall months of a pulse flow year and would remain within the typical range of operational variability experienced within the SWP/CVP system. These facilities would therefore not experience major fluctuations as a result of the pulse flow releases, and any changes in flow rates, water surface elevation, and/or reservoir storage involving these facilities during the WSIP Operational Exchange Process would remain within the typical range of existing operations.

Therefore, evaluation of significant environmental impacts in the Draft SEIR focuses on short- and long-term direct and indirect operational impacts associated with the release of pulse flows and the WSIP Operational Exchange Process within the Oroville Complex, the Low and High Flow channels of the Feather River, the Sacramento River from the Confluence with the Feather River to the Sacramento–San Joaquin Delta (Delta), and the Delta (geographic areas 1–5).

Only one potentially significant impact was identified in the Draft SEIR, related to ongoing Tribal consultation that could identify a tribal cultural resource that could be affected by the Pulse Flows Component (although no such resource has been identified at this time). This potentially significant impact can be reduced to a less-than-significant level through implementation of Mitigation Measure 3.8-1. No other significant impacts were identified in the analysis of the Draft SIER, and no other mitigation measures are required to reduce such impacts to a less-than-significant level. All cumulative impacts would be reduced to a less than cumulatively considerable level by the mitigation measure identified in this EIR.

5.2.4 Alternatives Considered but Rejected from Further Analysis

The CEQA Guidelines require an EIR to identify any alternatives that were considered by the lead agency but were rejected as infeasible, and to briefly explain the reasons underlying the lead agency's determination. Section 15126.6(c) of the CEQA Guidelines states the following:

> *The EIR should identify any alternatives that were considered by the lead agency but were rejected as infeasible during the scoping process and briefly explain the reasons underlying the lead agency's determination…Among the factors that may be used to eliminate alternatives from detailed consideration in an EIR are: (i) failure to meet most of the basic project objectives, (ii) infeasibility, or (iii) inability to avoid significant environmental impacts.*

The alternatives described below were rejected from further consideration and analysis because they would not avoid or substantially lessen significant environmental impacts, failed to meet the basic objectives, and/or were determined to be infeasible.

Alternate Pulse Flow Release Magnitude

The three WSIP Groundwater Projects have identified a maximum cumulative amount of water to collectively contribute to a pulse flow in any one-year period equivalent to approximately 100,000 acre-feet (af). The Contract for Administration of Public Benefits (CAPB) will govern CDFW's oversight with respect to the provision of public benefits from the WSIP Groundwater Projects, including CDFW's requests for the timing and magnitude of pulse flows to benefit native fish species.

As discussed in Section 2.4.1, "Description of the Potential Pulse Flow Releases," this Draft SEIR evaluated a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects, if available, and a maximum flow rate of 10,000 cubic feet per second (cfs) in the Low Flow Channel of the Feather River. This range of potential pulse flow magnitudes was proposed after careful consideration of alternate pulse flow volumes and flow rates outside this range. A pulse flow volume less than 5,000 af would likely not provide the volume of water or velocity needed for habitat benefits to be realized; therefore, the objectives of the Pulse Flows Component would not be met. On the other extreme, 100,000 af is the maximum volume of water that would be annually produced by the WSIP Groundwater Projects, so no greater volume is feasible; however, this volume of water could be released at a flow rate in the Low Flow Channel of the Feather River exceeding 10,000 cfs. Doing so may increase the benefits to habitat, spawning, and migration conditions for native fish but would also increase the likelihood of environmental impacts related to erosion, sediment transport, and inundation.

This alternative would not meet most objectives of the Pulse Flows Component and may increase short- or long-term direct or indirect effects on the environment and was therefore rejected from further consideration.

Alternate Pulse Flow Release Frequency

As discussed in Section 2.4.1, "Description of the Potential Pulse Flow Releases," this Draft SEIR evaluated pulse flows occurring at a frequency estimated to occur about every three years. This frequency of potential pulse flows was proposed after careful consideration of alternate pulse flow volumes and flow rates outside this range.

Certain alternate patterns for pulse flow release frequency were discussed, including:

- Annual releases at the maximum volume of 100,000 af in the early years of the Pulse Flows Component, followed by irregular releases through the Pulse Flows Component time horizon (50 years based on WSIP Groundwater Projects' estimated ability to fulfill the CAPB).
- Annual releases at a lower magnitude through the Pulse Flows Component time horizon (50 years).

The first alternate pattern would be infeasible because there would not be enough time for the WSIP Groundwater Projects to cumulatively develop enough water in their WSIP Exchange Storage Accounts to provide a full 100,000 af on an annual basis (see Section 2.4.2, "Description of Potential Pulse Flow Releases"). The second alternate pattern listed above would be infeasible because there is no practical way that wet years could be avoided. A pulse flow release in wet years (as opposed to dry or above-normal years) would unnecessarily increase potential impacts of the Pulse Flows Component (by adding pulse flows to higher baseline water levels and flow rates) while minimizing the potential ecosystem benefits (because wet years would naturally experience higher flow rates to the benefit of native fish species).

The evaluated conservative pulse flow release scenario frequency was informed based on the timing and volume of water anticipated to be developed by the WSIP Groundwater Projects and likely requests from CDFW based on biological benefits. Altering this timing would be infeasible and may increase short- or long-term direct or indirect effects on the environment and was therefore rejected from further consideration.

Alternate Pulse Flow Release and Recovery Period Timing

As discussed in Section 3.2, "Approach to Evaluate Impacts of the Pulse Flow Releases," this Draft SEIR evaluated the conservative pulse flow release scenario occurring in the spring months (March, April, May, or June) of critically dry or above-normal water year types about every three years, and evaluated the Lake Oroville Recovery Period (Recovery Period) occurring over the summer months (July, August, and September). This timing for the pulse flow release in spring months and Recovery Period in summer months was proposed after careful consideration of alternate timing.

A pulse flow release in spring months of drier years is designed to maximize habitat benefits to native fish species by occurring in tandem with the life histories and migration patterns of listed fish species (see Section 3.5, "Biological Resources–Aquatic"). A pulse flow release in an alternate season (i.e., in winter months) would reduce the ecosystem benefit derived from the pulse flow. In addition, a winter release would increase potential impacts of the Pulse Flows Component by adding a pulse flow during a time of year where baseline water levels are at their highest. Similarly, a pulse flow release in wet years (as opposed to dry or above-normal years) would unnecessarily increase potential impacts of the Pulse Flows Component while minimizing the potential ecosystem benefits (because wet years would naturally experience higher flow rates to the benefit of native fish species).

The summer Recovery Period was identified to recover Lake Oroville in the same calendar year as the pulse flow release while minimizing impacts on SWP contractors and water supplies. Discretionary Releases from Lake Oroville are minimal in the fall of drier years and therefore could not be relied on to accommodate recovery of storage levels. Reducing exports further could affect or impede water supply available to SWP contractors, water right holders, or other water suppliers, which would not meet the basic objectives of the Pulse Flows Component.

This alternative would not meet most objectives of the Pulse Flows Component and may increase short- or long-term direct or indirect effects on the environment and was therefore rejected from further consideration.

5.3 Alternatives to the Pulse Flows Component

Because the Pulse Flows Component would not result in any potentially significant impacts, only the No Project Alternative was identified for further evaluation in the Draft SEIR resulting from the alternatives development and screening process described above (as no other alternative was identified that would lessen a potentially adverse environmental effect). The No Project Alternative is described below, along with a comparison of the impacts of the alternative to the impacts of the implementation of the Pulse Flows Component. The No Project Alternative was also evaluated for an ability to achieve the objectives of the Pulse Flows Component.

Consistent with CEQA Guidelines Section 15126.6(d), the information provided in this Draft SEIR about the alternative is sufficient to allow for a meaningful evaluation, analysis, and comparison of the alternative with the Pulse Flows Component. If the alternative would cause one or more significant effects in addition to those identified for the Pulse Flows Component, the effects are discussed, but in less detail than for the Pulse Flows Component. In the following section, impacts are described with respect to whether they are likely to be similar to, more severe than, or less severe than the corresponding impacts of the Pulse Flows Component.

5.3.1 No Project Alternative

Description of the No Project Alternative

CEQA Guidelines Section 15126.6(e) requires consideration of a "no project" alternative. The purpose of this alternative is to allow the decision makers to compare the impacts of the proposed project with the impacts of not approving the proposed project. The No Project Alternative consists of existing conditions at the time the Notice of Preparation is published, and what would be reasonably expected to occur in the foreseeable future if the proposed project (i.e., Pulse Flows Component) were not approved, based on current plans and consistent with available infrastructure.

Under the No Project Alternative, DWR would not implement the Pulse Flows Component, defined by the following three actions, as described in Chapter 2, "Description of the Pulse Flows Component":

(1) Release of the pulse flows from Lake Oroville into the Low Flow Channel of the Feather River, with the goal of improving habitat conditions for listed salmonids, as well as improving spawning and migration conditions for other listed and non-listed native fish species.

(2) Implementation of the WSIP Operational Exchange Process that develops water used for pulse flow releases.

(3) Diversion and conveyance of water to Kern Fan and Willow Springs that would be stored, in part, for ecosystem benefit.

Operations at Lake Oroville and downstream facilities would remain unchanged from existing conditions. Pulse flows would not be released with the goal of providing ecosystem benefits to the Low Flow Channel of the Feather River, although DWR would continue to operate the SWP to meet all applicable procedures, guidelines, and contractual and regulatory requirements. DWR would continue to manage flows in the Low and High Flow Channels of the Feather River for fisheries purposes, based on agreements and BiOps (see Section 3.4.3) to preserve salmon and steelhead spawning and rearing habitat.

Because pulse flows would not be released, the WSIP Operational Exchange Process would not be needed to develop water used for the pulse flow releases. The amount of water stored at Lake Oroville and San Luis Reservoir and pumped at Banks Pumping Plant would remain the same as under existing conditions, which fluctuate seasonally and annually based on water year type, climate, water supply, and other operational factors. Diversion and conveyance of Article 21 water or pre-positioned yield water from the SWP to the WSIP Groundwater Projects would not occur, and the WSIP Groundwater Projects would not provide WSIP In-Lieu Table A Water to their Partner Contractors. Lake Oroville would not reduce Table A deliveries in the summer months, as storage levels would not need to be recovered from a pulse flow release.

The WSIP Groundwater Projects involve groundwater storage to improve local water supply in the San Joaquin Valley and Southern California. They received conditional funding from the California Water Commission for their water storage projects principally based on their ability to provide an ecosystem benefit, which would be accomplished via an exchange of water (the WSIP Operational Exchange Process) with DWR for the release of pulse flows from Lake Oroville into the Low Flow Channel of the Feather River. Without the ecosystem benefit provided by the Pulse Flows Component, the WSIP Groundwater Projects would be required to assess alternative means of providing ecosystem benefits, as a condition of their California Water Commission funding, or to find alternative funding mechanisms (outside the WSIP). At this time, it is unknown what alternative means of providing ecosystem benefits would be identified, and it would be speculative to determine whether those alternative means would result in environmental impacts.

Ability to Meet Project Objectives

The No Project Alternative would not meet the objectives of the Pulse Flows Component, which are to provide for the release of pulse flows from Lake Oroville (in addition to any flows required by regulatory permits); improve habitat conditions for listed salmonids, primarily spring-run Chinook salmon, and improve conditions for spawning and migration of other listed and non-listed native fish species downstream of Lake Oroville, especially during drier water year types; and utilize contractual and operational mechanisms to minimize impacts on SWP operations, SWP contractors, and water supplies that may result from pulse flow releases. Habitat and spawning and migration conditions for native fish species downstream of Lake Oroville would remain unimproved from existing conditions.

Environmental Impacts of the No Project Alternative Compared to those of the Pulse Flows Component

The No Project Alternative would not require any construction of new facilities or changes to existing operations. No short- or long-term direct or indirect effects on the environment would occur.

As summarized in Section 5.2.3, implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects' EIRs. SWP infrastructure downstream of the Delta (involved in the WSIP Operational Exchange Process and diversion and conveyance of water) would not experience any changes in flow rates or reservoir storage due to the Pulse Flows Component, as these facilities are operated and controlled based on regulatory requirements that would not change with implementation of the Pulse Flows Component. Additionally, as discussed in Section 3.4, "Hydrology and Water Quality," and Section 3.12, "Agriculture and Forestry Resources," and detailed in Appendix B, modeling results demonstrate that water levels and velocities associated with a maximum flow of 10,000 cfs in the Low Flow Channel during critically dry or above-normal years fall within ranges historically experienced in any given reach. While inundation extent associated with spring pulse flow releases may be increased as compared to typical spring conditions, the overall degree of inundation remains within the existing system's typical range of hydrologic variability as well. Changes to geomorphic processes (sediment transport and bank erosion) are also nominal, considering the natural variability of these processes in the Feather and Sacramento rivers. Therefore, the pulse flow releases would remain within the typical range of variability of the existing hydrologic system. Releases from Lake Oroville during the Recovery Period (as part of the WSIP Operational Exchange Process) would not fall below existing minimum operational and regulatory flow requirements and would therefore remain within the typical range of existing operational variability experienced within the system.

Because all changes to water levels, velocities, inundation extent, and geomorphic processes during the pulse flow releases and the Recovery Period would remain within a typical range of hydrologic and operational variability experienced in the existing system, the Pulse Flows Component would not result in any foreseeable short- or long-term direct or indirect effects on the environment. Only one potentially significant impact was identified in the Draft SEIR, and this potentially significant impact can be reduced to a less-than-significant level through implementation of Mitigation Measure 3.8-1.

The No Project Alternative would result in no impacts and the Pulse Flows Component would, depending on the resource, have either no impacts or less-than-significant impacts.

5.3.2 Environmentally Superior Alternative

CEQA requires identification of the environmentally superior alternative—that is, the alternative that would have the least significant impact on the environment. CEQA Guidelines Section 15126.6(e)(2) states: "If the environmentally superior alternative is the 'no project' alternative, the EIR shall also identify an environmentally superior alternative among the other alternatives."

As stated above, the No Project Alternative would have no impacts, whereas the Pulse Flows Component would, depending on the resource, have either no impacts or less-than-significant impacts. Therefore, the No Project Alternative would be the Environmentally Superior Alternative. However, only the Pulse Flows Component would achieve the objectives described in Section 5.2.2, including those associated with improved habitat conditions for listed salmonids and improved conditions for spawning and migration of other listed and non-listed native fish species downstream of Lake Oroville.

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CHAPTER 6
Other CEQA Considerations

6.1 Introduction

CEQA Guidelines Section 15126 requires that all phases of a project be considered in the evaluation of the project's impact on the environment, including planning, acquisition, development, and operation. As part of this analysis, the EIR must also identify all of the following elements:

- Significant environmental effects of the proposed project.
- Significant environmental effects that cannot be avoided if the proposed project is implemented.
- Significant irreversible environmental changes that would result from implementation of the proposed project.
- Growth-inducing impacts of the proposed project.

6.2 Significant and Unavoidable Impacts

CEQA Guidelines Section 15126.2(c) states that an EIR must describe impacts that would be significant and unavoidable if a proposed project were implemented. An impact is determined to be significant and unavoidable when either no mitigation, or only partial mitigation, is feasible to reduce the impact to a less-than-significant level.

As part of its certification action, DWR makes the final determination of the significance of impacts and feasibility of mitigation measures. The potential environmental impacts of the Pulse Flows Component are presented in Chapter 3, "Environmental Setting, Impacts, and Mitigation Measures," and summarized in the Executive Summary. All impacts can be feasibly mitigated to less-than-significant levels. Therefore, no significant and unavoidable adverse impacts would occur.

6.3 Significant Irreversible Environmental Changes

CEQA Guidelines Section 15126.2(d) requires an evaluation of the significant irreversible environmental changes that would be caused by a project if implemented. CEQA refers to the need to evaluate and justify the consumption of nonrenewable resources and the extent to which a project would commit future generations to similar uses of nonrenewable resources. In addition, CEQA requires that an EIR evaluate irreversible damage resulting from an environmental accident associated with the project.

As described in Chapter 2, “Description of the Pulse Flows Component,” the pulse flow releases and WSIP Operational Exchange Process would be managed by DWR in accordance with existing regulations and forthcoming agreements with the WSIP Groundwater Projects to ensure that pulse flow releases do not detrimentally affect operation of the SWP, including water supply, energy generation, and energy consumption.

As presented in Section 3.9, “Energy and Greenhouse Gas Emissions,” the Pulse Flows Component would not result in wasteful, inefficient, or unnecessary consumption of energy resources. The amount of energy consumed by the Pulse Flows Component and the rate of energy consumption would not result in the wasteful, inefficient, or unnecessary use of resources, and that energy would be consumed in a manner consistent with applicable laws and regulations. Therefore, the Pulse Flows Component would not result in substantial long-term consumption of energy and natural resources.

Finally, construction activities have the potential to result in an accidental release of hazardous materials that may lead to irreversible damage. Implementation of the Pulse Flows Component would not require construction of any new facilities in addition to those previously analyzed in the three WSIP Groundwater Projects’ EIRs. Existing facilities would be used, with operations modified to support the pulse flow releases. Therefore, no associated construction impacts would occur and there would not be irreversible damage resulting from an environmental accident.

6.4 Growth-Inducing Impacts

CEQA Guidelines Section 15126.2(e) requires that an EIR evaluate the growth-inducing impacts of a proposed project. For the reasons presented in Section 3.3.1, growth inducement is not discussed further.

CHAPTER 7
List of Preparers

7.1 CEQA Lead Agencies

Inland Empire Utilities Agency

Groundwater Banking Joint Powers Authority

Rosamond Community Services District

7.2 CEQA Responsible Agencies

California Department of Water Resources (Preparer of the Supplemental Environmental Impact Report)

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California Department of Fish and Wildlife

California Water Commission

State Water Resources Control Board

Rosedale-Rio Bravo Water Storage District

Irvine Ranch Water District

7.3 Supplemental Environmental Impact Report Consultant

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CHAPTER 8
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No references cited in this chapter.

Chapter 5, *Alternatives*

No references cited in this chapter.

Chapter 6, *Other CEQA Considerations*

No references cited in this chapter.

Chapter 7, *List of Preparers*

No references cited in this chapter.

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Appendix A
NOP and Public Scoping Comments

NOTICE OF PREPARATION
Draft Supplemental Environmental Impact Report
for the
Pulse Flows Component
of the
Water Storage Investment Program Groundwater Projects

Date: August 10, 2022
To: Public Agencies and Interested Parties
Subject: Notice of Preparation of a Draft Supplemental Environmental Impact Report
Project Title: Pulse Flows Component of the Water Storage Investment Program Groundwater Projects

Introduction

The three independent Water Storage Investment Program (WSIP) projects referenced in the title of this NOP are the:

1) Chino Basin Program (The Inland Empire Utilities Agency)

2) Kern Fan Groundwater Storage Project (The Groundwater Banking Joint Powers Authority, comprised of the Rosedale–Rio Bravo Water Storage District and Irvine Ranch Water District), and

3) Willow Springs Water Bank Project[1] (Rosamund Community Services District)

Collectively, these three projects will be referred to as the "WSIP groundwater projects."

The lead agencies (indicated in parentheses above) previously completed the CEQA review process for each of the WSIP groundwater projects. The projects involve groundwater storage and water exchange to enable pulse flows in the Feather River Watershed from Oroville Dam.

The California Department of Water Resources (DWR) will prepare a Supplemental Environmental Impact Report (SEIR) to supplement the existing environmental review for these three WSIP groundwater projects and to provide CEQA coverage for DWR's proposed action to facilitate a portion of the three projects: the Pulse Flows Component of the WSIP Groundwater Projects (Pulse Flows Component).

DWR, California Department of Fish and Wildlife (CDFW), and the State Water Resources Control Board (State Water Board) are responsible agencies (and/or trustee agency, in the case of CDFW) pursuant to CEQA for the WSIP groundwater projects. DWR, in conjunction with CDFW, will prepare the SEIR to analyze the environmental impacts of the Pulse Flows Component, and will conduct the associated CEQA public review process.

Water Storage Investment Program Background

WSIP is a $2.7 billion program for investments in water storage projects in California that was approved by voters in 2014 as part of Proposition 1. Storage projects eligible for WSIP funding include expanding

[1] The Willow Springs Water Bank Project was formerly known as the Antelope Valley Water Bank Project.

existing reservoirs, increasing groundwater storage, and building modern surface storage facilities. WSIP directs the California Water Commission to administer the program and distribute funding to potential projects through a competitive public process based on the projects' ability to deliver defined public benefits, including ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreation. After a rigorous review process, the California Water Commission awarded conditional funding to eight proposed projects in 2018. Following one project's withdrawal, seven projects continue to proceed towards completing the remaining WSIP requirements. These seven projects include the three WSIP groundwater projects that involve a water exchange and a pulse flow component that collectively is the subject of this Notice of Preparation (NOP).

The WSIP groundwater projects provide ecosystem benefits that will aid fish migration through the release of pulse flows from Lake Oroville by DWR. A "pulse flow" is an amount of water released above all regulatory requirements, creating flowrates for a specified period that exceed those that would have otherwise occurred. Generally, pulse flows would provide improved conditions related to (1) flow-dependent habitat availability, by affecting wetted area, depth, and velocity; (2) turbidity; (3) migration cues for juvenile and adult anadromous fishes; and (4) water temperature. Flowrates including pulse flows would not exceed those of a typical range of operational flows.

The WSIP groundwater projects would store new water supplies in groundwater facilities and distribute those supplies to partner contractors, for use in lieu of a portion of their deliveries from DWR's State Water Project (SWP) from Lake Oroville. SWP water that would have been released from Lake Oroville for deliveries to the partner contractors would be used for the pulse flows. The WSIP groundwater projects are independent of each other, and DWR would make pulse flow releases based on water made available to DWR by the WSIP groundwater projects that proceed to implementation.

The three WSIP groundwater projects' environmental documentation evaluated the impacts associated with construction and operation of the WSIP groundwater projects and are available at the following locations:

- Chino Basin Program (State Clearinghouse [SCH] #2021090310): https://www.ieua.org/chino-basin-program-ceqa-documents/.
- Kern Fan Groundwater Storage Project (SCH #2020049019): https://www.kernfanproject.com/environmental-review/
- Willow Springs Water Bank Project (SCH #2005091117): https://aquiferpumpedhydro.com/eir

The following description of the Pulse Flows Component details the pulse flow releases from Lake Oroville to aid fish migration as one of the benefit requirements of the WSIP groundwater projects.

Description of the Pulse Flows Component of the WSIP Groundwater Projects

The Pulse Flows Component of the WSIP groundwater projects, the subject of the SEIR DWR will prepare, would provide additional dedicated flows from Oroville Dam for fish enhancement for three WSIP groundwater projects that propose local supply improvements in their respective service areas in southern California.

To help achieve a return on the public funding they received, the WSIP groundwater projects would exchange water with the SWP to generate benefits for fish native to the Sacramento–San Joaquin Delta (Delta). The Pulse Flows Component of the WSIP groundwater projects would not involve construction;

rather, DWR in coordination with CDFW would make operational adjustments. DWR would release pulse flows from Lake Oroville at ecologically important times, to achieve higher instream flows for the benefit of native juvenile salmonid out-migration. In their applications for WSIP funding to the California Water Commission, the Chino Basin Program and Willow Springs Water Bank Project demonstrated improved emigration of juvenile Chinook Salmon, and the Kern Fan Groundwater Storage Project demonstrated benefits to Spring- and Winter-Run Chinook Salmon survival.

Through collaboration and adaptive management, in years selected based on environmental conditions and input from CDFW, DWR would release pulse flows of up to 100,000 acre-feet from Lake Oroville over a period of several days or weeks, as requested and as feasible. Volumes used for pulse flows at any given time will be limited by the amount of water stored specifically for this ecosystem purpose by one or more of the WSIP groundwater projects and available for exchange with SWP supplies stored in Lake Oroville.

Based on modeling, some level of pulse flow releases from Lake Oroville are projected to occur sporadically over a term of approximately 50 years, typically between March and May. The estimated term of the Chino Basin Program is 25 years. After the Chino Basin Program completes its contribution to environmental benefits, the water supplies available for pulse flows would be from the remaining two WSIP groundwater projects only. The pulse flows would not exceed the typical range of operational flows resulting from DWR's historic operation of Lake Oroville up to the time this NOP is published.

DWR would use this SEIR for CEQA coverage for any approvals needed for the WSIP groundwater projects, including for any agreements and water right changes needed for their implementation. For example, DWR is developing an agreement with CDFW to specify the criteria for the timing and volume of the pulse flow releases. The pulse flow releases from Lake Oroville would be in addition to releases necessary to meet regulatory requirements, as required by Proposition 1. DWR is also developing agreements with the WSIP groundwater project proponents, and agreements and/or contract amendments with SWP contractors involved in the WSIP groundwater projects. DWR will also seek an instream flow dedication (Water Code section 1707) from the State Water Board for the pulse flows to ensure that pulse flows are not improperly diverted from the Feather River, Sacramento River, or Delta by third parties.

Pulse Flows Component Location

The pulse flows component area, shown in Figure 1, extends along the Feather River (extending 0.5 mile from each bank of the river) from directly downstream of the Oroville Dam to its confluence with the Sacramento River (extending 0.5 mile from each bank of the river). It then follows the Sacramento River (extending 0.5 mile from each bank of the river) downstream of the Oroville Dam to the Delta, continues through the Delta and Suisun Marsh, and includes the SWP facilities from the Delta to the three WSIP groundwater projects. The primary SWP facilities associated with the pulse flows are Lake Oroville, the Harvey O. Banks Pumping Plant, and San Luis Reservoir. Water from San Luis Reservoir is released into the California Aqueduct, which conveys water supplies southward to the Central Coast, San Joaquin Valley, the Antelope Valley, and Southern California.

Pulse Flows Component Objectives

The objectives of the Pulse Flows Component are as follows:

- Provide for releases of pulse flows from Lake Oroville to facilitate fish migration without detrimentally affecting operation of the SWP, including water supply deliveries to SWP contractors. These pulse flows are in addition to any flows required by regulatory permits.
- Enhance conditions for salmonid and other fish species below Lake Oroville and farther downstream, especially during drier water year types.

Purpose of the Supplemental Environmental Impact Report

As explained in CEQA Guidelines Section 15163, a SEIR may be prepared when only minor additions or changes would be necessary to make the previously certified EIR adequately apply to the project in the changed situation. The SEIR needs to contain only the information necessary to make the previous CEQA documents adequate for the project as revised. Here, the changed situation is DWR refining the Pulse Flows Component originally proposed by the WSIP groundwater projects. When the CEQA lead agencies for the WSIP groundwater projects decide whether to make any discretionary approvals related to the WSIP groundwater projects, the decision-making bodies may consider the previous CEQA documents and this SEIR.

The SEIR will analyze environmental resources that may be affected by the Pulse Flows Component and will include regional setting information, regulatory background, identified thresholds of significance, an impact analysis, appropriate mitigation measures or alternatives to avoid or reduce any significant effects where feasible, and significance conclusions, as well as an assessment of project alternatives and cumulative and growth-inducing effects.

As stated above, the existing CEQA documents for the three WSIP groundwater projects evaluated the impacts of construction and operations of the WSIP groundwater projects, including local storage and management of exchange water, but could not provide a detailed analysis of the changes to SWP operations necessary to complete water exchanges, nor the release of the pulse flows from Lake Oroville. Thus, this SEIR will supplement the existing CEQA documents previously prepared for the three WSIP groundwater projects by evaluating the potential impact of the pulse flow releases on existing SWP operations and the affected environment.

Potential Environmental Effects

The SEIR will describe and analyze the potential environmental effects—both cumulative and project specific—of the Pulse Flows Component. It will summarize environmental issues for which potential impacts of the Pulse Flows Component are anticipated to be adequately addressed in the WSIP groundwater projects' environmental documentation, or for which the Pulse Flows Component is anticipated to have no impact(s): aesthetics; agriculture and forestry resources; growth inducement; land use; noise; population and housing; public safety and environmental hazards; transportation; and utilities and public services. The following resource areas are anticipated to be discussed in greater detail with additional impact analysis, because of the probability of environmental effects: air quality and greenhouse gas emissions; biological resources (vegetation, wildlife, and fisheries); cultural resources; tribal cultural resources; energy; geology, seismicity, soils, and mineral resources; hydrology and water quality (surface water and groundwater); recreation; and wildfire.

CEQA Scoping Meeting

DWR will host a virtual public scoping meeting to provide a brief presentation on the Pulse Flows Component with time for public comments on the scope and content of the SEIR. The scoping meeting will be held via remote teleconference on the Zoom platform on Monday, August 22nd, 2022 at 4:00 p.m. Please register in advance of the meeting at the following link: https://us02web.zoom.us/meeting/register/tZ0lfuiorTgoEtPNqbicnao7T1maFf_D7nIR. Registration will be open until the start of the meeting on August 22nd, 2022.

Written Comments

DWR is circulating this notice to solicit the views of interested persons, organizations, agencies, and California Native American Tribes, regarding the scope and content of the environmental information in connection with the Pulse Flows Component. The primary purpose of the scoping process is to identify important issues raised by the public, Tribal Governments, and responsible and trustee public agencies related to the issuance of regulatory permits and authorizations and natural resource protection. Written comments from interested parties are invited to ensure that the full range of environmental issues related to the development of the SEIR are identified.

As required by the CEQA Guidelines, within 30 days after receiving the Notice of Preparation, each responsible agency and trustee agency shall provide DWR with specific detail about the scope, significant environmental issues, reasonable alternatives, and mitigation measures related to each responsible or trustee agency's area of statutory responsibility that should be explored in the SEIR. In their responses, responsible and trustee agencies should indicate their respective level of responsibility for the project. DWR has commenced the Tribal consultation process regarding the SEIR.

This Notice of Preparation will be circulated for a 30-day public notice period beginning August 10, 2022, and ending September 9, 2022. At the end of the public notice period, DWR will consider all written comments received from interested persons, organizations, agencies, and Tribal Governments, in preparing the environmental analysis.

Written comments on the scope of the SEIR are due no later than 5 p.m. on September 9, 2022. Please submit your written comments via mail or email to:

Marianne Kirkland

California Department of Water Resources

P.O. Box 942836

Sacramento, CA 94236-0001

Email address: PulseFlowsComponent@water.ca.gov

If comments are provided via email, please include the project title in the subject line, attach comments in Microsoft Word format if possible, and include the commenter's U.S. Postal Service mailing address.

PLEASE NOTE: All comments received will be made available for public review in their entirety in the final EIR, including the names and addresses of the respondents. Individual commenters may request that DWR withhold their name and/or home addresses, but commenters who wish DWR to consider withholding this information must state this prominently at the beginning of their comments.

Jacob McQuirk

Jacob McQuirk, PE
Manager, Division of Operations and Maintenance, Water Projects Planning and Management Branch

Attachment

Figure 1: Pulse Flows Component Location

SOURCE: Esri, 2022; AECOM, 2021; DWR, 2016; ESA, 2022

Figure 1
Pulse Flows Component Location

ESA

California Water Boards

Gavin Newsom
Governor

Yana Garcia
Secretary for Environmental Protection

Lahontan Regional Water Quality Control Board

September 6, 2022

File: Environmental Doc Review
Kern County

Marianne Kirkland
California Department of Resources
P.O. Box 942836
Sacramento, CA 94236-0001
PulseFlowsComponent@water.ca.gov

Comments on the Notice of Preparation Draft Supplemental Environmental Impact Report for the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects – Willow Springs Water Bank Project, Kern County

Lahontan Regional Water Quality Control Board (Water Board) staff reviewed the Notice of Preparation (NOP) for the Draft Supplemental Environment Impact Report (Draft SEIR) for the Pulse Flow Component of the Water Storage Investment Program (Pulse Flow Project). The NOP of the SEIR, prepared by the California Department of Water Resources (DWR), was submitted in compliance with provisions of the California Environmental Quality Act (CEQA) soliciting input on the potential impacts on the environment and ways to avoid or mitigate those significant impacts.

The Water Board, acting as a CEQA responsible agency, initially provided comments in 2006, on the Draft Environmental Impact Report for the portion of the project related to the Antelope Valley Water Bank Project. The Antelope Valley Water Bank Project has since been renamed the Willow Springs Water Bank Project. Based on the information included in the NOP, the new components of the Pulse Flow Project do not appear to significantly impact the components the Willow Springs Water Bank Project at this time, however, Water Board staff would like to review the future Draft SEIR to properly comment on any updates to the overall scope of the project and any effects on the Lahontan Region.

If you have any questions regarding this letter, please contact me sergio.alonso@waterboards.ca.gov (760) 243-7324 or Ghasem Pour-Ghasemi, Senior Water Resource Engineer ghasem.pourghasemi@waterboards.ca.gov (760) 241-2434. Please send all future correspondence regarding this Project to the Water Board's email address at lahontan@waterboards.ca.gov and be sure to include the State Clearinghouse number and Project name in the subject line.

Sergio Alonso
Water Resource Control Engineer

State Water Resources Control Board

September 7, 2022

In Reply Refer to
JL: WSIP Pulse Flows
Project

CA Department of Water Resources c/o
Ms. Marianne Kirkland
P.O. Box 942836
Sacramento, CA 94236-0001
PulseFlowsComponent@water.ca.gov

Dear Ms. Kirkland:

NOTICE OF PREPARATION OF DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT (SEIR) FOR THE PULSE FLOWS COMPONENT OF THE WATER STORAGE INVESTMENT PROGRAM (WSIP) GROUNDWATER PROJECTS

The State Water Resources Control Board (State Water Board), Division of Water Rights (Division) staff has reviewed the Notice of Preparation (NOP) of the Draft SEIR for the Pulse Flows Component of the WSIP groundwater projects and appreciates the opportunity to comment as a CEQA Responsible Agency for approval of the water right changes associated with the proposed project. The Division's comments are as follows:

Pulse Flows Location
Page 3 of the NOP indicates the project area for the Pulse Flows Component extends along the Feather River downstream of the Oroville Dam to its confluence with the Sacramento River, then follows the Sacramento River to the Delta, and continues through the Delta and Suisun Marsh. The SEIR should describe if all the released pulse flows would be kept instream until they reach the Pacific Ocean or if any releases dedicated to the Pulse Flows Component would be rediverted or delivered to SWP contractors or customers following a pulse flow event. The NOP states that the primary SWP facilities associated with the Pulse Flows Component include Lake Oroville, the Harvey O. Banks Pumping Plant (Banks), and San Luis Reservoir. The SEIR should describe if any of the releases for the Pulse Flows Component would be rediverted at the Banks Pumping Plant or delivered to San Luis Reservoir and how this would change project operations at Banks or San Luis Reservoir.

Quantifying Operational Changes
The SEIR should analyze any potential and foreseeable impacts that may be caused by the Pulse Flows Component of the WSIP groundwater projects, including those that might stem from approval of any water rights change petitions. This analysis should

include a description of the changes to the flows and water quality within the affected streams due to the implementation of the Pulse Flows Component, in addition to the operational changes that would result through approval of the proposed water rights petitions. The cumulative impacts of the proposed project together with any other foreseeable projects on the Sacramento River system and the Delta should also be evaluated in the SEIR.

In addition, the SEIR should include:

- Information describing the pulse flow schedule, including: 1) the conditions under which pulse flows would occur, 2) how the water for the pulse flows is generated, and 3) the effects of changes in operation to make those pulse flows available, particularly in dry or critical years where operations and deliveries to contractors are governed by regulatory requirements, limited supply availability, and other factors outside of DWR's control;
- The decision-making process for the pulse flow release schedule;
- Accounting methodology to be used to track the pulse flow through the system and when it is no longer present;
- Modeling and analyses evaluating the effect of pulse flow releases on water temperatures, water quality, and flows, including during important migratory periods for native fish species;
- The relationship of pulse flows to a possible voluntary agreement related to the update and implementation of the Bay-Delta Water Quality Control Plan;
- In addition to analysis of impacts to the affected streams, the SEIR should analyze effects on Delta inflows, outflows, and water quality conditions caused by the implementation of the Pulse Flows Component.

We hope these recommendations are helpful in finalizing the scope of the environmental analysis required for the Pulse Flows Component of the WISP groundwater projects. If you require further assistance, please contact Jane Ling by email at Jane.Ling@waterboards.ca.gov. Written correspondence should be addressed as follows: State Water Resources Control Board, Division of Water Rights, Attn: Jane Ling, P.O. Box 2000, Sacramento, CA 95814.

Sincerely,

ORIGINAL SIGNED BY

Sam Boland-Brien, Manager
Petition, Licensing and Registration Section
Division of Water Rights

ec: Please see next page

ec: David Okita
David.Okita@water.ca.gov

Paige Uttley
Paige.Uttley@wildlife.ca.gov

Sarah Sugar
Sarah.Sugar@waterboards.ca.gov

Central Valley Regional Water Quality Control Board

8 September 2022

Marianne Kirkland
Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236
marianne.kirkland@water.ca.gov

COMMENTS TO REQUEST FOR REVIEW FOR THE NOTICE OF PREPARATION FOR THE DRAFT ENVIRONMENTAL IMPACT REPORT, PULSE FLOWS COMPONENT OF THE WATER STORAGE INVESTMENT PROGRAM GROUNDWATER PROJECTS, SCH#2022080216, ALAMEDA, BUTTE, CONTRA COSTA, FRESNO, KERN, KINGS, LOS ANGELES, RIVERSIDE, SACRAMENTO, SAN BERNARDINO, SAN JOAQUIN, SOLANO, STANISLAUS, SUTTER, YOLO, YUBA COUNTIES

Pursuant to the State Clearinghouse's 10 August 2022 request, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) has reviewed the *Request for Review for the Notice of Preparation for the Draft Environmental Impact Report* for the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects, located in Alameda, Butte, Contra Costa, Fresno, Kern, Kings, Los Angeles, Riverside, Sacramento, San Bernardino, San Joaquin, Solano, Stanislaus, Sutter, Yolo, Yuba Counties.

Our agency is delegated with the responsibility of protecting the quality of surface and groundwaters of the state; therefore, our comments will address concerns surrounding those issues.

I. Regulatory Setting

Basin Plan

The Central Valley Water Board is required to formulate and adopt Basin Plans for all areas within the Central Valley region under Section 13240 of the Porter-Cologne Water Quality Control Act. Each Basin Plan must contain water quality objectives to ensure the reasonable protection of beneficial uses, as well as a program of implementation for achieving water quality objectives with the Basin Plans. Federal regulations require each state to adopt water quality standards to protect the public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act. In California, the beneficial uses, water quality objectives, and the Antidegradation Policy are the State's water quality standards. Water quality standards are also contained in the National Toxics Rule, 40 CFR Section 131.36, and the California Toxics Rule, 40 CFR Section 131.38.

The Basin Plan is subject to modification as necessary, considering applicable laws, policies, technologies, water quality conditions and priorities. The original Basin Plans were adopted in 1975, and have been updated and revised periodically as required, using Basin Plan amendments. Once the Central Valley Water Board has adopted a Basin Plan amendment in noticed public hearings, it must be approved by the State Water Resources Control Board (State Water Board), Office of Administrative Law (OAL) and in some cases, the United States Environmental Protection Agency (USEPA). Basin Plan amendments only become effective after they have been approved by the OAL and in some cases, the USEPA. Every three (3) years, a review of the Basin Plan is completed that assesses the appropriateness of existing standards and evaluates and prioritizes Basin Planning issues. For more information on the *Water Quality Control Plan for the Sacramento and San Joaquin River Basins*, please visit our website:
http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/

Antidegradation Considerations

All wastewater discharges must comply with the Antidegradation Policy (State Water Board Resolution 68-16) and the Antidegradation Implementation Policy contained in the Basin Plan. The Antidegradation Implementation Policy is available on page 74 at:
https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr_201805.pdf

In part it states:

Any discharge of waste to high quality waters must apply best practicable treatment or control not only to prevent a condition of pollution or nuisance from occurring, but also to maintain the highest water quality possible consistent with the maximum benefit to the people of the State.

This information must be presented as an analysis of the impacts and potential impacts of the discharge on water quality, as measured by background concentrations and applicable water quality objectives.

The antidegradation analysis is a mandatory element in the National Pollutant Discharge Elimination System and land discharge Waste Discharge Requirements (WDRs) permitting processes. The environmental review document should evaluate potential impacts to both surface and groundwater quality.

II. Permitting Requirements

Construction Storm Water General Permit

Dischargers whose project disturb one or more acres of soil or where projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit), Construction General Permit Order No. 2009-0009-DWQ. Construction activity subject to this permit includes clearing, grading, grubbing, disturbances to the ground, such as stockpiling, or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). For more information on the Construction General Permit, visit the State Water Resources Control Board website at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtml

Clean Water Act Section 404 Permit

If the project will involve the discharge of dredged or fill material in navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the United States Army Corps of Engineers (USACE). If a Section 404 permit is required by the USACE, the Central Valley Water Board will review the permit application to ensure that discharge will not violate water quality standards. If the project requires surface water drainage realignment, the applicant is advised to contact the Department of Fish and Game for information on Streambed Alteration Permit requirements. If you have any questions regarding the Clean Water Act Section 404 permits, please contact the Regulatory Division of the Sacramento District of USACE at (916) 557-5250.

Clean Water Act Section 401 Permit – Water Quality Certification

If an USACE permit (e.g., Non-Reporting Nationwide Permit, Nationwide Permit, Letter of Permission, Individual Permit, Regional General Permit, Programmatic General Permit), or any other federal permit (e.g., Section 10 of the Rivers and Harbors Act or Section 9 from the United States Coast Guard), is required for this project due to the disturbance of waters of the United States (such as streams and wetlands), then a Water Quality Certification must be obtained from the Central Valley Water Board prior to initiation of project activities. There are no waivers for 401 Water Quality Certifications. For more information on the Water Quality Certification, visit the Central Valley Water Board website at: https://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_certification/

Waste Discharge Requirements – Discharges to Waters of the State

If USACE determines that only non-jurisdictional waters of the State (i.e., "non-federal" waters of the State) are present in the proposed project area, the proposed project may require a Waste Discharge Requirement (WDR) permit to be issued by Central Valley Water Board. Under the California Porter-Cologne Water Quality Control Act, discharges to all waters of the State, including all wetlands and other waters of the State including, but not limited to, isolated wetlands, are subject to State regulation. For more information on the Waste Discharges to Surface Water NPDES Program and WDR processes, visit the Central Valley Water Board website at:https://www.waterboards.ca.gov/centralvalley/water_issues/waste_to_surface_water/

Projects involving excavation or fill activities impacting less than 0.2 acre or 400 linear feet of non-jurisdictional waters of the state and projects involving dredging activities impacting less than 50 cubic yards of non-jurisdictional waters of the state may be eligible for coverage under the State Water Resources Control Board Water Quality Order No. 2004-0004-DWQ (General Order 2004-0004). For more information on the General Order 2004-0004, visit the State Water Resources Control Board website at:
https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2004/wqo/wqo2004-0004.pdf

Dewatering Permit

If the proposed project includes construction or groundwater dewatering to be discharged to land, the proponent may apply for coverage under State Water Board General Water Quality Order (Low Threat General Order) 2003-0003 or the Central Valley Water Board's Waiver of Report of Waste Discharge and Waste Discharge Requirements (Low Threat Waiver) R5-2018-0085. Small temporary construction dewatering projects are projects that discharge groundwater to land from excavation activities or dewatering of underground utility vaults. Dischargers seeking coverage under the General Order or Waiver must file a Notice of Intent with the Central Valley Water Board prior to beginning discharge.

For more information regarding the Low Threat General Order and the application process, visit the Central Valley Water Board website at:
http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2003/wqo/wqo2003-0003.pdf

For more information regarding the Low Threat Waiver and the application process, visit the Central Valley Water Board website at:
https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/waivers/r5-2018-0085.pdf

Limited Threat General NPDES Permit

If the proposed project includes construction dewatering and it is necessary to discharge the groundwater to waters of the United States, the proposed project will require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. Dewatering discharges are typically considered a low or limited threat to water quality and may be covered under the General Order for *Limited Threat Discharges to Surface Water* (Limited Threat General Order). A complete Notice of Intent must be submitted to the Central Valley Water Board to obtain coverage under

the Limited Threat General Order. For more information regarding the Limited Threat General Order and the application process, visit the Central Valley Water Board website at:
https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2016-0076-01.pdf

NPDES Permit

If the proposed project discharges waste that could affect the quality of surface waters of the State, other than into a community sewer system, the proposed project will require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. A complete Report of Waste Discharge must be submitted with the Central Valley Water Board to obtain a NPDES Permit. For more information regarding the NPDES Permit and the application process, visit the Central Valley Water Board website at: https://www.waterboards.ca.gov/centralvalley/help/permit/

If you have questions regarding these comments, please contact me at (916) 464-4684 or Peter.Minkel2@waterboards.ca.gov.

Peter Minkel

Peter Minkel
Engineering Geologist

cc: State Clearinghouse unit, Governor's Office of Planning and Research, Sacramento

Phone No. (661) 634-1400

Mailing Address
3200 Rio Mirada Drive
Bakersfield, CA 93308

September 9, 2022

Ms. Marianne Kirkland
California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236-0001

Re: Notice of Preparation for the Draft Supplemental Environmental Impact Report for the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects

Dear Ms. Kirkland:

The Kern County Water Agency (Agency) would like to thank you for the opportunity to review and comment on the Notice of Preparation (NOP) for the Draft Supplemental Environmental Impact Report (SEIR) for the Pulse Flows Component of the Water Storage Investment Program Groundwater Projects (Project).

The Agency was created by the California State Legislature in 1961 to contract with the California Department of Water Resources (DWR) for State Water Project (SWP) water. The Agency holds a water supply contract with DWR and has contracts with water districts throughout Kern County to deliver SWP water. Therefore, the Agency is uniquely qualified to provide comments.

Comment 1: The draft SEIR should demonstrate there will be no impacts to water supply, water deliveries or SWP finances.

The Agency is generally supportive of projects that seek to improve the water supply and reliability of Kern County water users. However, the proposed Project has the potential to significantly impact SWP Contractors and other water users within Kern County. The draft SEIR must demonstrate that the Project will not impact water supplies, water deliveries and/or SWP finances. The SEIR must demonstrate that the water released from Lake Oroville for pulse flows will be fully repaid in the same year it is released. The SEIR must also demonstrate that SWP Contractors' delivery schedules will not be impacted by the pulse flows. Releasing water from Lake Oroville earlier in the year can potentially reduce power generation opportunities. Further, the SEIR must demonstrate there will be no financial impacts to the SWP or SWP Contractors as a result of the Project.

If you have any questions, please contact Craig Wallace of my staff at (916) 407-7617.

Sincerely,

Holly Melton
Water Resources Manager

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Water Branch
P.O. Box 944209
Sacramento, CA 94244-2090
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

September 23, 2022

Marianne Kirkland
Supervising Engineer Water Resources Specialist
California Department of Water Resources
P.O. Box 942836
Sacramento, CA, 94236-0001

SUBJECT: PULSE FLOWS COMPONENT OF THE WATER STORAGE INVESTMENT PROGRAM (WSIP) GROUNDWATER PROJECTS (PROJECT) SCH# 2022080216

Dear Ms. Kirkland,

The California Department of Fish and Wildlife (CDFW) received a Notice of Preparation (NOP) from the California Department of Water Resources (DWR) pursuant to California Environmental Quality Act (CEQA) and CEQA Guidelines.[1]

Thank you for the opportunity to provide comments and recommendations regarding those activities involved in the Project that may affect California fish and wildlife. CDFW appreciates the opportunity to provide comments regarding aspects of the Project that the Department, by law, may be required to carry out or approve through the exercise of its own regulatory authority under the Fish and Game Code. While the comment period may have ended, CDFW would appreciate it if you will still consider our comments.

CDFW ROLE

CDFW is California's **Trustee Agency** for fish and wildlife resources and holds those resources in trust by statute for all the people of the State. (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a).) CDFW, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. (*Id.*, § 1802.) Similarly, for purposes of CEQA, CDFW is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources.

CDFW is also submitting comments as a **Responsible Agency** under CEQA. (Pub. Resources Code, § 21069; CEQA Guidelines, § 15381.) CDFW expects that it may need to exercise regulatory authority as provided by the Fish and Game Code. As proposed, for example, the Project may be subject to CDFW's lake and streambed alteration regulatory authority. (Fish & G. Code, § 1600 et seq.) Likewise, to the extent implementation of the Project as proposed may result in "take" as defined by State law of any species protected under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 et seq.), the project proponent may seek related take authorization as provided by the Fish and Game Code.

PROJECT DESCRIPTION SUMMARY

Proponent: California Department of Water Resources (DWR)

Objective: The objective of the Project is to supplement existing environmental review for three groundwater Water Storage Investment Program projects, Chino Basin Program, Kern Fan Authority, and Willow Springs Water Bank Project (WSIP Groundwater Projects), and to provide CEQA coverage for DWR's proposed action to facilitate the Pulse Flows Component of the WSIP Groundwater Projects, through preparation of a Supplemental Environmental Impact Report (SEIR).

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[1] CEQA is codified in the California Public Resources Code in section 21000 et seq. The "CEQA Guidelines" are found in Title 14 of the California Code of Regulations, commencing with section 15000.

Primary Project activities include facilitation of the Pulse Flow Component for WSIP Groundwater Projects. Specifically, pulse flow releases from Lake Oroville are intended to aid fish migration for public ecosystem benefit pursuant the WSIP requirements. Whereby "pulse flow" is defined as an amount of water released above all regulatory requirements, creating flow rates for a specified period that exceed those that would have otherwise occurred. DWR in coordination with CDFW, would make operational adjustments to release pulse flows from Lake Oroville to achieve higher instream flows for the benefit of native juvenile salmonid out-migration. DWR would release pulse flows up to 100,000 acre-feet from Lake Oroville over a term of approximately 50 years, between March and May. Pulse flow water is made available through exchanges with WSIP Groundwater Projects, which will store new water supplies, and distribute those supplies to State Water Project (SWP) partner contractors for use in lieu of a portion of their SWP deliveries from Lake Oroville. The SWP water, stored in Lake Oroville, that would have otherwise been used for deliveries would instead be used for pulse flows on the Feather River.

Location: The Project (Pulse Flows Component) extends along the Feather River from directly downstream of the Oroville Dam to its confluence with the Sacramento River, along the Sacramento River through the Delta and Suisun Marsh, and includes the SWP facilities from the Delta to the three WSIP Groundwater Projects.

COMMENTS AND RECOMMENDATIONS

CDFW offers the comments and recommendations below to assist DWR in adequately identifying and/or mitigating the Project's significant, or potentially significant direct and indirect impacts on fish and wildlife (biological) resources. To clarify, CDFW will consult with DWR on the Project SEIR to analyze the environmental impacts of the pulse flow component as a Responsible and Trustee Agency but does not intend to prepare the SEIR.

The WSIP Groundwater Projects may each have CDFW-related permitting requirements related to the California Endangered Species Act (CESA) and mitigation measures associated with CDFW's Lake and Streambed Alteration Program. As a Responsible Agency, through a CESA Incidental Take Permit or Lake and Streambed Alteration Agreement, CDFW may recommend or require project avoidance, minimization, or mitigation measures to reduce harmful impacts to fish and wildlife resources, which could necessitate modifications to either of the WSIP Groundwater Projects.

The Project, as analyzed by the SEIR, shall be distinct and provide additional water releases above all SWP regulatory requirements, including FERC Project No. 2100 requirements prescribed in the federal Biological Opinion, SWRCB Water Quality Certification, FERC Settlement Agreement, and the Sacramento-San Joaquin Bay-Delta Estuary Decision 1641 compliance. The NOP states four aspects of improved conditions provided by pulse flow(s) (p.2), (1) flow-dependent habitat availability, by affecting wetted area, depth, and velocity; (2) turbidity; (3) migration cues for juvenile and adult anadromous fishes; and (4) water temperature. The SEIR should also analyze and include a fifth condition; (5) reach specific survival in areas with high infectivity rate by in-river pathogens like *Ceratomyxa shasta.* Pulse flows benefit both native and hatchery in-river released juvenile salmonid out-migration by improving all five of these environmental conditions.

CDFW understands the purpose of this SEIR is to analyze potential Project constraints as well as evaluate potential effects related to a maximum combined pulse flow volume provided by the three WSIP Groundwater Projects collectively. However, the exact implementation details of future pulse flows are dependent on a number of factors including, but not limited to, when each of the WSIP Groundwater Projects becomes operational. As such, the SEIR should clearly articulate what general assumptions are included in the analysis, such as environmental condition, anticipated release volume, timing, ramping rates, and cumulative effects; as well as discuss any limitations of the assessment and acknowledge potential areas of uncertainty. The SEIR should also include a discussion of how forecasting and decision-based timelines will be implemented in the future and/or disclose in what agreements, contracts, and/or permits the associated process will be established and implemented.

ENVIRONMENTAL DATA

CEQA requires that information developed in environmental impact reports and negative declarations be incorporated into a database which may be used to make subsequent or supplemental environmental determinations. (Pub. Resources Code, § 21003, subd. (e).) Accordingly, please report any special status species and natural communities detected during Project surveys to the California Natural Diversity Database (CNDDB). The CNNDB field survey form can be filled out and submitted online at the following link: https://wildlife.ca.gov/Data/CNDDB/Submitting-Data. The types of information reported to CNDDB can be found at the following link: https://www.wildlife.ca.gov/Data/CNDDB/Plants-and-Animals.

ENVIRONMENTAL DOCUMENT FILING FEES

The Project, as proposed, would have an impact on fish and/or wildlife, and assessment of environmental document filing fees is necessary. Fees are payable upon filing of the Notice of Determination by the Lead Agency and serve to help defray the cost of environmental review by CDFW. Payment of the environmental document filing fee is required in order for the underlying project approval to be operative, vested, and final. (Cal. Code Regs, tit. 14, § 753.5; Fish & G. Code, § 711.4; Pub. Resources Code, § 21089.)

CONCLUSION

CDFW appreciates the opportunity to comment on this NOP to assist DWR in identifying and mitigating Project impacts on biological resources.

Questions regarding this letter or further coordination should be directed to Paige Uttley Senior Environmental Scientist Supervisor, at Paige.Uttley@wildlife.ca.gov.

Sincerely,

DocuSigned by:
Brooke Jacobs
63D88D861032425...

Brooke Jacobs
Acting Water Branch Chief

cc: Office of Planning and Research, State Clearinghouse, Sacramento

ec: **California Department of Water Resources**

David Okita, Special Consultant
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California Department of Fish and Wildlife

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California Water Commission

Joe Yun, Executive Officer
Joseph.Yun@water.ca.gov

Amy Young, WSIP Manager
Amy.Young@water.ca.gov

Appendix B

Hydraulic and Sediment Transport Analysis of the Feather and Sacramento Rivers California – Technical Support for the Supplemental Environmental Impact Report for the Pulse Flows Component of the Water Storage Investment Program (Draft)

HYDRAULIC AND SEDIMENT TRANSPORT ANALYSIS OF THE FEATHER AND SACRAMENTO RIVERS CALIFORNIA – TECHNICAL SUPPORT FOR THE SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT FOR THE PULSE FLOWS COMPONENT OF THE WATER STORAGE INVESTMENT PROGRAM

Prepared for
ICF Jones & Stokes, Inc.
California Department of Water Resources

Prepared by
cbec, inc.

September 2023

Project #: 23-1008

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GLOSSARY OF ACRONYMS

Acronym	Meaning
1D	one-dimensional
2D	two-dimensional
AN	above normal
BC	boundary condition
cbec	cbec eco engineering, inc.
CD	critically dry
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CVFED	Central Valley Floodplain Evaluation and Delineation Program
CVFPP	Central Valley Flood Protection Program
DEM	digital elevation model
DWR	California Department of Water Resources
FRRM	Feather River Regional Model
ft	feet
HEC	USACE Hydraulic Engineering Center
HEC-RAS	USACE Hydraulic Engineering Center – River Analysis System software
IQR	interquartile range
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
RM	river mile
RMSE	root-mean-square-error
RS	HEC-RAS model river station
RTK-GPS	Real-time Kinematic Global Positioning System
SEIR	Supplemental Environmental Impact Report
WSE	water surface elevation
WY	water year
WSIP	Water Storage Investment Program
XS	cross section

1 INTRODUCTION

cbec has conducted technical analysis to support the Supplemental Environmental Impact Report (SEIR) for the Pulse Flows Component of the Water Storage Investment Program (WSIP) Groundwater Projects (Pulse Flows Component). This analysis includes an evaluation of potential impacts related to the implementation of pulse flow releases to the lower Feather River from the Oroville Facility. The evaluation includes quantification of changes to hydraulic properties (depth, velocity, and inundation extents) on the Feather and Sacramento Rivers (**Figure 1**) that would be realized for the duration that the pulse flows are implemented relative to existing conditions. In addition, analysis has been conducted to provide insight into how the pulse flow may affect longer term geomorphic processes related to erosion and deposition within the river corridor.

1.1 PULSE FLOW RELEASE DESCRIPTION

A detailed description of the proposed pulse flow releases and the assumptions made to support the impact assessment are included in Section 2.4 of the Draft SEIR. Excerpts from this description are included below and provide a basis for the impact assessment.

The three WSIP Groundwater Projects have identified a maximum cumulative amount of water to collectively contribute to a pulse flow in any one-year period equivalent to approximately 100,000 acre-feet (af). The magnitude of a pulse flow release will depend on the volume of water made available by the WSIP Groundwater Projects, as well as on CDFW's request and DWR's approval of the pulse flow release. In a given year, CDFW may request a pulse flow volume ranging from 5,000 af to the full 100,000 af developed by the WSIP Groundwater Projects, if available, and may request a maximum flow rate of 10,000 cfs. The requested flow rate would be derived by considering the base flow of the low flow channel of the Feather River, which ranges from about 750 cfs to 3,000 cfs,[1] plus the pulse flow, so the combined potential flow would not exceed 10,000 cfs.

The pulse flow releases would augment flows in the lower Feather River, Sacramento River, and through the Delta in drier years when there are typically lower flows (e.g., dry or below normal water year types). The request for pulse flow releases could be made any time in the spring months (March, April, May, and/or June) of critically dry, dry, below normal, or above normal water year types. A "recovery period" for Lake Oroville would occur during the summer months (July through September) immediately following a pulse flow release. The recovery period is the expected amount of time it would take for Lake Oroville storage to reach an equivalent level that would have occurred without the pulse flow.

[1]A 2016 Biological Opinion issued by NMFS sets a minimum instream flow requirement for the low flow channel of the Feather River at 700 cfs, which increases to 800 cfs from September 9 through March 31 of each year to accommodate spawning, unless NMFS, USFWS, and CDFW provide a written notice that a flow between 700 and 800 cfs will substantially meet the needs of anadromous fish (in which event, DWR may release that lower flow) (NMFS 2016). This is a regulatory requirement, and all regulatory and operational requirements of the Oroville Complex and SWP would continue to be met with the Pulse Flows Component.

1.2 CONSERVATIVE PULSE FLOW RELEASE SCENARIO

For the impact analysis, the Draft SEIR defines a conservative pulse flow release scenario (magnitude, duration, and frequency) because there could be substantial variation in the number of pulse flows requested, the volume of water dedicated to each pulse flow, and/or the flow rate of each pulse flow release. The conservative pulse flow release scenario is defined as a maximum flow of 10,000 cfs (base flow plus pulse flow release) over a short duration (~5 days) in the spring months (March, April, May, or June) of critically dry (CD) and above normal (AN) water year types, estimated to occur about every three years.

DWR would not likely approve a pulse flow release in a critically dry year; however, evaluating anticipated effects of the pulse flows component in a critically dry year provides a conservative analysis of impacts across all dry water year types (i.e., critically dry, dry, and below normal water years); this is because the release of a pulse flow in a critically dry year would create the most noticeable change in flowrates, water levels, and inundation, and would necessitate the longest recovery period for Lake Oroville, as compared to “dry year” conditions. Similarly, as the pulse flow releases are aimed at augmenting flows in the lower Feather River, Sacramento River, and through the Delta in drier years, when there are typically lower flows, CDFW is unlikely to request a pulse flow in a wet water year. However, in the event a pulse flow occurs in a year that becomes wetter than expected, evaluating anticipated effects of the Pulse Flows Component under these conditions is necessary to analyze the upper range of potential impacts of increased flowrates, water levels, and inundation in a system experiencing an above normal water year.

The conservative pulse flow release scenario is simulated using a hydrodynamic HEC-RAS model of the Feather and Sacramento rivers to quantify effects of the pulse flow releases on hydraulic properties of existing conditions. In addition, output from the hydrodynamic model simulations are used to examine pulse flow effects on geomorphic processes including cumulative sediment transport mass and bank erosion.

2 MODEL DEVELOPMENT

2.1 CVFPP/SUTYOL MODEL ADAPTATION

For this study, we adapted the Sutter and Yolo Bypass HEC-RAS model (SUTYOL) originally developed by CH2M under the CVFPP Task Order 15-12 (DWR 2017). The SUTYOL model serves as the base model for the Feather River Regional Model (FRRM) we developed for use in this study (**Figure 2**). For a full description of the CVFPP 1D/2D model, the reader is referred to DWR (2017).

2.2 MODEL DOMAIN TRUNCATION

For this study, we implemented the Feather River Regional Model (FRRM) with HEC-RAS 6.3.1 software (USACE 2016). The SUTYOL 1D/ 2D hybrid model, developed as part of the CVFPP, extends south from Chico, CA to the Sacramento–San Joaquin River Delta, south of Rio Vista, CA. The model includes all major tributaries to the Sacramento River system, including the Feather River from Lake Oroville, Yuba River, Bear River, Sutter Bypass, and American River. We reduced the spatial domain of the model to focus on the areas of interest for this study and increase model efficiency. We truncated the model to move boundary conditions to long-standing gage (flow and stage) locations where available (**Figure 2**). The model roughness values were also modified from the original model to calibrate to observed water surface elevation data.

2.3 MANNING'S N VALUES

We adapted floodplain Manning's n (roughness) values in the 2D domains from vegetation cover from the California Department of Fish and Wildlife VegCAMP program. The VegCAMP data are based on higher resolution images and data extraction techniques than the original CVFPP model roughness mapping. We merged two data sets from the VegCAMP library to cover the entire Feather River Regional Model domain: the 2016 Delta Vegetation and Land Use Update (ds2855) and the Great Valley Ecoregion Vegetation and Land Use Mapping (ds2632). After initial simulations, we adjusted the Manning's n values to calibrate the model to stages observed at the gaging stations in 2019. **Figure 3** details the final calibrated roughness values. **Tables 1 and 2** present the final calibrated Manning's n values from the FRRM model. Calibration of the model elements representing sand-bed reaches required flow-varying roughness values to reflect bedform development with increasing discharge and depth.

Table 1. - 2D domain Manning's n values

Land Cover Type	Manning's n Value
Annual Grassland	0.03 – 0.055
Barren	0.03
Blue Oak-Foothill Pine	0.05
Coastal Oak Woodland	0.05
Coastal Scrub	0.06
Deciduous Orchard	0.0325 – 0.05
Eucalyptus	0.06
Evergreen Orchard	0.06
Fresh Emergent Wetland	0.06
Irrigated Grain Crops	0.03
Irrigated Row and Field Crops	0.03
Riverine	0.025 – 0.04
Mixed Chaparral	0.05
Montane Hardwood	0.05
Pasture	0.03
Rice	0.03
Saline Emergent Wetland	0.07
Urban	0.06
Valley Foothill Riparian	0.08
Valley Oak Woodland	0.05
Vineyard	0.04
Wet Meadow	0.03

Table 2. - 1D Manning's n values

River Name	Model Reach	Manning's n Values	
		Channel	Floodplain
American River	AME R01	0.035 – 0.04	0.035 - 0.1
Bear River	BEA R01	0.04	0.035 - 0.1
Colusa Basin Drain	COD R01	0.035	0.045 – 0.055
Feather River	FEA R01	0.027	0.04 – 0.065
	FEA R02	0.0275 – 0.03	0.06 – 0.088
	FEA R04	0.035 – 0.04	0.06 - 0.08
	FEA R05	0.035 – 0.04	0.055 – 0.08
Knight's Landing Ridge Cut	KNI R01	0.035 – 0.045	0.035 - 0.06
NEMDC/Steelhead Creek	NEM R01	0.039	0.056 – 0.062
Sacramento River	SAC R11	0.04	0.04 – 0.075
	SAC R12	0.03 – 0.037	0.04 – 0.075
Wadsworth Canal	WAD R01	0.04	0.04

2.4 BOUNDARY CONDITONS

Boundary conditions (BC) for a hydraulic model represent numerical points where water enters or exits the model. Upstream BCs are locations where water enters the system and are typically represented by time series corresponding to flow hydrographs. Downstream BCs are locations where water exits the system and are commonly represented by time series corresponding to stage hydrographs. **Figure 2** and **Table 3** detail the FRRM BC locations and source information.

2.4.1 FLOW

The majority of model inflow BCs were obtained from published records from the USGS and DWR (**Table 3**). Several model inflow locations were assumed to be steady inflows. These locations include Natomas Cross Canal, Steelhead Creek, and Wadsworth Canal, which are small tributaries to the model domain and do not have gaged data; and thus, an estimated minimum flow was specified to avoid numerical "dry" conditions and to maintain model stability. We determined the required minimum base flows at these locations though model sensitivity testing.

We estimated inflows to Bear River and Honcut Creek (tributaries to the Feather River) using hydrologic models (HEC HMS) of these watersheds originally developed in support of CVFED (USACE 2013a and 2013b). We used these models without parameter modification to simulate streamflow based upon observed 2019 precipitation data acquired from the National Oceanic and Atmospheric Administration (NOAA).

2.4.2 STAGE

Downstream BCs were stages at the Yolo Bypass at Lisbon Weir and on the Sacramento River at Freeport (**Table 3**; **Figure 2**). WSE data were converted from gage datums to NAVD88 for use in the FRRM.

Table 3. - Model boundary conditions summary

Location	Data Source	Data Source/ Weblink
Upstream (Flow)		
Feather River at Oroville	DWR A05191	Direct from DWR
Thermalito Afterbay	DWR A05975	Direct from DWR
Sacramento River at Colusa	USGS 11389500	https://waterdata.usgs.gov/ca/nwis/uv/?site_no=11389500
Butte Slough near Meridian	DWR A02972	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A02972
Colusa Basin Drain	DWR A02945	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A02945
Knights Landing Ridge Cut	DWR A02939	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A02939
Cache Creek Settling Basin	USGS 11452800	https://waterdata.usgs.gov/ca/nwis/uv/?site_no=11452800
Putah Creek	-	Estimated
Natomas Cross Canal	-	Estimated
Steelhead Creek/ NMDC	-	Estimated
Wadsworth Canal	-	Estimated
American River at Fair Oaks	USGS 11446500	https://waterdata.usgs.gov/ca/nwis/uv/?site_no=11446500
Downstream (Stage)		
Sacramento River at Freeport	USGS 11447650	https://waterdata.usgs.gov/ca/nwis/uv/?site_no=11447650
Yolo Bypass near Lisbon Weir	DWR B91560	https://wdl.water.ca.gov/ContinuousData.aspx?site2=B91560
Calibration Data		
Feather River near Gridley	DWR A05165	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A05165
Feather River at Yuba City	DWR A05135	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A05135
Feather River at Boyd's Landing	CDEC FSB	https://cdec.water.ca.gov/dynamicapp/QueryF?s=FSB
Feather River at Nicolaus	DWR A05102	https://wdl.water.ca.gov/ContinuousData.aspx?site2=A05102
Sacramento River at I-Street	DWR A02100	https://wdl.water.ca.gov/ContinuousData.aspx?site2= A02100

3 MODEL CALIBRATION

We calibrated the model by adjusting Manning's n values to obtain the best agreement between simulated and observed WSEs during a defined calibration period throughout the model domain. "Best agreement" was determined by the judgement of experienced hydraulic modelers carefully examining observed and simulated stage hydrographs for each gage. The following section details this procedure. Data for calibration was sourced as described in **Table 3** above. For the calibration period, basic summary statistics were computed, as well as root mean square errors (RMSE), which is an indicator of how well model results fit the observed data. The RMSE is the standard deviation of model errors. The smaller the RMSE, the better the model fit.

3.1 STAGE CALIBRATION RESULTS

The model was used to simulate water levels experienced from March 15, 2019 to May 28, 2019. Flow releases from Oroville Dam to the Low Flow Reach during this time ranged from about 1,650 to 16,500 cfs. Flows from the Thermalito Afterbay ranged between 3,200 to 8,500 cfs. These ranges of flow encompass planned pulse flow conditions. This period also provides a range of tributary flows. **Table 4** below details the calibration period results. Overall, simulated peak water surface elevations were within 0.5 ft of observed elevations, and RMSE's were less than 1 ft.

Figure 4 shows calibration results for the Feather River at Gridley. Calibration was achieved by balancing the lower stages with higher stages. By increasing or decreasing roughness values, better agreement between the model output and either high flow or low flow water levels could be obtained. However, we selected roughness values to best represent the full range of stages. This approach produced an RMSE of about 0.4 ft. The difference between the maximum observed stage and the maximum simulated stage was also about 0.4 ft.

Calibration results for the Feather River at Yuba City are shown in **Figure 5**. Excellent calibration was achieved across a range of stages including maxima. This calibration location experiences a backwater influence from the Yuba River, which is a critical hydraulic control in the system. The FRRM has been shown to replicate stages at Yuba City under a range of complicated hydraulic conditions.

Stage data from the gage at Boyd's Pump, situated about 7 miles downstream from Yuba City, serves to assess the model's performance downstream of the confluence of the Feather and Yuba Rivers. **Figure 6** shows calibration results for this station. The model is well calibrated across a range of stages, and both the difference in maximum stages and RMSE were about 0.25 ft.

The final calibration point along the Feather River is the Nicolaus station, just downstream of Highway 99, near where the Feather River joins the Sutter Bypass to the west. Similar to the Yuba City gage, the Nicolaus gage experiences backwatering from the Sutter Bypass and Sacramento Rivers. The backwater effect can lead to multiple stages for the same discharge rate over the course of a flood. **Figure 7** shows the calibrated water levels for the Nicolaus gage. Excellent calibration was achieved over a range of stages at this location.

Approximately 1.5 miles downstream of the confluence of the Feather and Sacramento Rivers, is the Verona gage operated by the USGS. Calibration results for the Verona gage are shown in **Figure 8**. The model is well calibrated for stages corresponding to water levels over 20 ft NAVD88. However, a short tidal-dominated period in May indicates the model slightly overpredicts at very low stages. This model overprediction during tidal periods leads to an elevated RMSE, because RMSE is sensitive to outliers. Figure 8 shows that during most of the model simulation period, simulated water levels match observed water levels well.

The final calibration point in the model is just downstream of the confluence of the Sacramento and American Rivers, in downtown Sacramento (**Figure 9**). These results closely follow the pattern observed at Verona. The model overpredicts stages during the tidal-dominated period; however, higher stages are well calibrated and peak water levels were simulated within 0.2 ft of observed levels.

Table 4. - Stage calibration summary

Location	Interval	Max. Observed (ft)	Max. Modeled (ft)	Max. Difference Mod-Obs (ft)	RMSE (ft)
Feather River near Gridley	Hourly	82.14	81.75	0.39	0.41
Feather River at Yuba City	Hourly	48.40	48.36	-0.04	0.36
Feather River at Boyd's Landing	Hourly	42.10	42.31	0.21	0.28
Feather River at Nicolaus	Hourly	35.46	35.43	-0.03	0.26
Sacramento River at Verona	Hourly	32.10	32.30	0.20	0.98
Sacramento River at Sacramento (I Street)	Hourly	23.73	23.88	0.15	0.71

4 HYDRAULIC IMPACT ASSESSMENT

An assessment was performed using the FRRM to investigate the impacts of a 10,000 cfs pulse flow + base flow release from the Oroville Dam to the Low Flow reach of the Feather River. This analysis was used to better understand the effects of pulse flows on depth, velocity, and inundation extent within the study area. These variables not only provide useful information to river managers about potential water level changes near infrastructure, but also act as a surrogate for other processes in the river system. For example, increased depth and velocity may increase forces on channel bed and banks, which in turn are linked to sediment transport and bank erosion processes. Although these hydraulic variables and geomorphic processes are related, subsequent sections in this document further explore relationships between pulse flows, sediment transport and bank erosion in a more rigorous fashion.

The Feather River below Oroville Dam has experienced radical change since European settlement of the region in the 1800s. Prior to the completion of the Oroville Dam in 1968, large snowmelt dominated floods were frequently experienced along the Feather River. Since dam closure, peak flows were significantly reduced. Not only did the dam reduce peak flows, but it also virtually eliminated sediment transport past the dam. Over time, reduced flows of water and sediment have resulted in an incised and narrowing channel geometry and a general coarsening of the bed material composition.

In the late 19th century gold mining boomed in California, and hydraulic mining was conducted along the Feather and Yuba Rivers. Hydraulic mining used pressurized water to blast apart steep slopes in search of gold. This method is highly effective and fast; however, it creates an abundance of sediment ("tailings") which were transported by the river. Over the course of many years, these hydraulic mining tailings were transported downstream and deposited in the Feather River floodplain. After hydraulic mining was outlawed in the late 1800s and with dam construction in the 1960s, the sediment supply was significantly reduced and the river subsequently eroded/incised into these mining deposits, creating the present-day channel of the Feather River. Between Gridley and Yuba City, fine-grained sandy material-comprised hydraulic mining deposits form high unstable banks along the river. In the following analysis, we have subdivided the study area into discrete geomorphic reaches to better capture the spatial variability associated with bed material composition, the predominance of hydraulic mining deposits as well as the changes in discharge due to tributary additions to the Feather River.

4.1 APPROACH

In this analysis, we investigated historical discharge records from water years (WY) (October 1st through September 30th) 1996 to 2021. To bookend our analysis and investigate a dry, low flow condition, and a wetter, higher flow condition, we limited this analysis to critically dry and above normal water years, as defined by the Sacramento River Index (https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST). Data from wet water years were withheld from this portion of the analysis, under the assumption that a pulse flow would likely not be implemented in a wet year. It was assumed that the pulse flows would not be released during floods or potential floods. This analysis also targeted flows between March and June, as this is when the pulse flows are planned.

The hydraulic impact analysis consists of two parts. The first examined the instantaneous effect of the pulse flow release in above normal (AN) and critically dry (CD) water years at the maximum proposed rate (10,000 cfs in the low flow channel) and volume (100,000 af). The effects were compared to existing conditions under a steady state by defining baseline with mean monthly flow data in the corresponding water year type. The second analysis served to contextualize the analysis under part one by testing whether depth and velocities associated with the pulse flow releases would typically fall within a range experienced by the river and its biota both spatially and temporally. This analysis compared the mean monthly, reach-averaged, depth and velocity results from the existing and the pulse flow conditions to depths and velocities from each day within five reference water years for each cross section or model element within the reach. The duration of the pulse flow applied varies slightly depending on flow in the low-flow reach at the time the pulse was applied, allowing for the required ramp-up and fall rates, but would typically be on the order of five days.

It should be noted that defining the baseline condition using mean monthly flows allows for an assessment of the influence of the pulse flow relative to typical (mean-monthly) conditions during timeframes and water year types at which it is proposed to be implemented. However, the pulse flow could be implemented over a wide range of flow conditions that fall above or below the mean monthly values considered in this analysis. As such, the relative effect of a pulse flow applied to a baseline condition that varies significantly from these typical, mean monthly conditions has not been considered in this analysis.

4.1.1 MEAN MONTHLY HYDRAULIC IMPACT ASSESMENT

Mean monthly discharges were calculated for six primary inflow boundary condition locations within the model domain. These locations are shown in **Figure 10** and not only represent most of the inflow, but also offer long periods of record. For each gage, a monthly mean discharge was calculated within the analysis period (WY 1996-2021) using daily data for both critically dry (CD), and above normal (AN) water years. The CD years used for this analysis were 2008, 2014, 2015, and 2021, and the AN years were 2000, 2003, and 2005.

Baseline condition model runs were developed for eight scenario runs for each of the months of March through June for two water years (**Table 5**). The monthly mean discharges for each primary boundary condition were run within the model for approximately ten days. This was done to allow the model to equilibrate to steady state across the entire model domain. Only the last time step of the model run was used in the subsequent analysis. Secondary BCs had a constant low flow discharge applied. This was done to enhance the signal of the pulse flow and serve as a conservative analysis. Additional tributary flows within the system can dampen the impacts associated with the pulse flows, as the relative percent of the total river discharge from the pulse flow is reduced each time tributary flows are added to the pulse flow.

Pulse flows were developed for this analysis by leaving all BCs consistent with the baseline condition except for Oroville, where water from the Oroville Dam enters the Low Flow reach. Discharge at this location was changed to 10,000 cfs for all eight scenarios.

Table 5. - Monthly mean discharge values (cfs) for water years 1996-2021

Location	Critically Dry				Above Normal			
	March	April	May	June	March	April	May	June
Feather River at Oroville	964	838	979	1,369	634	626	634	633
Thermalito Afterbay	199	592	937	1,177	3,916	1,622	2,072	3,267
Yuba River at Marysville	842	720	670	484	3,518	2,625	5,206	2,527
Butte Slough at Meridian	565	267	205	146	7,527	747	2,503	572
Sacramento River at Colusa	7,200	5,687	5,700	5,712	19,208	12,034	18,663	11,182
American River at Fair Oaks	964	1,018	1,209	2,372	4,753	3,530	6,059	4,893

Water level, velocity, and inundation extent model outputs were exported for each simulation and are discussed in section 4.2.1 below. Results are presented by reach (**Figure 11**). Reach endpoints generally corresponded to tributary mouths, listed from upstream to downstream: Thermalito Afterbay Outlet, Honcut Creek, Yuba River, Bear River, Sutter Bypass, Sacramento River and American River. Although the study reach delineation was first distilled from tributary confluences, each reach exhibited different hydraulic characteristics. Continuous longitudinal variations were also present. From upstream to downstream, the river slope decreased; the upper reaches exhibit dynamic multi-thread channels and transitioned to a single-thread meandering channel downstream. Furthermore, bed material becomes finer moving downstream, from cobbles and gravel to sand, much in part due to the change in energy environment (river slope), and contributions of sediment from tributary flow and sediment sourced from the channel margins.

4.1.2 MEAN DAILY FLOW CONTEXTUALIZATION ANALYSIS

Increasing flows to the river through a pulse flow from Oroville Dam is expected to increase water levels and velocity. However, the magnitude of change may or may not produce conditions outside the normal range. A second set of simulations were run to contextualize the results of the mean monthly hydraulic impact assessment. Depths and velocities associated with pulse flow releases were compared with the typical ranges experienced by the river and its biota. Five WYs were simulated within the FRRM. One of each WY type (critically dry, dry, below normal, above normal, and wet) were selected from the analysis period. The 2003, 2006, 2007, 2016, and 2021 WYs were selected to be representative of the typically observed range of hydraulic conditions.

Mean daily flow records for these WYs were applied to the model for the five WYs at the six primary boundary conditions used above in the mean monthly flow analysis (**Figure 10**). Secondary boundary condition locations were applied similarly to the analysis described above, with steady low flow conditions used at each location. Distributions of water level and velocity from these simulations were compared to those from steady state simulations from the monthly flow analysis described above.

4.2 RESULTS

The following sections detail the results of the analyses described above. As stated previously, these results are a qualitative surrogate for changes in geomorphic processes such as erosion and deposition which are driven by increased or decreased velocities, depths and associated boundary shear stresses. However, further detailed analyses were used to ascertain the quantitative implications on sediment transport and bank erosion. Sections 5 and 6 below feature those analyses.

4.2.1 MEAN MONTHLY HYDRAULIC IMPACT ASSESEMENT RESULTS

The following section outlines the results of the mean monthly hydraulic impact assessment presented by study reach (**Figure 11)**. **Figures 12-31** (excluding the inundation maps) include box plots of the water level and velocity differences between baseline and the pulse flow. The box plot figures are organized by month and water year type, with the CD WYs denoted in red and AN WYs shown in blue. The shading of each bar plot is intended to denote the different months and does not represent any other value. Each month's results comprise the water level difference between the pulse and baseline for each cross section within the study reach. South of the Nicolaus gage, the model domain is two-dimensional (2D), and in these reaches model data was extracted along the channel centerline from individual mesh elements. The water level and velocity differences shown in the box plots would occur only during pulse flow releases, which would be limited to a few days every few years.

For **Figures 12-31** (excluding the inundation maps), the median water level or velocity difference is denoted as the horizontal black line within the box of each "box and whisker". The box defines the interquartile range (IQR) of the data, meaning that 25% of the difference values fall below these levels (25^{th} percentile) and 25% of the difference values extend above the box (75^{th} percentile). The whiskers extending up and down are used to define a statistical minimum and maximum, which is calculated as (25^{th} percentile – 1.5 x IQR) and (75^{th} percentile – 1.5 x IQR), respectively. Data points above or below the whiskers are considered outliers, and these are representative of the actual minima and maxima of the data.

Table 6. - Inundation extent differences

Reach	Month	Critically Dry				Above Normal			
		Pulse (Acres)	Base (Acres)	Diff. (Acres)	Change (%)	Pulse (Acres)	Base (Acres)	Diff. (Acres)	Change (%)
Feather River - Low Flow Reach	March	512	324	188	57.8%	518	322	196	60.9%
	April	513	327	186	56.9%	514	319	195	61.2%
	May	513	333	180	54.1%	515	320	195	60.9%
	June	513	352	162	46.0%	517	321	196	60.9%
Feather River - LFR to Honcut C.	March	718	415	303	72.9%	803	518	285	55.0%
	April	727	438	289	66.0%	751	467	284	60.8%
	May	735	457	278	60.9%	760	478	282	59.0%
	June	741	474	267	56.2%	788	506	282	55.8%
Feather River - Honcut C. to Yuba R.	March	898	615	283	46.0%	977	722	254	35.2%
	April	906	636	271	42.6%	928	666	262	39.3%
	May	913	655	258	39.4%	943	682	260	38.2%
	June	918	675	243	36.1%	962	708	254	35.9%
Feather River - Yuba R. to Bear R.	March	1,020	776	244	31.5%	1,248	913	335	36.7%
	April	1,028	783	246	31.4%	1,108	824	284	34.5%
	May	1,037	791	246	31.2%	1,230	905	325	35.9%
	June	1,039	798	241	30.2%	1,157	855	302	35.4%
Feather River - Bear R. to Nicolaus	March	437	292	145	49.6%	578	433	145	33.5%
	April	440	299	141	47.2%	486	349	137	39.3%
	May	446	309	136	44.1%	545	404	141	35.0%
	June	446	319	128	40.1%	502	363	139	38.4%
Feather River - Nicolaus to Verona	March	757	664	93	14.0%	4,467	4,102	366	8.9%
	April	733	645	88	13.6%	1,439	744	695	93.5%
	May	735	647	88	13.6%	3,533	2,290	1,243	54.3%
	June	735	650	85	13.1%	1,527	750	777	103.6%
Sacramento River - Verona to American R.	March	1,351	1,302	49	3.7%	1,497	1,442	55	3.8%
	April	1,343	1,294	48	3.7%	1,398	1,348	50	3.7%
	May	1,344	1,296	47	3.7%	1,465	1,418	47	3.3%
	June	1,345	1,301	44	3.4%	1,410	1,354	56	4.1%
Sacramento River - American R. to Freeport	March	972	949	23	2.5%	1,049	1,028	21	2.0%
	April	968	946	22	2.4%	1,007	975	33	3.3%
	May	970	947	23	2.5%	1,038	1,018	20	2.0%
	June	971	950	21	2.2%	1,012	979	33	3.4%

4.2.1.1 LOW FLOW REACH RESULTS

The Low Flow reach extends from the Fish Barrier Dam to the Thermalito Afterbay Outlet, near the Oroville Wildlife Area (**Figure 11**). **Figure 12** shows the water level and velocity differences between the pulse flow and the baseline conditions for the Low Flow reach. Median water level differences range between 5-6 ft. Only May and June of the CD WY type show some variation. Median velocity increases from the pulse flow range between 2.0 and 2.5 feet per second (ft/s). Typical baseline flow levels in the Low Flow reach are between 600-1,000 cfs, while maximum pulse flows are 10,000 cfs. The Feather River at Oroville row in **Table 5** displays the flows within the Low Flow reach used in this analysis. Typical flows around 650 cfs are observed across the AN WY conditions, and result in nearly identical values for both water level and velocity differences. Slightly higher discharge values are observed during the CD simulation, which are presumed to be associated with flow increases to meet water temperature requirements. Due to these flow increases later in the pulse flow window (May and June), the potential pulse flow rate is reduced, which leads to lower water level and velocity changes. By capping the pulse flow release to a maximum of 10,000 cfs, elevated baseline flow levels reduce the additional water added during the pulse flow, which leads to lower water level and velocity differences. For example, a flow of 1,300 cfs under the baseline conditions leads to a peak pulse flow release of 8,700 cfs, whereas, a baseline flow of 650 cfs allows for a pulse flow of up to 9,350 cfs, and would result in a proportionally larger increase in water levels and velocity.

Table 6 contains the differences (pulse – baseline conditions) in the inundated area for the monthly mean model runs. The pulse flows increase the Low Flow reach inundation extents by 50-60% across the different WY types and months. As noted above, changes due to pulse flows would occur only on a few days every few years. The Low Flow reach is sensitive to changes in inundation extents, as the flow magnitude between the baseline condition and the pulse flow is approximately a factor of 10 (=10,000/1,000 cfs). Moving downstream during a pulse flow, the river receives tributary contributions which diminish the influence of the pulse flow. Furthermore, inundation extents respond to flow thresholds based on cross-sectional geometry. At low stages, the river may not fully occupy the active channel, and small increases in discharge produce large increases in inundation extent. For example, if there is a gravel bar on the channel margin with a slope of 10H:1V, every 1 ft Increase in water level inundates an additional 10 ft laterally. However, once the water surface contacts steep banks on both sides, the changes in inundation extent with stage are dramatically reduced. For example, if the bank is 5 ft high and vertical; once the wetted extent has reached the banks, the next 5 ft of water level increase will produce no increase in the inundation extent. However, once the top of banks is reached, a much higher rate of inundation expansion will occur, as the river has access to the floodplain, and small changes in water level lead to large changes in inundation extent.

Figures 13 and 14 display the inundation extents for the March AN and April CD simulations, respectively. These two model simulations were chosen because they bracket the range of inundation extents (lowest and highest) assessed in the mean monthly flow analysis (**see Table 5**). Inundation associated with the baseline condition is shown in blue whereas the pulse flow is shown in purple. The pulse flow inundation is mapped underneath the baseline such that areas mapped under the baseline are inundated under both flow conditions. Water levels simulated under the baseline hydrologic condition in the Low Flow reach are relatively low and only occupy a small portion of the mainstem channel. Model simulations of the maximum pulse flow of 10,000 cfs indicate that the inundation footprint would increase over the baseline, but would be fully contained within the mainstem channel and adjacent floodplain infrastructure would not be inundated. Increased inundation is only noted within the "Other Land" land use type within the river corridor of this reach. The inundation extents between the AN and CD simulations are very similar, as the baseline condition only vary by about 200 cfs (**Table 5**) and the simulated pulse flow are the same. The most notable difference in inundation is just upstream of the Oroville Wildlife area (near RM 61), where several backwater chute channels begin to activate with the addition of the pulse flow.

4.2.1.2 THERMALITO AFTERBAY OUTLET TO HONCUT CREEK RESULTS

Figure 15 displays the model results for the reach that extends from the Thermalito Afterbay Outlet (TAB) to about 14 miles downstream to the mouth of Honcut Creek (**Figure 11**). For this reach, the median water surface differences range between about 4.5 to 5.5 ft, and velocity differences are nearly the same across all months and WY types and are centered around 2 ft/s. Much of the variability in water level can be explained by the variations in flow contributions from the Thermalito Afterbay. Contributions from the Afterbay ranged between 200 cfs to about 1,200 cfs under CD conditions, while AN flows were much higher and ranged between 1,600 and 3,900 cfs (**Table 5**). Higher discharges from the Thermalito Afterbay reduced effects of pulse flows.

Figures 13 and 16 show the inundation extents from the March AN simulation whereas **Figures 14 and 17** display inundation associated with the April CD simulations. Baseline inundation extents in this reach are generally higher than in the low-flow reach due to the presence of numerous side / secondary channels. Overall, the increase in inundated area due to pulse flow is similar to the Low Flow reach and averages about 60%. Inundation extents associated with the AN simulation show slightly more inundation within the Oroville Wildlife Area (near RM 57), as water enters through the culvert at its southern extent near Oak Grove (**Figure 13**). **Figures 16 and 17** both show increased inundation in old relic oxbow channels and activation of several multi-thread channels, especially near Gridley Road (RMs 48-53). Within this reach, no prime farmland was inundated under the pulse flow condition simulations, and the inundation extents were generally contained within a "Other Land" classification.

4.2.1.3 HONCUT CREEK TO THE YUBA RIVER RESULTS

The river between Honcut Creek and the Yuba River is characterized by a significant transition in bed sediment size. The riverbed is typically gravel and cobble in the upper reaches, but it transitions to mixed sand and gravel bed in this reach, and by the time the Feather River meets the Yuba River, the bed material is mostly sand. **Figure 18** shows that median water level differences between pulse flow and baseline simulations range between 6-7 ft, and median velocity differences range between 1.5-2.0 ft/s. As the river transitions from a dynamic gravel bed reach that often features multiple channels threads and wider channel margins to a single thread channel, increases in flow are accommodated as changes in depth more than width because the channel is more confined. The change in channel morphology is expressed in the inundation analysis shown in **Table 5**.

Figures 19 and 20 display the inundation extents for the reach upstream of Yuba City, for March AN and April CD simulations, respectively. These graphics, along with **Figures 16 and 17**, show that the river channel within the reach has a more sinuous, single threaded channel planform compared to the reach upstream with the vast majority of inundation contained with the mainstem channel. Although this reach is bordered by prime and unique farmland, nearly all of inundation simulated occurs within a land use defined as “Other Land”.

4.2.1.4 YUBA RIVER TO BEAR RIVER RESULTS

This reach extends south from Yuba City / Marysville for about 15 miles (**Figure 11**). Flow contributions from the Yuba River range from roughly 500 to about 5,000 cfs, which mitigates the influence of the pulse flow. Median water level changes within this study reach range from 4-5 ft, and velocity differences range between 1-2 ft/s (**Figure 21**). Inundation extents increase 30-35% due to the pulse flow additions. **Figures 22 and 23** display simulated inundation between the baseline and pulse flow conditions for the AN and CD water year types. The largest differences in inundated area outside the main channel are between Star Bend and Abbott Lakes (RM 16-21). These areas inundate as the river stage increases and water enters these depressional areas on the floodplain. Under baseline conditions, these features are not hydrologically connected to the river, but are connected with the addition of the pulse flow. The mapping of simulated results indicate that lands inundated by the addition of the pulse flow are not classified as farmland.

4.2.1.5 BEAR RIVER TO NICOLAUS RESULTS

The Bear River to Nicolaus reach is relatively short and in part was delineated by the transition from the Feather River to the Sutter Bypass; however, the downstream boundary of this reach is also the boundary between 1D and 2D model domains. **Figure 24** depicts median water level increases of 4-5 ft and median velocity differences ranging from 0.5-1 ft/s. Of note is that the AN WY results exhibit an overall lower velocity difference than the CD WY. This is due to the elevated water levels in the lower tributaries, which create a backwater effect extending upward towards the Nicolaus gage. **Table 5** highlights how the AN model runs exhibit much higher flows from the Sutter Bypass (Butte Slough), the Sacramento River, and American River. **Figures 25 and 26** display the simulated inundation extents for March AN and April CD WYs, respectively. Inundation extents are increased from the previous reach, as side channels along the base of the levee extend from the Bear River confluence down to the Nicolaus gage on river left and to the Sutter Bypass on river right (directions referenced are looking downstream). These secondary channels receive more water under the pulse flows with overall inundation extent increases from 35- 50%.

4.2.1.6 NICOLAUS TO VERONA RESULTS

The reach between the Nicolaus gage and Verona is the last segment of the Feather River before the confluence with the Sacramento River (**Figure 11**). The Feather River runs along the river left (east bank) of the Sutter Bypass. The river is bound on its left bank by a federal levee and is bound by agricultural levees on the right bank. Approximately 1 mile west from the right bank of the Feather River is the bounding federal levee which is on the river right of the bypass. The agricultural levee overtops under high flow / water level conditions. Water levels in this reach of the Feathe River are subject to influence by flow levels on the Sacramento River due to its potential backwater effect. Water levels in the Sutter Bypass are also subject to influence from the Sacramento River backwater as well as inflows from the Sutter Bypass / Butte Basin and flow from the Feather River.

Figure 27 shows median water levels changes between 4.5-5.5 ft and median velocity differences between about 1.5-1.75 ft/s for the CD model runs. The AN runs exhibit a lower range of median values for both water levels and velocity differences due to backwater from the Sacramento River. Median water level increases range between 3.5-4.5 ft, and velocity increases fall between 1.0-1.25 ft/s. The highest water level and velocity differences are experienced when the Sacramento River flows are the lowest, thereby limiting the backwater influence. This also appears to work in conjunction with increased releases from the Thermalito Afterbay, which in turn reduces the relative magnitude of the peak pulse contribution; thereby limiting water level and velocity differences (**Table 5**). This trend is apparent in both the CD and AN model simulations.

Table 6 depicts the inundation acreage, and percent change from baseline for this reach. The CD model runs, which have Sutter bypass flows of around 500 cfs or less, exhibit limited inundation extent changes (~13%). Since the Feather River is constrained by federal and agricultural levees, the river does not overbank during the pulse flows from the Feather River, and the majority of the inundation is related to flooded extent increases within the Sutter Bypass. However, Nelson Slough allows water to enter the Sutter Bypass from Feather River near RM 8, before the agricultural levee overtops. The East Canal/Nelson Slough channel connection is represented in the model using two 48-inch culverts, estimated from high resolution imagery.

Flows entering the Sacramento River from the Sutter Bypass are backwatered in the Sutter Bypass due to pulse flow increasing stages in the Sacramento River. Under the lower flow conditions of the CD simulations in the Sutter Bypass, there are limited inundation extent increases. Under the AN condition, flows in the Feather River are higher, and lead to greater increases in inundation extents due to the backwater effect from the Sacramento River. The most notable increase is during the AN June simulation, where flows in the Sutter Bypass are actually quite low; however, the backing up of water due to the increased stages of the pulse flow, allow the small channel bounding the west levee to surpass bankfull and expand quickly outward. This occurs on low gradient floodplains where small increases in water surface elevation lead to significant increases in inundation extents. Although the inundation extent is expressed as the largest percent increase for the AN June simulation, the water depths are relatively shallow and on the order of 1 ft.

Figures 28 and 29 display the simulated inundation extents for March AN and April CD conditions, respectively. For the AN WY condition, model results indicate that the majority of the Sutter Bypass is inundated under baseline and an increase in inundation extent is apparent with the addition of the pulse flow (**Figure 28**). For the CD WY condition, model results indicate that the Sutter Bypass is only inundated along the margins of the agricultural drain that runs along the west side of the Bypass under baseline with slight increases in inundation along the drain associated with the addition of the pulse flow. The majority of the Sutter Bypass land use is classified as "Unique Farmland" per the California Department of Conservation's Important Farmlands Map (https://www.conservation.ca.gov/dlrp/fmmp).

4.2.1.7 VERONA TO AMERICAN RIVER RESULTS

The following two river reaches are just downstream of the confluence of the Feather and Sacramento Rivers. This reach of the Sacramento River is contained between two federal levees with limited floodplain inside the levees. In this reach, the median water level differences range between 3-4 ft (**Figure 30**) and velocity differences range between about 0.5-1.0 ft/s. Since the levees confine the river in this reach, the increased flows from the pulse contribution produce pronounced increases in water level. This is also observed in the inundation extents, as pulse flow only increases inundation area 3-4% over baseline inundation. Limited velocity differences are observed due to the relatively low slope of this reach. **Figures 28 and 29** show the inundation extents of the upper section of this reach. Little to no variation can be observed between the Baseline and Pulse flow conditions.

4.2.1.8 AMERICAN RIVER TO FREEPORT RESULTS

Figure 31 exhibits the decreasing trend of water level and velocity impacts moving downstream. Median water levels and velocity exhibit the lowest differences between pulse flows and baseline of all study reaches. Median water level differences range from 1.5-2.5 feet, and median velocity differences range between 0.4-0.8 ft/s. Pulse flow increases the inundation extent in this reach only 2-3%.

4.2.2 MEAN DAILY FLOW CONTEXTUALIZATION ANALYSIS RESULTS

This section reviews the results from mean daily flow contextualization analysis. Similar to the mean monthly flow analysis, box plots were used to depict statistical distributions. However, a few substantial differences should be noted. First, the contextualization box plots display absolute depth and velocity data, whereas the monthly average flow data displayed differences (pulse flow - baseline). Because of the addition of the baseline, pulse, and reference flows (results from the five water year simulations), the results for each WY type are presented in separate figures. The red box plots shown in **Figures 32-47** show the monthly mean baseline condition results for a given study reach for each month. The blue box plots in the center of the figure represent the monthly mean pulse flow results. Results for both the baseline and pulse flows represent conditions associated with one discrete flow rate, as defined by the monthly mean discharges. In contrast, the green box plots on the right side of **Figures 32-47** represent depths and velocities from each day within the five selected WYs for each cross section or model element within the reach.

The purpose of the flow contextualization is to test whether the pulse flow depth and velocity distributions fall within the typical range of conditions experienced by the river and its biota. Although the pulse flow is an elevated stage compared to a typical baseflow, the proposed maximum discharge rate (10,000 cfs) is well below the bankfull (the stage at which water reaches the top of the riverbank and any further rise results in floodplain inundation) and is expected to fall within the typical range of variability. The mean daily flow contextualization analysis uses the same study reaches as the mean monthly flow analysis. The map of the study areas can be found in **Figure 11**.

4.2.2.1 LOW FLOW REACH RESULTS

Figures 32 and 33 show the flow contextualization results for the CD and AN simulations. Similar results were observed for these two water year types. Median depth and velocity values for the pulse flow conditions fall between the 75th percentile and the statistical maxima for the reference WYs. These results suggest that a flow of 10,000 cfs is uncommon within this reach. However, this result is associated with operations of the Oroville Dam Complex as opposed to the natural hydrologic variability in the system. Typically, water is released into the Low Flow channel to meet the minimum flow requirements and flows above minimum are routed though the Thermalito Complex for irrigation and power generation. Elevated flows are normally released in the Low Flow reach only during high flow events. This operational scheme leads to a bi-modal distribution of flows, with frequent occurrence of either relatively high or low discharges. Furthermore, typical flood releases are of short duration, similar to the proposed pulse flow releases. In general, pulse flow depths and velocities values are slightly elevated in this reach relative to reference water year conditions. Potential impacts on riverine physical processes are assessed in Sections 5 and 6 below.

4.2.2.2 THERMALITO AFTERBAY OUTLET TO HONCUT CREEK RESULTS

Figures 34 and 35 show results for the reach between the Thermalito Afterbay Outflow and the mouth of Honcut Creek. These results were similar to those for the Low Flow Reach. Typical median depths and velocities for the pulse flow fall just within or above the inner quartile range of the reference runs. This suggests that the distributions of depth and velocity during pulse flows in this reach are within typical ranges for existing conditions.

4.2.2.3 HONCUT CREEK TO THE YUBA RIVER RESULTS

Median depth and velocity values are shown in **Figures 36 and 37** for the river reach between Honcut Creek and the Yuba River. As expected, pulse flows shifted depth and velocity distributions upward. Both the CD and AN model simulations produced median depths during pulse flows that were within the interquartile range of the reference water years. Velocity medians slightly exceeded the 75th percentile but were well below the statistical maxima. This suggests that the increased water depths and velocities during pulse flows in this reach will be well within the ranges experienced under current conditions.

4.2.2.4 YUBA RIVER TO BEAR RIVER RESULTS

Figures 38 and 39 depict the flow contextualization results for the reach between the mouths of the Yuba and Bear Rivers. Flow contributions from the Yuba River diminish the influence of pulse flow releases. Depth values within this reach are very similar to the reference runs, and not only the median but the majority of the pulse flow interquartile ranges overlap reference ranges. This suggests that the river commonly experiences similar depth distributions in this reach as under pulse flow conditions. Velocity values fall within a tighter range within this reach; median velocity values for the pulse flow overlap the interquartile range or slightly exceed the reference runs. Again, this suggests the pulse flow magnitude is commonly accommodated in this reach.

4.2.2.5 BEAR RIVER TO NICOLAUS RESULTS

Figures 40 and 41 show similar patterns as the reach immediately upstream. Median depth values fall within the typical range of variability of the system. Although median pulse flow velocity values are slightly above the 75th percentile of the reference runs, they are well below the maximum values and fall within the typically occurring range.

4.2.2.6 SUTTER BYPASS AND SACRAMENTO RIVER RESULTS

Figures 42 and 43 denote the depth and velocity contextualization analysis for the downstream most three reaches (Nicolaus to Verona, Verona to American River, and American River to Freeport). As previously mentioned, the further downstream from Oroville Dam, pulse flow comprises an increasingly smaller fraction of the total flow. Differences between baseline and pulse flow conditions become quite small. In many cases, the pulse flow interquartile ranges fall fully within the reference interquartile ranges. Although the pulse flow velocities are slightly increased over reference levels in some cases, the magnitude of these increases remains low.

5 SEDIMENT TRANSPORT IMPACT ASSESSMENT

The following sections detail the sediment transport impact assessment. Sediment movement is a riverine geomorphic process. Dynamic interactions of erosion and deposition can provide high quality aquatic habitat and enhance processes that support ecosystem function. However, very high sediment loads can reduce habitat quality due to increased turbidity or the deposition of fine-grained material on spawning gravels. In this analysis, we use hydraulic data from the FRRM, sediment grain size data from field data collection efforts, and standard sediment transport formulas derived from flume experiments and field data to assess if the proposed pulse flows will have a significant impact in sediment transport rates along the Feather River.

5.1 APPROACH

The sediment transport analysis was conducted by developing sediment transport rating curves for Feather River reaches. A sediment rating curve provides a relationship between river flow and sediment load. The application of a sediment rating curve allows for the cumulative mass of sediment transported past a given cross section over a given period to be calculated from a flow time series.

This analysis compares the total transported mass of sediment, for the period of analysis (WY's 1996-2021), for baseline and pulse flow conditions. A baseline condition time series was developed from mean daily flows for the primary gages shown in **Figure 10**. The baseline time series was developed by adding daily flow records for the appropriate mainstem gage and tributaries depending on the location of interest. The three mainstem gages considered in this analysis were the Feather River at Oroville, the Thermalito Afterbay Outlet, and the Yuba River at Marysville. The pulse flow hydrograph was developed in a similar manner; however, the pulse flows were added to the Oroville gage flows during the months of March through June for selected years. This method is discussed in greater detail below.

The FRRM was used to run a range of steady state discharges which were combined with sediment transport rating curves to compute sediment loads. Time series of discharge, depth, velocity, slope, and wetted width were extracted from the FRRM results. Grain size information collected by cbec in 2017 and 2018 was also used as input to the transport calculations. Data collection and processing techniques are detailed in section 5.1.2 below.

Feather River reaches and cross-sections used for sediment transport analysis are depicted in **Figure 48**. For this analysis, the river was divided into four reaches based on bed material size and hydraulic parameters. Two gravel-dominated reaches were delineated in the upstream portion of the model domain. The Low Flow reach was selected due to the distinctive large grain size present here. Downstream of the Thermalito Afterbay Outflow, flows increase, and bed sediment begins to fine; however, gravel and cobble are still present. Downstream of the mouth of Honcut Creek, more sand is present in the bed, gradually increasing to nearly all sand just above the mouth of the Yuba River. Riverbed slope and sediment are relatively homogeneous downstream from the Yuba confluence. Although both sand and gravel are present in the reach between the Honcut and Yuba confluences, sediment transport in this section was analyzed using only the sand. This was done to provide the most conservative (high) estimate of transport, as coarser material load is less sensitive to changes associated with pulse flows.

5.1.1 PULSE FLOW TIME SERIES

The pulse flow time series was generated using a computer algorithm. This method was implemented to better understand how varying the timing of the pulse flow would impact sediment transport. The Feather River at Oroville time series data were modified to add the pulse flow following these rules:

- The maximum flow rate in the low flow channel will not exceed 10,000 cfs.
- A total volume of 100,000 acre-feet will be released at the maximum flow rate.
- The pulse flow will only occur between March 1st and June 30th.
- The pulse flow will not be added in a wet water year.
- The pulse flow will occur every third year, except when the third year is a wet year. In that case, the pulse would be applied during the next WY that is not wet. This is a very conservative assumption and assumes that the pulse flow will be implemented at its maximum potential frequency. Although it is unlikely that this will occur in reality this assumption produces maximum potential impacts.
- For analysis, the first year in the time series during which the pulse is implemented is varied to create different sequences.
- The pulse flow would not be added during periods of elevated flow. The following lists includes the maximum allowable flow for any gage, Oroville = 5,000 cfs, Thermalito Afterbay = 5,000 cfs, Yuba River = 7,000 cfs, and Sacramento River at Verona = 30,000 cfs. These values were selected as a conservative estimate. These values were below flood stage at these gages, to ensure the pulse flow will not cause overbank flooding.
- The recovery period will not be applied. It is assumed that the 100,000-acre-foot pulse release will be offset in the summer months. These flow reductions were not applied for this analysis as the most conservative assumption for a sediment transport impact analysis would not decrease discharges later in the year.

Following the above assumptions, 100 pulse flow time series hydrographs were generated for the 25-yr analysis window. The pulse flow additions were added to the baseline conditions iteratively and offered a means for many permutations of the pulse flow to be applied to different start years, months, and days. Furthermore, it is worth noting that the added pulse flow was calculated to include the baseflow in the 10,000 cfs limit. For example, if the Low Flow reach was running at 1,000 cfs the pulse flow will add 9,000 cfs to the reach to meet the 10,000 cfs discharge limit. Since daily data was used, a typical pulse flow takes six days, where the first five days are set to a max level of 10,000 cfs, and the last day is used to pass the final volume required to satisfy a 100,000-acre-foot pulse flow. The pulse flow was also implemented with no ramp-up or draw-down rules. This is a conservative assumption expected to cause the greatest amount of sediment transport. The actual pulse flow will have to follow ramp-up and draw-down rules, which should reduce discharge values and sediment transport.

5.1.2 GRAIN SIZE MAPPING

In the fall of 2017 and 2018 cbec conducted sediment sampling along the Feather River. The Feather River upstream of Honcut Creek features mostly cobble and gravel. In this reach a digital photo-sieving technique introduced by Buscombe (2013) was implemented. Over 120 photos of the bed material were taken and spatially located with a GPS unit. These images were then processed using the Digital Grain Size (DGS) algorithm using the Python programing language (https://github.com/DigitalGrainSize/pyDGS). The result was a cumulative grain size distribution of surface sediment.

Downstream of Honcut Creek the river sediment begins to fine from gravel to sand. In areas of gravel deposits, the DGS method was implemented. Where sand and finer material was observed, grab samples were collected and sent to a laboratory for grain size analysis via sieve screening. Over 60 lab samples were collected between Honcut Creek and the confluence with the Sacramento River and analyzed.

The sediment particle size distribution information is presented as a longitudinal profile in **Figure 49**. For each study reach, the samples closest to the model cross-section used for the hydraulic parameters were reviewed and selected for the analysis. **Figure 49** denotes different grain size percentiles, such that the number associated with each line indicates the percent of material which is finer than a given grain size. For example, if the D84 line reads 75 mm this indicates that 16% of the sample is larger than 75 mm and 84% of the sample is finer than 75 mm. **Figure 49** also delineates the tributary junctions and helps to illustrate why the study reaches were defined between Oroville and the Afterbay, the Afterbay to Honcut Creek, Honcut Creek to the Yuba River, and the Yuba River to Nicolaus.

5.1.3 TRANSPORT EQUATIONS

Four sediment transport formulas were selected for this analysis. Sediment transport relations must be carefully selected based on environmental factors. Transport relationships are based on the principles of physics but rely on specific laboratory or field data. Transport relations must be selected and applied to match the hydraulic and sediment characteristics underlying the supporting datasets. Sand- and gravel-bed rivers transport sediment differently and require different tools for analysis. Gravel and coarser bed material is typically transported in continuous or intermitted contact with the bottom: sliding, rolling or skipping (bed load). In contrast, sand and silt can be transported as bed load or suspended in the water column (suspended load). Therefore, sand requires a transport equation that calculates the suspended load and the bed load. If one equation calculates both the bed load and suspended load, the equation is termed a total load equation. Sand and silt require lower fluid forces to initiate their movement than coarser materials.

Even the best sediment transport relations, correctly selected and applied, produce uncertain results. Large differences between computed and measured sediment load are common. Uncertainty can be reduced by using measured data to calibrate formulas used for computations. Even if calibration data are not available, a relative analysis in which two scenarios (e.g, baseline and pulse flow) are compared, can lead to meaningful information. For this study, two transport equations were chosen for each material type. This was done to provide a greater level of understanding of the sedimentation patterns of the river and provide cross validation between the two methods. If the two formulas have conflicting results, further work would be required; however, if both formulas suggest the same trend, the analysis gains certainty.

In the gravel sections of river, we chose to evaluate the sediment transport with the Wilcock-Crowe (2003) and Parker (1990) transport equations. These equations are widely used formulas well accepted within the profession, which calculate sediment transport for each grain size fraction within the bed. Both include a hiding function, which simulates the way smaller particles are protected from fluid forces by nearby larger particles. Particle hiding is important situations where beds include mixtures of sand and gravel or a wide range of gravel sizes.

For transport in the sand reaches we used the total load equations of Engelund and Hansen (1967) and Brownlie (1981). Of note is that the Engelund and Hansen equation does not require a minimum fluid stress to initiate sediment transport—this is a known limitation of this equation, and it is expected to overpredict transport at very low stages. Despite this limitation, the equation is well-suited for sand transport and is widely used. The Brownlie equation does incorporate a minimum stress to activate transport. This robust general-use equation was fitted from a very large empirical dataset including over 7,000 measurements and is widely applicable to a range of conditions.

5.2 RESULTS

The following section provides the results of the sediment transport impact assessment. **Table 7** depicts results broken down for each transport equation and study reach. The upper portion of the table denotes the gravel transport calculations, and the lower portion of the table details sand transport calculations. The reaches listed in the table are shown in **Figure 48**. In **Table 7** there are three transport values listed for each pulse flow simulation. The minimum, maximum and average calculations were taken from the 100 pulse flow time series iterations run as part of this analysis. The results of this Monte-Carlo type analysis suggest that varying when the pulse flow is applied following the rules listed in section 5.1.1 produces limited variability in the transported sediment mass.

Table 7. – Feather River cumulative sediment transport results by reach, 1996-2021

Transport Type	Reach	Statistic	Wilcock- Crowe Pulse (Tons)	Wilcock- Crowe Base (Tons)	Wilcock- Crowe Diff. (Tons)	Wilcock- Crowe % Change	Parker 1990 Pulse (Tons)	Parker 1990 Base (Tons)	Parker 1990 Diff. (Tons)	Parker 1990 % Change
Gravel	Low Flow (RM 66.5)	Min	56,438	56,304	134	0.24%	66,430	66,384	46	0.07%
		Mean	56,451		147	0.26%	66,437		53	0.08%
		Max	56,470		165	0.29%	66,444		61	0.09%
	High Flow (RM 53)	Min	85,352	85,350	2	0.00%	60,399	60,399	0	0.00%
		Mean	85,359		9	0.01%	60,406		7	0.01%
		Max	85,405		55	0.06%	60,472		74	0.12%

Transport Type	Reach	Statistic	Brownlie Pulse (Tons)	Brownlie Base (Tons)	Brownlie Diff. (Tons)	Brownlie % Change	Englund-Hansen Pulse (Tons)	Englund-Hansen Base (Tons)	Englund-Hansen Diff. (Tons)	Englund-Hansen % Change
Sand	Transition (RM 30)	Min	4,839,010	4,822,184	16,826	0.35%	322,653	321,153	1,501	0.47%
		Mean	4,849,169		26,985	0.56%	323,223		2,071	0.64%
		Max	4,865,730		43,546	0.90%	324,104		2,952	0.92%
	Below Yuba River (RM 22)	Min	5,202,836	5,189,240	13,596	0.26%	713,033	710,319	2,714	0.38%
		Mean	5,210,397		21,157	0.41%	713,614		3,294	0.46%
		Max	5,217,715		28,475	0.55%	714,287		3,967	0.56%

5.2.1 LOW FLOW REACH SEDIMENT TRANSPORT RESULTS

The bed of the Low Flow reach is dominated by cobble and gravel, and some of the upstream sections of the Low Flow reach have exposed bedrock. The coarse material requires substantial flow forces to transport it. Furthermore, the banks within this reach typically comprise coarse dredging material, some of which, was used for the construction of the Oroville Dam. Due to these factors, it is anticipated high discharges will be required to move a significant amount of sediment in these areas.

Figure 50 shows the sediment rating curves for the Low Flow reach. Both equations indicate transport rates during a pulse flow of 10,000 cfs less than 10 tons/day (the y-axis is a log scale). For context, 1.0 cubic yard of gravel typically weighs about 1.5 tons. Also of note is that the selected transport equations calculate the transport rates for each grain size found in the bed. The calculations for 10,000 cfs in this reach suggest that only the finest particles in the bed are mobile, and full mobility of the bed is not achieved until a much higher discharge.

Simulations indicate that 56,000 to 66,000 tons of material would be transported over the 25-year analysis window (**Table 7**). Pulse flows would increase these transport rates over baseline by less than 0.3% percent, with good agreement between the two sediment transport equations. These extremely small changes in transport rates are not significantly different, given the precision of the computed results.

5.2.2 HIGH FLOW REACH SEDIMENT TRANSPORT RESULTS

The high flow reach of the Feather River carries combined flows released from the Oroville Dam and the Thermalito Afterbay. This reach, extending down to Honcut Creek, features gravel and cobble material. The frequency of very large cobble observed in the Low Flow reach diminishes as we move downstream. **Figure 49** shows this pattern, where the D90 and D95 values decrease in this reach, but the overall median grain size (D50) remains similar, averaging around 30 mm.

The sediment rating curves calculated for this reach are shown in **Figure 51**. Although the grain sizes are only slightly finer, transport rates are lower in this reach. This is because channel velocities are lower in this reach than in the Low Flow reach due to lower channel bed slope. At low stages, the slope of the water surface is very low (0.0005) and does not substantially increase until flows exceed approximately 20,000 cfs. The steep gradient in the Low Flow reach creates higher velocities, and thus has more sediment transport capacity at a given discharge.

Due to very limited mobility under low flow conditions, the pulse flow shows almost no change (~0.1%) in the transported load between the baseline condition and the pulse flow (**Table 7**). These findings are supported by both transport equations and indicate the pulse flow will have non-significant impact on sediment transport in the high flow reach.

5.2.3 TRANSITION REACH SEDIMENT TRANSPORT RESULTS

The transition reach lies between the mouths of Honcut Creek and Yuba River (**Figure 48). Figure 49** shows significant variability of grain sizes within this reach. Our field experience in this reach revealed a complex mosaic of gravel and sand, either mixed or in heterogeneous patches. The reasons why river beds transition from gravel to sand is not well understood by science, and this process could be driven by multiple factors including terrain, local geology and vegetation patterns. However, for simplicity and to be conservative (higher transport) we computed sediment transport using only grain size information from the sand bed locations in this reach. The median grain size used for this reach was 0.5 mm and corresponds to medium/coarse grain sand.

Figure 53 shows the resulting sediment rating curves within this reach. Both transport equations predict generally the same patterns: transport rates accelerate around 5,000 cfs and plateau around 30,000 cfs. Transport equations often yield results for a given reach that differ by an order of magnitude or more, as in this case. Since this is a relative analysis, the overall magnitude of predicted sediment load is less important than the baseline/pulse ratio. **Figure 53** also shows that the Engelund and Hansen equation predicts sediment mobility (nonzero transport rates) at lower discharges than the Brownlie equation. This is due to the Engelund and Hansen equation not requiring a minimum stress to initiate transport. The Brownlie equation does incorporate a minimum or "critical" stress and thus indicates that flows much below 5,000 cfs transport no sediment.

The bottom half of **Table 7** presents the sand transport results. The overall mass of material transported in the sand reaches is one to two orders of magnitude greater than for the gravel reaches—a much greater amount of material is moved in the sand reaches due to the higher discharges there (due to tributary contributions), as well as the lower fluid forces required to move a grain of sand (diameter 0.0625–2 mm), versus that required for the larger gravel (diameter 32-64 mm). The maximum sediment mass transported through the transition reach under the pulse flow scenario was less than 1% greater than baseline, and the mean transport differences were about 0.5%. Since this reach contains sub-reaches or patches dominated by gravel which we did not consider, total transport mass was overpredicted in this analysis. Nevertheless, the small increases in transport rates computed due to the pulse flow are insignificant (not different from zero) given the uncertainty in the analysis.

5.2.4 LOWER FEATHER RIVER REACH SEDIMENT TRANSPORT RESULTS

The last study reach in the sediment transport impact assessment is a sand bed reach, which extends from the Yuba River confluence to Nicolaus. The median bed material size is 0.72 mm, which is coarse sand. Given similar bed material grain sizes and cross-sectional geometries, it is not surprising that the transition reach rating curve and the lower Feather rating curve (**Figure 49**) are very similar. As for the transition reach, bed material transport is essentially zero for flows less than 5,000 cfs.

The overall transport masses are greater than for upstream reaches, as flows from the Yuba River increase flow rates. However, once the river corridor fills from levee to levee and the floodway is fully activated, transport rates do not rapidly increase with increasing discharge. Transport rate increases under the pulse flow condition are approximately 0.5% over baseline. These transport rate differences are insignificant (not different from zero) given the uncertainty in the analysis.

5.2.5 SUTTER BYPASS AND SACRAMENTO RIVER SEDIMENT TRANSPORT DISCUSSION

Given the limited pulse flow impacts within the Feather River system shown above, it is assumed that continuing this analysis downstream would result in similar, and quite likely smaller potential impacts. With the addition of flows from other sources, the fractional increase in total flow due to the pulse diminishes. These observations are supported by our hydraulic impact assessment, where decreasing water level and velocity differences were observed in these downstream reaches. Furthermore, the contextualization analysis for these reaches indicated that conditions associated with pulse flows are within the typical range of variability and will lead to non-significant impacts to the river.

6 BANK EROSION IMPACT ASSESSMENT

To assess potential impacts of pulse flow on riverbank erosion, it is important to understand some of the fundamental processes associated with meander bend/riverbank migration in alluvial river systems. In general, meanders are formed by the processes of erosion and deposition. Bank erosion is generally most intense along the outside of a meander bend and some of the sediment derived from this erosion, primarily sand and gravel, is typically deposited on a point bar comprising the inside of the next meander bend downstream. Under equilibrium conditions, erosion on the outside of the bend is balanced by point bar deposition on the inside of the bend, maintaining average channel width roughly constant despite gradual lateral and longitudinal migration of the channel centerline. Bank erosion is generally greatest opposite the point bar (apex) due to the helical/circular flow (secondary current) through the channel bend, which allows the point bars to build more rapidly in a downstream direction. These processes facilitate the down-valley migration of channel meander bends through time. The fraction of material eroded from the channel bank and subsequently deposited on the adjacent point bar varies from system to system and is dependent upon reach characteristics such as the local slope, bed and bank material, and the configuration of adjacent bends. Other sources of sediment from upstream tributaries also contribute to deposition/bar growth within the reach.

The physical processes that influence riverbank erosion at the reach scale are controlled by a complex interaction of stresses and resisting forces that are a function of reach scale hydraulics (water velocity/ shear stress), geotechnical processes (slope stability), and bank material/ geometry/ vegetation (resisting forces). The rate at which these processes occur over the long-term is related to duration and frequency at which the stress forces applied to the riverbank exceed the resisting forces, which allows erosion to ensue. The proposed pulse flow release has the potential increase the duration and frequency of stress imposed on the riverbanks above that of the resisting forces, which could increase the rate of meander bend migration over the long-term. The analysis presented in the following sections is intended to quantify the potential for this to occur and provide a greater clarity on the significance of this occurrence.

6.1 APPROACH

Understanding of the fundamental processes governing river form allows for the interpretation of dynamic channel behavior and effects that impacts have on natural river corridor function. River form is controlled by the relative rates of sediment supply to the channel and the ability of the channel to transport that imposed supply ("transport capacity"). While quantitative metrics of sediment supply are difficult to prescribe, specific stream power provides a direct and quantitative index of transport capacity (Knighton, 1998).

Specific stream power is the unit rate at which energy is applied to the channel bed and banks and provides a quantitative measure of the "geomorphic energy regime" throughout a river system. It is closely related to dynamic processes including lateral riverbank migration and sediment transport. Specific stream power is defined as:

$$\Omega = \tau \mathrm{uw}$$

where τ is the average bed shear stress, u is velocity, and w is the width of the channel (Larsen et al., 2006). Reach-scale analysis of specific stream power together with information on sediment input and storage, is a powerful tool for understanding riverine physical processes.

Larsen (2006) demonstrated that bank erosion rates are proportional to the magnitude of stream power and used linear regression to correlate the cumulative stream power (the summation of stream power over a specific time interval) with rates of bank erosion at 13 sites on the middle Sacramento River in California. Only stream power for flows above a specific threshold was included in the summation. A similar approach was developed by Soar et al. (2017) for characterizing river reaches in terms of their geomorphological stability status and potential for morphological adjustment. We applied the Larsen (2006) approach to selected bank erosion sites along the lower Feather River to quantify the potential for the proposed pulse flow to increase the cumulative stream power/bank erosion rates over the analysis period from 1996-2021.

Cumulative stream power was calculated by developing a relationship (rating curve) between bed shear stress (τ) velocity (u) and wetted width (w) relative to flow over a range of hydrologic conditions at historical bank erosion sites along the Feather River. These parameters were derived from output from the FRRM simulation that simulated a wide range of flows. Using the relationships between river flow and velocity/shear stress/width, a long-term time series (1996-2021) was developed for these parameters allowing for a cumulative specific stream power to be calculated for each of the selected bank erosion sites (**Figure 54**).

6.2 RESULTS

Results from the cumulative stream power analysis were similar to those for the sediment transport analysis presented above (**Table 8**). The pulse flow produced cumulative stream power about 1% greater than baseline. The locations for the bank erosion analysis were selected at active bank erosion sites. In the upper sections of the study reach (upstream of Honcut Creek), very little bank erosion is observed. The banks typically comprise coarse material, much like the bed of the river, and are fairly erosion resistant. Furthermore, the finer material in this section of river has been winnowed away over the years since dam closure since the upstream sediment supply to the river has been shut off by the dam and reservoir. The river reach between Honcut Creek and Yuba City may be the most active section of the river for bank erosion. Tall, fine-grained banks allow the river to migrate laterally and more rapidly than the upstream reaches with coarser bank material. Two bank erosion sites were selected in this reach (**Figure 54)**. Downstream of the Yuba River, bank erosion is present but at a lower frequency than the reach immediately upstream. Contribution of sediment from the Yuba River means the river has less capacity to entrain sediment from the banks. Also, this section of the river is less sinuous, which limits the maximum magnitude of forces acting on the banks. Given the low relative magnitude of cumulative stream power increases associated with the pulse flow scenario, it is unlikely that bank erosion rates will increase due to pulse flows.

Table 8. – Cumulative Stream Power for Selected Feather River Bank Erosion Sites

Bank Erosion Site	Cumulative Stream Power (N/s)			% Change
	Pulse	Baseline	Diff.	
Farm Site (RM 45.5)	981,895	971,300	10,595	1.1%
Southern Pacific Railroad (RM 31.5)	1,962,332	1,946,555	15,777	0.8%
Bear River Confluence (RM 12)	4,154,016	4,117,819	36,197	0.9%

7 SUMMARY OF FINDINGS

The hydraulic effects of the proposed pulse flow release to the lower Feather and Sacramento Rivers were analyzed using HEC-RAS hydrodynamic model simulations. These simulations examined the instantaneous effect of the pulse flow release on water depth and velocity in AN and CD water years at the maximum proposed rate and volume. The effects were compared to existing baseline conditions by defining baseline with mean monthly flow data from either CD or AN water years. Findings from this analysis indicated that differences in depth, velocity, and inundation extent correlate closely with the relative differences in flow magnitude. The largest differences in these hydraulic properties were shown to be in the low flow reach of the Feather River where the increases in flow due to the pulse regime were the greatest. The differences tended to decrease moving in the downstream direction as flow contributions from tributaries dampened the pulse-associated differences in flow and the corresponding differences in the hydraulic conditions due to the pulse. Increases in channel size (width and depth) moving in the downstream direction also tend to dampen these differences. Nuanced differences in inundation extent between CD and AN water years occurred within the Sutter Bypass along the right bank of the lower Feather River between Nicholas and Verona. These differences appeared to be related to the effects the pulse flow release has on backwater conditions that persist at the confluence of the Sacramento and Feather Rivers.

Analysis was also conducted to further contextualize the results of the mean monthly hydraulic impact assessment. The purpose of the flow contextualization analysis was to test whether depths and velocities associated with the pulse flow releases fall within ranges experienced by the river both spatially and temporally. This analysis compared the mean monthly, reach-averaged depth and velocity results from the existing and the pulse flow conditions to depths and velocities from each day within the five reference water years for each cross section or model element within the reach. Results from this analysis confirm there is an increase in mean depth and velocity associated with the pulse flow release relative to those in the reference period, which correlates with the increase in flow. However, depths and velocities associated with the pulse flow condition fall within the range of depths and velocities experienced historically in a given river reach.

Although the hydraulic impact and flow contextualization assessments provide useful metrics that quantify changes in hydraulic conditions (depth, velocity, and inundation extent) associated with the proposed pulse flow release, they do not directly provide insight into how those differences may affect longer-term geomorphic processes that control riverine form and function. The magnitude, duration, and frequency at which these hydrologic changes occur are fundamental to their potential to influence longer-term geomorphic processes. Central to these geomorphic processes is the amount of sediment the river transports over decadal timescales. An understanding of how the implementation of the pulse flow will alter the hydrologic conditions that drive sediment transport rates helps to provide insight as to how these geomorphic processes may evolve in the future.

To provide the insight into these potential geomorphic effects, sediment transport rates were calculated for selected reaches of the Feather River for the 1996-2021 period under baseline (existing) and proposed pulse flow conditions. Conservative assumptions were made regarding the magnitude and frequency at which the pulse flows would be imposed. Further conservative assumptions were made regarding the dominance of sand over gravel in mixed bed reaches. Variation in pulse flow scheduling was considered by repeating the analysis using 100 variations of the 25-year time series. Findings from this analysis (means and extremes for the 100 realizations) indicate that sediment transport rates under the pulse flow conditions within the gravel-bed reaches would increase by less than 0.3% over the existing condition. Sediment transport rates in sand-bed reaches of the Feather River were shown to increase by less than 0.9% over the existing condition. Given uncertainties in the analysis, these differences are not significantly different from zero.

Geomorphic analysis was also conducted to further examine the potential for the proposed pulse flow release to affect bank erosion rates at three historic bank erosion sites along the Feather River. Similar to the sediment transport calculations, output from the hydrodynamic model was used to calculate cumulative specific stream power over the 1996-2021 timeframe under existing and proposed pulse flow conditions. Cumulative specific stream power has been demonstrated to correlate well with lateral bank migration rates at 13 erosion sites along the Sacramento River (Larsen, 2006). Results from this analysis indicate that the proposed pulse flow has the potential to increase cumulative specific stream power by no more than 1.1% across all three historic bank erosion sites.

This study relied on comparing modeled existing conditions (baseline) results to model pulse flow results. This methodology allows us to detect differences between two hydrologic scenarios, while limiting the uncertainty associated with absolute modeling results. Overall, the predicted impacts to reach scale hydraulics and the sediment transport regime associated with the proposed pulse flow are interpreted to be insignificant considering the natural variability of these processes in these river reaches and the accuracy at which these processes can be quantified and predicted.

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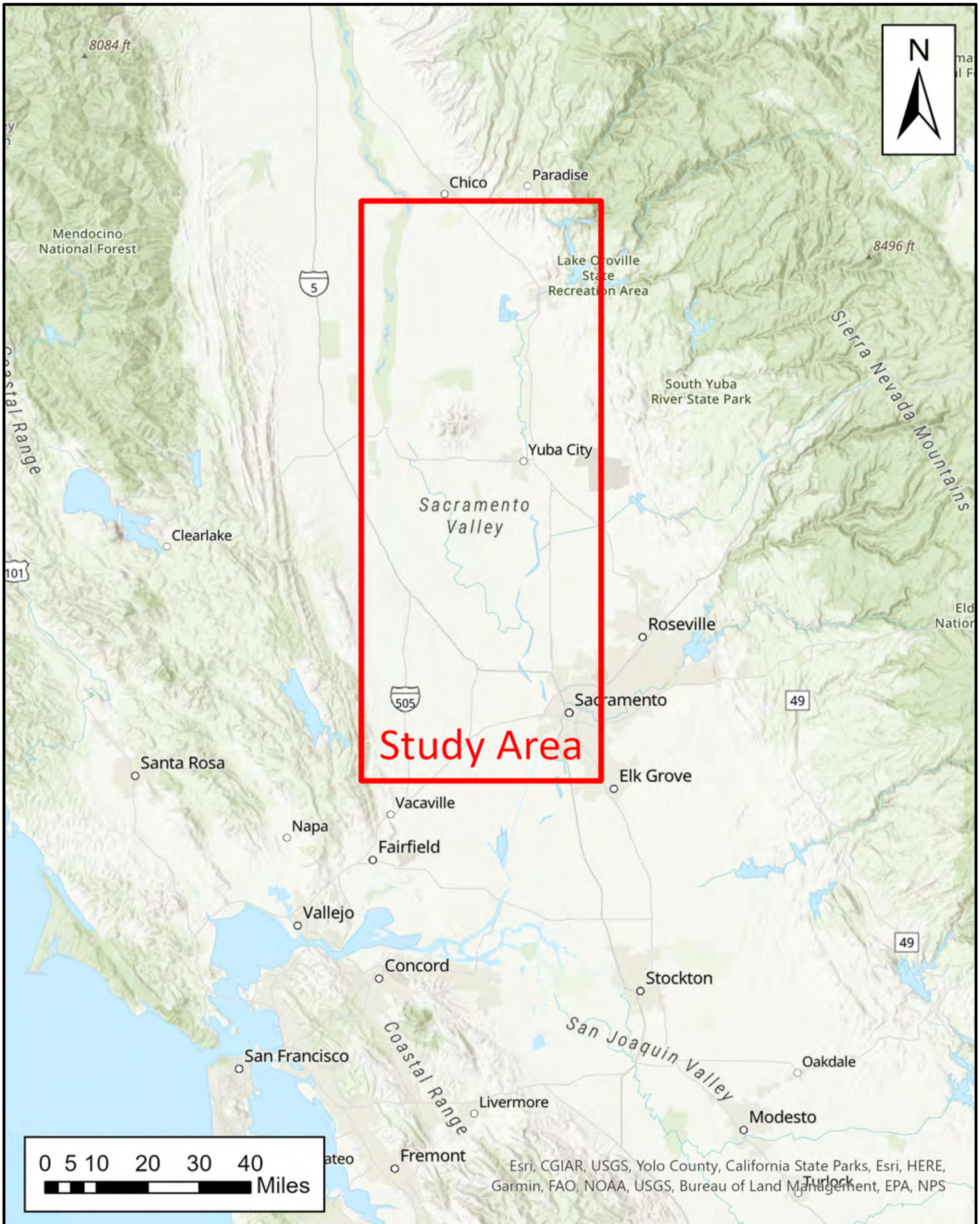

Notes:

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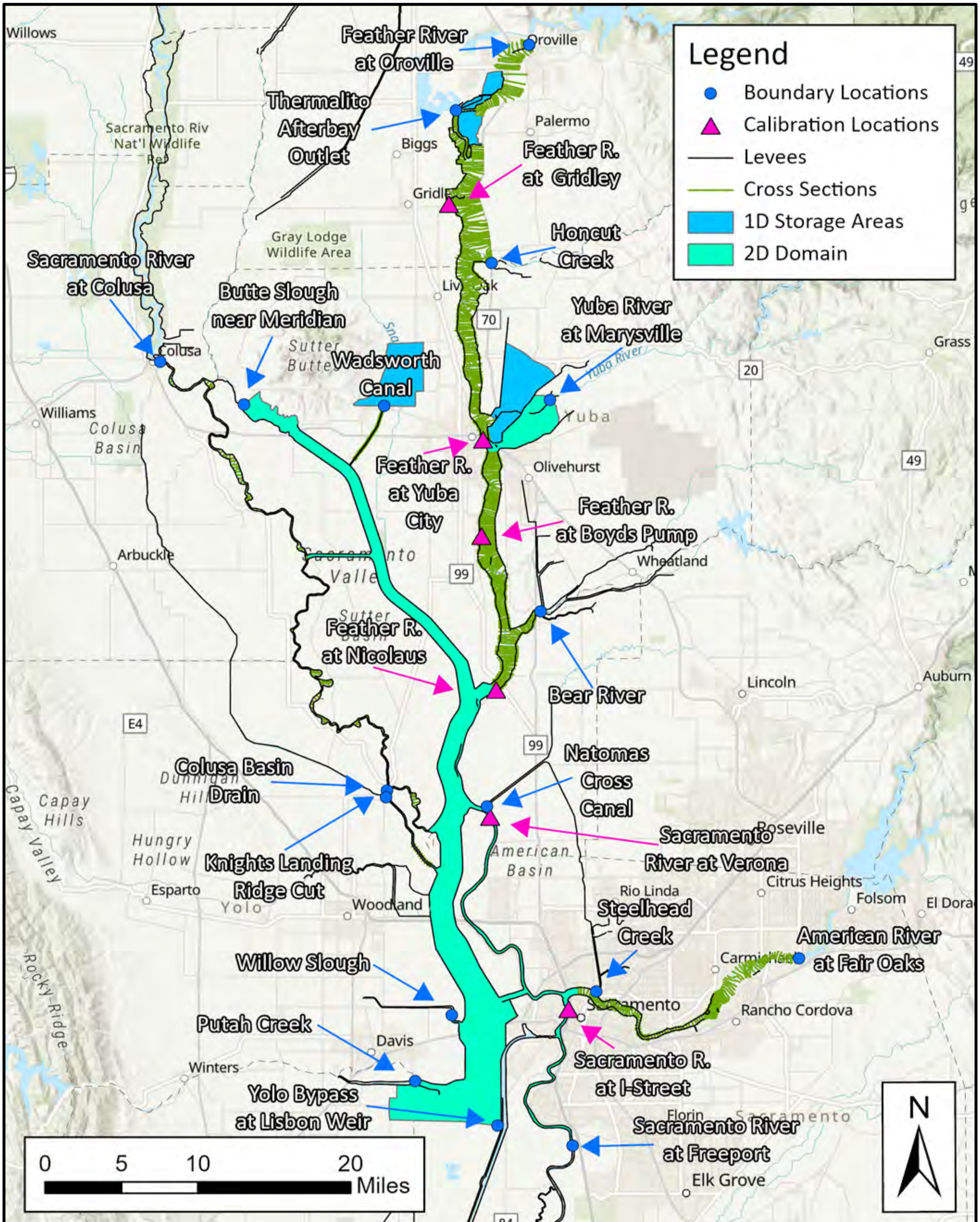
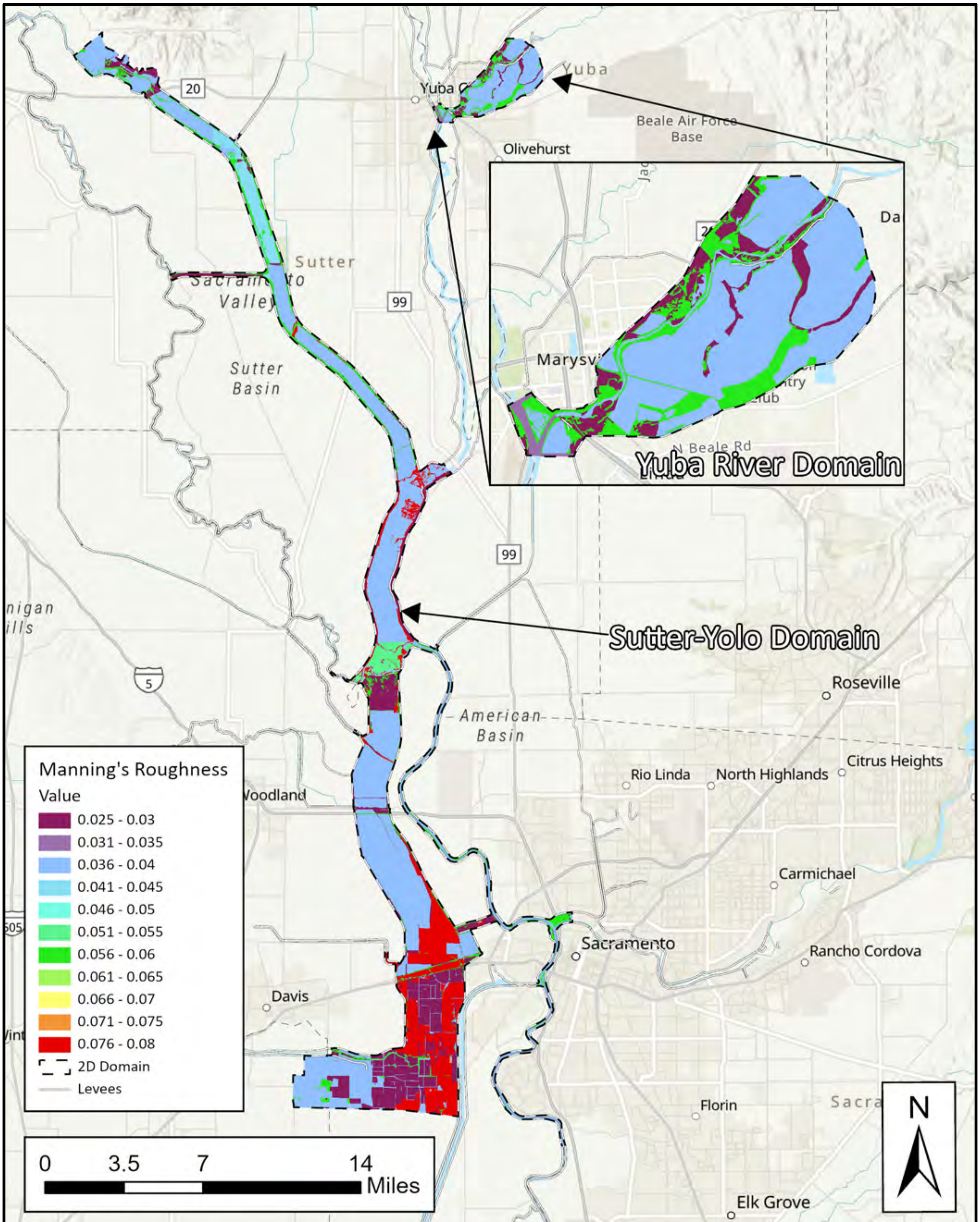
SEIR Impact Assessment of the Feather and Sacramento Rivers

Project Area Location Map

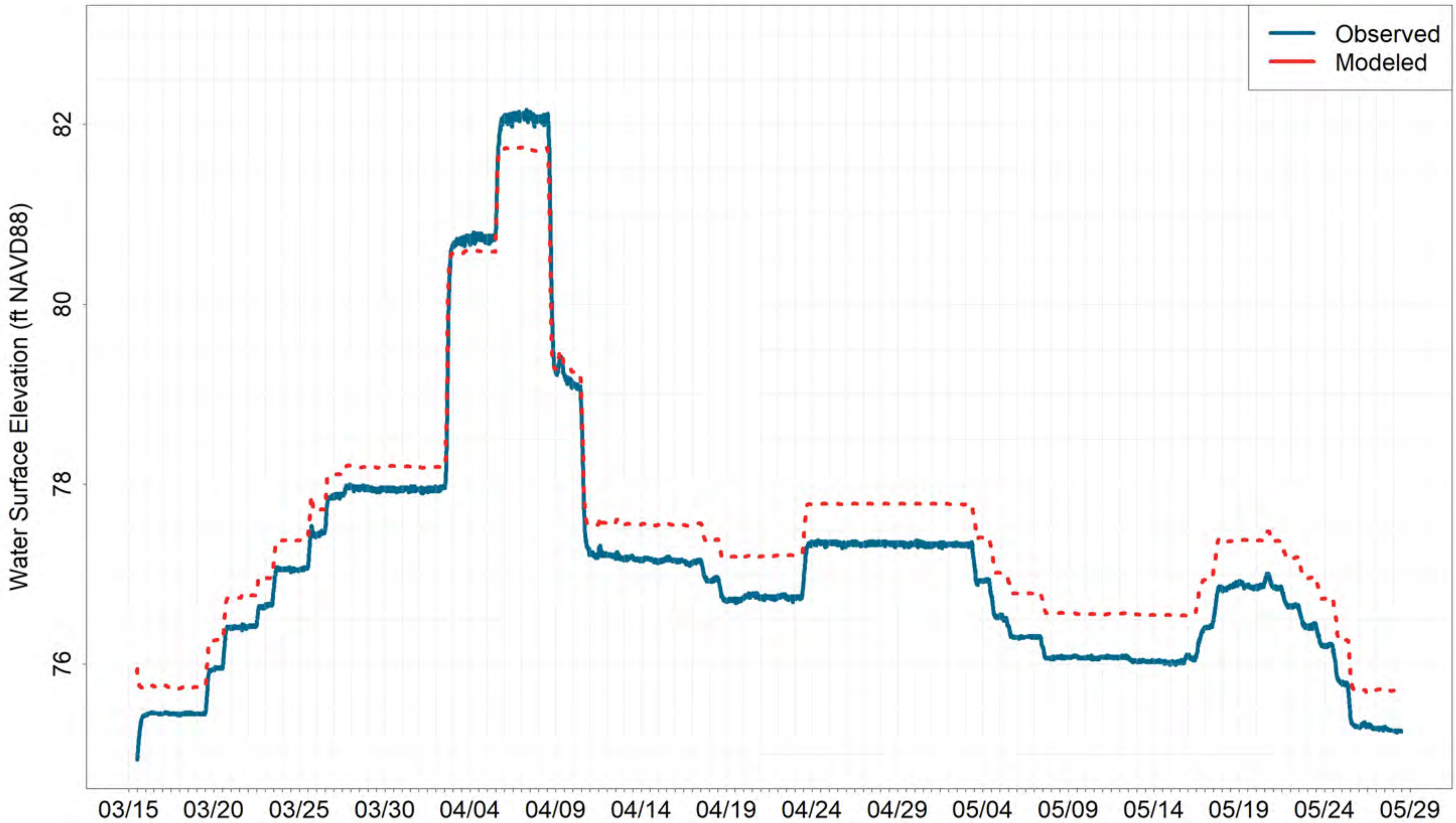
Project No. 23−1008	Created By: TKS	Figure 1



Notes:	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Feather River Regional Model Domain**		
		Project No. 23−1008	**Created By: TKS**	**Figure 2**



Notes:	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **2D Model Roughness Values**		
		Project No. 23−1008	**Created By: TKS**	**Figure 3**



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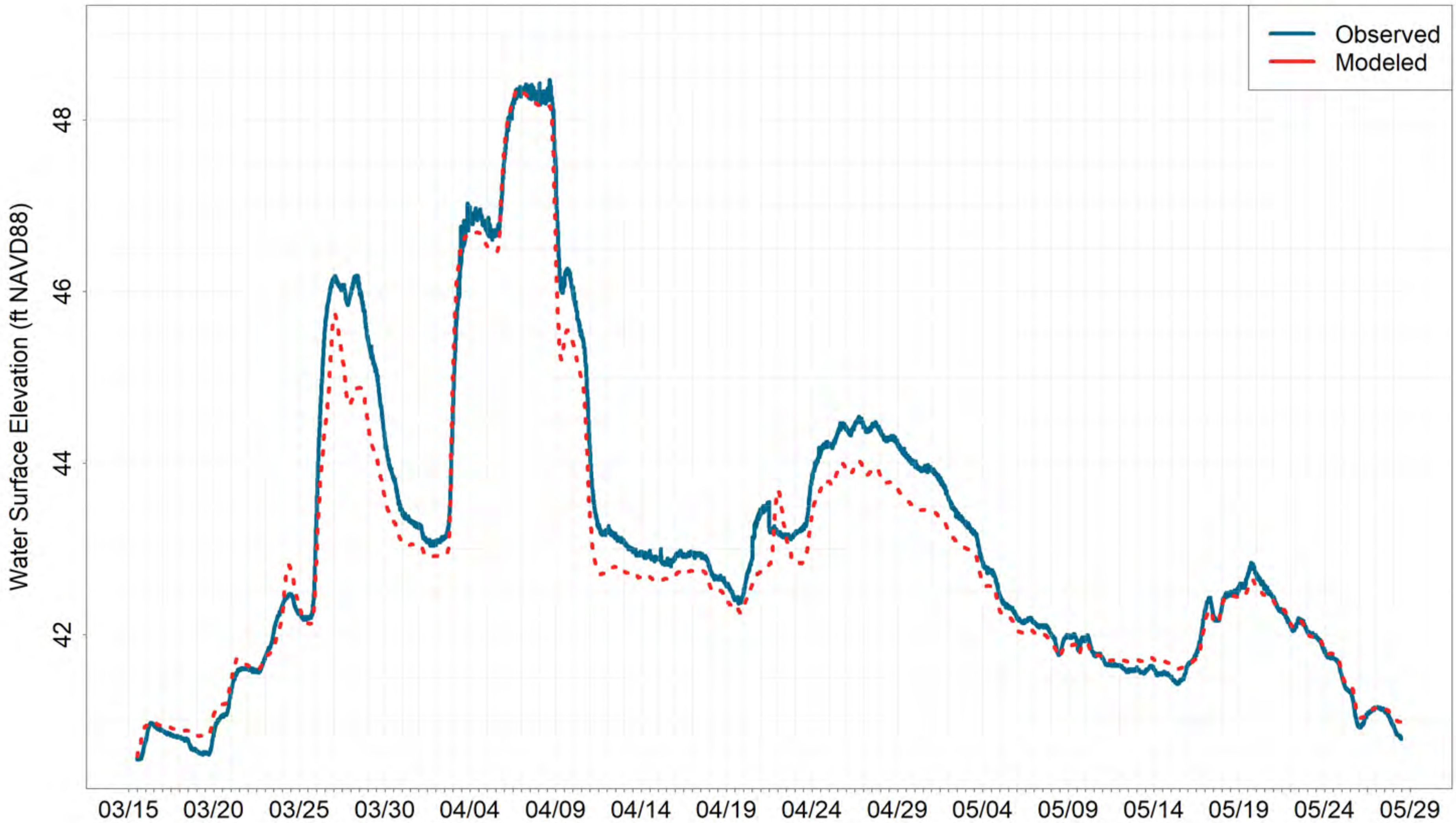
SEIR Impact Assessment of the Feather and Sacramento Rivers

Model Calibration − Feather River at Gridley 2019

Project No. 23−1008	**Created By: TKS**	**Figure 4**



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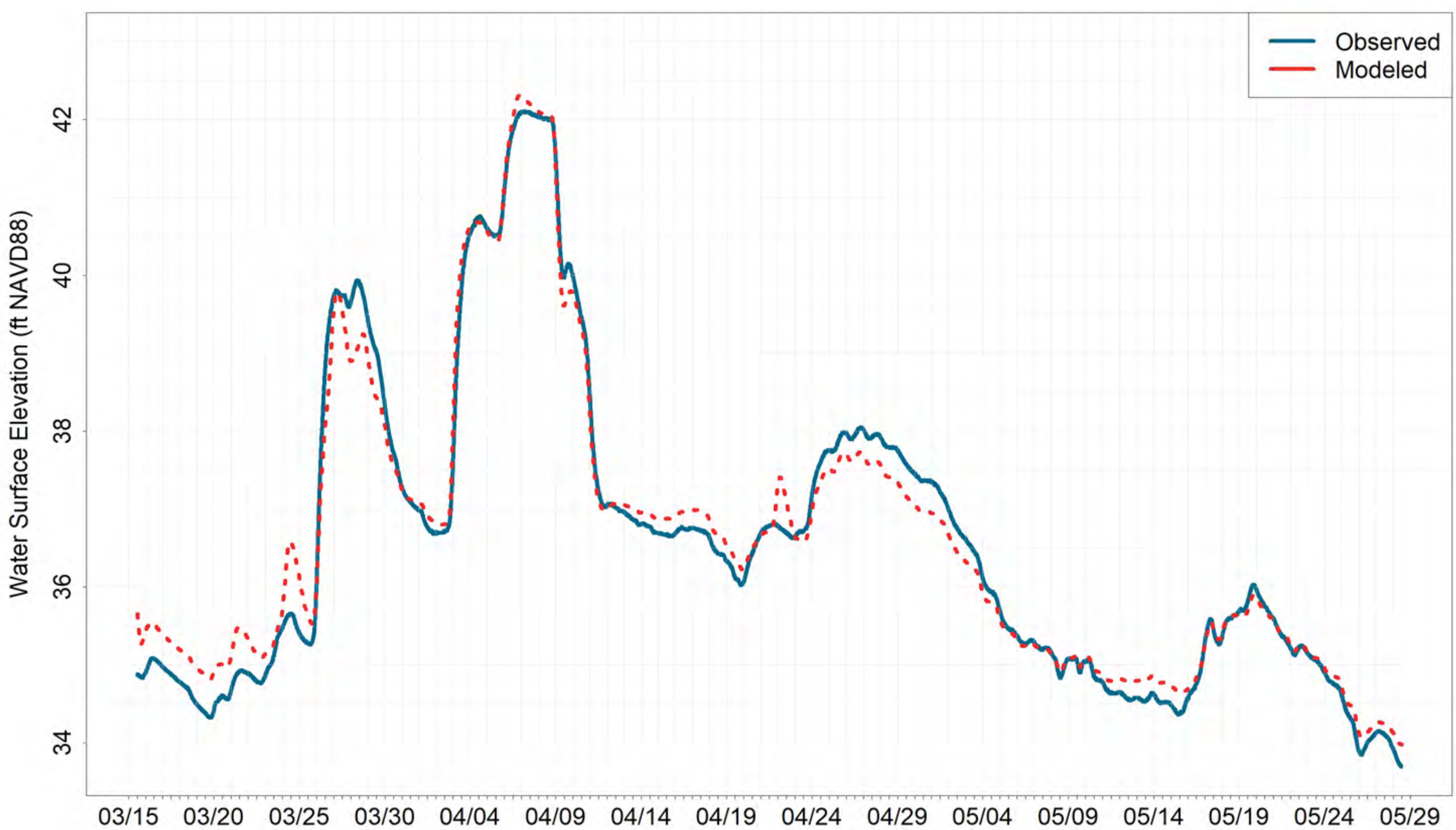
SEIR Impact Assessment of the Feather and Sacramento Rivers

Model Calibration − Feather River at Yuba City 2019

Project No. 23−1008	Created By: TKS	Figure 5



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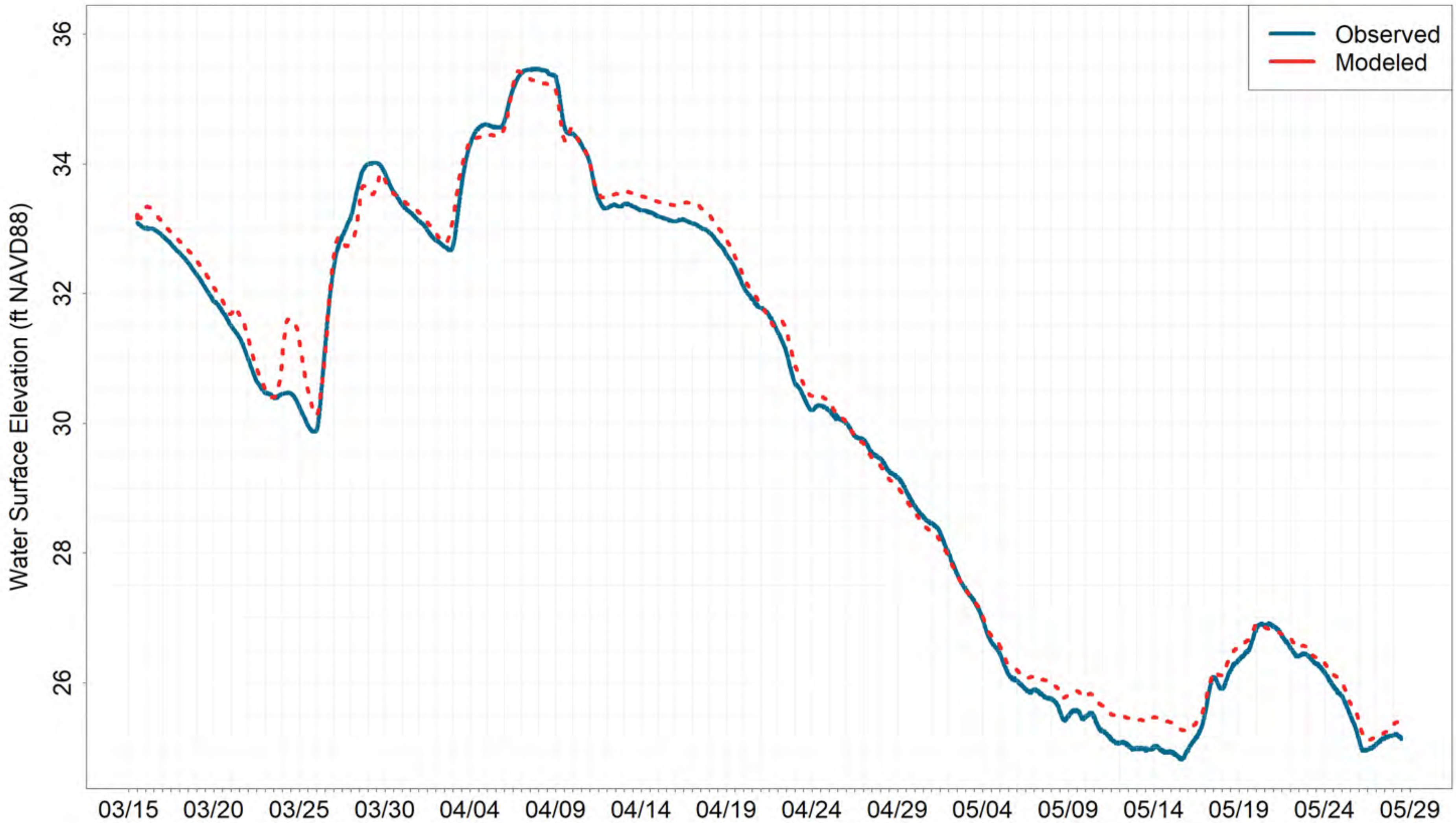
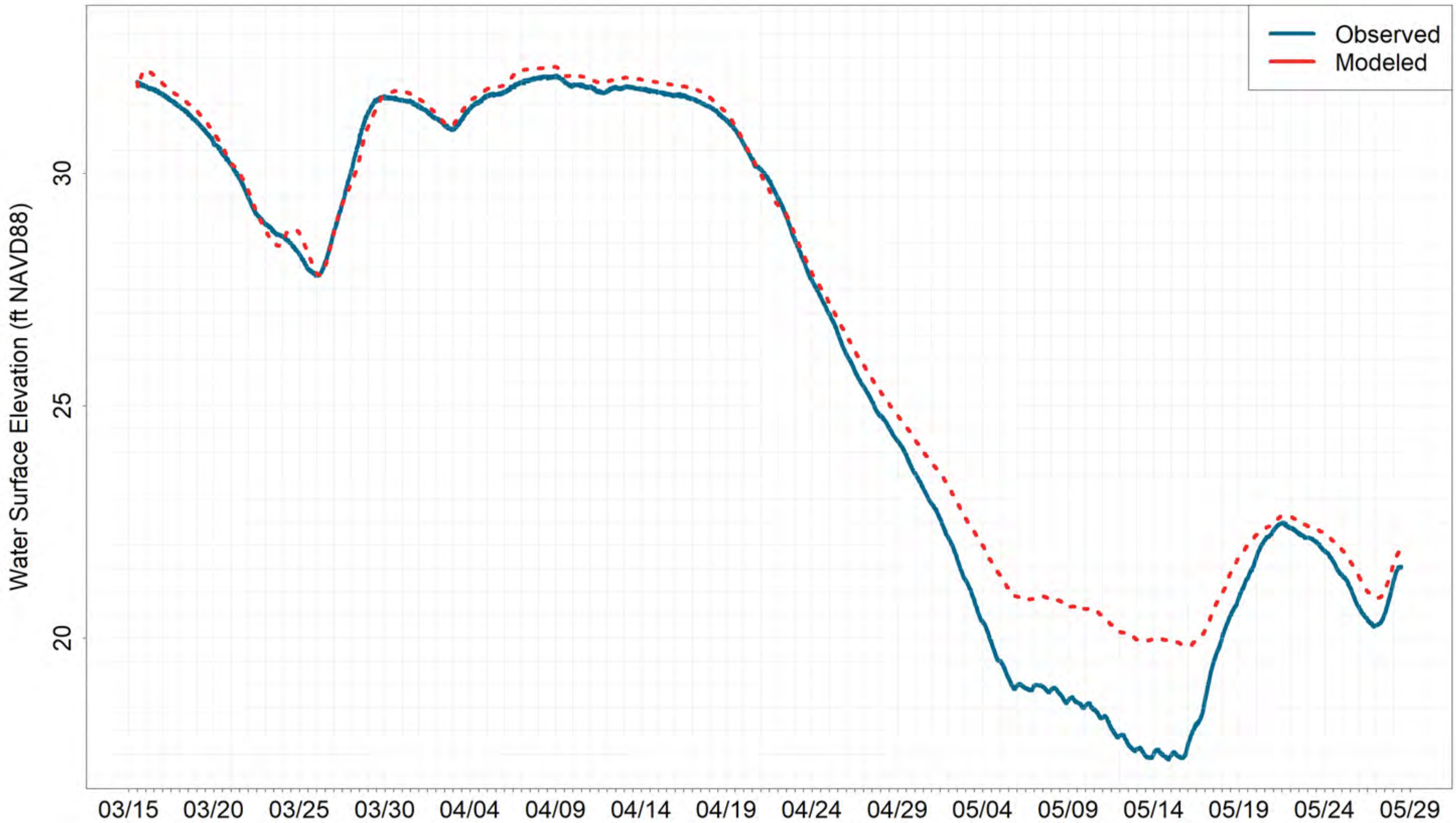
SEIR Impact Assessment of the Feather and Sacramento Rivers

Model Calibration − Feather River at Boyd's Pump 2019

Project No. 23−1008	**Created By: TKS**	**Figure 6**



Notes:	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Model Calibration − Feather River at Nicolaus 2019**		
		Project No. 23−1008	**Created By: TKS**	**Figure 7**



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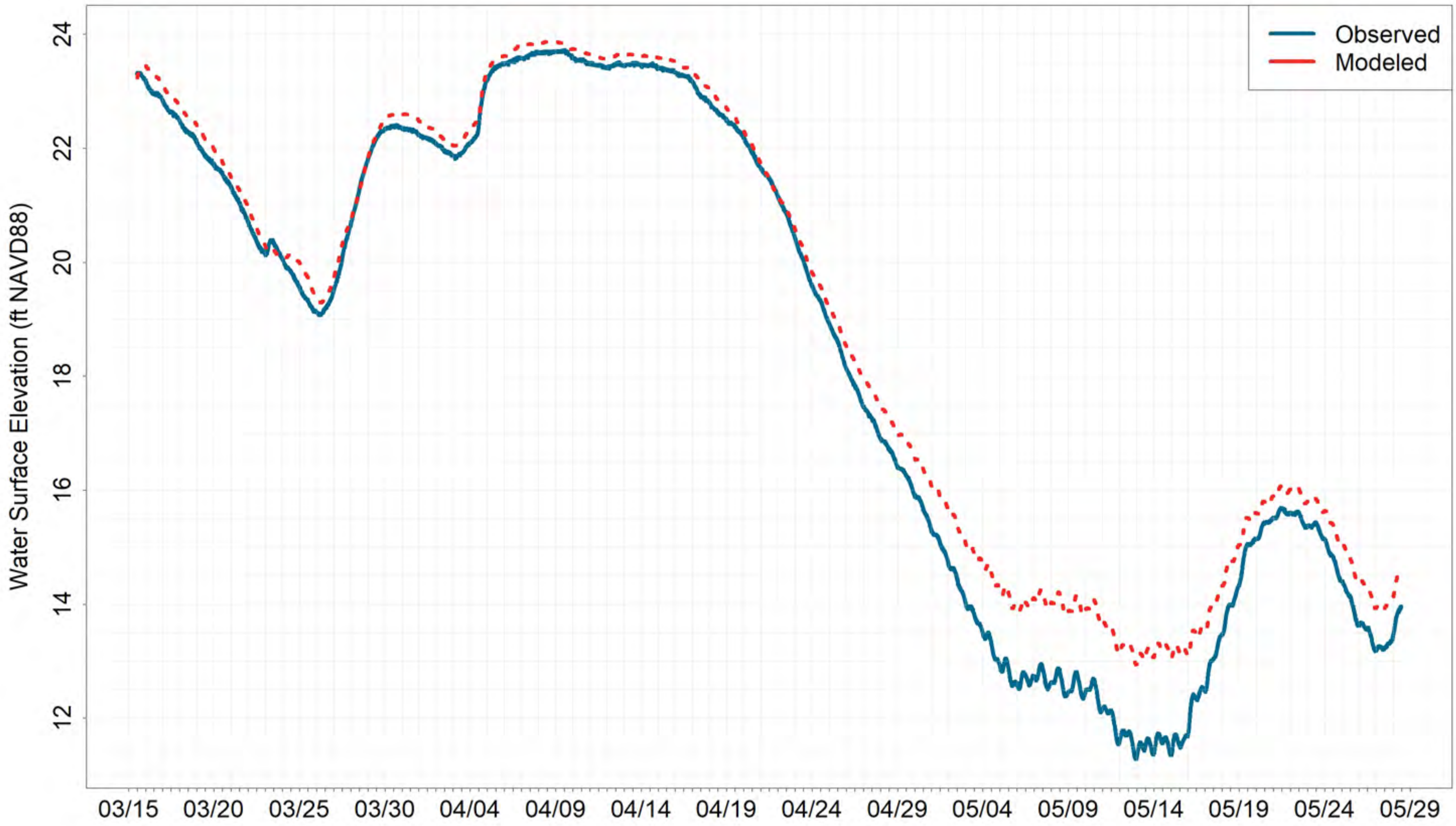
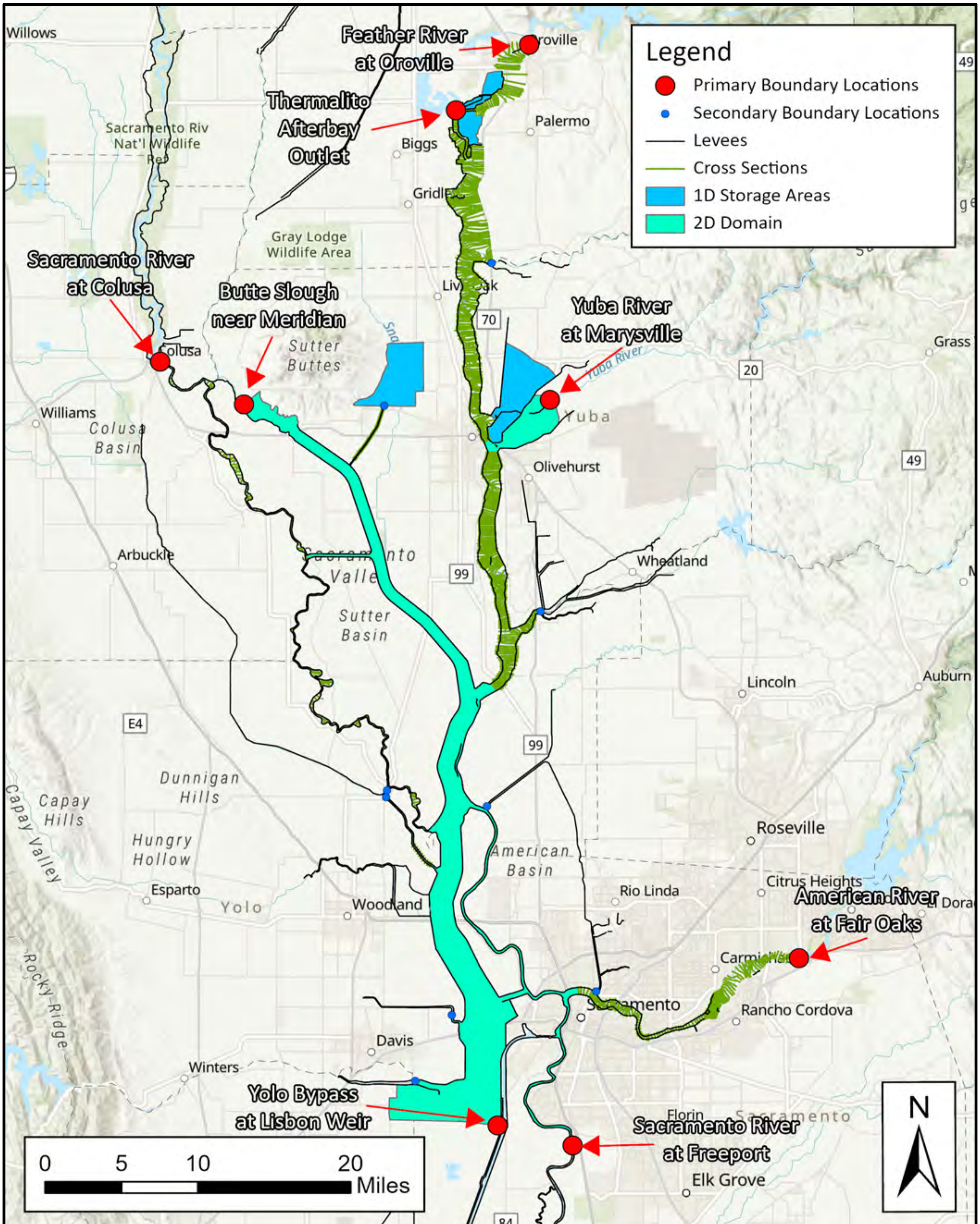
SEIR Impact Assessment of the Feather and Sacramento Rivers

Model Calibration − Sacramento River at Verona 2019

Project No. 23−1008	**Created By: TKS**	**Figure 8**



Notes:		*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Model Calibration − Sacramento River at I−Street 2019**		
		Project No. 23−1008	**Created By: TKS**	**Figure 9**



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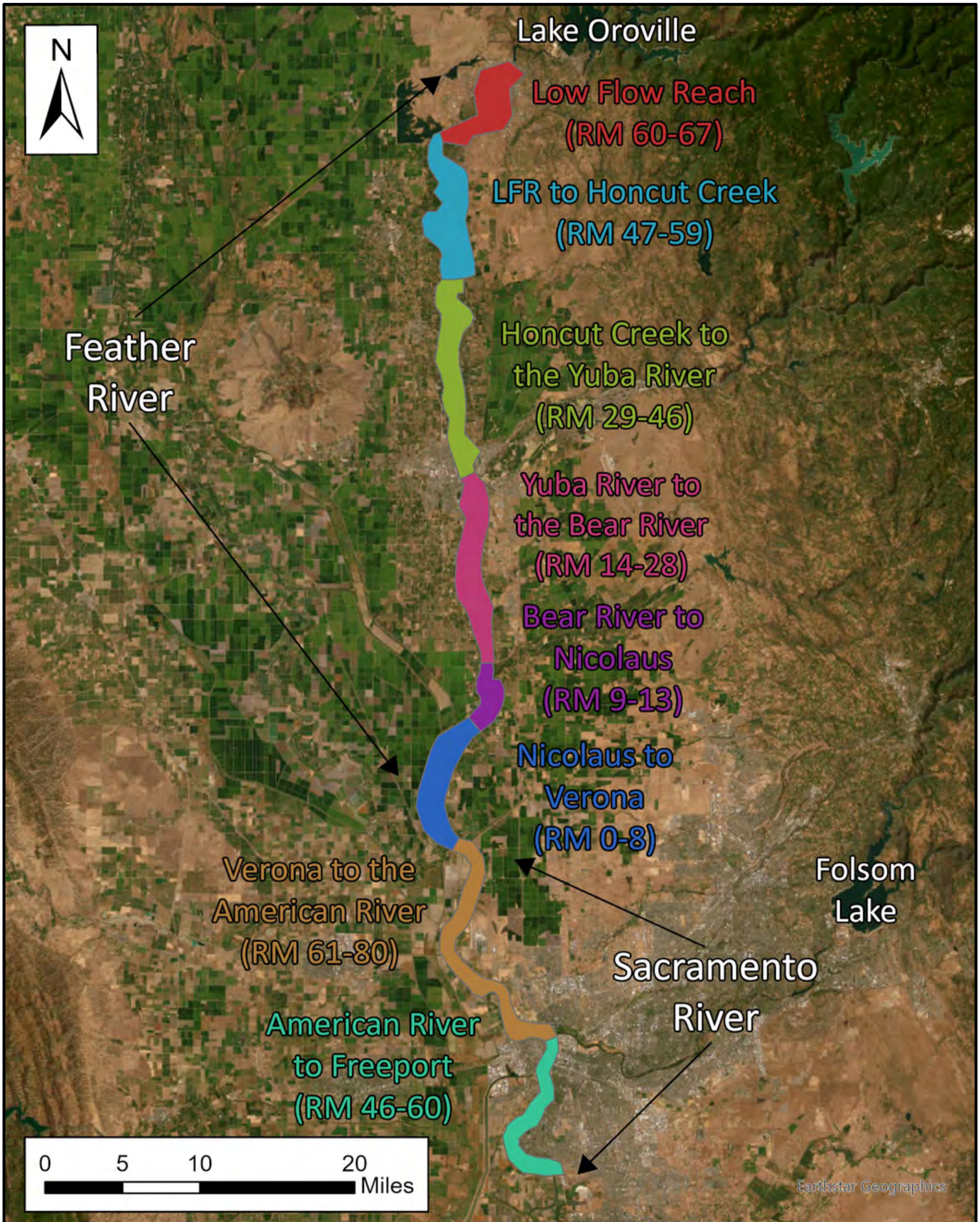
SEIR Impact Assessment of the Feather and Sacramento Rivers

Hydraulic Analysis Model Boundary Conditions

Project No. 23−1008	Created By: TKS	Figure 10



Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

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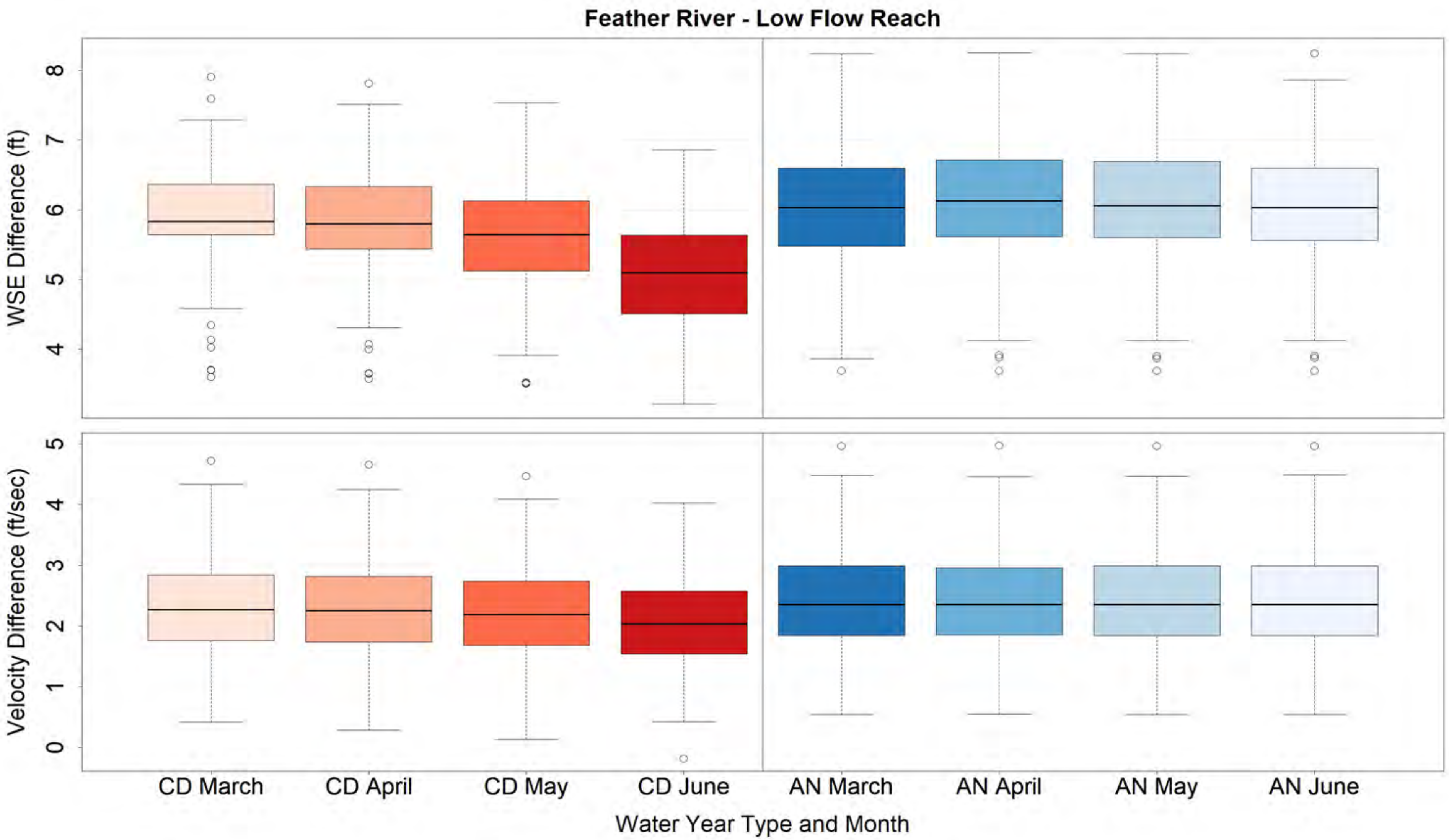
SEIR Impact Assessment of the Feather and Sacramento Rivers **Mean Monthly Impact Assessment − Study Reaches**		
Project No. 23−1008	**Created By: TKS**	**Figure 11**



Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

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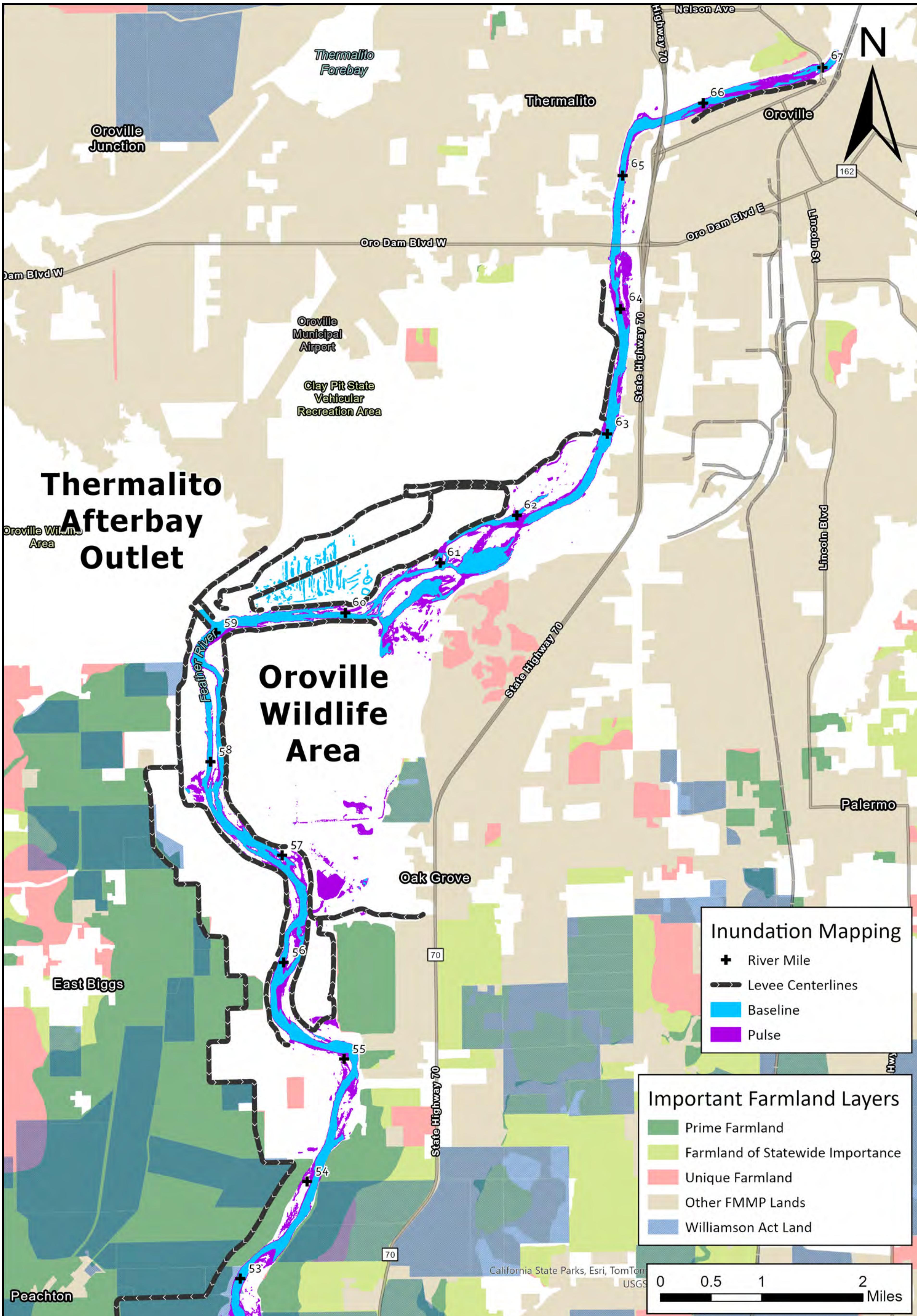
SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − Low Flow Reach

Project No. 23−1008	**Created By: TKS**	**Figure 12**

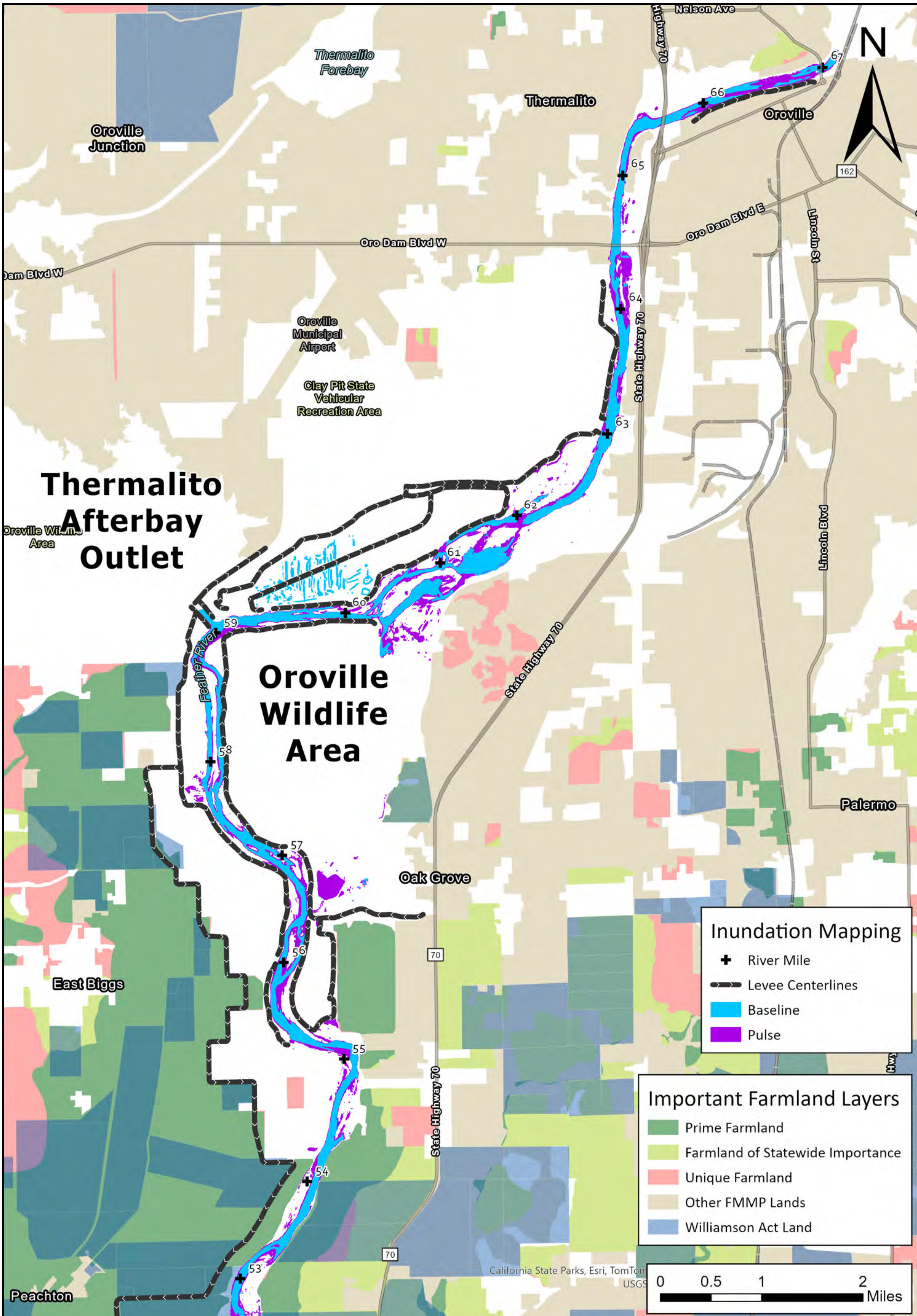


Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents – Panel 1 – March AN – Base vs. Pulse

Project No. 23–1008	Created By: TKS	Figure 13

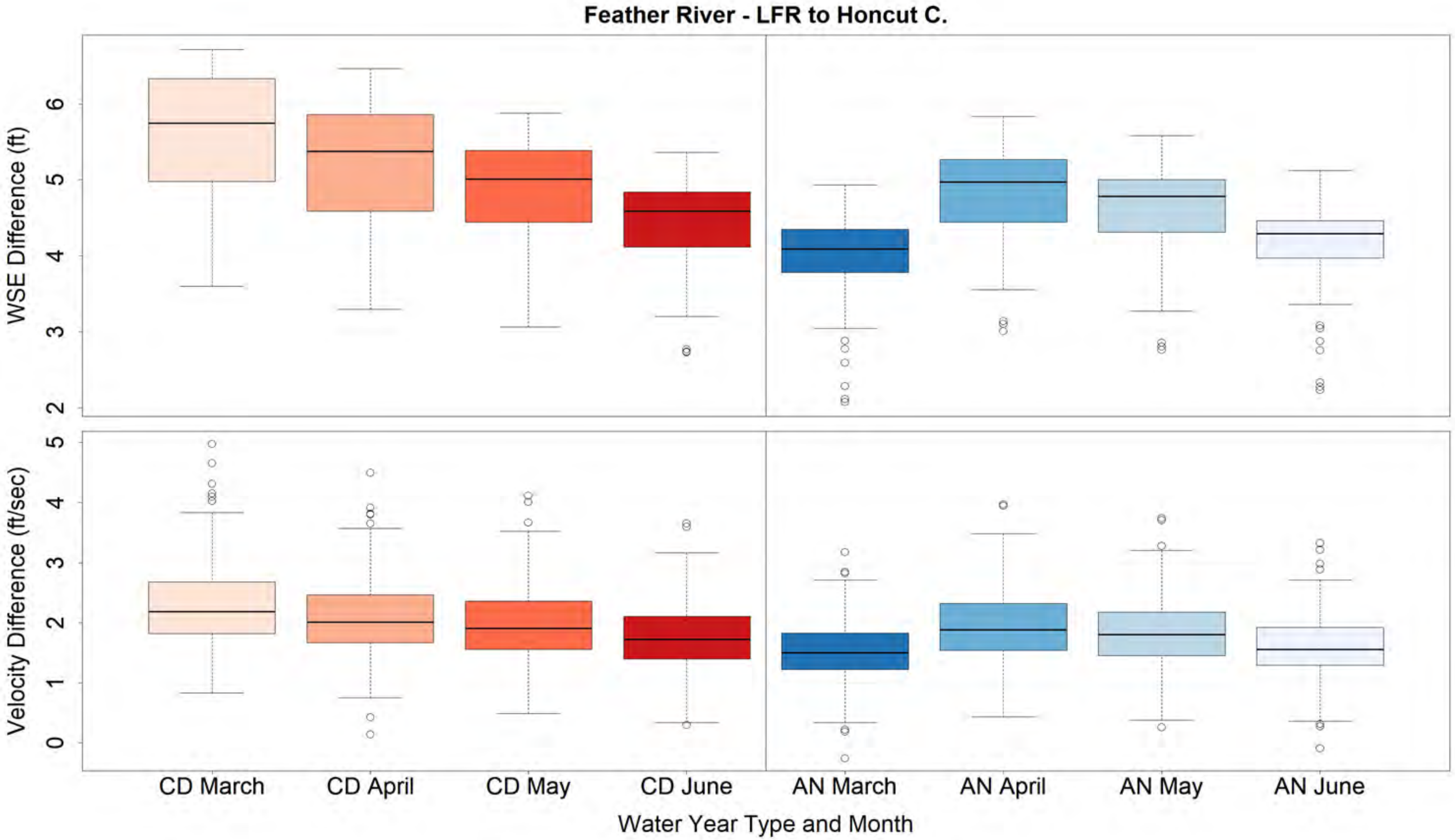


Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 1 − April CD − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 14

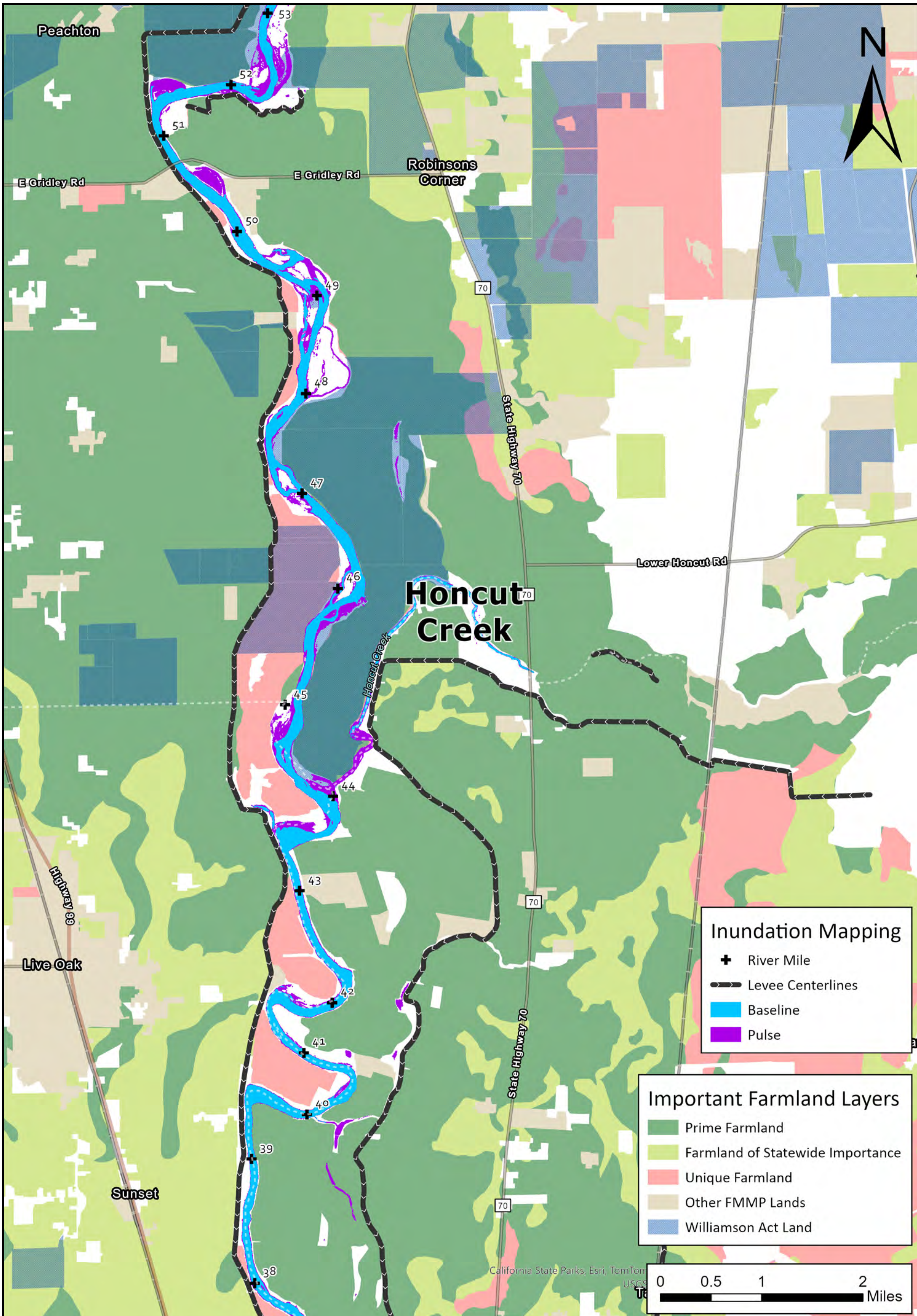


Notes: TAB = Thermalito Afterbay. WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − TAB to Honcut Creek

Project No. 23−1008	**Created By: TKS**	**Figure 15**



Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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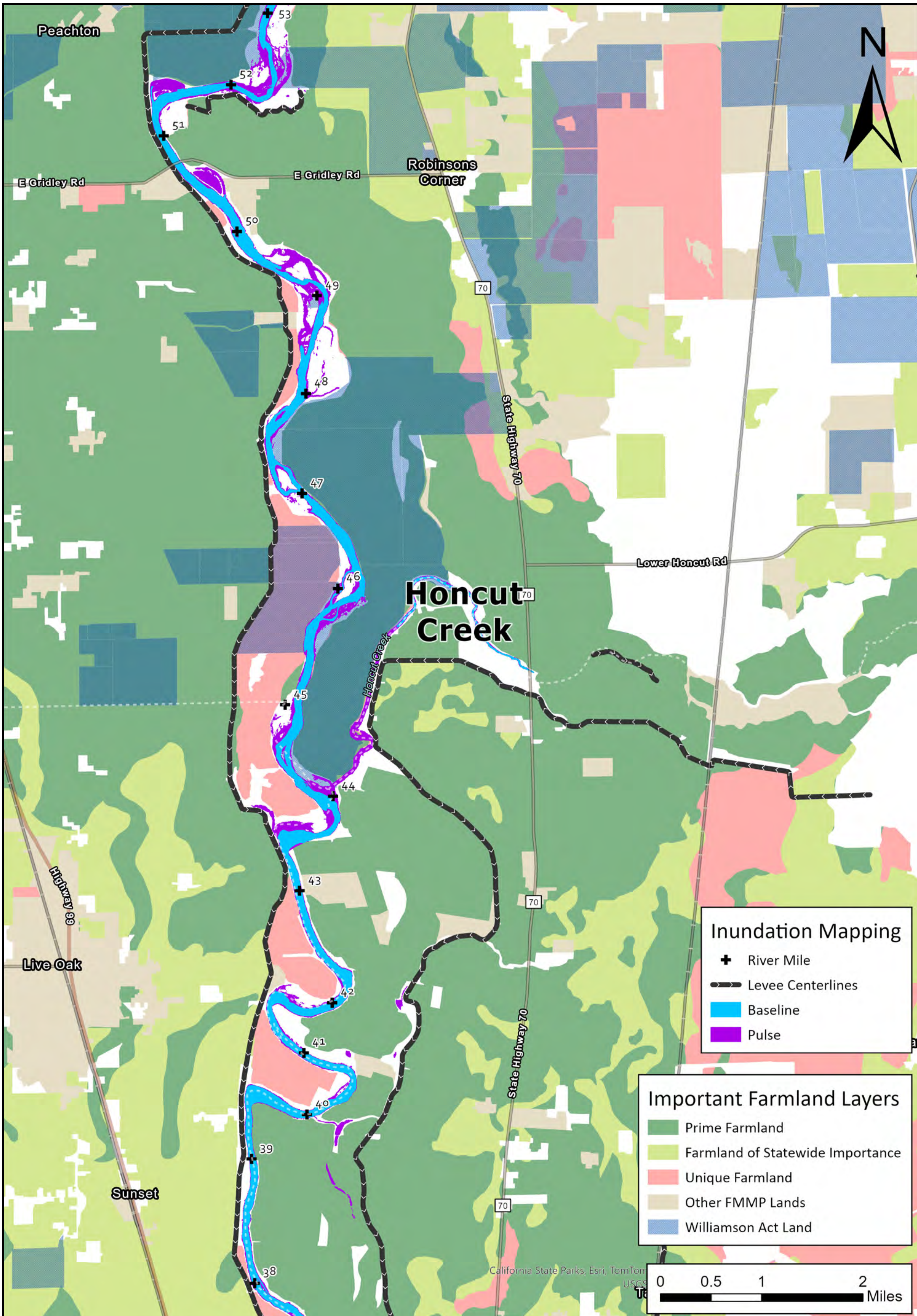
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 2 − March AN − Base vs. Pulse

Project No. 23−1008	**Created By: TKS**	**Figure 16**



Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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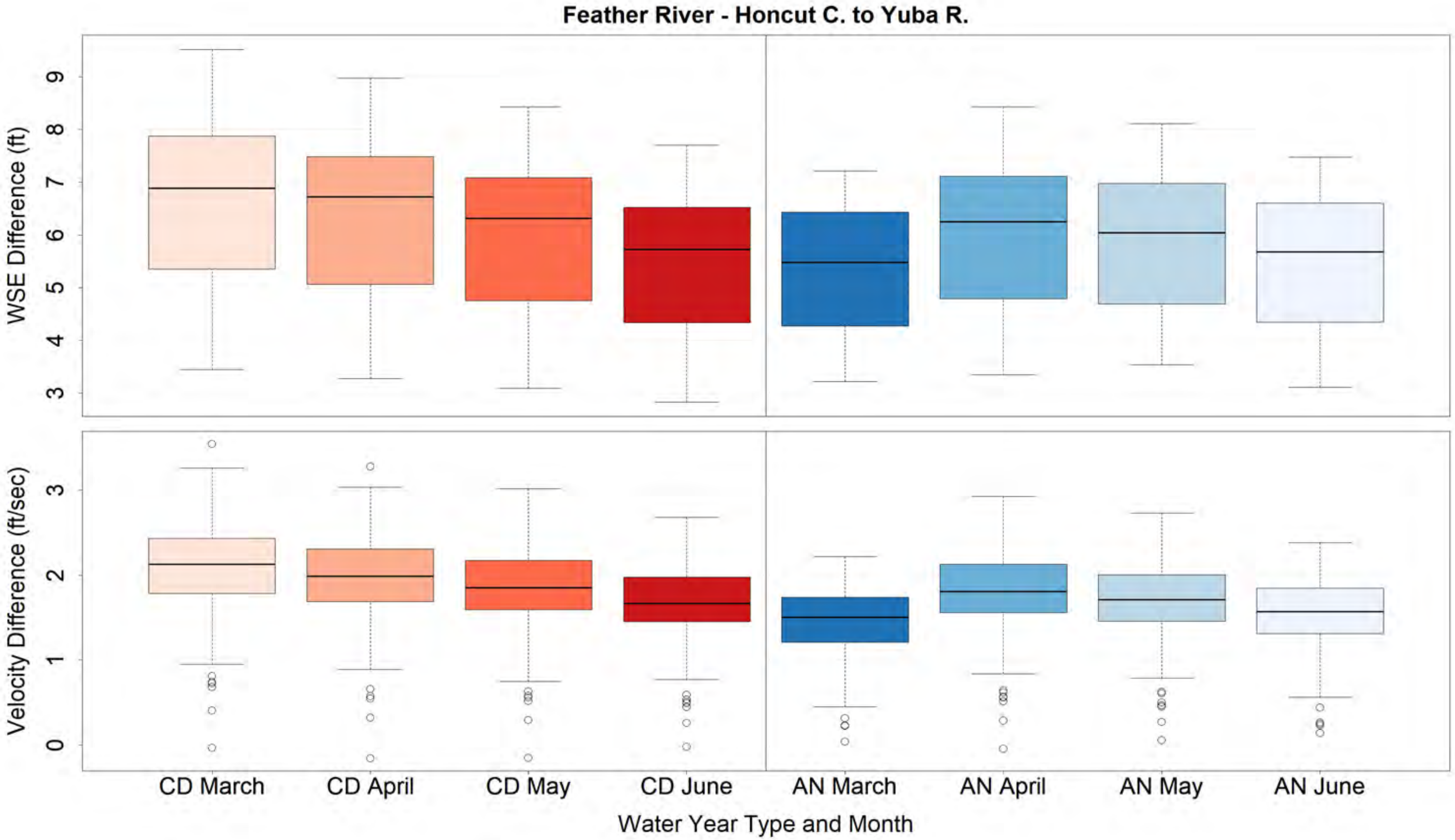
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 2 − April CD − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 17

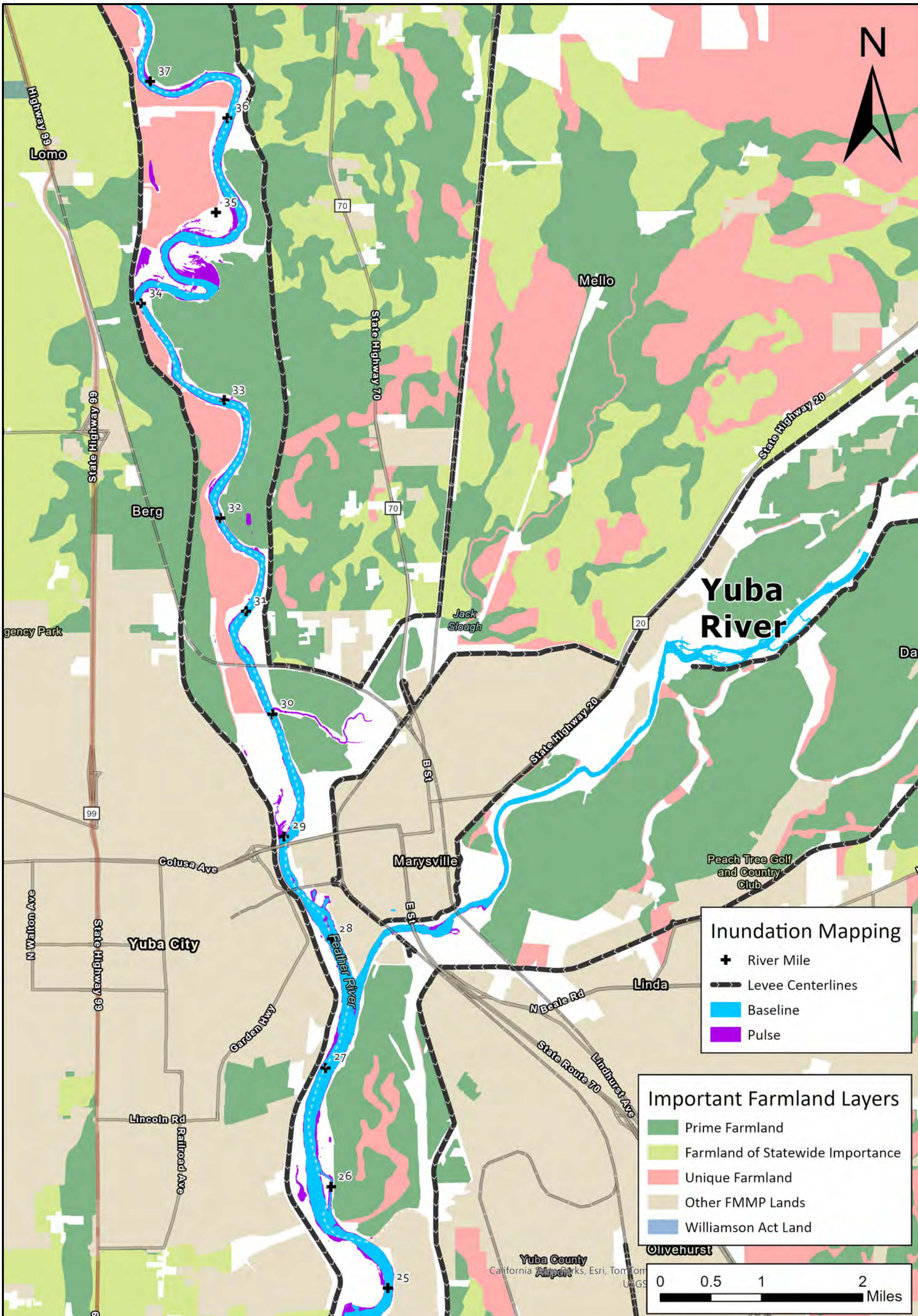


Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment – Honcut Creek to Yuba City

Project No. 23–1008	**Created By: TKS**	**Figure 18**



Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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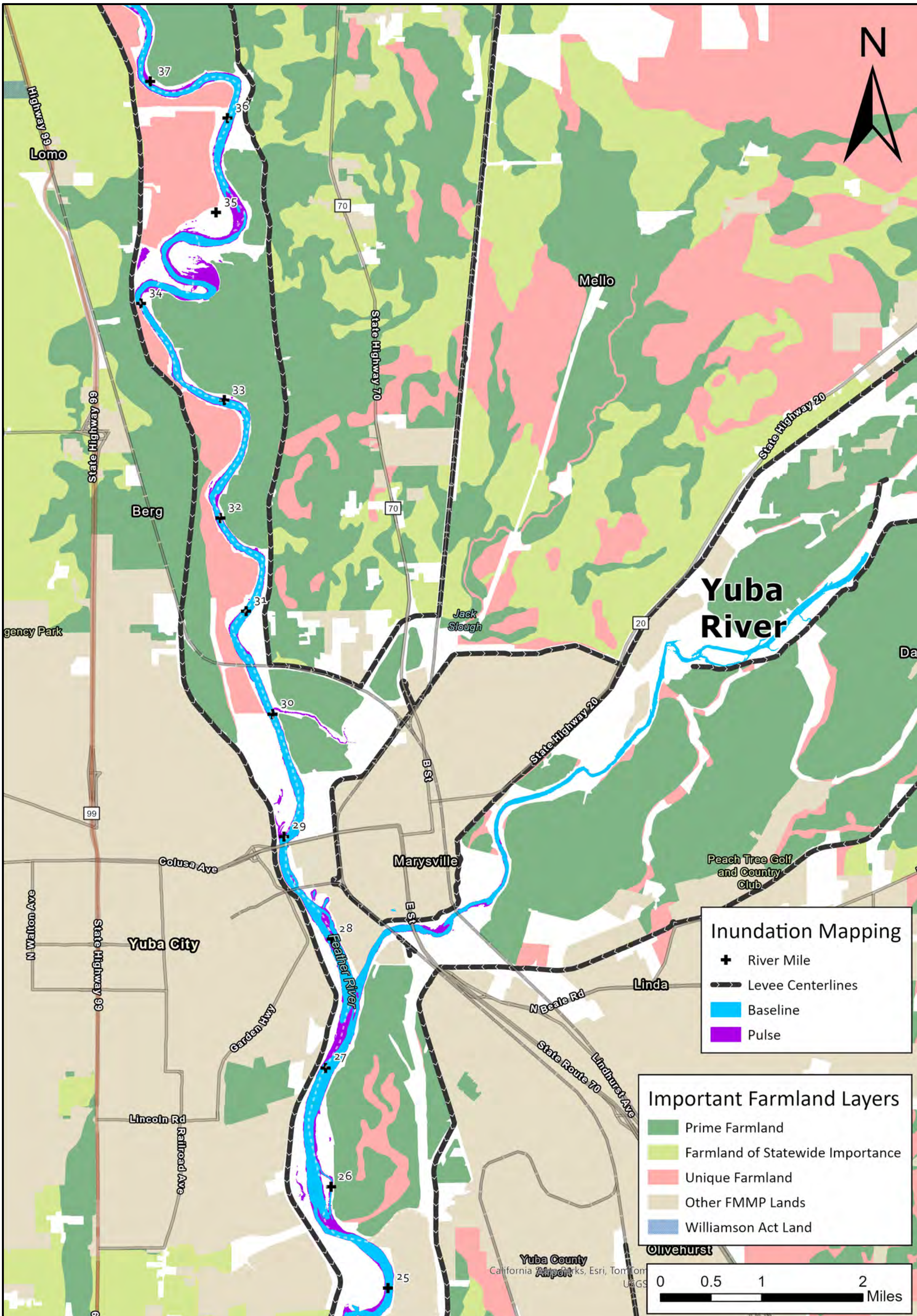
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 3 − March AN − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 19



Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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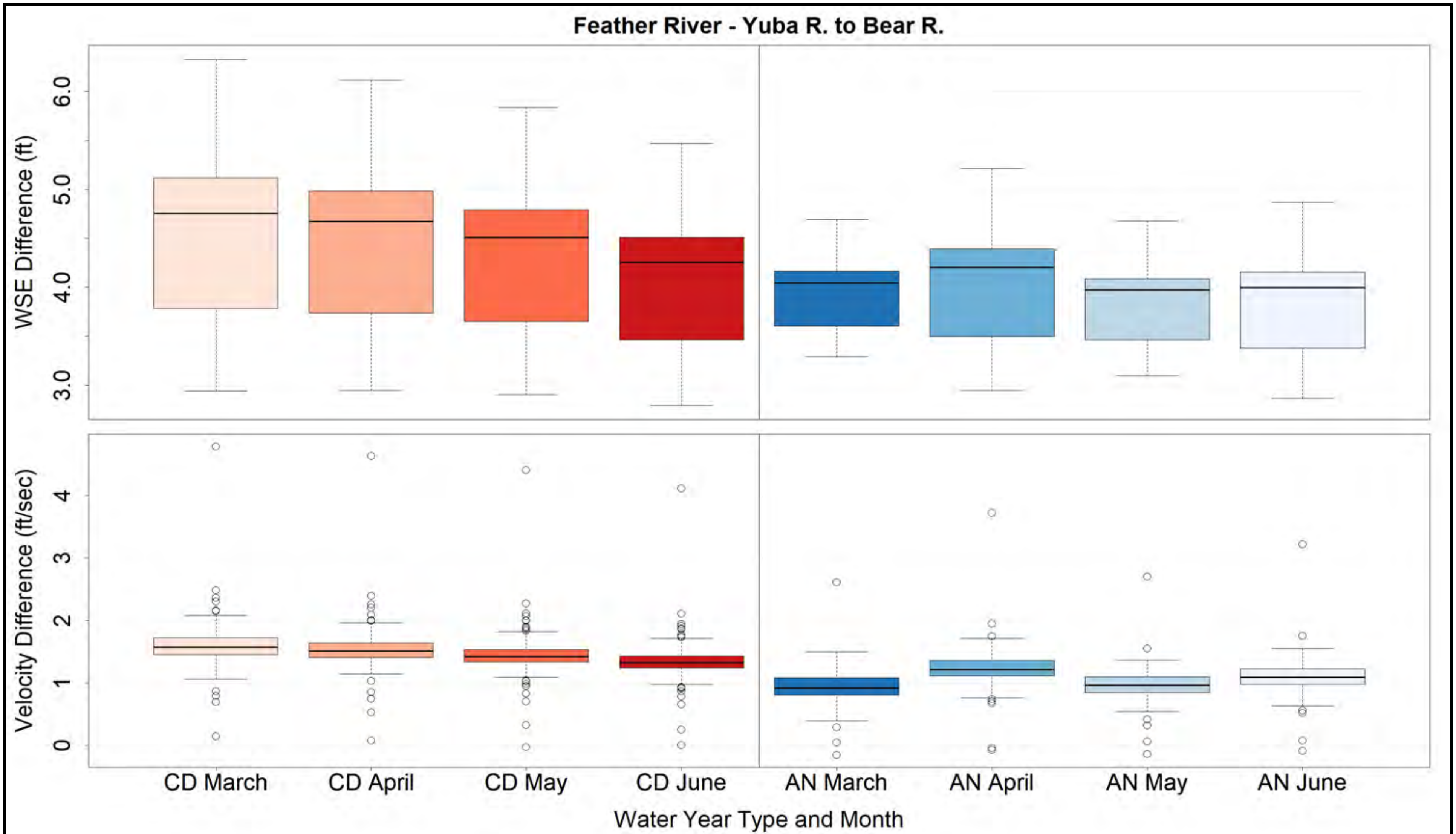
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 3 − April CD − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 20

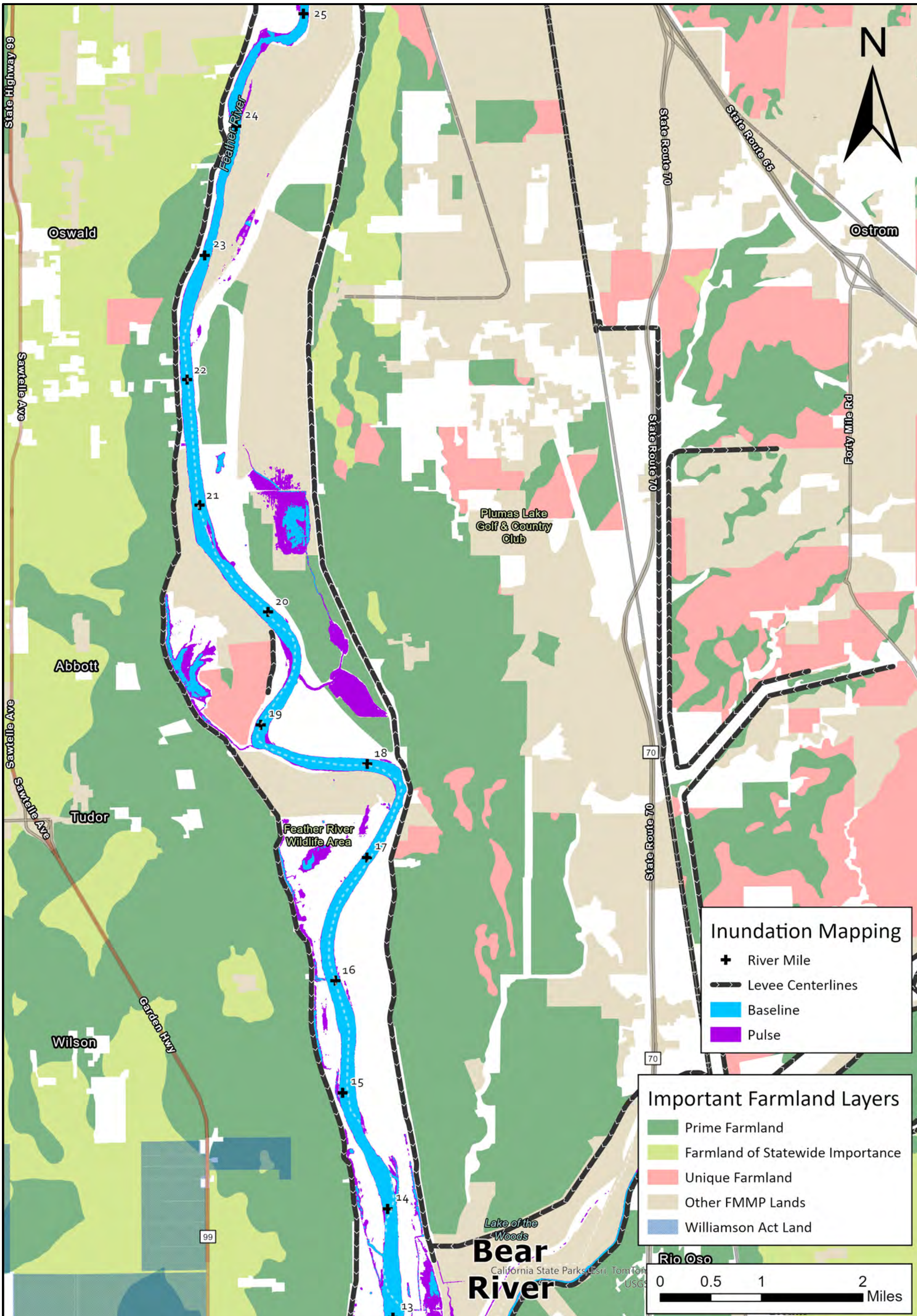


Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − Yuba City to Bear River

Project No. 23−1008	**Created By: TKS**	**Figure 21**



Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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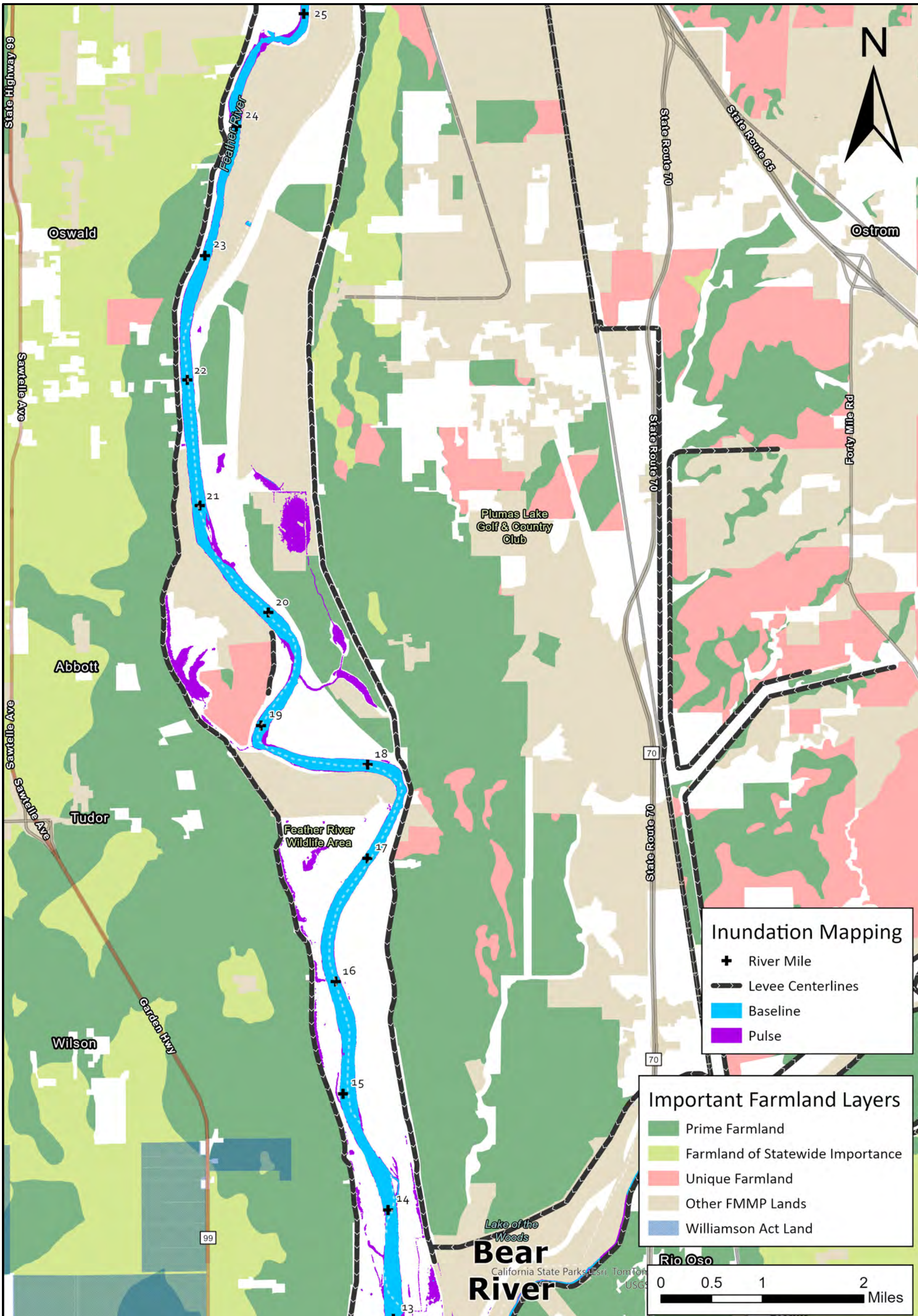
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 4 − March AN − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 22



Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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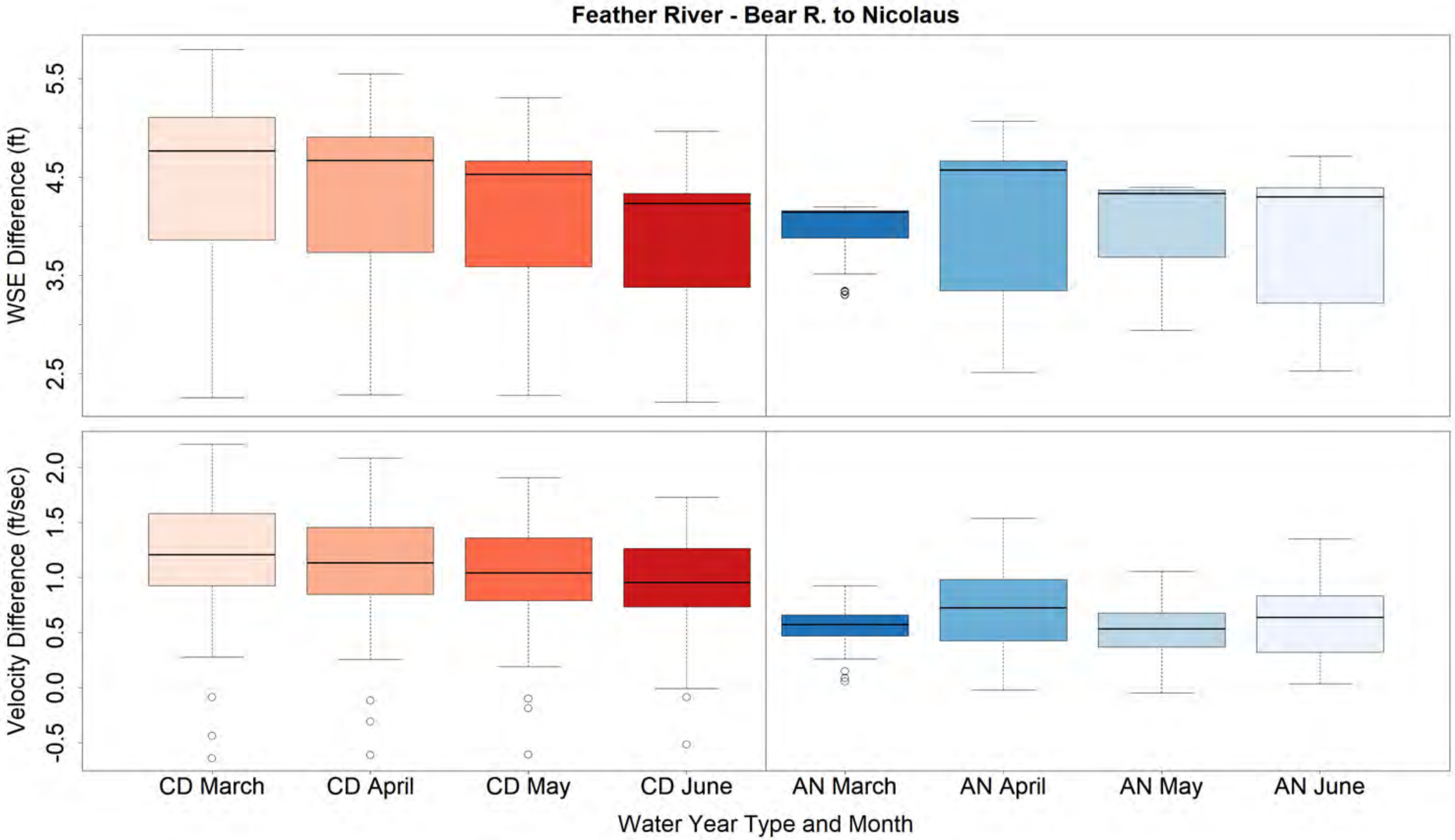
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 4 − April CD − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 23

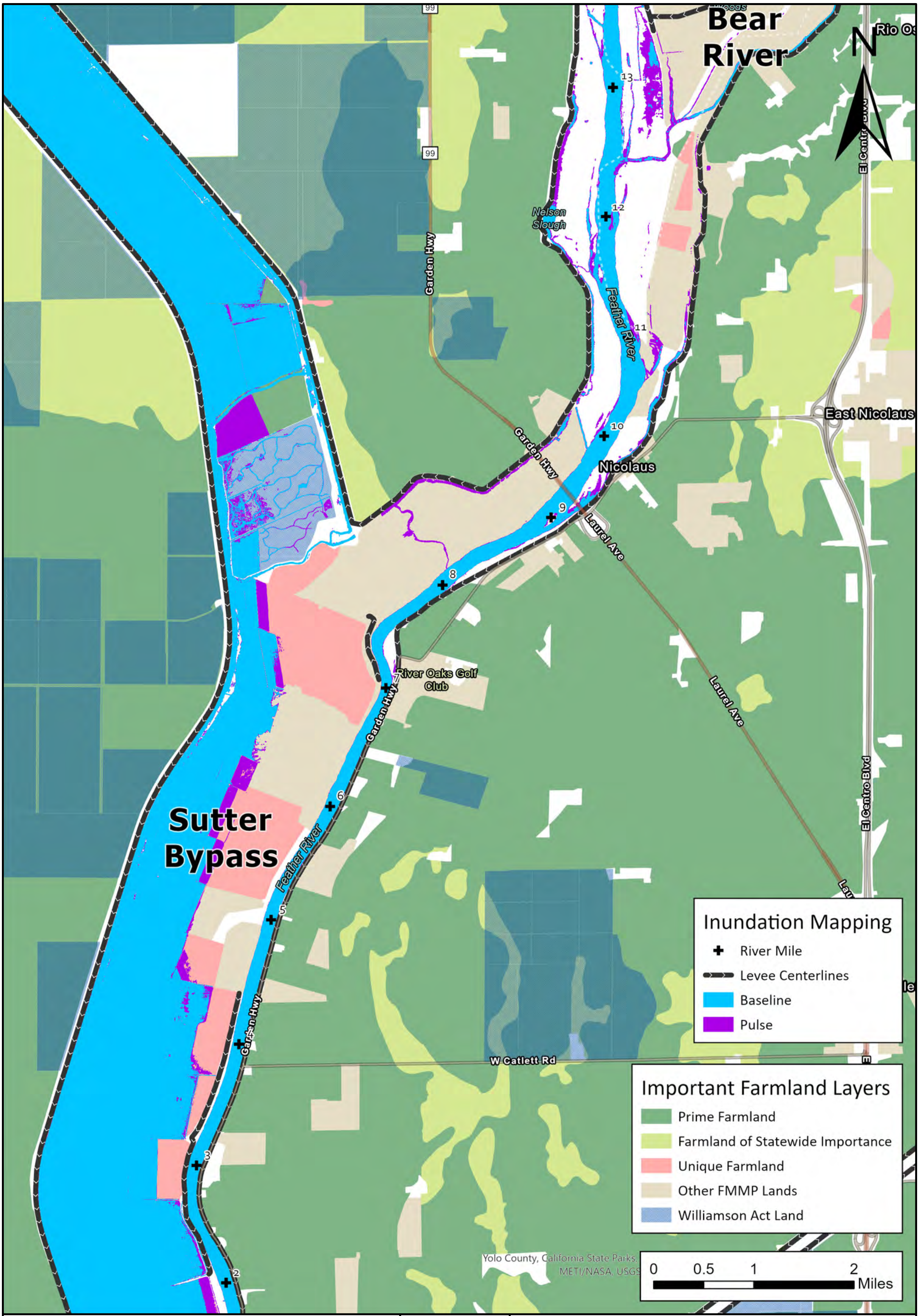


Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − Bear River to Nicolaus

Project No. 23−1008	**Created By: TKS**	**Figure 24**

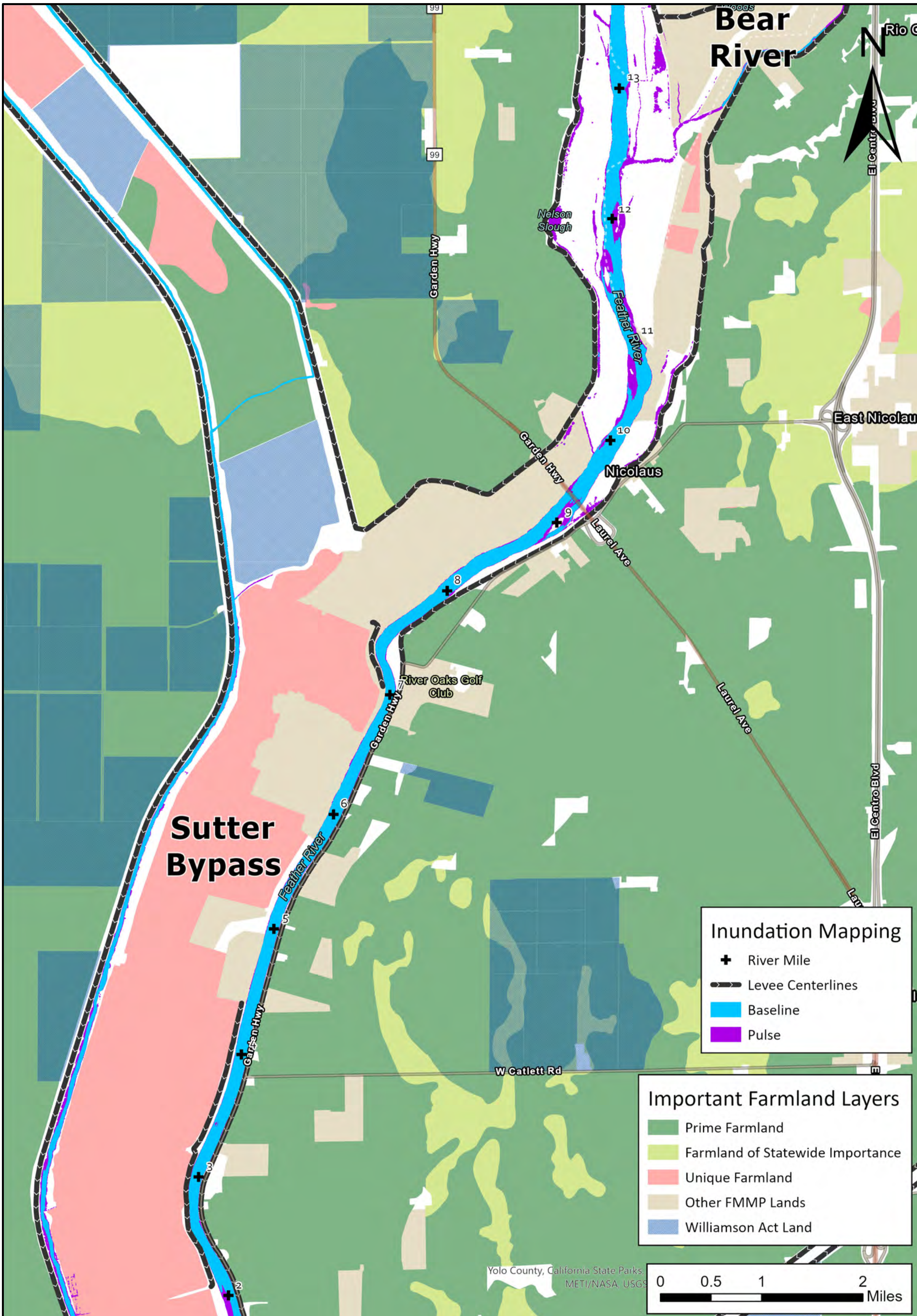


Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 5 − March AN − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 25



Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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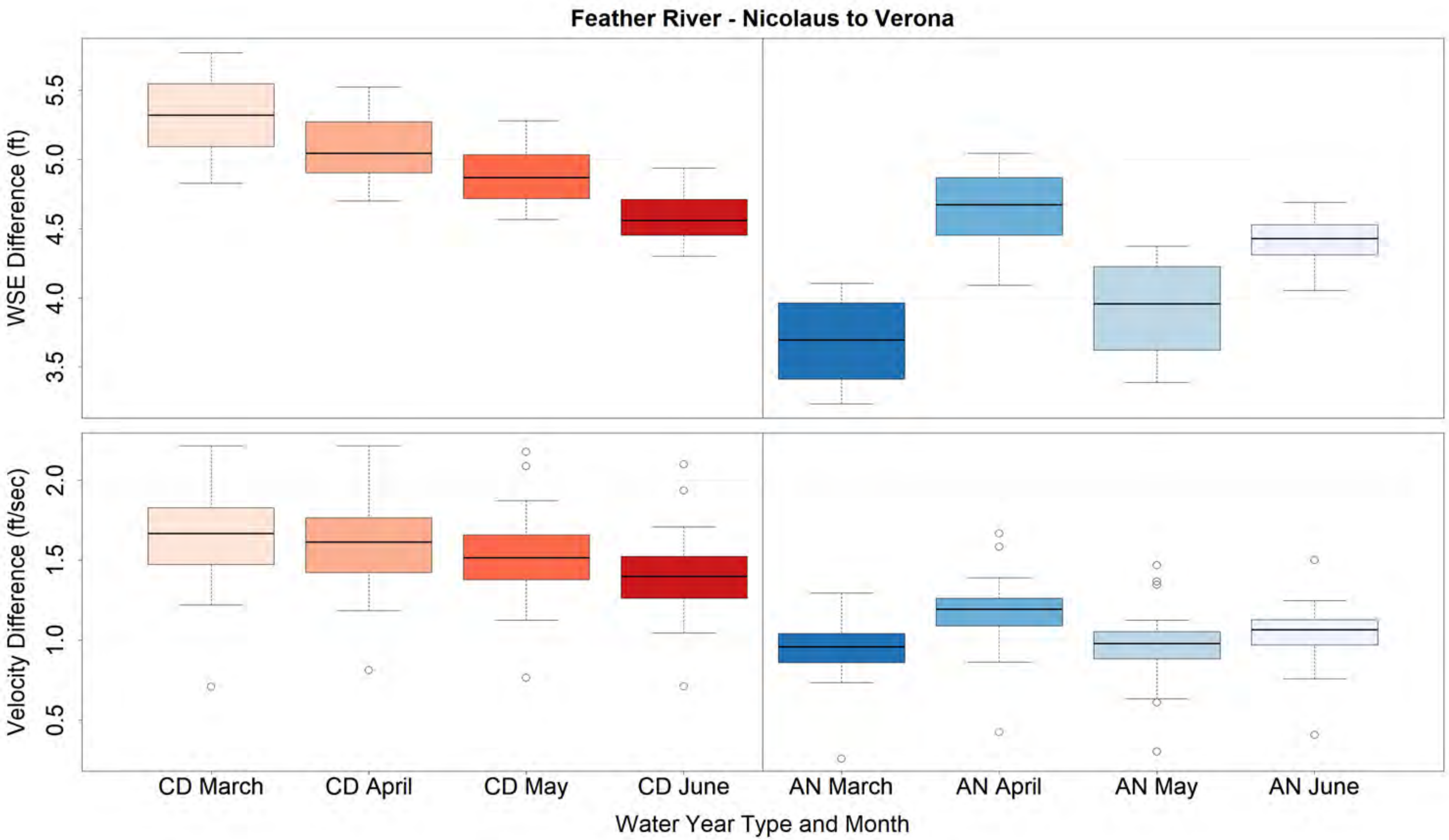
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 5 − April CD − Base vs. Pulse

Project No. 23−1008	**Created By: TKS**	**Figure 26**



Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

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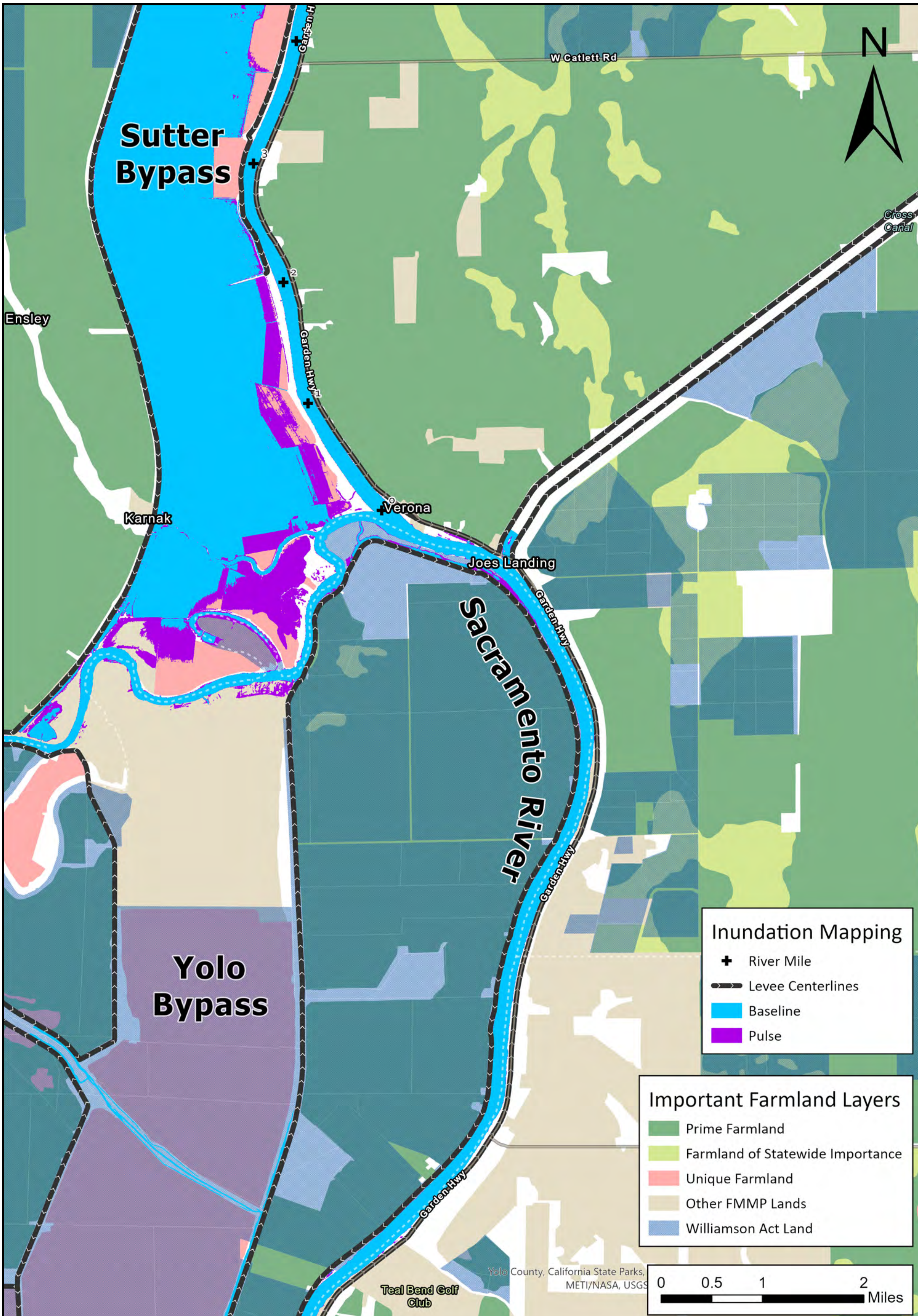
SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − Nicolaus to Verona

Project No. 23−1008	Created By: TKS	Figure 27



Notes: AN = above normal water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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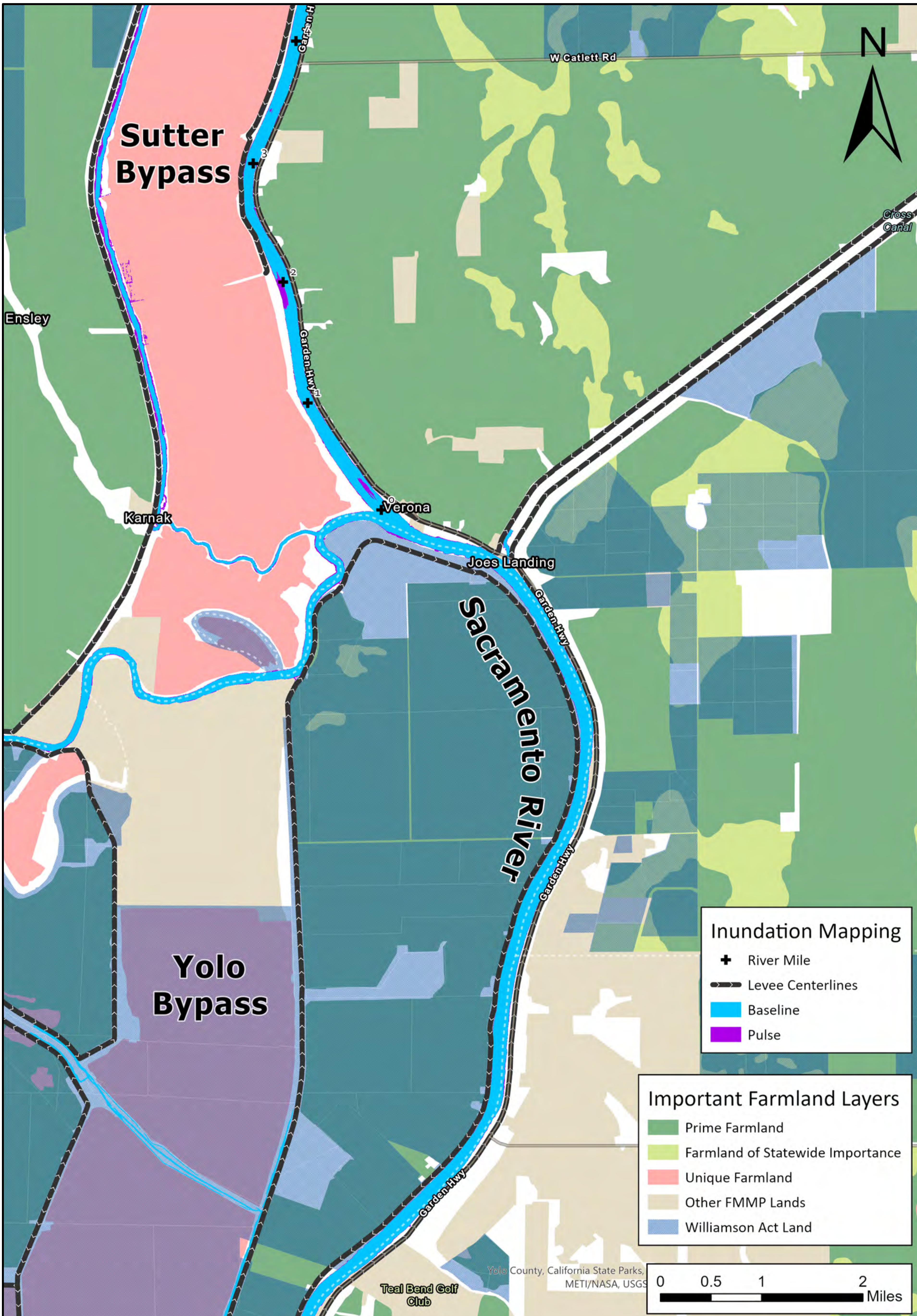
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 6 − March AN − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 28



Notes: CD = critically dry water year type. Data source: CA Dept. of Conservation Important Farmlands Map. (https://www.conservation.ca.gov/dlrp/fmmp)

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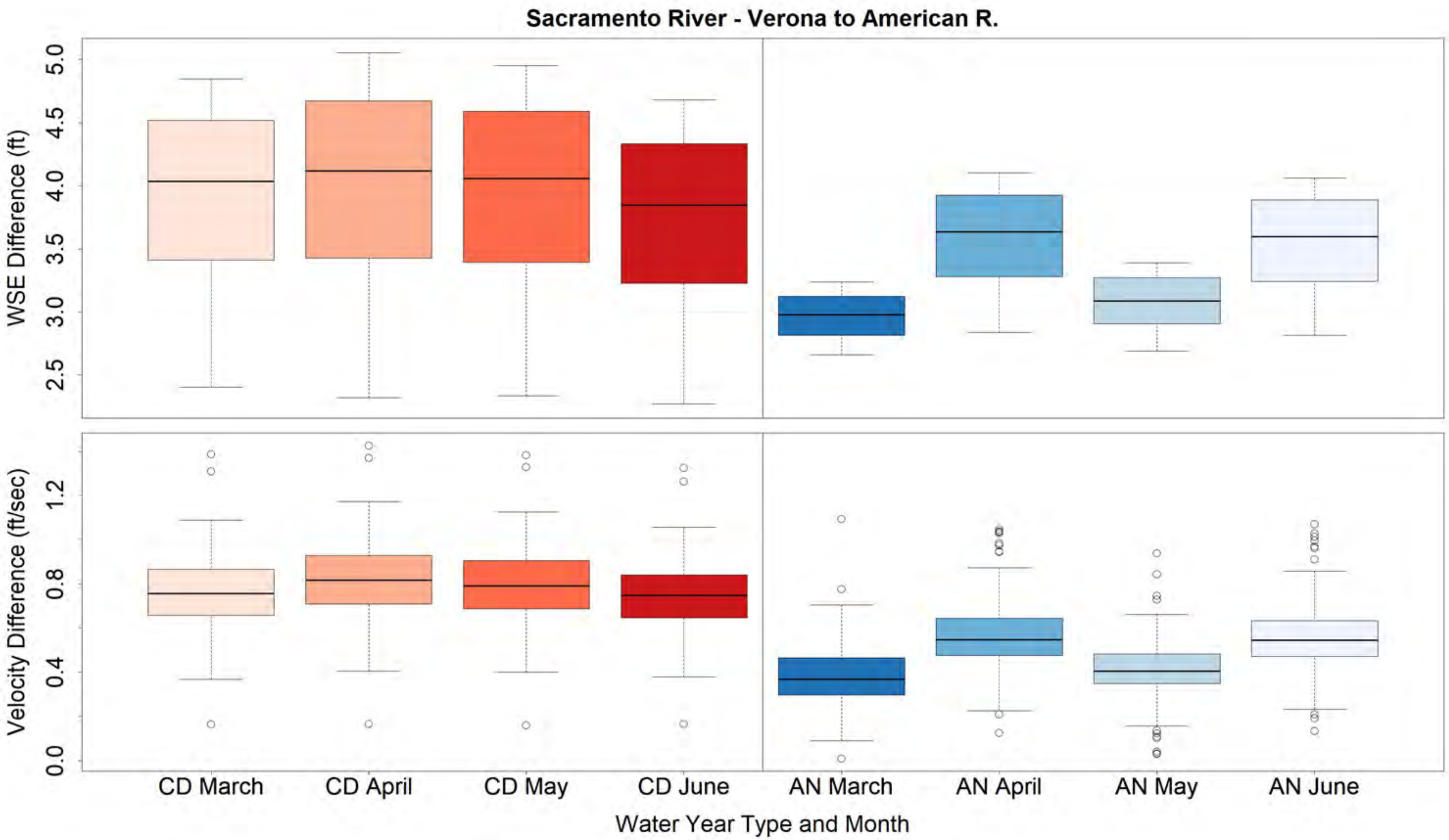
SEIR Impact Assessment of the Feather and Sacramento Rivers

Inundation Extents − Panel 6 − April CD − Base vs. Pulse

Project No. 23−1008	Created By: TKS	Figure 29

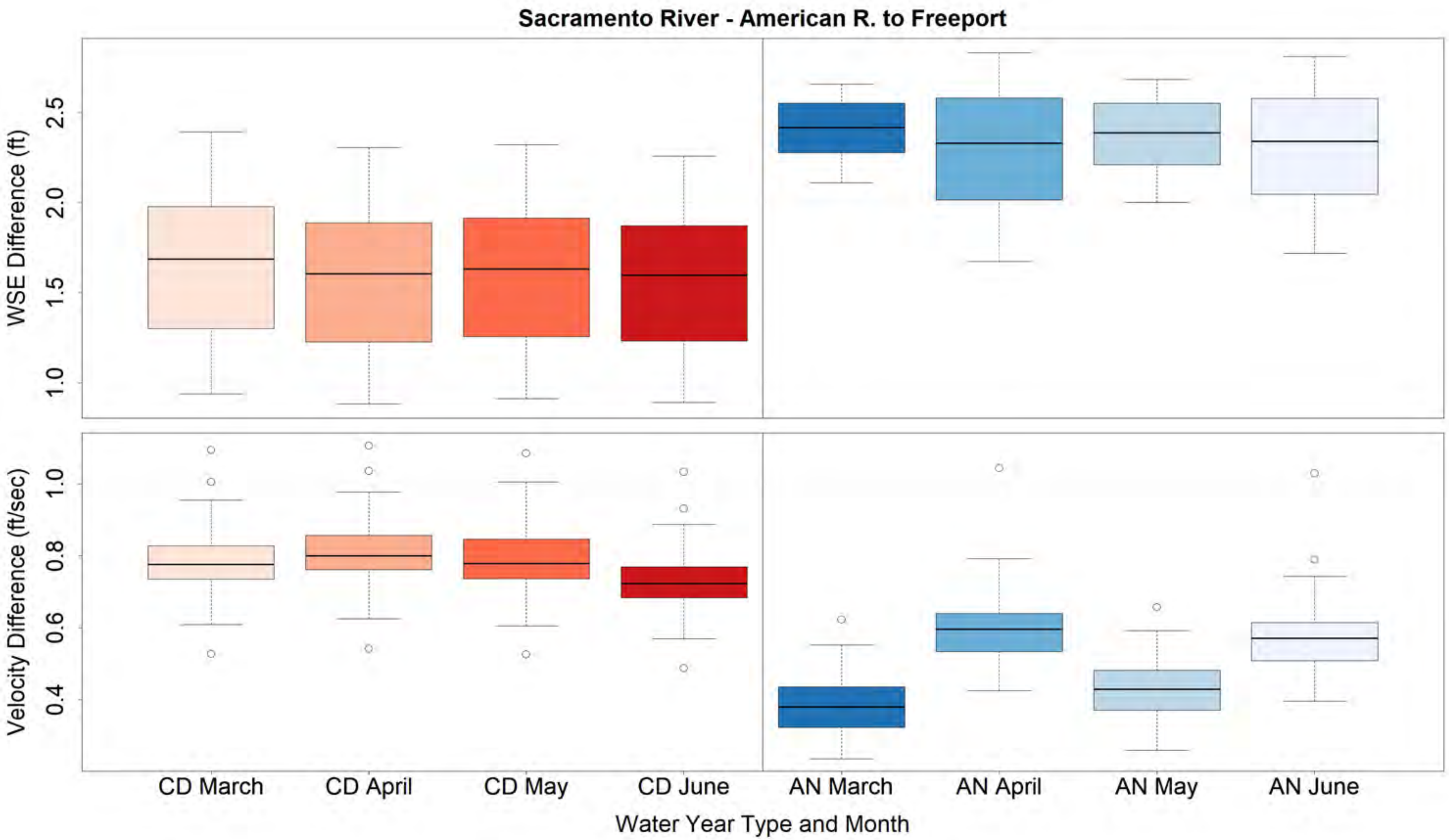


Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment − Verona to American River

Project No. 23−1008	**Created By: TKS**	**Figure 30**

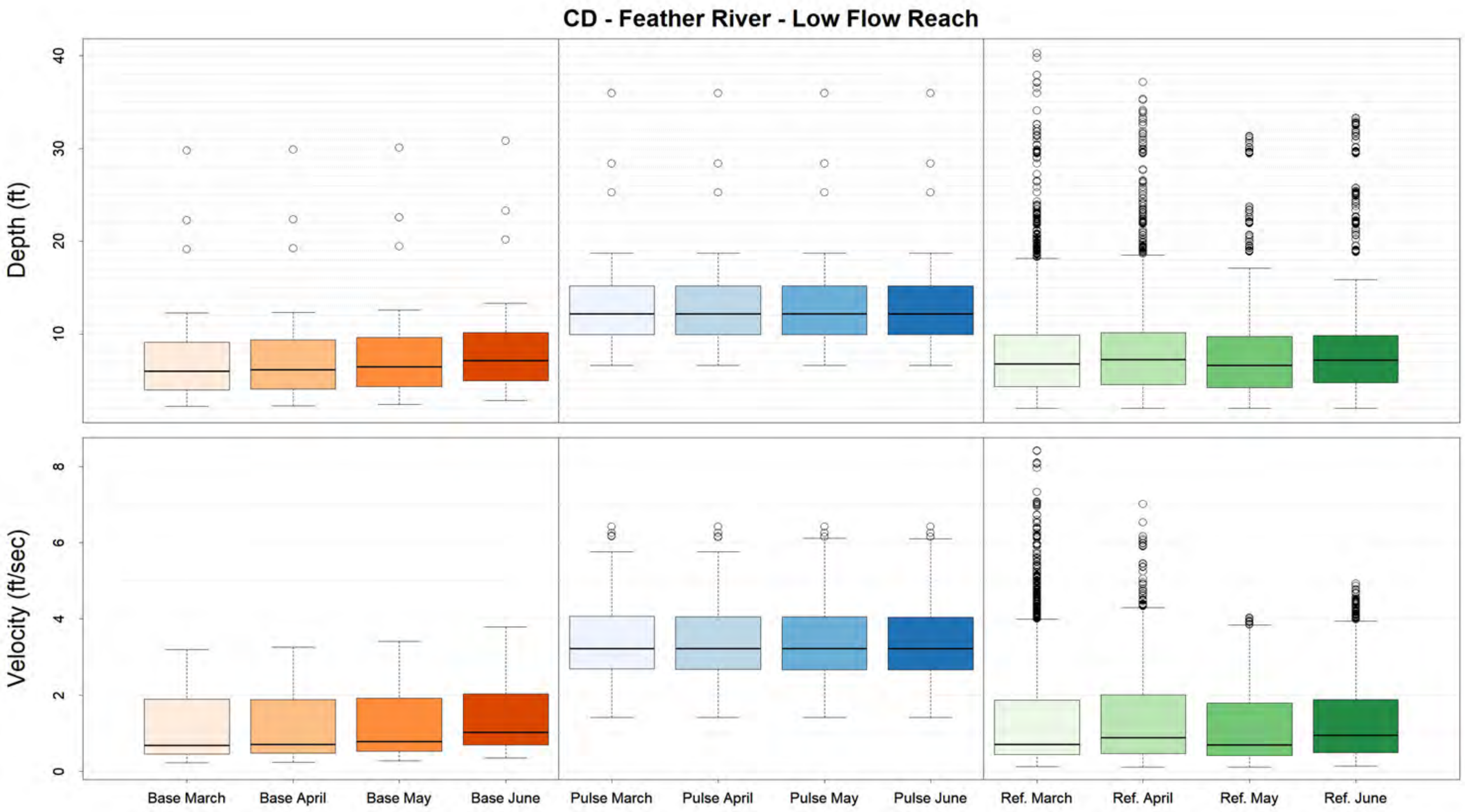


Notes: WSE = water surface elevation. CD = critically dry. AN = above normal. Bar plots repersent the difference in water level and velocity between a pulse flow and basline simulation.

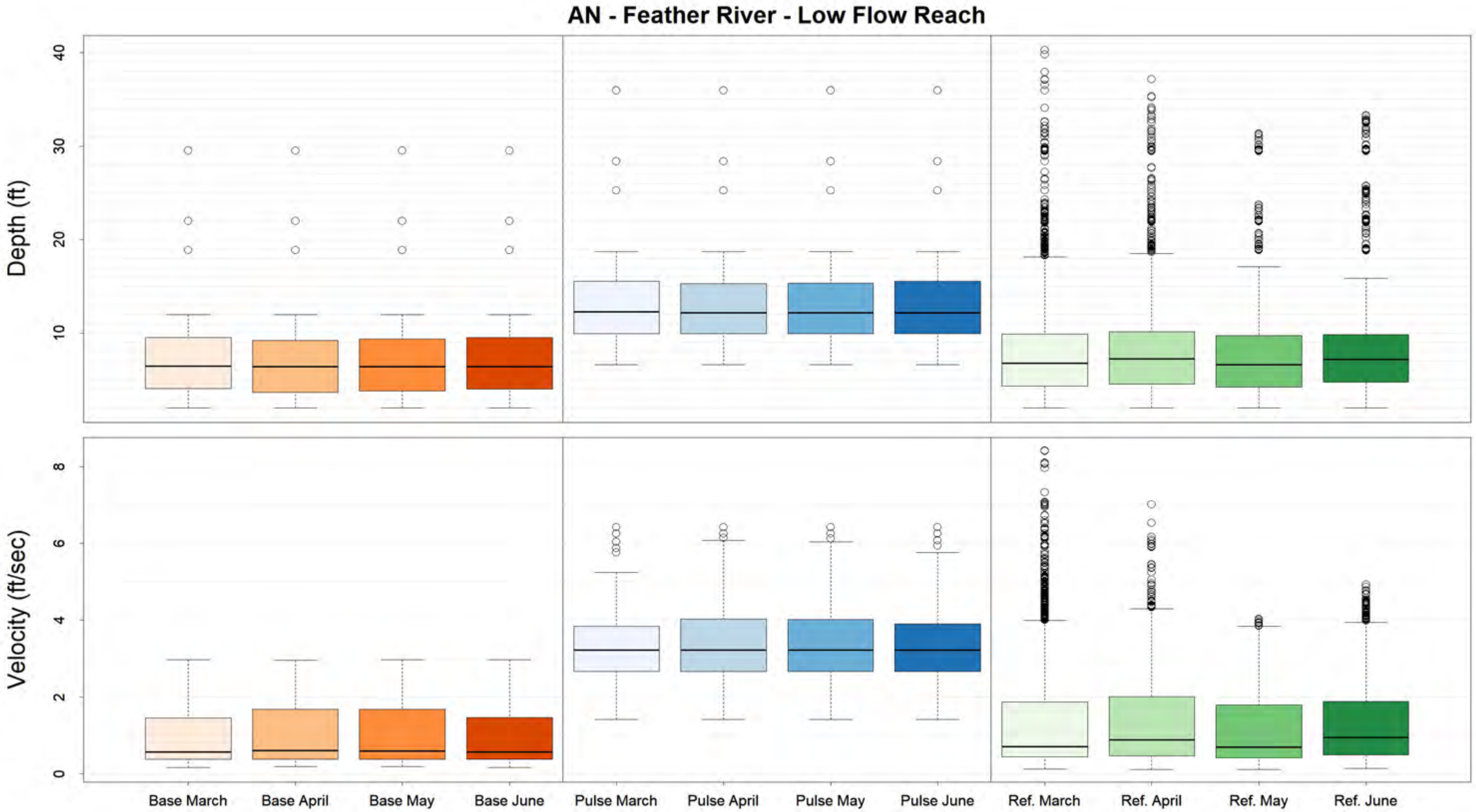
SEIR Impact Assessment of the Feather and Sacramento Rivers

Mean Monthly Impact Assessment – American River to Freeport

Project No. 23–1008	**Created By: TKS**	**Figure 31**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Flow Contextualization Results – CD – Low Flow Reach**
		Project No. 23–1008 | **Created By: TKS** | **Figure 32**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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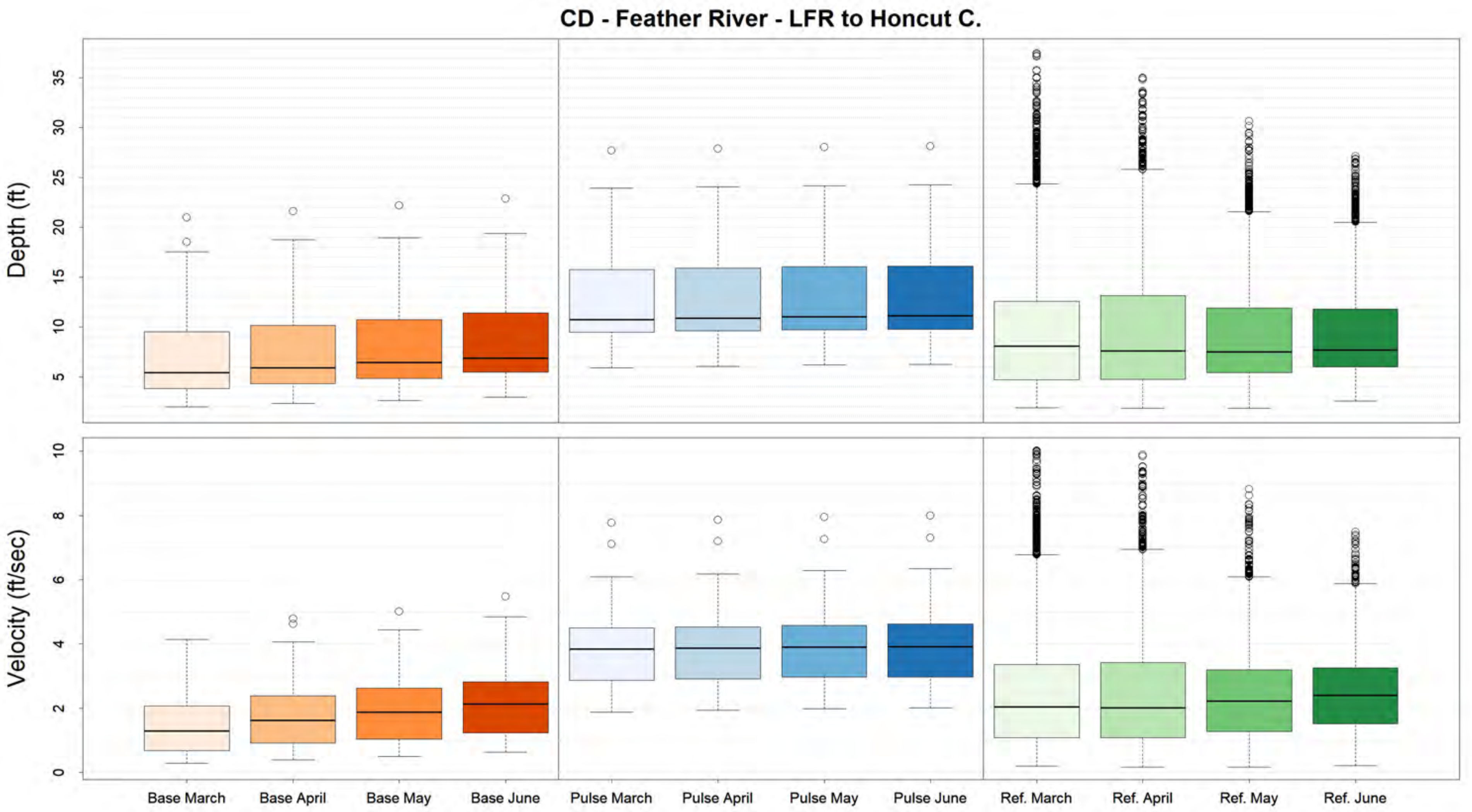
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – AN – Low Flow Reach

Project No. 23–1008	**Created By: TKS**	**Figure 33**



Notes: TAB = Thermalito Afterbay. CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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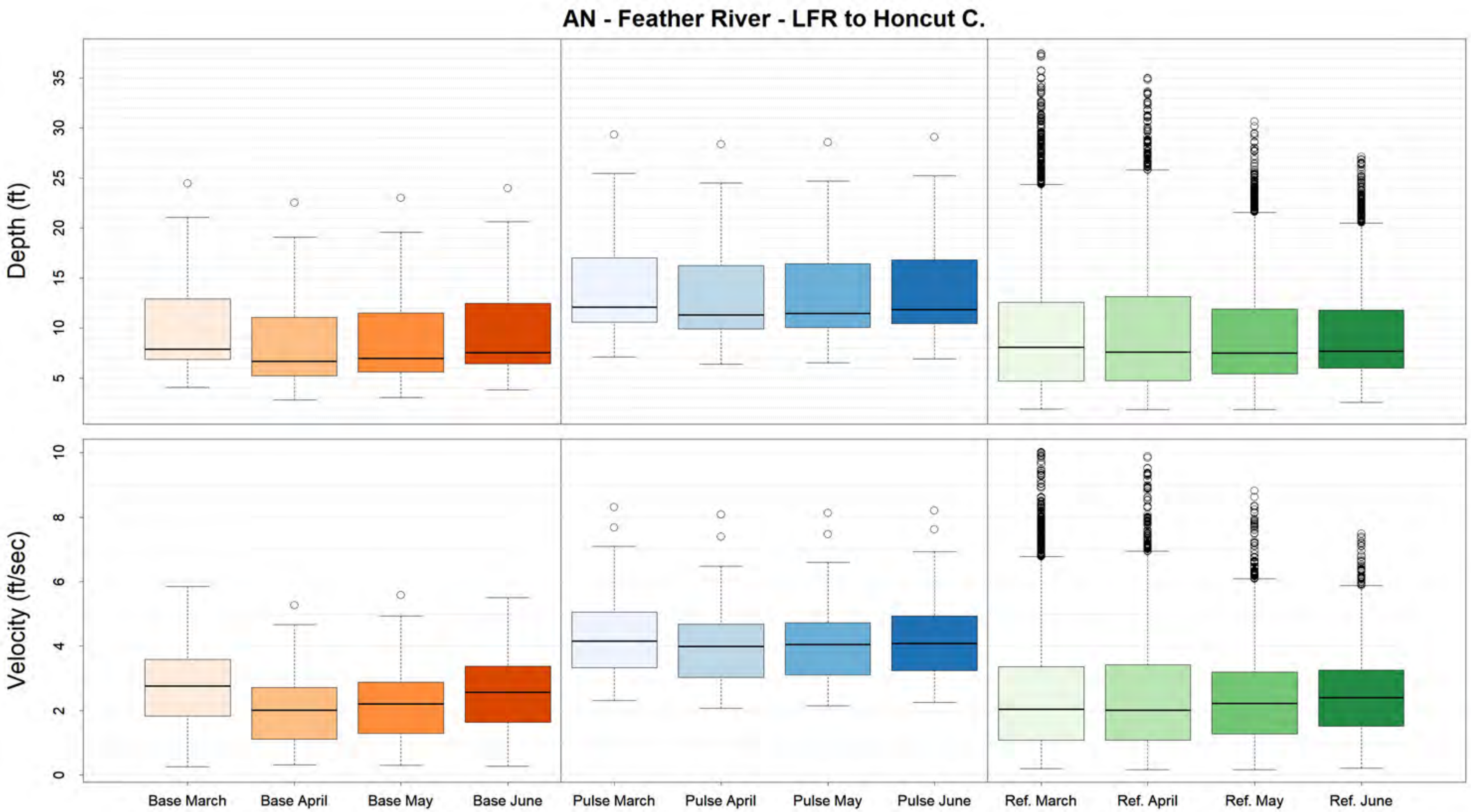
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – CD – TAB to Honcut Creek

Project No. 23–1008	**Created By: TKS**	**Figure 34**



Notes: TAB = Thermalito Afterbay. CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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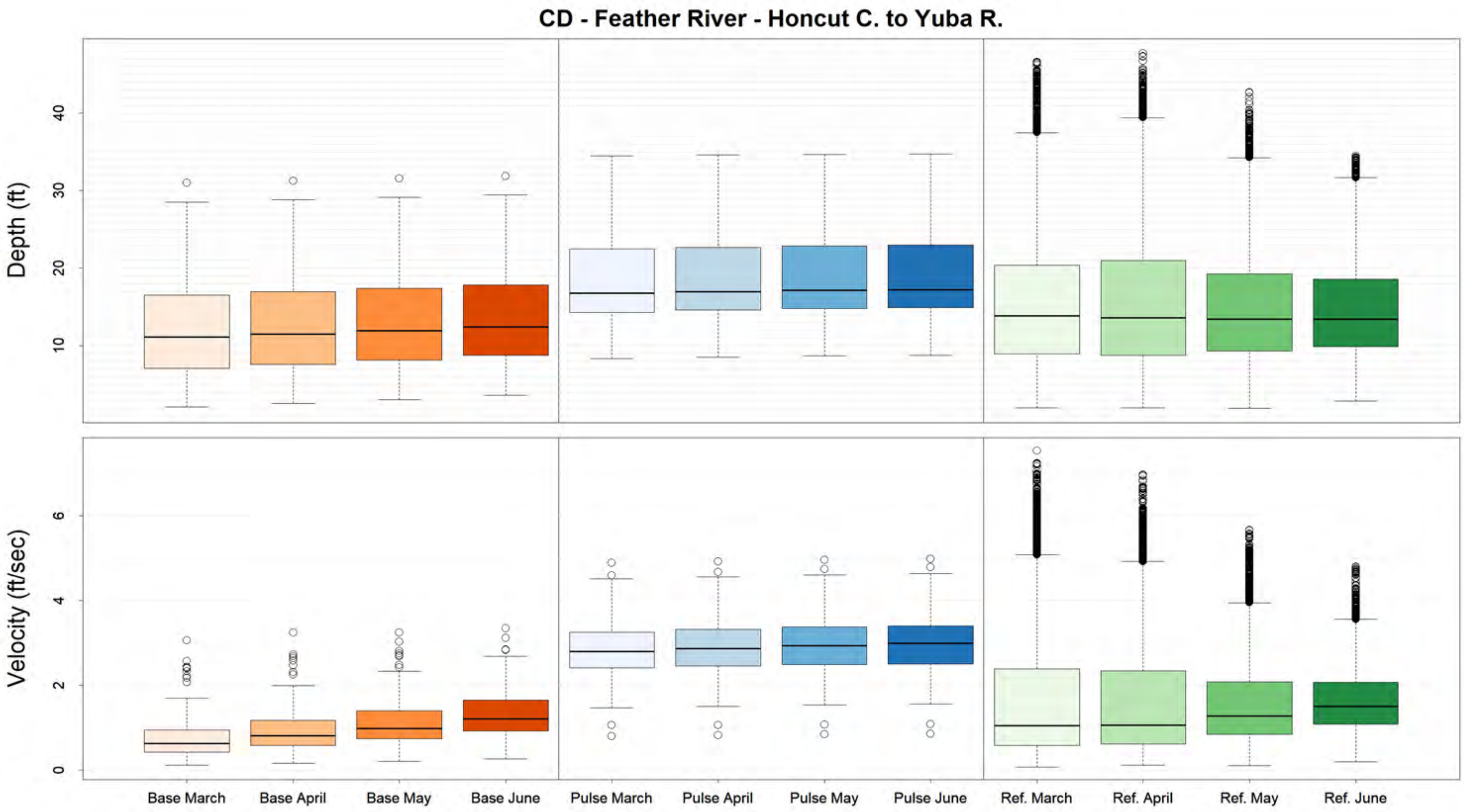
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results − AN − TAB to Honcut Creek

Project No. 23−1008	**Created By: TKS**	**Figure 35**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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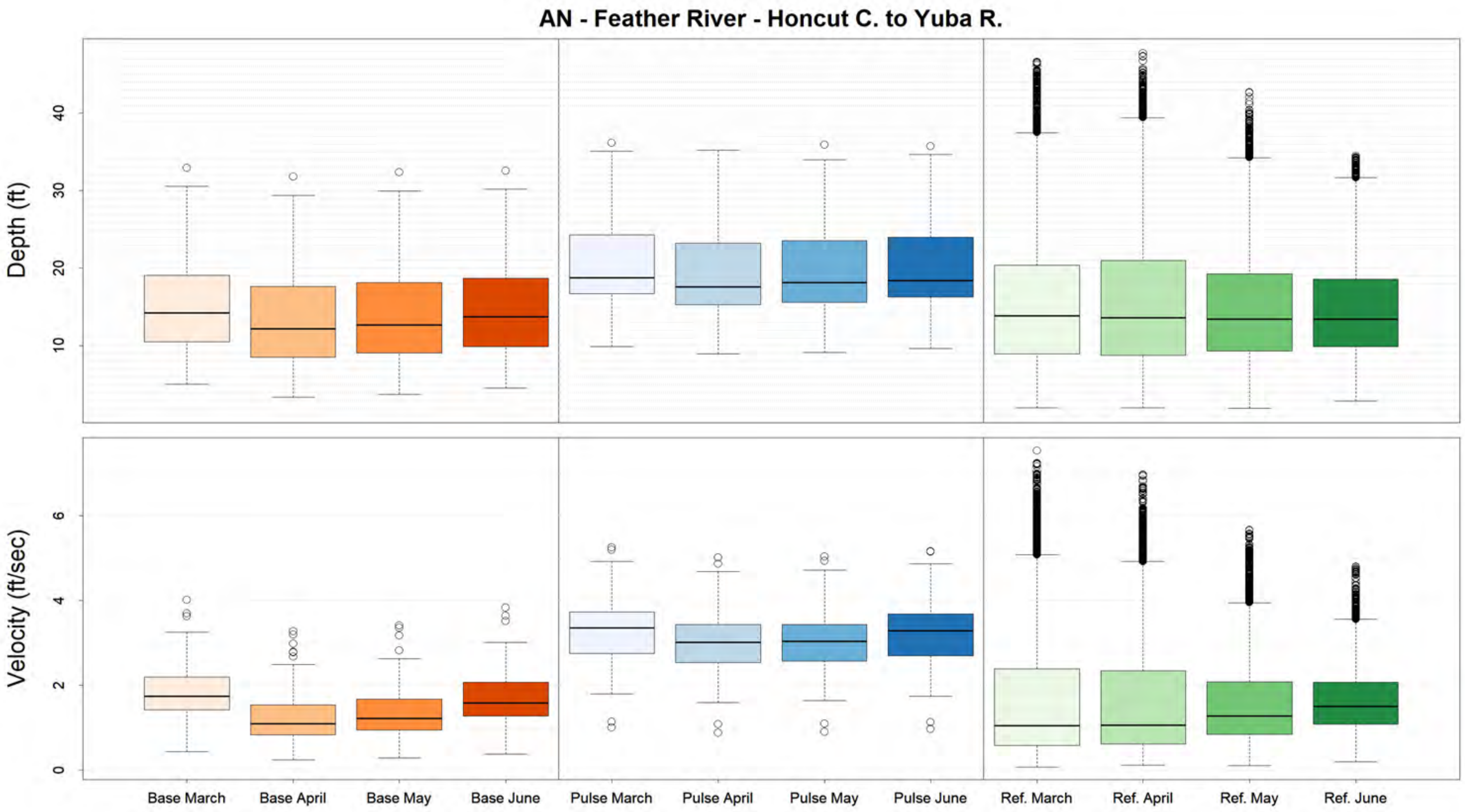
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results − CD − Honcut Creek to Yuba City

Project No. 23−1008	**Created By: TKS**	**Figure 36**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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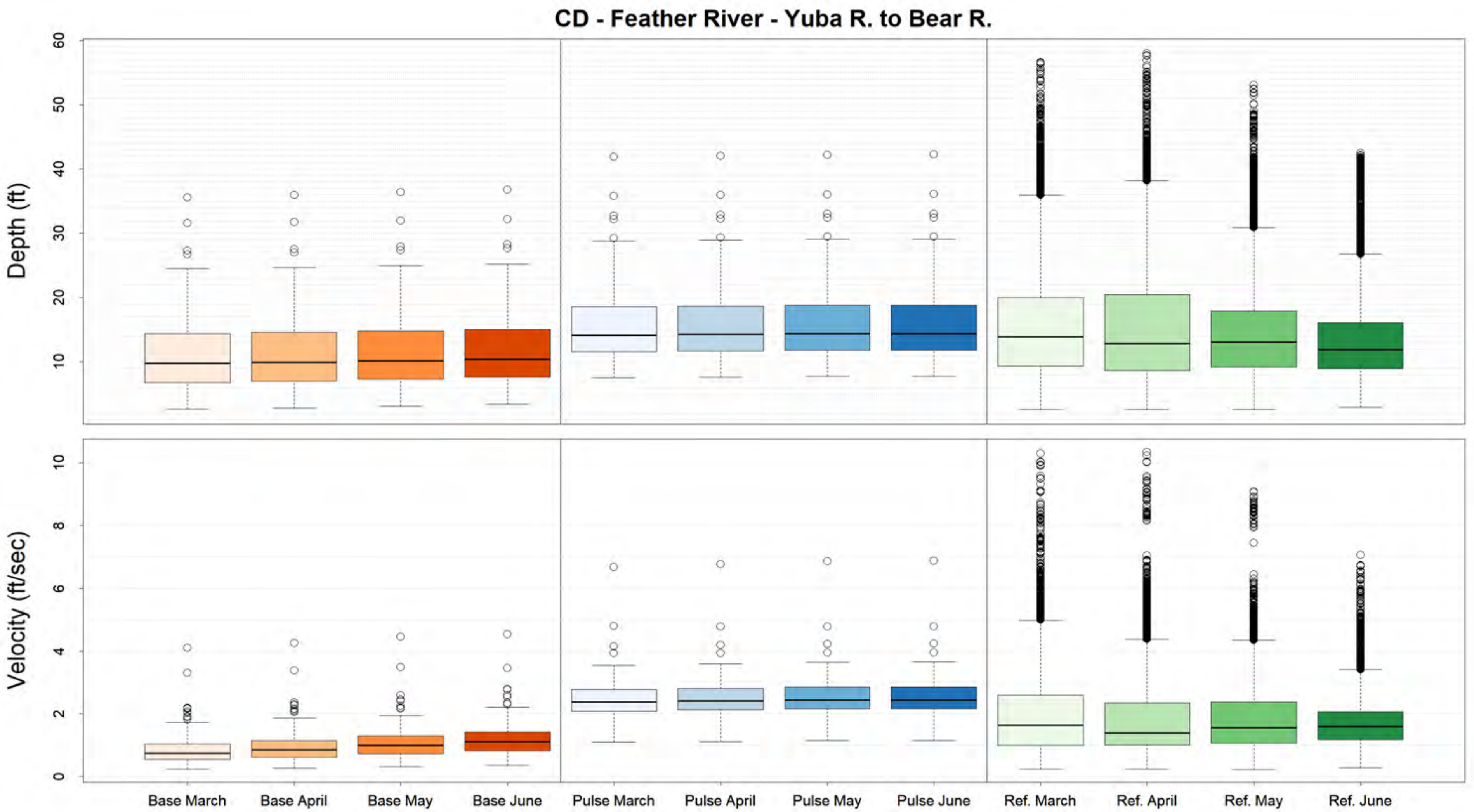
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – AN – Honcut Creek to Yuba City

Project No. 23–1008	**Created By: TKS**	**Figure 37**

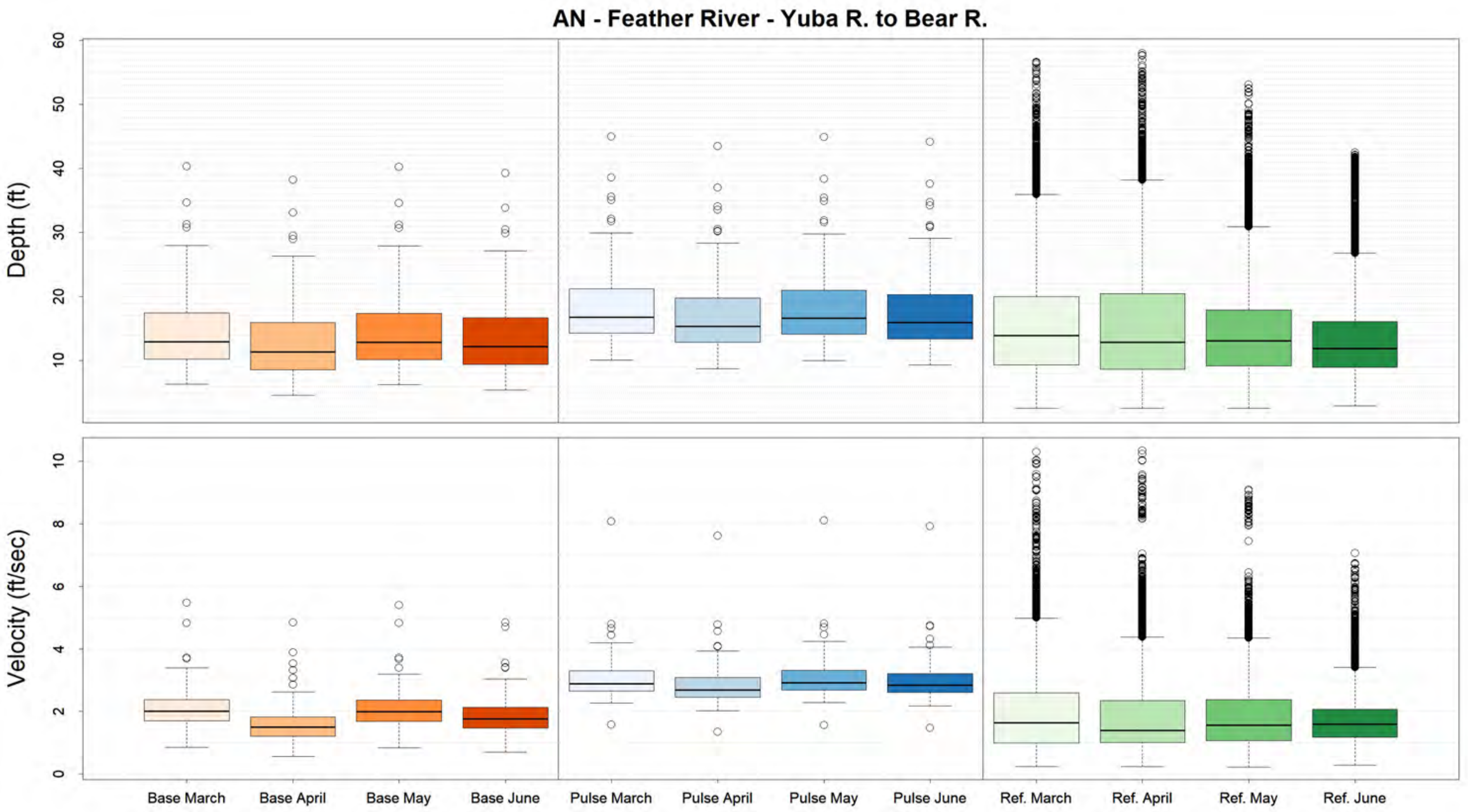


Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – CD – Yuba City to Bear River

Project No. 23–1008	Created By: TKS	Figure 38



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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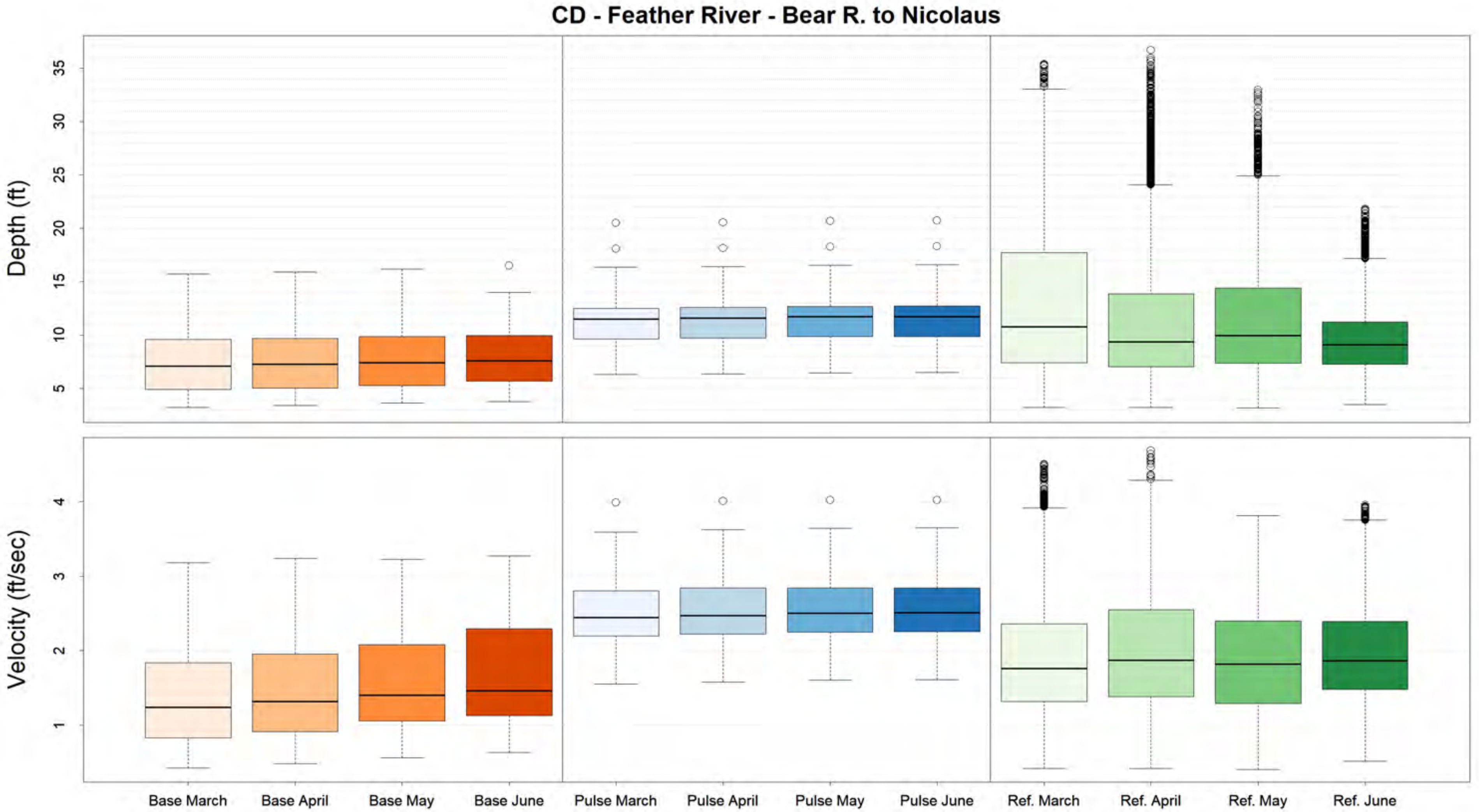
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – AN – Yuba City to Bear River

Project No. 23–1008	**Created By: TKS**	**Figure 39**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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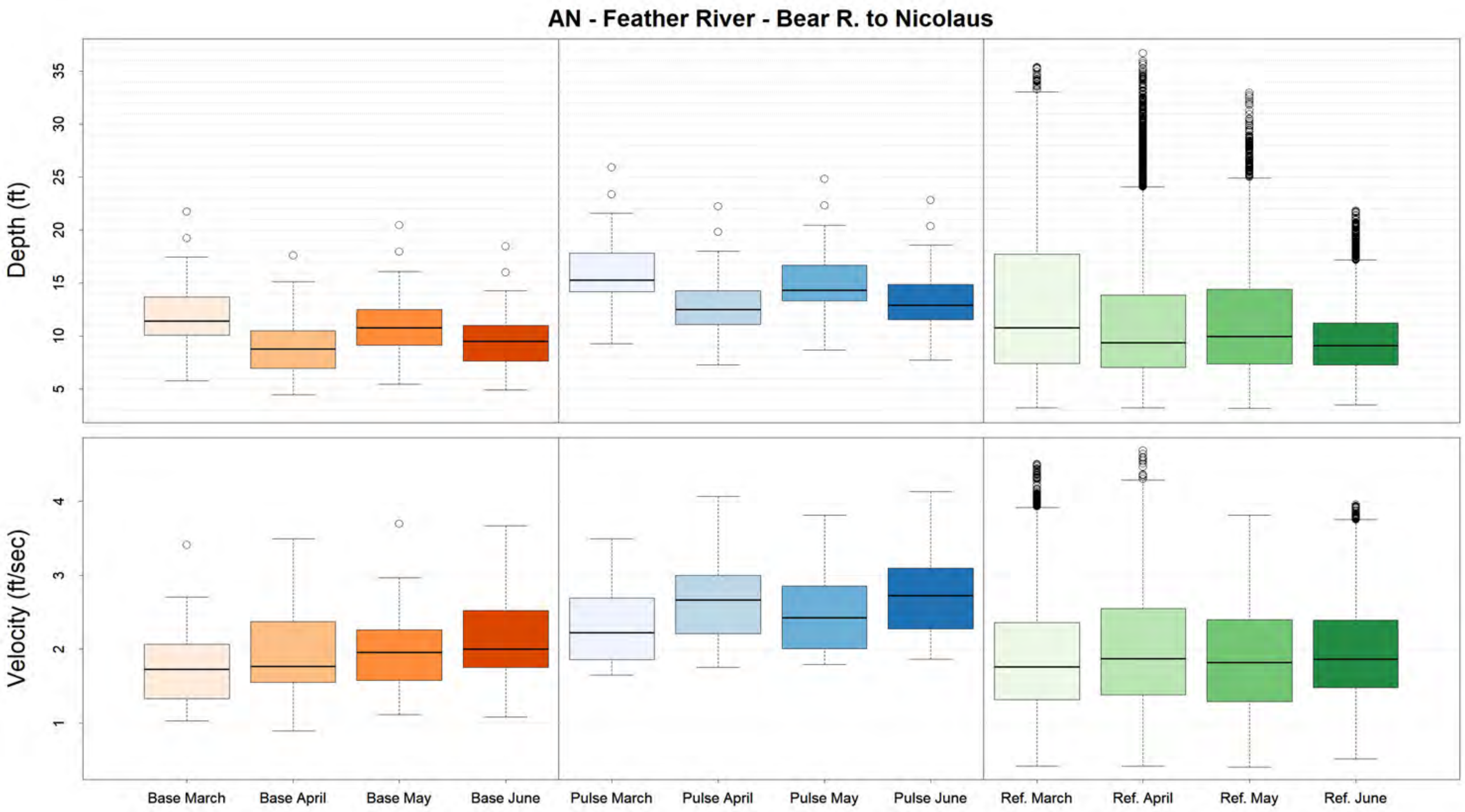
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results − CD − Bear River to Nicolaus

Project No. 23−1008	**Created By: TKS**	**Figure 40**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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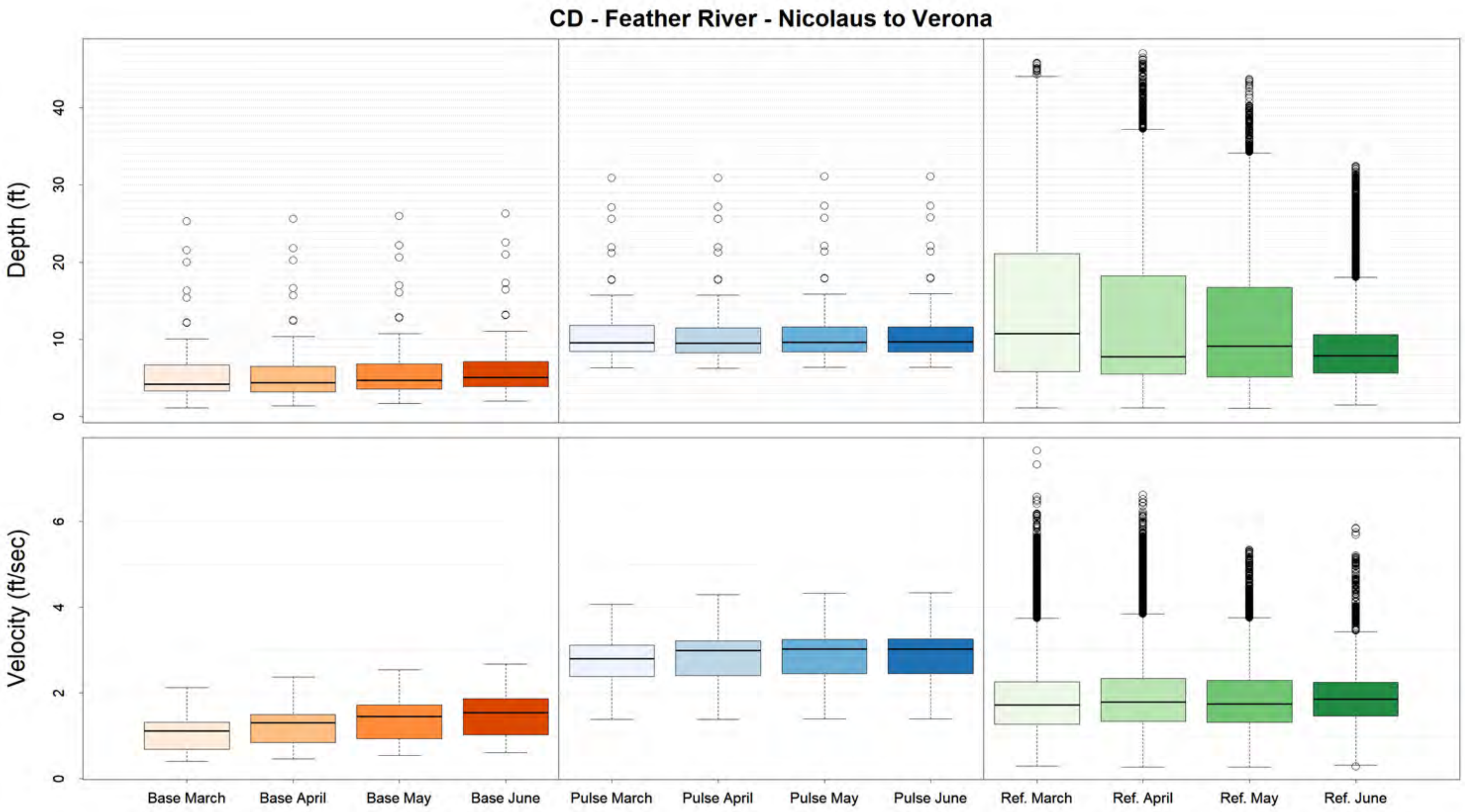
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results − AN − Bear River to Nicolaus

Project No. 23−1008	**Created By: TKS**	**Figure 41**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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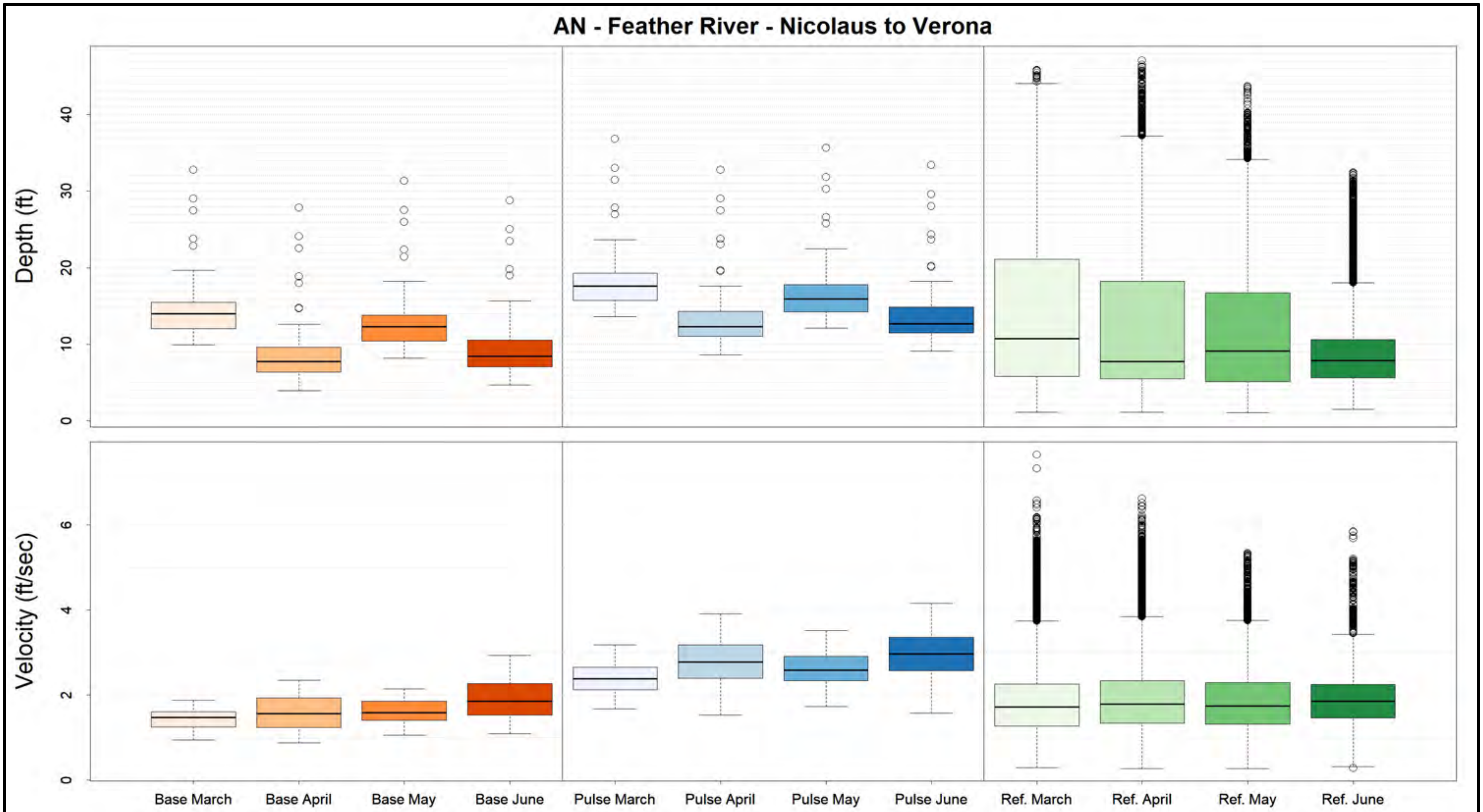
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – CD – Nicolaus to Verona

Project No. 23–1008	**Created By: TKS**	**Figure 42**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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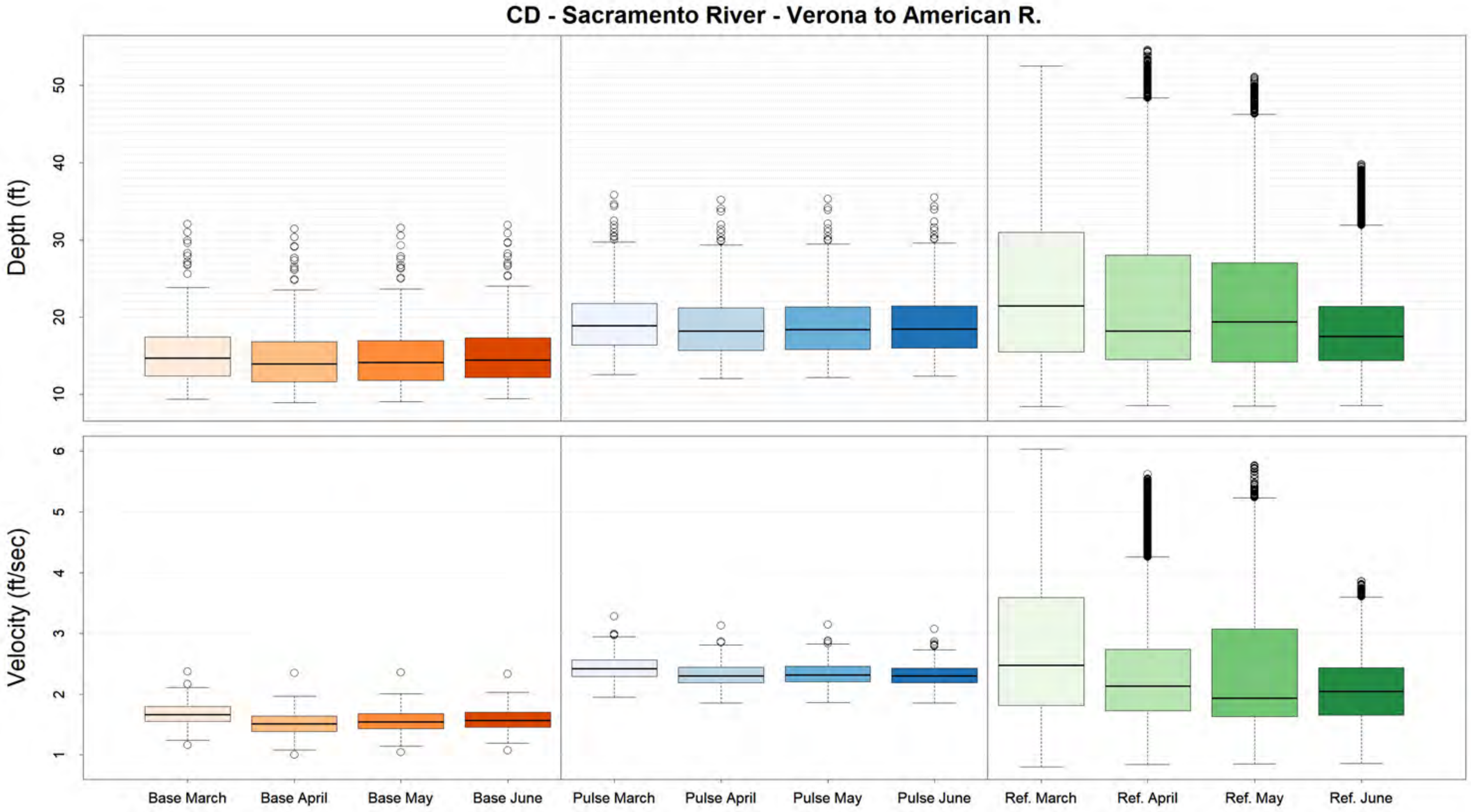
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – AN – Nicolaus to Verona

Project No. 23–1008	**Created By: TKS**	**Figure 43**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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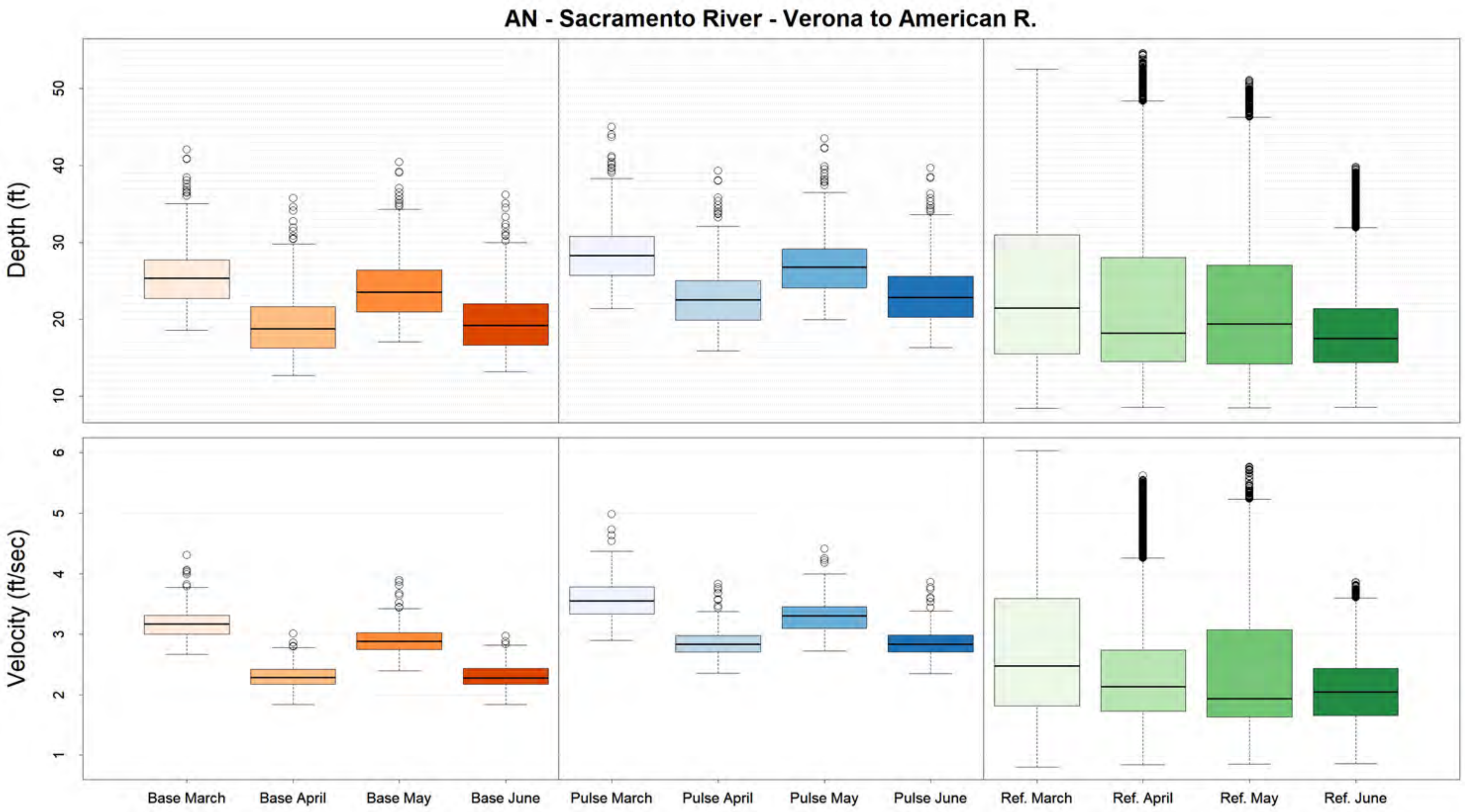
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – CD – Verona to American River

Project No. 23–1008	**Created By: TKS**	**Figure 44**

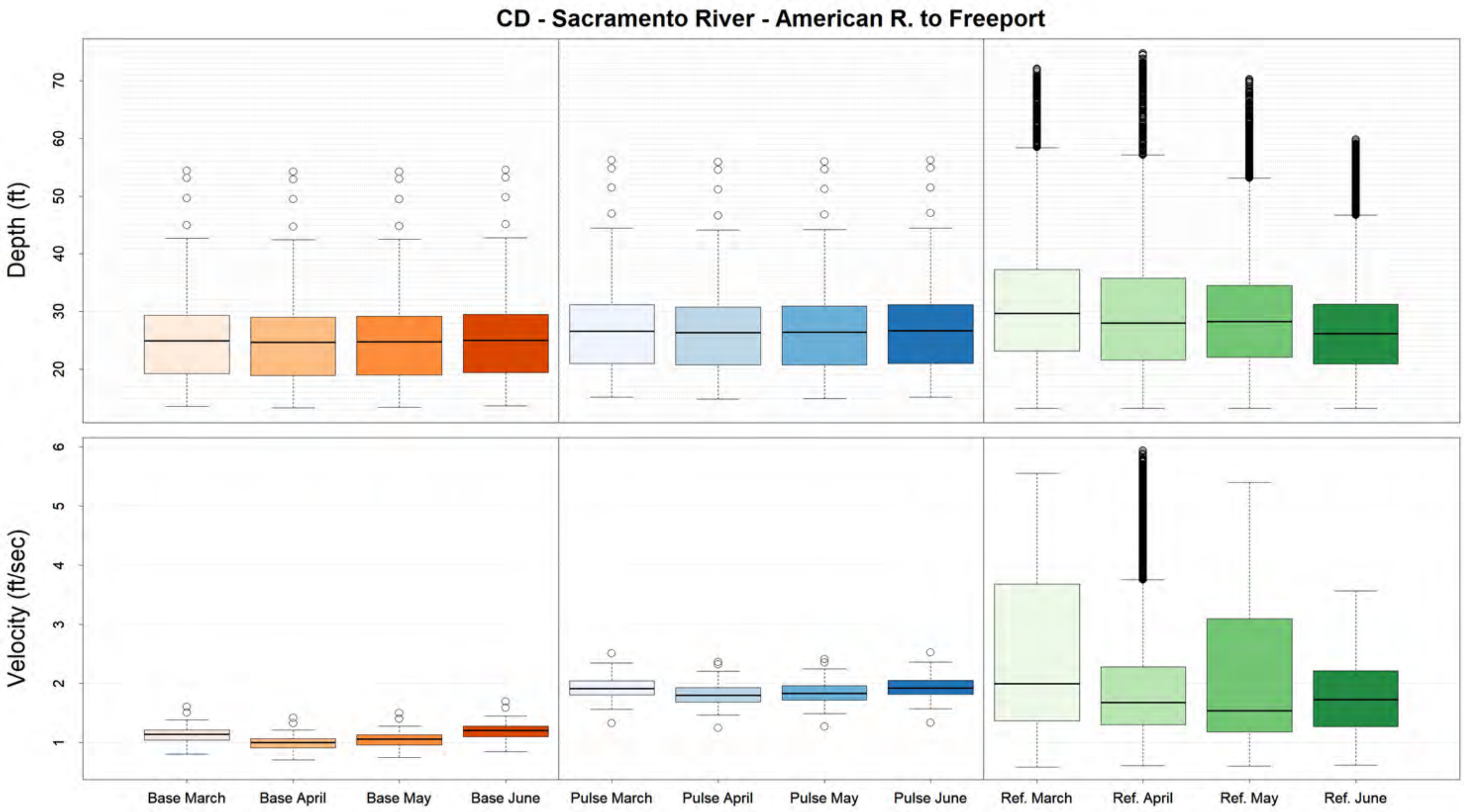


Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results − AN − Verona to American River

Project No. 23−1008	**Created By: TKS**	**Figure 45**

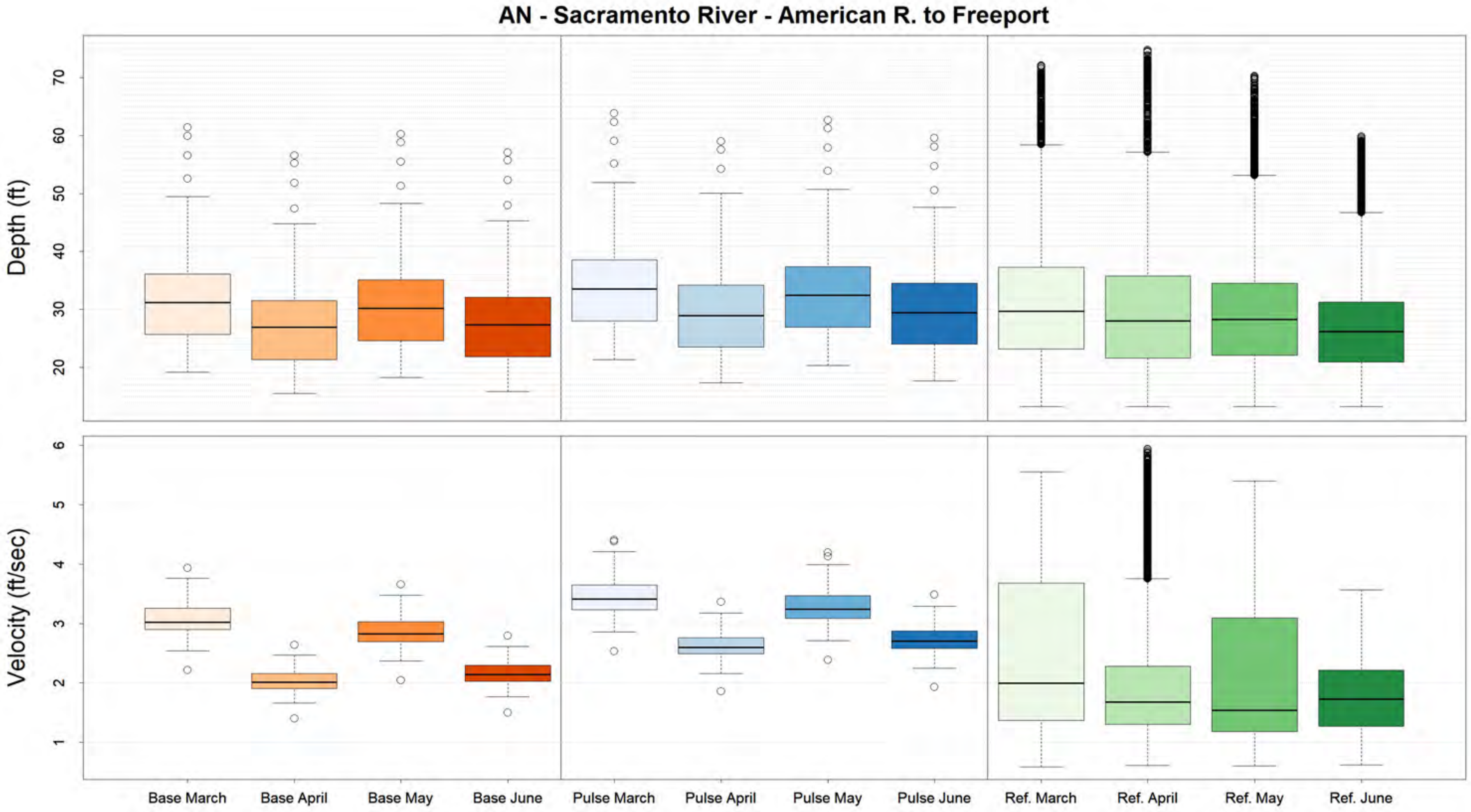


Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – CD – American River to Freeport

Project No. 23–1008	**Created By: TKS**	**Figure 46**



Notes: CD = critically dry. AN = above normal. Baseline and Pulse flow results represent a single flow based on the monthly mean discharges. The Reference data is derived from mean daily data selected from five water years (2003, 2006, 2007, 2016, & 2021).

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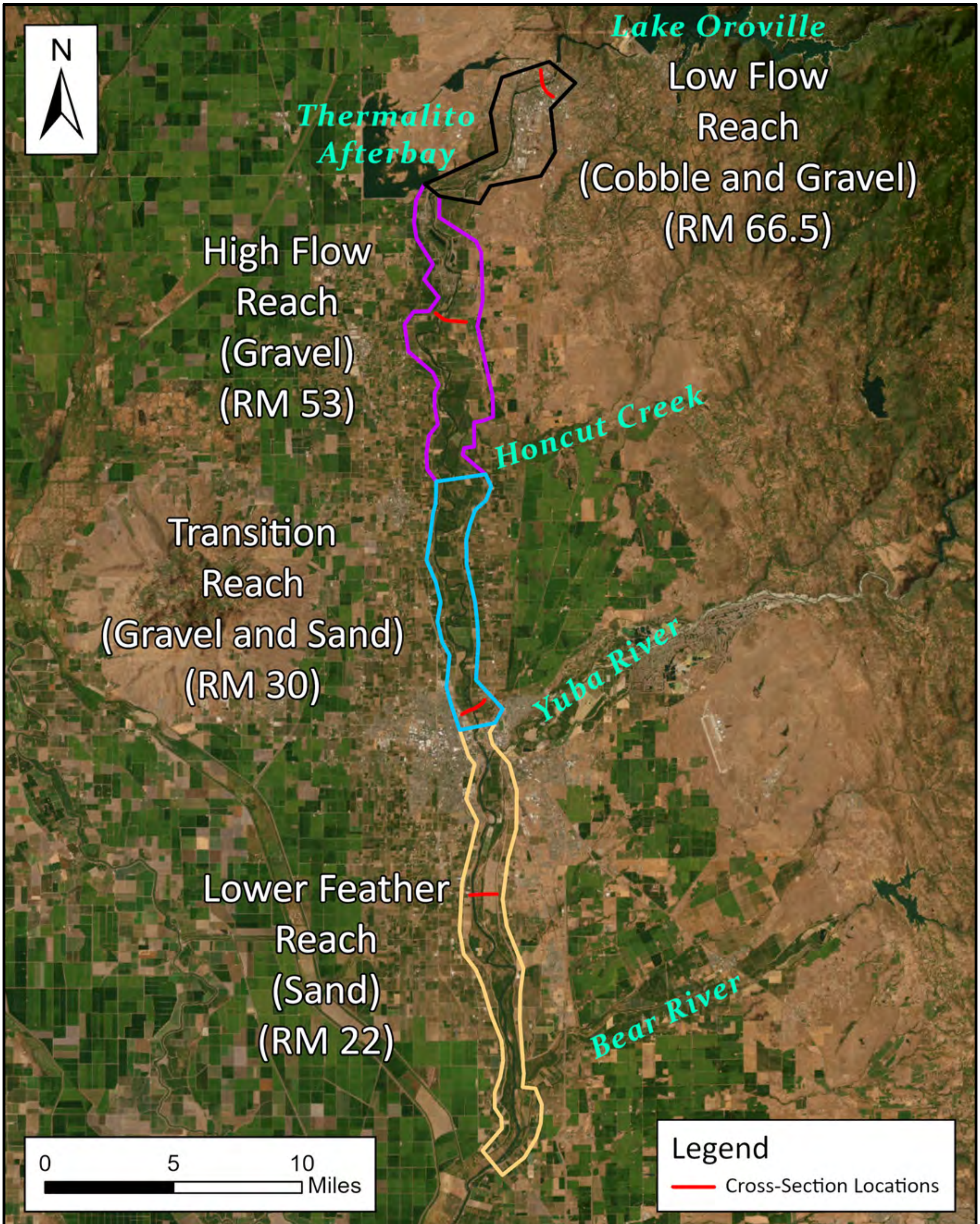
SEIR Impact Assessment of the Feather and Sacramento Rivers

Flow Contextualization Results – AN – American River to Freeport

Project No. 23–1008	**Created By: TKS**	**Figure 47**

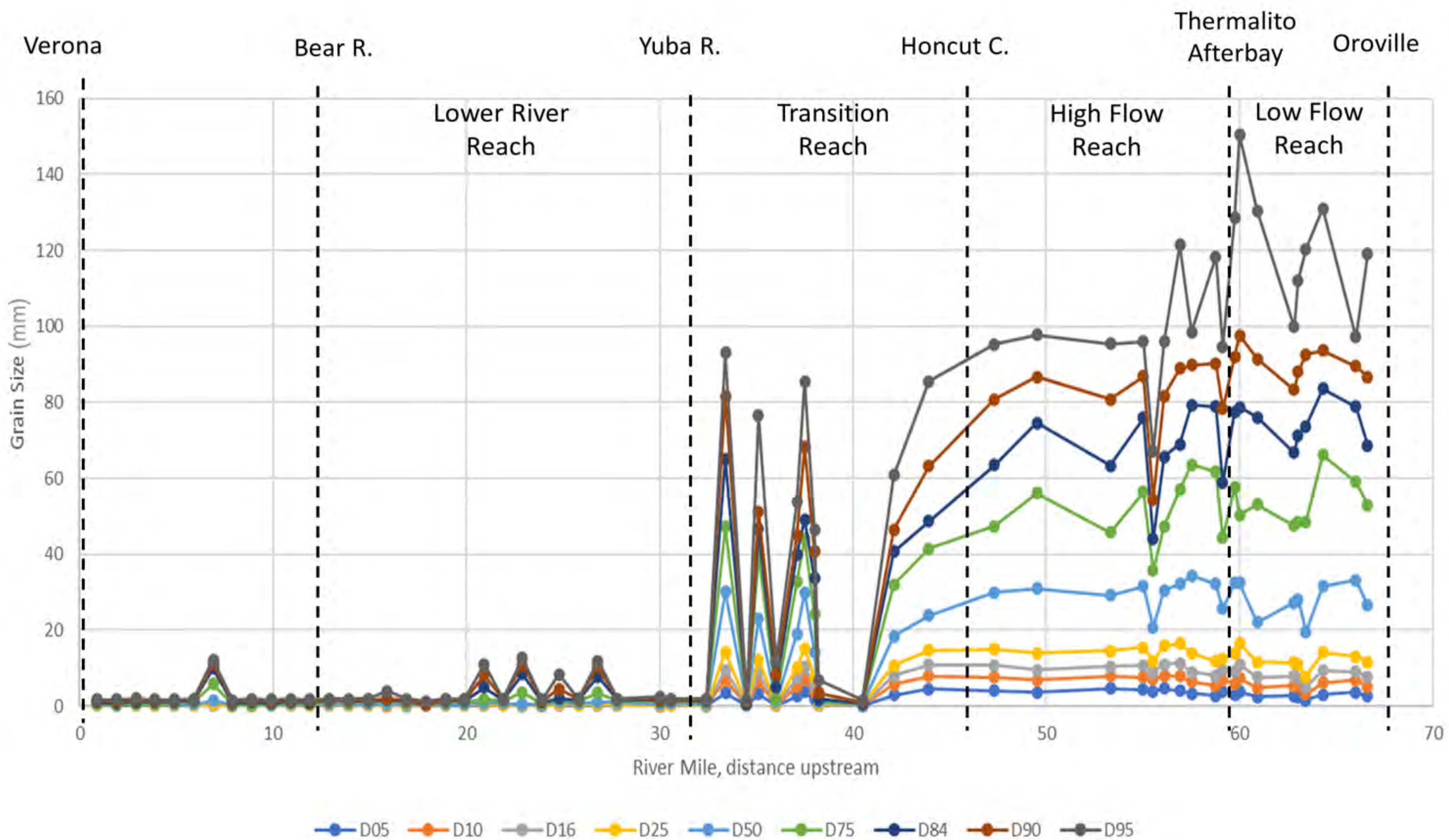


Notes:

SEIR Impact Assessment of the Feather and Sacramento Rivers

Sediment Transport Impact Assessment − Study Reaches

Project No. 23−1008	**Created By: TKS**	**Figure 48**



Notes: This figure denotes different grain size percentiles, such that the number associated with each line indicates the percent of material which is finer than a given grain size. For example, if the D84 line reads 75mm this indicates the sample had 16% of the sample is larger than 75mm and 84% of the sample is finer than 75mm.

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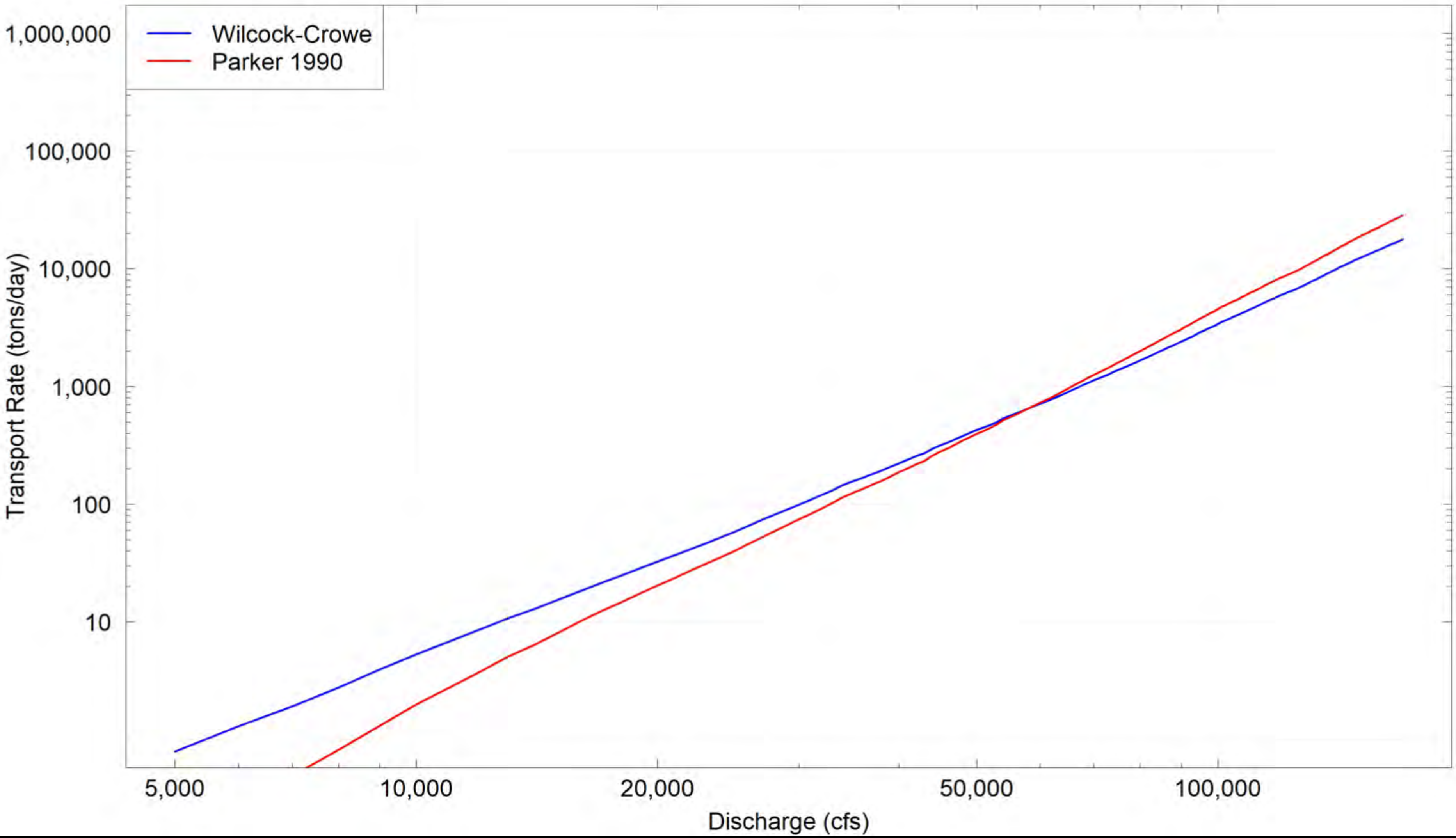
SEIR Impact Assessment of the Feather and Sacramento Rivers

Feather River Grain Size Measurements − Longitudinal Profile

Project No. 23−1008	**Created By: TKS**	**Figure 49**

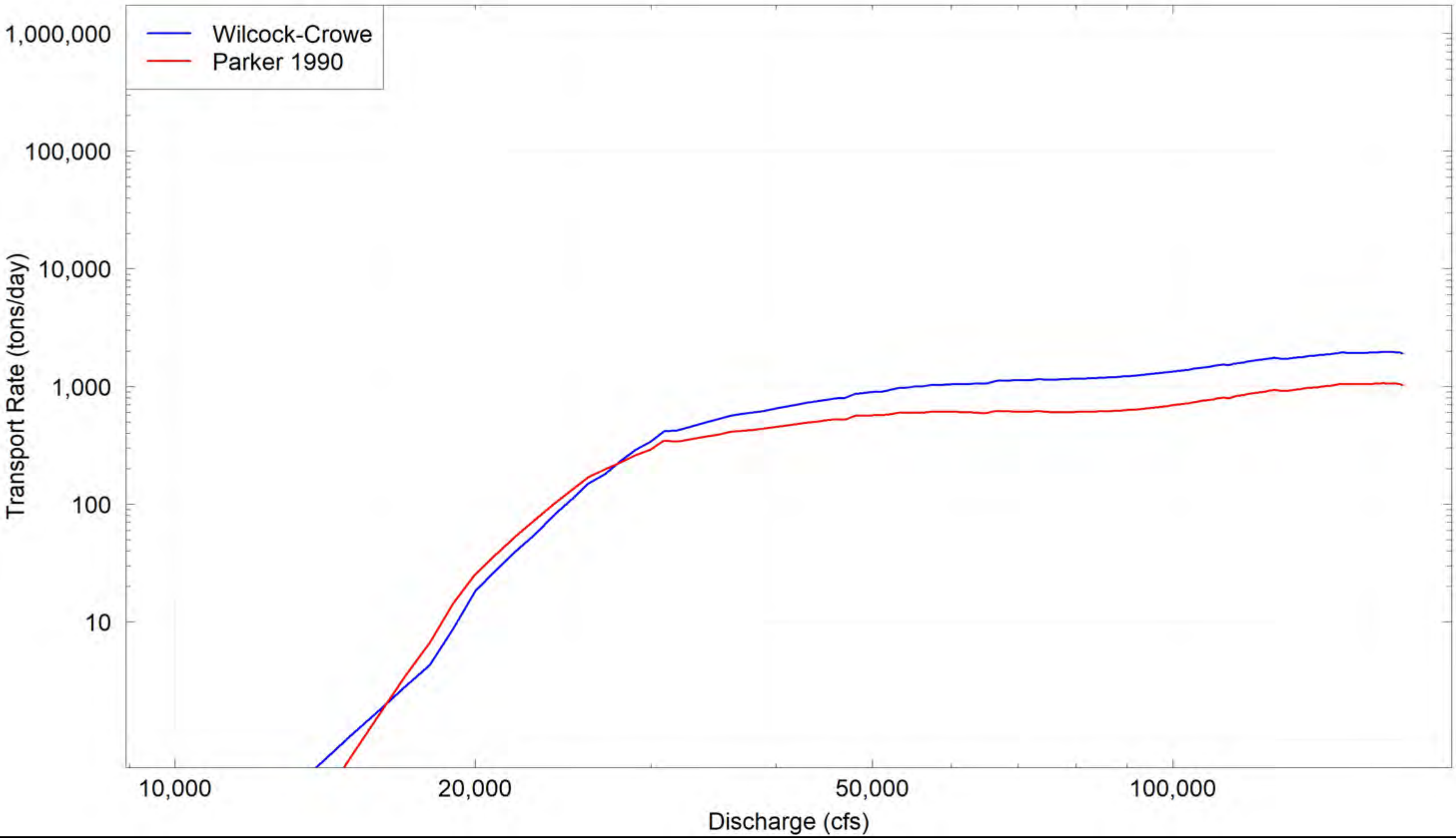


Notes:

SEIR Impact Assessment of the Feather and Sacramento Rivers

Sediment Transport Rating Curve – Low Flow Reach

Project No. 23–1008	**Created By: TKS**	**Figure 50**

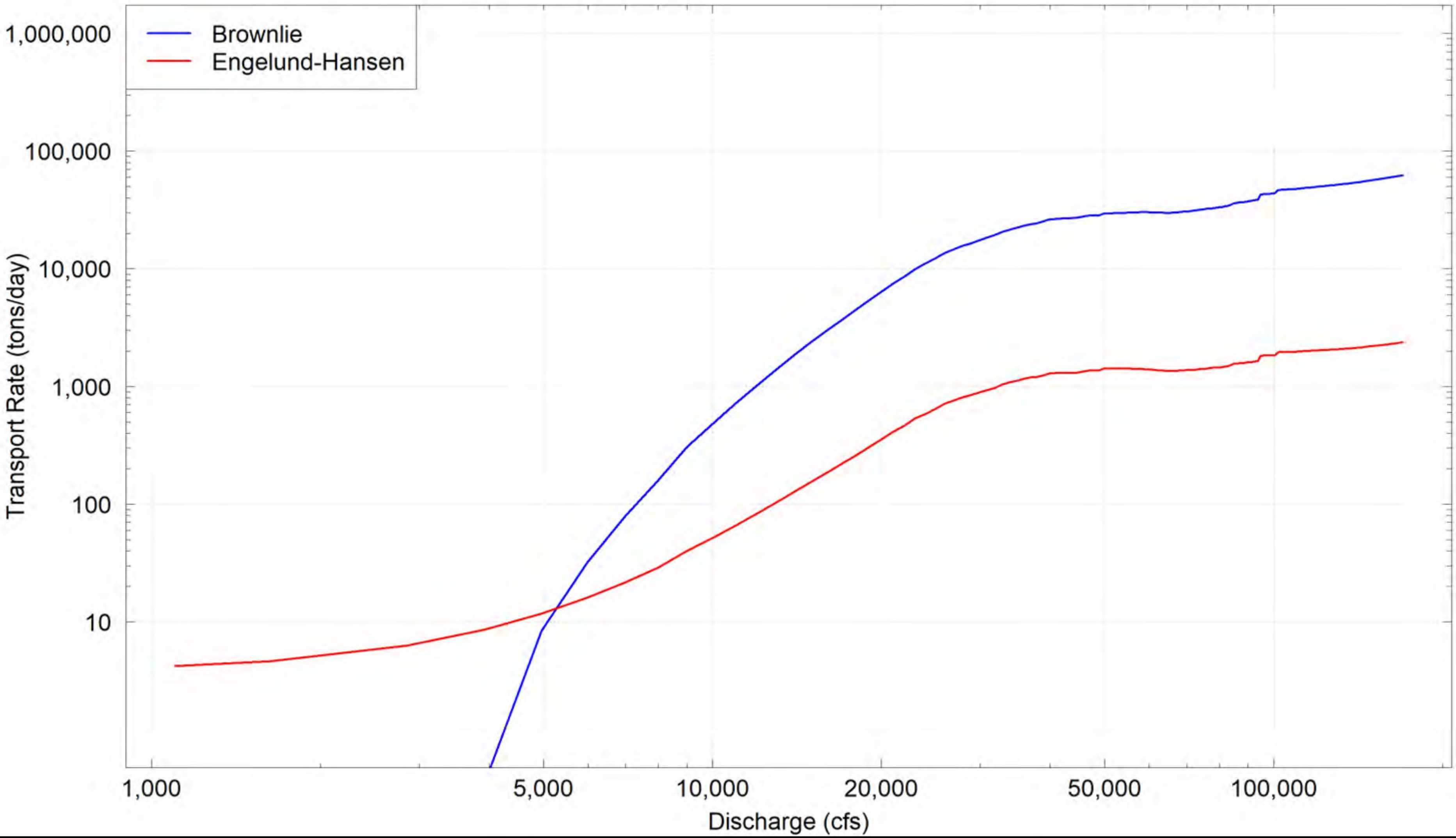


Notes:

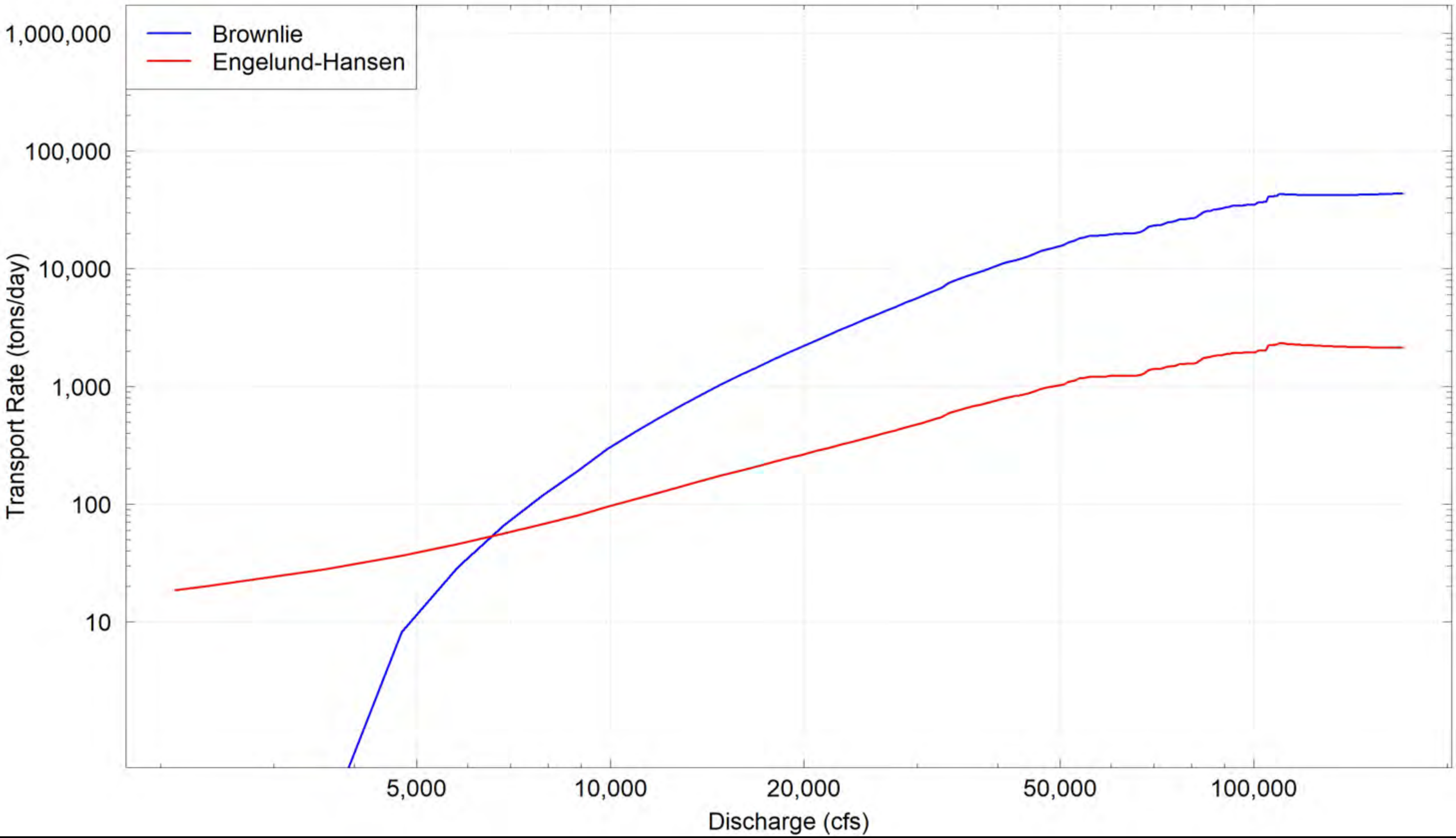
SEIR Impact Assessment of the Feather and Sacramento Rivers

Sediment Transport Rating Curve – High Flow Reach

Project No. 23–1008	**Created By: TKS**	**Figure 51**



Notes:	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Sediment Transport Rating Curve − Transition Flow Reach**		
		Project No. 23−1008	**Created By: TKS**	**Figure 52**



Notes:

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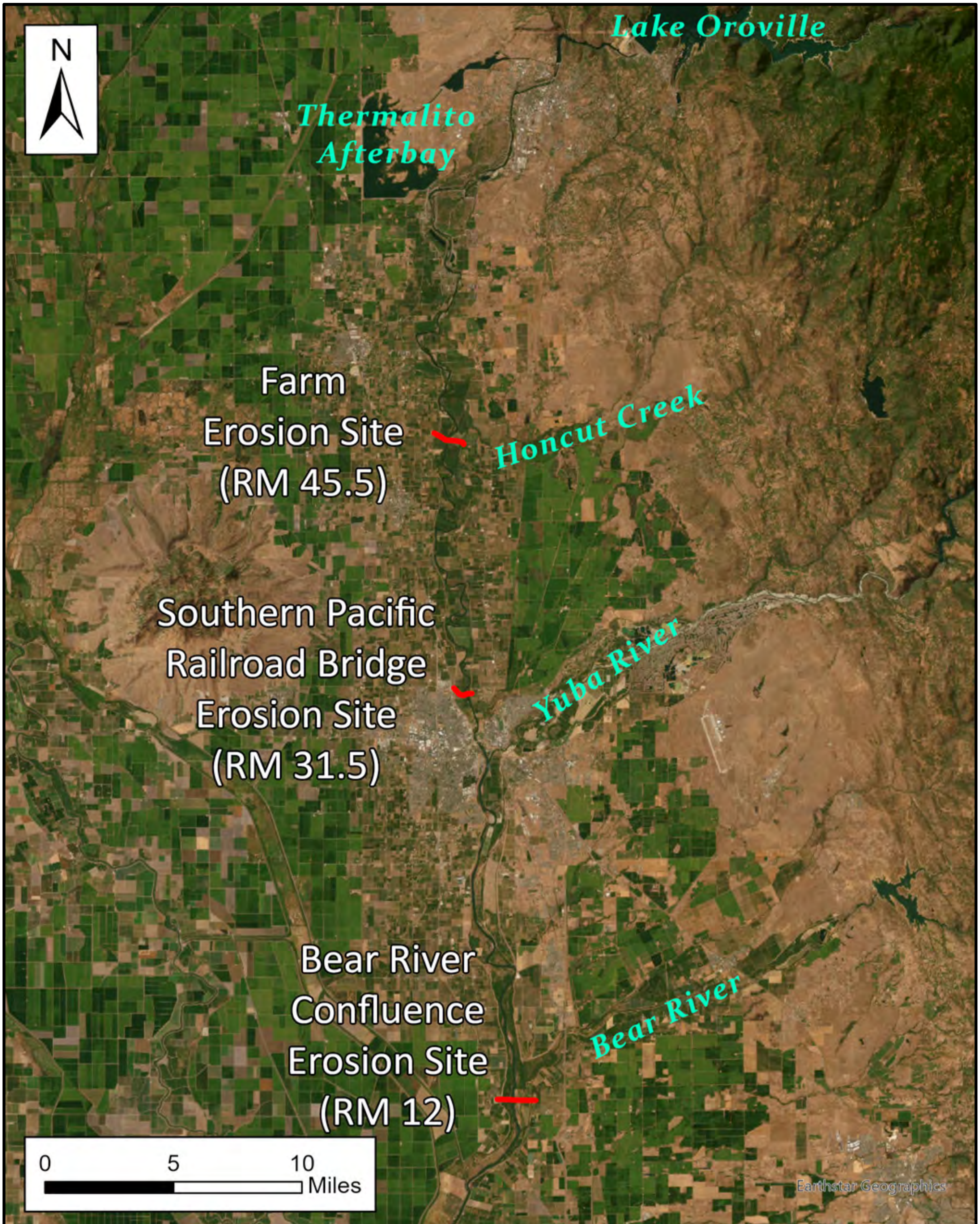
SEIR Impact Assessment of the Feather and Sacramento Rivers

Sediment Transport Rating Curve – Lower Feather River Flow Reach

Project No. 23–1008	**Created By: TKS**	**Figure 53**



Notes:	cbec eco engineering	*SEIR Impact Assessment of the Feather and Sacramento Rivers* **Bank Erosion Impact Assessment − Study Reaches**	
		Project No. 23−1008	**Created By: TKS**	**Figure 54**

Appendix C
Biological Resources – Terrestrial Special-Status Species Accounts

APPENDIX C
Biological Resources – Terrestrial Special-Status Species Accounts

The species accounts in this appendix provide an overview of special-status plants and wildlife known to occur or have an appreciable likelihood of occurring in the study area for Section 3.6: Biological Resources-Terrestrial (i.e., Geographic Area 1: Oroville Complex; Geographic Area 2: Low Flow Channel of the Feather River; Geographic Area 3: High Flow Channel of the Feather River). The special-status plant species accounts provided below present an overview of each species' listing status, known distribution relative to the study area, description of the plant, information on life history, habitat requirements, and known threats. For each of the fish and wildlife species addressed below, information is provided on the legal status, distribution, relevant natural history, and threats. Invertebrates are presented first, followed by vertebrates. The species are featured in alphabetical order by common name. Inventory records were searched for the following United States Geological Survey 7.5 minute quadrangles: Oroville Dam, Oroville, Shippee, Biggs, Palermo, Gridley, Honcut, Sutter, Yuba City, Olivehurst, Nicolaus, and Verona.

Special-Status Plants

Ahart's dwarf rush

Ahart's dwarf rush (*Juncus leiospermus var. ahartii*) is a CRPR 1B.2 species. It is an annual herb with a blooming period from March to May (CNPS 2023). Its general habitat includes valley and foothill grasslands. Threats to this species include development and grazing (CNPS 2023). There are no documented occurrences of this species within the study area in the geographic areas analyzed for the terrestrial biological resources section. The nearest documented occurrence for this species is located approximately 1.8 miles east of the Feather River downstream of the Thermalito Afterbay Outlet (CDFW 2023).

Ahart's paronychia

Ahart's paronychia (*Paronychia ahartii*) is a CRPR 1B.1 species. It is an annual herb with a blooming period from February to June (CNPS 2023). It grows in well-drained rocky outcrops and rocky soils within volcanic uplands – often on vernal pool edges. Threats to this species include grazing, road/trail construction, and off-roading vehicles. There are two documented occurrences of this species near the Thermalito Forebay (CNDDB occurrences 59 and 60) (CDFW 2023).

Bidwell's knotweed

Bidwell's knotweed (*Polygonum bidwelliae*) is a CRPR 4.3 species. It is an annual herb with a blooming period from April to July (CNPS 2023). It grows in chaparral, cismontane woodland, and valley and foothill grassland. Its threats include vehicles, foot traffic, soil erosion, and non-native plants (CNPS 2023). While there is potentially suitable habitat for this species within the study area, there are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Bolander's water-hemlock

Bolander's water hemlock (*Cicuta maculata* var. *bolanderi*) is a CRPR 2.1 species. It is a perennial herb with a blooming period from July to September (CNPS 2023). It is known from occurrences along California's South Coast and Central Coast regions and from Suisun Marsh. It grows in coastal brackish and freshwater marshes. Threats to Bolander's water-hemlock are development, competition from nonnative plants, and hydrological alterations (CNPS 2023). While there is potentially suitable habitat for this species within the study area, there are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Brandegee's clarkia

Brandegee's clarkia (*Clarkia biloba ssp. Brandegeeae*) is a CRPR 4.2 species. It is an annual herb with a blooming period from May to July (CNPS 2023). It grows in chaparral, cismontane woodland, and lower montane coniferous forest. Threats to this species include road and trail construction, herbicides, and non-native species (CNPS 2023). There are a several documented CNDDB occurrences of this species within the study area for geographic areas 1-3, including seven near Lake Oroville (CNDDB occurrences 56, 27, 58, 59, 67, 68, and 69) and one occurrence (occurrence 70) observed near the Thermalito Diversion Pool (CDFW 2023).

Brassy bryum

Brassy bryum (*Bryum chryseum*) is a CRPR 4.3 species. It is a moss species which is found in chaparral openings, cismontane woodland, and valley and foothill grassland (CNPS 2023). While there is potentially suitable habitat for this species within the study area, there are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Brazilian watermeal

Brazilian watermeal (*Wolffia brasiliensis*) is a CRPR 2B.3 species. It is a perennial aquatic herb growing in marshes and swamps. Its blooming period is from April to December. Threats include interspecies competition, altered hydrologic regimes, and bank protection projects (CNPS 2023). While there is potentially suitable habitat for this species within the study area, there are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

bristly leptosiphon

Bristly leptosiphon (*Leptosiphon acicularis*) is a CRPR 4.2 species. It is an annual herb which grows in chaparral, cismontane woodland, coastal prairie, and valley and foothill grassland. Its identification period is from April to July (CNPS 2023). It is potentially threatened by roadway widening projects (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Butte County calycadenia

Butte County calycadenia (*Calycadenia oppositifolia*) is a CRPR 4.2 species. It is an annual herb which grows in dry meadows, grassy to brushy openings, and road cuts within a variety of plant communities, including valley and foothill/basalt grassland, chaparral, foothill/cismontane woodland, and yellow pine forest. Its blooming period is from April to July. It is threatened by development, road construction, road maintenance, vehicles, recreational activities, and grazing (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Butte County fritillary

Butte County fritillary (*Fritillaria eastwoodiae*) is a CRPR 3.2 species. It is a perennial bulbiferous herb with a blooming period from April to July. It grows in chaparral, cismontane woodland, and lower montane coniferous forest openings. It is threatened by logging and development. Other threats include vehicles, road maintenance, recreational activities, alteration of fire regimes, erosion, and non-native plants (CNPS 2023). There are a several documented CNDDB occurrences of this species within the study area for geographic areas 1 (occurrence number 118, 119, 120, 121, 122, 123, 124, and 125), all found near Lake Oroville (CDFW 2023).

Butte County meadowfoam

Butte County meadowfoam (*Limnanthes floccosa var. californica*) is federally and state listed as endangered. It is a CRPR 1B.1 species. It is an annual herb which grows in Valley and foothill grassland, and vernal pools (CNPS 2023). It is threatened by urbanization, road construction, grazing, non-native plants, vehicles, and agriculture (CNPS 2023). There is a CNDDB documented occurrence of this species in close proximity to the Thermalito Forebay (CNDDB occurrence 31) (CDFW 2023).

Crownscale

Crownscale (*Atriplex coronata* var. *coronata*) is a CRPR 4.2 species and is endemic to California. Its range includes southern Sacramento Valley, the San Joaquin Valley, and the eastern Inner South Coast Ranges. There are documented occurrences of this plant species in Alameda, Contra Costa, Fresno, Glenn, Kings, Kern, Merced, Monterey, San Luis Obispo, Solano, and Stanislaus counties. Its blooming period is from March to October and occurs in alkaline, often clay soils, including grasslands and vernal pools. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Delta mudwort

Delta mudwort (*Limosella subulata*) is a CRPR 2.1 species. Delta mudwort is an aquatic, perennial herb in the snapdragon family (Scrophulariaceae). Within California, it is only found in the Delta. It occurs in tidal zones of marshes, rivers, and creeks. It blooms from May to August (CNPS 2023).

Delta mudwort is threatened by habitat destruction, including alteration of hydrology and recreational activities, such as boating, which creates wakes that erode banks and shorelines. Fishing and hunting access also pose a threat to this species. Petroleum product spills could have a significant impact on tidal flat biota, and non-biodegradable litter such as plastics could collect near the tidal drift line, inhibiting plant establishment and growth. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Delta tule pea

Delta tule pea (*Lathyrus jepsonii var. jepsonii*) is a CRPR 1B.2 species. It is endemic to California and its current range extends from Sacramento and Solano Counties to the north, Napa and Sonoma Counties in the west, and Contra Costa and San Joaquin Counties in the south. Delta tule pea occurs on the borders of fresh and brackish marshes from 0 to 13 feet in elevation (CNPS 2023). Delta tule pea blooms from May to September (CNPS 2023).

It was historically reported as common in Suisun Marsh, but it is currently reported as occasional to rare in Suisun Marsh. It currently occurs throughout the Delta and along the Napa River. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

The primary threat to Delta tule pea is the loss of marsh and floodplain habitat. Agriculture, water diversions, and erosion can potentially eliminate or degrade these habitats (CNPS 2023). Fishing and hunting access also pose a threat to Delta tule pea through trampling impacts.

Depauperate milk-vetch

Depauperate milk-vetch (*Astragalus pauperculus*) is a CRPR 4.3 species. It is an annual herb with a blooming period from March to June. It grows in chaparral, cismontane woodland, valley and foothill grassland (CNPS 2023). Its threats may include vehicles and non-native plants (CPNS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

English Peak greenbrier

English Peak greenbrier (*Smilax jamesii*) is a CRPR 4.2 species. It is a perennial rhizomatous herb with a main blooming period from May to July. It grows in broadleafed upland forest, lower montane coniferous forest, marshes and swamps, North Coast coniferous forest, and upper montane coniferous forest. Its threats include vehicles, recreational activities, foot traffic, grazing, trampling, alteration of fire regimes, hydrological alterations, and non-native plants. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Greene's tuctoria

Greene's tuctoria (*Tuctoria greenei*) is federally listed as endangered and listed as rare by the state. It has a CRPR 1B.1 species. It is an annual herb associated with vernal pools. Its main blooming period is from May to July. It is threatened by agriculture, urbanization, overgrazing, and habitat fragmentation and loss (CNPS 2023). There is a CNDDB documented occurrence of this species in close proximity to the Thermalito Forebay (CNDDB occurrence 19) (CDFW 2023).

Hairy Orcutt grass

Hairy Orcutt grass (*Orcuttia pilosa*) is federally and state listed as endangered. It is a CRPR 1B.1 species. It is an annual herb that grows in vernal pools. Its blooming season is from May to September. It is seriously threatened by threatened by agriculture, urbanization, overgrazing, and non-native plants (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Hartweg's golden sunburst

Hartweg's golden sunburst (*Pseudobahia bahiifolia*) is federally and state listed as endangered. It is a CRPR 1B.1 species. Its blooming period is from March to April. It is an annual herb that grows in cismontane woodland, valley and foothill grassland. It is seriously threatened by development, agriculture, overgrazing, and trampling (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

hogwallow starfish

Hogwallow starfish (*Hesperevax caulescens*) is a CRPR 4.2 species. It is an annual herb whose blooming period is from March to June. Its general habitat includes valley and foothill grassland and vernal pools. It is threatened by development and agriculture (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Hoover's spurge

Hoover's spurge (*Euphorbia hooveri*) is federally listed as threatened. It is a CRPR 1B.2 species. It is an annual herb whose blooming period is mainly from July to September. It is found in vernal pools. It is threatened by grazing, agriculture, and non-native plants (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Humboldt lily

Humboldt lily (*Lilium humboldtii ssp. humboldtii*) is a CRPR 4.2 species. It is a perennial bulbiferous herb. Its main blooming period is from May to July. It is found in chaparral, cismontane woodland, and lower montane coniferous forest. It is threatened by development, urbanization, horticultural collecting, deer browsing, non-native plants, and road maintenance (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Layne's ragwort

Layne's ragwort (*Packera layneae*) is federally listed as threatened and state listed as rare. It is a CRPR 1B.2 species. Its blooming period is from April to August. It is found in chaparral and cismontane woodland. It is threatened by urbanization, development, clearing, grazing, road construction, vehicles, non-native plants, and fire suppression (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Lewis Rose's groundsel

Lewis Rose's groundsel (*Packera eurycephala var. lewisrosei*) is a CRPR 1B.1 species. It is found in chaparral, cismontane woodland, and lower montane coniferous forest (CNPS 2023). It is a perennial herb whose blooming period is mainly from March to July. It is threatened by mining, road maintenance, and vehicles (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Mason's liliaeopsis

Mason's lilaeopsis (*Lilaeopsis masonii*) is State listed as rare under the California Native Plant Protection Act. In addition, it is listed on CRPR 1B.1.

The range of Mason's lilaeopsis extends from Napa and Solano counties in the north to Contra Costa and Alameda counties in the south, and from Marin County in the west to Sacramento and San Joaquin counties in the east. Although population trends of Mason's lilaeopsis have not been documented, this species has been determined to be stable to declining (CNDDB 2023). According to CNPS, occurrences of Mason's lilaeopsis in California are highly limited, and the species is at serious risk throughout its range. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Mason's lilaeopsis grows in regularly flooded tidal zones; on mudbanks and flats along erosional creekbanks, sloughs, and rivers (Fiedler and Zebell 1993); and in freshwater marshes, brackish marshes, and riparian scrubs that are influenced by saline water. It is a colonizing species (i.e., it "exploits" newly deposited or exposed sediments). Mason's lilaeopsis occurs with other rare plants, such as delta mudwort (*Limosella subulata*), Suisun Marsh aster (*Symphyotrichum lentum*), and delta tule pea. It blooms from April through November (CNPS 2023).

Mason's lilaeopsis is threatened by erosion, bank and channel stabilization, flood-control projects, development, and agricultural conversion. In some areas, it is also threatened by trampling by fishermen and encroachment of water hyacinth (*Eichhornia crassipes*), an extremely invasive aquatic plant (CNPS 2023).

Mexican mosquito fern

Mexican mosquito fern (*Azolla microphylla*) is a CRPR 4.2 species. It is found in marshes and swamps. It is found at elevations from 100 – 330 feet. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Mosquin's clarkia

Mosquin's clarkia (*Clarkia mosquinii*) is a CRPR 1B.1 species. It is an annual herb whose blooming period is from May to July. It is found in montane woodland and lower montane coniferous forest It is threatened by vehicles and potentially threatened by road maintenance, overshading, and non-native plants (CNPS 2023). There is a CNDDB documented occurrence of this species in close proximity to the Lake Oroville (CNDDB occurrence 55) (CDFW 2023).

Parry's rough tarplant

Parry's rough tarplant (*Centromadia parryi ssp. rudis*) is a CRPR 4.2 species. It is an annual herb whose blooming period is from May to October. It is found in valley and foothill grassland, and vernal pools. It is threatened by development, habitat alteration and habitat disturbance (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

red-stemmed cryptantha

Red-stemmed cryptantha (*Cryptantha rostellata*) is a CRPR 4.2 species. It is an annual herb whose bloming period is from April to June. It is found in cismontane woodland, and valley and foothill grassland. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Sanford's arrowhead

Sanford's arrowhead (Sagittaria sanfordii) is a CRPR 1B.2 species. It is a perennial rhizomatous herb. It can be found in marshes and swamps. Its main blooming period is from May to October. It is threatened by grazing, development, recreational activities, non-native plants, road widening, and channel alteration and maintenance. There is a CNDDB documented occurrence of this plant at Thermalito Afterbay (occurrence 67) (CDFW 2023). There is also a CNDDB record of the plant from 1955 located east of Feather River near Rio Oso (CDFW 2023).

Shield-bracted monkeyflower

Shield-bracted monkeyflower (*Erythranthe glaucescens*) is a CRPR 4.3 species. It is an annual herb found in chaparral, cismontane woodland, lower montane coniferous forest, and valley and foothill grassland. Its main blooming period is from February to August. It is threatened by vehicles and non-native plants. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Sierra Foothills brodiaea

Sierra Foothills brodiaea (*Brodiaea sierrae*) is a CRPR 4.3 species. It is found in chaparral, cismontane woodland, and lower montane coniferous forest. It is a perennial bulbiferous herb whose blooming period is from May to August. It is potentially threatened by vehicles, road maintenance, road widening, development, illegal dumping, urbanization, horticultural collecting, and hydrological alterations (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Slender Orcutt grass

Slender Orcutt grass (*Orcuttia tenuis*) is federally listed as threatened and state listed as endangered. It is a CRPR 1B.1 species. It is an annual herb found in vernal pools whose main blooming period is from May to September. It is seriously threatened by agriculture, residential development, grazing, trampling, vehicles, recreational activities, logging, fire, and non-native plants (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023). The nearest documented occurrences are located east of Highway 70 west of Palermo (CDFW 2023).

Small spikerush

Small spikerush (*Eleocharis parvula*) is a CRPR 4.3 species. It is a perennial herb whose main blooming period is from June to August. It is found in marshes and swamps. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Stinkbells

Stinkbells (*Fritillaria agrestis*) is a CRPR 4.2 species. It is a perennial bulbiferous herb whose blooming period is from March to June. It is found in chaparral, cismontane woodland, Pinyon and juniper woodland, and valley and foothill grassland. It is threatened by development, grazing, and vehicles (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Suisun Marsh aster

Suisun Marsh aster (*Symphyotrichum lentum*) is a CRPR 1B.2 species. The range of Suisun Marsh aster extends from Napa and Solano Counties in the north, to San Joaquin County in the south, to Contra Costa County in the west, and Sacramento County in the east. It is endemic to the Delta. Historically, it ranged from marshes in the East Bay portion of San Francisco Bay to the Sonoma and Napa Rivers. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Suisun Marsh aster grows on the upper margins of brackish and freshwater marshes in the ecotone with terrestrial habitats (CNPS 2023). It is found above erosional cuts and along the banks of sloughs and watercourses. Suisun Marsh aster is a perennial, rhizomatous herb in the sunflower family (Asteraceae) (CNPS 2023). Some occurrences may be single plants with one to several main stems. It blooms from May through November, depending on environmental conditions.

Historically, the marsh habitat suitable for Suisun Marsh aster has been lost mostly through development, dredge disposal, agricultural conversion, and diking. Diked marshes generally lack rare tidal marsh species. It is believed that the conditions brought about by dikes favor robust generalist species that can better tolerate the extremes of inundation and dryness in diked wetlands. Such habitat losses as a result of human activities still occur, but many of the large marshes are now parts of preserves or are otherwise in highly restrictive development zones.

Current threats to Suisun Marsh aster include invasive plants, erosion, creek channelization, levee maintenance and construction, and possibly herbicide applications (CNPS 2023).

Sylvan microseris

Sylvan microseris (*Microseris sylvatica*) is a CRPR 4.2 species. It is a perennial herb whose blooming period is from March to June. It is found in chaparral, cismontane woodland, Great Basin scrub, Pinyon and juniper woodland, valley and foothill grassland. It is threatened by wind energy development, grazing, agriculture, vehicles, and recreational activities. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Tehama navarretia

Tehama navarretia (*Navarretia heterandra*) is a CRPR 4.3 species. It is an annual herb whose blooming period from April to June. It is found in valley and foothill grasslands and vernal pools. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Thread-leaved beakseed

Thread-leaved beakseed (*Bulbostylis capillaris*) is a CRPR 4.2 species. It is an annual herb whose blooming period is from June to August. It is found in lower montane coniferous forest, meadows and seeps, and upper montane coniferous forest. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Valley brodiaea

Valley brodiaea (*Brodiaea rosea ssp. vallicola*) is a CRPR 4.2 species. It is a perennial bulbiferous herb whose main blooming period is from April to May. It is found in valley and foothill grassland and vernal pools. It is threatened by urbanization (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

White-stemmed clarkia

White-stemmed clarkia (*Clarkia gracilis ssp. albicaulis*) is a CRPR 1B.2 species. It is an annual herb whose blooming period is from May to July. It is found in chaparral, cismontane woodland, and sometimes serpentinite. It is threatened by urbanization and non-native plants (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Wine-colored tufa

Wine-colored tufa (*Plagiobryoides vinosula*) is a CRPR 4.2 species. It is found in cismontane woodland, Mojavean desert scrub, meadows and seeps, Pinyon and juniper woodland, and riparian woodland. It is threatened by grazing, trampling, and vehicles (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Woolly meadowfoam

Woolly meadowfoam (*Limnanthes floccosa ssp. floccose*) is a CRPR 4.2 species. It is an annual herb whose main blooming period is from March to May. It is found in chaparral, cismontane woodland, valley and foothill grassland, and vernal pools. It is threatened by grazing and road widening (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Woolly rose-mallow

Woolly rose-mallow (*Hibiscus lasiocarpos var. occidentalis*) is a CRPR 1B.2 species. It is a perennial rhizomatous herb whose blooming period is from June to September. It is found in marshes and swamps and often in riprap on sides of levees. It is seriously threatened by habitat disturbance, development, agriculture, recreational activities, and channelization of the Sacramento River and its tributaries (CNPS 2023). There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Special-Status Wildlife

Invertebrates

Conservancy fairy shrimp

The Conservancy fairy shrimp (*Branchinecta conservatio*) was listed as endangered throughout its range under the federal ESA on September 19, 1994 (59 *Federal Register* [FR] 48136). The Conservancy fairy shrimp has no state regulatory status. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Conservancy fairy shrimp are omnivorous filter feeders that indiscriminately filter particles of the appropriate size from their surroundings, and in turn are prey to a wide variety of animals. The diet of Conservancy fairy shrimp consists of bacteria, unicellular algae, protists, and suspended plant and animal particles. Animals feeding on Conservancy fairy shrimp are birds, fish, amphibians, dragonfly and damsel fly larvae, other insects, and vernal pool tadpole shrimp (USFWS 2005).

The Conservancy fairy shrimp is threatened primarily by habitat loss and fragmentation resulting from expansion of agricultural and developed land uses. Vernal pool habitat can also be lost or degraded by other activities that damage or puncture the hardpan (i.e., water-restrictive layer underlying the pool) or by activities that destroy or degrade uplands that contribute water to vernal pools. Besides habitat conversion, activities causing such loss or degradation include deep ripping of soils, water diversion or impoundment, and application of pesticides, fertilizers, or livestock wastes. Additional threats are incompatible grazing practices (e.g., overgrazing, undergrazing, or cessation of grazing where it has historically occurred), replacement of native plants by nonnatives, and introduction of fish to vernal pools (USFWS 2005).

Crotch bumble bee

Crotch bumble bee (*Bombus crotchii*) is a state candidate for listing of the California endangered species act. Its historical range extended from central California south to Baja California, largely excluding the mountainous regions of the California. It is found in open grasslands and shrubby landscapes. Food plants include *Asclepias*, *Chaenactis*, *Lupinus*, *Medicago*, *Phacelia*, and *Salvia*. They are believed to be generally threatened by habitat loss, pesticides, and climate change. Increasing aridity is a likely threat for this species, which has a very narrow climatic specialization compared to most bumble bees.

Monarch butterfly

The monarch butterfly (*Danaus plexippus*) is a candidate for listing under the federal endangered species act. Currently, this species is scheduled to be federally listed in 2024. Monarchs are not currently a candidate for listing under the California endangered species act. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Generally, breeding areas consist of virtually all patches of milkweed in North America. Overwintering habitats is quite limited and includes certain high altitude Mexican conifer forests and coastal California conifer or Eucalyptus groves. Lethal cold precludes successful overwintering in other areas of continent.

The host plant for monarch butterfly caterpillars are milkweed. Most milkweeds contain cardiac glycosides which are stored in the bodies of both the caterpillar and adult. These poisons are distasteful and emetic to birds and other vertebrate predators. As adults, monarch butterflies generally consume nectar from all milkweeds. Early in the season before milkweeds bloom, Monarchs visit a variety of flowers including dogbane, lilac, red clover, lantana, and thistles. In the fall adults visit composites including goldenrods, blazingstars, ironweed, and tickseed sunflower.

The population of monarch butterflies has declined significantly in the last couple decades. These declines could be the result of the recent loss of milkweed as a result of a major change in agricultural practice: widespread adoption of genetically modified herbicide-tolerant corn and soybeans and use of the herbicide glyphosate on these crops. Climate change is also an emerging threat.

Valley elderberry longhorn beetle

The valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*) is listed as threatened under the ESA (50 FR 52803) on August 8, 1980. There are a several documented CNDDB occurrences of this species within the study area within geographic area 3 (occurrence number 43, 89, 100, 102, 105, 190, 262, and 268) (CDFW 2023).

The VELB is endemic to the Central Valley at elevations below about 3,000 feet. It is found only in association with its host plants, the elderberry shrub (*Sambucus* spp.). In the Central Valley, the elderberry shrub is found primarily in riparian vegetation.

Adults feed on the foliage and possibly the flowers of elderberries from March to early June (USFWS 2017). During this period, the beetles mate and lay eggs on the bark of elderberry shrubs. After the eggs hatch, the larvae bore into and feed on the pith of the stems (i.e., the soft tissue at the center of elderberry stems) and also may feed on the wood. The larval stage may last for 1 to 2 years. Immediately before pupating, larvae excavate exit holes in the stems and temporarily fill them. During mid-March to early June, after pupation, the adults emerge.

Substantial amounts of riparian habitat containing the host plant for the VELB have been lost, and host plants in remaining habitat have been lost and damaged. However, the greatest current threat to the VELB may be predation and displacement by the invasive Argentine ant (*Linepithema humile*) (Huxel 2000).

Vernal pool fairy shrimp

The vernal pool fairy shrimp (*Branchinecta lynchi*) is listed as threatened under the federal ESA throughout its range (59 FR 48136, September 19, 1994). The vernal pool fairy shrimp has no state regulatory status. There are CNDDB documented observations of this species near Thermalito Forebay, Afterbay, and in areas just outside riparian corridor along the low flow channel of the Feather River (CDFW 2023).

The vernal pool fairy shrimp is found throughout the Central Valley and west to the central Coast Ranges, at sites 30 to 4,000 feet in elevation (USFWS 2005). The species has also been reported from the Agate Desert region of Oregon near Medford, and disjunct populations occur in San Luis Obispo, Santa Barbara, and Riverside counties.

The vernal pool fairy shrimp is threatened primarily by the habitat loss and fragmentation resulting from expansion of agricultural and developed land uses. Vernal pool habitat can also be lost or degraded by other activities that damage or puncture the hardpan (i.e., water-restrictive layer underlying the pool) or by activities that destroy or degrade uplands that contribute water to vernal pools. Besides habitat conversion, activities causing such loss or degradation include deep ripping of soils, water diversion or impoundment, and application of pesticides, fertilizers, or livestock wastes. Additional threats include incompatible grazing practices (e.g., overgrazing, undergrazing, or cessation of grazing where it has historically occurred), replacement of native plants by nonnatives, and introduction of fish to vernal pools (USFWS 2005).

Vernal pool tadpole shrimp

The vernal pool tadpole shrimp (*Lepidurus packardi*) was listed as endangered throughout its range under the federal ESA on September 19, 1994 (59 FR 48136). There is a documented CNDDB occurrence of this species within the study area within geographic area 1 (occurrence number 389) (CDFW 2023).

The vernal pool tadpole shrimp is endemic to the Central Valley, with most populations located in the Sacramento Valley. Within this geographic range, vernal pool tadpole shrimp occur in a wide variety of seasonal habitats: vernal pools, ponded clay flats, alkaline pools, ephemeral stock tanks, and roadside ditches (CNDDB 2023; Helm 1998; Rogers 2001). Habitats where vernal pool tadpole shrimp have been observed range in size from small, clear, vegetated vernal pools to highly turbid pools to large winter lakes (Helm 1998; Rogers 2001).

The vernal pool tadpole shrimp is threatened primarily by the habitat loss and fragmentation resulting from expansion of agricultural and developed land uses. Vernal pool habitat can also be lost or degraded by other activities that damage or puncture the hardpan (i.e., water-restrictive layer underlying the pool) or by activities that destroy or degrade uplands that contribute water to vernal pools. Besides habitat conversion, activities causing such loss or degradation include deep ripping of soils, water diversion or impoundment, and application of pesticides, fertilizers, or livestock wastes. Additional threats are incompatible grazing practices (e.g., overgrazing, undergrazing, or cessation of grazing where it has historically occurred), replacement of native plants by nonnatives, and introduction of fish to vernal pools (USFWS 2005).

Amphibians

Western spadefoot toad

The listing status of western spadefoot (*Spea hammondii*) under the federal endangered species act is currently under review. On July 11, 2012, USFWS received a petition requesting that 53 species of reptiles and amphibians, including the western spadefoot, be listed as endangered or threatened and critical habitat be designated. Based on the review of the petition and sources cited in the petition, in 2015 USFWS found that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted. CDFW has listed western spadefoot as a species of special concern. There is a documented CNDDB occurrence of this species in the Thermalito Complex (occurrence number 492) in geographic area 1 (CDFW 2022).

This species is native to central and southwestern regions of California. It has disappeared from several locations in the Central Valley and coastal southern California. Typically found within an elevation range of nearly sea level up to approximately 3000 feet, this species uses diverse habitats ranging from lowlands to foothills, including grasslands, open chaparral, and pine-oak woodlands. It particularly favors shortgrass plains and sandy or gravelly soils, such as alkali flats, washes, and alluvial fans.

Displaying fossorial behavior, this species reproduces in temporary rain pools and sluggish streams that are periodically flooded by intermittent streams. The Western spadefoot demonstrates migratory behavior, often traveling several hundred meters between its nonbreeding and breeding habitats. During much of the year, it remains dormant underground, seeking refuge from both dry and cold conditions. Its highest activity levels are observed during the rainy periods of the winter-spring breeding season.

This species is generally threatened due to impacts of urbanization and agricultural development. Some local populations may be threatened by habitat fragmentation or non-native species.

Reptiles

Giant garter snake

The giant garter snake (*Thamnophis gigas*) is federally and State listed as threatened. The State listed the giant garter snake as threatened on June 27, 1971. USFWS listed the species as federally threatened on October 20, 1993 (58 FR 54053). Critical habitat has not been designated for this species. There is a documented CNDDB occurrence of this species in 2014 at the Thermalito Afterbay boat ramp (occurrence number 304) (CDFW 2023).

The giant garter snake resides in marshes, ponds, sloughs, small lakes, low gradient streams, and other waterways, and in agricultural wetlands, including irrigation and drainage canals, rice fields, and the adjacent uplands (58 FR 54053, October 20, 1993). Habitat requirements include (1) adequate water during the snake's active season (early spring through midfall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Schoenoplectus* spp.), accompanied by vegetated banks for escape cover and foraging habitat during the active season; (3) basking habitat of grassy banks and openings in waterside vegetation; and (4) higher elevation uplands for cover and refuge from floodwaters during the snake's dormant season in the winter (USFWS 2017). It feeds primarily on small fish, tadpoles, and frogs. In some rice-growing areas, giant garter snakes have adapted well to vegetated, artificial waterways and associated rice fields. The giant garter snake resides in small mammal burrows and soil crevices located above prevailing flood elevations throughout its winter dormancy period (USFWS 2017). Giant garter snakes may hibernate up to 800 feet from water, and along waterways they may move considerable distances (e.g., up to 2 miles in a single day) (USFWS 2017).

Giant garter snakes are less active or dormant from October until April, when they emerge to breed and forage. They give birth to live young from late July through early September. Giant garter snakes are vulnerable to predation from both native species (e.g., raccoons, egrets, herons) and nonnative species (e.g., bullfrogs, feral cats) (58 FR 54053 to 54065, October 20, 1993). Predation may be the reason that giant garter snakes tend to be absent from larger rivers that support predatory fish. They are also affected by parasites and contaminants.

Giant garter snake is threatened primarily by habitat conversion, fragmentation, and degradation resulting from urban development (58 FR 54053 to 54065, October 20, 1993). Human disturbance contributes to habitat degradation because giant garter snakes are diurnal predators that are disturbed by human activities. It is also threatened by incompatible agricultural practices such as intensive vegetation control along canal banks and changes in crop composition.

Western pond turtle

The western pond turtle (*Emys marmorata*) is designated by CDFW as a species of special concern. The geographic range of the western pond turtle spans from western Washington state to central California in the south. This species is found at elevations ranging from near sea level to around 4700 feet. They make use of a diverse array of both permanent and temporary aquatic habitats, and they also dedicate a substantial portion of their time to upland terrestrial environments. Both adult and juvenile turtles exhibit a preference for aquatic habitats that provide access to zones of deep, slow-moving water, which include underwater shelters and emergent basking locations. Their requirements for terrestrial habitats vary across their range, but these habitats must encompass areas suitable for basking and nesting. Basking sites on land encompass mud banks, rocks, logs, and root wads along the shoreline, always remaining in proximity to water. Nesting activities occur on land, generally in open low-slope areas located anywhere from a few feet to hundreds of yards away from watercourses. The chosen nesting sites typically receive ample sunlight exposure and possess compact soil. There are several documented CNDDB occurrences of this species in the study area, including in geographic area 1 (occurrence numbers 636, 1272, and 1273), and geographic area 3 (occurrence numbers 491, 1274, and 1275) (CDFW 2023).

Birds

American peregrine falcon

The American peregrine falcon (*Falco peregrines anatum*) was listed as an endangered species under both the federal Endangered Species Act and California Endangered Species Act in 1973 and 1971. The species was federally delisted 1999 and state delisted in 2009. The peregrine is still considered a state fully-protected species. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

The peregrine prefers areas with cliffs for nesting but has adapted to human-made structures, including bridges, buildings, and power lines and occasionally uses tree snags, cavities, or old nests of other raptors. It breeds early March to late August. For foraging it prefers open areas with good vantage points for perching, usually near water. Its prey is almost exclusively birds, primarily waterbirds and pigeons, which it typically captures in the air from a steep swift dive from above.

Pesticides and heavy metals including mercury and lead continue to pose a threat to populations. Collisions with structures or objects, electrified wire strikes, and degradation of habitat are other threats to the peregrine falcon.

Bald eagle

Bald eagle (*Haliaeetus leucocephalus*) is federally delisted and State listed as endangered and is a California fully protected species. There are two CNDDB observations of this species in the study, including one near Lake Oroville in geographic area 1 (occurrence number 269) and one along the Feather River in geographic area 3 (occurrence number 347) (CDFW 2023).

Breeding habitat most commonly includes areas close to coastal areas, bays, rivers, lakes, reservoirs, or other bodies of water that reflect the general availability of primary food sources including fish, waterfowl, or seabirds. Nests are usually in tall trees or on pinnacles or cliffs near water. The same nest may be used year after year, or a nesting pair may use alternate nest sites in successive years.

In winter, bald eagles may associate with waterfowl concentrations or congregate in areas with abundant food resources. Wintering eagles tend to avoid areas with high levels of nearby human activity.

Threats to bald eagle include collisions with wind turbines and electric utility lines, and indirect impacts such as lead poisoning from feeding off carrion that has been shot with lead bullets.

Bank swallow

The bank swallow (*Riparia riparia*) is listed as a threatened species under CESA. It was listed by the California Fish and Game Commission in 1989. The bank swallow has no federal regulatory status; therefore, no critical habitat has been designated for this species. There are numerous CNDDB recorded observations of bank swallow along the Feather River (CDFW 2023).

The current breeding range (about 50 percent of the historical range) is primarily confined to parts of the Sacramento Valley and northeastern California, including the banks of the Sacramento and Feather rivers; a few scattered colonies persist along the central and northern coast. The main stronghold of the bank swallow is along the banks of the Sacramento River and its major tributaries.

Foraging bank swallows take insects on the wing from over a variety of land cover types (Garrison 1999). They use holes dug in cliffs and riverbanks for cover. Bank swallows also nest in burrows that they dig in nearly vertical banks and cliff faces. For bank swallows to dig these burrows, they require substrates made up of soft soils such as fine sandy loam, loam, silt loam, and sand. Suitable banks for nesting also must be more than 3 feet above the ground or water for predator avoidance. Colonies of several to more than 3,000 bank swallows may nest at locations that have these qualities. Suitable nest sites are few and are scattered throughout the species' remaining California range; they are found most often at coastal river mouths, large rivers (primarily in the Sacramento Valley), and occasionally in gravel and sand mines that provide and maintain nesting habitat (Grinnell and Miller 1944). Bank swallows usually initiate a single breeding attempt in April. They incubate their eggs for about 2 weeks and then care for their nestlings for another 3 weeks, until they are fledged (Garrison et al. 1999).

The greatest threat to the bank swallow has been loss of breeding sites along rivers and natural waterways resulting from conversion to concrete-lined flood control channels (in Southern California), and the application of riprap to natural riverbanks in the Central Valley. Other threats come from predators that have access to colonies, changes in gravel and sand mining operations that destroy or no longer create nesting habitat, and high spring floods that can scour out colonies along riverbanks (Garrison 1999).

Burrowing owl

Burrowing owl (*Athene cunicularia*) is a California species of special concern. Breeding range extends from southern California through the western United States, central Mexico, central and southern Florida, and the West Indies. California is an important winter area in the United States for burrowing owl. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3; the closest CNDDB observation is located approximately 0.6 miles away from the Thermalito Complex (CDFW 2023).

Habitat includes open grasslands, especially prairie, plains, and savanna, sometimes other open areas such as vacant lots near human habitation or airports. This owl spends much time on the ground or on low perches such as fence posts or dirt mounds. Nests are in abandoned burrows, such as those dug by prairie dogs, ground squirrels, and foxes. Owls may enlarge or modify existing burrows. Diet includes primarily large insects and rodents, with sometimes birds and amphibians.

Primary threats to this species include habitat loss (e.g., due to land conversion for agriculture and urban development), habitat degradation (e.g., via control of burrowing mammals) and habitat fragmentation. Other threats can include excessive predation mortality (e.g., cats) and contaminants.

California black rail

California black rail (*Laterallus jamaicensis coturniculus*) is listed as threatened under the California endangered species act. It also is a fully protected species under the California Fish and Game Code Section 3511. The fully protected status confers greater protection than State listing, which has provisions for take of listed species. Fully protected species may not be taken or possessed at any time, and no licenses or permits may be issued for their take except for collecting these species for necessary scientific research. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3; the closest CNDDB observation is located approximately 0.9 miles away from the Thermalito Forebay (CDFW 2023).

The bulk of the population was confined to the northern reaches of the San Francisco Bay estuary, especially the tidal marshland of San Pablo Bay and associated rivers. California black rail is found in various habitats, from high coastal marshes to freshwater marshes. In coastal and estuarine saltmarshes, favored areas are dominated by pickleweed, bulrushes, and matted salt grass and other marsh vegetation. It nests in or along edge of marsh, usually in site hidden in marsh grass or at base or Salicornia, sometimes on damp ground but usually on mat of previous year's dead grasses. Reported food items include insects, isopods, and seeds of aquatic plants.

Major threat to this species is loss and degradation of habitat. The population is progressively declining due to loss of coastal salt marshes and inland freshwater marshes.

Golden eagle

Golden eagle (*Aquila chrysaetos*) is a fully protected species under the California Fish and Game Code Section 3511 and is protected under the federal Bald Eagle and Golden Eagle Protection Act. Most fully protected species have also been listed as threatened or endangered species under the State endangered species laws and regulations; however, several species, including golden eagle, remain only on the fully protected list. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Golden eagles favor open grasslands, foothills, and mountain terrain. They nest on cliffs and large oaks, sycamores, pines and other trees in open areas in areas with good prey availability, especially where updrafts are common, which aid in soaring. Breeding territories are typically large and found at low densities across the landscape (e.g., average territory size of 48 square miles in Northern California (Zeiner et al. 1990). Golden eagles prey mostly on rabbits and rodents, but also take other small animals and some carrion (Zeiner et al. 1990).

Threats to golden eagles include direct sources such as trauma from collisions with wind power turbines and power lines and indirect sources such as lead poisoning. Disturbance at nests and loss of habitat to human encroachment are other sources of threats.

Greater sandhill crane

The greater sandhill crane (*Grus canadensis tabida*) is State listed as threatened under CESA (California Fish and Game Code, Sections 2050 et seq.). The species was listed by the California Fish and Game Commission in 1983. The greater sandhill crane is also designated as a State fully protected species. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Greater sandhill cranes are primarily birds of open freshwater wetlands. In California, nesting typically occurs in open grazed meadows. Wintering habitat is found almost entirely in agricultural fields and edges. Wintering habitat consists of three primary elements: foraging habitat, loafing habitat, and roosting habitat. Two principal types of foraging habitat are used during winter.

The most important threat to wintering greater sandhill cranes is the loss of traditional winter habitat from urbanization and agricultural conversion. Although relatively limited urbanization has occurred to date within key crane areas, surrounding development and increased levels of human disturbances may threaten the long-term sustainability of important wintering lands. Greater sandhill cranes are sensitive to human presence and do not tolerate regular disturbances, including low-level recreational disturbances. Types of disturbances include hunting, birding, photography, operating equipment for habitat management, boating, and aircraft overflights.

Loggerhead shrike

Loggerhead shrike (*Lanius ludovicianus*) is a California species of special concern. It is a resident throughout the southern half of the United States. Its breeding habitat in the southwestern United States includes scattered trees and shrubs, savanna, and desert scrub. Suitable hunting perches are an important part of the habitat. They do not appear to be particularly bothered by proximity to human activity. It feeds primarily on large insects (especially beetles and orthopterans). It also consumes other invertebrates, small birds, lizards, frogs, and rodents. Threats to this species include pesticide exposure and breeding habitat loss and degradation. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Northern harrier

Northern harrier (*Circus hudsonius*) is a California species of special concern. It occupies a diverse range of habitats which include open grasslands, marshes, wetlands, meadows, and agricultural fields. Its preferred habitats often consist of a mix of vegetation types that offer a blend of cover for hunting and nesting. It flies low over the ground to scan and hunt for prey. It feeds on small mammals, birds, and insects. In wetland areas, it can feed on amphibians and small fish. Nesting for this species typically occurs in relatively open areas with low vegetation. Nest sites may include grassy fields, marsh edges, or even elevated spots such as mounds. The nearest CNDDB occurrence of this species (occurrence number 17) is located by Thermalito Afterbay (CDFW 2023).

Purple martin

Purple martin (*Progne subis*) is a California species of special concern. It occupies a wide variety of open and partly open areas, frequently near water or around towns. It nests in tree cavities (including abandoned woodpecker holes) and crevices in rocks. It feeds on insects it catches in the area. It occasionally forages by walking along the ground. It forages often over fields, water, and marshes. Key threats to this species include competition with European starling and house sparrows for suitable cavity nest sites. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Saltmarsh common yellowthroat

Saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*) is a California species of special concern. Its breeding range includes salt marshes of the San Francisco Bay area, ranging from Tomales Bay to Carquinez Strait to San Jose. It nests just above ground or over water, in thick herbaceous vegetation, often at base of shrub or sapling. It eats various small invertebrates. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Short-eared owl

Short-eared owl (*Asio flammeus*) is a California species of special concern. It nests on the ground, generally in slight depressions beside or beneath a bush or clump of grass. The nests are located near water but generally on dry areas. The habitat types it frequently occupies include fresh and saltwater marshes, bogs, dunes, prairies, grassy plains, meadows, savanna, and open woodland. It mainly eats rodents, but also regularly consumes other small mammals, small birds, and insects. It hunts primarily by flying low, typically into wind, and dropping down onto prey. The main threat to this species is from degradation or destruction of suitable habitat of marshes, grasslands, and pastures. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Song sparrow “Modesto” population

Song sparrow “Modesto” population (*Melospiza melodia*) is a California species of special concern. It is found in brushy, shrubby, and deep grassy areas along watercourses and ocean coasts; and marshes. It nests on ground or around 1.5 to 30 feet high in small conifer, thorny bush, willows, cattails, cordgrass. It feeds mostly insects and seeds, and some small fruits. It forages in trees, grasses, bushes and on open ground. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Suisun song sparrow

Suisun song sparrow (*Melospiza melodia maxillaris*) is a California species of special concern. It is a resident in the Suisun Bay area (e.g., Southampton Bay, Grizzly Island, Port Costa, Pittsburg). It is found in brackish marshes. It nests on the ground or in herbaceous vegetation. It eats mostly insects and seeds. It forages in vegetation on the ground. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Swainson's hawk

The Swainson's hawk (*Buteo swainsoni*) is a State-listed threatened species. The Swainson's hawk population that nests in the Central Valley winters primarily in Mexico, while the population that nests in the interior of North America winters in South America. There are numerous CNDDB documented occurrences of this species along the Feather River (CDFW 2023).

Swainson's hawks arrive in the Central Valley between March and early April to establish breeding territories. Breeding occurs from late March to late August, peaking in late May through July. In the Central Valley, Swainson's hawks nest in isolated trees, small groves, or large woodlands next to open grasslands or agricultural fields. This species typically nests near riparian areas; however, it has been known to nest in urban areas as well. Nest locations are usually close to suitable foraging habitats, which include fallow fields, annual grasslands, irrigated pastures, alfalfa and other hay crops, and low-growing row crops. Swainson's hawks leave their breeding grounds to return to their wintering grounds in late August or early September.

Tricolored blackbird

The tricolored blackbird (*Agelaius tricolor*) is currently a candidate species being considered for listing under the California Endangered Species Act. The tricolored blackbird has no federal regulatory status; however, the species is protected under the federal Migratory Bird Treaty Act and is designated as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS). The closest CNDDB documented occurrence of this species is along the Thermalito Afterbay (occurrence number 901) (CDFW 2023).

Tricolored blackbirds have three basic requirements for selecting their breeding colony sites: 1) Open, accessible water; 2) A protected nesting substrate, including flooded, thorny, or spiny vegetation; and 3) A suitable foraging space providing adequate insect prey within five miles of the nesting colony (Beedy and Hamilton 1997).

The most significant historical and ongoing threat to the tricolored blackbird is habitat loss and alteration. The initial conversion from native landscapes to agriculture removed vast wetland areas in the state and caused initial declines in populations. The more recent conversion of suitable agricultural lands to urban areas has permanently removed historical breeding and foraging habitat for this species. In urbanizing areas, habitat fragmentation and proximity to human disturbances has also led to abandonment of large historical colonies (Beedy and Hamilton 1997).

Entire colonies (up to tens of thousands of nests) in cereal crops and silage are often destroyed by harvesting and plowing of agricultural lands (Beedy and Hamilton 1997). While adult birds can fly away, eggs and fledglings cannot. The concentrations of a high proportion of the known population in a few breeding colonies increases the risk of major reproductive failures, especially in vulnerable habitats such as active agricultural fields. Other major threats to Tricolored blackbird colonies include human disturbances, predation, and exposure to toxins and contaminants.

Western yellow-billed cuckoo

Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is federally listed as threatened and state listed as endangered. Western yellow-billed cuckoo nests and forages along broad, lower flood bottoms of larger river systems in dense riparian vegetation consisting of willow and cottonwood, with a lower story of blackberry, nettles, or wild grape. In California, this species nests in scattered, isolated areas in the Sacramento, Amargosa, Kern, Santa Ana, and Colorado River Valleys. This species breeds from mid-May to mid-July, with the entire breeding cycle lasting no more than 17 days. Threats to this species include loss, degradation, and fragmentation of riparian habitat. There are CNDDB documented occurrences of this species along the high flow channel of the Feather River (occurrence numbers 31, 91, 129, and 152) (CDFW 2023).

White-tailed kite

White-tailed kite (*Elanus leucurus*) is a California fully protected species. Its habitat includes savanna, open woodland, marshes, partially cleared lands and cultivated fields, mostly in lowland situations. It nests in trees, often near a marsh, usually around 20-50 feet above the ground in branches near the top of a tree. Diet consists predominately of voles and mice. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Yellow-breasted chat

Yellow-breasted chat (*Icteria virens*) is a California species of special concern. Its breeding habitat consists of shrubby old pastures, thickets, bushy areas, scrub, woodland undergrowth, and fence rows, including low wet places near streams, pond edges, or swamps; thickets with few tall trees; and early successional stages of forest regeneration. It nests in bushes, brier tangles, vines, and low trees, generally in dense vegetation less than 6 feet above ground. Its diet consists mostly of insects and small fruits. Threats to this species include habitat loss due to successional changes and clearing of land for agricultural or residential development. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Yellow warbler

Yellow warbler (*Setophaga petechia*) is a California species of special concern. Its habitat includes open scrub, second-growth woodland, thickets, farmlands, and gardens, especially near water. It also uses riparian woodlands, especially willows. Nesting occurs mainly in May-June but may continue into July or rarely August. It primarily eats insects and spiders. It takes most food items from leaves or bark. A key threat to this species includes loss of riparian habitat. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Mammals

Ringtail

Ringtail (*Bassariscus astutus*) is a California fully protected species. It is mainly nocturnal, though can be active at dusk and dawn. It is typically found in rocky areas with cliffs or crevices for daytime shelter; desert scrub, chaparral, pine-oak and conifer woodland. It is usually found within 0.5 miles of water. Dens usually in rock shelter; also can be in tree hollows, under tree roots, in burrow dug by other animal, and under brush piles. It is an omnivore but prefers animal matter, including birds, reptiles, and amphibians. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Salt marsh harvest mouse

The salt marsh harvest mouse (*Reithrodontomys ravivenstris*) is listed as endangered under the federal ESA and CESA. It is also designated as a State fully protected species. Critical habitat has not been designated for this species. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

Salt marsh harvest mice depend on thick cover of native halophytes. They use pickleweed as their primary habitat as long as they have nonsubmerged, salt-tolerant vegetation for escape during the highest tides. Refuge is taken from high tides in the upper zones of most marshes, usually in stands of fat hen and Australian salt bush (*Atriplex semibaccata*). Salt marsh harvest mice have shown an ability to disperse considerable distances; however, they apparently do not move through unvegetated areas, and thus, fragmentation of salt marsh habitats results in limited dispersal opportunities. A corridor of suitable vegetation is required for movement and dispersal into adjacent habitats. Loss and degradation of tidal marsh habitats continues to be the most important threat to the salt marsh harvest mouse and other tidal marsh species.

Townsend's big-eared bat

Townsend's big-eared bat (*Corynorhinus townsendii*) is a California species of special concern. Throughout much of the known range, these bats commonly occur in mesic habitats characterized by coniferous and deciduous forests. In the western United States, they are found regularly in forested regions and buildings, and in areas with a mosaic of woodland, grassland, and/or shrubland. Night roosts include caves, buildings, and tree cavities. Diet includes various flying insects often obtained near the foliage of trees and shrubs. The primary threat to this species appears to be disturbance and/or destruction of roost sites. The nearest CNDDB documented occurrence of this species was in the community of Oroville in the vicinity of the low-flow channel (occurrence number 470) (CDFW 2023).

Western mastiff bat

Western mastiff bat (*Eumops perotis californicus*) is a California species of special concern. It is found in arid and semiarid areas. It roosts in crevices and shallow caves on the sides of cliffs and rock walls, and occasionally buildings. It roosts usually high above ground with unobstructed approach. Most roosts are not used throughout the year. It may alternate between different day roosts. This species is insectivorous feeding on various insects including moths, cricks, and grasshoppers. The nearest CNDDB documented occurrence of this species was in the community of Oroville in the vicinity of the low-flow channel (occurrence number 160) (CDFW 2023).

Western red bat

The western red bat (*Lasiurus blossevillii*) is a California species of special concern. This species is locally common in certain areas of California. Roosting habitat includes forests and woodlands from sea level up through mixed conifer forests. The species feeds over a wide variety of habitats: grasslands, shrublands, open woodlands and forests, and croplands. Western red bats roost primarily in trees, less often in shrubs. Roost sites are often in edge habitats adjacent to streams, fields, or urban areas. Family groups roost together and nursery colonies are found with many females and their young. There are no documented CNDDB occurrences of this species within the study area for geographic areas 1-3 (CDFW 2023).

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