UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

OCT 24 2016

Refer to NMFS No: WCR-2016-4138

Ms. Alicia Forsythe
Program Manager
San Joaquin River Restoration Program
U.S. Bureau of Reclamation
2800 Cottage Way
Sacramento, California 95825-1898

Re: Programmatic Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Mendota Pool Bypass and Reach 2B Improvements Project

Dear Ms. Forsythe:

Thank you for your letter on January 14, 2016, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Mendota Pool Bypass and Reach 2B Improvements Project. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

Enclosed is NMFS's conference and biological opinion (Enclosure 1) based on our review of the proposed Mendota Pool Bypass and Reach 2B Improvements Project (proposed action) associated with the San Joaquin River Restoration Program in Fresno and Madera counties, California, and its effects on the Federally listed as threatened California Central Valley steelhead (*Oncorhynchus mykiss*) and the Central Valley spring-run Chinook salmon (*O. tshawytscha*) population being reintroduced by the SJRRP in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). This population of Central Valley spring-run Chinook salmon has been designated by NMFS as a Non-essential Experimental Population in accordance with Section 10(j) of the ESA. No proposed or designated critical habitat occurs within the action area.

This biological and conference opinion is based on information provided in the final biological assessment, received by NMFS on January 14, 2016, along with additional information received between March 14, 2016 and July 27, 2016, and numerous scientific articles and reports from both the peer reviewed literature and agency "gray literature." A complete administrative record of this consultation is on file at the Central Valley Office of NMFS.

Based on the best available scientific and commercial information, the conference and biological opinion concludes that the proposed action, as presented by Reclamation, is not likely to jeopardize the continued existence of the listed species or permanently destroy or adversely modify designated critical habitat. An incidental take statement that includes reasonable and prudent measures and non-discretionary terms and conditions that are expected to minimize the impact of the anticipated incidental take of California Central Valley steelhead is included with the biological opinion. These measures would also minimize impacts to CV spring-run Chinook salmon.

This letter also transmits NMFS' EFH conservation recommendations for Pacific Coast salmon (*O. tshawytscha*) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 et seq.; Enclosure 2). The document concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area and adopts all terms and conditions of the incidental take statement and the ESA conservation recommendations of the BO as the EFH conservation recommendations.

Reclamation has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NMFS within 30 days of receipt of these conservation recommendations that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH (50 CFR 600.920 (j)). In the case of a response that is inconsistent with our recommendations, Reclamation must explain its reasons for not following the recommendations, including scientific justification for any disagreements with NMFS over anticipated effects of the proposed action and measures needed to avoid, minimize, or mitigate such effects. If unable to complete a final response within 30 days, Reclamation should provide an interim written response within 30 days before submitting its final response.

Please contact Rhonda Reed in our California Central Valley Office at (916) 930-3609 or via e-mail at Rhonda.Reed@noaa.gov if you have any questions regarding this response or require additional information.

Sincerely,

Maria Rea

for Barry Thom
Regional Administrator

Enclosures (2)

1. Biological Opinion with appendices
2. Essential Fish Habitat Conservation Recommendations

cc: California Central Valley Office - Division Chron File: ARN 151422-WCR2016-SA00212

NMFS-PRD, Long Beach, CA

Robert Clarke and John Netto, USFWS, 2800 Cottage Way, W-2606, Sacramento, CA 95825

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Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation and Fish and Wildlife Coordination Act Recommendations

Mendota Pool Bypass and Reach 2B Improvements Project

NMFS Consultation Number: WCR-2016-4138

Action Agency: Bureau of Reclamation

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Central Valley Steelhead DPS (*O. mykiss*)	Threatened	Yes	No	
Central Valley Spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened (Non-essential Experimental Population)	Yes	No	

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

for Barry Thom
Regional Administrator

Date: OCT 24 2016

LIST OF ABBREVIATIONS AND ACRONYMS

BMPs	Best Management Practices
BA	Biological Assessment
BO	Biological Opinion
CCV	California Central Valley
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources
CV	Central Valley
CVI	Central Valley Index
TRT	Central Valley Technical Review Team
CWT	Coded-wire tag
CRR	Cohort Replacement Rates
Coleman	Coleman National Fish Hatchery
DO	Dissolved Oxygen
DPS	Distinct Population Segment
EBMUD	East Bay Municipal Utilities District
ESA	Endangered Species Act
EFH	Essential Fish Habitat
ESU	Evolutionarily Significant Unit
FRFH	Feather River Fish Hatchery
FRRP	Fish Rescue and Relocation Plan
GIS	Geographic Information System
LWM	Large Woody Material
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MMP	Monitoring and Maintenance Plan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NEP	Non-essential Experimental Population
PFMC	Pacific Fishery Management Council
PBFs	Physical or Biological Features
PVA	Population Viability Analysis
RBDD	Red Bluff Diversion Dam
RM	River Mile
RST	Rotary Screw Trap
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
T&C	Terms and Conditions
DQA	The Data Quality Act
Corps	U.S. Army Corps of Engineers
Reclamation	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
VSP	Viable Salmonid Population

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1. INTRODUCTION

1.1 Background, Authority, and Policy

The National Marine Fisheries Service (NMFS) prepared the biological opinion (BO) and incidental take statement portions (ITS) of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an EFH consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). A complete record of this consultation is on file at the NMFS California Central Valley Office.

Each Federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat unless that activity is exempt pursuant to the ESA (16 U.S.C. 1536(a)(2); 50 CFR 402.03). Furthermore, under Section 2 of the ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA.

The funding for the proposed action has either been dedicated through a federal authority for the SJRRP. Furthermore, Reclamation's authority for the proposed action is limited to the funding and construction of the proposed action and as an administrator in the permitting and implementation of projects.

Reclamation does not have discretion over the water deliveries requested by the Exchange Contractors. Therefore, incidental take exemptions under section 7 of the ESA, for listed anadromous fish affected by the proposed action, will only apply for aspects that Reclamation has discretion over (namely the completion and operation of the Mendota Pool Bypass and Reach 2B Improvements Project). The Take Statement (ITS) will be issued solely for these activities.

This BO contains a conferencing opinion for CV spring-run Chinook salmon because it was requested by Reclamation. A conferencing opinion is only required if the analysis of the proposed action results in a jeopardy determination and we concluded the proposed action will not jeopardize the continued existence of the species. The analysis for CV spring-run Chinook salmon is only included in this BO because it was requested by Reclamation. There will be no take issued for CV spring-run Chinook salmon as part of this BO, and the experimental population of CV spring-run Chinook salmon will not be addressed in the Incidental Take Statement. The analysis on CV spring-run Chinook salmon is for informational purposes only.

1.2 Consultation History

On January 14, 2016, NOAA's National Marine Fisheries Service (NMFS) received a letter and accompanying biological assessment (BA) from the U.S. Bureau of Reclamation (Reclamation) requesting initiation of section 7 consultation concerning the Mendota Pool Bypass and Reach 2B Improvement Project, Fresno and Madera Counties, CA. Reclamation determined that the proposed action may affect and is likely to adversely affect the California Central Valley steelhead (CCV steelhead, *Oncorhynchus mykiss*) Distinct Population Segment (DPS), Federally listed as threatened under the ESA. In addition, Reclamation determined that the proposed action may affect, but would not jeopardize the non-essential experimental population of Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) within the San Joaquin River or their respective habitats. Additionally, Reclamation determined that the proposed project would adversely affect Pacific Coast Salmon EFH. Reclamation requested a formal consultation under Section 7(a)(2) of the ESA for CCV steelhead and a conference for CV spring-run Chinook salmon.

On February 18, 2016, NMFS issued to Reclamation an insufficiency letter requesting additional information in regards to construction details, take analysis, and project descriptions that were not contained in the BA and associated initiation request.

On March 3, 2016, NMFS and Reclamation met to discuss the BA insufficiencies.

On March 24, 2016, NMFS received additional information from Reclamation in response to the insufficiency letter addressing each outstanding item. In addition, Reclamation requested the consultation be programmatic in nature due to the step-wise construction of the project.

On May 5, 2016, NMFS received information that changed the project description to include a fifth step in the programmatic consultation which consists of construction of a fish screen at the Mendota Pool Compact Bypass Control Structure.

On July 18, 2016, NMFS received an email from Reclamation that outlined a change in take request and species effects analysis associated with the change in project description.

On July 27, 2016, NMFS received an email from Reclamation that provided additional required construction details on the revised project description.

On July 27, NMFS initiated formal consultation.

On August 12, 2016, NMFS sent a sufficiency letter to Reclamation.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The proposed action is a result of the settlement (Settlement) (Stipulation of Settlement in NRDC et al. v. Kirk Rodgers et al.), and is a component of the San Joaquin River Restoration Program (SJRRP). The SJRRP calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of CV spring-run and fall-run Chinook salmon.

This programmatic BO addresses the remaining fish passage improvement actions that are planned from 36.785339, -120.368449 to 36.773870, -120.284971 within the SJRRP restoration area. Designs for the entire Mendota Pool Bypass and Reach 2B Improvement Project are not complete. Currently there are 30% designs for the Columbia Canal Intake Siphon, the compact bypass, and the Compact Bypass Bifurcation Structure. However, NMFS considers these actions as reasonably certain to occur in the near future and that the general design parameters and effects associated with construction and maintenance are anticipated to be generally similar to other small fish passage projects that have been designed, constructed and consulted on through section 7(a)(2) of the ESA. Furthermore, these future actions are expected to meet NMFS and CDFW fish passage standards and/or engineering approval. Therefore, this BO also addresses, analyzes and provides incidental take exemption for future construction of fish passage actions within the proposed action area.

The Mendota Pool Bypass and Reach 2B improvements defined in the Settlement are (Settlement Paragraph 11[a]):

> *(1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cubic feet per second (cfs) from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*
>
> *(2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

The new compact bypass channel would provide for conveyance of 4,500 cfs between Reach 2B and Reach 3, while avoiding entrainment into Mendota Pool. The proposed action would also include a bifurcation system that would allow water deliveries of up 2,500 cfs into Mendota Pool; a fish screen in front of Mendota Pool is also included to reduce entrainment during water deliveries. To increase rearing habitat in Reach 2B, levees would be set back from the Chowchilla Bypass Bifurcation Structure to the new compact bypass, allowing for increased capacity and integrated floodplains.

Reclamation proposes improvement projects that are reasonably certain to occur in Reach 2B of the restoration area of the upper San Joaquin River, including the following steps:

1. The Columbia Canal Intake Siphon (2017-2018)
2. The compact bypass, the Compact Bypass Control Structure, including a fish ladder, and the Mendota Pool Control Structure (2018-2021)
3. Reach 2B Grading, Levees, and Floodplain Project (2020-2026)
4. A fish passage facility on the San Joaquin River Control Structure at the Chowchilla Bifurcation Structure (2026+)
5. The Mendota Pool Control Structure fish screen (2026+)

The action area is in Fresno and Madera counties, near the town of Mendota. The majority of actions would take place at the confluence of the San Joaquin River and Fresno Slough approximately 2 miles northeast of Mendota, California.

1.3.1 Columbia Canal Intake and Siphon

Modification of the Columbia Canal intake and siphon is the first step of the proposed action. The Columbia Canal runs north out of Mendota Pool. The proposed compact bypass channel would also be directly north of Mendota Pool, and would therefore block the transport of water from Mendota Pool into the Columbia Canal. Therefore, the Columbia Canal intake and siphon must be modified to allow it to function during and after construction of the proposed action. This step of the action must be completed prior to work on the second step of the action: the compact bypass, the Compact Bypass Control Structure, including a fish ladder, and the Mendota Pool Control Structure.

The Columbia Canal intake siphon would connect the Columbia Canal to the Mendota Pool, without water exchange with the compact bypass. The majority of the compact bypass channel would be constructed without interruption to the San Joaquin River flow or the Columbia Canal, by excavating the compact bypass in the dry and constructing the compact bypass bifurcation structure last. The siphon under the planned bypass channel would be constructed first. The Columbia Canal water intake facility would be located within Mendota Pool, and likely would consist of eight 15-foot-wide, 7-foot-tall bays, with a bar screen to prevent aquatic vegetation entering the siphon. The extensive intake area would be required to maintain appropriate velocities and minimize sediment and vegetation issues. Intake bays would be seven feet tall to account for five feet of future, anticipated land subsidence.

Based on land subsidence data collected from December 2011 to July of 2015, Reclamation is designing this proposed action for five feet of land subsidence, which is equal to the current rate for 25 years. In 2042 (25 years from the start of construction of this proposed action), the Sustainable Groundwater Management Act requires Groundwater Sustainability Agencies to have reached sustainable levels of withdrawal in all state groundwater basins, presumably meaning subsidence would have stopped. Existing water surface elevations in Mendota Pool are anticipated to rise approximately two feet above the proposed intake crest elevation.

Columbia Canal intake structure operations include removal of sediment in the sediment collection basin and running the automatic trash sweep. The bar screen would be cleaned by an automatic trash rack. A sediment sump would be provided in the center bay to allow for sediment removal. The top of the intake facility would be covered with grating to allow for easy access for maintenance.

The Columbia Canal siphon would cross underneath the compact bypass from the intake facility on Mendota Pool to the pumping plant located near the existing Columbia Canal, which is approximately 1,000 feet. The siphon would consist of two adjacent 4-foot by 6-foot concrete box culverts, that would be buried a minimum of five feet below the low flow channel in the compact bypass. The discharge facility for the Columbia Canal siphon would be located where Drive 10 ½ crosses the Columbia Canal, on the north side of the future compact bypass (Figure 1). The pumping plant would be located adjacent to this facility. The Columbia Canal intake facility and pumping plant would be constructed with supervisory control and data acquisition capability, but able to be manually operated as well. The pumping plant would include a steel plate door and cinder block walls and would be enclosed within a fenced and gated area to minimize vandalism.

Installation of the Columbia Canal intake siphon within Mendota Pool would require the use of a cofferdam. Cofferdams would be installed to allow construction to occur in isolation from Mendota Pool and in the dry (to the extent that dewatering achieves a dry condition), to minimize river turbidity, and to limit contact between proposed action activities and the channel segments potentially supporting CCV steelhead or CV spring-run Chinook salmon. Installation of cofferdams would require enclosing and dewatering the area contained by the cofferdam.

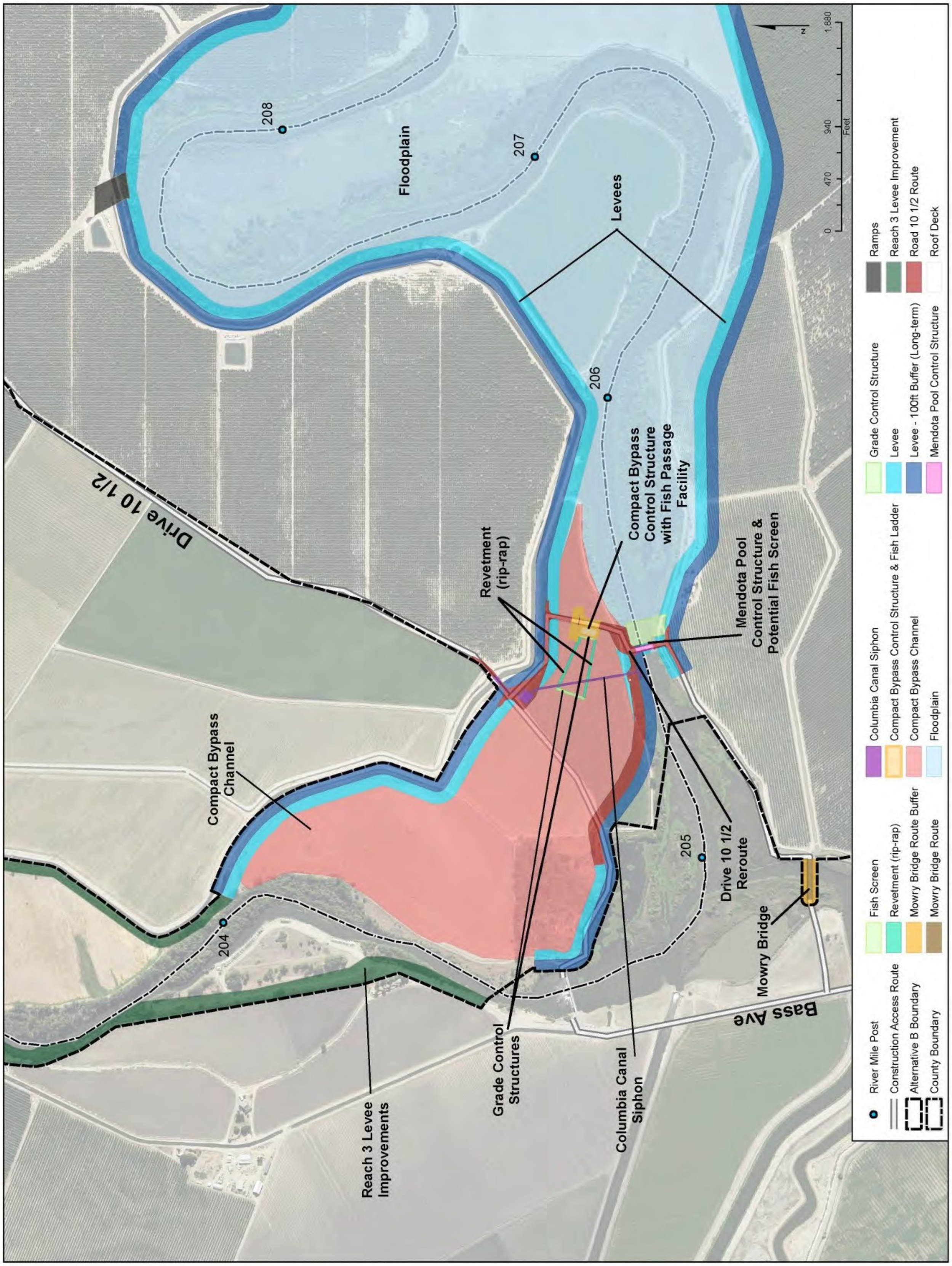

Figure 1. Inset map of proposed action (Pg. 1-7, Figure 3, Reclamation BA)

1.3.2 Compact Bypass, Compact Bypass Control Structure, and Mendota Pool Control Structure

This action would create the compact bypass channel between Reach 2B and Reach 3, to allow river flows and native fishes to bypass Mendota Pool. Restoration flows would enter Reach 2B and then flow through the compact bypass channel into Reach 3. This action would also create a bifurcation system consisting of two new structures, the Compact Bypass Control Structure and the Mendota Pool Control Structure. These two structures are referred to as the Compact Bypass Bifurcation Structure.

The Mendota Pool Control Structure would be capable of conveying up to 2,500 cfs from the river into Mendota Pool. The Compact Bypass Control Structure would have anadromous fish passage, built to the standards of the Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001) and the Anadromous Salmonid Passage Facility Design (NMFS 2008). The majority of the time all native fishes would be able to volitionally pass through the Compact Bypass Control Structure, while being excluded from Mendota Pool.

1.3.2.1 Compact Bypass Channel

The bypass channel is designed as an earthen channel and would be able to convey 4,500 cfs around Mendota Pool. The bypass channel would bypass the Mendota Pool to the north, connect to Reach 2B approximately 0.9 mile upstream from Mendota Dam (approximately RM 205.5), and connect to Reach 3 approximately 0.6 mile downstream from Mendota Dam (approximately RM 204). The bypass channel would have a total length of approximately 0.8 miles or approximately 4,000 feet with a total corridor width of approximately 510 feet.

Once constructed, the bypass channel would become the new river channel. The in-channel structures that would be built as part of the proposed action include: the Compact Bypass Control Structure; Mendota Pool Control Structure; two grade control structures within the bypass; and a fish passage facility at the Compact Bypass Control Structure. The bypass channel and associated structures would provide downstream passage of juvenile Chinook salmon and upstream passage of adult Chinook salmon, as well as passage for other native fishes, while isolating Mendota Pool from restoration flows.

The bypass channel would be a multi-stage channel designed to facilitate fish passage at low flows, channel stability at moderate flows, and contain high flows (up to 4,500 cfs). The low flow channel would be approximately 70 feet wide and have an average depth of approximately 3 feet deep. It is designed to contain approximately 200 cfs and is sinuous.

The bypass would be excavated in the dry, while restoration flows are routed through Mendota Pool. During excavation, soil plugs at either end of the bypass would be left in place to keep flows out of the bypass. Flows would not be allowed into the bypass until dense vegetation has been established in order to stabilize the soils. If high flows were released in the bypass before allowing sufficient time for revegetation, much of the bank could be lost to erosion because revegetation efforts are the primary bank stabilization methods for the majority of the bypass. The first stage of flows, 200 cfs, would be introduced in the spring of the third year after initial revegetation. These initial flows would be introduced through the fish ladder to avoid incision of Reach 2B. The second stage of flows, 1200 cfs, would begin in spring of the fourth year of revegetation and should be preceded by the removal of the irrigation system. Flows in the second stage would be allowed through the open gates of the Compact Bypass Control Structure and Reclamation expects a significant geomorphic change in Reach 2B (U.S. Bureau of Reclamation 2015). The third stage of flows, 4,500 cfs, would be dependent on the completion of all setback levees in the floodplain step (step 3) of the proposed action.

The elevation of the Compact Bypass Control Structure is designed at 141 feet in order to promote sediment stability throughout Reaches 2 and 3 and minimize the need for grade control in the compact bypass (Figure 2). The average slope of the channel would be approximately 0.0005 (approximately 2.6 feet per mile), while the total elevation drop in the compact bypass after channel stabilization would be approximately two feet.

The entrance to the bypass is located approximately 7 feet below the current thalweg of Reach 2B. A pilot channel within Reach 2B would be constructed to create a smoother transition between Reach 2B and the bypass channel. The pilot channel would be a 70-foot-wide channel with 2:1 horizontal to vertical side slopes (2H:1V). It would be excavated within Reach 2B, upstream of the junction between the bypass and San Joaquin River. The excavation would be performed just prior to the reintroduction of the second stage flows (1,200 cfs) to the bypass so that sediment does not refill the channel. Some of the material excavated from the pilot channel could be placed in the bed of the low flow channel located in the bypass to a maximum depth of one foot. Two grade-control structures just downstream of the Compact Bypass Control Structure would be included to achieve the necessary elevation change (Figure 1).

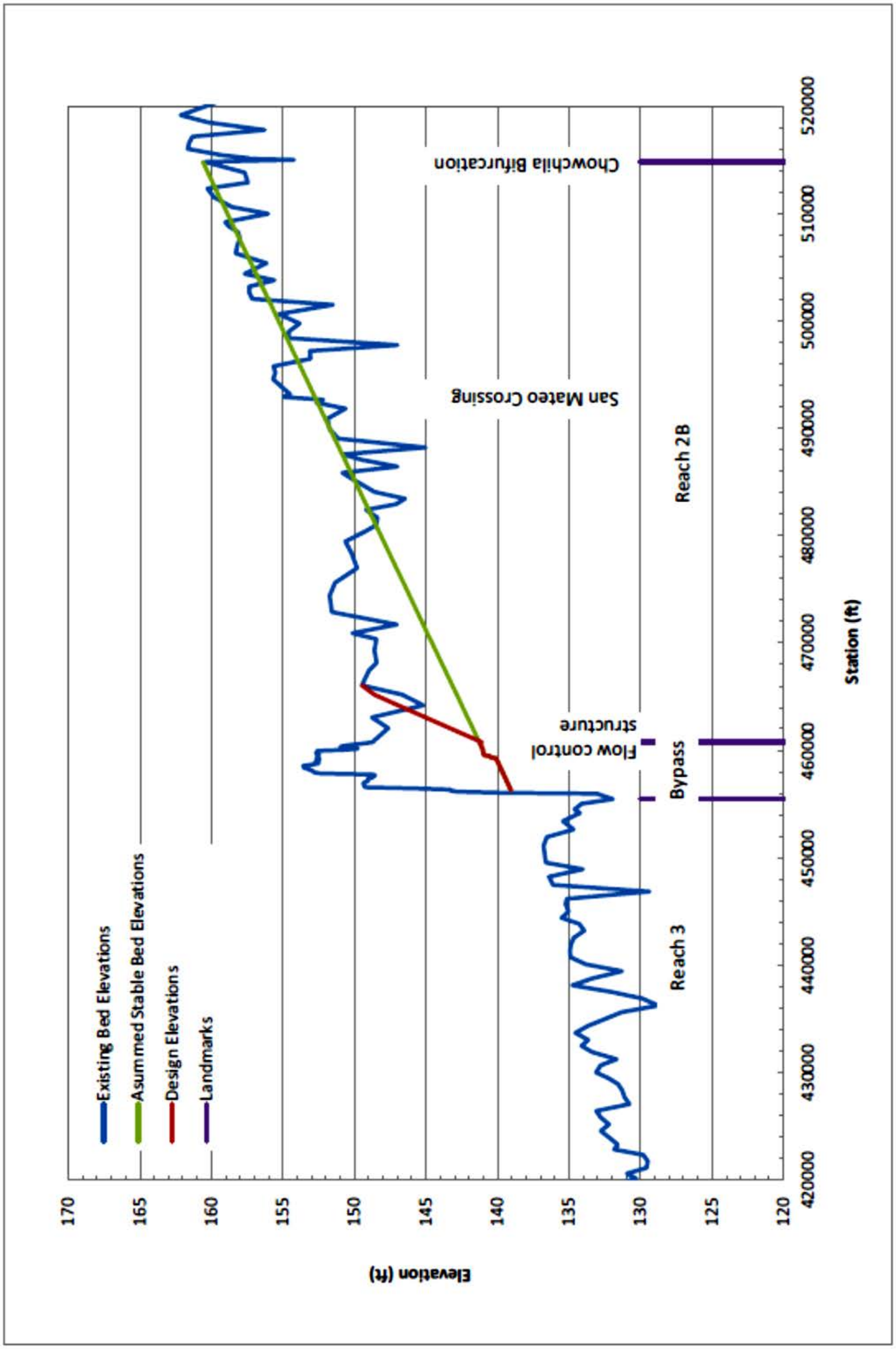

Figure 2. Existing and design profiles in Reach 2B through the compact bypass. (Pg. 2-5, Figure 5, Reclamation BA)

1.3.2.2 Grade Control Structures

There would be two grade control structures built in the compact bypass, designed as rock ramps per the *Rock Ramp Design Guidelines* (Reclamation 2007) and *Hydraulic Design of Flood Control Channels, EM 1110-2-1601* (Corps 1994). The most upstream grade control structure would be located immediately downstream of the Compact Bypass Control Structure. The second grade control structure would be located near the Columbia Canal siphon crossing (Figure 1). The siphon crossing would be located approximately underneath the second grade control structure so that the grade control structure would also serve to protect the siphon crossing. Each grade control structure would extend across the main channel and key into the overbanks to protect against flanking, resulting in a total structure width of about 220 feet. Each grade control structure would have approximately 0.4 feet of drop across it, with a maximum downstream slope of 0.04 feet, and be a minimum of 25 feet in length in the stream wise direction (Figure 3). Riprap, used to fill the structure, would be approximately 12 inches in diameter. Two filter layers would be constructed underneath the rock ramps, one of gravel and one of sand.

Bank protection measures would be incorporated into the bypass between the Compact Bypass Control Structure and the most downstream grade control structure, totaling about 500 linear feet of bank protection on either side of the compact bypass channel. Downstream of the grade control structures, no bank protection would be necessary after establishment of riparian vegetation. Bank protection measures could include: vegetated revetment, rock vanes, bioengineering techniques, and riparian vegetation. The vegetated revetment would consist of buried riprap, covered with topsoil, erosion control fabric, and native woody vegetation, so that fish would experience natural channel banks. Native woody vegetation directly upstream, downstream, and adjacent to the grade control structures would provide shading and habitat.

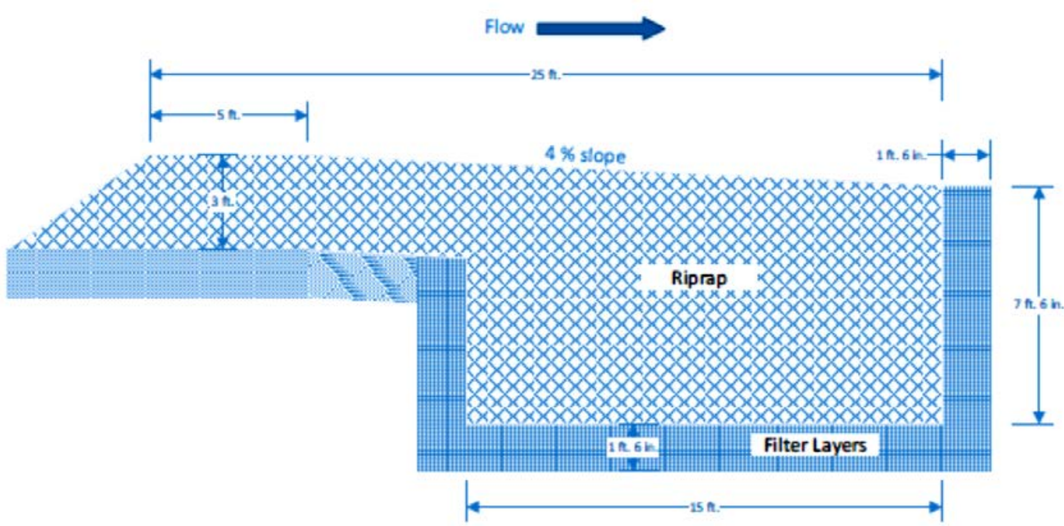

Figure 3. Conceptual profile of grade control rock ramps. (Pg. 2-11, Figure 8, Reclamation BA)

1.3.2.3 Compact Bypass Control Structure and Mendota Pool Control Structure

A bifurcation structure would be constructed at the upstream end of the compact bypass (Figure 1). The bifurcation structure consists of two control structures: one across the path of restoration flows, also known as the Compact Bypass Control Structure, and one across the path of water deliveries to Mendota Pool, also known as the Mendota Pool Control Structure. A fish screen directly in front of the Mendota Pool Control Structure would also be included, but constructed at a much later date than the other two structures (see section 1.3.5). The Compact Bypass Control Structure includes a fish passage facility on the downstream side of the structure for fish migration during deliveries to Mendota Pool.

Each control structure would be placed in the middle of the channel, perpendicular to the direction of flow and would have earthen embankments. The earthen embankments are designed as dams as they would have water both upstream and downstream and connect the structure to the proposed levees. Seepage cut off walls would be constructed within the south bypass levees (between the compact bypass and Mendota Pool), the levees adjacent to the Columbia Canal, and a small portion of the most southern levees. Seepage cut off walls consist of water, cement, and bentonite mixed together and piped into the levee. The seepage cut off walls would be installed using a big stick excavator, be approximately 3 feet wide and 28 feet deep; about 20 feet of the wall would be below ground, with the remaining 8 feet above ground within the levee. (For a more detailed description of levee construction please refer to the floodplain section of this document, section 1.3.3.5). On top of each control structure would be 16-foot-wide roadways and 20-foot-wide platforms for maintenance and operations.

Compact Bypass Control Structure

The Compact Bypass Control Structure would be designed to accommodate up to 4,500 cfs and consists of eight 14-foot-wide bays. Conditions in this control structure would be designed based on Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001) and Anadromous Salmonid Passage Facility Design (NMFS 2008) fish passage criteria. Each bay would be outfitted with a radial gate. The bays and radial gates would be constructed in the dry behind a soil plug, effectively disconnecting the river from the construction area. Machinery, equipment, and supplies would be staged nearby.

The radial gates would remain open except for two circumstances when water would be delivered from the San Joaquin River into Mendota Pool. The first delivery circumstance would be releases from Friant Dam to satisfy the Exchange Contractors. These can occur any time water deliveries from the Delta Mendota Canal cannot fulfil the Exchange Contractors agreement; but are only likely to occur in Critical Low or Critical High water years, when it is likely that there would be no restoration flows. The second situation would be flood flow deliveries to Mendota Pool of up to 2,500 cfs. Flood flows can be further split into precautionary releases and mandatory releases. Precautionary releases are to increase capacity of Millerton Lake in anticipation of expected runoff. Mandatory releases occur when Millerton Lake is at or near capacity (Reclamation 2016) .

When water deliveries to Mendota Pool occur, most of the gates of the Compact Bypass Control Structure would be shut nearly all the way (the amount of gates shut would depend on routing decisions for Arroyo Canal's (downstream of the proposed action) portion of water and/or flood operations). The water surface elevation would then be increased by 10-12 feet on the upstream side of the structure. Once the proper water elevation is reached, the gates of the Mendota Pool Control Structure would open and water would be delivered to Mendota Pool. Fish passage and restoration flows would primarily pass through the fish passage facility on the northern side of the Compact Bypass Control Structure. Any water passing through the Compact Bypass Control Structure would likely be forced through a partially opened radial gate creating a hydraulic jump. To allow for the hydraulic jump to dissipate and not undermine the structure a stilling basin has been included in the design of the structure.

Compact Bypass Fish Passage Facility

The Compact Bypass Control Structure includes a fish passage facility on the northern side of the structure. The fish passage facility would be necessary to provide fish passage during water deliveries to Mendota Pool. The current design for the fish passage facility is a vertical slot ladder with a sloped bottom, a roughly 12 horizontal to 1 vertical slope (12H:1V), 12 feet of drop, and approximately 3 feet of flow depth. Fish would only pass through this facility when deliveries are occurring to Mendota Pool, approximately 5 percent of the time when fish could be present (Reclamation 2016). The fish passage facility opening would be aligned so that when water is backed up behind the Compact Bypass Control Structure 10-12 feet it would be wetted. Unless water is being delivered into Mendota Pool, the upstream entrance of the fish ladder would be far above the normal river water level, making it inaccessible, as well as, unnecessary, for fish passage.

Mendota Pool Control Structure.

The control structure across the old San Joaquin River channel (the path of the water deliveries) would be designed to accommodate deliveries of up to 2,500 cfs. The structure would have twelve bays that are 10 feet wide, and would contain slide gates to control the flow of water rather than radial gates, since Mendota Pool would be impounded on the downstream side of the structure at all times. Guides for stop logs would be provided in all bays to allow for maintenance. A 5-foot barrier wall can be added to the upstream side of the structure to allow continued operation with anticipated subsidence rates.

1.3.2.4 Operations of the Compact Bypass Channel

The purpose of this proposed action is to route restoration flows around Mendota Pool instead of through Mendota Pool. During the majority of hydrological conditions the radial gates of the compact bypass would be fully open allowing flows and fish to pass by Mendota pool unassisted and unencumbered. There are three conditions where water can be delivered into Mendota Pool: precautionary flood flows, mandatory flood flows, and Exchange Contractor flows.

Precautionary flood flows occur every 3.5-3.9 years on average, mostly happen in February and March, and tend to occur in all water year types except Critical-Low. Mandatory flood flows occur every 4 years on average and typically occur in June or July but can happen May through August in extreme cases. Mandatory flows only occur during Wet and Normal-Wet years. Exchange Contractor flows have occurred three times in the history of Friant Dam (2014, 2015, and 2016). The 2014 and 2015 Exchange Contractor deliveries lasted from May to August and were Critical- Low water years. It is likely that in Critical-Low water years, some reaches of the river would be dry and there would be no restoration flows or fish passage. The 2016 Exchange Contractor delivery lasted from July 20th to August 8th. Because 2016 was a Normal-Dry year an Exchange Contractor delivery was unexpected and likely an anomaly. The 2016 release was caused by a combination of pumping restrictions in the Delta and water exchanges of the previous year.

The model used by Reclamation predicted that the most common type of deliveries to Mendota Pool would be from precautionary flood releases, but the predictions made by the model are likely overestimated (Reclamation 2016). The model was not able to capture and reflect the ability of the Restoration Administrator to work with Reclamation to adjust restoration flows to account for water that needs to be released from Friant.

Climate change modeling indicates that rising air temperatures in the San Joaquin River valley will likely impact both the timing of river flows due to changes in rainfall patterns and water temperature (Reclamation 2016a). Decreasing rainfall would result in lower snowpack in the mountains above Friant Dam would result in less spring and summer runoff into Millerton Reservoir. In addition, increases in water temperature within Reach 2B are likely over time but the timing and degree of change is uncertain (Reclamation 2015). Due to the uncertainty related to climate change modeling, it is difficult to predict how the shift in water runoff patterns and increase in water temperatures would impact the operational capacity of the compact bypass system overtime.

1.3.3 Reach 2B Grading, Levees, and Floodplain Project Descriptions

Improvements to Reach 2B would include modifications to the San Joaquin River channel from the Chowchilla Bypass Bifurcation Structure to the Compact Bypass Bifurcation Structure to provide a capacity of at least 4,500 cfs, with integrated floodplain habitat. New levees would be constructed along Reach 2B to increase the channel capacity while allowing for new floodplain habitat.

This portion of the proposed action includes building set-back levees capable of conveying flows up to 4,500 cfs with 3 feet of freeboard. The new floodplain would have an average width of approximately 4,200 feet to provide benefit to salmonids and other native fishes. This would involve relocating, removing, or floodproofing existing infrastructure in the future floodplain; creating or improving construction access routes; grading the floodplain and channel; breaching portions of the existing levees; erecting new set-back levees, and restoring floodplain habitat.

1.3.3.1 Relocating, Removing, or Floodproofing Existing Infrastructure within Floodplain Area

Existing infrastructure (Figure 4) such as road crossings, groundwater wells, pumps, electrical and gas distribution lines, water pipelines, and canals located in the proposed action area would require relocation, retrofitting, or floodproofing to protect the structures from future restoration flows and increased floodplain area. Floodproofing could include extending the levees, raising the ground surface, and construction of a sheet pile wall or slurry wall. Although the relocations, retrofits, and floodproofing are included as part of the proposed action, the actual relocation, retrofit, or floodproofing work may be performed by others. As a result of the proposed action, some existing infrastructure may be unnecessary in the future (e.g., power lines that service pumps relocated to outside the proposed action area). In these cases, infrastructure may be demolished or abandoned in place.

Specific plans for relocations, where known, are identified below:

San Mateo Avenue Crossing Removal

The San Mateo Avenue crossing is an existing river crossing located within a public right-of-way in Madera County and on private land in Fresno County at approximately RM 211.8. The crossing transitions from public right-of-way to private land at the center of the river. The crossing consists of a low flow or dip crossing with a single culvert. As part of the proposed action, the culvert and road embankments would be removed and no river crossing would be provided at this location. This part of the proposed action removes a structure that is a barrier to anadromous fish migration at certain flows.

Electrical and Gas Distribution

Approximately 48,500 feet of electrical distribution lines and 11,000 feet of gas distribution lines were identified for possible relocation. Information from Pacific Gas & Electric was available for portions of the area in Geographic Information System (GIS) shapefile format and was supplemented by field data. At the current level of design, it was assumed that a portion of the existing electrical and gas distribution lines found within the proposed action area would need to be replaced and/or excavated and buried lower in the soil column. Three gas pipelines are buried under the San Joaquin River in this reach. They would need to be re-buried deeper or floodproofed. This may involve trenching and excavation along the pipeline length, within and outside of the future floodplain area, to re-bury it deeper in the soil column below any potential impacts from floodplain grading.

Canals and Drains

Approximately 31,500 feet of canals were identified for possible relocation. On-farm canals and drains visible on the LiDAR imagery (CVFED 2009) and identified during on-site field meetings with landowners were quantified. No canals or drains outside the proposed action footprint have yet been identified for redesign. Some portions of canals and drains could be discontinued in the future; the extent of discontinued and replaced canals would be considered during landowner negotiations. No subsurface drains were able to be quantified; however, some are believed to exist within the area.

Lift Pumps

Ten lift pumps were identified for possible relocation. Lift pumps visible on the LiDAR imagery (CVFED 2009) or noted in the CalFish Passage Assessment Database (CalFish 2014) were assumed to require relocation to new facilities on the edge of the proposed levees. A pilot channel dug from the low flow river channel to the intake of the relocated pumps was also assumed. Locations in the CalFish Passage Assessment database were confirmed using the LiDAR imagery when possible.

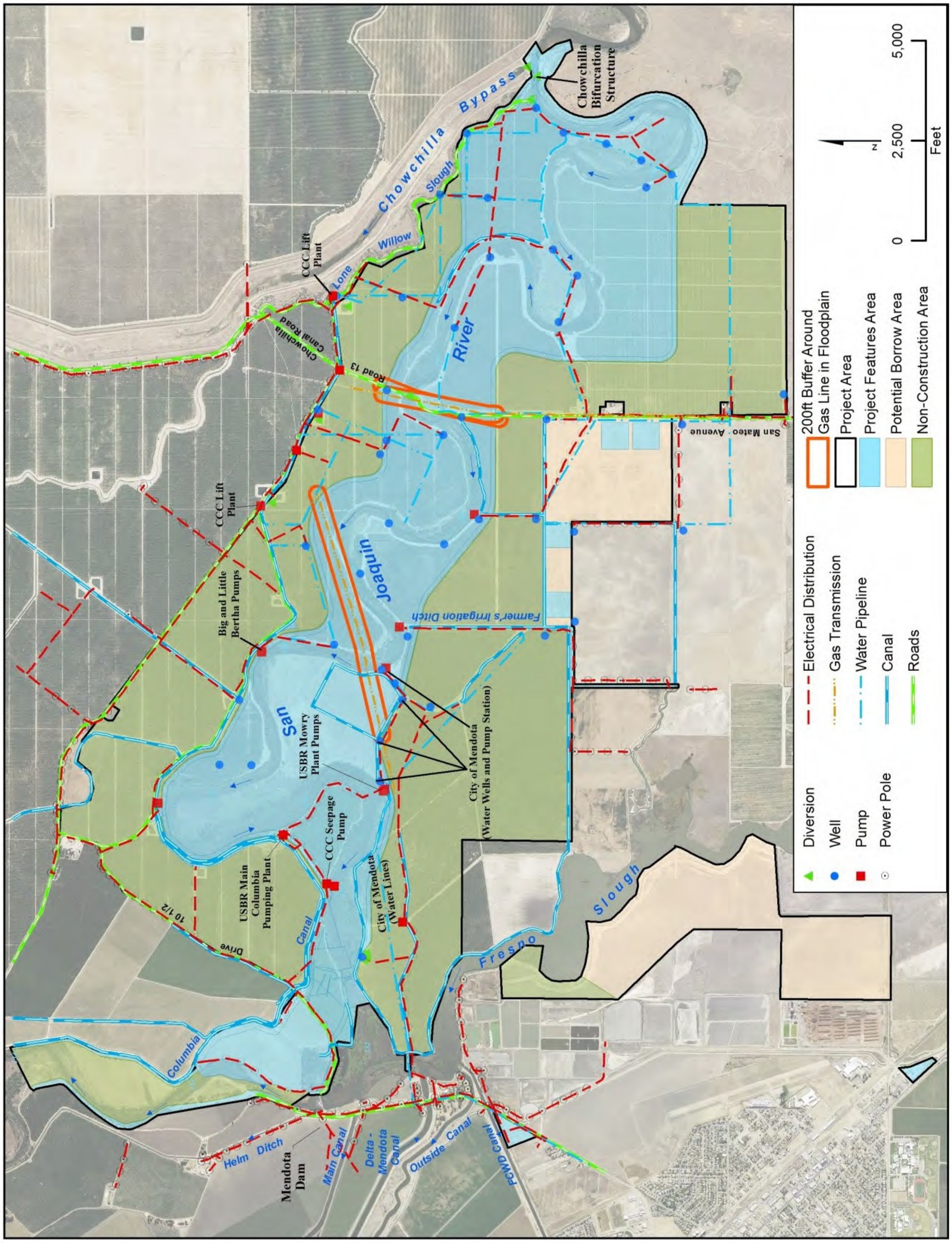

Figure 4. Existing Infrastructure in the proposed action area. (Pg. 2-29, Figure 12, Reclamation BA)

Groundwater Wells

Thirty-two groundwater wells were identified for possible floodproofing or relocation, including the city of Mendota groundwater wells. Wells were identified within the area using aerial photography. During design, the California Department of Water Resources (DWR) wells database would be consulted to find abandoned wells that have not been destroyed, so that these old wells could be filled in to prevent a flood water conduit to the groundwater. A formal well canvas would also be conducted. Flood proofed wells would be provided with year-round vehicular access via a raised roadbed across the floodplain. The roadbed could include multiple culverts to support floodplain connectivity, depending on the length of the access road and its effect on floodplain flows. Relocated wells would provide equal utility. Wells taken out of service by the proposed action would be abandoned in accordance with U.S. Environmental Protection Agency, DWR and/or local regulations.

The levee alignment has been designed so that two of the city of Mendota's three groundwater wells would be outside of the levees and floodplain area, and unaffected by the proposed action. The remaining well is inside the levee and right next to the river, and would be floodproofed. The set-back levee would be extended around the groundwater well to allow access and prevent flooding.

Regulating Reservoirs

A number of irrigation regulating reservoirs were identified for possible relocation. Reservoirs were assumed to be a typical size, contain one lift pump, and half of the reservoir located below the surrounding grade and half above the surrounding grade.

Oil and Gas Wells

Two closed or active oil and gas wells have been identified within the proposed action area for potential closure, relocation, or buyout. If active oil and gas wells cannot be avoided, the destruction or closure of those wells would be conducted in accordance with the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources regulations.

Other Utilities

Other infrastructure was identified within the impacted areas. These other facilities include high voltage transmission lines and water pipelines. High voltage transmission lines are assumed to be high enough to not be impacted. Water pipelines were quantified from existing maps and discussions with landowners. Water pipelines may be relocated or abandoned depending on their future use requirements. The city of Mendota has a water pipeline from their three groundwater wells that crosses Mowry Bridge. This pipeline may need to be modified as the set-back levee would cross it, and Mowry Bridge would likely need replacement for construction access. Service line crossings (e.g., gas, water, electrical) would be considered during levee design.

1.3.3.2 Construction Access

Access for vehicles carrying materials, equipment, and personnel to and from the construction area would be provided via several existing roadways in the proposed action vicinity (Figure 5). Improvements may be required to upgrade roadways, pavements, and crossings for anticipated construction traffic and loads, provide adequate turning radii and site distances, and to control dust on non-paved roads. Anticipated improvements include:

- Eastside Drive – Approximately 0.6 mile of dirt road starting at Road 10 ½ would likely require overlaying, and the implementation of dust control measures.
- Chowchilla Canal Road/Road 13 – Approximately 0.3 mile of road starting at Eastside Drive would likely require some overlaying and the implementation of dust control measures.
- San Mateo Avenue – Approximately 0.5 mile of gravel and 1.5 miles of oil-dirt road starting at the existing San Joaquin River levees would likely require some overlying and the implementation of dust control measures.
- Bass Avenue Canal Crossings – These crossings may need additional bracing and shoring to ensure that they would be able to support the load of the construction equipment and activities. All the construction equipment on Bass Avenue would be within the legal loads (see note below). This crossing is on the Fresno County replacement list.
- Delta-Mendota Canal Crossing – This crossing may need additional bracing and supports to ensure that it would be able to support the load of the construction equipment activities.
- Mowry Bridge – This bridge would need replacement as it is currently condemned due to beaver activity. It would provide convenient access to the site of the Mendota Pool control structure.

Dust control measures for non-paved roads would include the use of water trucks or dust palliative for dust control or gravel placement where necessary. Legal loads would be used on all roads, and once construction is completed, the roads would be returned to the same condition as they were prior to the proposed action.

Areas temporarily disturbed during construction would be restored to their previous contours, if feasible, and then seeded with a native vegetation seed mixture to prevent soil erosion. Some areas, such as borrow areas, may not be feasible to restore previous contours, but these areas would be smoothed and seeded. Staging and borrow areas would occur on annual cropland or land purchased for the proposed action and not on permanent cropland outside of the proposed action levees.

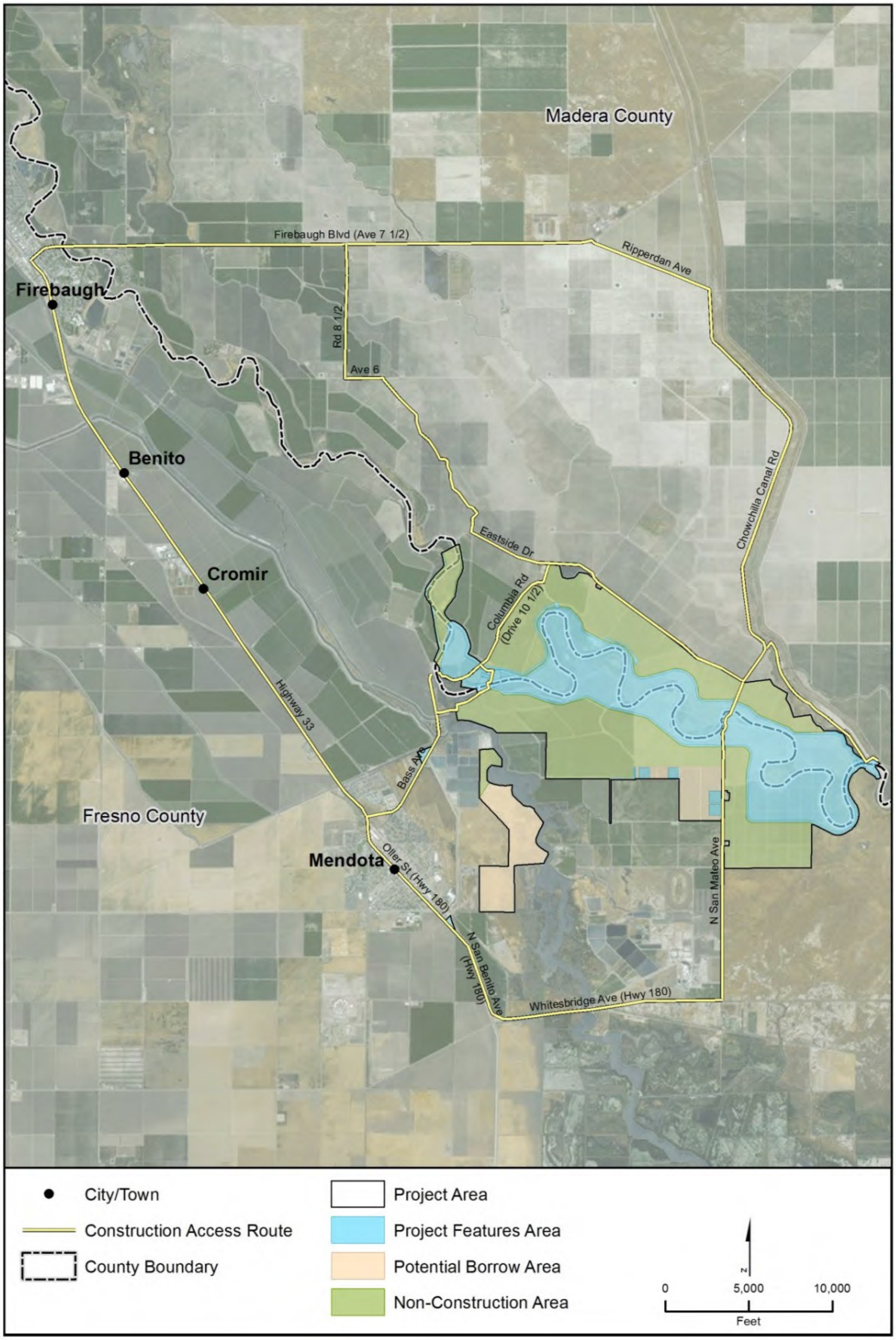

Figure 5. Construction Access Routes. (Pg. 2-32, Figure 13, Reclamation BA)

1.3.3.3 Floodplain and Channel Grading

Floodplain creation is part of step 3 of the proposed action. The purpose of creating floodplain would be to provide riparian and floodplain habitat and support the migration and seasonal rearing of salmonids and other native fishes in Reach 2B. At 2,500 cfs, the proposed floodplain has an average width of approximately 4,200 feet and an inundated area of approximately 1,000 acres.

The proposed action would provide floodplain habitat resulting in approximately 440 acres of shallow water habitat for primary production as well as approximately 560 acres of habitat that supports direct rearing of juvenile salmonids at 2,500 cfs. Approximately 44 percent of the floodplain would inundate less than 1 foot deep at 2,500 cfs. The proposed action also would create approximately 650 acres of shallow water habitat at flows of 4,500 cfs. In order to create functional floodplain habitat, floodplain and channel grading would include any or all of the following at locations to be determined during design:

- Creating high-flow channels through the floodplain to increase the inundation extent at lower flows.
- Connecting low-lying areas on the floodplain to the river to prevent stranding.
- Removing high areas where flow connectivity would be impeded (e.g., farm road grades).
- Excavating floodplain benches adjacent to the river channel to increase the frequency of inundation.
- Creating greater inundation depth diversity on the floodplain.
- Excavating channels in portions of the proposed action area to tie into existing elevations upstream and downstream of the proposed action or to create desirable sediment transport conditions.

Figures 6 and 7 provide an example of how various floodplain grading approaches can be used to expand inundation on the floodplain. The “existing channel” graphic shows an example of how inundation would occur without floodplain grading. The “lowered floodplain” example show floodplain benches and lowered areas to either side of the channel, could be used to inundate floodplain areas at lesser flows. This graphic also shows how lowered floodplains could affect inundation at moderate flows. The “high flow channels” graphic shows an example of how high flow channels, side channels that initiate at larger flows than the main channel, could be used to expand floodplain inundation.

Channel Bank Protection

The proposed action could include riparian vegetation, rock vanes, woody materials, revetment, or other measures designed to protect channel banks from erosion. Bank protection measures would be installed in locations susceptible to and likely to experience bank erosion.

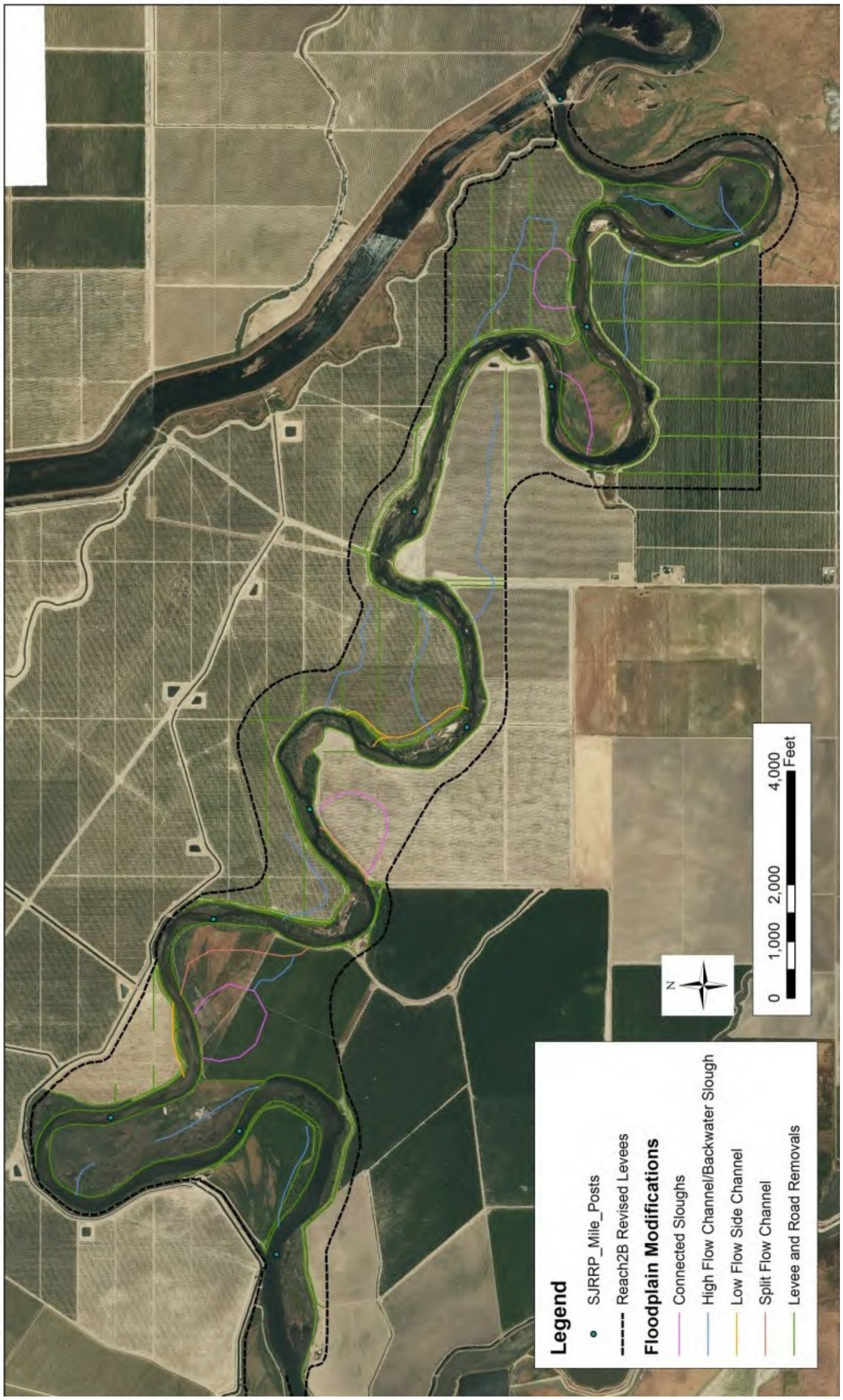

Figure 6. Example Floodplain Grading Approach – Plan View. (Pg. 2-25, Figure 10, Reclamation BA)

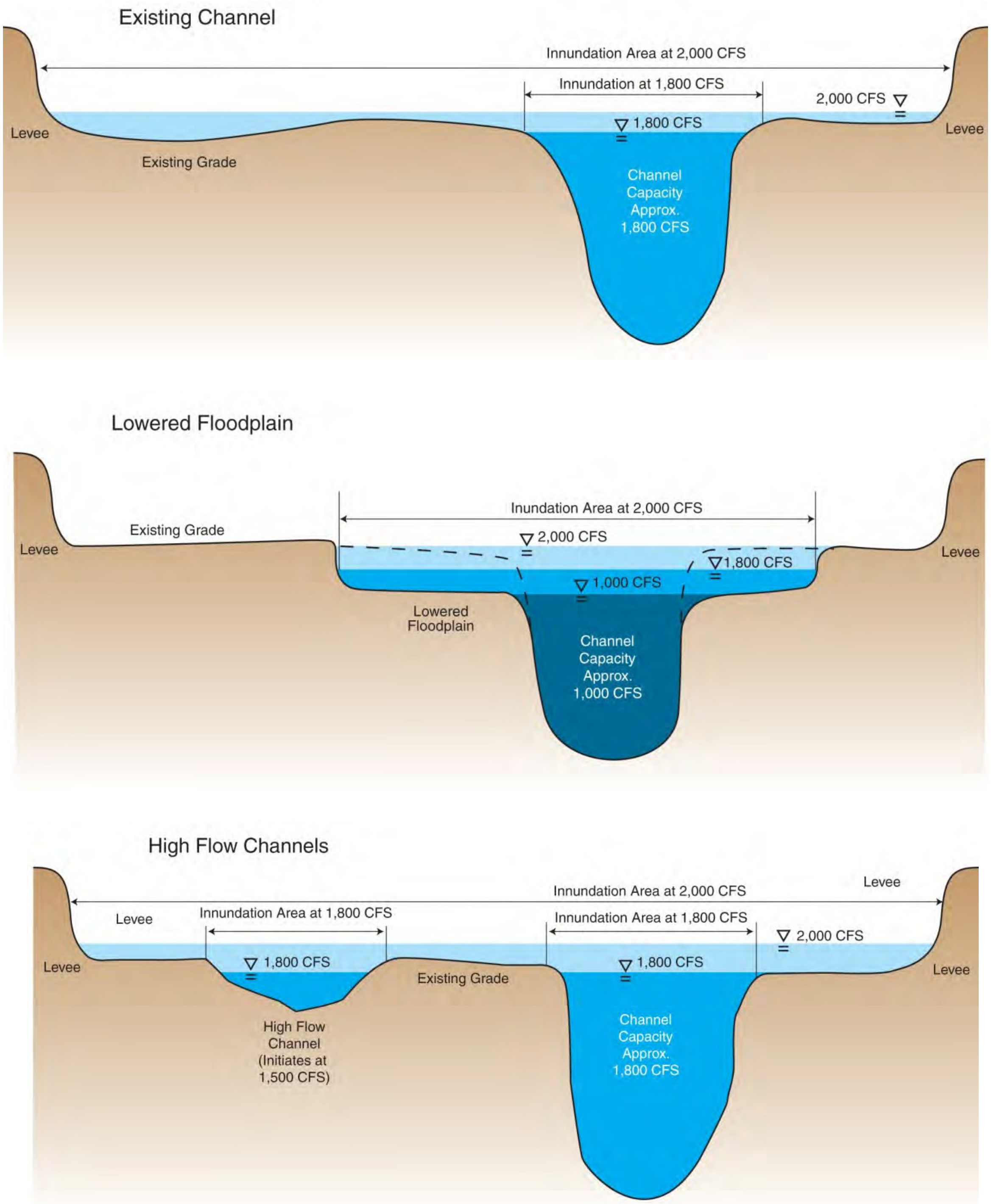

Figure 7. Example Floodplain Grading Approaches – Cross Section. (Pg. 2-26, Figure 11, Reclamation BA)

1.3.3.4 Breaching and Removal of Existing Levees

Removal of portions of the existing levees is included and designed to expand the inundation area of the floodplain out to the proposed levees and improve connectivity between the river channel and proposed floodplain. The locations of existing levee removal would be based upon the hydraulic performance of the channel and floodplain. In certain locations, however, highly desirable existing vegetation (native and sensitive vegetation communities that can serve as seed banks for future vegetation communities) can be found on the existing levees. Where hydraulic performance and connectivity of the floodplain would not be negatively affected, portions of the existing levees with highly desirable vegetation would remain in place. Materials that are removed from the existing levees would likely be reused within the proposed action area.

1.3.3.5 Levee Construction

Set-back levees would be required along the length of the proposed action area to contain restoration flows. While the height and footprint of the levees vary according to their location along the channel and the ground elevation, the capacity, freeboard, and cross-section would be consistent. Localized backwater and redirection effects at proposed action structures would be considered during design of levee heights. Levees would be designed to maintain at least 3 feet of freeboard on the levees at 4,500 cfs. Levee design would be based on the U.S. Army Corps of Engineers (Corps) *Engineer Manual 1110-2-1913-Design and Construction of Levees* guidelines (Corps 2000) and *Engineer Technical Letter 1110-2- 583 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams and Appurtenant Structures* (Corps 2014). The design includes seepage control measures, maintenance roads, and inspection and drainage trenches to direct off-site drainage where required.

Levee alignments maintain a 300-foot buffer zone, where appropriate, between the levee and river channel to avoid impact to levees over time due to potential channel migration. In areas where a minimum 300-foot buffer zone between the main river channel and levee cannot be maintained, bank revetment would be incorporated in the design.

New levees would be designed to have side-slopes of 3 horizontal to 1 vertical (3H:1V) on the waterside and landside. A maintenance road and surface drainage ditch would also be included. Surface drainage ditches would only be intended to capture and direct runoff; they are not intended to address groundwater seepage (i.e., water going underneath the levee) or through-levee seepage (i.e., water going through the levee). By following the Corps standards, levees would either have a seepage cutoff wall or would have an inspection trench. Seepage cutoff walls would be constructed on levee segments on the north bypass, south bypass, and north Reach 2B levees to the high point of the Columbia Canal to inhibit groundwater seepage and through-levee seepage during a flood event.

Seepage cutoff walls would be composed of water, cement, and bentonite mixed together before being piped to levee segments using a big stick excavator to install a 3-foot-wide and approximately 28-foot-tall slurry wall. The slurry wall would be 8 feet above the ground and 20 feet below the ground. The above-ground portion would be composed of 3 feet of freeboard and 5 feet of subsidence bentonite slurry cutoff wall. The below-ground portion would include a 15- to 20-foot-tall bentonite slurry cutoff wall.

The levee alignments shown on the plan views of the proposed action may be adjusted during final design (Figure 9). Adjustments may be made for several reasons, including to improve flow conditions on the floodplain, to improve habitat conditions on the floodplain, to reduce potential erosion, to accommodate adverse soil conditions, and to avoid existing infrastructure among others. The final levee alignments would be within the impact areas evaluated in this document.

Seepage Control Measures

Seepage of river water through or under levees is a concern for levee integrity and adjacent land uses. Through-seepage, water that seeps laterally through the levee section, would be addressed through proper levee design and construction (e.g., selection of low porosity materials and proper compaction). Under-seepage, water that seeps laterally by travelling under the levee section, is primarily controlled by the native soils beneath the levee; seepage control measures would be included where native soils do not provide sufficient control. Seepage control measures would be included, as necessary, in the proposed action in areas where under-seepage is likely to affect adjacent land uses. Seepage control measures could include: cut-off walls, interceptor drains or ditches, seepage wells, seepage berms, seepage easements and other measures that can be implemented within the proposed action area.

Levee and Structure Protection

The proposed action generally provides a minimum 300-foot buffer between the existing channel and the proposed levee, where appropriate and feasible. For locations where the 300-foot buffer was not included, erosion protection for the levee in the form of revetment would be included. The revetment would be riprap material covered by soil and then planted to provide a vegetated surface. However, softer approaches, such as bioengineering or dense planting, may be considered during design depending on velocities and scour potential.

Locations that require revetment include areas where the 300-foot buffer was not included due to the proximity of existing infrastructure, near the proposed structures, and along river bends less than 300 feet from the levee in areas that have the potential to erode, as determined in the design process.

1.3.3.6 Floodplain Construction

The proposed action includes a mixture of active and passive riparian and floodplain habitat restoration and compatible agricultural activities in the floodplain. Active restoration planting of native riparian species would occur along both banks of the low flow channel of the river up to 450 feet from the bank, and would be irrigated with a planting density of approximately 545 plants per acre. The native species selected would provide shade and reduce air temperatures to help minimize water temperatures, provide large woody debris and organic matter needed to provide habitat and food, and help stabilize the low-flow channel. The irrigated area would include 16-foot spacing between irrigation lines for equipment access and 5-foot spacing along irrigation lines to maximize density. Forbs and grasses would be planted as plugs or transplants in-between irrigation lines in order to encourage structural diversity. Some areas may be passively revegetated by creating riparian establishment areas that provide a riparian seed bank of native species. The remaining areas would be seeded with native grasses and forbs to minimize erosion and to help control invasive species. These upland areas would be broadcast seeded or drilled with incorporation, as necessary.

Active revegetation activities would likely include a combination of seeding, transplanting, and pole/live stake plantings. Plantings may be designed as either clusters of trees and shrubs with larger areas of seeded grasses and forbs or as dense forests. Spacing and alignment of plantings would take into account species growth patterns, potential equipment access needs for monitoring and maintenance, and desired future stand development.

Passive restoration would occur in areas that rely on restoration flows for additional vegetation recruitment. Natural riparian recruitment (passive restoration) would promote continual habitat succession, particularly in areas where sediment is deposited or vegetation is removed by natural processes. Table 1 lists the species that are likely to be planted or seeded during active restoration, and is draft and subject to change. Emergent wetlands and water tolerant woody species of riparian scrub would be selected for development within the main channel, woody shrubs and trees with an herbaceous understory would be selected for development along the main river channel banks, and bands of other habitat types (e.g., grasses) would be selected for development at higher elevations along the channel corridor. Active vegetation restoration would occur following construction and these areas would be irrigated and managed as necessary during the establishment period.

Phased implementation of active vegetation restoration at strategic locations could occur concurrently with phased implementation of construction and physical infrastructure. Agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) could occur on the floodplain in previous agricultural areas outside of State-owned and public trust lands. Growers would be required to leave cover on the ground and would be required to develop and implement a Water Quality Plan, approved by Reclamation, to meet current water quality standards for aquatic resources and coldwater fisheries, as well as meeting the specific needs for anadromous fishes in adjacent and downstream areas. If grazing occurs the lessee would be required to develop and implement a Grazing Plan, to be approved by Reclamation, in addition to the Water Quality Plan.

Table 1.
Potential Species for Revegetation

Common Name	**Scientific Name**	**Vegetation Type**
Riparian Shrub and Wetland Areas (0 to 2 feet above summer baseflow elevations)		
Fremont cottonwood	*Populus fremontii*	Tree
Gooding's willow	*Salix gooddingii*	Tree
box elder	*Acer negundo*	Tree
Oregon ash	*Fraxinus latifolia*	Tree
red willow	*Salix laevigata*	Tree
yerba mansa	*Anemopsis californica*	Forb
common buttonbrush	*Cephalanthus occidentalis*	Shrub
baltic rush	*Juncus balticus*	Tule
California blackberry	*Rubus ursinus*	Shrub
sandbar willow	*Salix exigua*	Shrub
arroyo willow	*Salix lasiolepis*	Shrub
shining willow	*Salix lucida* ssp. *Lasiandra*	Tree
blue elderberry	*Sambucus nigra* ssp. *caerulea*	Shrub
meadow barley	*Hordeum brachyantherum*	Grass
Creeping wildrye	*Elymus triticoides*	Grass
dwarf barley	*Hordeum depressum*	Grass
Douglas' sagewort	*Artemisia douglasiana*	Forb
Great Valley gumweed	*Grindelia camporum*	Forb
Western goldenrod	*Euthamia occidentalis*	Forb
meadow barley	*Hordeum brachyantherum*	Grass
Creeping wildrye	*Elymus triticoides*	Grass
dwarf barley	*Hordeum depressum*	Grass
Dense Riparian Areas (2 to 8 feet above summer baseflow elevations)		
meadow barley	*Hordeum brachyantherum*	Grass
Creeping wildrye	*Elymus triticoides*	Grass
dwarf barley	*Hordeum depressum*	Grass
Douglas' sagewort	*Artemisia douglasiana*	Forb
Great Valley gumweed	*Grindelia camporum*	Forb
Western goldenrod	*Euthamia occidentalis*	Forb
meadow barley	*Hordeum brachyantherum*	Grass
creeping wildrye	*Elymus triticoides*	Grass
red willow	*Salix laevigata*	Tree
shining willow	*Salix lasiandra* var. *lasiandra*	Tree
arroyo willow	*Salix lasiolepis*	Shrub
box elder	*Acer negundo*	Tree
narrow-leafed milkweed	*Asclepias fascicularis*	Herb
coyote brush	*Baccharis pilularis*	Shrub
Buttonbush	*Cephalanthus occidentalis*	Shrub
blue wildrye	*Elymus glaucus*	Grass
valley oak	*Quercus lobata*	Tree
golden currant	*Ribes aureum*	Shrub
California wildrose	*Rosa californica*	Shrub
California blackberry	*Rubus ursinus*	Shrub

Table 1. (Cont.)
Potential Species for Revegetation

Common Name	Scientific Name	Vegetation Type
Gooding's willow	*Salix gooddingii*	Tree
blue elderberry	*Sambucus nigra* ssp. *caerulea*	Shrub
Upland Areas (greater than 8 feet above summer baseflow elevations)		
creeping wildrye	*Elymus triticoides*	Grass
California wildrose	*Rosa californica*	shrub
narrow-leafed milkweed	*Asclepias fascicularis*	Forb
valley oak	*Quercus lobata*	Tree
golden currant	*Ribes aureum*	shrub
quail bush	*Atriplex lentiformis*	Forb
western goldenrod	*Euthamia occidentalis*	Forb
small fescue	*Festuca microstachys*	Grass
purple needlegrass	*Stipa pulchra*	Grass
Yarrow	*Achillea millefolium*	Forb
Spanish lotus	*Acmispon americanus* var. *americanus*	Forb
Great Valley gumweed	*Grindelia camporum*	Forb
telegraph weed	*Heterotheca grandiflora*	Forb
tomcat clover	*Trifolium willdenovii*	Forb

Existing Native Vegetation Protection

The existing native vegetation in the proposed action area designated to remain would be temporarily fenced with orange snow fencing (or equivalent) to prevent entry, driving, parking, or storing equipment or material within these areas during construction. Existing vegetation would be left in place or only minimally trimmed to facilitate access and work at the site. The existing soil is an ideal growing medium for all the desired native plants. In order to maximize plant growth and planting success, existing soil and topsoil would be preserved, and in areas where excavation is required, would be stockpiled to later place on top of the excavated bypass channel for planting. If the soil contains invasive non-native seed or fragmented stems and rhizomes, it would not be preserved. Disturbance during construction to existing vegetation would be minimized to the maximum practicable extent.

Invasive Species Control

Invasive, non-native species would be removed from the proposed action area during the installation, plant establishment and maintenance periods. Invasive species management would consist of removal of the most invasive non-native species within the reach such as giant reed grass (*Arundo donax*), perennial pepperweed (*Lepidium latifolium*) and poison hemlock (*Conium maculatum*). Invasive species management would also include removal of other invasive species that are currently found in upstream reaches and may eventually colonize in the proposed action area such as red sesbania (*Sesbania punicea*), salt cedar (*Tamarix species*), and Chinese tallow (*Sapium sebiferum*). Invasive plant removal techniques may include mechanical removal, root excavation, hand pulling, mowing, disking, controlled burning, grazing, aquatic-safe herbicides, or a combination of techniques as appropriate.

The SJRRP has an existing invasive species management plan, and completed the Invasive Vegetation Monitoring and Management Environmental Assessment in 2012 that describes the methods that would be followed for Reach 2B invasive species removal. Details are provided in Section 2.2 of the Environmental Assessment (SJRRP 2012a).

Temporary Irrigation System and Water Supply

Proposed plantings that are wetland species or borderline wetland species would need regular aboveground irrigation (typically April through October) during their establishment period (typically 3 to 5 years depending on rainfall conditions and the plants' growth rates and vigor). An extensive temporary aboveground irrigation system, such as aerial spray, would provide water for the plants several times a week during the hot months of the year. If an aerial spray irrigation system is installed, the irrigation distribution piping would be installed aboveground and anchored to the ground so that it would not be damaged during high flows inundating the floodplain. If an aerial spray system is used, sprinkler heads would likely be installed on braced standpipes so that their irrigation stream would not be blocked or diverted by growing vegetation. The irrigation system would be disassembled and removed at the end of the establishment period.

The SJRRP would pursue options for irrigation water supply, including groundwater wells or water pumped from the river with portable, skid-mounted, diesel- or gas- powered pumps and stored in tanks. Additionally, purchases from willing sellers may be required to withdraw water from the river or other nearby water sources (e.g., Mendota Pool). If water is pumped from the river, the amount of water diverted would be controlled so that river water temperatures do not increase and passage for salmonids is not impaired. The diversion from the river would also be screened if necessary to prevent entraining juvenile salmonids.

1.3.3.7 Floodplain and Levees Operations and Maintenance

Floodplain Vegetation Maintenance and Monitoring

Floodplain maintenance includes vegetation management for invasive species, periodic floodplain and channel shaping to retain capacity and prevent fish stranding, and other floodplain maintenance activities such as debris removal and repair of channel banks and bank protection measures.

Maintenance and monitoring would be conducted following revegetation for 10 years, yearly for the first 3 years, every other year until year 7, and a final assessment at year 10. Monitoring activities include monitoring of the installed plants for drought stress and overwatering, identification of competitive, invasive, non-native species for removal, identification of diseased, dead and washed-out plants, irrigation system function, and identification of trash and debris for removal. Maintenance activities would include controlling invasive plant species, mitigating animal damage, irrigation, replacement of diseased, dead, or washed-out plants, irrigation system maintenance, and removal of trash and debris. Management of invasive species would ensure that the desirable vegetation dominates the landscape and provides habitat diversity, productivity, and sustainability. Animal damage to newly planted or germinated vegetation could be alleviated with screens, aquatic-safe chemical deterrents, or other exclusion methods.

Temporary irrigation of wetland and riparian areas during establishment, especially if precipitation is below normal, would facilitate root system development into the alluvium groundwater. Irrigation infrastructure would need to be installed and remain in place for at least 3 years. The irrigation system would be used each year on a biweekly to daily basis during the hot part of the growing season. The landscape contractor would be required to regularly check the integrity of the system and make sure that system is not clogged or damaged. Upland areas would be seeded in the fall before the winter precipitation season, and it is likely that these areas would become established to an acceptable level after one season of normal precipitation. There may be more than one active revegetation effort required to establish a dense riparian corridor necessary to naturally stabilize the compact bypass channel. Removal of trash and debris from the restoration areas on both sides of the river would be performed on an as-needed basis for the duration of the entire monitoring period.

Long-Term Management

While it is not anticipated that major management actions would be needed, the key objective of management would be to monitor and identify any environmental issues that arise, and use adaptive management to determine what actions would be most appropriate to correct these issues.

The general management approach to the long-term maintenance of the floodplain areas would be to maintain quality habitat for each natural resource, with on-going monitoring and maintenance of key environmental characteristics of the entire floodplain area within the reach. An adaptive management approach would be used to incorporate changes to management practices, including corrective actions as determined to be appropriate by Reclamation and/or the California State Lands Commission. Adaptive management includes those activities necessary to address the effects of climate change, fire, flood, or other natural events, force majeure, etc.

The expected long-term management needs (and activities necessary to maintain any on- site mitigation sites) would be:

- Resource specific long-term maintenance activities and other general maintenance activities such as exotic species elimination, grazing management, clean-up and trash removal
- Infrastructure management such as gate, fence, road, culvert, signage and drainage-feature repair
- Other maintenance activities necessary to maintain the riparian and floodplain habitat quality

These activities are expected to continue for the foreseeable future.

Levee Maintenance and Monitoring

Levees would require maintenance for vegetation management, access roads, levee inspections, levee restoration, rodent control, minor structures, encroachment removal, levee patrolling during flood events, and equipment. Levee vegetation management includes equipment to drag or mow the levee banks or aquatic-safe herbicide applications. Maintenance of access roads includes replacing gravel or scraping and filling of ruts to keep the roads in good condition. Levee restoration includes restoring areas with erosion or settlement problems or adding armor. Rodent control includes setting traps with bait and periodically checking the traps. Minor structures maintenance includes repair or replacement of gates, locks or fences. Encroachment removal involves removing illegally dumped materials.

Seepage control measure maintenance is dependent on the type of measures implemented but could include activities such as periodic sediment removal and channel re-shaping for interceptor ditches, cleaning or flushing of interceptor drains, repair and replacement of pump parts for seepage wells and lift pumps, and vegetation management, berm restoration, and rodent control for seepage berms. If 15-foot-deep slurry walls are constructed at all setback levees, as expected in the compact bypass area, maintenance efforts associated with the seepage control measure is expected to be minimal.

Levee and structure protection maintenance includes repair and restoration of protection measures due to erosion or degradation and vegetation management.

Maintenance Schedule

Maintenance of levees and floodplains with aquatic-safe herbicide treatment would occur sometime between spring and fall and would depend on the plant species that are being treated. Typically the herbicide would be administered prior to the plant going to seed and may need to be sprayed more than once. Disking for vegetation management usually occurs twice within the year; once in early spring after the rainfall season and then again in late summer prior to plants going to seed. Access road and levee restoration work would likely be done in the summer after the rainfall season, and timing and projects would be dependent on environmental clearance for small mammals, nesting birds or burrowing owls, and other wildlife species. Rodent control would likely be done by a pest control advisor and would likely be done in the spring through fall and not during the rainfall season. All levee and floodplain work can be impacted by the presence of nesting birds, so in some areas work may not begin until the nesting birds have fledged or if there is some other biological reason to believe that the maintenance activities would not impact the nesting birds.

1.3.4 Fish Passage Facility on the San Joaquin River Control Structure at the Chowchilla Bifurcation Structure

In flood conditions the Chowchilla Bifurcation Structure could divert San Joaquin River flows from Reach 2A into the Chowchilla Bypass, instead of or in conjunction with, flows being routed into Reach 2B. The proposed action includes a fish passage structure to be added to the Chowchilla Bifurcation System to accommodate migrating fish if the system is flooding during the migration period and their normal migration paths are unavailable or modified.

The existing San Joaquin River control structure at the Chowchilla Bifurcation Structure would not be passable for up-migrating salmon and native fish during any flows or flow splits between the river and the Chowchilla Bypass. The undershot gates, sill across the downstream side of the structure, and trash rack on the upstream side contribute to the lack of suitable passage. A fish passage facility would be required for upmigrating salmon and other native fish to swim into Reach 2A from the Chowchilla Bypass under most flow conditions.

Passage Facility Design

The design of the fish passage facility would be based on criteria in the Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001), and the Anadromous Salmonid Passage Facility Design (NMFS 2008) fish passage criteria. The size and geometry of the fish passage facility would be dictated by the flow requirements for juvenile and adult fish. Several types of fish passage facility may be considered in detailed design: vertical slot weir ladder design was included for its ability to accommodate a greater range of water depths (hydraulic head at the upstream and downstream ends), but the design may also consider ice-harbor, pool and chute, rock ramp fishway or other passage facility designs.

Attraction Flows

The attraction flow magnitude would be 5 to 10 percent of the total flow through the control structure over the path of restoration flows. The proposed action requires conveyance of at least 4,500 cfs, so the attraction flow at the passage facility entrance could be as high as 450 cfs. The passage facility itself may have a design flow rate less than the maximum attraction flow. In this case, the balance of attraction flows could be provided at the passage facility entrance (downstream side) through supplementary water, as described below.

Supplementary Water

Supplementary water, if needed, is river water which is piped to the fish passage facility entrance to augment attraction flows (Figure 8). The supplementary water allows the passage facility to operate under a wider range of river flows by supplying additional attraction flow when the need exceeds the design flow rate through the passage facility. Supplementary water would also be used to control the hydraulic head at the passage facility entrance. Supplementary flow would be collected by a water delivery intake structure located upstream from the fish passage facility. The intake structure would include a trash rack and a fish screen to prevent migrating fish from entering the intake. River water would enter the intake structure, and travel downriver through pipes to the passage facility entrance.

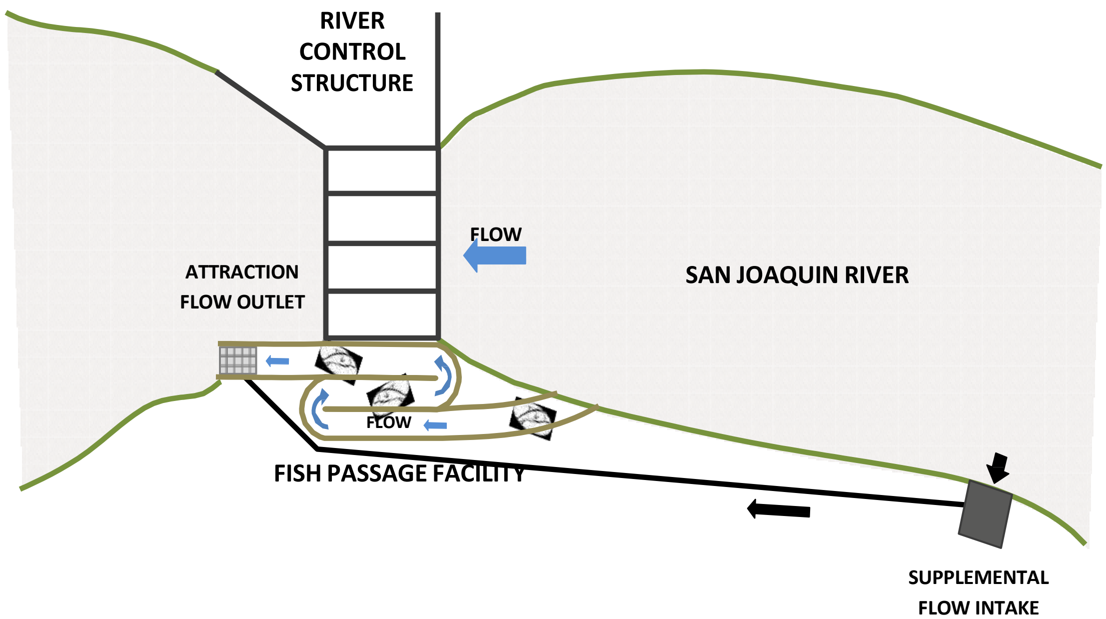

Figure 8. Supplementary Flow System Plan-view Diagram (Pg. 2-6, Figure 6, Reclamation BA)

1.3.4.1 San Joaquin River Control Structure at the Chowchilla Bifurcation Structure Modifications

In addition to the passage facility, the San Joaquin River control structure at the Chowchilla Bifurcation Structure would be modified to improve fish passage through the control structure itself or to improve operations of the passage facility. Fish passage through the modified river control structure may meet passage criteria only for certain flows, so the fish passage facility described above would still be required. Improvements to the river control structure could include removing the trash racks, replacing one or more radial gates with over-shot gates (e.g., inflatable Obermeyer weir gates), notching or removal of the baffle wall or weir, removing the dragon’s teeth, and replacing or modifying the scour protection. Improvements would be designed based on NMFS 2001 and NMFS 2008 passage criteria. Improvements would not affect the ability of the structure to divert flood water into the Chowchilla Bypass.

Maintenance

Fish passage facility maintenance is needed to ensure that the passage facility is functioning to NMFS standards. Depending on the type of fish passage facility built, fish passage facility maintenance could include removing sediment and debris from the facility, in-channel sediment removal in the structure vicinity, inspection of gates and seals and periodic replacement of seals, periodic repair or replacement of weir gates, periodic repair or replacement of supplementary water system components, inspection for operation, greasing and inspecting motors, and replacement of riprap, grouting, boulders, large woody debris, or other “natural” features of the fish passage facility.

Seepage control measure maintenance is dependent on the type of measures implemented but could include activities such as periodic sediment removal and channel re-shaping for interceptor ditches, cleaning or flushing of interceptor drains, repair and replacement of pump parts for seepage wells and lift pumps, and vegetation management, berm restoration, and rodent control for seepage berms.

Operation

Fish passage facility operations could occur every day during fish migration. Operations include visually inspecting the facility, verifying flow, clearing obstructions and debris, adjusting the weirs, permitting and regulatory compliance measures, estimating performance (i.e., velocity measurements), fish monitoring, and powering mechanically controlled weirs.

1.3.5 Mendota Pool Control Structure Fish Screen

In step 5 of the proposed action, a fish screen would be included adjacent to the head of the compact bypass, in front of the Mendota Pool Control Structure. Any water being diverted into Mendota Pool would pass through the fish screen. The fish screen would keep fish out of Mendota Pool or return fish to the compact bypass (the path of restoration flows) during water deliveries. The Compact Bypass Bifurcation Structure are only operated in a manner that would entrain fish during Exchange Contractor deliveries or during precautionary and uncontrolled flood flow deliveries. Therefore, the fish screen would only be necessary during these times.

The screen would be designed to pass flow up to 2,500 cfs. The fish screen design could be a fixed flat plate in "V" configuration, vertical flat plate, inclined flat plate, cone, or cylindrical screens. Depending on the design type, the fish screen facility may include trash racks, stainless steel wedge wire fish screens, flow control baffle systems behind the screens, screen cleaning systems for the trash racks and screens, bypass flow control weirs, fish-friendly pumps, and/or fish bypass pressure pipelines. The trash racks would be installed at the entrance to the screen structures to protect screens from trash, logs, and other large debris.

Approach, sweeping, and bypass entrance velocities would be kept within established fish screen criteria (NMFS 2008). Flow through the fish screens may be controlled by baffles behind the fish screens. Cleaning of the screens would be accomplished using an automated brush system. Electric power would be needed for fish friendly pumps, if included, and screen cleaning systems. Operation of the fish screens would include methods to reduce predation of juvenile fish (e.g., noise systems to scatter predators, netting, and periodic draining of the screen return pipes).

Construction would require removable cofferdams in two phases, as not to block flows. The possible return/bypass fish pipes and outlet would be constructed in the dry using conventional construction methods.

Fish screen operations include visually inspecting screens, verifying flow, clearing obstruction and debris, adjusting the baffles, permitting and regulatory compliance measures, estimating performance, powering the screen, running the pumps for the sediment removal system, running automatic brush cleaning the trash rake motors, and running pumps for the fish diversion pipe. Operations also could include methods to reduce predation of juvenile fish (e.g., noise systems to scatter predators, netting, and periodic draining of the screen return pipes) and may include the addition of juvenile and/or adult fish traps.

Fish screen maintenance would be needed to ensure that screens are functioning to NMFS standards and capable of diverting the required flow. Fish screen maintenance would include removing the screens for cleaning, replacing screens when needed, periodic repair or replacement of brush cleaning system components, periodic repair or replacement of trash rack components, inspection for operation, greasing and inspecting motors, and in-channel sediment removal in the structure vicinity.

1.3.6 Conservation Measures and Avoidance/Minimization Measures

1.3.6.1 Measures to Minimize Impacts to Listed Species

- The Hills Ferry Barrier would be operated and maintained to exclude Central Valley steelhead from the restoration area during construction activities and until suitable habitat conditions are restored, and trapping and monitoring would occur to detect steelhead moving upstream and relocate them to the mouth of the Merced River.
- A Fish Rescue and Relocation Plan would be developed by Reclamation or contractors and provided to NMFS for approval 90 days prior to cofferdam construction. The plan would include methods of flow bypass, diversion, dewatering, salmonid collection, transport and release, water quality data, and formation of a team of qualified biologists with expertise in handling, collecting, and relocating salmonids. NMFS would have 45 days to review the Fish Rescue and Relocation Plan so contractors can be given time to make necessary changes, if any, to follow NMFS guidance or criteria while staying on construction schedule.
- If individuals of listed species are observed present within the proposed action area, NMFS would be notified. NMFS personnel would have access to construction sites during construction, and following completion, to evaluate species presence and condition and/or habitat conditions.
- A NMFS-appointed representative would be identified to employees and contractors to ensure that questions regarding avoidance and protection measures are addressed in a timely manner.
- A qualified biological monitor would be present during all construction activities, including clearing, grubbing, pruning, and trimming of vegetation at each job site during construction initiation, midway through construction, and at the close of construction to monitor implementation of conservation measures and water quality.
- The bottom topography of the San Joaquin River channel would be designed to decrease or eliminate predator holding habitat.
- Before construction, Reclamation would conduct an education program for all agency and contracted employees relative to the Federally listed species that may be encountered within the proposed action area, and required practices for their avoidance and protection.

- If bank stabilization activities should be necessary, then such stabilization would be constructed in such a way as to minimize fish predator habitat.

1.3.6.2 Measures to Control Turbidity and Suspended Sediment during Construction

- Best Management Practices (BMPs) to control erosion and storm water sediment runoff would be implemented. This may include, but is not limited to, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from proposed action areas.
- Equipment operation in the active channel would be kept to the minimum necessary to meet the proposed action goals.
- If bank stabilization activities should be necessary, then such stabilization would be constructed to minimize erosion potential, minimize sedimentation of the waterway, and contain material suitable for supporting riparian vegetation.

1.3.6.3 Measures to Minimize or Avoid Adverse Effects to Riparian Vegetation

- Disturbance of riparian vegetation would be avoided to the greatest extent practicable.
- Riparian vegetation removed or damaged would be replaced, as applicable, in accordance with the Riparian Habitat Monitoring Management and Mitigation Plan, and would be coordinated with NMFS and other agencies as appropriate.
- Equipment used for the proposed action would be thoroughly washed off-site to remove invasive plant seed, stems, etc. and inspected to prevent transfer of aquatic invasive species, such as quagga mussel and New Zealand mud snail, prior to arriving at the construction area.
- If bank stabilization activities should be necessary, then such stabilization would contain material suitable for supporting riparian vegetation.

1.3.6.4 Measures to Prevent and Manage Potential Spills of Hazardous Materials

- A spill prevention plan would be prepared describing measures to be taken to minimize the risk of fluids or other materials used during construction (e.g., oils, transmission and hydraulic fluids, cement, fuel) from entering the San Joaquin River or contaminating riparian areas adjacent to the river itself. In addition to a spill prevention plan, a cleanup protocol would be developed before construction begins and would be implemented in case of a spill.
- Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, would be restricted to the designated construction staging areas, exclusive of any riparian and wetland areas.
- All construction equipment refueling and maintenance would be restricted to designated staging areas located away from the river and sensitive habitats.
- Construction BMPs for off-channel staging and storage of equipment and vehicles would be implemented to minimize the risk of contaminating the waters of the San Joaquin River by spilled materials.

1.4 Action Area

The regulations governing consultations under the ESA define *action area* as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (51 FR 19957). The action area should be determined based on all direct and indirect effects of the proposed action (50 CFR 402.02 and 402.14[b][2]).

For the purposes of this consultation, the action area encompasses the anadromous habitat of the San Joaquin River from about 1,800 linear feet of river upstream of the Chowchilla Bifurcation Structure to about one mile of the river downstream of Mendota Dam, and includes roughly a mile upstream into Fresno Slough. Additionally, the action area extends beyond the proposed action footprint to areas where site-specific activities may cause increased turbidity or high levels of noise. The proposed action area includes areas directly and indirectly affected by the proposed action, including the entire proposed action footprint shown in Figure 9.

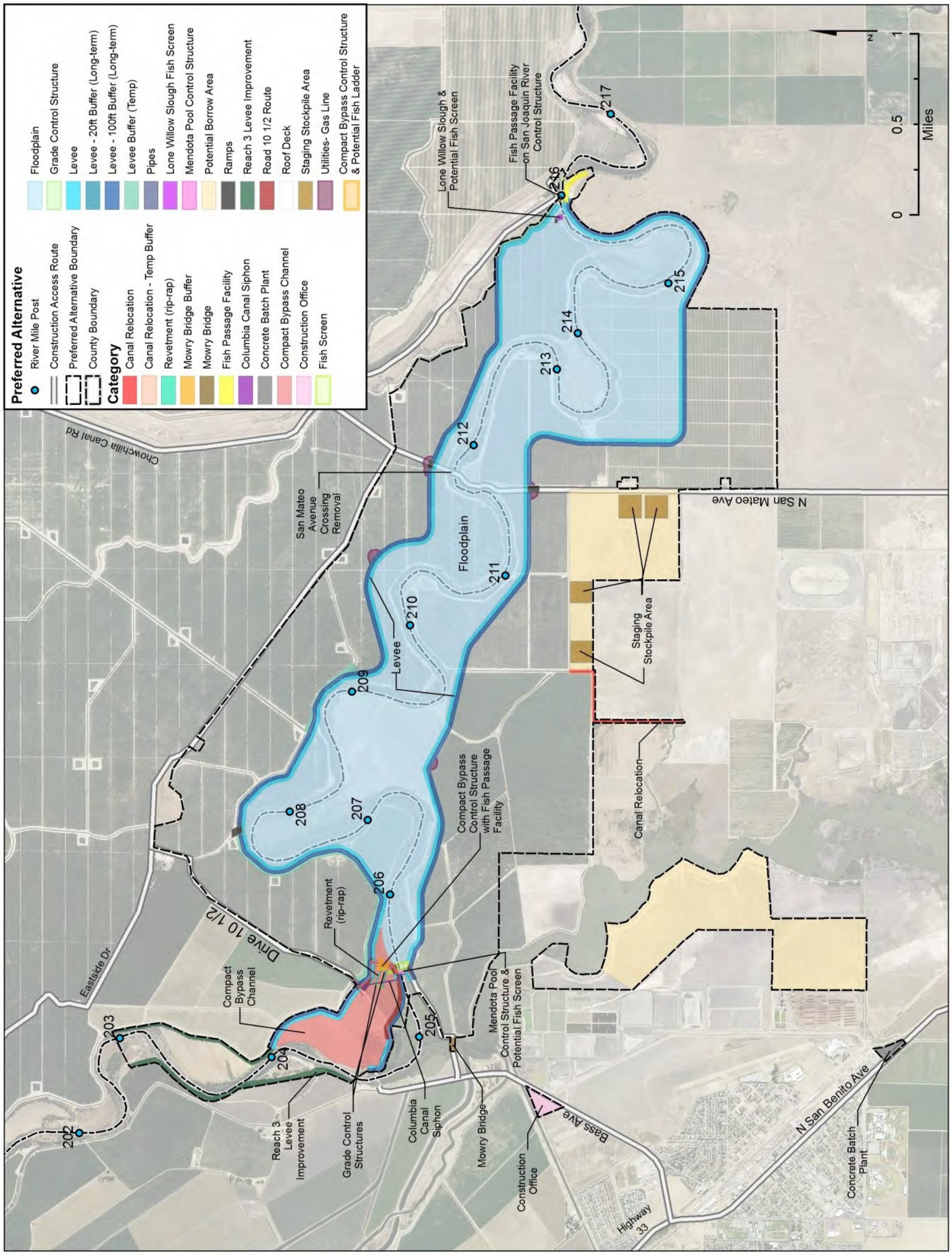

Figure 9. Plan view of proposed action. (Pg. 1-6, Figure 2, Reclamation BA)

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion only includes a jeopardy analysis because there is no critical habitat within the action area.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the range-wide status of the species expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species.
- Reach jeopardy conclusions.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

There is no critical habitat currently present within proposed action area, however, the habitat components of critical habitat were used to assist with the analysis of the proposed action's effects and the effects to Essential Fish Habitat (EFH).

2.2 Range-wide Status of the Species

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

The descriptions of the status of species in this BO are a synopsis of the detailed information available on NMFS' West Coast Regional website (http://www.westcoast.fisheries.noaa.gov/). The table below lists the Federally listed species ESUs or DPSs in the action area and may be affected by the proposed action. The website links to more detailed information about life history information, distribution and Federal Register Notices can be found on the website.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Central Valley Spring-run Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened (Non-essential Experimental Population) (78 FR 79622)	9/16/1999 64 FR 50394 Threatened	6/28/2005 70 FR 37160 Threatened	9/2/2005 70 FR 52488
Steelhead (*O. mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488

Detailed CV spring-run Chinook salmon ESU and critical habitat information:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/central_valley_spring_run/central_valley_spring_run_chinook.html

Detailed CCV steelhead DPS and critical habitat information:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/california_central_valley/california_central_valley_steelhead.html

2.2.2 California Central Valley Steelhead distinct population segment (DPS)

- Originally listed as threatened on March 19, 1998 (63 FR 13347)
- Reaffirmed as threatened August 15, 2011 (76 FR 157)
- Critical habitat designated September 2, 2005 (70 FR 52488)

The Federally listed DPS of California Central Valley (CCV) steelhead occurs in the action area and may be affected by the proposed action.

A. Species Listing History

CCV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good *et al.* 2005a) and after application of the agency's hatchery listing policy, NMFS reaffirmed its status as threatened and also listed the Feather River Hatchery and Coleman National Fish Hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid evolutionarily significant units (ESUs) and DPSs, NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological, and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On May 5, 2016, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2016a). Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488).

B. Life History

1. Egg to Parr

The length of time it takes for eggs to hatch depends mostly on water temperature. Steelhead eggs hatch in three to four weeks at 10°C (50°F) to 15°C (59°F) (Moyle 2002). After hatching, alevins remain in the gravel for an additional two to five weeks while absorbing their yolk sacs, and emerge in spring or early summer (Barnhart 1986). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, fry inhale air at the stream surface to fill their air bladders, absorb the remains of their yolks in the course of a few days, and start to feed actively, often in schools (Barnhart 1986, NMFS 1996).

The newly emerged juveniles move to shallow, protected areas associated within the stream margin (McEwan and Jackson 1996). As steelhead parr increase in size and their swimming abilities improve, they increasingly exhibit a preference for higher velocity and deeper mid-channel areas (Hartman 1965; Everest and Chapman 1972; Fontaine 1988).

Productive juvenile rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or bolders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Optimal water temperatures for growth range from 15°C (59°F) to 20°C (68°F) (McCullough et al. 2001, Spina 2006). Cherry et al. (1975) found preferred temperatures for rainbow trout ranged from 11°C (51.8°F) to 21°C (69.8°F) depending on acclimation temperatures (cited in Myrick and Cech 2001).

2. Smolt Migration

Juvenile steelhead would often migrate downstream as parr in the summer or fall of their first year of life, but this is not a true smolt migration (Loch et al. 1988). Smolt migrations occur in the late winter through spring, when juveniles have undergone a physiological transformation to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating steelhead smolts use the lower reaches of the Sacramento River, the San Joaquin River, and the Delta primarily as a migration corridor to the ocean. There is little evidence that they rear in the Delta or on floodplains, though there are few behavioral studies of this life-stage in the California Central Valley (Table 2). Smolt migration timing in the San Joaquin River system is variable but mostly centers around early to mid-spring and this timing could change once the upper San Joaquin River is reconnected at the confluence of the Merced.

3. Ocean Behavior

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986). It is possible that California steelhead may not migrate to the Gulf of Alaska region of the north Pacific as commonly as more northern populations such as those in Washington and British Colombia. (Burgner 1993) reported that no coded-wire tagged steelhead from California hatcheries were recovered from the open ocean surveys or fisheries that were sampled for steelhead between 1980 and 1988. Only a small number of disk-tagged fish from California were captured. This behavior might explain the small average size of CCV steelhead relative to populations in the Pacific Northwest, as food abundance in the nearshore coastal zone may not be as high as in the Gulf of Alaska.

Pearcy (1990) found that the diets of juvenile steelhead caught in coastal waters of Oregon and Washington were highly diverse and included many species of insects, copepods, andamphipods, but by biomass the dominant prey items were small fishes (including rockfish and greenling) and euphausids.

There are no commercial fisheries for steelhead in California, Oregon, or Washington, with the exception of some tribal fisheries in Washington waters.

4. Spawning

CCV steelhead generally enter freshwater from August to November (with a peak in September [Hallock et al. 1961]), and spawn from December to April, with a peak in January through March, in rivers and streams where cold, well oxygenated water is available (Table 2; Williams 2006; Hallock et al. 1961; McEwan and Jackson 1996). The timing of upstream migration is correlated with high flow events, such as freshets, and the associated change in water temperatures (Workman et al. 2002). Adults typically spend a few months in freshwater before spawning (Williams 2006), but very little is known about where they hold between entering freshwater and spawning in rivers and streams. The threshold of a 56°F maximum water temperature that is commonly used for Chinook salmon is often extended to steelhead, but temperatures for spawning steelhead are not usually a concern as this activity occurs in the late fall and winter months when water temperatures are low. Female steelhead construct redds in suitable gravel and cobble substrate, primarily in pool tailouts and heads of riffles.

Few direct counts of fecundity are available for CCV steelhead populations, but since the number of eggs laid per female is highly correlated with adult size, adult size can be used to estimate fecundity with reasonable precision. Adult steelhead size depends on the duration of and growth rate during their ocean residency (Meehan and Bjornn 1991). CCV steelhead generally return to freshwater after one or two years at sea (Hallock et al. 1961), and adults typically range in size from two to twelve pounds (Reynolds et al. 1993). Steelhead about 55 cm (FL) long may have fewer than 2,000 eggs, whereas steelhead 85 cm (FL) long can have 5,000 to 10,000 eggs, depending on the stock (Meehan and Bjornn 1991). The average for Coleman National Fish Hatchery since 1999 is about 3,900 eggs per female (USFWS 2011).

Unlike Pacific salmon, steelhead are iteroparous, meaning they are capable of spawning multiple times before death (Busby et al. 1996). However, it is rare for steelhead to spawn more than twice before dying; and repeat spawners tend to be biased towards females (Busby et al. 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners were relatively numerous (17.2 percent) in Waddell Creek. Null et al. (2013) found between 36 percent and 48 percent of kelts released from Coleman NFH in 2005 and 2006 survived to spawn the following spring, which is in sharp contrast to what Hallock (1989) reported for Coleman NFH in the 1971 season, where only 1.1 percent of adults were fish that had been tagged the previous year. Most populations have never been studied to determine the percentage of repeat spawners. Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider et al. 1986).

5. Kelts

Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo et al. 2011), but that most return to the ocean (Null et al. 2013).

Table 2. The temporal occurrence of (a) adult and (b) juvenile California CV steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1]Sacramento R. at Fremont Weir												
[2]Sacramento R. at RBDD												
[3]Mill & Deer Creeks												
[4]Mill Creek at Clough Dam												
[5]San Joaquin River												

(b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento R. near Fremont Weir												
[6]Sacramento R. at Knights Landing												
[7]Mill & Deer Creeks (silvery parr/smolts)												
[7]Mill & Deer Creeks (fry/parr)												
[8]Chipps Island (clipped)												
[8]ChippsIsland (unclipped)												
[9]San Joaquin R. at Mossdale												
[10]Mokelumne R. (silvery parr/smolts)												
[10]Mokelumne R. (fry/parr)												
[11]Stanislaus R. at Caswell												
[12]Sacramento R. at Hood												

Relative Abundance: = High = Medium = Low

Sources: [1](Hallock 1957); [2](McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson and Merrick 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by FishBio) summarized by John Hannon (Reclamation) ; [12](Schaffter 1980).

D. Description of Viable Salmonid Population (VSP) Parameters

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a viable salmonid population (VSP). The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany *et al.* 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity.

1. Abundance

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the Red Bluff Diversion Dam (RBDD) declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, and comprehensive steelhead population monitoring has not taken place in the Central Valley since then, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being planned (Eilers et al. 2010).

Current abundance data is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Coleman National Fish Hatchery (Coleman) operates a weir on Battle Creek, where all upstream fish movement is blocked August through February, during the hatchery spawning season. Counts of steelhead captured at and passed above this weir represent one of the better data sources for the Central Valley DPS. However, changes in hatchery policies and transfer of fish complicate the interpretation of these data. In 2005, per NMFS request, Coleman stopped transferring all adipose-fin clipped steelhead above the weir, resulting in a large decrease in the overall numbers of steelhead above the weir in recent years. In addition, in 2003, Coleman transferred about 1,000 clipped adult steelhead to Keswick Reservoir, and these fish are not included in the data. The result is that the only unbiased time series for Battle Creek is the number of unclipped (wild) steelhead since 2001, which have declined slightly since that time, mostly because of the high returns observed in 2002 and 2003.

Prior to 2002, hatchery and natural-origin steelhead in Battle Creek were not differentiable, and all steelhead were managed as a single, homogeneous stock, although USFWS believes the majority of returning fish in years prior to 2002 were hatchery-origin. Abundance estimates of natural-origin steelhead in Battle Creek began in 2001. These estimates of steelhead abundance include all *O. mykiss*, including resident and anadromous fish (Figure 10).

Steelhead returns to Coleman NFH have increased over the last four years. After hitting a low of only 790 fish in 2010, the last two years have averaged 2,895 fish (Figure 11). Since 2003, adults returning to the hatchery have been classified as wild (intact adipose) or hatchery produced (adipose fin clipped). Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relative steady, typically 200-300 fish each year. Numbers of wild adults returning each year have ranged from 252 to 610 from 2010 to 2014 (Figure 11).

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 143 redds have been counted on the American River from 2002-2015 [(Figure 12; data from (Hannon *et al.* 2003, Hannon and Deason 2008, Chase 2010)]. Surveys were not conducted in some years on the American River due to high flows and low visibility. An average of 178 redds have been counted in Clear Creek from 2001 to 2015 (Figure 13; data from USFW). The Clear Creek steelhead population appears to have increased in abundance since Saeltzer Dam was removed in 2000, as the number of redds observed in surveys conducted by the USFWS has steadily increased since 2001 (Figure 13). The average redd index from 2001 to 2011 is 178, representing a range of approximately 100-1023 spawning adult steelhead on average each year, based on an approximate observed adult-to-redd ratio in Clear Creek (U.S. Fish and Wildlife Service 2015). The vast majority of these steelhead are wild fish, as no hatchery steelhead are stocked in Clear Creek.

The East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season, and the overall trend is a slight increase. However, it is generally believed that most of the *O. mykiss* spawning in the Mokelumne River are resident fish (Satterthwaite *et al.* 2010b), which are not part of the CCV steelhead DPS. In the most recent 5-year status review, NMFS upheld its decision not to include this population in the DPS (National Marine Fisheries Service 2016c).

The returns of steelhead to the Feather River Hatchery experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively (Figure 14). In recent years, however, returns have experienced an increase with 830, 1797, and 1505 fish returning in 2012, 2013 and 2014 respectively. Almost all these fish are hatchery fish, and stocking levels have remained fairly constant, suggesting that smolt and/or ocean survival was poor for age classes that showed poor returns in the late 2000s.

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the proportion of wild steelhead relative to hatchery steelhead (CDFG; ftp.delta.dfg.ca.gov/salvage). The overall catch of steelhead at these facilities has been highly variable since 1993 (Figure 14). Variability in catch is likely due to differences in water year types as Delta exports fluctuate. The percentage of wild origin steelhead in salvage has also fluctuated, but has generally declined since 100 percent clipping started in 1998. The number of hatchery origin steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated.

The years 2009 and 2010 showed poor returns of steelhead to the Feather River Hatchery and Coleman Hatchery, probably due to three consecutive drought years in 2007-2009, which would have impacted parr and smolt growth and survival in the rivers, and possibly due to poor coastal upwelling conditions in 2005 and 2006, which strongly impacted fall-run Chinook salmon post-smolt survival (Lindley *et al.* 2009b). Wild origin (intact adipose) adult counts appear not to have decreased as greatly in those same years, based on returns to the hatcheries and redd counts conducted on Clear Creek, and the American and Mokelumne rivers. This may reflect greater fitness of naturally produced steelhead relative to hatchery fish, and certainly merits further study.

Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present, other than the fact that the numbers are still far below those seen in the 1960s and 1970s, and only a tiny fraction of the historical estimate. Returns of natural origin fish are very poorly monitored, but the little data available suggest that the numbers are very small, though perhaps not as variable from year to year as the hatchery returns.

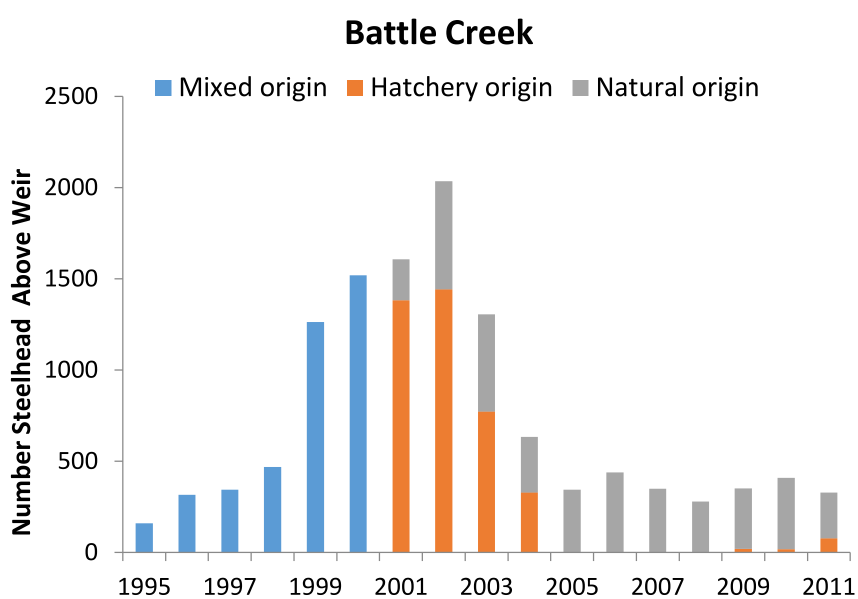

Figure 10. Steelhead returns to Battle Creek from 1995-2009. Starting in 2001, *O. mykiss* were classified as either wild (intact adipose) or hatchery produced (adipose clipped). Includes fish passed above the weir during broodstock collection and fish passing through the fish ladder March 1 to August 31. Data are from USFWS.

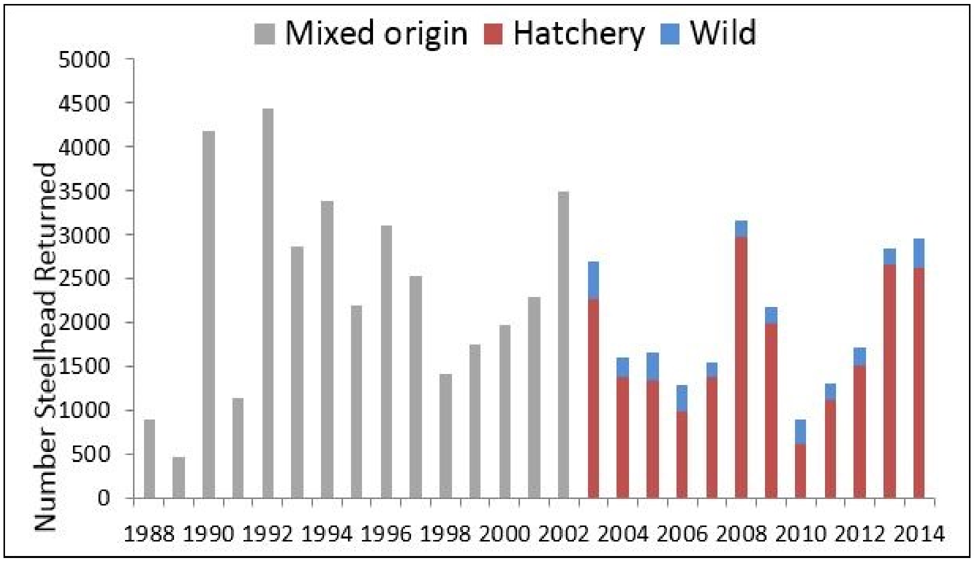

Figure 11. Steelhead returns to Coleman NFH from 1988-2014. Starting in 2001, fish were classified as either wild (unclipped) or hatchery produced (clipped).

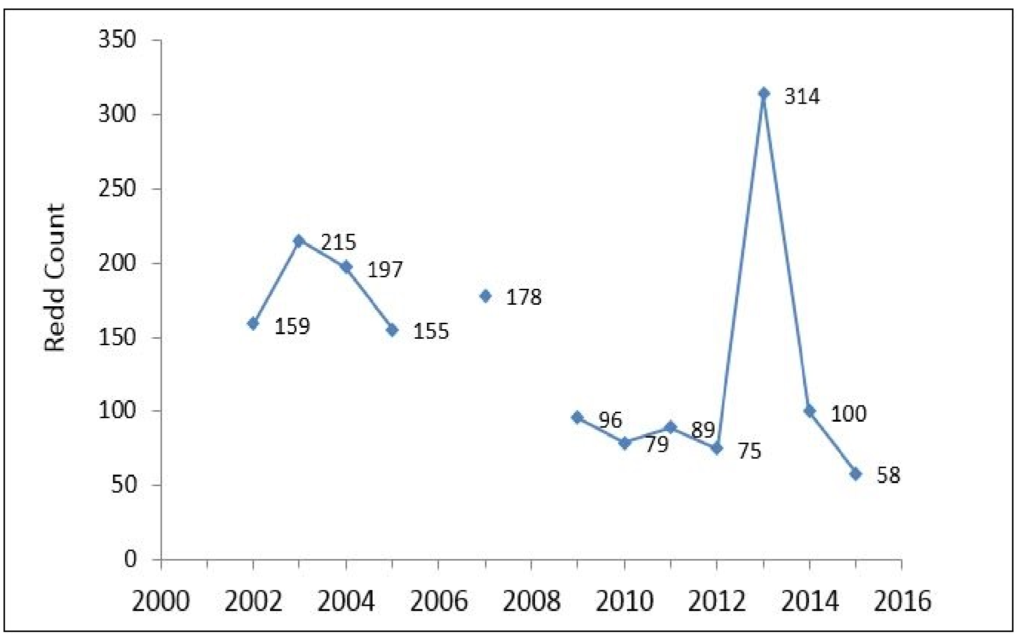

Figure 12. Steelhead redd counts from surveys on the American River from 2002-2015. Surveys could not be conducted in some years due to high flows and low visibility.

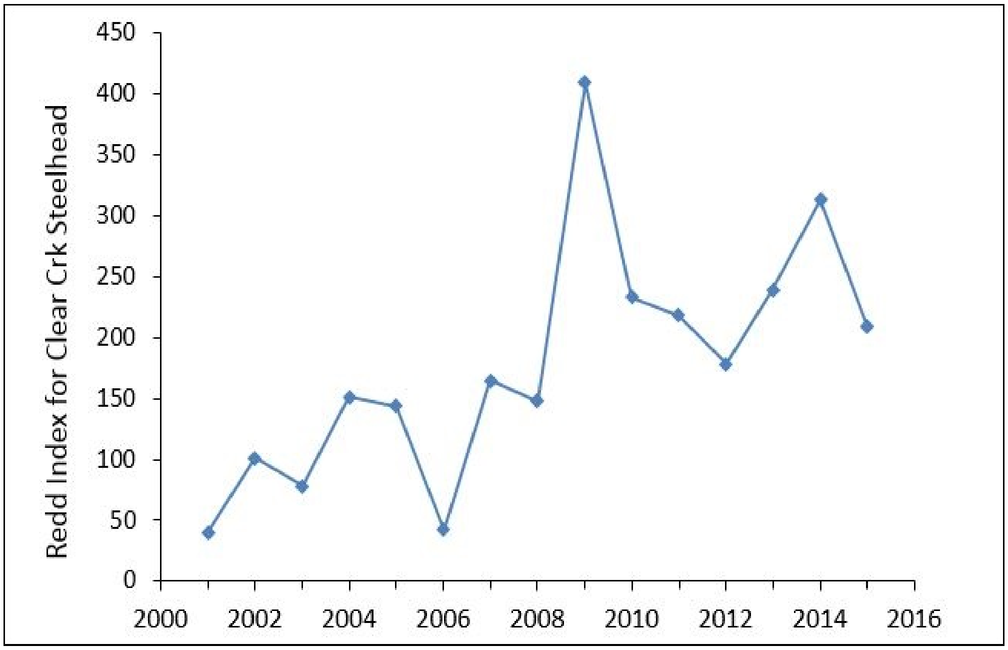

Figure 13. Redd counts from USFWS surveys on Clear Creek from 2001-2015.

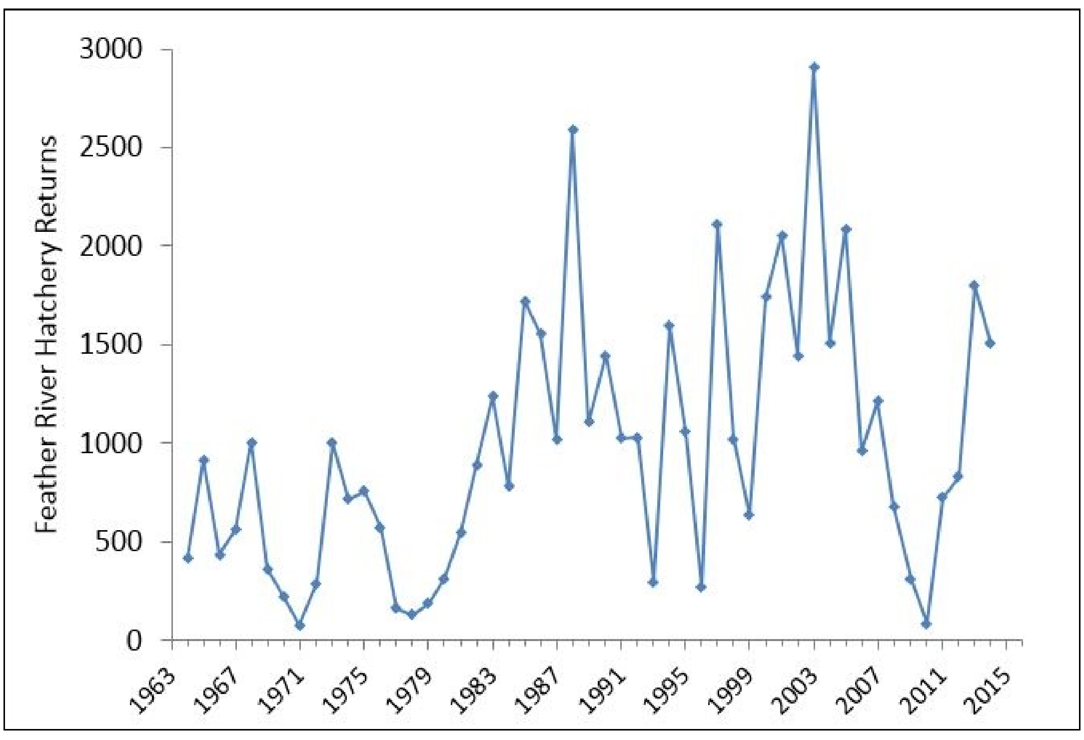

Figure 14. Steelhead returns to the Feather River Hatchery from 1964-2015.

2. Productivity

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are expected to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams et al. 2011).

Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Good et al. (2005) made the following conclusion based on the Chipps Island data:

> *"If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s".*

The Chipps Island midwater trawl dataset maintained by the USFWS provides information on the trend in abundance for the CCV steelhead DPS as a whole. Updated through 2014, the trawl data indicate that the level of natural production of steelhead has remained very low since the 2011 status review (Figure 15). Catch per unit effort (CPUE) has fluctuated but remained level over the past decade, but the proportion of the catch that is adipose-clipped (100% of hatchery steelhead production have been adipose fin-clipped starting in 1998) has risen, exceeding 90 percent in some years and reaching a high of 95 percent in 2010 (Williams *et al.* 2011a). Because hatchery releases have been fairly constant, this implies that natural production of juvenile steelhead has been declining in the Central Valley.

The top of Figure 15 shows the catch of steelhead at Chipps Island by the USFWS midwater trawl survey. The middle section shows the fraction of the catch bearing an adipose fin clip. 100 percent of steelhead production has been marked starting in 1998, denoted with the vertical gray line. The bottom section shows CPUE in fish per million m-3 swept volume. CPUE is not easily comparable across the entire period of record, as over time, sampling has occurred over more of the year and catches of juvenile steelhead are expected to be low outside of the primary migratory season.

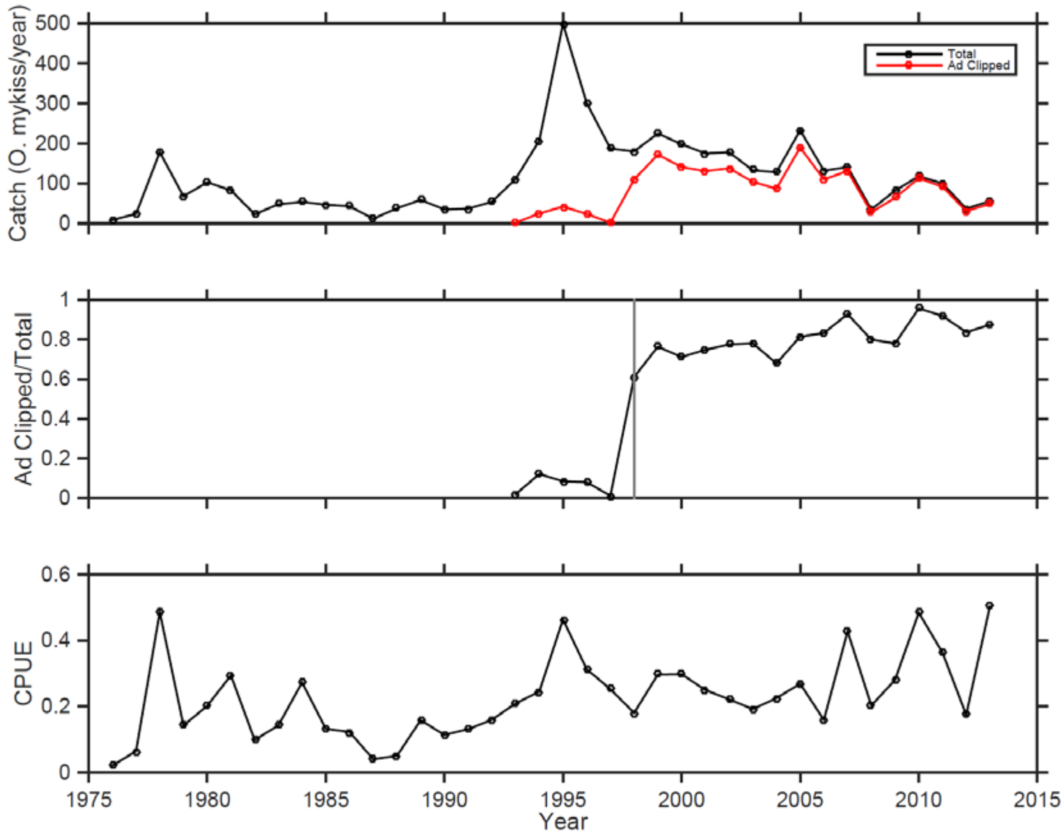

Figure 15. Steelhead Catch at Chipps Island midwater trawl.

In the Mokelumne River, East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite et al. (2010), it is likely that most of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production. In the past, this hatchery received fish imported from the Feather River and Nimbus hatcheries (Merz 2002). However, this practice was discontinued for Nimbus stock after 1991, and discontinued for Feather River stock after 2008. Recent genetic studies show that the Mokelumne River Hatchery steelhead are closely related to Feather River fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the production of wild steelhead relative to hatchery steelhead (ftp.delta.dfg.ca.gov/salvage). The overall catch of steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years, as measured by expanded salvage (Figure 16). The percentage of wild fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated. This relatively constant hatchery production, coupled with the dramatic decline in hatchery-origin steelhead catch at the south Delta fish collection facilities suggests that either stocked hatchery fish from the Sacramento basin are using a more natural outmigration path and not being pulled into the south Delta fish facilities or the immediate survival of those stocked fish has decreased. With respect to wild steelhead, the data shown in figure 16 indicate that over the last few years fewer adults are spawning (fewer eggs deposited), survival of early life stages has decreased, and/or wild steelhead are experiencing reduced exposure to the south Delta fish facilities.

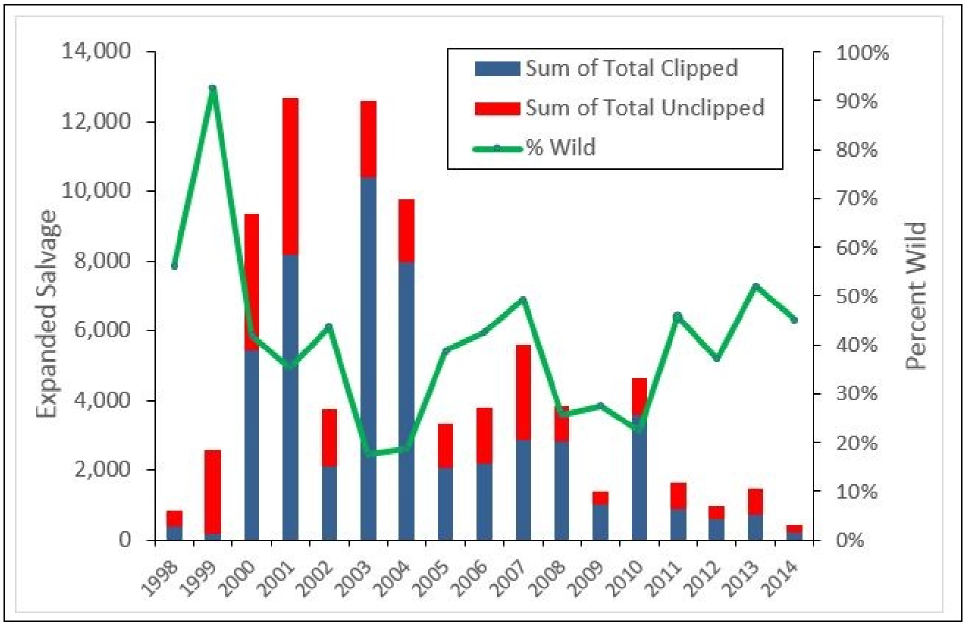

Figure 16. Steelhead salvaged in the Delta fish collection facilities from 1993 to 2014. All hatchery steelhead have been adipose fin-clipped since 1998. Data are from CDFW, at: ftp.delta.dfg.ca.gov/salvage.

Since 2003, fish returning to the Coleman National Fish Hatchery have been identified as wild (adipose fin intact) or hatchery produced (ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year.

3. Spatial Structure

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the Central Valley is now upstream of impassible dams (Lindley et al. 2006). The extent of habitat loss for CCV steelhead most likely was much higher than that for salmon because CCV steelhead were more extensively distributed (Lindley *et al.* 2006). Due to their superior jumping ability, the timing of their upstream migration which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, CCV steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama et al. 1996). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. CCV steelhead were found as far south as the Kings River (and possibly Kern River systems in wet years) (McEwan 2001).

Native American groups such as the Chunut people have had accounts of CCV steelhead in the Tulare Basin (Latta 1977).

Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good *et al.* 2005a, National Marine Fisheries Service 2016c). Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries.

Monitoring has detected small numbers of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer & Associates 2000). A counting weir has been in place in the Stanislaus River since 2002 and in the Tuolumne River since 2009 to detect adult salmon; these weirs have also detected *O. mykiss* passage. In 2012, 15 adult *O. mykiss* were detected passing the Tuolumne River weir and 82 adult *O. mykiss* were detected at the Stanislaus River weir (FISHBIO LLC 2012, FISHBIO 2013a). Also, rotary screw trap sampling has occurred since 1995 in the Tuolumne River, but only one juvenile *O. mykiss* was caught during the 2012 season (FISHBIO 2013b). Rotary screw traps are well known to be very inefficient at catching steelhead smolts, so the actual numbers of smolts produced in these rivers could be much higher. Rotary screw trapping on the Merced River has occurred since 1999. A fish counting weir was installed on this river in 2012. Since installation, one adult *O. mykiss* has been reported passing the weir. Juvenile *O. mykiss* were not reported captured in the rotary screw traps on the Merced River until 2012, when a total of 381 were caught (FISHBIO LLC 2013). The unusually high number of *O. mykiss* captured may be attributed to a flashy storm event that rapidly increased flows over a 24-hour period. Annual Kodiak trawl surveys are conducted on the San Joaquin River at Mossdale by CDFW. A total of 17 *O. mykiss* were caught during the 2012 season (California Department of Fish and Wildlife 2013).

Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adult intercepted at the Coleman NFH weir), the American River, Feather River, and Mokelumne River. This is confounded, of course, by the fact that most of the dedicated monitoring programs in the Central Valley occur on rivers that are annually stocked. Clear Creek and Mill Creek are the exceptions.

Implementation of CDFW's Steelhead Monitoring Program began in the Sacramento River Basin during the fall of 2015. Important components of the program include a Mainstem Sacramento River Steelhead Mark-Recapture Program and an Upper Sacramento River Basin Adult Steelhead Video/DIDSON Monitoring Program. The monitoring program would use a temporally stratified mark-recapture survey design in the lower Sacramento River, employing wire fyke traps to capture, mark, and recapture upstream migrating adult steelhead to estimate adult steelhead escapement from the Sacramento-San Joaquin River Delta. Data collected from recaptured adult steelhead would provide additional information on tributary escapement, survival, population structure, population distribution, and spatial and temporal behavior of both hatchery- and natural-origin steelhead.

The low adult returns to the San Joaquin tributaries and the low numbers of juvenile emigrants typically captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

Efforts to provide passage of salmonids over impassable dams have the potential to increase the spatial diversity of Central Valley steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2016a).

4. Diversity

a. Genetic Diversity: CCV steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al. 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen et al. 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers.

The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley et al. 2007). There are four hatcheries (Coleman National Fish Hatchery, Feather River Fish Hatchery, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the Central Valley which combined release approximately 1.6 million yearling CCV steelhead smolts each year. These programs are intended to mitigate for the loss of CCV steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (primarily from the Eel and Mad rivers) and are not presently considered part of the DPS.

b. Life-History Diversity: CCV steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning.

Between 1944 and 1947, annual counts of summer-run CCV steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish. After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run CCV steelhead were no longer able to access their historic spawning areas, and perished in the warm water downstream of Old Folsom Dam (Gerstung 1971).

Only winter-run (ocean maturing) CCV steelhead currently are found in California Central Valley rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run CCV steelhead have been extirpated due to a lack of suitable holding and staging habitat, such as cold-water pools in the headwaters of CV streams, presently located above impassible dams (Lindley et al. 2006).

Juvenile CCV steelhead (parr) rear in freshwater for one to three years before migrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is inversely related to their growth rate, with faster-growing members of a cohort smolting at an earlier age but a smaller size (Peven et al. 1994, Seelbach 1993). Hallock et al. (1961) aged 100 adult CCV steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the Central Valley, most CCV steelhead return to their natal streams as adults at a total age of two to four years (Hallock et al. 1961, McEwan and Jackson 1996).

Deer and Mill creeks were monitored from 1994 to 2010 by the CDFW using rotary screw traps to capture emigrating juvenile CCV steelhead (Johnson and Merrick 2012). Fish in the fry stage averaged 34 and 41 mm FL in Deer and Mill, respectively, while those in the parr stage averaged 115 mm FL in both streams. Silvery parr averaged 180 and 181 mm in Deer and Mill creeks, while smolts averaged 210 mm and 204 mm. Most silvery parr and smolts were caught in the spring months from March through May, while fry and parr peaked later in the spring (May and June) and were fairly common in the fall (October through December) as well.

In contrast to the upper Sacramento River tributaries, Lower American River juvenile CCV steelhead have been shown to smolt at a very large size (270 to 350 mm FL), and nearly all smolt at age-1 (Sogard *et al.* 2012).

5. <u>Summary of ESU Viability</u>

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005a, National Marine Fisheries Service 2016c); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock.

The ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance has remained at a relatively steady state since the 2011 status review and remains much lower than percentages observed in previous decades. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past decade.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley *et al.* (2007a) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley *et al.* (2007a) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown because very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The most recent status review of the CCV steelhead DPS (National Marine Fisheries Service 2016c) found that the status of the population appears to have remained unchanged since the 2011 status review (Good *et al.* 2005a), when it was considered to be in danger of extinction.

2.2.1 Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (ESU)

- listed as threatened (September 16, 1999, 64 FR 50394)
- designated critical habitat (September 2, 2005, 70 FR 52488)
- designated San Joaquin River Experimental Population (December 31st, 2013, 78 FR 79622)

A. Species Listing

CV spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of CV spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent CV spring-run Chinook salmon listing decision (70 FR 37160, June 28, 2005). Although FRFH spring-run Chinook salmon production is included in the ESU, these fish do not have a section 9 take prohibition if they are adipose fin clipped. Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

In April 2016, NMFS completed an updated status review of five Pacific Salmon ESUs, including CV spring-run Chinook salmon (National Marine Fisheries Service 2016b), and concluded that the species' status should remain as previously listed.

A final rule was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species between Friant Dam and the confluence with the Merced River on the San Joaquin River as part of the SJRRP (78 FR 251; December 31, 2013). Pursuant to ESA section 10(j), for the purpose of this conferencing opinion, the experimental population shall be treated as a candidate species. However, the rule includes proposed protective regulations under ESA section 4(d) that would provide specific exceptions to prohibitions under ESA section 9 for taking CV spring-run Chinook salmon within the experimental population area, and in specific instances elsewhere.

B. Life History

1. Adult Migration and Holding

Chinook salmon runs are designated on the basis of adult migration timing. Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (California Department of Fish and Game 1998b) and enter the Sacramento River beginning in March (Yoshiyama *et al.* 1998). CV spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.*, Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid- to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley et al. 2004, see Table 3 in text). Typically, CV spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

During their upstream migration, adult Chinook salmon require stream flows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate stream flows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 3ºC (38ºF) to 13ºC (56ºF) (Bell 1991, California Department of Fish and Game 1998c). Boles *et al.* (1988) recommends water temperatures below 18ºC (65ºF) for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 21ºC (70ºF), and that fish can become stressed as temperatures approach 21ºC (70ºF). Reclamation reports that CV spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 15.6 ºC (60ºF); although salmon can tolerate temperatures up to 18 ºC (65ºF) before they experience an increased susceptibility to disease (Williams 2006a).

2. Adult Spawning

CV spring-run Chinook salmon spawning occurs in September and October (Moyle 2002). Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998), but primarily at age 3 (Fisher 1994). Between 56 and 87 percent of adult CV spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994); CV spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months.

CV spring-run Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (U.S. Fish and Wildlife Service 1995, National Marine Fisheries Service

2007). Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. Velocity typically ranging from1.2 feet/second to 3.5 feet/second, and water depths greater than 0.5 feet (Yuba County Water Agency *et al.* 2007). The upper preferred water temperature for spawning Chinook salmon is 13 ºC to 14 ºC (55ºF to 57ºF) (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, California Department of Fish and Game 2001). Chinook salmon are semelparous (die after spawning).

3. <u>Eggs and Fry Incubation to Emergence</u>

The CV spring-run Chinook salmon embryo incubation period encompasses the time period from egg deposition through hatching, as well as the additional time while alevins remain in the gravel while absorbing their yolk sac prior to emergence. A compilation of data from multiple surveys has shown that Chinook salmon prefer a range of substrate sizes between approximately 22mm and 48mm (Kondolf and Wolman 1993). The length of time for CV spring-run Chinook salmon embryos to develop depends largely on water temperatures. In well-oxygenated intergravel environs where water temperatures range from about 5 to 13ºC (41 to 55.4ºF) embryos hatch in 40 to 60 days and remain in the gravel as alevins for another 4 to 6 weeks, usually after the yolk sac is fully absorbed (National Marine Fisheries Service 2014). In Butte and Big Chico creeks, emergence occurs from November through January, and in the colder waters of Mill and Deer creeks, emergence typically occurs from January through as late as May (Moyle 2002). Incubating eggs require sufficient concentrations of dissolved oxygen. Coble (1961) noted that a positive correlation exists between dissolved oxygen (DO) levels and flow within redd gravel, and Geist *et al.* (2006) observed an emergence delay of 6-10 days at 4 mg/L DO relative to water with complete oxygen saturation.

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel permeability, and poor water quality. Studies of Chinook salmon egg survival to emergence conducted by Shelton (1955) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The optimal water temperature for egg incubation ranges from 5 ºC to 14 ºC (41ºF to 56ºF) (National Marine Fisheries Service 1997, Rich 1997, Moyle 2002). A significant reduction in egg viability occurs at water temperatures above 14 ºC (57.5ºF) and total embryo mortality can occur at temperatures above 17 ºC (62ºF) (National Marine Fisheries Service 1997). Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 16ºC and 3ºC (61ºF and 37ºF), respectively, when the incubation temperature was held constant. As water temperatures increase, the rate of embryo malformations also increases, as well as the susceptibility to fungus and bacterial infestations. The length of development for Chinook salmon embryos is dependent on the ambient water temperature surrounding the egg pocket in the redd. Colder water necessitates longer development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel.

During the 4 to 6 week period when alevins remain in the gravel, they utilize their yolk-sac to nourish their bodies. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. The newly emerged fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on zooplankton, small insects, and small invertebrates. As they switch from endogenous nourishment to exogenous feeding, the fry's yolk-sac is reabsorbed, and the belly suture closes over the former location of the yolk-sac (button-up fry). Fry typically range from 25 millimeters (mm) to 40 mm during this stage. Some fry may take up residence in their natal stream for several weeks to a year or more, while others migrate downstream to suitable habitat. Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in river reaches farther downstream for a period of time ranging from weeks to a year (Healey 1991).

4. Juvenile Rearing and Outmigration

Once juveniles emerge from the gravel, they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also would disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow larger. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002).

When juvenile Chinook salmon reach a length of 50 mm to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 feet to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams may spur outmigration of juveniles when they have reached the appropriate stage of development (Kjelson *et al.* 1982, Brandes and McLain 2001).

As fish begin their emigration, they are displaced by the river's current downstream of their natal reaches. Similar to adult movement, juvenile salmonid downstream movement is primarily crepuscular. The daily migration of juveniles passing RBDD is highest in the four hour period prior to sunrise (Martin *et al.* 2001). Juvenile Chinook salmon migration rates vary considerably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found that Chinook salmon fry travel as fast as 30 km per day in the Sacramento River. As Chinook salmon begin the smolt stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

CV spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year, or as juveniles, or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2004). Studies in Butte Creek (Ward *et al.* 2003, McReynolds *et al.* 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which emigrated primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al.* 2004). The California Department of Fish and Game (1998a) observed the emigration period for CV spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. In addition, CV spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin et al. 1997, CDFG 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 12ºC to 14 ºC (54ºF to 57ºF) (Brett 1952).

5. <u>Estuarine Rearing</u>

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982, Levings 1982, Levings et al. 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1989) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean.

6. Ocean Rearing

Once in the ocean, juvenile Chinook salmon tend to stay along the California Coast (Moyle 2002). This is likely due to the high productivity caused by the upwelling of the California Current. These food-rich waters are important to ocean survival, as indicated by a decline in survival during years when the current does not flow as strongly and upwelling decreases (Moyle 2002, Lindley *et al.* 2009a). After entering the ocean, juveniles become voracious predators on small fish and crustaceans, and invertebrates such as crab larvae and amphipods. As they grow larger, fish increasingly dominate their diet. They typically feed on whatever pelagic plankton is most abundant, usually herring, anchovies, juvenile rockfish, and sardines. The Ocean stage of the Chinook life cycle lasts one to five years. Information on salmon abundance and distribution in the ocean is based upon CWT recoveries from ocean fisheries. For over 30 years, the marine distribution and relative abundance of specific stocks, including ESA-listed ESUs, has been estimated using a representative CWT hatchery stock (or stocks) to serve as proxies for the natural and hatchery-origin fish within ESUs. One extremely important assumption of this approach is that hatchery and natural stock components are assumed to be similar in their life histories and ocean migration patterns.

Ocean harvest of CV Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI). The CVI is the ratio of Chinook salmon harvested south of Point Arena (where 85 percent of CV Chinook salmon are caught) to escapement (adult spawner populations that have “escaped” the ocean fisheries and made it into the rivers to spawn). CWT returns indicate that Sacramento River Chinook salmon congregate off the California coast between Point Arena and Morro Bay.

Table 3. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River basin[a,b]					Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low					
Sac. River Mainstem[b,c]		Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low								
Mill Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium	Low	Low									
Deer Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium											
Butte Creek[d,g]			Low	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Low											
(b) Adult Holding[a,b]				Low	Low	Medium	Medium	High	High	High	High	High	High	High	High	Medium	Medium	Low	Low					
(c) Adult Spawning[a,b,c]															Low	Medium	High	High	Medium	Low				

(d) Juvenile migration

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Tribs[e]	Medium	Medium	Medium	Medium	Medium	Medium													Medium	Medium	High	High	High	High
Upper Butte Creek[f,g]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	High	High
Mill, Deer, Butte Creeks[d,g]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	Low	Low
Sac. River at RBDD[c]	High	High	Low	Low	Low	Low	Low	Low	Low												High	High	High	High
Sac. River at KL[h]	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium											Medium	Medium	High	High

Relative Abundance: ■ = High ■ = Medium ■ = Low

Sources: [a]Yoshiyama et al. (1998); [b]Moyle (2002); [c]Myers *et al.* (1998); [d]Lindley et al. (2004); [e]CDFG (1998); [f]McReynolds et al. (2007); [g]Ward et al. (2003); [h]Snider and Titus (2000)

Note: Yearling CV spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year CV spring-run Chinook salmon emigrate during the first spring after they hatch.

D. Description of Viable Salmonid Population (VSP) Parameters

As an approach to evaluate the likelihood of viability of the CV spring-run Chinook salmon ESU, and determine the extinction risk of the ESU, NMFS uses the VSP concept. In this section, we evaluate the VSP parameters of abundance, productivity, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000)

1. Abundance

Historically spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (California Department of Fish and Game 1990). These fish occupied the upper and middle elevation reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1872, Rutter 1904, Clark 1929).

The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (California Department of Fish and Game 1998a). The San Joaquin River historically supported a large run of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000–500,000 adults returning annually (California Department of Fish and Game 1990). Construction of Friant Dam on the San Joaquin River began in 1939 and when completed in 1942 blocked access to all upstream habitat. This population persisted until the Madera and Friant-Kern Canals were brought on line, several years later.

The FRFH spring-run Chinook salmon population represents the only remaining evolutionary legacy of the spring-run Chinook salmon populations that once spawned above Oroville Dam, and has been included in the ESU based on its genetic linkage to the natural spawning population and the potential development of a conservation strategy for the hatchery program. On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. Since 1954, spawning escapement has been estimated using combinations of in-river estimates and hatchery counts, with estimates ranging from 2,908 in 1964 to 2 fish in 1978 (California Department of Water Resources 2001). However, after 1981, CDFG (now CDFW, California Department of Fish and Wildlife) ceased to estimate in-river spawning spring-run Chinook salmon because spatial and temporal overlap with fall-run Chinook salmon spawners made it impossible to distinguish between the two races. Spring-run Chinook salmon estimates after 1981 have been based solely on salmon entering the hatchery during the month of September. The 5-year moving averages from 1997 to 2006 had been more than 4,000 fish, but from 2007 to 2011, the 5-year moving averages have declined each year to a low of 1,742 fish in 2011, and 2012 through 2015 were back up slightly to just over 2,000 fish [(California Department of Fish and Wildlife 2016); Table 4].

Genetic testing has indicated that substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to temporal overlap and hatchery practices (California Department of Water Resources 2001). Because Chinook salmon have not always been spatially separated in the FRFH, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock (Good *et al.* 2005a, Cavallo *et al.* 2011).

In addition, coded-wire tag (CWT) information from these hatchery returns has indicated that fall-run and spring-run Chinook salmon have overlapped (California Department of Water Resources 2001). For the reasons discussed above, the FRFH spring-run Chinook salmon numbers are not included in the following discussion of ESU abundance trends.

Monitoring the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates that some spawning occurs in the river. The lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem very difficult, but counts of Chinook salmon redds in September are typically used as an indicator of spring-run Chinook salmon abundance. Less than 15 Chinook salmon redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (The Energy Planning and Instream Flow Branch 2003).

Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 Chinook salmon redds from Keswick Dam downstream to the RBDD, ranging from 3 to 105 redds; 2012 observed zero redds, and 2013, 57 redds in September (CDFG, unpublished data, 2014).

Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely extensive introgression between the populations has occurred (California Department of Fish and Game 1998a). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the majority of the abundance, and are currently the only independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance. All tributaries combined are shown in Table 4, which are dominated by returns in Mill, Deer and Butte creek. Combined tributary returns from 1988 to 2015 have ranged from 1,013 in 1993 to 23,787 in 1998 (Table 4). Escapement numbers are dominated by Butte Creek returns (Good *et al.* 2005a), which averaged over 7,000 fish from 1995 to 2005, but then declined in years 2006 through 2011 with an average of just over 3,000 fish. During this same period, adult returns on Mill and Deer creeks have averaged over 2,000 fish total and just over 1,000 fish total, respectively. Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remained well below estimates of historic abundance.

Additionally, in 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006a). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of *Columnaris* (*Flexibacter columnaris*) and *Ichthyophthiriasis* (*Ichthyophthirius multifiis*) diseases in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to a pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the diseases. In 2015, Butte Creek again experienced severe temperature conditions, with nearly 2,000 fish entering the creek, only 1,081 observed during the snorkel survey, and only 413 carcasses observed, which indicates a large number of pre-spawn mortality.

Declines in abundance from 2005 to 2016 placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (National Marine Fisheries Service 2016b). Butte Creek has sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2016 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include Butte, Deer, and Mill creeks (National Marine Fisheries Service 2016b). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek, have seen population gains in the years from 2001 to 2014, but the overall abundance numbers have remained low. 2012 was a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 escapement numbers increased, in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. However, 2014 appears to be lower, just over 5,000 fish for the tributaries combined, which indicates a highly fluctuating and unstable ESU abundance. Even more concerning were returns for 2015, which were record lows for some populations. The next several years are anticipated to remain quite low as the effects of the 2012-2015 drought are fully realized.

2. <u>Productivity</u>

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested criteria for a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used. Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation.

From 1993 to 2007 the 5-year moving average of the tributary population CRR remained over 1.0, but then declined to a low of 0.47 in years 2007 through 2011. The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run Chinook salmon ESU currently is unknown, however the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.84, and 8.68 in 2013, due to increases in abundance for most populations. Although 2014 returns were lower than the previous two years, the CRR was still positive (1.85). However, 2015 returns were very low, with a CRR of 0.14, when using Butte Creek snorkel survey numbers, the lowest on record. Using the Butte Creek carcass surveys, the 2015 CRR for just Butte Creek was only 0.02.

Table 4. Central Valley Spring-run Chinook salmon population estimates from CDFW Grand Tab (2015) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average Tributary Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1,658	5.24		4,948	2.30	
1991	5,101	4,303	798	1,376	0.36		5,240	0.56	
1992	2,673	1,497	1,176	1,551	0.60		5,471	0.38	
1993	5,685	4,672	1,013	1,307	0.64	1.55	4,795	1.63	1.22
1994	5,325	3,641	1,684	1,253	2.11	1.79	4,454	1.04	1.18
1995	14,812	5,414	9,398	2,814	7.99	2.34	6,719	5.54	1.83
1996	8,705	6,381	2,324	3,119	2.29	2.73	7,440	1.53	2.03
1997	5,065	3,653	1,412	3,166	0.84	2.77	7,918	0.95	2.14
1998	30,533	6,746	23,787	7,721	2.53	3.15	12,888	2.06	2.23
1999	9,838	3,731	6,107	8,606	2.63	3.26	13,791	1.13	2.24
2000	9,201	3,657	5,544	7,835	3.93	2.44	12,669	1.82	1.50
2001	16,865	4,135	12,730	9,916	0.54	2.09	14,300	0.55	1.30
2002	17,212	4,189	13,023	12,238	2.13	2.35	16,730	1.75	1.46
2003	17,691	8,662	9,029	9,287	1.63	2.17	14,161	1.92	1.43
2004	13,612	4,212	9,400	9,945	0.74	1.79	14,916	0.81	1.37
2005	16,096	1,774	14,322	11,701	1.10	1.23	16,295	0.94	1.19
2006	10,828	2,061	8,767	10,908	0.97	1.31	15,088	0.61	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,591	0.71	1.00
2008	6,162	1,418	4,744	8,857	0.33	0.78	11,285	0.38	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,323	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.53	6,862	0.39	0.49
2011	5,033	1,969	3,064	3,961	0.65	0.47	5,703	0.82	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,702	3.87	1.16
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	4.85	2.06
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.68	2.32
2015	3,074	1,586	1,488	7,057	0.14	2.63	9,930	0.21	2.28
Median	9,775	3,616	6,159	6,541	1.97	1.89	10,220	1.00	1.46

[a] NMFS is only including the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.
[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

3. Spatial Structure

Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (*e.g.*, a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genotypic (DNA) characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genotypic diversity, on the other hand, provides populations with the ability to survive long-term changes in the environment. To meet the objective of representation and redundancy, diversity groups need to contain multiple populations to survive in a dynamic ecosystem subject to unpredictable stochastic events, such as pyroclastic events or wild fires.

The Central Valley Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Figure 17) (Lindley *et al.* 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and Butte creeks tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks, and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998). All historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated, although Battle Creek in the basalt and porous lava diversity group has had a small persistent population in Battle Creek since 1995, and the upper Sacramento River may have a small persisting population spawning in the mainstem river as well. The northwestern California diversity group did not historically contain independent populations, and currently contains two small persisting populations, in Clear Creek, and Beegum Creek (tributary to Cottonwood Creek) that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence. Construction of low elevation dams in the foothills of the Sierras on the San Joaquin, Mokelumne, Stanislaus, Tuolumne, and Merced rivers, is thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American River of the Sacramento River basin. However, observations in the last decade suggest that perhaps spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2014) .

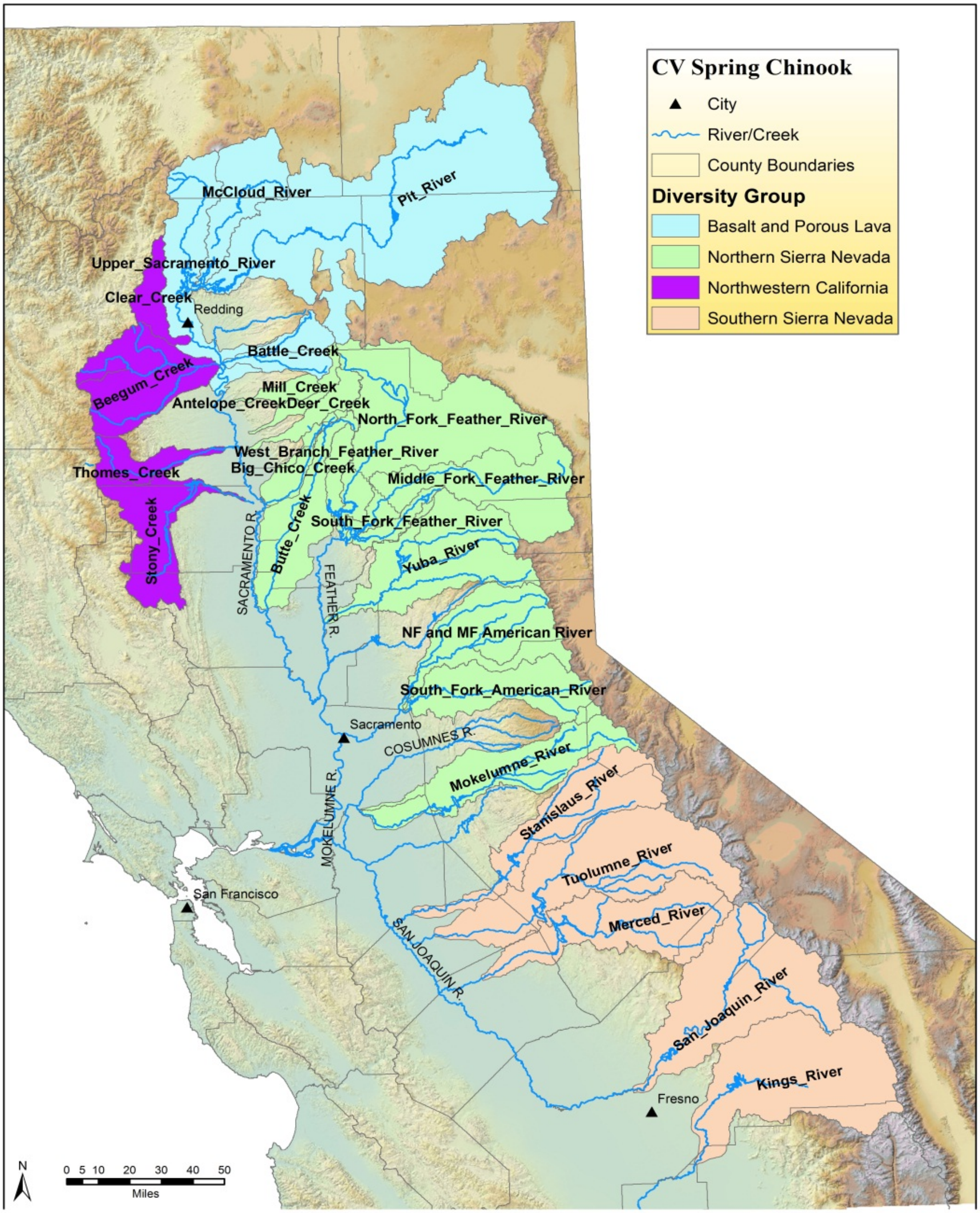

Figure 17. Diversity Groups for the Central Valley spring-run Chinook salmon ESU.

With only one of four diversity groups currently containing viable independent populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon adult returns are currently utilizing all available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration proposed actions completed and more underway, are anticipated to add to the spatial structure of the CV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the CV spring-run Chinook salmon ESU would still be lacking due to the extirpation of all San Joaquin River basin spring-run Chinook salmon populations. However, recent information suggests that perhaps a self-sustaining population of CV spring-run Chinook salmon is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne rivers.

Snorkel surveys (Kennedy and Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and 2004, as well as observed Chinook fry in December of 2003, which would indicate CV spring-run Chinook salmon spawning timing. In addition, monitoring on the Stanislaus since 2003 and on the Tuolumne since 2009, has indicated upstream migration of adult CV spring-run Chinook salmon (Anderson *et al.* 2007), and 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Finally, rotary screw trap (RST) data provided by Stockton U.S. Fish and Wildlife Service (USFWS) corroborates the CV spring-run Chinook salmon adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with CV spring-run juvenile Chinook salmon emigration (Franks 2014). Although there have been observations of springtime running Chinook salmon returning to the San Joaquin tributaries in recent years, there is insufficient information to determine the specific origin of these fish, and whether or not they are straying into the basin or returning to natal streams. Genetic assessment or natal stream analyses of hard tissues could inform our understanding of the relationship of these fish to the ESU.

The SJRRP has also been releasing juvenile CV spring-run Chinook into Reach 5 of the San Joaquin River Restoration area. The first release of CV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April, 2014. A second release occurred in 2015, and future releases are planned to continue annually during the spring. The 2016 releases included the first generation of CV spring-run Chinook salmon reared entirely in the San Joaquin River in over 60 years. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined, but the NMFS 2016 recovery plan specifically targets the San Joaquin River spring-run Chinook population as key to the recovery of the entire CV spring-run Chinook population.

Lindley *et al.* (2007b) described a general criteria for "representation and redundancy" of spatial structure, which was for each diversity group to have at least two viable populations. More specific recovery criteria for the spatial structure of each diversity group have been laid out in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014). According to the criteria, one viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group, in addition to maintaining dependent populations are needed for recovery. It is clear that further efforts would need to involve more than restoration of currently accessible watersheds to make the ESU viable. The NMFS Central Valley Salmon and Steelhead Recovery

Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as the reintroduction of a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River (NMFS 2014).

4. Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics (including rate of gene-flow among populations). Criteria for the diversity parameter are that human-caused factors should not alter variation of traits. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The CV spring-run Chinook salmon ESU is composed of two known genetic complexes. Analysis of natural and hatchery CV spring-run Chinook salmon stocks in the Central Valley indicates that the northern Sierra Nevada diversity group CV spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retains genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the Feather River fall-run Chinook salmon, and it appears that the Yuba River spring-run Chinook salmon population may have been impacted by FRFH fish straying into the Yuba River (and likely introgression with wild Yuba River fall-run has occurred). Additionally, the diversity of the CV spring-run Chinook salmon ESU has been further reduced with the loss of the majority if not all of the San Joaquin River basin spring-run Chinook salmon populations. Efforts underway like the San Joaquin River Restoration Project (to reintroduce a CV spring-run population below Friant Dam), are needed to improve the diversity of CV spring-run Chinook salmon.

5. Summary of ESU Viability

Because the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley *et al.* (2007a) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

Until 2012, the status of CV spring-run Chinook salmon ESU had deteriorated on balance since the 2005 status review and the Lindley *et al.* (2007a) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Additionally, Butte Creek remained at low risk, although it was on the verge of moving towards high risk, due to rate of population decline. In contrast, spring-run Chinook salmon in Battle and Clear creeks had increased in abundance since 1998, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have likely increased at least in part due to extensive habitat restoration. The Southwest Fisheries Science Center concluded in their viability report that the status of CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased (Williams *et al.* 2011a). The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

The viability assessment of CV spring-run Chinook salmon conducted during NMFS' 2010 status review (National Marine Fisheries Service 2011), found that the biological status of the ESU had worsened since the last status review (2005) and recommend that its status be reassessed in two to three years as opposed to waiting another five years, if the decreasing trend continued and the ESU did not respond positively to improvements in environmental conditions and management actions. In 2012 and 2013, most tributary populations increased in returning adults, averaging over 13,000. However, 2014 returns were lower again, just over 5,000 fish, indicating the ESU remains highly fluctuating. The most recent status review was conducted in 2015 (National Marine Fisheries Service 2016b), which looked at promising increasing populations in 2012-2014. However the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record lows. Because the effects of the 2012-2015 drought have not been fully realized, we anticipate at least several more years of very low returns, which may reach catastrophic rates of decline.

2.2.3 Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley, and aquatic habitat at large is climate change.

Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen *et al.* 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991, Dettinger *et al.* 2004). Specifically, the Sacramento River basin annual runoff amount for April-July has been decreasing since about 1950 (Roos 1991). Increased temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen *et al.* 2004). Factors modeled by VanRheenen *et al*. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100% in shallow snowpack areas). Additionally, an air temperature increase of 2.1°C (3.8°F) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen *et al*. 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south.

Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006b). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951- 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally producing fall-run Chinook salmon are thermally acceptable. This would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al.* 2013).

Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough *et al.* 2001b). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.3.1 Status of the Species in the Action Area

2.3.1.1 Status of Central Valley Spring-run Chinook salmon in the Action Area

Historically, CV spring-run Chinook salmon spawned in the San Joaquin River from about the present day location of Friant Dam to as far upstream as Mammoth Pool (RM 322) (McBain and Trush 2002). During the late 1930s and early 1940s, as Friant Dam was being constructed, large runs continued to return to the river. After the dam was completed and the reservoir was filling, runs of 30,000 to 50,000 fish continued to return and spawn in the river downstream of Friant Dam. These runs were completely gone by 1950, as diversions from Friant Dam resulted in the river being dry for extended sections starting at Gravelly Ford and below Sack Dam (McBain and Trush 2002). The occurrence data and available information suggest that CV spring-run Chinook salmon were not recently present within the proposed action area prior to SJRRP restoration activities.

The SJRRP started releasing juvenile CV spring-run Chinook salmon into the San Joaquin River in 2014 (60,114 from Feather River Fish Hatchery (FRFH)), 2015 (54,924 FRFH), and 2016 (57,320 FRFH and 47,550 from the Interim Salmon Conservation and Research Facility). Some of the hatchery-reared juvenile CV spring-run Chinook salmon could have returned to the San Joaquin River as early as spring 2016, but none were seen; likely due to the drought conditions of 2014 and 2015.

When adult CV spring-run Chinook salmon do return they would be trapped at the Hills Ferry Barrier and hauled to Reach 1 until there is unimpeded passage, which is anticipated to occur in 2021. With unimpeded passage, there will also be an increased possibility of CV spring-run Chinook salmon from outside the Restoration area naturally straying into the action area. These fish will be treated as part of the experimental population once they enter the Restoration area. Some migrating adult CV spring-run Chinook salmon may bypass the traps at the Hills Ferry Barrier location and continue migrating upstream. In order for these individuals to enter the action area, they would need to ascend past both Sack Dam and Mendota Dam, which would likely be possible only during high flow events when the flash boards are removed at Mendota Dam.

When adult CV spring-run Chinook successfully spawn in Reach 1, either after migrating naturally during a flood flow or being trapped and hauled from Reach 5, juveniles could emigrate through the proposed action Area during the early stages of construction: approximately 2017 to 2019 (SJRRP 2015). As proposed action construction progresses (approximately 2020 to 2021), a permanent fish passage structure is expected to become operational at Sack Dam, increasing the possibility that adult CV spring-run Chinook could naturally enter the proposed action area. However, Mendota Dam would continue to be passable during only high flow events and the compact bypass would not yet be open. Trapping of migrating adults would continue within Reach 5 and individuals would continue to be hauled to Reach 1 and released.

Beginning in 2021, the compact bypass channel would open, allowing CV spring-run Chinook salmon to migrate through the proposed action area unimpeded. Once the compact bypass channel is opened, the likelihood of CV spring-run Chinook salmon migrating through the proposed action area to spawn in Reach 1 would significantly increase. Similarly, the likelihood of emigrating juveniles would significantly increase after the compact bypass is functional.

The NMFS 2014 Recovery Plan identifies the SJRRP as a primary area for the reintroduction of CV spring-run Chinook salmon. The plan identifies there needs to be two distinct populations of CV spring-run Chinook salmon within the Southern Sierra Nevada range but the area below Friant Dam is the primary reintroduction priority. The proposed action is a key project in creating volitional passage from the confluence of the Merced to the spring-run holding areas below Friant Dam and will be an important milestone in the reintroduction of CV spring-run Chinook to the San Joaquin River.

2.3.1.2 Status of California Central Valley Steelhead in the Action Area

Historic abundance of CCV steelhead in the action area is difficult to determine, but CCV steelhead were widely distributed, with abundance estimates of 1 to 2 million adults annually, throughout the Central Valley system as a whole (McEwan 2001). There is currently a very low potential for CCV steelhead to pass downstream barriers and arrive naturally in the action area. CCV steelhead cannot access the action area during most flows because there is no fish passage over Sack or Mendota dam, although passage is possible during very high flow events. Should CCV steelhead swim over Sack Dam during higher flow events, they may not be able to ascend Mendota Dam. CCV steelhead could potentially access the San Joaquin River upstream of Mendota Dam when the flash boards are removed during very high flow events. If adult CCV steelhead were to successfully migrate and spawn in Reach 1, then juveniles could access Reach 2B (the action area) under current conditions by swimming downstream. Kelts could also emigrate through Reach 2B from Reach 1 after spawning. If CCV steelhead were present in the action area, the likelihood of survival would be low, as current conditions do not reliably provide suitable rearing or migratory habitat.

Steelhead have been captured in the three main tributaries of the San Joaquin River: the Stanislaus, Tuolumne, and Merced rivers. However, they likely do not currently occur in the San

Joaquin River mainstem upstream of the lower terminus of Reach 5, which includes the action area (Eilers *et al.* 2010). Two successive years of monitoring in 2012 and 2013 failed to capture CCV steelhead in Reaches 4B and 5, leading to the belief that CCV steelhead have been extirpated from all reaches of the SJRRP Restoration Area (SJRRP 2012b, SJRRP 2013). However, CCV steelhead were observed in Reach 1 during flood conditions in the mid-1990's (Rhonda Reed, Personal Communication) when the river flowed between Friant Dam and the Merced River. Monitoring would continue in the downstream reaches of the SJRRP Restoration Area as part of the CCV steelhead Monitoring Plan (SJRRP 2015b).

Presence of anadromous fish upstream of the action area would initially be controlled by the SJRRP. Over the course of proposed action construction, the likelihood of salmonid presence in the area would increase due to the construction of fish passage improvements in the Restoration Area. During the early stages of proposed action construction (approximately 2016 through 2019), a temporary trap and haul program is expected to be necessary to provide fish passage in portions of the restoration area. No passage would be provided at Mendota Dam and it would continue to be passable only under very high flows. The likelihood of CCV steelhead presence in the action area would continue to be low, unless large flood releases were to occur. CCV steelhead monitoring in Reach 5 would occur when the Hills Ferry Barrier is not in place (mid-December through mid-September) and when restoration flows meet with the Merced River. When monitoring is taking place, fyke traps would be installed and the majority of migrating CCV steelhead would be trapped and released at the mouth of the Merced River. Some CCV steelhead would bypass the fyke traps and continue migrating upstream, potentially entering the action area. However, due to the monitoring efforts, there would be some warning that CCV steelhead could be present in the San Joaquin River during construction so that an increased effort can be made to avoid impacts to CCV steelhead during these times. If CCV steelhead successfully migrate and spawn in Reach 1, juveniles and kelts could emigrate through the action area during construction. CCV steelhead present in the action area during the early stages of proposed action construction would likely experience low survival rates as the conditions would not yet reliably provide suitable rearing or migratory habitat.

As proposed action construction progresses (approximately 2020 to 2021), a permanent fish passage structure would become operational at Sack Dam, increasing the possibility that CCV steelhead could enter the action area. Mendota Dam would continue to be passable during only high flows and the compact bypass may not yet be open. Trapping and monitoring of migrating CCV steelhead would continue to help inform Reclamation of the possible presence of CCV steelhead through the action area during construction. There likely would be poor survival of CCV steelhead present in the action area during this period as suitable rearing and migratory habitat would not be reliably present.

Estimation of CCV Steelhead Abundance in the Action Area

Because no spawning population of CCV steelhead currently exists in the upper reaches of the San Joaquin River an estimate of the possible future number of CCV steelhead, potentially occurring in the action area sometime during or after construction of the proposed action, was calculated using data of non-hatchery origin adult and juvenile CCV steelhead from the Mokelumne River system. Reclamation took this approach during their effects analysis for the Biological Assessment, as the best available science.

Spawning Adults. The number of non-hatchery origin adult CCV steelhead (i.e., CCV steelhead with intact adipose fins) was divided by the estimated length of available habitat from the Mokelumne River system to obtain the density of fish spawning per mile of habitat.

Between 2002 and 2010, an average of 22 adult CCV steelhead (wild fish greater than 16 inches) per year returned to the river (MRHS 2012). The length of available habitat on the Mokelumne River was estimated to be 33.5 river miles, which is the distance between the confluence with the Sacramento-San Joaquin Delta and the Camanche Dam, the upstream limit of anadromous salmonid migration on the Mokelumne River (Merz and Setka 2004). This area contains suitable temperatures and flows to support the migration of spawning adults, but not all available habitat is necessarily spawning habitat. Based on this calculation, each river mile of the Mokelumne River supports 0.7 spawning adults annually.

Similarly to the available habitat estimate for Mokelumne River, available habitat for the San Joaquin River was defined as habitat containing suitable temperatures and flows to support spawning adult migration, but not necessarily containing suitable spawning habitat. Currently such habitat is limited to Reach 1A, where available salmonid habitat has been identified using temperature and flow models (Reclamation 2014) . These models predict that a total of 24 river miles of available habitat exists from below Friant Dam (Mile Post [MP] 267) to State Route 99 Bridge (MP 243; Reclamation 2014).

In order to calculate the number of adult CCV steelhead that could potentially spawn in Reach 1A, the estimated number of spawning adults per river mile in the Mokelumne River was multiplied by the number of river miles containing suitable habitat in Reach 1A. This calculation assumes that Reach 1A would support a density of spawning adults similar to the Mokelumne River, and that the density of spawning habitat in Reach 1A is similar to the Mokelumne River. Based on this calculation, Reach 1A would support 17 spawning adult CCV steelhead annually (rounded up to the nearest whole fish). The rate of CCV steelhead iteroparity is estimated to be between 17 and 23 percent in California (Boggs *et al.* 2008). Therefore, of the total number of estimated spawning adults, 4 kelts could survive spawning and emigrate through Reach 2B annually.

Emigrating Juveniles. The number of non-hatchery origin juveniles (i.e., juveniles with intact adipose fins) was taken from rotary screw trap data (Bilski *et al.* 2011, 2013, 2014) with an average annual total of 294 emigrating juveniles (rounded up to the nearest whole fish) from February to June of 2011, 2013, and 2014 (Table 5).

Table 5. Monthly Totals of Juvenile Emigrating California Central Valley Steelhead (Intact Adipose) in the Lower Mokelumne River in 2011, 2013, and 2014. (Pg. 3-10, Table 7, Reclamation BA)

Year	Mont					Total
	Feb	Mar	Apr	May	June	
2010-2011	2	4	38	172	121	337
2012-2013	22	82	114	129	7	354
2013-2014	10	43	76	41	19	189
Average/sampling	11.33	43	76	114	49	293.33

Additionally, an estimated number of emigrating juveniles was calculated using the assumption of 17 spawning adult CCV steelhead in the San Joaquin River (See Spawning Adults calculation above). Assuming the male to female ratio is 1:1, there would be approximately 9 spawning females. A female CCV steelhead can carry approximately 2,000 eggs per kilogram (kg) of body weight (Moyle 2002). Spawning female CCV steelhead weigh an average of 0.68 kg; therefore, a typical spawning female can carry approximately 1,360 eggs. The survival of CCV steelhead from egg to smolt is 0.014 (Williams 2010), so each spawning female can potentially produce 19 smolt annually. If each of the estimated 9 spawning females in the San Joaquin River produced 19 smolt annually, there would be a total of 171 juveniles (rounded up to the nearest whole fish) that could potentially survive, rear in, and emigrate through Reach 2B from February to June.

The number of emigrating juveniles from the Mokelumne River rotary screw trap (294 emigrating juveniles) and the number calculated using the adult fecundity and survival assumptions (171 juveniles) were averaged to obtain a population estimate of 233 emigrating juvenile CCV steelhead in the San Joaquin River.

Beginning in 2021, the compact bypass channel would open, allowing for unimpeded migration through the Action Area. Once the compact bypass channel is opened, the likelihood of CCV steelhead migrating through the action area to spawn in Reach 1 would increase. Similarly, the likelihood of emigrating juveniles and kelts would increase after the compact bypass is opened. In-water construction of the Mendota Pool Control Structure and the Chowchilla Fish Passage Structure would continue to occur until 2024. Once the floodplain is restored and the proposed action is complete in 2027, the likelihood of survival of CCV steelhead in Reach 2B would increase due to the presence of high quality rearing and migratory habitat. If and when CCV steelhead recolonize the upper San Joaquin River, they would most likely spawn in Reach 1 and utilize Reach 2B as a migration corridor and as rearing habitat.

2.3.2 Factors Affecting the Species in the Action Area

The action area encompasses a small portion of the area utilized by the CV spring-run Chinook salmon ESU and the CCV steelhead DPS. Many of the factors affecting these species throughout their range are discussed in the *Status of the Species* section of this BO, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed project.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Flows released from Millerton Reservoir through Friant Dam have generally dried up or gone subsurface before or once reaching Gravelly Ford, and water that is pumped from the Delta via the Delta Mendota Canal forms Mendota Pool at the bottom of reach 2B. Mendota Pool has been dewatered multiple times for construction and maintenance of water conveyance infrastructure. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices upstream require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.* levees and bypasses). Consequently, managed flows in the mainstem of the river often truncate the peak of the flood hydrograph and extended the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel, and disrupt natural sediment transfer in general.

High water temperatures also limit habitat availability for listed salmonids in the lower San Joaquin River. High summer water temperatures in the lower San Joaquin River can exceed 72^{o}F, and create a thermal barrier to the migration of adult and juvenile salmonids (Myers *et al*. 1998). In addition, water diversions at the dams (*i.e.* Friant, Goodwin, La Grange, Folsom, Nimbus, and other dams) for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of juvenile salmonids (Reynolds *et al*. 1993) in these tailwater sections.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of and within the action area. The effects of these impacts are discussed in detail in the *Status of the Species* section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*e.g.* green sturgeon, Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.* heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the San Joaquin River (USFWS 1995b).

Downstream migration barriers, which represent an important impact to adult migration present in the action area, are discussed in the *Status of Species* section above.

As previously stated in the *Status of the Species*, the transformation of the San Joaquin River from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the river's sinuosity (USFWS 2000). In addition, the change in the ecosystem as a result of the removal of riparian vegetation in the Delta likely impacted potential prey items and species interaction that green sturgeon would experience while holding. The effects of channelization on upstream migration of green sturgeon are unknown.

2.3.3 NMFS' Salmon and Steelhead Recovery Plan Action Recommendations

The NFMS recovery plan that includes both CCV steelhead and CV spring-run Chinook salmon (NMFS 2014), identifies recovery goals for the San Joaquin River Restoration Program area Population which includes the proposed action area. Recovery efforts are focused on addressing several key stressors including: (1) elevated water temperatures affecting adult migration and holding; (2) low flows and poor fish passage facilities, affecting attraction and migratory cues of migrating adults; and (3) possible catastrophic events (e.g. fire or volcanic activity). Recovery actions identified in the recovery plan that are relevant to this consultation include: implementing restoration flows outlined in the SJRRP settlement agreement, reintroducing CV spring-run Chinook salmon, implementing channel modifications as outlined in the SJRRP settlement agreement, minimizing entrainment to non-viable migration pathways, and construction of a Mendota Pool Bypass.

2.3.4 Climate Change

Rangewide climate change information for CCV steelhead and CV spring-run is presented in Section 2.2 of this opinion and potential operational impacts due to changes in river runoff patterns and increases in water temperature from climate change are described in Section 2.3.2.

In the future, the proposed action area will likely experience additional changes in environmental conditions due to climate change. These changes may overlap with the direct and indirect effects of long term proposed actions. Thus, for long-term actions, we can no longer assume current environmental variability adequately describes environmental baseline conditions. Instead, we need to project baseline conditions into the future, synchronizing our projections with the duration of the effects of the proposed action we are analyzing.

Within the context of the relatively brief period of time over which the proposed action is scheduled to be constructed and operated, however, the near term effects of global climate change are unlikely to result in any perceptible declines to the overall health or distribution of the listed populations of anadromous fish within the action area that are the subject of this consultation.

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that would be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The SJRRP would implement a Steelhead Monitoring Program from February to March to monitor for the presence of CCV steelhead. The monitoring program has not observed CCV steelhead in the restoration area since its inception in 2012, leading to the belief that CCV steelhead have been extirpated from all reaches of the SJRRP Restoration Area (SJRRP 2012b, SJRRP 2013). In 2016 the San Joaquin River is expected to be reconnected throughout the restoration area (Reach 1-5). Although these new flows have the potential to attract CCV steelhead into the restoration area, they are currently very low due to seepage requirements within Reach 4B, and until those issues can be resolved no more than 40 cfs would be released past Sack Dam, so connectivity for fish passage would be possible but unlikely. However, in large water years, with uncontrolled flood flows, there is a potential for the SJR to reconnect and volitional passage could be restored for a limited amount of time. Thus, this effects analysis is predicated on the fact that there is the unlikely possibility of CCV steelhead being present within the action area during proposed action construction.

If adult CV spring-run Chinook salmon were to return in spring of 2017 or beyond, they would also potentially be able to enter the construction area during uncontrolled flood flows. Returning adult CV spring-run Chinook salmon could enter the construction area if the SJRRP monitoring program detects wild CV spring-run Chinook salmon adults within Reach 5. Those fish would be trapped and hauled up to Reach 1, and then volitionally move down from Reach 1 into the construction area, despite anticipated temperature barriers.

Construction effects on juvenile CV spring-run Chinook salmon and CCV steelhead could be more significant if adults successfully arrive in Reach 1, spawn, and produce offspring. Currently there are plans to trap juvenile CV spring-run Chinook salmon if wild adults are observed spawning, but it is unlikely that these efforts would capture all juveniles produced. Therefore, there is a possibility that some juvenile CV spring-run Chinook salmon could show up at the construction area. However, the CV spring-run Chinook salmon juveniles that could be present during construction would not have take prohibitions under Section 9 of ESA because of their designation as an Experimental Population under the 10(j) rule.

CCV steelhead juveniles could only be present in the construction area if a pair of adults successfully migrated into Reach 1, spawned, and then produced offspring that migrate to the ocean. Although this scenario is possible, it is not likely. Therefore, the likelihood of the presence of juvenile CV spring-run Chinook salmon and CCV steelhead in the proposed action area during construction is not high, and the potential effects are likely minor.

Fish passage would improve when the first steps in the proposed action become complete. While this is good for SJRRP and for the fish populations, it would increase the likelihood for both adult and juvenile CV spring-run Chinook salmon and CCV steelhead to be present in the action area in much greater numbers than in the early stages of the proposed action. Therefore, the BMPs and minimization measures must be maintained throughout the entirety of the proposed action.

The overall proposed action involves the following potential effects:

1) Construction and Maintenance Effects
    a. Erosion and Sedimentation
    b. Increased Turbidity
    c. Loss/degradation of habitat
    d. Hazardous Materials
    e. Increased Temperature
    f. Hazardous Noise Levels
    g. Physical Disturbance

2) Operations
    a. Entrainment

3) Beneficial Effects
    a. Habitat Improvements
    b. Fish Passage
    c. Entrainment Reduction

2.4.1 Construction and Maintenance Effects

The majority of construction and maintenance activities would occur in the dry, and would therefore not have direct affects to fish. Construction activities with potential to impact CCV steelhead and CV spring-run Chinook salmon include several actions that require the construction of cofferdams, including: the removal of the San Mateo Avenue crossing, installation of the Columbia Canal intake siphon in Mendota Pool, construction of the Mendota Pool Control Structure, installation of sheet piles along the north levee prior to the construction of the Compact Bypass Control Structure and excavation of the compact bypass immediately upstream of the control structure, and construction of the Chowchilla Fish Passage Structure.

Cofferdams would be installed to allow construction to occur in isolation from the river channel or Mendota Pool, in the dry (to the extent that dewatering achieves a dry condition), to minimize river turbidity, and to limit contact between proposed action activities and the channel segments potentially supporting CCV steelhead or CV spring-run Chinook salmon. However, the installation of cofferdams generates a number of potential effects, including: entrainment, erosion and sedimentation, turbidity, noise issues, passage issues, and physical disturbance. In addition, fish entrained behind the cofferdam would be exposed to increased water temperatures and decreased DO concentrations, and would be vulnerable to predation by other entrained fish and potential stranding (Cushman 1985).

Construction and maintenance activities would involve the use of heavy machinery, the removal of existing infrastructure, and the application of greases and other chemicals that are standard for maintenance, all of which have the potential to introduce hazardous materials to the site.

All construction related effects will be prevented or avoided, to the best ability, with implementation measures and BMPs listed in section 1.3.6. Also, during the planning and concurrence phase of each step of the proposed action, specific BMPs and potential effects will be considered and accounted for.

2.4.1.1 Erosion and Sedimentation

The proposed action activities, including construction of the cofferdams, may cause erosion, which could result in sediment entering the existing San Joaquin River channel. Adverse effects of increased sedimentation in the river channel could lead to a reduction in prey abundance for salmonids, and habitat alterations that are deleterious for spawning or migration, but would be minimized by implementing the Conservation Measures as described in Section 1.3.6.2 above. Also, fish are unlikely to be present in the area during this time.

2.4.1.2 Increased Turbidity

Construction of proposed action components that occur in the San Joaquin River channel may cause temporary increases in turbidity in the action area. Installation of cofferdams may cause temporarily elevated turbidity levels as sheet piles are driven. Prior to construction of the Compact Bypass Control Structure and excavation of the area immediately upstream of the control structure, a row of sheet piles may be driven along the existing levee north of the San Joaquin River between the levee and the river. Driving of these sheet piles may also temporarily increase turbidity levels in the San Joaquin River. Finally, creation of the Pilot Channel, which would create a smoother transition between Reach 2B and the Bypass channel and reduce sedimentation downstream into Reach 3, would require dredging of the San Joaquin River for approximately one mile beginning at the Compact Bypass Control Structure and moving upstream.

If salmonids are present in the action area during construction, elevated turbidity levels may negatively impact foraging ability, which could in turn lead to reductions in growth. Short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, and exposure to sediment released into the water column. Fish responses to increased turbidity and suspended sediment can range from behavioral changes (alarm reactions, abandonment of cover, and avoidance) to sublethal effects (e.g., reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe and Jensen 1996). However, turbidity would occur only during construction activities and would therefore be localized and short-term. Adverse effects to CCV steelhead and CV spring-run Chinook salmon resulting from turbidity would be minimized by implementing the Conservation Measures as described in Section 1.3.6.2 above. In addition, excavation of the Pilot Channel, which would likely create the largest increase in turbidity, would occur during summer months when high temperatures in Mendota Pool would discourage salmonid presence.

2.4.1.3 Loss/Degradation of Habitat

The proposed action construction activities may result in the temporary loss of habitat that may be occupied by CCV steelhead or CV spring-run Chinook salmon. Loss of habitat could occur due to construction of cofferdams, which would dewater portions of the channel. Removal of riparian vegetation could cause a temporary reduction in cover for salmonids. During construction, the proposed action would cause temporary loss of salmonid habitat due to dewatering or removal of riparian vegetation; however after proposed action completion and in the long term, the proposed action would result in a net increase in rearing and migration habitat for salmonids.

2.4.1.4 Hazardous Materials

Accidental spills of hazardous materials (e.g., oils, transmission and hydraulic fluids, cement, fuel, rodenticides, etc.) could occur during construction and maintenance. These materials could enter the San Joaquin River or contaminate riparian areas adjacent to the river. Adverse effects of pollutants in the river channel could include injury or mortality of CCV steelhead or CV spring-run Chinook salmon. The introduction of pollutants may also harm salmonids if the pollutants cause a reduction in available prey abundance or if contaminated prey are consumed by salmonids. However, adverse effects would be avoided through implementation of Conservation Measures as described in Section 1.3.6.4 above.

Adherence to BMPs that dictate the use, containment, and cleanup of contaminants would minimize the risk of introducing such products to the waterway because the prevention and contingency measures would require frequent equipment checks to prevent leaks, would keep stockpiled materials away from the water, and would require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. Heavy equipment operated in the river would use biodegradable hydraulic fluid. Implementation of BMPs would prevent fuel spills or toxic compounds from causing injury or death to individual fish. The use of avoidance and minimization measures for the handling and containment of hazardous materials would minimize the risk of injury or mortality to all life stages of spring- run Chinook salmon, and CCV steelhead, to a level where take would not occur.

2.4.1.5 Increased Temperature

The proposed action may cause temporary changes in water temperature in the existing channel. Water temperatures may increase if proposed action activities alter flows or channel morphology during construction. In addition, removal of riparian vegetation associated with proposed action activities could cause a temporary reduction in shading of the existing channel and thus lead to increases in water temperature. Further, fish that may become entrained upstream of temporary cofferdams may experience increased water temperatures.

CCV steelhead reach optimal growth rates when water temperatures are between 15 and 18 degrees Celsius (°C; Moyle 2002). Moderate increases in water temperature (to 22°C) cause behavioral changes associated with thermal stress including decreased rates of foraging and increased intraspecific aggression in CCV steelhead (Nielsen *et al.* 1994). Water temperatures above 25°C cause significant CCV steelhead mortality (Myrick and Cech 2001). Adult Chinook salmon prefer to migrate upstream from the Delta to the San Joaquin River when water temperatures are 18.3°C, however they would continue to migrate until water temperatures reach 21.1°C (Boles *et al.* 1988). Adult CV spring-run Chinook salmon in the Sacramento-San Joaquin River system spend the summer in pools below 21 to 25 °C (Moyle *et al.* 1995). Spawning occurs between 4.5 and 12.8°C and rearing juveniles can survive temperatures ranging from 0 to 24°C (Raleigh *et al.* 1986). Sustained water temperatures above 27°C cause mortality in adult CV spring-run Chinook salmon (Moyle *et al*. 1995). As discussed at the beginning of section 2.4, it is unlikely that fish would be present when the proposed action is causing water levels to increase to toxic levels.

2.4.1.6 Hazardous Noise Levels

Construction activities may produce noise that has the potential to harm CCV steelhead or CV spring-run Chinook salmon if they are present near proposed action activities during construction. Sheet pile installation would occur during construction of cofferdam, and sheet piles may also be installed along the existing north levee adjacent to the future entrance of the compact bypass prior to the construction of the Compact Bypass Control Structure and excavation of the area immediately upstream of the control structure.

Sheet pile installation would create noise and vibrations within the water column that could impact fish that are present near the work area. Underwater noise generated during sheet pile installation would most likely cause behavioral changes in salmonids, if present. Fish may display dispersal or avoidance behavior in response to underwater noise. Individuals may be injured or killed if they occur directly adjacent to proposed action activities that produce extremely loud underwater noise.

Applicable Noise Criteria for Fish. On July 8, 2008, the Fisheries Hydroacoustic Working Group (FHWG), whose members include NMFS' Southwest and Northwest Divisions; California, Washington, and Oregon departments of transportation; the DFW; and the U.S. Federal Highway Administration issued an agreement for the establishment of interim threshold criteria to determine the effects of high-intensity sound on fish.

While these criteria are not formal regulatory standards, they are generally accepted as viable criteria for underwater noise effects on fish. These criteria were established after extensive review of analysis of the effect of underwater noise on fish. The agreed-upon threshold criteria for impulse-type noise to harm fish have been set at 206 dB peak, 187 dB accumulated SEL for fish over 2 grams, and 183 dB for fish less than 2 grams (Table 6).

Table 6. FHWG Underwater Noise Thresholds for Fish

Impulse and Continuous Sound	Peak Noise (dB)	Accumulated Noise (SEL) (dB)
Fish under two grams in weight	>206	>183
Fish over two grams in weight	>206	>187

Source: (FHWG 2008), dB = decibel, SEL = sound exposure level

The FHWG has determined that noise at or above the 206-dB peak level can cause barotrauma to auditory tissues, the swim bladder, or other sensitive organs. Noise levels above the accumulated SEL may cause temporary hearing-threshold shifts in fish.

Behavioral effects are not covered under these criteria but could occur at these levels or lower. Behavioral effects may include fleeing and the temporary cessation of feeding behaviors. A specific criterion has not yet been set by the FHWG for continuous noise, such as vibratory driving, so the same criteria as impulse-type noise would be used for this analysis. Juvenile CV spring-run Chinook salmon emigrate downstream as smolts between the sizes of 80 to 150 millimeter fork length, when they weigh approximately 6 to greater than 14 grams (MacFarlane and Norton 2002, Moyle 2002). Therefore, for the purposes of this analysis, a 206-dB peak level and 187-dB SEL are used as thresholds for potential harm to listed fish species.

Effects to Salmonids during Sheet Pile Installation. Sheet piles may be installed into the alluvium of San Joaquin River to create temporary cofferdams needed for the flow diversion systems or to reinforce levees. When possible, sheet piles would be installed using a vibratory hammer because NMFS considers this method to be less harmful to fish than pile driving with an impact hammer. However, certain scenarios may require the use of impact pile driving. The sound generated from either method is not expected to reach levels that would harm or injure fish. Some of the sheet piles would be placed and driven outside of the wetted channel which would attenuate sound transmission more rapidly. Yet, fish are unlikely to be in the area during construction.

2.4.1.7 Summary

In summary, the majority of construction and maintenance activities would occur in the dry, and would therefore not have direct affects to fish. However, as noted above, several construction activities require the construction of cofferdams, which can generate a number of potential negative effects including entrainment, erosion and sedimentation, turbidity, hazardous noise levels, passage issues, physical disturbance, pollution, predation, and diminished water quality conditions. These activities include: the removal of the San Mateo Avenue crossing, installation of the Columbia Canal intake siphon in Mendota Pool, construction of the Mendota Pool Control Structure, installation of sheet piles along the north levee prior to the construction of the Compact Bypass Control Structure and excavation of the compact bypass immediately upstream of the control structure, and construction of the Chowchilla Fish Passage Structure. However, all construction related effects will be prevented or avoided, to the best ability, with implementation measures and BMPs listed in section 1.3.6. Further, after proposed action completion and in the long term, the proposed action would result in a net increase in rearing and migration habitat for salmonids.

2.4.2 Operational Effects

The primary potential effects to listed species from the proposed action may occur from operations of the Reach 2B project elements.

2.4.2.1 Entrainment

Water Delivery Operations/Flood Flow Operations

During deliveries to Mendota Pool, most or all of the compact bypass gates would be closed to back up water roughly 10-12 feet in elevation. This would create a slack water pool directly behind the compact bypass that extends for roughly seven miles upstream of the bifurcation system. There is a high potential for migrating salmonids to be present during these times (juvenile CV spring-run Chinook during flood releases and juvenile CCV steelhead during Exchange Contractor deliveries). It is likely this pool would create predator friendly habitat and inhibit the migration of juvenile/adult salmonids. Upstream passage of adult salmonids would be available due to a fish ladder that would be operational when water has been backed up to elevation of Mendota Pool (roughly 10-12 feet). The fish ladder would be modeled using criteria based on *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guideline for Salmonid Passage at Stream* Crossing (NMFS 2001).

The slack water would act as a small reservoir forcing juvenile salmonids to actively swim downstream, potentially increasing stress (Personal Communication: Cyril Michel, SWFSC). If one or more of the gates are partially open it could be difficult for the juveniles to navigate to the open gates. If none of the gates are open then there would not be volitional passage downstream. There is a possibility that 20-22% of the water being delivered to Mendota Pool would be allowed to pass through the compact bypass because 20% of the exchange contractors flows are distributed downstream to Arroyo Canal (Reclamation 2016); but, routing decisions on the Arroyo Canal distribution would be made on a case by case basis. There is also an opening at the bottom of Mendota Dam which is how water currently flows into Reach 3 to be delivered to Arroyo Canal; which could also potentially provided downstream passage for juvenile salmon.

There is evidence that reservoir like conditions create issues for juvenile salmon migration (Jepsen *et al.* 1998). Juvenile salmon become metabolically stressed with increased temperature and decreased dissolved oxygen, while predators (such as Striped Bass) become more metabolically fit with increased temperatures and lowered dissolved oxygen (Personal Communication: Brendan Lehman, SWFSC). This could lead to reduced salmonid fitness while concurrently leading to increased predator fitness creating higher risk of predation throughout these areas, during delivery situations. There is also evidence of increased predator presence in areas with habitat alterations, such as small dams and that ‘predator pits’ can be created downstream of dammed pools (Sabal *et al.* 2016). There is currently no standardized way to account for how much predation may occur due to these altered migration conditions. During water deliveries to Mendota Pool there would likely be increased predation within the slack water upstream of the bifurcation system, on the downstream side of the compact bypass, and the water conditions caused by the standing water would increase metabolic stress to juvenile salmonids moving through the system.

There is also an issue of fish being entrained in Mendota Pool during deliveries. The Mendota Pool Entrainment: Fish Screen Assessment (Reclamation 2016) estimates that on average 2.68% of CCV steelhead juveniles and 3.96% of juvenile CV spring-run Chinook salmon could be annually entrained in Mendota Pool and lost to the population (Tables 7 and 8). On further inspection some years there would be no deliveries to Mendota Pool resulting in no losses of juveniles but in other years the model predicts, as much as, 40% of juvenile CCV steelhead or 25% of juvenile CV spring-run Chinook salmon could be lost to Mendota Pool during delivery years (Reclamation 2016). During any type of flood flows from the Kings River, the boards at Mendota Dam would be pulled, increasing the likelihood of juvenile salmonids to successfully navigate Mendota Pool into Reach 3 (Personal Communication: Katrina Harrison, Reclamation).

To minimize these losses Reclamation has proposed to add a fish screen on the river side of the Mendota Pool Control Structure, likely as the last step (step 5) of this proposed action. Although a fish screen would not provide 100% protection for juvenile salmonids, especially since the months of highest entrainment potential would correspond with the smaller sizes of juvenile salmonids, Reclamation expects there would be a roughly 50% reduction in juvenile entrainment during years where there is a water delivery to Mendota Pool (Reclamation 2016). Reclamation expects what with the fish screen installed an average 1-2% of the juvenile CCV steelhead and CV spring-run Chinook population would be lost to entrainment into Mendota Pool (Reclamation 2016).

Table 7. Juvenile Central Valley Spring-Run Chinook Entrainment by Water Year Type

Water Year Type	Numbers of years in Model run	Average % of Annual Juvenile CV Spring-run Chinook Salmon Population Entrained	Average Annual Number of Juvenile CV Spring-run Chinook Salmon Possibly Entrained by Into Mendota Pool
Wet	16	3.7%	1,628- 58,275
Normal-Dry	24	3.35%	1,474- 52,762
Normal-Wet	25	4.15%	1,826-65,363
Dry	12	2.55%	1,122-40,163
Critical-High	4	2.1%	924- 33,075
Critical-Low	1	1.8%	792- 28,350

*Adapted from Page 4-12 Table 11. Reclamation BA, with new calculations of entrainment based on the completion of the Mendota Pool Fish Screen and personal communication with Katrina Harrison at Reclamation.

Table 8. Juvenile California Central Valley Steelhead Entrainment by Water Year Type

Water Year Type	Numbers of years in Model run	Average % of Annual Juvenile CCV Steelhead Population Entrained Due to Exchange Contractor Flows	Average % of Annual Juvenile CCV Steelhead Population Entrained Due to Flood Flows	Average Annual Number of Juvenile CV Spring-run Chinook Salmon Possibly Entrained by Into Mendota Pool
Wet	16	1.75%	1.75%	5-9
Normal-Dry	24	3.25%	3.25%	8-16
Normal-Wet	25	0.65%	0.65%	2-4
Dry	12	0.35%	0.35%	1-2
Critical-High	4	0.85%	0.85%	2-4
Critical-Low	1	24.65%	0%	0

*Adapted from Page 4-10 Table 10. Reclamation BA, with new calculations of entrainment based on the completion of the Mendota Pool Fish Screen and personal communication with Katrina Harrison at Reclamation.

2.4.2.2 Floodplain Stranding

Rearing juvenile salmonids could become stranded on the floodplain under certain conditions, resulting in possible mortality if the stranded areas desiccate or if the stranded fish are exposed to elevated temperatures or levels of predation. Most floodplain stranding occurs in manmade pits or behind structures like levees, berms, or weirs that impede drainage (Moyle *et al.* 2007). However, the risk of salmonid stranding on floodplains appears to be relatively low even when manmade structures are present on the floodplain; a study of CV spring-run Chinook salmon in the Yolo Bypass found that, despite natural and manmade structures potentially creating stranding pools, the majority of fish survived and successfully emigrated off the floodplain (Sommer *et al.* 2005). Stranding of all fishes is reduced on floodplains with well-drained topography with channels that allow flows to drain back to the river unimpeded (Sommer *et al.* 2005, Moyle *et al.* 2007).

The risk of floodplain stranding would be minimized by managing unnatural stranding, including: removal of existing roads, levees, and other blockages in the floodplain; filling in, permanent isolation, or flow connection through borrow areas and gravel pits; floodplain grading that generally grades toward the river when possible; and creating side channels and high flow channels to minimize grading and stranding. Floodplain grading would help ensure that low-lying floodplain areas are connected to the river and that escape routes are graded to prevent stranding during receding flows. In addition, monitoring efforts would continue after the compact bypass is opened in order to identify any potential stranding issues and, should such issues arise, adaptive management would be used to minimize stranding. Due to the low risk of floodplain stranding of salmonids, the comparative benefit of floodplain habitat for rearing, and the measures that would be taken to avoid stranding, the adverse impact of floodplain stranding to CCV steelhead and CV spring-run Chinook salmon would be minimal.

2.4.3 Beneficial Effects

The proposed action would have a near-term beneficial effect to CCV steelhead and CV spring-run Chinook salmon by improving river connectivity. Long-term beneficial effects of the proposed action include: increasing floodplain habitat and improving the aquatic food web in Reach 2B, facilitating upstream and downstream fish passage around Mendota Dam, and providing rearing habitat for juvenile salmonids.

2.4.3.1 Habitat Improvements

Rearing Habitat

Floodplain and channel grading can provide benefits to salmon and other native fish by allowing inundation to occur at lower flows, by distributing suitable rearing habitats further into the floodplain, by connecting rearing habitat to primary production areas (shallow water habitat), by providing escape routes during receding flows, and by confining flows to a deeper, narrower channel to limit temperature increases.

The proposed action would provide a new levee system that would create a 4,200-foot average-width floodplain through Reach 2B that would support food production and rearing habitat. The levee setbacks would allow inundation of 1,000 acres of floodplain at 2,500 cfs. This magnitude of flow would create approximately 440 acres of shallow water habitat (less than 1 foot deep) for primary production and approximately 560 acres of deeper habitat that could directly support rearing conditions. Floodplain areas adjacent to the main channel would start inundating between 1,200 and 2,200 cfs and would encourage riparian regeneration.

In addition, active riparian and floodplain habitat restoration would occur along both banks of the low flow channel of the river up to 450 feet from the bank. Active floodplain restoration would include native species that would provide shade, reduce air temperatures, minimize water temperatures, provide large woody debris and organic matter needed to provide salmonid habitat and food, and help stabilize the low-flow channel.

Aquatic Food Web

The proposed action would provide improved food-web conditions through increased capacity and expanded floodplains. Levees would be set back and floodplain areas would be expanded, making it possible to inundate the majority of the floodplain about every other year through restoration flows up to 4,500 cfs, which would potentially create conditions for improved primary and secondary production that would otherwise not occur. The increased floodplain area, increased frequency of inundation, and the wider floodplains combined with restoration flows would have a beneficial effect on the aquatic food web in Reach 2B.

2.4.3.2 Fish Passage Improvements

Upstream Migration of Adult Salmonids

The proposed action would provide upstream passage from Reach 3 through Reach 2B and into Reach 2A. The compact bypass would be constructed with two grade control steps to facilitate upstream passage. A fish passage facility would provide up and downstream fish passage between the compact bypass and the river upstream of the Compact Bypass Control Structure during times when operation of the control structure impedes passage. The San Mateo Avenue crossing would be removed which would eliminate a large culvert that frequently overtops. The Chowchilla Bifurcation Structure would have a fish passage facility to provide passage when operation impedes passage through the structure. There would be up to 41 hydraulic steps that fish would have to pass over and four river-spanning structures between Reach 3 and Reach 2A (two compact bypass grade control structures, Compact Bypass Control Structure and passage facility, and the Chowchilla Bifurcation Structure and passage facility). If control structures are being operated for fish passage, which would occur most of the time, then the number of hydraulic steps between Reach 3 and Reach 2A would be reduced to as few as four. Diversions would be screened or isolated in Mendota Pool, which would minimize false migration pathways. These measures would ensure that upstream migration of adult salmonids would be greatly improved as a result of the proposed action.

Downstream Migration of Juvenile Salmonids

The proposed action would improve downstream passage by screening water diversions, isolating operations of Mendota Pool from the river, and providing improved downstream passage for juvenile salmon. Mendota Pool would only be operated for Exchange Contractor diversions in summer months in highly infrequent dry years or during flood flow deliveries, when flows split several times before entering Mendota Pool and fish survival through the bypasses is high. Downstream fish passage would be improved at the Chowchilla Bifurcation Structure by installation of a fish passage facility on the San Joaquin River Control Structure. A fish passage facility at the Compact Bypass Control Structure would also allow fish to migrate into the compact bypass channel when water delivery operations impede downstream passage. The San Mateo Avenue crossing would be removed, eliminating a large culvert directly in the migration path. These measures ensure that downstream migration of juvenile salmonids would be greatly improved as a result of the proposed action.

2.4.3.3 Mendota Pool Entrainment Reduction

Modeling analysis by Reclamation estimates that on average 2.68% of CCV steelhead juveniles and 3.96% of juvenile CV spring-run Chinook salmon could be entrained in Mendota Pool and lost to the population in situations where water delivery is needed into Mendota Pool: precautionary flood flows, mandatory flood flows, and Exchange Contractor Flows (Reclamation 2016). The model predicts that in some atypical water years, as much as, 40% of juvenile CCV steelhead or 25% of juvenile CV spring-run Chinook salmon could be lost to Mendota Pool (Reclamation 2016). Reclamation anticipates entrainment of juvenile salmonids into Mendota Pool would be reduced by roughly 50% with the addition of a fish screen on the river side of the Mendota Pool Control Structure, with average juvenile salmonid entrainment dropping to roughly 1-2% (Reclamation 2016).

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultations pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.3).

A. Agricultural Practices

Agricultural practices in the San Joaquin River and Delta may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. Unscreened agricultural diversions throughout the San Joaquin River and Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the San Joaquin River and Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998a, Dubrovsky *et al.* 1998b, Daughton 2003).

B. Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. For example, the General Plans for the cities of Stockton, Brentwood, Lathrop, Tracy and Manteca and their surrounding communities anticipate rapid growth for several decades to come. From 2010 to 2015 the population of the City of Manteca increased by 12% reaching over 75,000 people (U.S. Census Bureau 2015). The population of the City of Lathrop grew by approximately 15% from 2010 to 2015 (U.S. Census Bureau 2015). Increased growth would place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, would not require Federal permits, and thus would not undergo review through the ESA section 7 consultation processes with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially would degrade riparian and wetland habitat by eroding channel banks and mid-Channel Islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation in the San Joaquin River and Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the San Joaquin River and Delta.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species.

The Analytical Approach section above described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the Status of the Species, the Environmental Baseline, and the Effects of the proposed action sections.

2.6.1 Status of the Species and Effects of the action on listed species

The Status of the Species ESUs/DPSs are described in section 2.2 above. Currently CCV steelhead are believed to be extirpated from the action area, and the only use of the action area by CV spring-run Chinook salmon would be the unlikely result of activities related to the 10(j) non-essential experimental population reintroduction. However, once SJRRP restoration and reintroduction activities have progressed, the action area is likely to become an important migratory pathway for both species, and may also provide juvenile rearing and spawning habitat.

Populations of CV spring-run Chinook salmon and CCV steelhead in California have declined drastically over the last century, and some subpopulations have been extirpated. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (NMFS 2016). This severe decline in populations over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which would assist in the recovery of both of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of CV spring-run Chinook salmon, and CCV steelhead could be at risk.

2.6.1.1 Construction effects

As described in the effects section above (2.4), construction activities with greatest potential to impact CCV steelhead and CV spring-run Chinook salmon are activities that require the construction of cofferdams including: the removal of the San Mateo Avenue crossing, installation of the Columbia Canal intake siphon in Mendota Pool, construction of the Mendota Pool Control Structure, installation of sheet piles along the north levee prior to the construction of the Compact Bypass Control Structure and excavation of the compact bypass immediately upstream of the control structure, and construction of the Chowchilla Fish Passage Structure.

There are a number of potential effects of cofferdam construction to various salmonid life stages, as described in Section 2.4.1 above. However, the likelihood of presence of any life stages of salmonid species in the action area during cofferdam construction is low, as described in Section 2.4 above. Juvenile and adult salmonids would most likely not be able to access the action area during construction because there would not be volitional passage until the proposed action is complete, and the implementation of the fish rescue and relocation plan should keep fish out of the area. The potential for impacts from all construction activities is therefore minimal.

The other project activity with a large potential to impact CCV steelhead and CV spring-run Chinook salmon involves the operation of the water delivery and associated floodplain operations which may result in entrainment of salmonids, as described in Section 2.4.2.1 above.

2.6.1.2 Floodplain stranding effects

Fish may be entrained in depressions on the floodplain, in an ephemeral slackwater upstream of Mendota pool, or in Mendota pool itself. However, the risk of floodplain stranding would be decreased by managing unnatural stranding, therefore the impact should be minimal.

2.6.1.3 Operational effects

Mendota Pool Control Structure operations are designed to minimize entrainment, including the presence of a fish screen to be constructed at the entrance to Mendota Pool; modeling predicts that there would be a roughly 50% reduction in juvenile entrainment during years where there is a water delivery to Mendota Pool (Reclamation 2016). Due to the low risk of floodplain stranding of salmonids, the comparative benefit of floodplain habitat for rearing, the adverse impact of floodplain stranding to CCV steelhead and CV spring-run Chinook salmon would be minor.

As a result of implementation of the proposed action, migratory fish passage, spawning habitat, and rearing habitat are expected to improve for listed species. A long-term benefit of the continued SJRRP activities, including the proposed action, is that population abundances are expected to increase. In addition, a newly established population of CV spring-run Chinook salmon in the Southern Sierra diversity group would contribute to the population spatial structure of the species as a whole.

The cumulative effects described above in the action area of the San Joaquin River, are not expected to be additive to the temporary adverse effects of the proposed action, and habitat conditions are expected to improve as a result of the proposed action.

2.6.2 Summary

The NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) calls for "representation and redundancy" of spatial structure, including reestablishing populations into historical habitats they used to occupy. The SJRRP activities, as outlined in the settlement agreement, including the proposed action, are designed to facilitate that goal for CV spring-run Chinook salmon and CCV steelhead in the SJRRP restoration area, from the Merced River confluence to Friant Dam. Rearing habitat restoration was also identified as a high priority recovery action in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Some potential effects of the implementation of the proposed action are expected to result in incidental take of listed anadromous fish in the action area, although negative effects are expected to be minimal. Most significant immediate and long-term effects of the habitat restoration proposed actions would be to improve overall conditions for listed salmonids by increasing and improving spawning and rearing habitat.

The adverse effects that are anticipated to result from the implementation are not the type or magnitude that would be expected to appreciably reduce the likelihood of survival and recovery of the affected species in the action area, or at the ESU/DPS level. Since the action area is not designated or proposed critical habitat, no effects to critical habitat are expected to reduce the value of designated or proposed critical habitat for the conservation of the species. VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be appreciably reduced; in contrast, implementing this proposed action is expected to improve these parameters, which would be necessary for the San Joaquin River populations to reach a viable status, or for the San Joaquin to function as a major migratory corridor for all species. NMFS expects that any adverse effects of this proposed action would be outweighed by the immediate and long-term benefits to species survival, and increasing abundance, produced by the improvement in spawning and rearing habitat.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead. No critical habitat has been designated or proposed for this species in the action area; therefore, none was analyzed.

This BO determined the proposed activities are not likely to jeopardize the continued existence of CV spring-run Chinook salmon, and a conferencing opinion is only required if the analysis of the proposed action results in a jeopardy determination. Therefore, a conferencing opinion is not required. The analysis for CV spring-run Chinook salmon is only included in this BO because it was requested by Reclamation. There will be no take issued for CV spring-run Chinook salmon as part of this BO, and the experimental population of CV spring-run Chinook salmon will not be addressed in the Incidental Take Statement. The analysis on CV spring-run Chinook salmon is for informational purposes only.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

NMFS anticipates incidental take of CCV steelhead due to impacts directly related to cofferdam placement and entrainment into the Mendota Pool before and after the Mendota Pool screen is operational.

Juvenile and adult CCV steelhead may be killed, injured, or harassed during the implementation of the proposed action. The actual number of CCV Steelhead taken as a result of the activities of the proposed action is impossible to track, due to the variability and uncertainty associated with the response of listed species to the effects of the proposed action, the varying population size, annual variations in the timing of spawning and migration, and individual habitat use within the proposed action area. However, it is possible to analyze those elements of the proposed action that are expected to result in take, and are also somewhat predictable and measurable, with the ability to monitor elements to determine the level of take that is occurring.

2.8.1.1 California Central Valley Steelhead

No spawning population of CCV steelhead currently exists in the San Joaquin River, therefore a rough estimate of the potential incidental take was calculated using data from non-hatchery origin adult and hatchery-origin juvenile CCV steelhead from the Mokelumne River system as a surrogate. This method was used by Reclamation to calculate effects within the Biological Assessment and is considered to be the best available science.

This calculation estimated that 17 migrating adult CCV steelhead, four emigrating adult CCV steelhead (kelts), and 17,127 emigrating juveniles could move through Reach 2B annually, following full connectivity of the San Joaquin River from Sack Dam to Reach 1A and restoration of the a CCV steelhead run in the San Joaquin River. The estimate assumes that adult CCV steelhead would be able to bypass current downstream barriers (e.g., Sack Dam and Mendota Dam) and successfully spawn in Reach 1A, that in-water work would occur year-round, and that 100 percent of fish that come into contact with construction or operations associated with the proposed action would be incidentally taken.

The take from operations and construction may include injury or death of juvenile CCV steelhead. In addition, take may result from temporarily modifying important migration and rearing habitat, as described in section 2.4.1 and 2.4.2. This disruption of habitat may cause fish migration to be delayed or displaced, which may result in increased predation risk, decreased feeding, and increased interspecies competition. The behavioral modifications that result from the habitat modification are the ecological surrogates for take. There is not a stronger ecological surrogate based on the information available at this time.

It is important to note that for the majority of years and water year types, entrainment into Mendota Pool would not be possible because the gates to the Mendota Pool Control Structure would be closed to intentionally separate the river from Mendota Pool. Also, take during Exchange Contractor deliveries are not covered under this consultation. Water operations are described in greater detail in section 2.4.2.1.

Construction

With the implementation of a fish rescue and relocation plan and the avoidance and minimization measures described in Section 1.3.6.1, construction effects to CCV steelhead would be largely eliminated. Actual incidental take numbers during proposed action construction are not expected to exceed one juvenile, one spawning adult, and one kelt CCV steelhead per year (Table 9). This incidental take would most likely be in the form of harassment to a fish that would be trapped in a cofferdam, rescued, and relocated to suitable habitat.

Operations Pre-Mendota Pool Fish Screen Completion

Take levels during annual operations before the Mendota Pool fish screen is installed would also be dependent on the Steelhead Monitoring Plan. If CCV steelhead are actively excluded from Reaches above the proposed action area then they should not be entrained into Mendota Pool. If Reclamation is no longer operating the Steelhead Monitoring Plan or a spawning population of CCV steelhead is established in the reaches above the proposed action area, then take of juvenile CCV steelhead would be assumed to be proportionate to the amount of unscreened water being delivered into Mendota Pool, during juvenile CCV steelhead migration. Juvenile CCV steelhead migration is expected to peak in April-June based on the surrogate CCV steelhead population in the Mokulumne River (Reclamation 2016b). It is also important to note that the migration timing for juvenile CCV steelhead in the lower San Joaquin River may vary from what is analyzed because it is difficult to predict their movements before the area is fully restored. Specific take numbers based on the above calculations are expected to be forty five juveniles and one kelt annually entrained in Mendota Pool before the installation of the fish screen (Table 9).

Operations Post-Mendota Pool Fish Screen Completion

Once the proposed action is complete and the Mendota Pool fish screen is in place, the screen will be required to undergo effectiveness and compliance monitoring combined with a performance monitoring plan. This would assess the effectiveness of the screen to prevent entrainment of juvenile CCV steelhead into Mendota Pool. Currently, Reclamation assumes that the screen would reduce entrainment by 50%. Given a paucity of data related to the potential effectiveness of the fish screen, and a lack of fish screen specification, there is not currently a better estimate available. Therefore, the take threshold of entrainment into Mendota Pool after the fish screen is installed would be considered to be 50% of the juvenile CCV steelhead migrating through the system, when deliveries are made to Mendota Pool. Specific take numbers are expected to range from twenty three to forty five juveniles annually and one kelt (Table 9).

Table 9: Annual take of California Central Valley (CCV) steelhead for Construction activities and operations.

	Annual Construction Take*	**Annual Operation Take Pre Mendota Pool Fish Screen**	**Annual Operation Take Post Mendota Pool Fish Screen Installation**
CCV steelhead (juvenile)	1	45	23-45
CCV steelhead (adult)	1	-	-
CCV steelhead (kelt)	1	1	1

*Annual Construction Take includes only the years before the compact bypass is completely operational. Reclamation would maintain a fish rescue and relocation plan to divert 100% of salmonids that come in contact with construction activities.

2.8.2 Effect of the Take

In the BO, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of the species.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that future proposed actions related to the Mendota Pool Bypass and Reach 2B Improvements Project minimize, to the maximum extent practicable, any adverse effects on Federally listed salmon and steelhead that are subject to this consultation.

2. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through a Monitoring and Maintenance Plan (MMP) to ensure their effectiveness.

3. Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids. Also, actions shall be taken to ensure riparian habitat is preserved and protected to the maximum extent allowed within the functional designs of the proposed action. Preserved habitat shall be combined with restorative plantings and features to enhance natural recruitment of riparian vegetation, for protection and creation of fish habitat features that are the subject of this BO.

4. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these proposed actions implement the proposed actions as laid out in the biological assessment and this BO.

5. Continue to implement the Steelhead Monitoring Plan or similar action to prevent steelhead from entering the action area before completion of all aspects of the proposed action.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and Reclamation or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). Reclamation or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.
Please send all corresponding reports to: National Marine Fisheries Service, California Central Valley Office, 650 Capital Mall Suite 5-100, Sacramento, CA 95814.

1. The following terms and conditions implement reasonable and prudent measure 1: "*Measures shall be taken to ensure that future proposed actions related to the Mendota Pool Bypass and Reach 2B Improvements Project minimize, to the maximum extent practicable, any adverse effects on Federally listed salmon and steelhead that are subject to this consultation.*"

    a. Reclamation shall convene an existing or new interagency working group (such as the Environmental Compliance Workgroup or the Reach 2B and Mendota Pool Bypass Meeting) associated with the SJRRP to coordinate input into future actions associated with the Mendota Pool Bypass and Reach 2B Improvements Project. Membership in the interagency working group would be subject to Reclamation's decision, but should at a minimum include participation of SJRRP resource agency staff from USFWS, NMFS, CDFW, and DFW.

b. Reclamation shall coordinate with NMFS during project development as future projects are designed and future operations decisions are made, to ensure conservation measures are incorporated and ecological benefits are maximized, to the extent practicable and feasible.

c. Reclamation shall confer with NMFS at all major engineering and planning decision points, including but not limited to the completion of 30%, 60%, 90% and 100% designs. To initiate conference, Reclamation shall send NMFS a letter requesting concurrence that the plans are within the scope of effects considered in this BO. All relevant plan details would be included in the concurrence request package. Reclamation would give NMFS biologists and engineers 45 days to review plans. If NMFS determines that the plans and designs provided by Reclamation do not comply with NMFS standards then NMFS has the right to request changes, and NMFS would work with Reclamation to the extent possible to find a consensus. Approval would consist of a formal letter documenting NMFS concurrence with the provided plans.

d. If Reclamation changes operations of the proposed actions from what is analyzed in this BO then NMFS must be notified with a formal letter at least 45 days before proposed changes take place. The notification should include any additional analysis to determine if take would exceed what is currently authorized in the ITS of this opinion from the operational changes. NMFS would work with Reclamation to find solutions to operational changes to the extent reasonable and feasible that does not cause harm to populations of listed fish.

e. A Fish Rescue and Relocation Plan (FRRP) shall be developed by Reclamation or their contractors and provided to NMFS for approval 90 days prior to cofferdam construction. The FRRP shall include methods of flow bypass, diversion, dewatering, salmonid collection, transport and release, water quality data, and formation of a team of qualified biologists with expertise in handling, collecting, and relocating salmonids. NMFS shall have 45 days to review and approve the FRRP so contractors can be given time to make necessary changes, if any, to follow NMFS guidance or criteria while staying on construction schedule.

f. During Preconstruction Engineering and Design, Reclamation shall coordinate with NMFS to provide documentation of operation of the Mendota Pool Bypass, Mendota Pool Fish Screen, Chowchilla Bypass, compact bypass, and their associated fish passage facilities would allow, without detrimental effects to flood management operations, or water supply needs, fish passage as stated in the opinion.

g. Before final approval of 100% designs Effectiveness and Compliance Monitoring Plans shall be submitted for the Mendota Pool Fish Screen, Compact Bypass Control Structure Fish Passage Facility, and Chowchilla Bypass Fish Passage Facility. These plans must include monitoring that shows these facilities are working in their intended manor, to NMFS criteria, and do not cause additional take of listed fish. This monitoring for the Compact Bypass Control Structure should consist of, at a minimum, the following: juvenile survival rates though Mendota Pool while the

Compact Bypass Control Structure radial gates are closed, juvenile survival through the fish passage structure on the Compact Bypass Control Structure, and juvenile survival through partially opened radial gates on the Compact Bypass Control Structure.

h. Reclamation shall monitor for take at the Mendota Pool Fish Screen to show that take is not exceeding levels given in this BO. Monitoring shall be reported to NMFS with a weekly report when the fish screen is in use. The weekly report shall be sent to all appropriate NMFS staff and shall consist of a summarized statement from data collected by the Effectiveness and Compliance Monitoring Plan.

i. Reclamation shall update the Operations & Maintenance (O&M) manual for the new bifurcation system to incorporate, without detrimental effects to flood objectives and water supply needs, an adaptive management plan for operations of the Mendota Pool Bypass, Mendota Pool Fish Screen, Chowchilla Bypass, compact bypass, and their associated fish passage facilities. This manual must allow for ramp down flows in a manner that minimizes juvenile and adult fish stranding and during a time when fish are not using the facility.

j. Reclamation shall, to the extent feasible, coordinate efforts with levee districts and other flood managers to address changes in flow conditions, flood management actions, and the need to maintain fish in good condition within the proposed action area.

2. The following terms and conditions implement reasonable and prudent measure 2: "*Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the MMP to ensure their effectiveness*."

    a. Reclamation shall develop a Monitoring and Maintenance Plan (MMP) with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value, as well as, monitoring effects of conservation measures and construction actions to determine if actual take numbers are comparable to those calculated in this opinion. The MMP shall include specific goals and objectives and a clear strategy for maintaining all of the proposed action conservation elements for the life of the proposed action. The MMP shall be consulted on with NMFS, and NMFS must approve the MMP, prior to the onset of any construction of any projects related to the Mendota Pool Bypass and Reach 2B Improvements Project, including placement of in-water revetment or removal of riparian vegetation

    b. The MMP measures shall be monitored by Reclamation for 10 years following construction of the final phase of the proposed action and shall update their O&M manual to ensure the MMP is adopted and that the goals and objectives of the conservation measures are met for the life of the proposed action.

c. The MMP shall include specific goals and objectives and a clear strategy for achieving full compensation for all proposed action-related impacts on the affected species described above.

d. Reclamation shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the MMP. Annual reports shall be sent to relevant staff members of the NMFS San Joaquin River branch. Annual reports shall consist of summarized data and findings from the MMP and clearly state how well the project functioned according to how it was designed, with respect to listed fish, restoration actions, and restoration flows. Reclamation must issue annual reports for five years following completion of the entire proposed action construction or once the proposed action has been observed in all water year types. The purpose is to ensure that conservation features of the proposed action are developing consistent with the MMP.

e. Reclamation shall update their O&M Manual to ensure that the self-mitigating elements are meeting the criteria established in the MMP.

3. The following terms and conditions implement reasonable and prudent measure 3: "*Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids. Also, actions shall be taken to ensure riparian habitat is preserved and protected to the maximum extent allowed within the functional designs of the proposed action. Preserved habitat shall be combined with restorative plantings and features to enhance natural recruitment of riparian vegetation, for protection and creation of fish habitat features that are the subject of this BO.*"

    a. Reclamation shall minimize the removal of existing riparian vegetation and replace riparian vegetation where it has been removed.

    b. Reclamation shall ensure that native vegetation is used in all replanted areas. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

    c. Reclamation shall design floodplains with high-flow channels that increase the inundation extent at lower flows, and remove unconnected low-lying areas in the floodplain to prevent stranding.

    d. Reclamation shall develop a vegetation plan in consultation with NMFS to allow for the protection of existing vegetation in place and the planting and establishment of new native riparian vegetation.

4. The following terms and conditions implement reasonable and prudent measure 4: "*Measures shall be taken to insure that contractors, construction workers, and all other*

parties involved with these proposed actions implement the proposed actions as proposed in the biological assessment and this BO."

a. Reclamation shall provide a copy of this BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the proposed action as to the requirements of this BO.

b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this BO. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

2. The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions that should be implemented do not always address the underlying processes that led to habitat loss. NMFS recommends that the Reclamation use species recovery plans to help ensure that their actions would address the underlying processes that limit fish recovery, and to identify key actions in the action area when prioritizing proposed action sites each year. The final recovery plan for Central Valley listed salmonids is available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_salmon_recovery_domain.html

3. Continue to monitor the effects of water delivery operations on the physiological condition of juvenile and adult salmonids in all water year types, including predation around structures, potentially increased predation within the slack water created when water elevation is raised to make water deliveries into Mendota Pool, and possible increased stress from temperatures and water conditions (e.g. dissolved oxygen content, turbidity, or exposure to toxins).

4. NMFS recognizes that Reclamation is obligated to provide water supply to the Exchange Contractors, either from the Delta-Mendota Canal (DMC) or from Friant Dam operations. Reclamation is not precluded from operation of the CVP facilities in a manner that could ensure Exchange Contractor needs are provided and that minimizes adverse effects to ESA listed species. NMFS recommends that Reclamation include the Friant Division operations in the reinitiation of consultation on the long term operations of the Central Valley Project, including evaluation of effects of Exchange Contract deliveries and unscreened diversions.

5. Reclamation should encourage cost share sponsors, stakeholders, and neighboring landowners to develop floodplain and riparian corridor enhancement plans as part of the proposed action and the larger SJRRP effort.

6. Reclamation should seek out opportunities for setback levees and other flood management activities in the restoration area that promote overall riverine system restoration.

7. Reclamation should support and promote aquatic and riparian habitat restoration within the San Joaquin River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.

8. Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration proposed actions.

9. Reclamation should continue to work with NMFS and other agencies and interested entities to restore fish passage to support the improved growth, survival, and recovery of native fish species in the San Joaquin River Restoration Area.

10. Reclamation should work with NMFS to implement compatible agriculture uses and activities on floodplain areas, as appropriate.

11. Reclamation should consider installing instream woody material for actions associated with the Mendota Pool Bypass and Reach 2B Improvements Project. The purpose is to maximize the refugia and rearing habitats for juvenile fish and reduce predation.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Mendota Pool Bypass and Reach 2B Improvements proposed action.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by Reclamation and descriptions of EFH for Pacific coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

In response to the incremental, long-term, multistage nature of the proposed action, this EFH consultation is programmatic. The goal of the programmatic EFH consultation is to identify adverse impacts and provide EFH Conservation Recommendations as appropriate given the current level of knowledge of the proposed action, while allowing for further EFH consultation to occur on subsequent program actions that require Section 7 Consultation.

3.1 Essential Fish Habitat Affected by the Proposed Action

The Fisheries Management Plan for Pacific Coast Salmon has designated the Sacramento and San Joaquin River basins as EFH. The proposed action area occurs within the boundaries of EFH for Pacific Coast salmon. The San Joaquin River is historic habitat for fall-run, late fall-run, and spring-run Chinook salmon (*Oncorhynchus tshawytscha)*, and contains the southernmost populations of Chinook salmon, though anthropogenic changes in the environment have severely adversely impacted their ability to use this river over the last century. The combined Sacramento -San Joaquin River system once supported Chinook salmon runs comparable to those of the Columbia and Fraser rivers.

The *proposed action* is described in detail in Section 1.3 of the BO. Although the proposed action area is considered EFH, the presence of several fish barriers and current flow conditions almost completely separate the proposed action area from the lower San Joaquin River and the ocean fishery. The freshwater Pacific Salmon Coast EFH components affected by this project include juvenile rearing habitat, and juvenile and adult migratory pathways, but does not include spawning habitat.

After Friant Dam became fully operational in the l 950's, the upper San Joaquin River was not connected regularly to the Sacramento/San Joaquin Delta or the Pacific Ocean, and all anadromous salmonids were extirpated from the action area. However, since 2009, the SJRRP and NMFS have been working towards a wetted connected river channel. In 2010, the SJRRP began trap and transport activities to move fall-run Chinook salmon around dry stretches of the river as an interim action until river connectivity is achieved. Actions scheduled for completion in 2016 will allow river connectivity to be implemented in fall 2016, and fish passage improvement projects will also be implemented. In summer months, water temperatures regularly reach lethal temperatures for adult salmonids in the action area. However, the US Bureau of Reclamation may implement water management actions during summer months, resulting in suitable temperatures in the action area. By late October, water temperatures in the action area typically are suitable for salmonids and can continue at that level through late spring, depending on the water year.

In 2013, 2014, and 2015 translocated fall-run Chinook salmon were reported to be spawning in the San Joaquin River upstream of the action area (Castle et al. 2016). In June 2016, 25 adult spring-run Chinook salmon, including 15 males and 10 females, were released into the wetted portion of the San Joaquin River below Friant Dam. At present, one male has died, at least 19 individuals have been detected via underwater acoustic tracking, and two redds have been identified. Given that fall-run Chinook salmon were able to utilize the riverbed in this area for spawning, NMFS expects that spring-run Chinook salmon would also utilize the area if afforded the opportunity, adequate water temperatures, and the accessibility of suitable spawning substrate.

3.1.1 Life History

Chinook salmon generalized life history includes migrating from the ocean into freshwater rivers and streams to spawn as adults; incubating, hatching, emerging, and rearing in freshwater until juveniles; traveling to estuarine habitat for rearing and growth, migrating to oceanic habitats for extended feeding and growth; and culminating in a return to natal waters to spawn. However, Chinook salmon display a variety of complex life- history patterns (PFMC 2014).

General life history information for CV spring-run Chinook salmon is outlined in Section 2.2 of the enclosed biological opinion (BO) as part of this consultation. CV fall/late fall-run Chinook salmon life history information is summarized below. Further detailed information on Chinook salmon ESUs are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myer *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (March 9, 1998, 63 FR 11482).

Adult CV fall-run Chinook salmon enter the Sacramento and San Joaquin rivers from July through December and spawn from October through December, while adult CV late fall-run Chinook salmon enter the Sacramento and San Joaquin rivers from October to April and spawn from January to April (USFWS 1998). Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less than 5 percent fines (Reiser and Bjornn 1979).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse to the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970).

As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation.

3.1.2 Habitat Areas of Particular Concern

Habitat areas of particular concern (HAPCs), as designated under the FMP, include (1) complex channels and floodplain habitats, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation. The HAPCs present in the action area are (1) complex channels and floodplain habitats, and potentially (2) thermal refugia.

3.2 Adverse Effects on Essential Fish Habitat

The proposed action construction activities may cause temporary and localized negative effects to Pacific Coast Salmon EFH, including habitat for fall-run and late fall-run Chinook salmon. During construction the proposed action may cause: a temporary reduction in available habitat area, erosion and sedimentation, local increases in turbidity, changes in temperature, and introduction of pollutants into the San Joaquin River. The causes and implications of these impacts for Pacific Coast Salmon EFH would be similar to those discussed for CCV steelhead and CV spring-run Chinook salmon (Section 2.4). All of the potential adverse impacts would be short term in nature, with the exception of agricultural or grazing activity on the expanded floodplain, and would result from construction, materials storage, staging, and access during implementation of the proposed action. The proposed action goals include restoring floodplain habitat and providing upstream and downstream fish passage for the benefit of juvenile and adult salmonids and other native fishes. Overall the proposed action would benefit EFH by improving habitat and connectivity.

3.3 Essential Fish Habitat Conservation Recommendations

Adverse effects to EFH associated with the proposed action would occur in EFH utilized by salmonid species including CV spring-run, fall-run, and late fall-run Chinook salmon. The following conservation recommendations are necessary to mitigate, offset, or avoid impacts to EFH:

1. For effects related to the temporary reduction in available habitat area, NMFS recommends that the following Conservation Recommendation should be followed:

    a. Avoid restoration work during critical fish windows to reduce direct impacts to important ecological functions such as spawning, nursery, and migration. This conservation measure requires scheduling projects when managed species are not expected in the area. These periods should be determined prior to project implementation to reduce or avoid any potential impacts.

    b. Minimize the removal of existing native riparian vegetation.

    c. Mitigate fully any unavoidable damage to EFH during project implementation and accomplish within reasonable period of time after the impacts occurred.

2. For effects related to erosion/sedimentation, increased turbidity, changes in temperature, and potential introduction of pollutants during construction, NMFS recommends the following Conservation Recommendations should be followed:

    a. Use BMPs in all construction and maintenance activities such as avoiding ground disturbing activities during the wet season, minimizing the time disturbed lands are left exposed, using erosion prevention and sediment control methods, minimizing vegetation disturbance, maintaining buffers of vegetation around wetlands, streams and drainage ways, and avoiding building activities in areas of steep slopes with highly erodible soils. Use methods such as sediment ponds, sediment traps, or other facilities designed to slow water run-off and trap sediment and nutrients.

    b. Minimize the loss of native riparian vegetation as much as possible.

    c. Include efforts to preserve and enhance EFH by adequately grading low flow channels of the proper depth and velocity to provide adequate ingress and egress to and from flood plain, such that rearing salmonids may utilize the flood plain without stranding.

3. If agriculture activity is implemented within the proposed action area, the following Conservation Recommendations should be followed:

    a. Section 2.9 Conservation Recommendation 10 should be followed.

b. Ensure that agricultural managers should maintain riparian management zones between the agriculture and the river. Riparian management zones should be wide enough to restore and support riparian functions including shading, LWD input, leaf litter inputs, sediment and nutrient control, and bank stabilization functions.

c. Ensure that agricultural managers reduce erosion and run-off by using practices such as contour plowing and terracing, no till agriculture, conservation tillage, crop sequencing, cover and green manure cropping and crop residue, and, by maximizing the use of filter strips, field borders, grassed waterways, terraces with safe outlet structures, contour strip cropping, diversion channels, sediment retention basins and other mechanisms including re-establishment of vegetation.

d. Ensure that agricultural managers participate in and benefit from existing programs to encourage wetland conservation and conservation reserves, avoid planting in areas of steep slopes and erodible soils and avoid disturbance or draining of wetlands and marshes.

e. Ensure that agricultural managers incorporate water quality monitoring as an element of land owner assistance programs for water quality, and evaluate monitoring results and adjust practices accordingly.

f. Ensure that agricultural managers minimize the use of chemical treatments within the riparian management zone. To that end, agricultural managers should: review pesticide use strategies to minimize impact to EFH; reduce pesticide application by evaluating pest problems, past pest control measures and following integrated pest management strategies; and select pesticides considering their persistence, toxicity, runoff potential, and leaching potential.

g. Ensure that agricultural managers Encourage farmers to take advantage of the conservation programs that were reauthorized in the Food, Conservation, and Energy Act of 2008 (i.e., Farm Bill)

4. If grazing activity is implemented within the proposed action area, the following Conservation Recommendations should be followed:

a. Ensure that grazing managers utilize focused monitoring, management, and grazing regimes or special mitigation activities that allow recovery of degraded areas and maintain streams, wetlands, and riparian areas in properly functioning condition.

b. Ensure that grazing managers establish proper streambank alteration move triggers and grazing season of use endpoint indicators to reduce the amount streambank damage and allow banks to stabilize over time, reduce the amount of the fine sediment introduced into streams; and reduce the amount of damage to streambanks which will also assist in retaining important undercut streambanks, large woody debris, and overhanging vegetation that provide cover.

c. Reclamation should determine cumulative effects of past and current grazing operations on EFH when designing grazing management strategies.

d. Ensure that grazing managers minimize application of chemical treatments within the riparian management zone.

e. Ensure that grazing managers utilize innovative grazing practices such as variants of restrotation grazing systems, late season riparian grazing systems, winter grazing and management of stocking rates.

f. Encourage livestock owners to take advantage of The Conservation of Private Grazing Land Program (CPGL) and the Conservation Reserve Enhancement Program (CREP). CPGL and CREP are voluntary programs that help owners and managers of private grazing land address natural resource concerns while enhancing the economic and social stability of grazing land enterprises and the rural communities that depend on them. Technical assistance is provided by the Natural Resource Conservation Service.

g. Ensure that grazing managers establish proper streambank alteration move triggers and endpoint indicators in combination with the other management measures intended to reduce the amount of time livestock spend in riparian areas to reduce the amount of the fine sediment introduced into streams.

Fully implementing the above actions would help protect EFH, by avoiding or minimizing the adverse effects described in section 3.2.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, Reclamation must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

Reclamation must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)). As noted above, further EFH consultation is expected to occur on subsequent program actions that require Section 7 Consultation.

4. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

The following recommendations apply to the proposed action:

1. Reclamation should continue to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) to the maximum extent feasible.

2. Flood operations and water deliveries should include ramping to prevent dewatering of habitat important to anadromous fish and be scheduled with the intention to minimize impacts on anadromous fish, where possible.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA. This concludes the FWCA portion of this consultation.

5. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion is Reclamation. Other interested users could include Corps, USFWS, CDFW, and DWR. Individual copies of this opinion were provided to Reclamation. This opinion would be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

5.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

5.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation, contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA MSA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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