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

Refer to NMFS No: ***WCR-2017-6161***

June 29, 2017

Rain L. Emerson
Supervisory Natural Resources Specialist
U.S. Bureau of Reclamation
Mid-Pacific Region
South-Central California Area Office
1243 N Street
Fresno, California 93721-1813

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the *Rock Slough Fish Screen Facilities Improvement Project* located in Contra Costa County, California.

Dear Ms. Emerson:

Thank you for your letter and biological assessment of December 21, 2016, requesting initiation of formal 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 proposed *Rock Slough Fish Screen Facilities Improvement Project* (Project). The facilities are owned by the U.S. Bureau of Reclamation and currently operated under an Assistance Agreement with the Contra Costa Water District.

In the enclosed biological opinion, NMFS concludes that the Project is not likely to jeopardize the continued existence of federally listed species. Critical habitat is not designated within the action area, therefore, consultation on designated critical habitats is not warranted. Additionally, NMFS has included an incidental take statement with non-discretionary terms and conditions is included.

This letter also transmits the results of the Essential Fish Habitat (EFH) consultation under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act as amended (16 U.S.C. 1801 *et seq*.). NMFS has reviewed the likely effects of the proposed action on EFH and concluded that the action would adversely affect the EFH of Pacific Coast Salmon, therefore, we have included the results of that review in Section 3 of this document.

Please contact Bruce Oppenheim at the California Central Valley Office at 916-930-3603, or via e-mail at bruce.oppenheim@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Barry A. Thom
Regional Administrator

Enclosure

cc: California Central Valley Office
File: ARN 151422-WCR2014-SA00018

Kaylee Allen, U.S. Fish and Wildlife Service, Bay-Delta Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814-4700
Elizabeth Vasquez, U.S. Bureau of Reclamation, Central Valley Operations Office, 3310 El Camino Ave., Suite 300, Sacramento, CA 95821
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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Response

Rock Slough Fish Screen Facilities Improvement Project

NMFS Consultation Number: **ARN 151422WCR2014-SA00018 / PCTS# WCR-2017-6161**

Action Agency: U.S. Bureau of Reclamation

Affected Species and NMFS's Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	N/A	N/A
Central Valley spring-run Chinook (*O. tshawytscha*)	Threatened	Yes	No	N/A	N/A
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	N/A	N/A
Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	N/A	N/A

N/A = not applicable

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

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

Issued By: [signature] for

Barry A. Thom
Regional Administrator

Date: June 29, 2017

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List of Acronyms

BA	Biological Assessment
BCF	Bioconcentration Factor
BMPs	Best Management Practices
Cal-EPA	California Environmental Protection Agency
CCWD	Contra Costa Water District
CDBW	California Division of Boating and Waterways
CDFG	California Department of Fish and Game (through 2012)
CDFW	California Department of Fish and Wildlife (beginning in 2013)
CDPR	California Department of Pesticide Regulation
cfs	cubic feet per second
cm	centimeters
CWT	coded wire tag
CVP	Central Valley Project
CY	cubic yards
DPS	distinct population segment
EFH	essential fish habitat
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FL	Fork Length
FMP	Fishery Management Plan
IPMP	Integrated Pest Management Program
LC50	Lethal concentration where 50% tested die in a specified period of time
m	meter
mm	millimeter
mg/L	milligrams/liter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
NGDV	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PFMC	Pacific Fisheries Management Council
ppt	parts per thousand (unit)
ppm	parts per million (unit)
ppb	parts per billion (unit)
Reclamation	U.S. Bureau of Reclamation
RSFS	Rock Slough Fish Screen
SCADA	Supervisory Control and Data Acquisition stations
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VSP	viable salmonid population
WAPA	Western Area Power Administration

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions 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 essential fish habitat (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.

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 (DQA) (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 NMFS California Central Valley Office in Sacramento, California.

Contra Costa Water District (CCWD) conducts operations and maintenance (O&M) activities upstream of the Rock Slough Fish Screen (RSFS), along the unlined portion of the Contra Costa Canal (Canal) in the vicinity of the RSFS Facility, and in the surrounding area. The Canal was built by the U.S. Bureau of Reclamation (Reclamation) in 1937 as the first part of the Central Valley Project (CVP). The Canal runs from the Rock Slough Intake/RSFS in the Delta about 30 miles west to the San Francisco Bay area where it provides water to the cities of Martinez, Concord, Walnut Creek, and Pleasant Hill. The RSFS Facility (*i.e.,* fish screen, Headworks, afterbay, Flood Isolation Structure, Bridge, and maintenance building) is located at the junction of Reclamation's unlined Canal and Rock Slough, approximately four miles southeast of the first pumping plant (PP1) and the City of Oakley (Figure 1).

Reclamation began construction on the RSFS in 2009 in order to comply with requirements of the 1992 Central Valley Improvement Project Act (CVPIA) and the Los Vaqueros Project biological opinions (NMFS 1993, USFWS 1993). Major construction work at the RSFS was deemed by Reclamation to be substantially complete in 2011; however, mechanical, safety, and operational issues with the facility remain unresolved. Consequently, the RSFS is not considered by Reclamation and CCWD to be fully operational. Since 2011, NMFS has consulted on O&M activities as separate actions (*e.g.*, rake system improvements, mechanical weed control, and log boom placement). In order to facilitate the consultation process, Reclamation combined the improvements and O&M activities of the RSFS into one project, called the Rock Slough Fish Screen Facilities Improvement Project (Project).

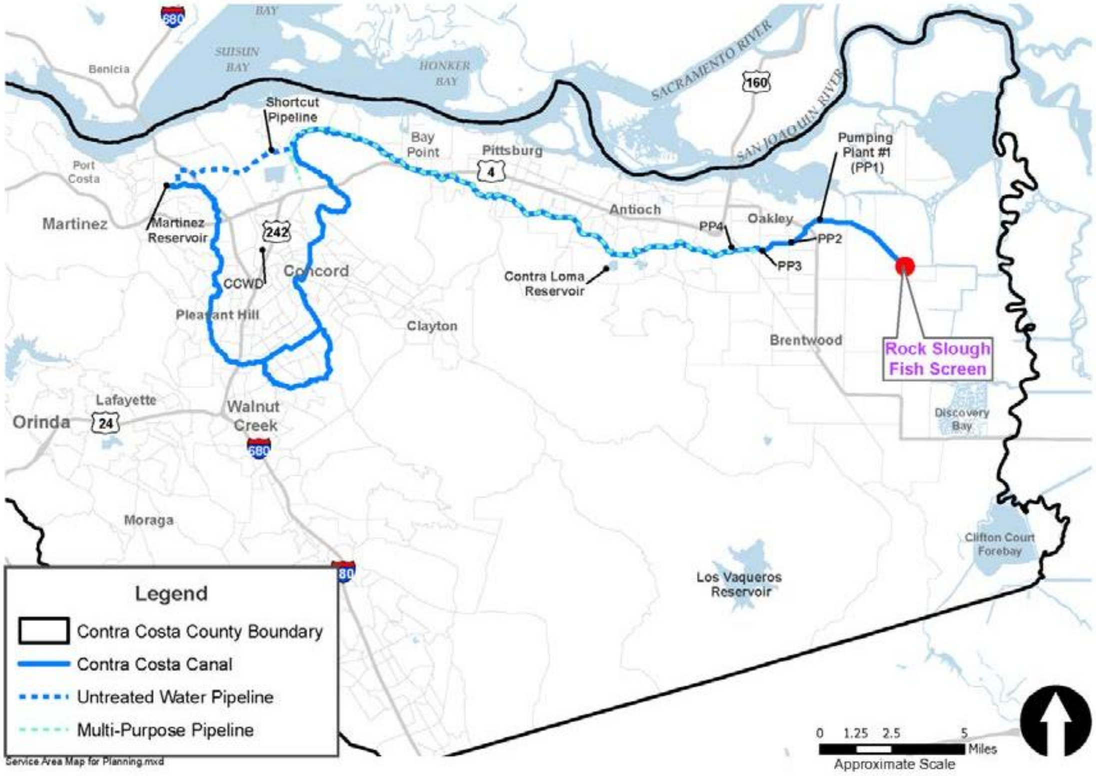

Figure 1. Vicinity map showing location of the RSFS in the Delta, Contra Costa Canal, and Pumping Plants (Reclamation 2016).

1.2 Consultation History

- June 4, 2009. NMFS issued a biological opinion to Reclamation on the long-term operations of the CVP and SWP (NMFS 2009). Annual incidental take was included for the Rock Slough intake for: 5 juvenile winter-run, 10 juvenile CV spring-run, 10 juvenile California Central Valley steelhead (CCV steelhead), and 0 Southern distinct population segment of North American green sturgeon (sDPS green sturgeon) until the RSFS was constructed. Once the RSFS became operational, the authorized incidental take would no longer apply.

- October 28, 2010. Reclamation requested an amendment to the Los Vaqueros Reservoir Project biological opinion (NMFS 1993) to bring it up to date and coordinate operations of CCWD's four diversions in the Delta with the operations of the CVP and SWP contained in USFWS (2008) and (NMFS) 2009. CCWD was the applicant.

- September 1, 2011. NMFS issued an insufficiency letter (NMFS 2011a) responding to Reclamation's October 28, 2010, requested amendment to the Los Vaqueros Reservoir Project biological opinion (NMFS 1993). NMFS recommended that O&M activities for CCWD's four screened diversions (*i.e.*, Old River, Rock Slough, Middle River, and Mallard Slough) be consolidated into one ESA section 7 consultation, to cover maintenance such as: cleaning of the fish screens, aquatic weed control, periodic desilting (dredging), and other activities not considered in previous biological opinions.

- February 17, 2012. NMFS received Reclamation's draft biological assessment (Reclamation 2012a) titled: *Transfer of Operations and Maintenance of the RSFS to CCWD,* and provided comments on February 24, 2012.

- May 22, 2015. NMFS receives Draft Project Description for the Rock Slough Fish Screen Facilities Improvement Project.

- May 29, 2015. Site visit and meeting at the RSFS Facility. The site visit was attended by USFWS, NMFS, CCWD, Reclamation, and Tenera Environmental, Inc. (Tenera). The purpose of the site visit and meeting was to discuss the proposed RSFS Facilities Improvement Project and to observe the operation of the RSFS rake cleaning system.

- September 24, 2015. NMFS provided comments on the Draft Project Description for the Project.

- December 1, 2016. RSFS site visit with Tenera and CCWD. The purpose of the site visit was to observe improvements in the rake cleaning system and efficiency of the block net under the re-deployed log-boom across Rock Slough.

- December 21, 2016. Reclamation requested initiation of formal consultation with NMFS for the Project and provided a BA (Reclamation 2016). Reclamation determined that the Project may affect ESA-listed species.

- January 18, 2017. Reclamation sends NMFS a supplemental letter to clarify that the Project is likely to adversely affect all NMFS species. In addition, Reclamation determined that there are no effects to designated critical habitat in the action area, and minimal adverse effects to EFH under the MSA.

- January 23, 2017. NMFS letter determined that the information provided in the BA is sufficient to initiate formal consultation.

- June 9, 2017. Reclamation modifies the project description in response to questions from NMFS (emails dated 5/15/17, 5/19/17, and 6/2/17). CCWD agrees to the changes and the addition of monitoring requirements during a conference call on June 7, 2017.

- June 21, 2017. The U.S. Corps of Engineers designated Reclamation as the lead Federal action agency to conduct the ESA section 7 consultation.

1.3 Proposed Federal 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). The proposed Project contains the following main components:

1) improvements to the RSFS, as well as various site improvements and adjustments designed to address mechanical failures, hydraulic fluid releases, excessive maintenance, and other deficiencies to allow RSFS to be operated more safely, effectively, and efficiently;
2) administrative actions: such as the transfer of O&M activities from Reclamation to CCWD, land acquisition, and/or the issuance of land use authorizations; and
3) O&M activities of the RSFS and associated appurtenances.

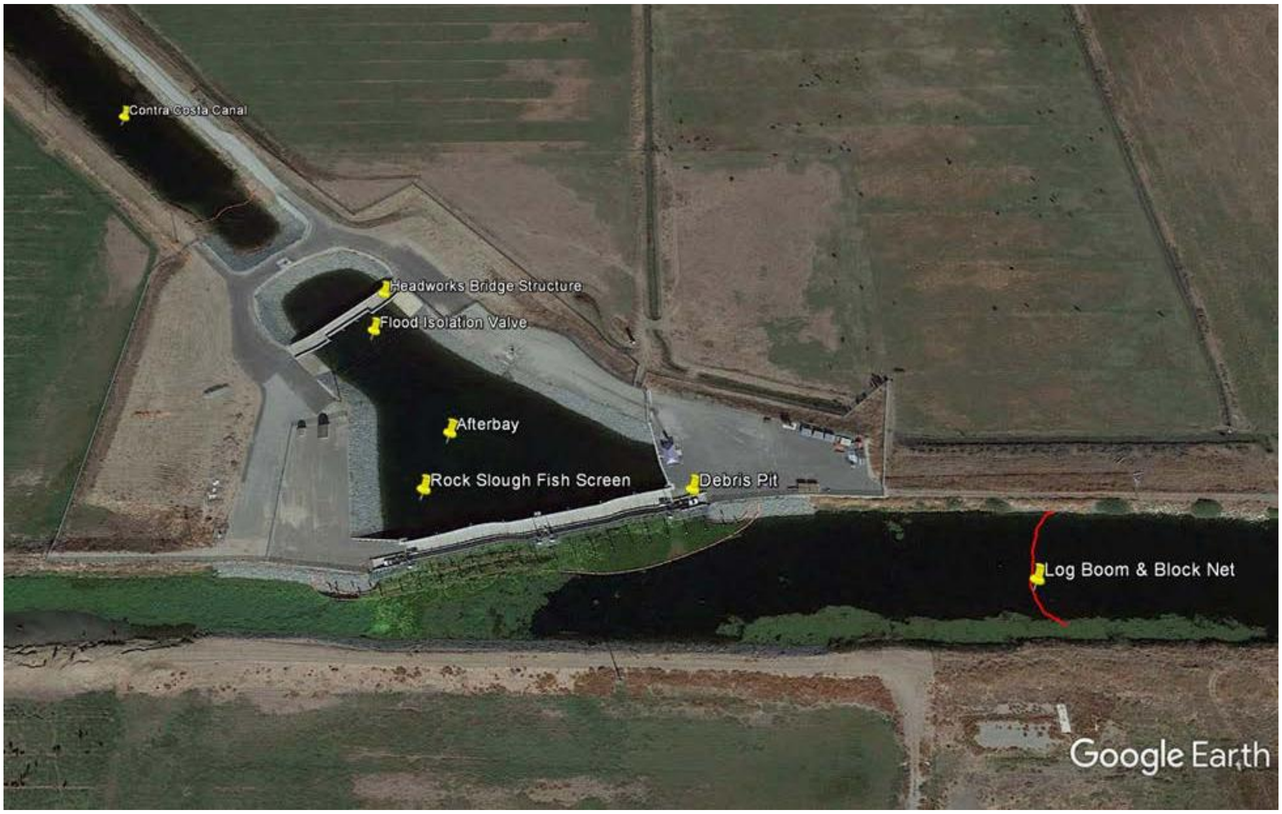

Figure 2. Rock Slough Fish Screen showing facility structures (headworks, afterbay, canal, debris pits), aquatic weeds in 2015, and approximate location of re-located log boom in 2016.

1.3.1 <u>Rock Slough Fish Screen Facility Improvements</u>

A description of the RSFS Facility improvements, site access, equipment to be used, irrigation system improvements, and land encroachment repairs are provided below.

A. RSFS Rake Improvements

To ensure that screen approach velocities are uniform across the entire screen and do not exceed NMFS and USFWS screen criteria of 0.2 feet per second for protection of delta smelt (*Hypomesus transpacificus*), CCWD will replace the existing rakes (Figure 3) with new automated hydraulic rakes/heads, including four rakes/heads that will empty onto the debris conveyance system. The fully-automated rake cleaning system is controlled remotely from CCWD's office[1] through a series of water level sensors. The rake repairs include the following modifications: (1) replacement of the rake head with a re-designed head (see prototype rake, Figure 4) that will more effectively capture and remove debris, and clean the screen; (2) installation of hydraulic seal containment/cooling/alarm systems to return fluid to the hydraulic reservoir in the event of a hydraulic cylinder seal failure; and (3) re-programming of the rake head to provide multiple cleaning modes that will improve cleaning and enable testing of various debris removal and brush-only cycles. Although these modifications are anticipated to correct deficiencies in the current facilities, subsequent, iterative modifications may be required to achieve functional operation meeting the intended goals set for the RSFS Facility. Improvement of the rakes will not require any in-water work within Rock Slough.

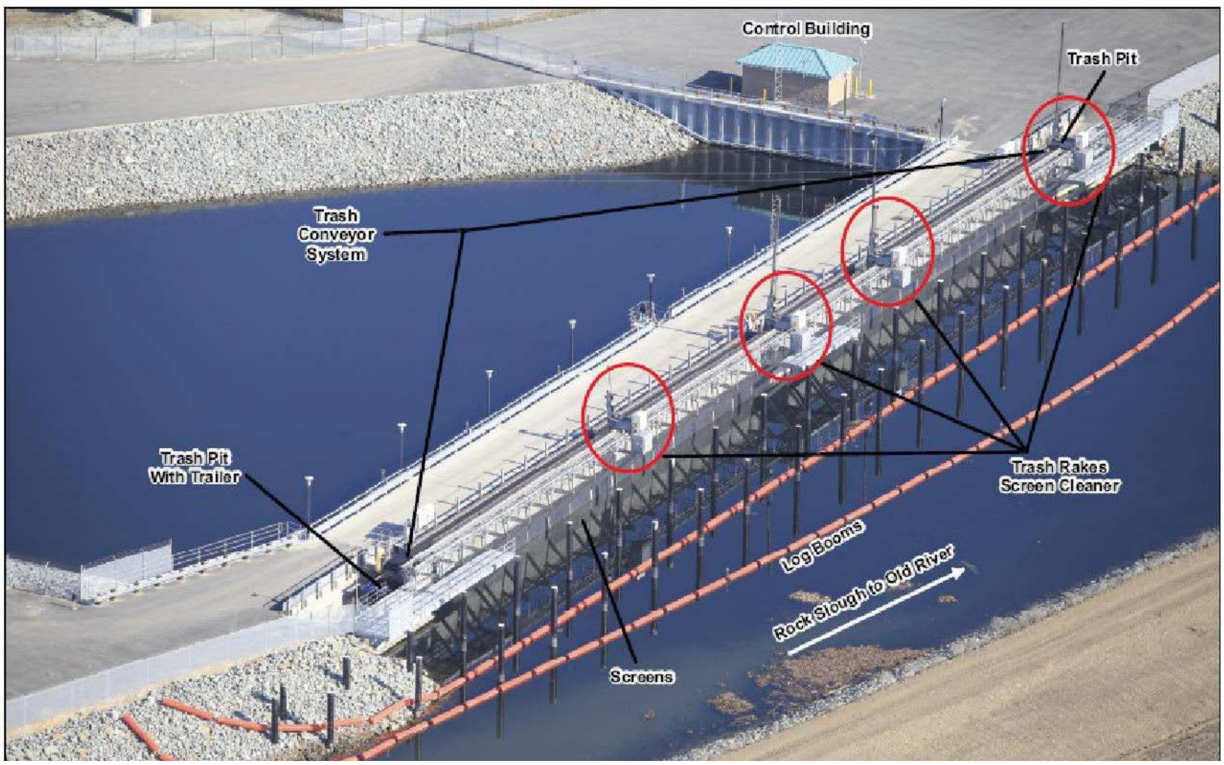

Figure 3. The existing RSFS Facility showing 4 automated hydraulic rakes (circled in red), trash pits, conveyor belt, and original log booms (Reclamation 2016).

The rake heads will be fabricated off-site and installed onto the RSFS. Installation will involve manual labor, movement of heavy loads with a crane or boom truck, and the use of hand tools. Installation of the new rakes is not anticipated to require more than 3 months.

[1] CCWD Operations Control Office is located at the Bollman Water Treatment Plant in Concord, California.

Figure 4. New prototype rake bucket (upper) and hydraulic arm (lower) operating at RSFS (May 29, 2015 site visit).

B. Debris Conveyance System Improvements

The existing concrete debris pits will be modified so that small tractors can be used to safely remove debris and carry debris to the drying area at the site. Improvements would consist of filling in an open concrete area under the conveyor belt where it discharges into the existing pit. The open area under the conveyor is lined with concrete. It will be filled with gravel and covered with concrete, and a bulkhead wall will be installed at the base of the conveyor belt where it discharges into the pit. The area to be filled is approximately 8 feet long, 5 feet in height, and approximately 12 feet wide. The bulkhead wall within the smaller debris pit will allow small tractors to pick up the debris that could build up in the open area under the conveyor belt that was otherwise not reachable with equipment. Improvements to the debris conveyance system will be completed in approximately 2 months.

C. Platform Extension

The existing platform system (which is segmented in three pieces, one on each side of Rock Slough, and a third in the middle to span across the full length of the screen) will be extended outward, away from the screen's face, to provide safe access to the rake system for maintenance in the event the rakes either stop operation or they need to be serviced at locations other than where the existing platforms currently provide access. Figure 5 shows the existing safety deck on the northeast side of the RSFS. The open-grated platform extensions will be fabricated off-site and installed at the RSFS. The work will be accomplished with hand tools and welding equipment. Movement of heavy loads will be accomplished with a crane or boom truck. Construction of the platform extensions will be completed in approximately 2 months. Installation of the platform extensions will not require any in-water work within Rock Slough.

Figure 5. Existing safety deck and hydraulic rakes on the northeast side of the RSFS (Reclamation 2016).

D. Boat Ramp Construction

CCWD will install two boat ramps (upstream and downstream of the RSFS) from July 1 through October 31; this time period includes both in-water work and land work. The ramps will provide access for inspection and maintenance of the in-water components of the RSFS. The boat ramps will also be used to launch vessels to deploy booms if there is an accidental release of fluids, to launch vessels for mechanical weed harvesting, application of aquatic herbicides, or for other procedures where water access may be needed. A silt curtain will be installed prior to in-water work in order to minimize the amount of turbidity during construction. The sites for the two boat ramps will be prepared by removing overlying rip rap and excavating into existing soils of levee banks to create ramps down to elevation minus 4 feet mean sea level (elevation referenced to NGDV 29). The site plan and the location of the boat ramps are shown in Figure 6.

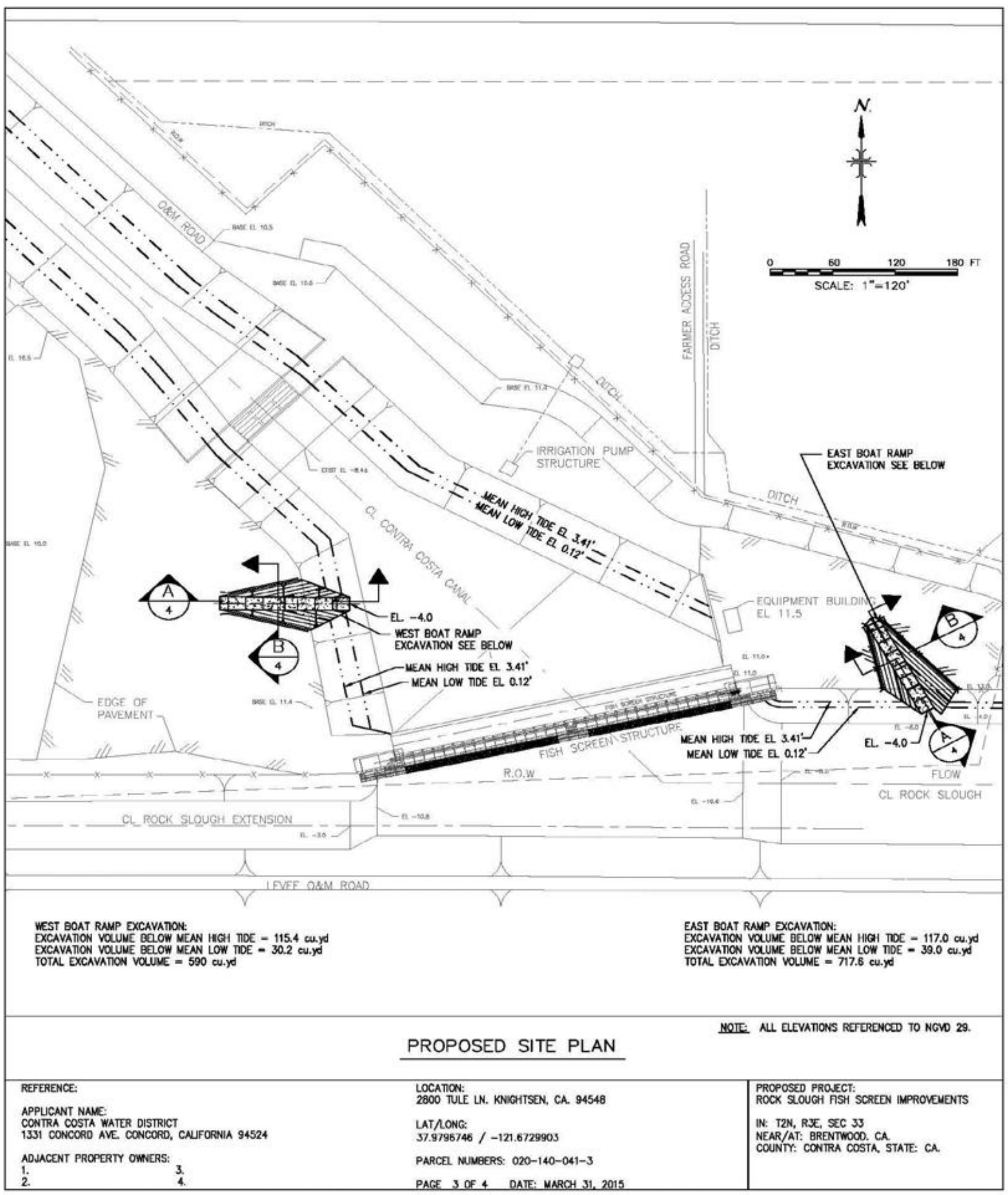

Figure 6. RSFS proposed boat ramp design and site plan (Reclamation 2016).

The west boat ramp (located in the afterbay, downstream of the RSFS) excavation volume below mean high tide is 115.4 cubic yards (CY), 30.2 CY below mean low tide, and total excavation volume is 590 CY. The east boat ramp (located in Rock Slough, upstream of the RSFS) excavation volume below mean high tide is 117.0 CY, 39.0 CY below mean low tide, and total excavation volume is 717.6 CY. The ramp surfaces will be precast reinforced concrete of an interlocking design that allows for settling and requires no concrete casting in or near the water. Construction of the boat ramps will involve cutting and removal of pavement, excavation of soils with conventional earth moving equipment, and a workboat. Construction is anticipated to require an excavator, wheeled front-end loader, and dump trucks for hauling excess material offsite for disposal. A workboat will be required for placement of silt curtains. Excavation will be followed by compaction of the subgrade using a plate or roller compactor. A layer of drain rock will be placed beneath the side slope rip rap and boat ramp precast concrete; this material will be placed with a combination of an excavator, front-end loader, and hand raking. Rip rap on the side slopes will be placed with an excavator and by some hand work. The precast sections of concrete may be placed using an excavator, front-end loader, fork lift, or mobile crane depending upon the type of equipment the contractor has on-site. Dewatering to construct the boat ramps will not be required. The material placement will be accomplished during low tide periods and only the boom of an excavator will enter the water. Before the use of any vehicles or equipment on-site, the vehicles and equipment will be thoroughly cleaned and inspected for fuel and oil leaks, and Reclamation's decontamination procedures will be followed (Reclamation 2012b). No leaking vehicles or equipment will be allowed on-site at any time.

E. Log Boom Placement

A log boom is positioned approximately 600 feet upstream of the RSFS and spans the width (approximately 165 feet) of Rock Slough. The log boom in this location could be modified in the near future to include a gate so that the downstream property owners can enter and exit the area via a boat. CCWD is monitoring the performance of the temporary anchor blocks monthly to ensure that no shifting has occurred. If shifting occurs, CCWD will adjust the blocks and/or install additional anchor blocks. A flatbed truck, dump truck, and a backhoe would be used to move or place new blocks. Previous placement of the temporary anchors was completed within 1 week and it would be expected to require the same amount of time to move or place new anchors.

These temporary anchors may remain for up to 5 years or until such time as the proposed Rock Slough Bridge is constructed by Caltrans (see NMFS 2016c). Once the Rock Slough Bridge is constructed, the log boom will likely be relocated and anchored upstream of the new bridge so that it is visible to boaters. At that time, CCWD will replace the temporary ecology blocks with more permanent pilings in order to anchor the log boom. The permanent log boom anchoring system will be installed in existing rip rap placed on the levee bank of the south side of Rock Slough and in an earthen sloped bank on the north side of Rock Slough. Construction of the pilings will take place above the mean high tide level within Rock Slough, on the stream side of the banks within Rock Slough. The piling anchors will require excavation to approximately 2 feet below ground surface to install a 6 foot by 6 foot concrete pad, 1 foot thick anchor pad, and a 2 foot diameter boring 7 feet below ground surface. Approximately 94 CY of levee material, consisting of silt, clay, and sand will be removed for each anchor; however, approximately 36

CY will be placed back over the top of the 36 square feet anchor pad and the material will be compacted.

Each anchor will permanently remove 58 CY of levee material for disposal off site. Where existing rip rap has been moved to facilitate construction of the anchors, the rip rap will be stored on site and moved back over the anchor pad after construction. Construction of the anchors may require access for a well drilling rig, concrete truck, small backhoe, and/or pickup trucks. Construction of the anchors will take up to 4 weeks to excavate, set forms, pour concrete, and to ensure that concrete has reached maximum strength prior to attaching the log boom to the anchors. The equipment for this work would be staged inside the fenced RSFS Facility, preferentially on paved areas.

Installation or movement of the log boom will be accomplished using a boat for in-water portions of the work and a skid steer or boom truck for shore operations. Once the log boom has been relocated to the new anchors, CCWD will inspect and maintain the log boom and anchors up to two times per year, or additionally should unexpected events occur that could affect the boom or supports (*e.g.,* large storm tides, earthquakes, *etc*.). If the proposed new location for the log boom proves to be problematic, then CCWD will consider either removing the log boom completely and/or installing the pilings in the current location of the relocated log boom. Considerations for the eventual final placement of the log boom will include navigational safety, requirements to maintain a block net long term, landowner permission to access the south side of Rock Slough, and maintenance activities associated with mechanical harvesting. CCWD expects that during the initial period of deployment it will gain a better understanding of the above considerations.

F. Irrigation System Improvements

When the RSFS was constructed, it was necessary to relocate the adjacent ranchers' irrigation system that had been located upstream of the Canal. The ranchers' irrigation system was relocated downstream of the fish screen and created a benefit to fish by screening an otherwise unscreened intake. However since the irrigation system was relocated there have been numerous issues related to the pumps, freshwater irrigation intake, and irrigation valves that will be addressed, as follows.

1. Pump Replacement:

As part of the Project, two existing pumps will be replaced by the neighboring ranchers. The existing 40 horse power (hp) two-stage bowl assembly will be replaced with a 25 hp single bowl assembly. The existing 5 hp mixed-flow bowl assembly will be replaced with a 10 hp axial-flow bowl assembly.

2. Freshwater Irrigation Intake Improvements:

When the relief panel at the RSFS was lifted in May and June of 2016, the ranchers installed a chain link fence around the freshwater intake in the afterbay as a means of limiting the amount of weeds that can directly impact the submerged water intake (Figure 7). However, the ranchers still must clean the debris from the submerged fence. In order to minimize safety concerns due to the cleaning of the submerged fence, CCWD will allow the ranchers access to the afterbay boat ramp so that the ranchers can use a small boat to clean the submerged fence around the intake.

3. Irrigation Valves:
There are two existing valves used to withdraw water from downstream of the RSFS to irrigate a private landowner's agricultural field. As shown in Figure 7, the two existing valves will be replaced and one new valve installed by the ranchers. All ditches and wetted areas will be avoided during access to the work sites. Each valve will require a 10 foot deep excavation over a 10 foot by 10 foot area. The spoils will be placed immediately next to the excavation site. Once the valve work is completed, the spoils will be placed back into the excavated area and any remaining spoils will be spread around the work area. All work will be conducted from May 1 through October 31. Once the valve work is completed, it is expected all O&M activities associated with the valve work will be conducted by the landowner (ranchers) pursuant to a Reclamation issued land use authorization. Reclamation will ensure that all the requirements from this ESA consultation will be included in agreements with landowners.

A. Site Access
The primary route to the Project area is from East Cypress Road in the City of Oakley (Figure 11). Construction crews and equipment will enter the Reclamation right-of-way on the existing northeast aggregate (gravel) maintenance road along the unlined portion of the Canal. Equipment and construction crews will travel approximately 1.5 miles along the northeast maintenance road towards the start of the unlined portion of the Canal near the confluence with Rock Slough where the fish screen is located. CCWD will likely need to access the south side of the log boom from Delta Road along an existing private gravel road (future Bethel Island Road Extension Right of Way).

B. Staging Areas & Parking
The RSFS Facility site includes substantial paved and unpaved areas that can be used for temporary construction and staging to accommodate construction equipment, materials, fuels, lubricants, and solvents. Petroleum products will be stored in areas with secondary containment and will be handled according to a spill prevention plan to be developed for the construction work before work begins.

C. Equipment
Excavators, backhoes, loaders, fork lifts, compaction equipment, work boats, welders, pavers, and dump trucks will be required for construction of the improvements. A crane or boom truck will be needed to maneuver the rakes into place and to set the precast sections of the boat ramps.

D. Fencing
The perimeter property boundary surrounding the Canal and the RSFS Facility has been secured by installation of a 6-foot tall chain link fence. In the event that a settlement is not made with the property owner on the encroachment land area matter described above, CCWD intends to place a temporary fence (three-strand barbed wire) or fiberglass markers on the correct property line approximately 50 feet from the existing fence. This will ensure that all future work and maintenance remains within the RSFS Facility property boundary. CCWD will likely continue to use and maintain this property until the land area encroachment issue is resolved.

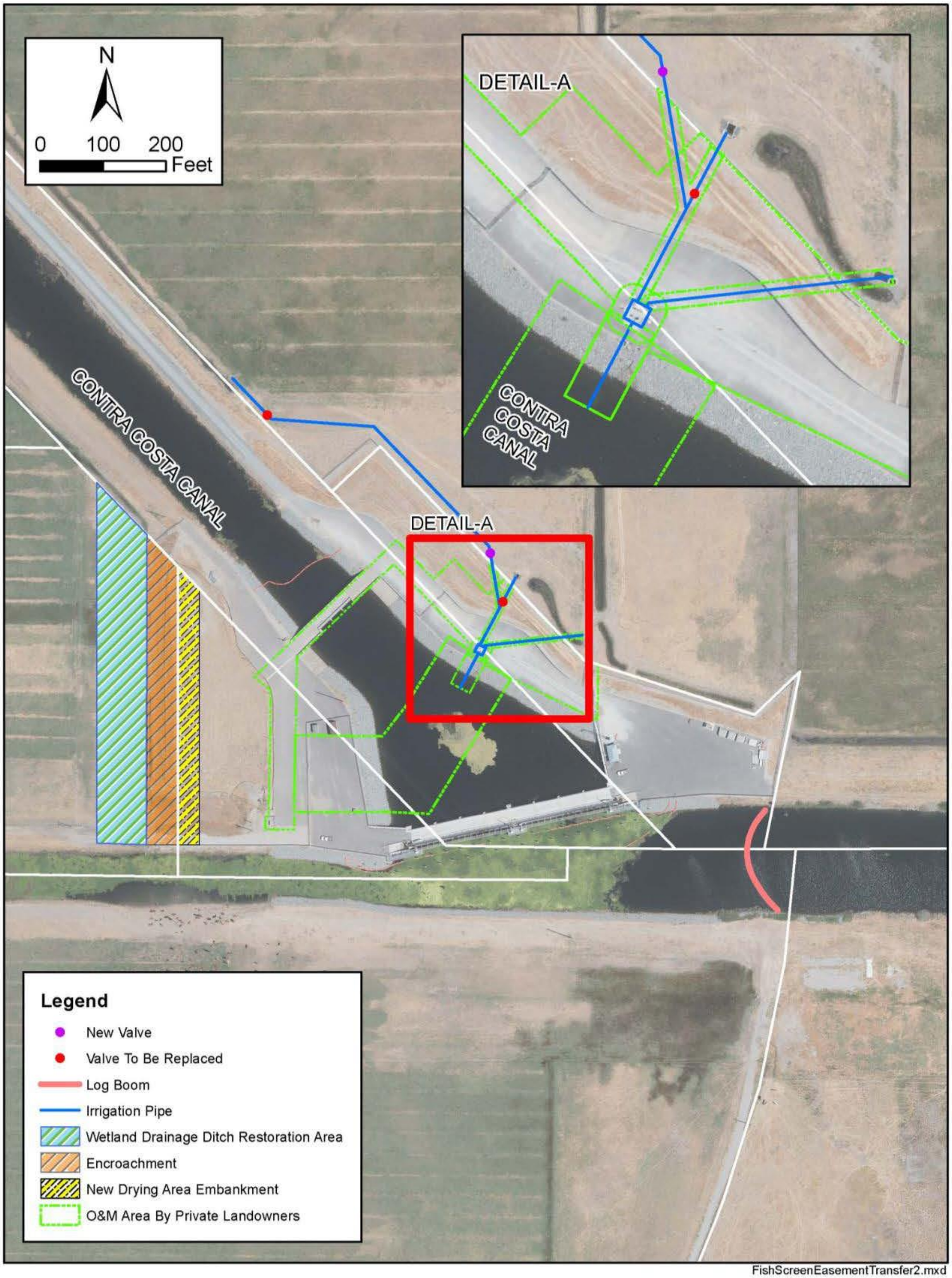

Figure 7. Proposed Irrigation System Improvements and log boom location (Reclamation 2016).

E. Silt Curtains

Silt curtains will be installed in Rock Slough during construction of the two boat ramps, desilting the Canal, and bridge maintenance. This will minimize any turbidity during boat ramp construction from extending into Rock Slough or the Canal. The silt curtain will have a floating plastic boom that will support the curtain. The curtain will be an impermeable membrane that extends from the float at the water's surface to the invert of the channel. The bottom of the curtain is weighted to hold it in place and the ends of the floating boom are anchored. The silt curtain is installed with a workboat and lifting equipment for unloading.

1.3.2 Schedule for RSFS Improvements**:**

An estimated construction sequence is provided in Table 1. The timing of construction will be dependent on available funding and permitting of the Project. CCWD would like to start construction of the improvements as early as July 2018, with completion expected by June 2019. Land, water, and wetland impacts are expected to be completed first with work completed by the fall of the same year. However, depending on the timing it may be necessary to complete restoration in the early spring of the following year (Gruenhagen 2017).

Table 1. Summary of proposed construction sequence.

Type of Activity	Time Period	Construction Duration
Log boom relocation	June	2 weeks
Bird nesting deterrents; paint, netting, and spiking	April–September	4 weeks
Rake modifications	April–September	3 months
Debris handling systems	April–September	2 months
Access Platform extension	April–September	2 months
Boat ramp construction	April–September	2–5 months
Prototype rake testing	November – March	2 years
Miscellaneous improvements	May – October	2 months

1.3.3 Operations and Maintenance (O&M) of the RSFS Facility

Operation of the improved RSFS includes several tasks. The automatic rake system will be operated remotely by CCWD to ensure that the screen is clean and approach velocities are achieved consistent with USFWS and NMFS screen criteria (0.2 feet per second approach velocity). CCWD will test the new rakes to ensure that they can be reliably and effectively operated once installed. CCWD will manage the debris that is removed by the operation of the rakes and also from behind the screens or is otherwise removed to maintain the operation of RSFS. Debris will be removed to the on-site drying area as necessary. The location of the on-site drying area is shown in Figure 11. Fish and debris monitoring data will be used to assess the presence of salmonids and other ESA-listed fish species. Fish data will be collected during CCWD's routine sieve net monitoring program, either weekly (mid-December through mid-July) or monthly (late-July through early-December) and also during debris monitoring while the rakes are operating. Debris monitoring entails identifying the type and amount of debris (and any fish) removed by the rakes during their cleaning operation. Visual observations of the intake forebay area are also conducted during debris monitoring.

Proposed O&M Activities

CCWD has been maintaining the RSFS since Reclamation completed construction of the facility in 2011 consistent with O&M activities covered in the USFWS biological opinion (USFWS 2005). The Project considers the ongoing O&M activities described in USFWS (2005), as well as additional actions not previously covered for the RSFS Facility. The Project includes 41 O&M activities proposed for the RSFS Facility that could occur in the vicinity of the RSFS Facility. The identified O&M activities are based on CCWD's experience at the RSFS, within the Canal system and at its other screened Delta intakes, and could be subject to change as specific experience maintaining the RSFS Facility is obtained. The O&M activities will apply to both land and water area owned by Reclamation between the Canal Headworks/Flood Isolation structures and the area in front of and around the RSFS Facility up to the property line where the relocated log boom was placed across Rock Slough (some of these areas are on private property).

The 41 O&M activities are described individually below. These O&M activities are numbered as they were in USFWS (2005) biological opinion, and therefore are not numbered sequentially.

1. Aquatic Weed Contact Herbicide Application

Invasive aquatic weeds have been a problem at the RSFS Facility since construction was completed in 2011 (Figure 8). Since that time, Tenera has documented the types and quantities of aquatic weeds collected by the screen cleaning system. Additionally, during fish monitoring events at RSFS, Tenera has visually inspected and documented the composition of aquatic weeds located in front (upstream) of the fish screen. During these visual surveys, water hyacinth (*Eichhornia crassipes*) has had the largest presence among the aquatic weeds at the RSFS. Water primrose (*Ludwigia peploides*) has occasionally emerged among the floating flora, however, to a lesser extent than water hyacinth. Submerged aquatic weeds in front of the RSFS include Brazilian elodea (*Egeria densa*), coontail (*Ceratophyllum demersum*), and filamentous algae, with Brazilian elodea being the dominant species. Of the quantities of weeds collected by the rakes at the RSFS, Brazilian elodea has dominated, followed by water hyacinth and coontail. The percent composition of aquatic weeds collected by the screen cleaning system is provided in Reclamation (2016).

Figure 8. View upstream (east) of aquatic weeds in Rock Slough (Reclamation 2016).

The extent of the area where herbicide will be applied varies and will depend on the distribution of aquatic weeds, but is generally the area from downstream of the RSFS to Headworks/Flood Isolation structures (intake afterbay) and the area upstream of the RSFS from the Rock Slough Extension to the current location of the log boom (approximately 800 feet upstream of the RSFS). Herbicide application will occur in the same area as mechanical harvesting (Figure 11). The proposed application area in front of the RSFS and Rock Slough Extension is estimated at approximately 4 acres and the area within the Canal downstream of the RSFS and upstream of the Headworks Structure is estimated at 2 acres.

Herbicides will be delivered from pressurized tanks and sprayed from vehicle and/or boat-mounted booms, via backpack sprayers, or other application rig, or by manually wicking herbicides directly onto vegetation. Aerial spraying using aircraft will not be conducted. Applications will be made following the herbicide label instructions and are timed to occur when weeds are most susceptible, which is usually when plants are young or are actively growing (commonly as early as March or as late as October). The best time to treat the weeds is generally when the plants are just beginning to grow (during the spring). Treatment during this period will minimize the amounts of herbicides required for adequate control; mature plants require more product to ensure effective treatment. However, the application schedule depends on the mode of action of the herbicide and plant phenology. The majority of herbicide application is expected to occur from June through October following CCWD's approved Integrated Pest Management Plan (IPMP; Reclamation 2016, Appendix B), and Reclamation's requirements while applying herbicides within Rock Slough or the RSFS intake afterbay (Reclamation Manual, undated). IPMP Plans are reviewed annually by the California Environmental Protection Agency's (Cal-EPA) Department of Pesticide Regulation and are modified as new compounds become available. Aquatic pesticide use in the Canal and raw water reservoirs is regulated under the Statewide General National Pollutant Discharge Elimination System (NPDES) for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States (general permit). The current NPDES general permit identifies specific monitoring and reporting requirements on pesticide use which became effective December 1, 2013, and will expire on November 30, 2018.

CCWD evaluated several strategies for applying aquatic herbicides in order to avoid and minimize effects to listed species to the extent possible while still meeting needs for controlling weeds that compromise the operation of the RSFS Facility. CCWD proposes to conduct mechanical harvesting and aquatic herbicide application from June 1 through October 31, a period when listed fish species are least likely to occur in the vicinity (see discussion below). CCWD chose the least toxic herbicides out of a suite of herbicides approved for use in California. It is important to keep the area in front of RSFS clear of weeds: (1) to ensure that the rakes can operate effectively so that velocities remain at or below fish screen requirements; (2) to prevent high differentials (*i.e.*, difference in water levels behind the screens) that can damage the screen panels or structures; and (3) to allow monitoring of adult Chinook salmon that generally appear at the RSFS in mid-November, which may require adjusting rake operations in order to prevent salmon entrapment.

In addition to the established August through October in-water work window allowed for delta smelt, CCWD proposes to apply aquatic herbicides and mechanically harvest in June and July, or earlier, if necessary. June and July were included in the period of proposed herbicide application based on CCWD and CDFW fish monitoring data (Table 2).

Table 2. Total number by species and months listed species were collected by sieve net from 1999–2009 at the Rock Slough Headworks prior to construction of the fish screen (Reclamation 2016).

Listed Species	Total Number collected	Year, (Month collected), and Total/Year
Winter-run	0	None collected
CV Spring-run	11	2004 (Mar, Apr) 3 total 2005 (May) 4 total 2006 (May) 3 total 2008 (Feb) 1 total
CCV steelhead	15	2005 (Feb, Mar, Apr) 4 total 2006 (Jan, Mar) 2 total 2007 (May) 1 total 2008 (Feb, Mar) 8 total
sDPS green sturgeon	0	None collected

In order to apply herbicides in June and July, CCWD proposes to conduct ichthyoplankton monitoring three times a week regardless of the results of CDFW's surveys that either initiate or end CCWD's ichthyoplankton sampling. Samples will be processed immediately and results reported to CCWD and Reclamation. If larval/post larval smelts are found, CCWD will not conduct herbicide applications until such time that larval smelts are not collected during three consecutive sampling events.

During some years, there could be situations that occur outside of the June through October time period when large quantities of weeds may threaten the integrity of the screen. CCWD proposes to use aquatic herbicides to alleviate the issues in front of the screen. CCWD would advise Reclamation's Engineer and Biologist (Fresno Office) before any work commences. Work would not be initiated without authorization from the Engineer. If further environmental review is required, CCWD would comply with the requirements. CCWD will coordinate any herbicide application upstream of the RSFS with California Division of Boating and Waterways (CDBW) to avoid over application and to review dosage and post application monitoring procedures. Under an existing Memorandum of Understanding (MOU) between CDBW and CCWD, CDBW is prohibited from applying aquatic herbicides within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, without the prior consent of CCWD.

CCWD compiled a list of the problematic aquatic plants at RSFS using data collected during debris tracking. The majority of plants are the non-native water hyacinth, Brazilian elodea, and water primrose, the native coontail, and filamentous algae. CCWD proposes to use the following herbicides to help control the presence and spread of aquatic plant species at RSFS: Clearcast®, Roundup Custom™ GreenClean® Liquid 2.0, and Phycomycin® SCP. The 4 herbicides and the aquatic plants they control are listed in Table 3.

Table 3. Proposed herbicides and application rates in the vicinity of the RSFS (Reclamation 2016). mg/L = milligrams/liter, ppm = parts per million, ppb = parts per billion, µg = microgram.

Brand Name	Active Ingredient	Target Species	Degrades	Application Rates	Label Warnings	Toxicity
Clearcast®	Ammonium salt (imazamox 12.1%)	hyacinth, primrose, coontail, elodea	50% in 4-49 days	Broadcast Hyacinth: 16-32 oz/acre; 50-200 ppb Primrose: 32-64 oz/acre; 50-200 ppb Coontail: 200-500 ppb Elodea: 200-500 ppb	Water not drinkable for 6 days	*Bluegill*: 96 hr LC50>119 mg/L; 119,000 ppb *Trout:* 96 hr LC50 > 122 mg/L=122,000 ppb *Bees*: LD50>100 µg/bee
GreenClean ®Liquid 2.0	Hydrogen dioxide (27.1%)	algae	100% at 24 hours	Spray from boat or shore, inject via pipes into water, 2.4-24.0 gal/acre or 0.5-5 ppm, depending on density	Apply during calm, sunny conditions in early spring	*Trout*: 48 hr LC50 > 40mg/L; >40ppm *Crustacean*:48-hr EC50; 126.8 mg/L *Bees*: highly toxic
Phycomycin ®SCP	Sodium carbonate peroxhydrate (SCP 85%)	algae	100% at 24 hours	Broadcast or mechanical spreader, 3-100 lb/acre, 0.3-10.2 ppm	Apply after growth starts, allow 8-10 hours daylight, depletes DO	*Bluegill*: 96 hr LC50=320 mg/L; 320 ppm *Fathead minnow:* 96 hr LC50=70.7 mg/L: 71ppm
Roundup Custom™	Glyphosate (53.8%)	hyacinth, primrose	50% 12 days-10 weeks	Broadcast 3-7 pints/acre, 1.5% solution by volume for spray, requires surfactant (nonionic at 2 qts/100 gal)	Water not drinkable for 48 hours unless < 0.7 ppm	*Trout:* Acute, 96 hr, static, LC50 >1000 mg/L *Daphnia*: Acute, 48 hr static, EC 50: 930 mg/L *Bees*: 38 hrs, LD50 oral 100 ug, contact > 100 µg/bee

a. Clearcast®

Clearcast® is a systemic herbicide used to control/suppress certain submerged, floating, and aquatic vegetation. It may be broadcast-applied to the water surface or injected below the water surface under surface-matted conditions. It may also be applied aerially by both fixed-wing aircraft and helicopter. Its active ingredient is ammonium salt of imazamox (12.1%) (Clearcast® Specimen Label). At RSFS, Clearcast® will be effective at controlling water hyacinth, and to a lesser extent coontail and Brazilian elodea. Clearcast® also is effective at controlling pondweed, watermilfoil, hydrilla, and water stargrass (Clearcast® Specimen Label). It is a systemic herbicide which acts by moving throughout the plant tissue, preventing plants from producing a necessary enzyme (acetolactate synthase) which is not found in animals. Treated plants will stop growing after treatment, and plant death and decomposition will occur over several weeks [Wisconsin Department of Natural Resources (WDNR) 2012a]. Water treated with Clearcast® is considered potable six days after treatment. Imazamox has a half-life ranging from 4 to 49 days in lakes, however breakdown does not occur in deep, poorly oxygenated water with no light. In this case, imazamox will bind to sediment rather than breaking down, resulting in a half-life of 2 years. Its breakdown products are nicotinic acid and di- and tricarboxylic acids, none of which are herbicidal or suggest concerns for aquatic organisms (WDNR 2012a). Imazamox is classified by the U.S. Department of Agriculture (USDA) as practically non-toxic to fish and aquatic inverts, and it does not bioaccumulate in fish. Toxicity (LC50, 96 hr) for rainbow trout (*Oncorhynchus mykiss [O. mykiss]*) is greater than 122 mg/L and is greater than 119 mg/L for bluegill (*Lepomis macrochirus*) [Clearcast® Material Safety Data Sheet (MSDS)]. Laboratory tests using rainbow trout, bluegill, and water fleas (*Daphnia*) indicate that imazamox is not toxic to these species at labeled application rates (USDA and CDBW 2012b).

Imazamox is not acutely harmful to terrestrial organisms, and is toxic to birds only at dosages exceeding approved application rates. Honeybees are affected at application rates, so application should be in a manner that does not allow for drift into blooming crops or weeds while bees are actively visiting the treatment area (Clearcast® Specimen Label). Toxic impacts to amphibians and reptiles resulting from the application of imazamox are highly unlikely (USDA and CDBW 2012b). CCWD will apply the product according to labeled application rates (Reclamation 2016, Table 7).

b. GreenClean® Liquid 2.0

GreenClean® Liquid 2.0 is a broad spectrum algaecide/bactericide used to treat filamentous algae and cyanobacteria. Its active ingredients are hydrogen dioxide (27.1%) and peroxyacetic acid (2.0%). It acts by oxidizing the algae, destroying algal cell membranes and chlorophyll (GreenClean® Specimen Label). GreenClean® Liquid 2.0 is listed as toxic to birds, fish, and bees on its label. CCWD will apply GreenClean® Liquid 2.0 according to the labeled rates (Reclamation 2016, Table 8). GreenClean® Liquid 2.0 toxicity (LC50, 48 hr) to rainbow trout is greater than 40 mg/L and its toxicity to crustaceans (EC, 48 hr) is 126.8 mg/L. Its half-life is very short with nearly 100% degradation within 24 hours (GreenClean® MSDS). The end product from breakdown is hydrogen and oxygen (WDNR 2012b). It is highly toxic to bees exposed to direct contact on blooming crops or weeds, so application should be in a manner that does not allow for drift into blooming crops or weeds while bees are actively visiting the treatment area (GreenClean® Specimen Label). Treatment can result in oxygen loss from decomposition of dead or decaying algae; treatment should begin along the shore and proceed outward in bands to allow fish to move into untreated areas. Treatment of algae with GreenClean® Liquid 2.0 will be conducted through water application, either by surface injection, or by spot treatment. For spot treatment, GreenClean ® Liquid 2.0 is applied directly over the infested area (GreenClean® Specimen Label). Retreatment is required when heavy growth appears; CCWD will allow 48 hours between consecutive treatments. Control is most effective when algae are not yet established and water temperatures are warm. Therefore, CCWD will apply the herbicide in the summer during the morning under calm, sunny conditions when the water temperature is at least 60°F.

c. Phycomycin® SCP

Phycomycin® SCP is an algaecide and oxidizer used to treat filamentous algae and blue-green algae (cyanobacteria), as well as coontail at higher application rates. Phycomycin® SCP is similar to GreenClean® Liquid 2.0; however, it is granular in form. Its active ingredient is sodium carbonate peroxyhydrate (85%) (Phycomycin® SCP Specimen Label). Sodium carbonate peroxyhydrate (SCP) acts by oxidizing algae, destroying algal cell membranes and chlorophyll (WDNR 2012b). It is toxic to birds and fish, but is considered nontoxic to birds and fish when used at the labeled rates (Phycomycin® SCP Specimen Label). CCWD will apply the herbicide at label rates (Reclamation 2016, Table 9). Its toxicity (LC50) to fathead minnow (*Pimephales promelas*) is 70.7 mg/L and is 320 mg/L to bluegill (Phycomycin® SCP Fact Sheet). Its half-life is very short with nearly 100% degradation within 24 hours (Phycomycin® SCP Specimen Label, WDNR 2012b). The end product from breakdown is hydrogen and oxygen (WDNR 2012b). It is highly toxic to bees exposed to direct contact on blooming crops or weeds, so application should be in a manner that does not allow for drift into blooming crops or weeds while bees are actively visiting the treatment area. Treatment of algae with Phycomycin® SCP is conducted by broadcasting or use of a mechanical spreader. Control is most effective when water temperatures are warm, so CCWD will apply early in the day under calm, sunny conditions when the water temperature is at least 60°F (Phycomycin® Specimen Label). CCWD will apply the herbicide from shallow water and proceed towards deeper waters to allow fish and mobile biota the opportunity to move away from the treatment area.

d. Roundup Custom™

Roundup Custom™ is a systemic herbicide used to treat aquatic plants growing above water. Its active ingredient is glyphosate (53.8%), and it acts by inhibiting an important enzyme needed for multiple plant processes, including growth [Michigan Department of Natural Resources (MDNR) 2015]. At the RSFS, it will be effective in controlling water hyacinth and water primrose. It is applied at the surface either aerially, via broadcast equipment, or by handheld equipment (Roundup Custom™ Specimen Label). A surfactant approved for aquatic sites must be used in conjunction with Roundup Custom™ to help the herbicide stick to the plant surfaces and to increase the rate of absorption (MDNR 2015). Reclamation proposes to use two nonionic surfactants with Roundup Custom™: R-11 Spreader-Activator and Prospreader Activator. For controlling water hyacinth, the ideal herbicide treatment time is when the plant is in the early growth phases, which in the Delta has historically occurred from early May to the end of June (USDA and CDBW 2012a). After application, plants will gradually wilt, appear yellow, and die in approximately 2 to 7 days (MDNR 2015). Roundup Custom™ cannot be applied within ½ mile upstream of an active potable water intake. If application is made within ½ mile upstream of a potable water intake, intakes must remain off for 48 hours after treatment, unless assay determines glyphosate level is below 0.7 ppm. CCWD's pumps are nearly 4 miles from RSFS treatment area. In water, glyphosate has a half-life between 12 days to 10 weeks, depending on water conditions (Tu *et al.* 2001). Concentration of glyphosate is reduced through rapid dispersal by water movement, by binding to sediments, and through breakdown by microorganisms. The primary breakdown product is aminomethylphosphonic acid, which is further broken down by microbes in the water and soil, and is considered not to pose any hazards distinct from glyphosate (MDNR 2015). Laboratory testing indicates that Roundup Custom™ is toxic to fish only at dosages well above label application rates (MDNR 2015). CCWD will apply according to label application rates. Acute toxicity (96 hr, LC50) to both rainbow trout and bluegill is greater than 1,000 mg/L. Roundup Custom™ is no more than slightly toxic to birds and is practically non-toxic to bees. It is relatively non-toxic to domestic animals, however ingestion of large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (Roundup Custom™ Specimen Label). The use of glyphosate can result in oxygen depletion by decomposition of dead plants, therefore in order to prevent fish kills caused by dissolved oxygen

(DO) depletion, only one-third to one-half of any water body should be treated at any one time (Tu *et al*. 2001).

2. Blading and Disking of Rights-of-Way

A grader or tractor with mounted blade or disc is used to scrape or shallowly till the soil to kill, prevent, or retard growth or spread of weeds, to reduce cover for pests, and to limit vegetation fuel load while providing fire breaks. Blading is practiced, in part, to reduce reliance on chemical herbicides and minimize development of herbicide resistance in weeds. Blading and disking is conducted along rights-of-way (following canals and pipelines or conduits and their access routes) and around support facilities and structures. Blading and disking may be conducted at any time of year, but is concentrated in the dry period (March through November). The action may be conducted once to several times a year, as needed to control weeds.

3. Blading of O&M Roads

A grader or tractor with a mounted blade is used to scrape unpaved roadways and road shoulders to remove weedy vegetation, ruts, and to level and maintain the surface for access to the Project. Blading occurs during the dry season, primarily from May through November. Machinery disturbs soil on the roadway and on the shoulders.

4. Canal Bank Revegetation

Revegetation with native non-weedy plants is conducted to stabilize slopes and prevent erosion, retain support of the Canal, exclude weeds, and also provide wildlife habitat. Prior to revegetation, plots are scarified either by a gradall, loader, or klodbuster if they are on slopes, or by a disc if on level terrain. Large flat plots are drilled, and hilly terrain is hydro-seeded. Small (approximately 30 feet by 60 feet) test plots are hand broadcast. Plots may be mulched with straw, which may be tackified with wood fiber and a mulch tackifier to hold it in place. CCWD will use hydroseeding to control erosion on slopes both inside and outside of the levee.

5. Canal/Tunnel/Conduit Liner Repair

Liners, tunnels, and conduits are typically constructed of reinforced concrete. Cracked or broken liner panels, damaged sections on canals, or areas on wasteways and the aprons or outlets from canals are patched with concrete, grout compound, shotcrete, or other similar material that is pumped, blown, or fed from a mixer by gravity.

A damaged liner that cannot be repaired is overlaid with shotcrete or removed with heavy equipment and a new panel is fashioned in place. When panels are removed, the soil behind the panel may be excavated and then re-compacted. Rebar is installed before concrete is poured in place. Repairs usually are made when facilities are dewatered or water delivery is minimal, often in the fall and winter. However, repairs may be conducted from winter through the end of March on the Canal.

6. Contact Terrestrial Herbicide Applications

Contact herbicides are applied to control vegetation on canal banks, on rights of way, around water intakes and other structures, and at facilities compounds. Herbicides approved for use in California by the United States Environmental Protection Agency (USEPA) and the California Department of Pesticide Regulation (CDPR) are applied to check growth of vegetation that could threaten the integrity of facilities or foul its operation, maintain access to facilities, enable facilities inspections, reduce fire hazards, and to reduce the spread of noxious or invasive weeds.

Additionally, contact herbicides are sprayed to reduce or eliminate habitat for pests, enhance security surveillance, and provide for a well-kept appearance at facilities. Herbicides are delivered from pressurized tanks and sprayed from vehicle mounted booms, via backpack sprayers or other application rig, bean gun, wand, or by manually wicking herbicides directly onto vegetation; aerial applications using aircraft are not conducted. Applications are made following instructions on the label and are timed to occur when weeds are most susceptible, usually when plants are young or are actively growing (February–October), although this depends on the mode of action of the herbicide and plant phenology. One or more applications are made annually as needed, depending on weed pressure and need for control. A typical regimen for weed control around the RSFS Facility includes pre-emergent applications for control of winter annuals, followed by one to several applications of contact herbicides for control of other annuals, which may be integrated with mechanical controls. CCWD will follow its approved IPMP (Reclamation 2016, Appendix B) and Reclamation's requirements (Reclamation Manual, undated) when applying contact herbicides.

Two contact terrestrial herbicides are used by CCWD: Capstone® and Roundup Custom™. Capstone® is used for control of annual and perennial broadleaf weeds, woody plants, and vines. It is labeled for use on rangeland, permanent grass pastures, forests, non-cropland areas (airports, communication transmission lines, electrical power and utility rights-of-way, industrial sites, roadsides, railroads, etc.), natural areas, and Conservation Reserve Program sites. Capstone's® active ingredients are Triisopropanolammonium salt of 2-pyridine carboxylic acid, 4-amino-3, 6-dicholoro- (2.2%) and Triethylamine salt of [(3, 5, 6-trichloro-2-pyridinyl) oxy]acetic acid (16.22%). It will be applied either through ground broadcast, or by handheld equipment for foliar or spot application. Roundup Custom™ is a broad-spectrum post-emergence herbicide used for aquatic, crop, nonagricultural crop, industrial, turf, ornamental, forestry, roadside, and utility rights-of-way weed control. Roundup Custom™ active ingredient is glyphosate (53.8%). It provides control of annual weeds, perennial weeds, woody brush, and trees. Roundup Custom™ works by inhibiting the production of an enzyme that is essential to the formation of specific amino acids.

7. Canal Dewatering

Dewatering is done to facilitate maintenance of canal facilities, including repair or replacement of liner or inspecting or repairing siphons. During the process, water to one or more sections of the Canal is "cut off." In some cases, water may be pumped "upstream" behind a check or control structure. The action is conducted when demand for Canal use is lowest (usually October through March).

8. Drain, Ditch and Channel Maintenance

This maintenance is conducted to ensure conveyance of water through facilities or away from facilities. Surface (*e.g.,* ditches, flumes, and overchutes) and subsurface (*e.g.,* downdrains, pipes, and underchutes) drains, as well as the main channels of canals are maintained. Maintenance includes cleaning debris (both large and small), trash, soil, sediment, and vegetation from open ditches, canals, and areas in front of the RSFS, reshaping them with heavy equipment if necessary. Debris and vegetation that periodically accumulates in collecting basins or pipe is removed by hand or with a shovel. If piping is cracked, soil may be excavated and piping replaced. Backhoes, gradalls, excavators, dredges, draglines, tractors, and hand shovels may be used to remove material in surface areas.

Cleared soil and vegetation may be piled on adjacent land or, when extensive, may be transported in trucks to a spoil site. Activities occur primarily in fall and spring, but are concentrated during the end of the dry season (especially August through October) and before fall rains begin. Soil on ditch banks and soil and vegetation that occurs along banks and in depressions is disturbed or removed.

9. Hand and Mechanical Control of Vegetation

Hand control is used to remove small amounts of nuisance or weedy vegetation at facilities or around structures where use of equipment or herbicides is impractical, such as where the extent of the problem is small. Removal is done by hand pulling vegetation, or removing it with aid of stringed weed cutters, spades, hoes, shovels, adzes, saws, or other hand implements. Disturbance occurs from cutting and removal of vegetation.

CCWD and/or its designee will mechanically harvest aquatic weeds from the area in front of the RSFS from the Rock Slough Extension to approximately 100–200 feet beyond the log boom, and from the area downstream of the fish screen and upstream of the Rock Slough Headworks Structure (Figure 11). The harvester will cut the weeds at a depth of approximately 5 feet below the water surface. In shallower areas (6 feet deep or less), the harvester will cut the weeds as close to the bottom as practicable. No disturbance of the bottom of Rock Slough or the Canal would occur. Cut aquatic weeds will then be pulled up onto the harvester via conveyor belt until the harvester is full. Once full, the aquatic weeds will be pulled off the harvester by a crane at the RSFS. It may be necessary to use an excavator to scoop out the weeds using the bucket and the thumb. The aquatic weeds will then be loaded onto trucks or other equipment and transported to the drying area (Figure 11). Once the weeds have dried sufficiently, they will either be removed or composted on site. Mechanical harvesting is proposed to occur from June through October.

During some years, there could be situations that occur outside of the June through October time period caused by large amounts of aquatic weeds offshore of the screen that threaten the integrity of the screen. CCWD proposes to use mechanical harvesting, and other mechanical equipment including excavators, cranes, pontoon boats, *etc*., to alleviate the issues offshore of the screen. CCWD would advise Reclamation's Engineer and Biologist before any work commences. Work would not be initiated without authorization from the Engineer. If further environmental review is required, CCWD would comply with any and all requirements.

The proposed harvesting area in front of the RSFS and Rock Slough Extension is estimated at approximately 4 acres and the area within the Canal downstream of the fish screen and upstream of the Headworks Structure is estimated at 2 acres. Total time to harvest is expected to take approximately 1 week to complete (1 acre/day at approximately 2 miles per hour).

10. Insecticidal Sprays

Arthropod pests can present a human health hazard for people allergic to stings or bites. Pesticides registered for use in California by the USEPA and the CDPR are applied to control bees, wasps, spiders, ants, cockroaches, fleas, termites, mosquitoes, and other arthropods. Insecticides are applied year round, as needed, but primarily from spring through fall, according to the product label. They are applied in and around remote sensing Supervisory Control and Data Acquisition (SCADA) stations at RSFS, at inspection stations, and other structures along conveyance facilities and appurtenant structures. Insecticide application varies, but often those with quick knock-down are dispensed directly from canisters. These may be applied by applicators or hired structural pest control specialists. Insecticide spray applied at recorder houses, vaults, and outbuildings before precipitation events could lead to pesticide runoff. However, CCWD procedures ensure that no insecticidal sprays will enter the Canal or Rock Slough. All application of insecticidal sprays will follow the guidelines and procedures specified in CCWD's IPMP (Reclamation 2016, Appendix B) and Reclamation's requirements (Reclamation Manual, undated).

11. Mudjacking and/or Injecting Grout

Grout or fill (liquefied clay) is used to fill cracks in the canal liner and/or rip rap and voids behind the liner and/or rip rap. When leaks appear on the outside of the prism of the Canal, or are associated with liner voids or cracks, holes are bored behind the liner with an auger and grout or fill is gravity fed from a mixer through tubes or hole borings into the void. When no additional material is accepted into borings and leakage stops, the leak is assumed to be patched and additional borings are unnecessary. The grout or fill restores physical support to the Canal liner, rip rap, and levee, which otherwise could fail due to the force on the liner and/or rip rap from water inside the Canal. Failure could result in a "blowout" that would flood surrounding land. Repairs are conducted when defects are discovered, with work preferentially conducted during dewatering. If required, this work would be conducted on a small section of concrete liner upstream of the Headworks Structure.

12. Pre-emergent Herbicide Applications

These applications are made as part of weed control programs that deal with nearly year-round weed problems that exist in much of the San Joaquin CVP project area. Where weeds are not tolerated, such as on the inner prism of canal banks adjacent to the liner, weed germination is suppressed with pre-emergent herbicides to limit the spread of noxious or invasive weeds, reduce habitat for pests, help maintain access to facilities, enable inspections, check growth that could threaten facility integrity, limit fuel load and reduce fire hazards, and to provide for a well-kept appearance of facilities. Like contact herbicides, pre-emergent herbicides are applied around water intakes, on canal banks (particularly inner banks), on rights-of-way, around structures, and at facilities compounds. Applications are made following the herbicide label instructions and are timed to occur when weeds are most susceptible. Unlike contact herbicides which are applied directly to foliage, pre-emergents are applied to soil before seeds germinate, usually once annually in fall or early winter. Applications are made from pressurized spray tanks with a vehicle mounted boom sprayer, a backpack sprayer, or for granular formulations, with spreaders. CCWD will follow its approved IPMP (Reclamation 2016, Appendix B) and Reclamation's requirements (Reclamation Manual, undated) when applying pre-emergent herbicides. Herbicides reduce vegetative cover that may be used by ESA-listed species or their prey.

Three pre-emergent terrestrial herbicides are used by CCWD: (1) Dimension® 2 EW, (2) Dimension®Ultra 40WP, and (3) Capstone®. Capstone® specialty herbicide is used for control of annual and perennial broadleaf weeds, woody plants, and vines. It is labeled for use on rangeland, permanent grass pastures, forests, non-cropland areas (*e.g*., airports, communication transmission lines, electrical power and utility rights-of-way, industrial sites, roadsides, railroads, *etc*.), natural areas, and Conservation Reserve Program sites. Capstone's® active ingredients are Triisopropanolammonium salt of 2-pyridine carboxylic acid, 4-amino-3,6-dicholoro- (2.2%) and Triethylamine salt of [(3, 5, 6-trichloro-2-pyridinyl) oxy]acetic acid (16.22%). It may be applied either through ground broadcast, or by handheld equipment for foliar or spot application.

Dimension® Ultra 40 WP provides control of annual grasses and broadleaf weeds. Its active ingredients (40%) are dithiopyr: 3, 5-pyridinedicarbothioic acid, 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluorormethyl)-S, S-dimethyl ester.

Dimension® 2EW is a specialty herbicide provides pre-emergence and early post-emergence control of crabgrass, goosegrass, foxtail, spurge, and Poa annua grass. It comes in liquid, granular, and wettable powder formulations. Dimension 2EW's® active ingredients are dithiopyr (24.0%), cyclohexanone (13%), 2- ethylhexanol (1.9%), and toluene (0.1%).

13. Rights-of-Way Dust Abatement

Dust abatement is conducted to minimize fugitive dust where the unpaved (non-operational) roadway or outer Canal bank is graded and where construction is occurring or spoils soil is being hauled during work operations at the RSFS Facility. Typically, a water truck traverses the roadway or work area and sprays water directly onto the soil surface during single or multiple passes. Flooding also may be used to limit dust. Dust abatement will occur in the construction laydown areas for the installation of the boat ramps.

14. Rights-of-Way Mowing

Mowing is conducted with a rotary, sickle bar, or other mower blade attached to a tractor. Mowing is conducted primarily in spring to control weeds and reduce or eliminate the need for herbicide applications. Mowing equipment disturbs sites and reduces vegetative cover used by listed species or their prey.

15. Rip Rap

Rip rap is comprised of large rocks and boulders of varying sizes that are placed at dams, spillways, and canal or levee banks, especially near bridges and canal undercrossings, or water control structures, to prevent erosion of shorelines or embankments, and to strengthen the channel. The work is conducted when needed to protect banks, but it is preferentially performed during the dry season. Rock is delivered to the site by truck and trailer; dumped rock is piled with the aid of backhoes and excavators.

16. Squirrel Baiting

Rodenticides are applied to control ground squirrels that burrow into embankments, canal levees, at earthen fill dams, around buildings, at pumping stations and other facilities, on canals, or waterways. Burrowing is a nuisance, creates hazards, and can undermine the integrity of roadways and structures, by creating voids that weaken the integrity of conveyance structures or that lead to "piping" (water leakage). Toxic grain baits are made available by broadcast or in bait stations. CCWD uses the edible grain bait treated with Diphacinone. When not in use, traps are closed or bait removed. All baits will be applied according to the guidelines and procedures specified in CCWD's IPMP (Reclamation 2016 Appendix B,) and Reclamation's requirements (Reclamation Manual, undated). CCWD will take steps to ensure that rodenticides do not enter the Canal or Rock Slough.

17. Bargate/Fence Installations

Gate and fence installations and repairs are made to limit access to facilities, to provide security and where safety or the protection of resources is a concern or encroachment is a problem. Barbed wire fencing is strung at perimeters of Reclamation rights-of-way. Chain link fence is installed where the public has access to facilities and it is necessary to protect public health and safety, or where it is necessary to protect the Canal or facilities from dumping or vandalism.

Bargates are installed where Canal rights-of-way intersect public roadways, such as at corners of bridges, on secondary and primary roads, and on parallel fences at or near structures. Holes for support structures for fencing and bargates are dug by hand tools, power auger, or backhoes. Barbed wire is attached to steel t-posts that are driven with a post driver; wooden braces and corners may be set as anchors if the fence is constructed around uneven terrain. Pipe rods are set in the ground with concrete to which chain link fencing is attached. Installations or repairs are made as needed. Gates are cleaned and painted when needed.

18. Bridge Maintenance (running pad replacement)

This activity applies to both the Canal Headworks/Flood Isolation structures and RSFS bridge structures. Bridge surfaces, including railings, are pressure washed with water, and when necessary, painted by hand with brush or roller. Support pillars that have rotted or been damaged are removed with a crane or hoist and replaced with new pillars that are driven into place. Concrete decking would replace any existing concrete or metal decking when needed. Support pillars are prepared with re-bar and concrete is poured in place in forms. Steel cross beam under-decking is lowered onto pillars and prefabricated concrete pads are lowered onto the cross beams using a crane. Maintenance is usually conducted in the spring or fall.

19. Cableway Maintenance (painting/cleaning/repair)

These activities will occur at the RSFS's relief panel pulley system and at the four rakes, which utilize a cable and pulley system for operation. Cables and pulleys are checked for wear, pulleys are lubricated and baskets are or painted with brushes. Drip or spills may occur during painting and lubricating the facilities. Where cables enter structures, debris, and animal nesting material is removed.

20. Drainage Improvements (ditches or pipe)

Heavy equipment, including dozers, tractors, backhoes, longsticks, and graders, *etc*., are used to excavate drainage trenches and install drain pipe or to fill low spots to improve drainage. Additionally, trenches and drains are cleared of vegetation and silt with heavy equipment or by hand. Excavated material is piled on levees or rights-of-way, or is transported by truck to an offsite location. Drainage improvements are made as needed, although most occur annually. Work occurs preferentially during dry conditions, usually in the fall, before rains begin.

Removal of accumulated vegetation, debris, and soil from existing drains (downdrains, lateral drains, overchutes, or underchutes, *etc*.) is accomplished by using heavy equipment or by hand.

21. Electrical Repairs by Utility Companies (PG&E, WAPA, or others).
Repairs are made at all utility serviced facilities, as needed, year-round, and primarily at buildings. Repairs to, or replacement of, transformers, power poles, and severed underground utility lines are made occasionally by utility line crews operating from service vehicles. Pole replacement and underground line repair requires soil excavation.

22. Embankment Maintenance (filling washes and gullies).
Fill embankments from the sides of canals or intakes where the canal or intake is higher than the surrounding terrain. Protective and training embankments occur along the uphill side of Rock Slough; the former function to reduce runoff and erosion of soil into the Canal, and the latter to divert water toward underdrains or overchutes. Backhoes, graders, excavators, or hand implements are employed to fill gullies, burrows, compact soil and grade slopes as needed; however, work occurs primarily during the dry season. Trucks are used to haul fill.

23. Facilities Inspection
All facilities are inspected at least once annually. Mechanical (gates, pumps, *etc*.) and electrical equipment (communications, monitoring, and computer systems, *etc*.) is visually examined and operated to test functionality. Inspection may occur from both land and water. Conveyance and storage facilities (*i.e.,* canals, screens, bridges, *etc*.) and other physical facilities are visually inspected for integrity. The RSFS Facility will be inspected once or twice per year in late winter and/or early spring.

24. Graffiti Removal from Concrete Structures
Graffiti is painted over by hand with a brush or roller, or is removed by sandblasting. Waste materials from sandblasting is collected and disposed of at an appropriate waste disposal site.

25. Guardrail Installation/Repair
Damaged railings and support pillars are removed, repaired, and replaced as needed. Backhoes or other excavators, or shovels are used to excavate and fill pilot holes for support pillars. Vehicle mounted hoists may be used to remove damaged rails or reposition railings. Guardrail locations to be determined in coordination with CCWD project engineer.

26. Valve Rehabilitation
Valve function is checked on pumps and when they do not operate, they are removed and repaired or replaced. Work may be conducted within and/or outside of Reclamation property in both paved and unimproved areas. Valves, if buried, would require excavation with heavy equipment such as a backhoe or front-end loader.

27. Ladders/Safety Nets/Float/Log Boom Repair and Replacement
Ladders, nets, floats, and log booms are inspected at least annually and repaired or replaced when damaged. The RSFS log boom and block net is inspected twice per year for tears or holes using underwater SCUBA gear. Some minor site disturbance may occur from re-locating the log booms or repairing the block net.

28. Pull and Check Pumps

Pumps are checked annually. Pumps enclosed in casings are raised with a hoist or winch, or for smaller units, by hand using a tether. Pump seals, bearings, impellers, motors, and electrical connections are visually inspected or tested and replaced as needed.

29. Instrument Recorder House Maintenance (door repair, painting, cleaning, etc.)

The RSFS buildings are swept, and doors are washed and painted by hand with a brush or roller, as necessary.

30. Removal of Trash or Debris

Trash, debris, and waste are removed from virtually all of the Project area, including the Canal, debris pits, laydown areas, and drainage channels on an ongoing basis. Small items are collected by hand and disposed of properly. Where needed, trained hazardous waste handlers are enlisted to handle removal and waste disposal. Large debris and trash (including trees, vehicles, refrigerators and other large appliances) in front of the RSFS are removed with the aid of hoists, excavators, or work boats. Aquatic weeds are moved from the RSFS via conveyor belts and from the debris pits via trucks. Aquatic weeds are dried on site and removed with the aid of heavy equipment and trucks for transporting off-site when necessary.

31. Right-of-Ways Trash Removal

Tires, plastics, lumber, bedding, scrap metal and other trash and garbage are removed by hand from right-of-ways and hauled by truck to appropriate waste disposal site. Larger items such as vehicles and appliances are removed with the aid of service trucks with hoists or winches. Where needed, trained hazardous waste handlers are used to collect and dispose of hazardous materials.

32. SCADA System Repair and Upgrade

The SCADA equipment is located at control structures at the RSFS Facility. Security systems, level transmitters, water quality equipment, and auxiliary systems are all monitored remotely by SCADA equipment. Repair includes removal and replacement of electrical, computer, or communications equipment, primarily modular components or panels.

33. Sign Repair/Replacement/Installation

New signs may be installed, and damaged sign faces or supports are repaired. Faces of signs are repainted or replaced. Pilot holes for support posts are dug with an auger, shovel, or equipment such as a backhoe. Repairs or replacement of signs occurs at most Project facilities, on an as needed basis.

34. Stilling Well Maintenance (pumping/backflush, etc.)

Stilling wells are concrete or metal pipes placed vertically in Rock Slough, both in front and behind the fish screens. Movement of water into the well permits accurate measurement of the height of water in the Canal. Debris and silt that collects in the connector pipe or the well is Back flushed with a pump to clear the system of debris as frequently as monthly at some locales, but more commonly annually, or as needed.

35. Utility Trenching (SCADA stations/power/misc.)

Work is done with a trencher, backhoe or excavator to lay underground utilities to facilities and upgrade the systems in place. Most utility infrastructure has already been provided and the need for trenching is infrequent.

36. Wash and Paint Turnouts and Check Structures (includes Headworks/Flood Isolation and RSFS Structures)

Structures are pressure washed with water or cleaned with a wire brush and painted with rollers or brushes using epoxy paint during dewatering. CCWD proposes to paint certain structures (*e.g.,* the Headworks Structure and the underside of the RSFS) with nesting bird-deterrent coating to prevent birds from nesting on structures. Structures are generally washed annually and painted either annually or as needed. Accidental spill of paint could contaminate waterways.

37. Wash Bridges and Fish Screens

Dirt is removed from bridges, railings, and the RSFS screen panels with a portable pressure washer using water. Bridges, such as the one at the Headworks Structure, and the RSFS are washed annually. Railings on bridges are hand or spray painted after being washed.

38. Canal Desilting Operations

Desilting is done at turnouts, wasteways, and in the canals or their lateral drains. Suction cleaning and desilting is planned along the concrete apron in front of and behind the fish screens at the RSFS. Desilting is done as needed; as frequently as monthly or infrequently as canals are dewatered on main canals. Silt is flushed by opening gates or checks at wasteways and turnouts to remove sediment. Additionally, heavy equipment such as a longstick, draglines, or backhoes also may be used to physically remove accumulated sediments from the bottoms of canals or basins. Flushed sediment may be washed further down conveyance. Accumulated sediment will be either; piled on a canal bank adjacent to the RSFS Facility, loaded in a truck and transported to either temporary or permanent spoil piles, or be hauled to a site where it is used as fill. Sediment spoil piles may or may not be seeded to prevent erosion.

39. Minor Road Construction/Rehabilitation

Road rehabilitation or construction is done to provide new access to facilities or to recondition existing roads along and around the RSFS Facility. It can involve ripping and removal of existing asphalt, regrading of roadbed, compaction of the new bed and underlying soil. Sand is spread by truck, along with crushed rock, and new asphalt that is compressed. Road construction is done irregularly or on a limited scale annually. When needed, major road construction/rehabilitation would be addressed under a separate environmental review.

40. Small Structure Construction (blockhouses, stilling wells, etc.)

Structures are constructed on an as-needed basis when new operational facilities are added. Sites are graded and forms set for pouring concrete pads. Framing may use concrete block, metal, or wood with metal siding. Trenching may be done to provide underground utilities to the site.

41. Utility and Facilities Repair

These repair activities include irregularly implemented minor repairs. Major repairs are done after completing separate environmental review. Utility companies may send service vehicle(s) to repair electrical connections or replace transformers. There is a limited chance for impacts to listed species when repairs require soil disturbance. Repairs may occur anywhere along the RSFS Facility but are primarily conducted inside structures. The entire area was filled in 2011; any future trenching would occur in non-native soil.

The actual O&M activities may vary from the above list and will be limited by the 41 proposed maintenance activities within USFWS (2005) that are adopted for the RSFS Facility.

1.3.4 Land Acquisition and/or Land Use Authorizations

There are land acquisition and/or land use authorization activities that Reclamation may implement as part of this Project that Reclamation has determined will have no effect on ESA-listed species as they are administrative in nature (*e.g.,* transferring of land from CCWD to Reclamation, from Reclamation to private landowners, *etc*.). Therefore, they not discussed further. Those activities associated with land acquisition and/or land use authorizations that may affect ESA-listed species are described below:

A. Irrigation System Improvements

As described in Section 2.2.1, there are several irrigation system improvements proposed to fix ongoing issues with existing infrastructure (Figure 7). Reclamation will provide land use authorization for the improvements as well as landowner access for ongoing O&M of the irrigation facility. Ongoing O&M of the existing pipelines will continue to be done in this area by the owners of the pipelines which may involve removing dirt around the pipelines for access as well as working within the afterbay area behind the RSFS.

B. Land Encroachment Repairs

The northwestern fence boundary originally installed for the RSFS Facility was placed 50 feet beyond the actual RSFS Facility property line (referred to as "Encroachment Area" in Figure 7). The area east of the northwestern fence (approximately 500 feet by 85 feet, or approximately one acre) was covered with approximately 10 feet of soil to form a debris drying area and has been kept free of vegetation (referred to as "Aquatic Weed Drying Area" in Figure 11). There is also a jurisdictional ditch [U.S. Army Corps of Engineers (USACE) Permit Number: SPK-2009-00600, Sacramento District Office] located in an area approximately 5 to 12 feet west of the northwestern fence that terminates into an 18-inch concrete culvert that extends through the northern berm to drain into the Rock Slough Extension. The ditch has not performed as intended and much of the ditch has filled in with sediment. In addition, the area around the ditch has transformed into a wetland area due to poor drainage.

Reclamation is in ongoing negotiations with the landowner to resolve the encroachment issue. Possibilities for resolution include leaving the fence where it is or moving the fence to its correct alignment. If the fence was left in place, property utilization is expected to remain the same. If the fence is moved to its correct alignment, the following would be required (Figure 9), and therefore, proposed as part of the Project:

- Restoration of the encroached areas to RSFS Facility pre-construction conditions. This would entail removing and re-contouring an embankment by moving it back 50 feet from the current location of the fence line to the correct RSFS Facility boundary. This would require removing about 10,000 CY of material and shifting 500 linear feet of fence. Approximately 2,777 square yards of the earth beneath the existing embankment would need to be restored. This may include reseeding and/or planting vegetation in addition to earth contouring work. The approximate 10,000 CY of spoil may be spread on the adjoining property owner lands or Reclamation lands, likely within the unlined portion of the Canal, or on a portion of the RSFS Facility property to expand the drying area.

- The jurisdictional ditch would be reconstructed to drain the adjoining RSFS Facility property and the area around the ditch would be reconstructed so that it drains better. The adjoining property, where the ditch was initially constructed, may need improved grading as, absent such grading, it is subject to ponding. A portion of the fill material to be removed may be used for this grading. Approximately one-half acre of wetlands has been identified in this area. This may also be done even if the fence is not moved.

The culvert located west of the northwestern fence at the base of the earthen berm may also need to be relocated to the area along the new fence line and a corresponding drainage ditch would be installed to connect the toe drain from the unlined Canal to the Rock Slough Extension. The new 500-foot drainage ditch may be constructed approximately 7 feet from the correct property line and an 18-inch diameter culvert may be installed through the berm to drain this ditch into the Rock Slough Extension. The earthen berm dimensions are approximately a 2 foot crest with 5 feet for the banks on either side, for a total area of 12 feet. The estimated area of restoration and reconstruction for the encroachment property may be as large as 1.85 acres. Installation of the new culvert will require placement of a U-shaped 40-foot long coffer dam around the culvert within the Rock Slough Extension. The coffer dam will be installed during the work window of August 1 through October 31 to avoid or minimize exposure to listed fish. The coffer dam will isolate the work area from Rock Slough for the culvert installation. A contractor will use a vibratory hammer to drive sheet piles for the coffer dam.

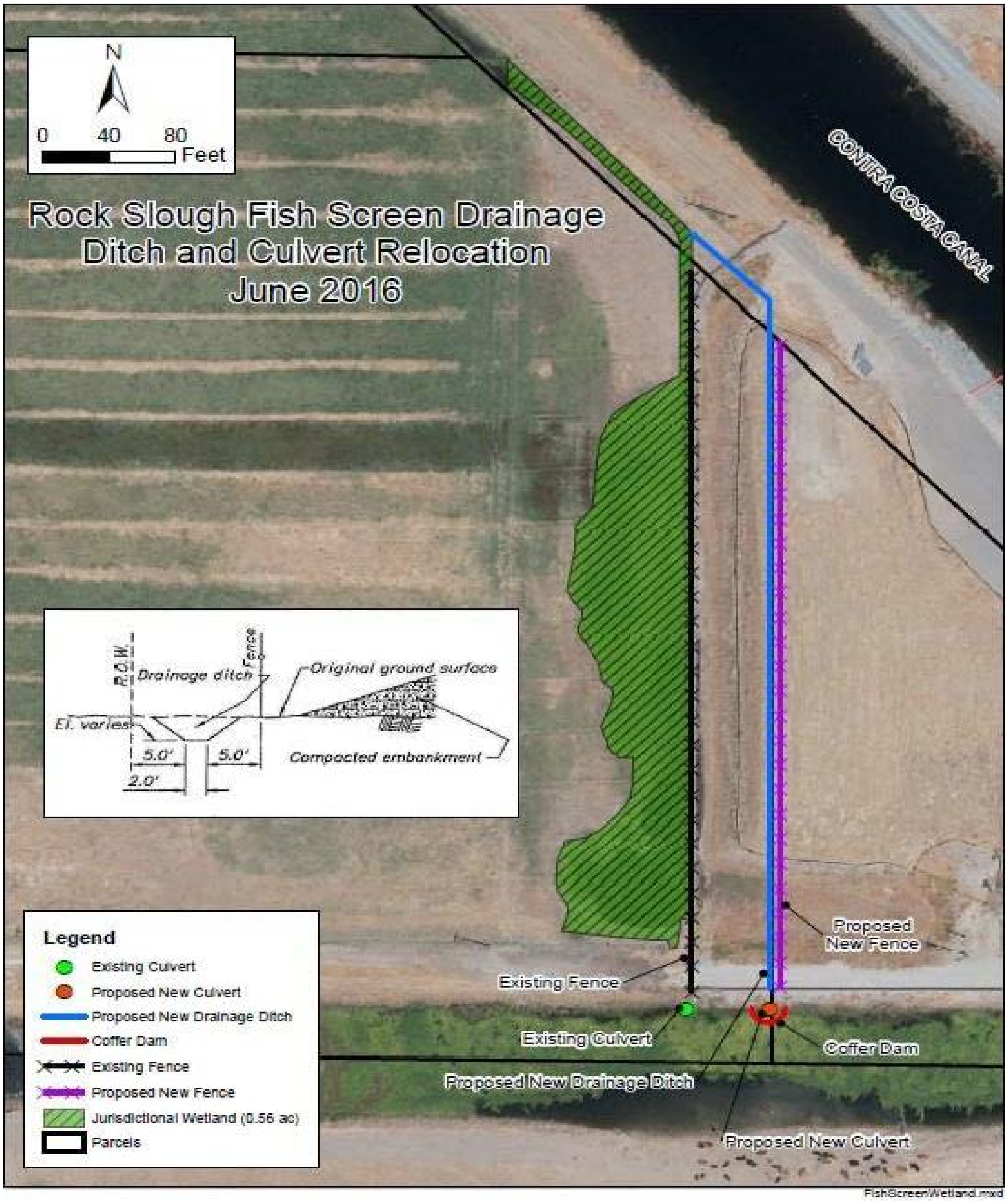

Figure 9. RSFS proposed drainage ditch and culvert relocation (Reclamation 2016).

C. Western Area Power Association (WAPA) Access Road Easements

Reclamation would acquire three existing access road easements purchased by CCWD in 2009 with Reclamation funding. These would then be transferred to WAPA to facilitate ongoing maintenance of the existing 69 kilovolt (kV) power lines that are used by CCWD for Pumping Plants 1 through 4 on the Canal.

1.4 Conservation Measures

This section describes the avoidance, minimization, and mitigation measures that Reclamation and CCWD will implement to avoid and/or minimize potential effects from the proposed Project to the species addressed in the BA [*i.e.,* winter-run, CV spring-run, CCV steelhead, sDPS green sturgeon, delta smelt, giant garter snake *(Thamnophis gigas)*, and long-fin smelt (*Spirinchus thaleichthys*)]. Another 10 species were considered and found not to be affected by the Project (see Reclamation 2016, Table 1).

The Project has already mitigated for the loss of 0.2 acre of benthic habitat loss in Rock Slough due to the boat ramps. All of the areas where construction is being done were in the original project area for the construction of the RSFS. Reclamation purchased 0.3 acre of shallow water habitat at Kimball Island Mitigation Bank and 30.5 acres of wetlands at the Big Break shoreline. CCWD further obtained 36 acres of habitat mitigation credits at the Liberty Island Mitigation Bank for winter-run, CV spring-run, and CCV steelhead. This was intended to address all of CCWD's intakes and included the Rock Slough intake which was unscreened at that time.

The following general avoidance and minimization measures for listed species and their habitats will be implemented:

- In-water work window for ESA-listed fish species: July 1 through October 31;
- Use of silt curtains for in-water work;
- Material placement will be accomplished during low tide periods and only the boom of an excavator will enter the water;
- Decontamination procedures for fuel and oil leaks per Reclamation (2012b);
- Adherence to a spill prevention plan;
- Adherence to an IPMP:
- Modified operations of the RSFS. The approach to minimize or avoid effects may include: (a) operating the rakes in the brush-only mode, (b) operating only during flood tides, or (c) periodically shutting down the rakes if possible. Reclamation will collaborate with CCWD and the USFWS or NMFS, as appropriate to determine the best approach to minimize and avoid effects;
- CCWD will advise Reclamation's Engineer and Biologist before any mechanical weed harvesting commences;
- Movement of heavy equipment to and from the Project site will be restricted to established roadways (including levee roads), when possible, to minimize disturbance;
- After completion of construction activities, any temporary fill and construction debris will be removed, and wherever feasible, disturbed areas will be restored to pre-Project conditions;
- All fueling and maintenance of vehicles or other equipment and staging areas will occur at least 150 feet from any waterbody. CCWD will ensure that contamination of potential habitat does not occur during such operations. Prior to the onset of work, CCWD will ensure that contractors have prepared a plan to allow prompt and effective response to any accidental spills. All workers will be informed of the importance of preventing spills and the appropriate measures to implement should a spill occur; and

- Wetland impacts are estimated to be approximate 0.5 acre of permanent impacts while temporary impacts are expected to be minimal. All temporary wetland impacts will be restored within 1 year of completion of the Project.

Additional specific avoidance and minimization measures for each of the Project components are described below.

1.4.1 Conservation Measures for RSFS Improvements

The proposed avoidance and minimization measures for the RSFS Improvements include the following:

Rake Improvements

- Monitoring of the modified rakes for signs that non-listed surrogate species (*e.g.*, fall-run Chinook salmon) are being entrapped at lower rates than those at non-modified rakes. (see also Section 2.3.2)

Platform Extension

- The platform extension will be grated to minimize shading and therefore avoid any potential of attracting ESA-listed species to the face of the fish screens where they could become entrapped.

Boat Ramp Construction

- All in-water work will be conducted from July 1 through September 31 when ESA-listed fish species are not likely to be present in the vicinity of the RSFS;
- During construction a silt curtain will be used to minimize increases in turbidity and to keep fish out of the construction area. The silt curtain will be removed on incoming tide so that suspended sediments enter the RSFS afterbay rather than entering Rock Slough;
- Boats, equipment, and vehicles will be operated carefully at slow speeds; and
- Boats will be refueled out of the water and over paved areas.

Construction Access

- Dust abatement actions will be taken; and
- Equipment and vehicles will be operated carefully at slow speeds.

Staging Areas & Parking

- Prior to initiating construction and/or O&M activities, a spill prevention plan will be prepared and implemented to ensure prompt and effective response to any accidental spills;
- Vehicles or other equipment will be fueled and maintained at least 150 feet from any water body and measures will be implemented to ensure that contamination of potential habitat does not occur during such operations;
- Spill containment equipment will be provided and all contractors will be made aware of its location; and
- Vehicles and heavy equipment moving to and from the will be restricted to established roadways (including levee roads).

1.4.2 Conservation Measures for Operation of the RSFS Rakes

Avoidance and minimization measures for ongoing operation of the RSFS rakes are described by activity below.

A. Rake Operations

- Rakes will be operated from November through April to minimize the potential for ESA-listed salmonids presence;
- If salmonids are present based on monitoring, the rakes will be operated on flood tides (*i.e*., avoid ebb tides which seem to attract salmon to the fish screen) or using the "brush only" mode, if possible;
- With the objective of maintaining uniform approach velocities, the rake mechanism cycle timer will be adjusted based on screen differentials; and
- Improvement to the hydraulic system will be implemented to reduce the potential of accidental spills.

B. Debris Monitoring

- Aquatic weeds in debris pits or drying areas will be monitored for fish species in order to make operational changes above.
- Fish monitoring data, intake forebay observations, and debris monitoring data will be assessed to determine if ESA-listed species are present. Debris monitoring efforts will be increased if ESA-listed species are present. If ESA-listed fish species are found the above measures will be implemented

1.4.3 Conservation Measures for Ongoing O&M Activities

Avoidance and minimization measures for O&M activities that occur in or over water include:

- All aquatic herbicides will be applied based on labeled rates and will follow the requirements of CCWD's approved IPMP (Reclamation 2016, Appendix B) and Reclamation's requirements (Reclamation Manual, undated); herbicides will be applied on the flood tide if possible; CDBW will be notified to ensure they are not applying herbicides in the same area. To determine if herbicides can be applied in June and July, CCWD will continue ichthyoplankton monitoring 3 times per week and will use the fish monitoring data and data from CDFW's 20-mm and Summer Townet surveys. If larval/post larval smelts are found, CCWD will not conduct herbicide applications until such time that larval smelts are not collected during three consecutive sampling events;
- CCWD will coordinate mechanical harvesting and herbicide applications with CDBW;
- Boat speeds will be limited to less than 5 miles per hour (mph);
- Prior to conducting mechanical harvesting from December through June, CCWD will check its most recent fish monitoring data (sieve net, rake entrainment, and debris pits) to ensure that no ESA-listed fish species have been seen in the area. If listed species are detected, mechanical harvesting will be delayed until the species is no longer found;
- Desilting will be conducted during the ESA-listed fish in-water work window (August 1 through October 31). If possible, desilting will be conducted during a flood tide. A silt curtain will be used if work must be conducted outside the work window; and

- The removal and replacement of bridge or structure support pillars at the Canal Headworks/Flood Isolation Structure and RSFS will be conducted from August 1 through October 31 when ESA-listed fish are not likely to be present. A silt curtain will be used and the work will occur during incoming tide.

1.4.4 Environmental Awareness Training (EAT) Program and Survey Protocol

A USFWS-approved biologist will conduct environmental awareness training for employees. The training will be provided in a language other than English, if required. The training will include instruction regarding giant garter snake identification, natural history, habitat protection needs, and conservation measures to be implemented on site. Color photographs of the snake will be distributed during the training session and will be posted on site.

1.4.5 General Housekeeping Practices

Good housekeeping practices will be followed in all work areas. CCWD will ensure that it or its contractors supply closeable trash containers, frequently remove and replace of all trash containers (emptied at least once per week) to ensure that adequate empty containers are on site at all times, store materials a sufficient distance away from the Canal or Rock Slough to prevent accidental releases from reaching the water, and make available containment booms in order to minimize the effects of project activities on ESA-listed species.

1.5 Relationship of the Proposed Action to Other Reclamation Actions

"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). Interrelated activities associated with the RSFS proposed action are described below. There are no interdependent actions.

1.5.1 Los Vaqueros Reservoir Project

Reclamation is the Federal lead for the Los Vaqueros Reservoir Phase 2 Expansion Project, which would increase the storage capacity from 160 TAF to 275 TAF. NMFS has agreed to be a cooperating agency for the EIS/EIR review. This project will increase diversions from Rock Slough.

1.5.2 Contra Costa Canal Encasement Project

This project is an ongoing multiyear project that involves the encasement of the unlined Canal into a buried 10-foot diameter pipeline that will eventually reach the RSFS. Currently, the former open Canal has been encased from PP1 to the Cypress Road crossing (Figure 11). Encasing the Canal will reduce the tidal fluctuations at the RSFS that likely attract adult salmonids from the Delta. As tidal flow in the Canal decreases, the likelihood of entraining ESA-listed species at RSFS is expected to decrease significantly. This project is being conducted as a separate action by Reclamation and CCWD.

This ongoing, multi-phased project will result in tidal flows being significantly reduced at the RSFS. NMFS has advised CCWD that salmonids will likely be less attracted to the RSFS if tidal flows through the RSFS can be reduced (Figure 10). Modeling of tidal flows at the RSFS demonstrate the effectiveness Canal encasement to attenuate the tides. CCWD expects to have sufficient funds to complete the encasement project by the year 2020, assuming receipt of grant funding from the California Department of Water Resources (CDWR) and developer funding.

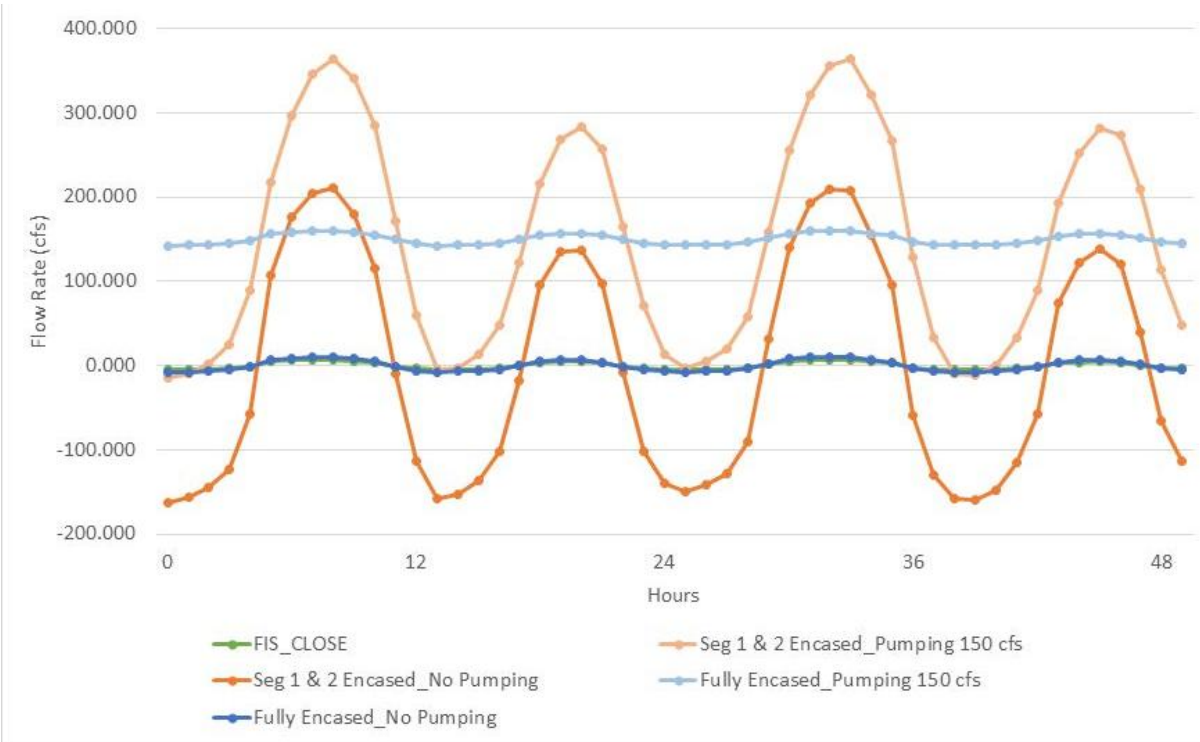

Figure 10. Modeled tidal flow at the RSFS for five conditions: (1) existing Canal with no pumping (dark orange line); (2) existing Canal pumping 150 cfs (light orange line); (3) the Flood Isolation Structure (FIS) closed (green line); (4) the Canal fully encased in a pipeline (dark blue line); and (5) Canal fully encased pumping 150 cfs (light blue line). Source: (Reclamation 2016)

1.5.3 Canal Aquatic Vegetation Management Program

Reclamation consulted with NMFS and USFWS in 2007 (pre-RSFS) on the use of aquatic herbicides in the unlined portion (4 miles from the confluence with Rock Slough to PP1) of the Canal. CCWD developed an Aquatic Vegetation Management Program that included herbicide and algaecide application in the Canal during July and September (CCWD 2007). This program was permitted for copper-based herbicides: Komeen, Nautique, and AquaMaster during periods when the Canal could be isolated from Rock Slough through the use of stop logs at the Rock Slough Headworks Structure. Since 2007, a large part of the Canal has been encased (see Section 2.4.1 above). The Rock Slough Headworks were modified in 2009 when the RSFS was constructed. Future application of herbicides within the unlined portion of the Canal (*i.e.,* from Cypress Road to the RSFS) and the RSFS afterbay are now proposed as part of the O&M activities of this Project.

1.5.4 East Cypress Preserve Project

Reclamation consulted with NMFS on the East Cypress Preserve Project, which is a residential development bordering the RSFS Facility and the Canal on January 26, 2016. NMFS issued a biological opinion on July 7, 2016 (NMFS 2016c). The Federal action added an additional 1,246 acres to CCWD's service area for delivery of CVP water supplies. Agricultural lands to the east of RSFS would be converted to 2,400 residential homes. The project increases the water demands on the Rock Slough intake and includes an access bridge to be built over Rock Slough on the southeast corner of the RSFS Facility. The construction of the bridge will require CCWD to relocate the log-boom and block net east of the new bridge. The log boom across Rock Slough prevents boats and aquatic weeds from entering the area in front of the RSFS.

1.5.5 Coordinated Operations with CVP and SWP

The impact of CVP and SWP long-term operations on ESA-listed species and their designated critical habitat have been previously analyzed in biological opinions (NMFS 2004; 2009, USFWS 2008). The impact of water diversions through the unscreened Rock Slough Intake were included in the NMFS (2004; 2009) biological opinions. However, the RSFS had not been constructed in 2009, therefore, O&M activities of the RSFS were not previously considered in the NMFS (2009) biological opinion. Incidental take for CCWD's Rock Slough Intake was anticipated to cease once the RSFS became fully operational.

On August 2, 2016, Reclamation requested re-initiation of the long-term operations of the CVP and SWP with NMFS and USFWS. The re-initiation process is ongoing and is expected to take several years to complete and may eventually incorporate the O&M activities of the RSFS.

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, each Federal agency must ensure that its 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 habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. 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 rangewide status of the species and critical habitat 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 by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

In reviewing the information provided, NMFS had to make certain assumptions concerning the extent of herbicides once they enter the waters of Rock Slough. NMFS relied on herbicide monitoring information from NPDES reporting requirements, and protocols provided by the CDBW for Delta waterways (USDA and CDBW 2012a, 2012b). For distribution and run timing of ESA-listed species, NMFS relied on data from various monitoring locations, fish salvage data, literature reports, and recreational angler surveys (*e.g.*, CDFW, CDWR, and USFWS data). Trawl data from Chipps Island, Mossdale, and Sacramento were obtained from the Delta Juvenile Fish Monitoring Program (DJFMP) either in annual reports or as unpublished data. Gear selectivity for the various monitoring locations may preclude the detection of certain species like sDPS green sturgeon in the trawl data because they are typically found near the bottom.

2.2 Rangewide Status of the Species and Critical Habitat

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. Because critical habitat for listed species is exempted, or not designated within the action area, the status of critical habitat is not discussed in this biological opinion.

2.2.1 Sacramento River Winter-run Chinook Salmon

- First listed as threatened (August 4, 1989, 54 FR 32085).
- Reclassified as endangered (January 4, 1994, 59 FR 440), reaffirmed as endangered (June 28, 2005, 70 FR 37160).
- Designated critical habitat (June 16, 1993, 58 FR 33212).

The Federally listed evolutionarily significant unit (ESU) of winter-run occurs in the action area and may be affected by the proposed action. Designated critical habitat for winter-run does not occur within Rock Slough, but is present further to the north in the Delta. Detailed information regarding ESU listing and critical habitat designation history, description of designated critical habitat, ESU life history, and viable salmonid population (VSP) parameters can be found in NMFS (2014a).

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011b). Since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively (CDFW 2016a). However, from 2007 to 2011, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (CDFW 2016a). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival rates (NMFS 2011b). In 2014 and 2015, the population was approximately 3,000 adults, slightly above the 2007–2012 average, but below the high (17,296) for the last 10 years (CDFW 2016a). In 2016, the number of adult spawners dropped to 1,546.

2014 and 2015 were the third and fourth years of a drought that resulted in increased water temperatures in the upper Sacramento River, and egg-to-fry survival to the RBDD was approximately 5 and 4 percent, respectively (Williams *et al*. 2016). Due to the anticipated lower than average survival in 2014, hatchery production from LSNFH was tripled (*i.e*., 612,056 released) to offset the impact of the drought (SWRCB 2014). In 2014, hatchery production represented 83 percent of the total juvenile production. In 2015, egg-to-fry survival was the lowest on record (~4 percent) due to the lack of cold water in Shasta Reservoir during the fourth year of drought conditions. Hatchery production representing 80 percent of the total juvenile production in 2015. Adult returns are expected to be low in 2017 and 2018, as they show the impact of drought on juveniles from brood years 2014 and 2015 (Williams *et al.* 2016).

Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at Livingston Stone National Fish Hatchery (LSNFH) is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001-2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002-2010 average (Poytress and Carrillo 2011). Hatchery production typically represents approximately 3-4 percent of the total in-river juvenile winter-run production in any given year. However, the natural in-river production has declined to an average of 130,809 juveniles per year (2014-2016) during the drought, indicating the population is now mainly composed of hatchery-origin juveniles.

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Yoshiyama *et al.* 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman National Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in Battle Creek and possibly establish an additional population in the future. Approximately 299 miles of former tributary spawning habitat above Shasta Dam is inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the upper Sacramento River had a "potential spawning capacity" of approximately 14,000 redds, equivalent to 28,000 adult spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011b). The Winter-run population is comprised of only one population that spawns below Keswick Dam. The remnant and remaining population cannot access 95 percent of their historical spawning habitat and must, therefore, be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and (3) regulation of the finite cold-water pool behind Shasta Dam to reduce water temperatures.

Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure but restoration is not scheduled to be completed until 2020. The Central Valley Salmon and Steelhead Recovery Plan includes criteria for recovering winter-run, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2014a).

Winter-run embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, so this run is particularly at risk from climate warming. The only remaining population of winter-run relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates *et al.* 2008). The long-term projection of how the CVP/SWP will operate incorporates the effects of climate change in three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (Reclamation 2014). Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Beechie *et al*. 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of winter-run habitat available downstream of Keswick Dam. It is imperative for additional populations of winter-run to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (NMFS 2014a).

2.2.1.1 Summary of the Sacramento River Winter-Run Chinook salmon ESU Viability

In summary, the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005, and several listing factors have contributed to the recent decline, including drought and poor ocean conditions. Large-scale fish passage and habitat restoration actions are necessary for improving the winter-run ESU viability (Williams *et al.* 2016).

2.2.2 Central Valley Spring-run Chinook Salmon

- Listed as threatened (September 16, 1999, 64 FR 50394), reaffirmed (June 28, 2005, 70 FR 37160).
- Designated critical habitat (September 2, 2005, 70 FR 52488)

Detailed information regarding ESU listing and critical habitat designation history, description of designated critical habitat, ESU life history, and VSP parameters can be found in NMFS (2014a).

Historically, CV spring-run were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 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 1874, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported a CV spring-run population as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported a large run of CV spring-run, 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 (CDFG 1990).

Monitoring of the Sacramento River during the time period that CV spring-run spawn indicates some spawning occurred from 1995–2009 in the mainstem upper portion of the river (CDFW 2016a). Genetic introgression has likely occurred here due to lack of physical separation between spring-run and fall-run Chinook salmon populations (CDFG 1998).

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance (NMFS 2011c; 2016a). The Feather River Fish Hatchery (FRFH) CV spring-run population represents an evolutionary legacy of populations that once spawned above Oroville Dam. The FRFH population is included in the ESU based on its genetic linkage to the natural spawning population, and the potential for development of a conservation strategy (June 28, 2005, 70 FR 37160).

The Central Valley Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (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).

In the San Joaquin River basin, observations in the last decade suggest that spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2013). A final rule was published (FR 78 FR 251; December 31, 2013) to designate a nonessential experimental population of CV spring-run to allow reintroduction of the species below Friant Dam as part of the San Joaquin River Restoration Program (SJRRP). Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. The first release of CV spring-run juveniles into the San Joaquin River occurred in April, 2014. A second release occurred in 2015, and continued annual releases are planned each spring. Juveniles from these releases have been collected in the Delta at the CVP and SWP Fish Collection Facilities, however, the SJRRP's contribution to the spring-run ESU has yet to be determined (NMFS 2017).

The CV spring-run ESU is comprised of two known genetic complexes. Analysis of natural and hatchery CV spring-run stocks in the Central Valley indicates that the northern Sierra Nevada diversity group populations in Mill, Deer, and Butte creeks retain genetic integrity as opposed to the genetic integrity of the Feather River population, which is introgressed with the fall-run ESU (Good *et al*. 2005, Cavallo *et al*. 2011).

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 in these watersheds (McElhany *et al.* 2000). Over the long term, these three remaining populations are considered to be vulnerable to anthropomorphic and naturally occurring catastrophic events. The viability assessment of CV spring-run conducted during the status review (NMFS 2011c), found that the biological status of the ESU had worsened since the last status review (2005) and recommended that the species status be reassessed in two to three years as opposed to waiting another 5 years, if the decreasing trend continued. 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 (NMFS 2016a) found the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record lows. Since 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 result in severe rates of decline (NMFS 2016a).

CV spring-run adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). CV spring-run 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 cold 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*. 2012).

2.2.2.1 Summary of the CV Spring-run ESU Viability

In summary, the extinction risk for the CV spring-run ESU remains at moderate risk of extinction (NMFS 2016a). Based on the severity of the drought and the low escapements as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, there is concern that these CV spring-run strongholds will deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (NMFS 2016a).

2.2.3 California Central Valley (CCV) Steelhead

- Originally listed as threatened (March 19, 1998, 63 FR 13347); reaffirmed as threatened (January 5, 2006, 71 FR 834, and August 15, 2011, 76 FR 50447).
- Designated critical habitat (September 2, 2005, 70 FR 52488).

The Federally listed distinct population segment (DPS) of CCV steelhead occurs in the action area and may be affected by the proposed action. Designated critical habitat for CCV steelhead does not occur within the action area (Figure 12). Detailed information regarding CCV steelhead listing, CCV steelhead life history, and VSP parameters can be found in NMFS (2014a).

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 CCV steelhead run size had declined to about 40,000 adults (McEwan 2001). Current abundance data for CCV steelhead are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

CCV steelhead returns to Coleman National Fish Hatchery (CNFH) have increased over the four years, from 2011 to 2014 (NMFS 2016b). After reaching a low of only 790 fish in 2010, 2014 and 2015 have averaged 3,213 fish. Wild adults counted at CNFH each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200–300 fish each year. The number of wild adult returns have ranged from 185 to 334 for 2010 to 2014 (NMFS 2016b).

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 [data from Hannon *et al.* (2003), Hannon and Deason (2008), Chase (2010)]. An average of 178 redds have been counted in Clear Creek from 2001 to 2015 following the removal of Saeltzer Dam, which allowed steelhead access to additional spawning habitat. The Clear Creek redd count data ranges from 100-1023 and indicates an upward trend in abundance since 2006 (USFWS 2015a).

The returns of CCV steelhead to the FRFH experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively. In recent years, however, returns have experienced an increase with 830, 1797, and 1505 fish returning in 2012, 2013, and 2014, respectively (NMFS 2016b). Overall, CCV steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present.

An estimated 100,000 to 300,000 naturally produced juvenile CCV steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (ad-clip, hatchery) to unclipped (wild) steelhead smolt catch ratios in the USFWS Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 CCV steelhead smolts are produced naturally each year in the Central Valley. Trawl data indicate that the level of natural production of CCV steelhead has remained very low since the 2011 status review, suggesting a decline in natural production based on consistent hatchery releases (NMFS 2011d). Catches of CCV steelhead at the CVP/SWP fish collection facilities in the southern Delta are another source of information on the production of wild steelhead relative to hatchery steelhead (CDFW 2016b data: ftp.delta.dfg.ca.gov/salvage). The overall catch of CCV steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years. The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999.

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). 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 are well-distributed throughout the Central Valley below the major rim dams (Good *et al.* 2005, NMFS 2016b). There are 6 diversity groups with approximately 24 remaining spawning populations. Most of the CCV steelhead populations in the Central Valley have a high hatchery component, including Battle Creek, the American River, Feather River, and Mokelumne River.

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 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, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). Steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms. Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams as summer-run have been extirpated (McEwan and Jackson 1996, Moyle 2002).

Although CCV steelhead will likely experience similar effects of climate change to Chinook salmon in the Central Valley, as they are also blocked from the vast majority (80%) 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*. 2001). 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 CCV steelhead populations.

2.2.3.1 Summary of California Central Valley steelhead DPS Viability

Natural CCV steelhead populations continue to decrease in abundance and the proportion of natural fish compared to hatchery fish has declined over the past 25 years (Good *et al.* 2005, NMFS 2011d; 2016b). The long-term abundance trend remains negative. Hatchery production and returns dominant this ESU. 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.

In summary, the status of the CCV steelhead DPS appears to have remained unchanged since the 2011 status review, and the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (NMFS 2016b).

2.2.4 Southern Distinct Population Segment (sDPS) of North American Green Sturgeon

- Listed as threatened (April 7, 2006, 71 FR 17757).
- Critical habitat designated (October 9, 2009, 74 FR 52300).

The Federally listed sDPS green sturgeon occurs in the action area and may be affected by the proposed action. Designated critical habitat for sDPS green sturgeon within Rock Slough has been excluded (74 FR 52200). Detailed information regarding sDPS green sturgeon listing, sDPS green sturgeon life history, and VSP parameters can be found in the 5-Year Status Review (NMFS 2015a).

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Using polyploid microsatellite data, Israel *et al.* (2009) found that green sturgeon within the Central Valley of California belong to the sDPS.

Additionally, results of acoustic tagging studies have found that green sturgeon spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley *et al.* 2011). In California, sDPS green sturgeon are known to range throughout the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (Isreal *et al*. 2009, Cramer Fish Sciences 2011, Seeholtz *et al.* 2014). It is unlikely that sDPS green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon, and adult spawning has not been documented there (Jackson and Van Eenennaam 2013).

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and possibly even the Yuba River (Cramer Fish Sciences 2011, Seesholtz *et al.* 2014). Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent, but unconfirmed, extirpation of spawning populations from the San Joaquin River narrows the available habitat within their range, offering fewer habitat alternatives. Whether sDPS green sturgeon display diverse phenotypic traits such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS 2015a).

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the State and Federal pumping facilities (see below), and (2) by incidental catch in the CDFW's white sturgeon sampling/tagging program. Historical estimates from these sources are likely unreliable because the sDPS was likely not taken into account in incidental catch data, and salvage does not capture range-wide abundance in all water year types. A decrease in sDPS green sturgeon abundance has been inferred from the amount of salvage observed at the south Delta pumping facilities. These data should be interpreted with some caution. Operations and practices at the facilities have changed over the decades, which may affect salvage data. These data likely indicate a high production year vs. a low production year qualitatively, but cannot be used to rigorously quantify abundance.

Since 2010, more robust estimates of sDPS green sturgeon have been generated (Israel *et al*. 2010). Acoustic telemetry surveys has been used to locate green sturgeon in the Sacramento River and to derive an adult spawner abundance estimate (Mora *et al.* 2014). Preliminary results of these surveys estimate an average annual spawning run of 272 adults with a total population size of 1,008. This estimate does not include the number of spawning adults in the lower Feather or Yuba Rivers, where sDPS green sturgeon spawning was recently confirmed (Seesholtz *et al.* 2014).

The parameters of sDPS green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data shows enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events (NMFS 2010a). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. The Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of sDPS green sturgeon passage in the Sacramento River (71 FR 17757, April 7, 2006). However, (Mora *et al.* 2014) found the upriver extent of sDPS green sturgeon spawning is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of sDPS green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if sDPS green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of sDPS green sturgeon in other accessible habitats in the Central Valley (*i.e*., the Feather River) is limited, in part, by late spring and summer water temperatures (NMFS 2015a). Similar to salmonids in the Central Valley, sDPS green sturgeon spawning in tributaries to the Sacramento River is likely to be further limited if water temperatures increase and higher elevation habitats remain inaccessible.

2.2.4.1 Summary of sDPS Green Sturgeon Viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (NMFS 2010a). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Lindley *et al.* (2008), in discussing winter-run, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to the sDPS green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated, such as mortality from commercial fisheries and removal of some passage barriers (NMFS 2015a). However, since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS 2015a).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area includes a one mile portion of Rock Slough from the RSFS to the junction with Sand Mound Slough (Figure 12), and the unlined portion of the Canal from RSFS to Cypress Road. The action area also includes the land area within the boundary of the RSFS Facility, as well as the RSFS afterbay, Headworks Structure, and the Flood Isolation Structure (Figure 11). The action area outside the RSFS Facility boundary includes one small area that is on private land northeast of the RSFS (Figure 7) and two access roads (one on the north side and one on the south side of Rock Slough).

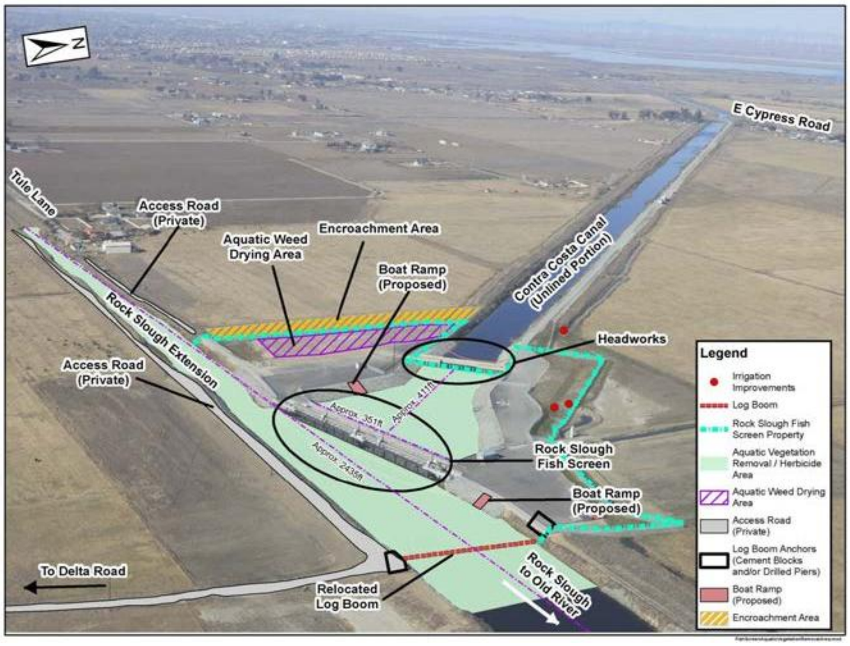

Figure 11. Action area for RSFS Facilities Improvement Project (Reclamation 2016).

Within the action area described above, the immediate waters of Rock Slough on either side of the RSFS to the junction of Sand Mound Slough (for a distance of approximately 1 mile) are excluded from designated critical habitat for all NMFS listed species (Figure 12).

Figure 12. Map of RSFS action area shown in blue in relation to nearest designated critical habitat, one mile from CCV steelhead (red line), and three miles from sDPS green sturgeon (green line).

2.4 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).

The Project is located in the southeast region of the Sacramento-San Joaquin Delta between Big Break and Old River, an area commonly referred to as the southern Delta (Figure 1). The RSFS is located approximately 3.5 miles from Old River and 10 miles from the San Joaquin River which are the main migratory routes for listed fish species in the southern Delta. This freshwater to low salinity estuarine habitat provides marginal rearing and migratory habitat for listed fish species. Habitat within the unlined portion of the Canal is populated primarily by non-native fishes and supports a high population of striped bass, largemouth bass, and various sunfish species. The Canal has limited cover and aquatic vegetation present include: algae, Brazilian elodea, water hyacinth, cattails, and tules. The Canal was historically treated with herbicides to reduce aquatic vegetation.

Rock Slough connects to the larger Delta through Old River, which is tidally influenced. Due to a water control structure in Sand Mound Slough, water can only flow one way from Rock Slough to Sand Mound Slough during incoming tides. Since the RSFS is located near the end of a dead-end slough, water enters the Canal through the RSFS on incoming tides. Water depth in Rock Slough is typically 10 feet or less at mean high water (MHW). The amount of flow through the RSFS depends on tides, pumping rate, and is controlled to meet the screen criteria of 0.2 feet per second. Water can also exist the Canal on the outgoing tide. Flow rates at the RSFS range from a maximum of 350 cfs to negative (reversed) of 150 cfs (Figure 10). The water exiting the Canal on the ebb tide passes through the RSFS creating a false attraction to adult salmon and steelhead that are migrating upstream to reach their natal spawning areas. Adult salmon are caught and killed on the RSFS from November through January (Reclamation 2016; Table A-2).

Hydraulic rake testing at RSFS will likely continue through 2017, but may extend into 2018, due to the iterative design, installation, and testing process required to acquire a functional design for final installation. In 2016, the log boom was repositioned across Rock Slough upstream of the RSFS and is expected to reduce the number of aquatic weeds that drift into the screen due to tidal action (Figure 2). This should improve future maintenance and reduce the need for mechanical weed harvesting in front of the RSFS. Also, a block net was installed underneath the log boom in order to test the rakes from November through April when ESA-listed salmonids are likely to be present.

O&M activities have occurred and will continue to occur at the RSFS and at the land and water areas around the RSFS Facility. Aquatic weed management is an ongoing activity in the Canal and RSFS afterbay and in Rock Slough. The land area within the RSFS Facility boundary contains the aquatic weed drying area, the permanent anchors for the relocated log boom, and the land required for construction of both boat ramps.

Habitats in the action area consist of subtidal and intertidal habitats. Salinities in the action area range from 0.2 to 0.5 parts per thousand (ppt). The salinity is managed by the CVP and SWP[2] on the low side (0.2 ppt) to prevent salt water intrusion into the Delta which would degrade irrigation diversions for agriculture, as well as municipal water supplies. Water quality within the Canal is managed by the larger CVP/SWP export facilities to between 150 and 240 mg/L chlorides maximum mean daily [measured in Rock Slough at (California Data Exchange Center CDEC) Station RSL] depending on water year type (SWRCB 2000).

Land use within the vicinity of the Canal and Rock Slough includes agriculture and urban areas, with the latter becoming more prominent with recent housing developments being built nearby (see Cypress Preserve Project, NMFS 2016c). Agricultural canals and ditches seasonally flood and drain pastures with Delta water that is either pumped from or to the Delta. Subsurface water can flow from the surrounded agricultural fields into the unlined portion of the Canal and impact water quality, as observed during the Canal Encasement Project (NMFS 2007). The existing levees along Rock Slough were built in the late 1800s and are maintained for agricultural purposes by Reclamation District 799 and 2035.

The Delta region, where the Project is located, historically supported a healthy aquatic ecosystem, but its habitat value for ESA-listed species is considered greatly reduced from historic conditions. Since the 1850s, wetland reclamation for urban and agricultural development has caused the cumulative loss of 96 percent of seasonal wetlands and 94-98 percent of riparian forests in the Central Valley (Whipple *et al.* 2012). Several factors are thought to contribute to the decline in the health of the habitat including: entrainment into the south Delta SWP and CVP pumping facilities, reverse flows, maintenance dredging in the ship channels, and increased predation by nonnative predator species (*e.g*., striped bass and largemouth bass) (Baxter *et al*. 2007). The increase in the abundance of largemouth bass, as shown by the salvage data at the CVP and SWP pumps, occurred at the same time as the increase in the range of the invasive submerged macrophyte *Egeria densa* (Brown and Michniuk 2007).

In the south Delta region, low-salinity water management, invasive aquatic plants (*Egeria densa*), and other factors have resulted in increased numbers of nonnative predators, most important of which are striped bass and largemouth bass. Nobriga and Feyrer (2007) report that largemouth bass have a more limited distribution in the Delta than striped bass, although their impact on prey species, such as juvenile salmonids, is higher. The proliferation of *E. densa* provides habitat for largemouth bass as well as their prey, and its rapid expansion in the Delta increased more than 10 percent per year from 2004 to 2006 (Baxter *et al.* 2007). Although Chinook salmon fry are often found in the south Delta and make use of the dense stands of *E. densa* for habitat, Brown (2003) found that survival is lower for fry than those rearing in tributary streams. Those fry that migrate through the south and central Delta rather than directly through the Sacramento or San Joaquin River also have a lower survival rate (Brown 2003).

Aside from increasing the habitat area for predators, the proliferation of *E. densa* and water hyacinth (*Eichhornia crassipes)* may have other negative impacts on ESA-listed species. It can overwhelm littoral habitats where salmonids and sDPS green sturgeon rear, and it also appears to

[2] The CVP and SWP jointly manage the water quality in the Delta pursuant to their permit requirements in the State Water Resource Control Board Decision 1641 (SWRCB 2000). Rock Slough is one of the monitoring locations.

contribute to the recent reduction in turbidity of the central and south Delta regions by reducing flow velocity (Brown 2003) and mechanically filtering the water column (Nobriga *et al*. 2005). The resulting increased water clarity can have a negative impact on juvenile salmonids by increasing their susceptibility to predation.

2.4.1 Status of the Species within the Action Area

The action area, from RSFS to the junction of Sand Mound Slough, provides very limited rearing and migratory habitat for salmonids during the winter months. Water temperatures in Rock Slough, particularly near the RSFS, are generally warmer than those preferred by salmonids (Figure 13). Water temperatures are recorded along with electrical conductivity every 15 minutes at the CDEC station for Rock Slough (RSL) located approximately 0.2 miles upstream from the RSFS at latitude 37.97631 and longitude -121.63760. Water temperatures in Rock Slough range from lows of about 45°F in winter (December and January) to over 70°F beginning in May and continuing through October.

Water temperatures above 68°F can impair growth in salmonids, and above 72°F can be lethal (McCullough *et al.* 2001, USEPA 2003). Therefore, habitat in Rock Slough is only usable by salmonids from October through May in most years, as evidenced by the fish monitoring data in the BA (Reclamation 2016). However, in wet years juvenile salmonids may utilize the habitat in Rock Slough until June. Warmer water temperatures in Rock Slough are more aptly tolerated by the many non-native fish such as largemouth bass and striped bass.

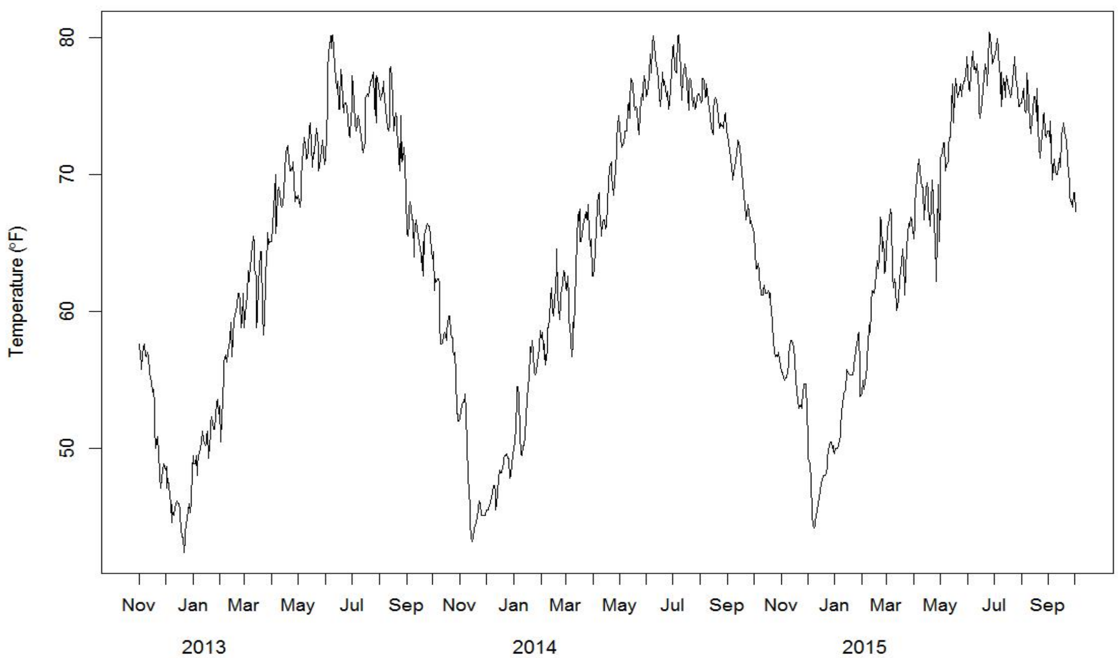

Figure 13. Daily high water temperatures measured in Rock Slough 2012–2015, based on 15-minute period recordings at CDEC Station RSL (Reclamation 2016). Data were sorted to identify daily tidal cycles based on the occurrence of two high and two low stages. A weekly average water temperature was computed from the water temperatures recorded at the time of each day's highest stage (high tide).

2.4.1.1 Winter-run Chinook salmon

Adult winter-run are unlikely to be present in the action area since most migrate upstream in the Sacramento River, which is approximately 10 miles from Rock Slough. Juveniles usually migrate downstream through the northern portion of the Delta/Sacramento River (Table 4). Juvenile winter-run typically enter the Delta and rear for several months from November through May based on USFWS trawl data (USFWS 2012). However, juvenile winter-run are sometimes drawn into the southern Delta under reverse flows and high CVP/SWP pumping rates. A review of the fish salvage data at the combined CVP/SWP export facilities (located 12 miles to the south) showed that on average 1,292 winter-run were salvaged per year from 2010-2014 (CDFW 2016b). At the Rock Slough Headworks, no winter-run were salvaged in the 11 years (1999–2009) prior to construction of the RSFS (Reclamation 2016). However, prior to that period, juvenile winter-run were captured in the Canal up to the first pumping plant (PP1). As a requirement in the NMFS (1993) biological opinion, CDFG conducted fish monitoring from 1994–2002. A total of 13 juvenile winter-run were captured from January through May (CDFG 2002).

Table 4. Temporal occurrence of winter-run (WR) in the Delta.

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult WR*	■	■	■	■	■	■					■	■
Juvenile WR**	■	■	■	■							■	■

*Adults enter the Bay November to June (Hallock and Fisher 1985) and are in spawning ground at a peak time of June to July (Vogel and Marine 1991).
**Juvenile presence in the Delta was determined using DJFMP data (USFWS 2012, 2015b, 2016).

2.4.1.2 CV Spring-run Chinook salmon

Adult CV spring-run are unlikely to be present in the action area since most migrate upstream to spawn from March through September with peak migration from May through June (Moyle 2002). Rock Slough is located far from the main migration routes for CV spring-run on the Sacramento and San Joaquin rivers, and May–September water temperatures are above the suitable range for salmonids (Figure 13).

Most juvenile CV spring-run migrate downstream from November through May with up to 69 percent of the young-of-the-year fish outmigrating during this period (CDFG 1998). Timing of CV spring-run smolts that emigrate as yearlings is variable, but most migrate downstream during December or during March through May (Table 5). As with juvenile winter-run, CV spring-run can be drawn into the southern Delta under reverse flows and high CVP/SWP pumping rates. A review of the fish salvage data for the 5 years (2010–2014) at the combined CVP/SWP export facilities (located 12 miles to the south) showed that on average 3,747 CV spring-run were salvaged per year (CDFW 2016b). Most of these were salvaged from March through May. Marked CV spring-run juveniles from the SJRRP releases were collected from March through May in 2016; 59 from the Mossdale Trawl (lower San Joaquin River), 148 at the CVP/SWP Fish Collection Facilities (Delta), and 1 at Chipps Island Trawl (NMFS 2017).

At the Rock Slough Headworks Structure, 11 juvenile CV spring-run were salvaged during March, April, and May (1999–2009) prior to construction of the RSFS (Reclamation 2016). However, prior to that period from 1994 through 1999, CDFG conducted fish monitoring at the Rock Slough Intake and in the Canal up to the first pumping plant (PP1) as a requirement in the NMFS (1993) biological opinion. A total of 108 juvenile CV spring-run were captured from March through May (CDFG 2002).

Table 5. Temporal occurrence of CV spring-run (SR) in the Delta.

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult SR*	■	■	■	■	■	■						
Juvenile SR**	■	■	■	■	■							■

*Adults enter the Bay late January to early February (CDFG 1998) and enter the Sacramento River in March (Yoshiyama *et al.* 1998). Adults travel to tributaries as late as July (Lindley *et al.* 2004). Spawning occurs September to October (Moyle 2002).
**Juvenile presence in the Delta was determined using DJFMP data (USFWS 2012, 2015b, 2016).

2.4.1.3 CCV Steelhead

CCV steelhead juveniles (smolts) can start to appear in the action area as early as October, based on the data from the Chipps Island trawl (USFWS 2016) and CVP/SWP Fish Salvage Facilities (CDFW 2016b). In the Sacramento River, juvenile steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age and 100 to 250 mm FL, with peak migration through the Delta in March and April (Reynolds *et al.* 1993).

CCV steelhead presence in CVP/SWP Fish Salvage Facilities increases from November through January (21.6 percent of average annual salvage) and peaks in February (37.0 percent) and March (31.1 percent) before rapidly declining in April (7.7 percent). By June, emigration essentially ends, with only a small number of fish being salvaged through the summer at the CVP/SWP Fish Salvage Facilities (Table 6). Kodiak trawls conducted by the USFWS and CDFW on the mainstem of the San Joaquin River downstream at Mossdale (upstream of Stockton) routinely catch low numbers of CCV steelhead smolts from March to the beginning of June (CDFW 2013; 2013–2016).

Fish monitoring in the Canal from 1994–1996 captured 36 juvenile steelhead from February to May (CDFG 2002). Over the 11 years prior to construction of the RSFS (1999–2009), there were 15 juvenile steelhead collected at the Rock Slough Headworks from February to May (Reclamation 2016). In addition, one adult steelhead (622 mm FL, adipose fin intact) was collected and released during fish rescue efforts in November 2009, for the construction of the RSFS, and one juvenile steelhead (254 mm FL, ad-clipped) was found dead in the trash pits on April 24, 2012 (Reclamation 2016). Based on the monitoring, juvenile steelhead presence in Rock Slough is seasonal from February to June, with the potential for adults to stray into the area as they migrate through the Delta. Residency is likely to be from a few hours to a few days based on life-history (migratory life-style).

Table 6. Temporal occurrence of CCV steelhead (SH) in the Delta**.**

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult SH*												
Juvenile SH**												

*Adult presence was determined using information in Moyle (2002), Hallock *et al.* (1961), and CDFG (2007).
**Juvenile presence in the Delta was determined using DJFMP data (USFWS 2015b, 2016; and Hallock *et al.* 1961).

2.4.1.4 Southern DPS Green Sturgeon

Adult green are unlikely to be present in the action area since they typically prefer to migrate upstream through the mainstem Sacramento River. Rock Slough is located in the southern portion of the Delta approximately 10 miles from the Sacramento River and 8 miles from the San Joaquin River. Adult sDPS green sturgeon have not been observed spawning in the San Joaquin River (Jackson and Van Eenennaam 2013).

Juvenile/sub-adult green sturgeon are considered present year-round in the Delta (Table 7). Juvenile green sturgeon have been collected at the CVP/SWP South Delta Fish Facilities throughout the year. Green sturgeon numbers are considerably lower than for other species of fish monitored at the facilities. Based on the salvage records from 1981–2015, sDPS green sturgeon may be present during any month of the year, but only a few juveniles have been observed since 2011. The average size of salvaged sDPS green sturgeon is 330 mm (range 136 mm–774 mm). The size range indicates that these are sub-adults rather than adult or larval/juvenile fish. These sub-adult fish likely utilize the Delta for rearing for a period of up to approximately 3 years. Observations of sport caught sDPS green sturgeon in the San Joaquin River indicate that sub-adult green sturgeon could be present near the action area (CDFG 2011a, 2011b; CDFW 2014). However, it is likely that their population density would be low within the action area. It is difficult to draw conclusions from the lack of observations in the trawl data, since green sturgeon are benthic species and are not typically caught in surface-oriented gear like trawls and seines. Within Rock Slough, it is unlikely that sub-adult sDPS green sturgeon would be present due to the shallow depth and warm water temperatures (Figure 13) which make it unsuitable habitat during most of the year. A review of the 24 years of fish monitoring data (1994–2017) at the RSFS both pre and post-construction showed that sDPS green sturgeon have never been observed in Rock Slough (CDFG 2002, Reclamation 2016).

Table 7. Temporal occurrence of sDPS green sturgeon (GS) in the Delta.

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult GS*												
Juvenile GS**												

*Adult presence was determined to be year round according to information in (CDFG 2008-2014), (Heublein *et al.* 2008), and (Moyle 2002).
**Juvenile presence in the Delta was determined to be year round by using information in (USFWS 2015b, 2016, DJFMP data), (Moyle *et al.* 1995) and (Radtke 1966).

2.4.2 Effects of Global Climate Change in the Action Area

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 m to 1.0 m (3 feet) along the Pacific coast in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, estuarine, riverine, mud flats) affecting salmonid habitat in the Delta. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat.

Droughts along the West Coast and in the interior Central Valley of California are already occurring and likely to increase with climate change. This means decreased groundwater storage and stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water declines, while pollution, acidity, and salinity levels may increase. Warmer stream temperatures will allow for invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2°C and 7°C (3.6°F and 12.6°F) by the year 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Dettinger 2005, and Reclamation 2014), with a drier hydrology predominated by precipitation rather than snowfall. The Sierra Nevada snow pack is likely to decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. Summer temperatures and flow levels will likely become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. Without the necessary cold water pool from snow melt, water temperatures could potentially rise above thermal tolerances for salmonids that must spawn and rear below reservoirs in the summer and fall.

From 2012–2015, California experienced one of the worst droughts in the last 83 years. Salmon, steelhead, and green sturgeon populations experienced lower egg and juvenile survival due to poor freshwater conditions (*e.g.*, low flows, higher temperatures) caused by the drought (SWRCB 2014). Adult abundance of listed salmonids and green sturgeon is expected to decline significantly in 2017 and 2018, given the poor river conditions since 2012.

The RSFS was designed to withstand the impacts of global climate change. The footprint of the Project was raised above the surround levee height to accommodate sea level rise. A large flood isolation valve was added to the Rock Slough Headworks, so that the Canal can be isolated from rising flood waters or extreme high tides. In addition, once the Canal Encasement Project (Section 2.4.2) is completed to the Headworks, the impact of rising sea water will be minimal.

2.5 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 will 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.

Many of the proposed Project activities have the potential to result in mortality or injury to listed fish species, although the risk may be low (*e.g.*, activities that occur on land, or behind the RSFS in the Canal). NMFS did not consider activities that may impact terrestrial species or that Reclamation determined would have no impacts on either salmonids or green sturgeon. Implementation of CCWD's minimization and avoidance measures are expected to reduce some of the risk of exposure. A summary from the BA of activities that may negatively affect listed fish is provided in Table 8.

Table 8. Summary of Project Activities that May Negatively Affect ESA-Listed Fish Species (Reclamation 2016).

Activity	Potential Effects	Minimization or Avoidance Measures
Platform Extension	Minor shading over water	None
Boat ramp construction	Mortality or injury, loss of 0.02 acre, reduction in prey	Mitigated at Kimball Island (0.3 acre) and Big Break (30.5 acres)
Log Boom placement	Mortality or injury from boat	Slow boat speed, environ. training
Irrigation System Improvements	Mortality from pumps, propellers, turbidity, installation of cofferdam and culvert	Slow boat speed
Land Area Encroachment	Mortality or injury from turbidity during culvert and cofferdam construction	In-water work window, fish rescue prior to construction
Staging Area	Mortality or injury from; fuels, lubricants, and solvents draining or spilling into Rock Slough	Environmental training, spill prevention plan, containment booms, spill curtains
Rake Operation	Mortality or injury from contact with rake, entrapment, removal from water, hydraulic leaks, and temporary disturbance	Testing of brush only mode of operation, operating according to tides, improvement of hydraulic fluid system, use of non-toxic fluid
1. Herbicide application	Mortality from herbicide exposure, reduced prey species, reduced DO, and propeller strikes	Slow boat speed, June–October work window, herbicides applied at labeled rates by trained personnel, applied during incoming tides, use of silt curtain, EAT, notify CDBW, use fish monitoring data to determine presence in area in June.
8. Terrestrial Herbicide Application	Mortality or injury if herbicide enters the water from spills or runoff	Apply according to label, do not apply if rain is forecasted
11. Drain, Ditch, and Channel Maintenance	Mortality or injury from equipment strikes, reduced prey, noise and turbidity	Maintenance during work window, EAT, and slow boat speed.
13. Mechanical Control of Vegetation	Mortality or injury from boat harvester, entanglement in removed vegetation, reduced prey, temporary disturbance	Mechanical harvester from June 1–Oct 31, EAT, and log boom removal
14. Insecticidal Sprays	Mortality if insecticides enter the water from spills or runoff	Implement IPMP and Reclamation's procedures, apply according to label, ensure no spray over water
16. Pre-emergent Herbicide Application	Mortality or injury if herbicide enters the water from spills or runoff	Implement IPMP and Reclamation's procedures, apply according to label, do not apply if rain is forecasted
20. Placement of Rip Rap	Mortality or injury from rock placement and reduced water quality	None
24. Bridge Maintenance	Mortality or injury from wash water and paint spills, turbidity and noise from pile driving, reduction in prey species, changes in water quality	Conduct removal and replacement of support pillars during August–October work window. Use silt curtain and work during incoming tides.

Activity	Potential Effects	Minimization or Avoidance Measures
25. Cableway Maintenance	Mortality or injury from paints and cleaning products spilled into Rock Slough	Use best management practices (BMPs) to ensure no paints or cleaning products are spilled into water. Use contaminant booms in the event of a spill.
32. Facility Inspections	Mortality or injury from propeller strikes and disturbance	Slow boat speed and EAT.
33. Graffiti Removal and Sandblasting	Mortality or injury from propeller strikes, increased turbidity, spills of contaminants, temporarily disturbances	Slow boat speeds, BMPs to ensure no paints or sand are spilled into the water
36. Ladders, Safety Nets, Buoys, and Log Boom Repair	Mortality or injury from equipment in water, temporary disturbances	Slow boat speeds
40. Trash Removal	Mortality or injury from propeller strikes	Environ. training, slow boat speeds
43. Sign repair or replacement	Mortality or injury from propeller strikes, reduction of prey, temporary disturbance	Slow boat speeds
44. Stilling Well Maintenance (pump or back flushing)	Mortality or injury from increased turbidity and disturbance of prey	None
49. Wash and Paint Turnouts, Check Structures (Headworks, Flood Isolation, RSFS)	Mortality or injury from propeller strikes, increased turbidity from pressure washing, spilled contaminants, and temporary disturbance	Slow boat speeds, BMPs to ensure paints are not spilled, use contaminant booms in the event of a spill
50. Wash Bridges and Fish Screens	Mortality or injury from contact with screen panels, or blanks during removal or installation, increased turbidity, spilled contaminants, increased predation, and propeller strikes	Slow boat speeds
53. Canal Desilting	Mortality from entrainment into suction, increased turbidity, and latent mortality after injury	Schedule desilting during in-water work window, use of silt curtain if outside work window, desilt during flood tide

EAT=Environmental Awareness Training, IPMP=Integrated Pest Management Program

2.5.1 Rock Slough Fish Screen Improvements (new rake cleaning system)

The rake cleaning system on the RSFS (Figure 4) removes aquatic weeds and debris that build up on the screen surface and prevent water from flowing through the 2/32 inch (1.75 mm) perforated plate openings. Without a clean surface, the water surface elevation increases on the Rock Slough side, causing a head differential. This differential can, over time, damage the fish screens or the facility structure. In 2016, the head differential from the aquatic weeds on the fish screens was so great that CCWD had to pull a relief panel which allowed unscreened water to flow through the RSFS into the Canal for several weeks.

As part of the Project, Reclamation proposes for CCWD to operate the new rake cleaning system in Rock Slough, which will have direct effects and are analyzed below in Section 2.5.1.1. Reclamation determined that the rake system improvements would have a net beneficial effect on listed fish species by increasing the efficiency of the fish screen and reducing areas of high velocity that can entrain and impinge juvenile salmonids and sturgeon.

2.5.1.1 Hydraulic Rake Operations

Hydraulic trash rakes are designed to remove debris from the fish screens by pulling it up and depositing it on conveyors. Four trash rakes are designed to run automatically and concurrently, two on each half of the fish screen structure. Sensors on either side of the fish screens record the difference in water surface elevation. If the differential reaches 9–12 inches, the rakes automatically start-up the cleaning cycle along the 351-foot screen. If the differential reaches 18–21 inches, a hoist is activated to raise the relief panel in the middle of the fish screen (Reclamation 2011). The operation of the hydraulic rake cleaning system has been shown to trap and kill adult Chinook salmon and other non-listed fish (Reclamation 2016). These fish are entangled in the large mats of aquatic weeds lifted out of the water in the rake buckets which are then placed on a conveyor belt that dumps debris at either end of the RSFS in large concrete pits. Adult Chinook salmon are thought to be attracted to the RSFS during the ebb tide when the Canal is draining (Table 10). At a site visit on December 1, 2016, adult salmon were observed nosing up to the RSFS seeking a way through the fish screens. At this point they are vulnerable to being trapped in the rake head bucket and lifted out of the water (Figure 4). Adult salmonids carcasses were recovered from the RSFS debris pits and examined for an ad-clip (Figure 14).

Figure 14. And adult Chinook salmon with adipose fin clip, indicating hatchery origin, found in the debris pit on November 17, 2011 (source: Tenera 2011).

Heads were removed from ad-clipped salmon and sent to the USFWS, Lodi Office, for coded-wire tag (CWT) dissection and reading. Of the 47 salmon recovered from 2011–2016, approximately 60 percent were of hatchery origin (Tenera 2017, Reclamation 2016, Appendix A). The CWTs revealed that all were fall-run Chinook salmon released from either Mokelumne River (53 percent), Merced River (6 percent), or Nimbus (2 percent) fish hatcheries (Table 9).

Table 9. Adult salmon and steelhead carcasses recovered from the debris pits 2011–2016 (Reclamation 2016, Appendix A; and Tenera 2017). In 2014, the rakes were not operated from May–December due to Canal construction. In 2016, a block net was installed at the log boom.

Year Collected	Species	Number Collected	Size FL (mm)	Date Collected	Hatchery	Brood-year	Percent Marked	Run*
2011	Chinook	35	533–832	11/15–12/19	Mokelumne, Merced, Nimbus	2009	90–99.8%	Fall
2012	Chinook	4	558–864	1/16–1/31 and 11/19–12/3	Mokelumne	2007	25%	Fall
2012	Steelhead	1	254	4/24	unknown		25%	n/a
2013								
2014								
2015	Chinook	1	610	11/10	unknown	n/a	n/a	n/a
2016	Chinook	7	610–910	11/28–12/13	Mokelumne	2013, 2014	25%	Fall

* Run determination based on CWTs read by USFWS, Lodi Office, n/a = not applicable

The majority of salmon collected at RSFS from 2011–2016 were identified as fall-run Chinook based on the CWTs and time of year (November through January). A block net (3/8 inch openings) was installed across Rock Slough in October of 2016 to prevent salmon from being entrapped in the rake cleaning system, while allowing smaller fish to pass through. However, some salmon got through the block net due to holes from fishing boats driving over the net. Adult Chinook salmon caught at RSFS varied in age from 3 to 5 years old and weight from 4 to 20 lbs (Reclamation 2016, Appendix A). One ad-clipped steelhead was collected on April 24, 2012. Based on the size, the steelhead was likely a hatchery released smolt. No sturgeon have ever been collected in Rock Slough, the Headworks, or the Canal.

Table 10. Date, time, and tidal cycle for adult Chinook salmon recovered at the RSFS based on video footage (source: Tenera 2012, salmon log)

Date	Side	# salmon	Date/Time Recovered	Tide	Total Number
01/13/2012	West	1	1/13/2012 13:10	Ebb	1
12/16-12/17/2011	West	1	12/17/2011 2:19	Ebb	1
12/13-12/14/2011	West	1	12/14/2011 3:34	Flood	1
12/1-12/2/2011	West	1	12/1/2011 16:57	Ebb	
	West	2	12/1/2011 4:10	Ebb	
	West	3	Unable to determine		
	East	1	12/1/2011 16:01	Ebb	
	East	2	12/1/2011 16:48	Ebb	
	East	3	12/1/2011 17:19	Ebb	
	East	4	12/2/2011 0:47	Ebb	
	East	5	12/2/2011 3:51	Ebb	
	East	6	12/2/2011 4:15	Ebb	
	East	7	Unable to determine		10
11/30-12/1/2011	East	1	Unable to determine		
	East	2	Unable to determine		
	East	3	Unable to determine		
	West	1	Unable to determine		
	Middle	1	Unable to determine		5
11/29-11/30/2011	West	1	11/30/2011 3:11	Ebb	
	West	2	11/30/2011 4:00	Ebb	3
11/28-11/29/2011	West	1	11/28/2011 23:47	Ebb	
	West	2	11/29/2011 1:48	Ebb	
	East	1	11/29/2011 4:23	Flood	4
11/26-11/27/2011	West	1	11/27/2011 0:30	Ebb	1
11/27-11/28/2011	West	1	11/27/2011 21:27	Ebb	1
11/26-11/28/2011	West	2	Unable to determine		2
11/23-11/24/2011	West	1	11/23/2011 19:17	Ebb	1
Total					**30**

Based on the number of adult Chinook salmon collected at the RSFS, it is likely that ESA-listed Chinook salmon and CCV steelhead could be killed or injured from contact with the rake cleaning system while it is being operated. However, due to the location of the RSFS at the end of a dead-end slough, far from the main migratory routes (*i.e.*, 10 miles), it is unlikely that adult winter-run, CV spring-run, and CCV steelhead will stray into Rock Slough where they would encounter the rake cleaning system. The only ESA-listed fish that was collected at the RSFS in the 6 years (2011–2016) of operating the rakes was 1 hatchery released juvenile steelhead (254 mm). The conservation measures implemented by CCWD in Section 2.3.1, and listed below, are also expected to minimize listed fish mortalities.

- Monitoring of rake operations using fall-run Chinook salmon as surrogates
- Use of a block net across Rock Slough from November 1–April 30
- Reduced rake operation November 1–April 30 based on fish monitoring
- Operating rake system on flood tides, or in "brush only" mode
- Improved hydraulic system

The hydraulic system improvements include new seals to reduce the potential for leaks. CCWD has also replaced the hydraulic fluid with a non-toxic vegetable oil-based fluid (Biohydran ISO 32) that is biodegradable (Seedall 2017). These changes should reduce the chance of hydraulic leaks contaminating the water in Rock Slough and reduce the potential for negative impact to listed fish species. NMFS previously consulted with Reclamation on the impacts of testing the new rake system until 2018 (NMFS 2015b). Future operations of the rake system will be determined after CCWD and Reclamation review the prototype testing results and adaptively managed utilizing the minimization measures based on the fish monitoring and timing of mortalities (*e.g*., operate tidally, or reduce operations during daylight hours). CCWD will consult with Reclamation on rake operations when fall-run Chinook salmon are being collected. Reclamation has proposed to use fall-run Chinook salmon as a surrogate to adaptively monitor the effectiveness of the rake operations.

Reclamation and CCWD propose to minimize the negative impacts of the rake cleaning system by adopting one or more of the following conservation measures; 1) operate tidally on incoming/flood tides or in brush only mode, 2) reduce cleaning during daylight hours, 3) operate when adult salmon are not present in Rock Slough based on monitoring from November to April, 4) reduce cleaning time based on screen differentials to maintain uniform approach velocities, 5) reduce aquatic weed buildup in front of RSFS, and 6) use of a block net in Rock Slough to keep ESA-listed species away from rake cleaning system.

Overall, operation of the re-designed rake cleaning system is expected to reduce the number of adult Chinook salmon that come in contact with the RSFS. The re-designed rake system will reduce negative impacts by operating more efficiently, maintaining the 0.2 feet/sec approach velocity requirement, minimizing impingement, and reducing the chance of hydraulic fluid spills. The risk to ESA-listed species (*i.e*., winter-run, CV spring-run, CCV steelhead, and sDPS green sturgeon) from mortality and injury is lower once the improvements are made due to implementing the conservation measures proposed above. The likelihood that listed fish will be present near the RSFS is low due to: (1) the distance from migration routes (*i.e.*, 3.5 miles from Old River, 10 miles from the San Joaquin River), and (2) the poor habitat conditions in Rock Slough (*i.e*., low DO, high water temperatures, and prevalence of aquatic weeds). Nevertheless, a small number of listed fish could stray into Rock Slough, or be attracted by the reverse flows coming out of the Canal on ebb tides (Table 10).

2.5.1.2 Debris Removal System

The large amounts of aquatic weeds (and fish) removed by the automated rake cleaning system are placed onto a moving conveyor belt that dumps into the debris pits on either side of the RSFS. The debris is then removed by trucks to the drying area where fish, if observed, are counted, measured, and removed. If Chinook salmon or steelhead are present, they are inspected for CWTs (indicated by ad-clips) and removed for transport to the USFWS Lodi Office. Once dried, the debris is trucked to a landfill for disposal. There are no adverse impacts to listed fish once the debris is removed from the fish screens since at this point the fish are already dead.

2.5.1.3 Platform Construction

The platform extensions will connect the exiting platform all the way across the RSFS so that the fish screen can be accessed and the rakes repaired, if necessary. The existing platforms only extend part way (in 3 sections) across the 351-foot fish screen (Figure 3). The platform extensions will be fabricated off-site and installed at the RSFS. Construction will be accomplished with hand tools, welding equipment, and a crane to lift the sections in place. Installation will not require any in-water work. Potentially negative impacts of construction are limited to accidental spills and minor shading over the water directly in front of the RSFS. Spills will be minimized by use of BMPs and the shading is not considered significant since listed fish species do not rear, shelter, or feed in front of the RSFS. Shading may attract some adult salmonids that are looking for a resting area as they migrate upstream, but it also provides an area where predators can hide in wait for juvenile salmonids. Since the platform is an open grated design, sunlight can penetrate through the platform to the water. Therefore, the shading effect is unlikely to cause an increase in predation. Adult Chinook salmon and steelhead will be prevented from nearing the RSFS by the block net (see Section below, 2.5.1.4), therefore, shading is not expected to negatively impact adults or juvenile listed fish.

2.5.1.4 Log Boom Installation and Block Net Maintenance

The placement of the two original log booms in 2011 parallel to the RSFS (Figure 3) allowed open navigation past the RSFS to the end of the Rock Slough (see extension area). However, the log booms were not effective at preventing aquatic weeds from contacting the fish screens. Aquatic weeds simply grew over and under the original log booms. Aquatic weeds grow from the dead-end extension (west of the RSFS) eastward into Rock Slough and also drift into Rock Slough from the surrounding Delta (see baseline). The dense mats of aquatic weeds became so heavy that the hydraulic rake cleaning system could not handle the load and caused frequent breakdowns. In 2015, CCWD relocated the remaining log boom 600 feet upstream (east) of the RSFS and across the 165-foot wide Rock Slough (Figure 2 and 7) to prevent weeds from drifting into the fish screens while testing the new rake designs. The log boom was anchored to the sides using temporary ecology blocks (*i.e.*, large concrete blocks, 5 feet x 2.5 feet x 2.5 feet, weighing 4,500 lbs each). The ecology blocks will remain for up to 5 years, or until Caltrans constructs a new bridge over Rock Slough (see Cypress Preserve Project, NMFS 2016c).

Once the Rock Slough Bridge is constructed, CCWD will permanently anchor the log boom upstream of the new bridge so that it is visible to boaters. Permanent anchors will require pilings in the bank in order to secure the log boom. Installation of the pilings will take place in the dry above the mean high tide level in the levee rip rap on the north and south banks. The piling anchors will require excavation in the levee bank 2 feet below the surface to install a 6 foot x 6 foot concrete pad and a 2-foot diameter boring, 7 feet below ground surface. Approximately 58 CY of levee material will be permanently removed off site. Existing rip rap will be moved, stored, and moved back over the concrete anchor pad. Construction will require a well drilling rig, concrete truck, small backhoe, and pickup trucks. Construction of the permanent anchors is anticipated to take up to 4 weeks during the in-water work window of July 1 to October 31.

Negative impacts of constructing the permanent anchors include noise, turbidity, and loss of bank habitat. However, since the construction is occurring in the dry above the high tide and listed fish species are not expected to be present during the work window, negative impacts would have a low likelihood of occurring. The loss of habitat (58 CY levee material) and 6 foot x 6 foot concrete pad will reduce the quality of habitat along the levee bank making it less likely that prey species (aquatic insects) will utilize this habitat. Therefore, there is a minimal indirect impact to listed fish through a reduction in food availability.

In October of 2016, a block net (3/8 inch openings) was installed under the relocated log boom to prevent adult Chinook salmon from becoming entrapped in the rake cleaning system (see section 2.5.1.1 above). During a site visit on December 1, 2016, the block net was determined to be effective at deterring salmon and also marine mammals which were observed in Rock Slough. However, recreational fishing boats had driven over the log boom to access the Rock Slough extension, which cut holes in the block net. Large buoys and signage were subsequently installed by CCWD on the plastic floats to warn boaters of the hazards from driving over the log boom.

Beneficial impacts to listed fish of relocating the log boom and installing a block net are:

- Controlling floating aquatic weeds that drift into the RSFS
- Reducing the amount of herbicide application in Rock Slough
- Reducing the size of area requiring mechanical or herbicide treatment
- Increasing DO levels from less aquatic weeds
- Increasing turbidity from less aquatic weeds
- Removing shading effect caused by plants covering water surface
- Reducing predation associated with aquatic weed coverage
- Increasing water movement through Rock Slough

The negative impacts to listed fish are from work boat disturbance and possible propeller strikes while installing, removing, and inspecting the block net twice a year. Placement of the temporary anchors was completed in one week without any permanent impacts to the bank or Rock Slough.

2.5.1.5 Boat Ramp Construction

The portion of Rock Slough and the Canal where the 2 boat ramps are to be constructed will be contained within a floating silt curtain during construction. This will minimize any turbidity during the in-water excavation extending into Rock Slough or the Canal. The silt curtain will have a floating plastic boom that will support the curtain. The curtain will be made of an impermeable membrane that extends from the plastic boom at the water's surface to the bottom of the channel. The bottom of the silt curtain will be weighted to hold it in place and the ends of the floating boom will be anchored to the bank with ropes tied to large rocks or adjacent pilings. The silt curtain will be installed with the aid of a workboat and lifting equipment.

Construction of each boat ramp is not expected to require more than 75 days to complete (Reclamation 2016). Construction is scheduled to take place from April through September (Table 1). A review of the fish monitoring data before construction of the RSFS (Table 2) indicates that small numbers of juvenile CCV steelhead and CV spring-run may be present from

April–May. Excavation and gravel or fill placement will be accomplished during low tide periods, so that only the boom of an excavator will enter the water. The east boat ramp (afterbay) will require 30.2 CY of substrate excavated below mean low tide and the west boat ramp (in Rock Slough) will require 39.0 CY of substrate to be removed. A small area of benthic habitat will be permanently removed in Rock Slough (~0.02 acre) and in the afterbay of the RSFS (~0.02 acre). The benthic habitat being removed contains amphipods, annelid worms, and various life stages of insects, clams, and snails, all of which can provide food for listed fish species. The east boat ramp is behind the RSFS, therefore, it is not accessible to any life-stage of listed fish species, therefore the boat ramp behind the screen will not permanently displace foraging habitat for listed fish. For the west side boat ramp, the permanent removal of prey species in 39 CY (~0.02 acres) of substrate represents a minimal reduction in the forage base. The substrate being excavated is mainly rip-rap that provides very little forage base. The use of the silt curtains and work during low tide is expected to keep listed fish species from direct contact with heavy equipment (*i.e.,* excavators, front-end loaders, or dump trucks).

Since the boat ramps are made of pre-cast interlocking concrete sections, there will be minimal noise and no concrete mixing in-water from the placement of the boat ramps. However, there will be noise from the heavy equipment used to excavate rock and sediment. The noise from equipment working potentially could cause listed fish to avoid the area in Rock Slough. NMFS uses 187 decibels (dB) as the threshold for behavioral effects during pile driving ESA section 7 consultations (FHWG 2008). FHWG (2008) established the following thresholds for the onset of physical injury to fish > 2 grams: peak sound pressure level = 206 dB and cumulative sound exposure level (SEL) = 187 dB for behavioral avoidance. Based on life history stages and timing, all NMFS listed fish species would be > 2 grams by the time they reached the action area. The background noise in the action area is expected to be comparable to that in the San Francisco Bay. For avoiding negative behavioral effects to fish, NMFS considers the background or ambient noise levels in the San Francisco Bay to be comparable to measured noise levels at 130–140 dB (Caltrans 2009). Increased noise from the use of heavy equipment and work boats are not expected to exceed the 150 dB background levels and are expected to last less than 75 days (2 1/2 months). Listed fish species that encounter underwater noise during the construction period are expected to exhibit avoidance behavior (*i.e*., swim away from the construction area either back down Rock Slough or towards the Rock Slough Extension. Fish that swim into the Rock Slough Extension would likely die due to the poor conditions found there (*e.g*., low DO, high temperature, shallow water, and contaminants from agricultural runoff). Based on the historical fish monitoring data before the construction of RSFS (Table 2, and CDFG 2002), less than 5 juvenile winter-run, 40 juvenile CV spring-run, and 10 juvenile CCV steelhead would be impacted by the boat ramp construction and noise disturbance. The use of silt curtains is likely to reduce underwater noise levels and prevent fish from swimming near the construction equipment. SDPS green sturgeon are not likely to be impacted by the construction due to the distance from Old River (main rearing area) and unfavorable habitat conditions in Rock Slough (*i.e*., shallow depth, warm water, and low DO would preclude green sturgeon presence).

The boat ramp construction in Rock Slough will result in a permanent loss of approximately 1,400 square feet (0.02 acre) of benthic habitat to the mean high tide level in Rock Slough and approximately 1,400 square feet (0.02 acre) of benthic habitat to the mean high tide level in the RSFS afterbay. Reclamation and CCWD previously mitigated for the loss of 0.04 acres of benthic habitat through the purchase of credits in a mitigation bank (see Section 2.3 Conservation Measures). The combined 0.04 acres is also jurisdictional wetlands and CCWD will be requesting a Clean Water Act section 404 nationwide permit and a Rivers and Harbors Act section 10 permit from the USACE, as well as a 401 permit from the California Regional Water Quality Control Board.

2.5.1.6 Irrigation System Improvements

Since RSFS was constructed, two of the existing unscreened irrigation pumps in Rock Slough were re-located behind the RSFS. This benefited listed fish by reducing the number of unscreened agricultural intakes in the Delta. The two existing pumps behind the RSFS that supply water to the surrounding ranches are proposed to be replaced, as well as two irrigation valves that withdraw water. The work entails excavating 10-foot deep ditches to the irrigation valves (see insert, Figure 7). All construction work will be conducted from May 1 through October 31. Since all activity takes place in the afterbay (behind the RSFS), no listed fish species are expected to be present. Excavation of the ditches and replacement of the valves is not expected to negatively impact listed fish because the work occurs on land. The work is far enough away from the waters of Rock Slough that no runoff or sediment is expected to enter the water (*i.e.,* impacts confined to ranch lands adjacent to RSFS).

2.5.2 Operations and Maintenance Activities for RSFS

2.5.2.1 Herbicide Application

NMFS conducted effects analyses on the proposed herbicides using the well-established process developed by the USDA and NMFS for consultation on CDBW's Water Hyacinth Control Program (NMFS 2013) and Egeria Control Program (NMFS 2014b). Briefly, the analytical framework includes organizing, evaluating, and synthesizing available data and information on listed resources and the potential stressors of the proposed action. Separate evaluations are conducted for the effect and risk to listed species and to designated critical habitats from the stressors of the proposed action. However, critical habitat is not present in the action area for this consultation (Figure 12). Studies using listed species are preferable, however, no specific toxicity data exist for listed species found in the vicinity of the RSFS. When there is not a complete suite of information relating to effects on listed fish species, data from surrogate species are used. Specifically, rainbow trout are used as surrogates for salmonids and white sturgeon for green sturgeon. Even though there may be interspecies extrapolation, data from surrogates are considered the best available and were used in previous national pesticide consultations. NMFS considered effects on all life stages of salmonids and green sturgeon (direct effects), as well as effects on plants and prey items (indirect effects). NMFS used the following risk assessment for herbicides on listed species (NMFS 2011e).

Exposure to herbicides sufficient to:

a) kill salmonids or green sturgeon from direct or acute exposure;
b) reduce salmonid or green sturgeon survival through impacts to growth and development;
c) reduce salmonid or green sturgeon growth through impacts to salmonid prey; and
d) reduce migration, and reproduction through impacts to olfactory-mediated behaviors.

A central tenet of toxicology is that at some exposure dose, an effect is not measurable (meaning that at some point the dose is so low that an effect cannot be observed) in the response tested, and this is considered a valid model for this assessment. This dose or concentration is known as the no observable adverse effect level, or the chronic concentration level. The lowest observable adverse effect level or chronic concentration corresponds to the lowest dose at which a statistically significant difference is measurable relative to an unexposed control group. Beyond these typical measures, standard toxicological terms include the LC50, the exposure concentration that kills 50 percent of the animals tested and the EC50, the concentration that elicits a non-lethal effect in 50 percent of the organisms tested with the measurement endpoint. The assessment endpoints from these tests for an individual organism generally include only survival (or death), reproduction, and growth measured in laboratory dose-response experiments conducted on a single active ingredient. Survival is typically measured in both acute (48-96 hour) and chronic (21-60 day) tests. Fish reproduction and growth are generally measured using chronic tests (21-60 day).

The USEPA ecological risk assessments primarily summarize acute and chronic toxicity data from "standardized toxicity tests" submitted by pesticide registrants during the registration process, or tests from government laboratories available in USEPA databases, or from peer-reviewed scientific publications (Table 11).

Table 11. Aquatic Animal Ecotoxicity Categories (USEPA 2011)

Toxicity Category	Fish or Aquatic Invertebrates Acute Concentration LC50 or EC50 (mg/L)	Fish or Aquatic Invertebrates Chronic Concentration or no observable adverse effect (mg/L)
Very highly toxic	<0.1	<0.1
Highly toxic	0.1-1	0.1-1
Moderately toxic	>1-10	>1-10
Slightly (low) toxic	>10-100	>10
Practically non-toxic	>100	Not specified

Biological tissues may act as an additional reservoir for chemicals applied intentionally or inadvertently to the environment. Bioconcentration is the accumulation of chemicals in an organism's tissues following direct exposure. Bioaccumulate occurs if the chemical accumulates at a rate faster than normal metabolic processes eliminate it. Biomagnification in the food web occurs if the organism is consumed (predated upon) by another organism, resulting in a higher concentration of the chemical in the predator.

Reclamation and CCWD propose to utilize chemical treatment and mechanical harvesters (see Section 2.5.4 below) to control aquatic weeds (*i.e.*, water hyacinth, water primrose, coontail, Brazilian elodea, and filamentous algae) in the waters of Rock Slough in front of and behind the RSFS. All of the above aquatic weeds are present during the year, with Brazilian elodea composing the majority of what is collected from the trash pits (Reclamation 2016). Filamentous algae is problematic in that it can cause head differential that can damage or shut down the RSFS. CCWD considered the effects of 7 herbicides and chose 4 of the least toxic products: Clearcast®, GreenClean® Liquid 2.0, Phycomycin® SCP, and Roundup Custom™. Table 12 provides a description of the products and their characteristics. The herbicides will be broadcast by pressurized tanks and sprayers, or from boats injected below the water surface. The proposed application period is from June through October, but may start as early as March depending on when new growth starts. The use of herbicides will be decided based on: (1) if the weeds in Rock Slough near the RSFS exceed the rated capacity of the rakes, (2) if the weeds would cause a differential at the fish screens, and (3) if weeds cover the surface area in front of the RSFS.

Table 12. Environmental effect concentration and fate of the proposed herbicides. Acute concentrations determined from LC50 and chronic concentrations from lowest observable negative impact.

Product	Active Ingredient	Rate applied (mg/L)	Estimated Environmental Concentration (mg/L)		Treatment Duration (Day)	Aquatic Half-life*	BCF**
			Acute	Chronic			
Clearcast®	12% ammonium salt of imazamox	0.05-0.5	122	unknown	14-28	4-49 days	0.1
GreenClean® Liquid 2.0	50% sodium carbonate peroxhydrate	0.5-5.0	40	unknown	5-7	100% at 1 day	0.0
Phycomycin® SCP	85% sodium carbonate peroxhydrate	0.3-10.2	320	unknown	2-4	100% at 1 day	0.0
Roundup Custom™	54% glyphosate + surfactant	0.05-5.0	1000	10	1-2	12-70 days	1.4-5.9

*Time it takes for 50% of material to degrade in water

**The bioconcentration factor (BCF) is a measure of the tendency for a substance in water to accumulate in organisms, especially fish. It is the ratio of the concentration of a chemical inside an organism to the concentration in the surrounding environment (ENVIRON 2012, Geer 2016).

The surface area to be treated includes the afterbay and Rock Slough from the Extension to 200 feet upstream of the log boom on the east side of the RSFS (Figure 15). A total of 2 acres in the afterbay and 4 acres in Rock Slough would be treated (Areas 1 and 2, respectively; Figure 15). The total herbicide application acreage represents a small fraction (7.14 percent) of the total waterways acres in Rock Slough. CCWD will coordinate any herbicide application upstream of the RSFS with CDBW to avoid over application and to review dosage and post application monitoring procedures. Under an existing MOU between CDBW and CCWD, CDBW is prohibited from applying aquatic herbicides within Rock Slough or within one mile of the confluence of Rock Slough and Old River without the prior consent of CCWD.

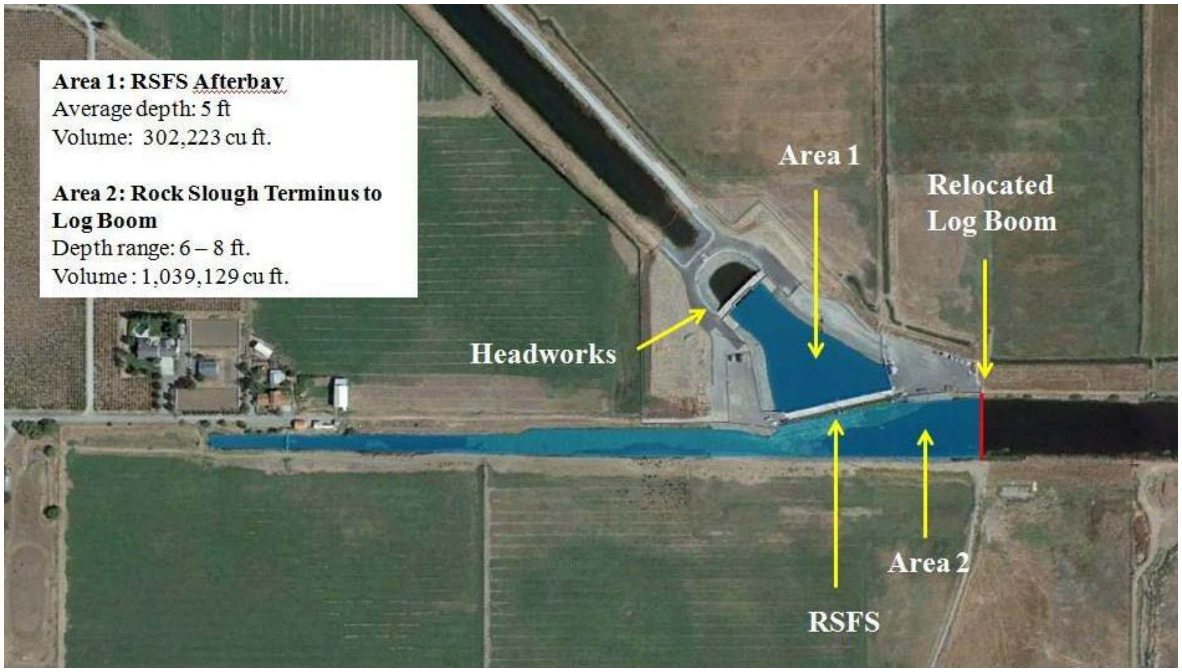

Figure 15. Area of proposed herbicide application for the RSFS Improvement Project (Reclamation 2016)

Listed fish species in Rock Slough could be adversely affected by the application of herbicides if the application rate exceeds a species acute toxicity, as measured by LC50 data, or between the acute and chronic toxicity. The reported toxicity tolerances of surrogate taxa were compared with the effective concentration (labeled application rate) of each herbicide needed to treat its intended target plant species. The concentrations required of Clearcast®, GreenClean ® Liquid 2.0, Phycomycin® SCP, and Roundup Custom™, according to their labels, all fall well below the reported toxicity tolerances of bluegill and rainbow trout (Table 3).

a. Clearcast®

CCWD proposes to apply Clearcast (imazamox) over a 2- to 7-week period in June to October at a range of 50-500 ppb, depending on the target plant species (Table 4). For comparison, CDBW typical application rates in the Delta for imazamox range from 25 ppb to 125 ppb. Imazamox is classified by the USDA as practically non-toxic to fish and aquatic invertebrates at label application rates, and it does not bioaccumulate in fish. Clearcast® toxicity to bluegill (96-hr LC50) is above 119,000 ppb and is above 122,000 ppb for rainbow trout; the concentration needed to control Brazilian elodea (the highest concentration required) is 200-500 ppb, well below what is considered toxic to bluegill and rainbow trout. Laboratory tests using rainbow trout, bluegill, and water fleas indicate that imazamox is not toxic to these species at label application rates (USDA and CDBW 2012b).

b. Phycomycin® SCP and GreenClean® Liquid 2.0

Sodium carbonate peroxyhydrate (SCP) is the active ingredient in both of these products, which was first registered with the USEPA in 2002. It is a granular product that is used in lakes as an algaecide. SCP is created from sodium carbonate and hydrogen peroxide. It is sold under the trade names Phycomycin® and GreenClean®. It is 100 percent soluble in water, rapidly dissociating to sodium carbonate and hydrogen peroxide (H_2O_2) molecules within minutes of granular application. Hydrogen peroxide is a mild antiseptic used on the human skin to prevent infection. Substantial aquatic organism toxicity data for both sodium carbonate and hydrogen peroxide has been generated, with 67 and 123 records respectively available through the USEPA's ECOTOX online database (https://cfpub.epa.gov/ecotox/). Sodium carbonate has very low toxicity to all organisms for which USEPA results are reported. Hydrogen peroxide was at most moderately toxic in the reported studies. In addition, SCP has not been found to persist in sediments or water and does not bioaccumulate (WDNR 2012b).

SCP is not toxic to minnows at labeled application rates, but has not been tested on other fish (WDNR 2012b). It is toxic to *Daphnia* at application rates, but dosages on the lower end of the labeled rates (<2 ppm) do not affect *Daphnia*. Geer (2016) compared the response of aquatic organisms to Phycomycin®SCP and found the 96-hour LC50 was 14.5 mg/L, for (*Hyalella azteca*), a common benthic amphipod, 4.7 mg/L for *Ceriodaphnia dubia*, a microcrustacean, and 80.8 mg/L for fathead minnows . This is similar to the acute toxicity listed in Reclamation (2016) for fathead minnows (96-hr LC50 = 70.7 mg/L) and bluegill (96 hr LC50 = 320 mg/L), which would indicate a low to moderate toxicity level based on the USEPA criteria (Table 11). The concentration of Phycomycin® SCP required to control filamentous algae is 0.3‐10.2 mg/L and 0.5–5.0 mg/L for GreenClean® Liquid 2.0 (Table 12). Therefore, applied at the labeled concentration rates, Phycomycin® SCP and GreenClean® Liquid 2.0 would not be expected to have acute impacts on listed fish species. However, it is unknown how sensitive juvenile green sturgeon, Chinook salmon, and steelhead are to these herbicides. Salmonids are typically more sensitive in toxicity testing than fathead minnows and bluegill, which are warm water species. Green sturgeon physiology and long life-span makes them relatively resilient to chemical toxins, indicating short-term exposure to contaminated sediments would only have a marginal effect. The USEPA's TOXNET assessment concludes that sodium carbonate is a naturally-occurring salt commonly found in soil and water in the environment, suggesting that releasing low levels of these chemicals would not be expected to negatively affect wildlife or water resources (https://toxnet.nlm.nih.gov). Based on studies (Geer 2016, WDNR 2012b, and USEPA's assessment), SCP applied at 0.3 to 10 mg/L (labeled rates) for use to control algae may affect, but is not likely to adversely affect juvenile salmonids and green sturgeon. Acute and chronic effects to benthic prey species are likely, but growth and reproduction effects on listed fish are unlikely given that most listed species spend little time rearing in Rock Slough as they migrate through the Delta.

c. Roundup Custom™

The label for Roundup Custom™ (53.8 percent glyphosate) does not list application concentrations in ppm or ppb, however the MSDS states that this product is practically non-toxic to fish and invertebrates, with a 96-hr LC50 to rainbow trout of greater than 1,000 ppm and a 48-hr EC50 to *Daphnia* of 930 ppm (Roundup Custom™ MSDS). According to the MSDS, Roundup Custom™ applied according to the label concentrations is not likely not to cause direct mortality to the species tested.

The environmental fate of glyphosate once it enters water is relatively low. Complete degradation is slow, but dissipation in water is rapid because glyphosate is bound in sediments and has low biological availability to aquatic organisms. These characteristics suggest a low potential for bioconcentration in aquatic organisms and this has been verified by laboratory investigations of glyphosate bioconcentration in numerous marine and freshwater organisms with and without soil (MDNR 2015). The maximum whole body bioconcentration factors (BCFs) for fish were observed to be less than one. The BCFs for sediment dwelling mollusks and crayfish tended to be slightly higher, but were always less than 10. Contardo-Jara *et al.* (2009) showed that glyphosate in Roundup® bioaccumulates in California blackworms (*Lumbriculus variegatus)*, despite the hydrophilic character of the herbicide. The accumulated amounts of glyphosate and the added surfactants in Roundup Ultra (similar to Roundup Custom™) caused an elevation of the biotransformation enzyme sGST at nontoxic concentrations. The BCF varied between 1.4 and 5.9 for the different concentrations, and was higher than estimated when used with its surfactant.

Glyphosate found in Roundup Custom™ can have acute and chronic impacts to fish if the application is repeated in the same area, or fish remain in the treatment area. Pérez *et al.* (2011) found acute impacts (96 hr LC50) to both salmon (*O. nerka*) and rainbow trout *(O. mykiss*) ranging from 8.1 to 10.0 mg/L, which is far lower than the stated acute toxicity levels on the Roundup® MSDS or Specimen Label (*i.e*., LC50 for *O. mykiss* is 1,000 mg/L). Tierney *et al.* (2007) found negative olfactory responses (avoidance) in rainbow trout exposed to concentrations of > 10 mg/L of glyphostate in Roundup®. Roundup® may have had added toxicity due to active ingredients found in the surfactants that must be added at application. One such ingredient was the surfactant polyoxyethylene amine (POEA), a chemical that greatly enhances Roundup®'s toxicity to aquatic life (Tsui and Chu 2003, Pérez *et al.* 2011). In addition, as a result of herbicide exposure, rainbow trout exhibited hyper- and hypoactivity, which are sublethal effects that may result in latent mortality in the field, such as through increasing susceptibility to predation or decreased predator avoidance (Tierney *et al.* 2007, 2010).

Reclamation proposes to use two nonionic surfactants with Roundup Custom™: R-11 Spreader-Activator and Prospreader Activator. Both surfactants are listed as approved for use in aquatic environments in California (Reclamation 2016, Appendix B, IPMP). The surfactants will be mixed with the herbicide based on labeled rates and following CCWD's IPMP requirements. According to the material safety data sheets (MSDS), R-11 is a mixture of octylphenoxypolyethoxyethanol, n-butanol and compounded silicone. These ingredients comprise 90 percent of the formulation; the remaining 10% is identified as "constituents ineffective as spray adjuvant." The MSDS for R-11 lists the hazardous ingredients as 20 percent butyl alcohol and 80 percent nonionic surfactants.

A review of the aquatic toxicity data for R-11, at the labeled concentration rate (2 quarts/100 gallon, or 6 ppm, or 6 mg/L), showed the acute 96-hour LC50 for juvenile bluegill was 4.2 mg/L, and for juvenile rainbow trout was 3.8 mg/L. The acute 48-hour LC50 in *Daphnia magna* was 19 mg/L (USDA 1997). The Prospreader Activator MSDS indicates that the LC50 acute toxicity for bluegill was 6.0 mg/L, for rainbow trout was 3.3 mg/L, and for *Daphnia magna* was 7.3 mg/L. Smith *et al*. (2004) showed that the surfactant R-11 was highly toxic to rainbow trout at application rates used with Rodeo (similar to Roundup Custom) and more toxic than the herbicide itself. Behavioral effects included erratic swimming and gilling on the bottom at concentrations as 3.5 mg/L. Death occurred as early as 24 hours after exposure. The acute toxicity of nonionic surfactants, such as R-11 and Prospreader Activator, to aquatic organisms appears to be related to chemical-induced non-specific narcosis (defined as a reversible state of arrested activity) characterized by lethargy and unconsciousness (Hecht and Boese 2002 *op cit*. Smith *et al.* 2004). Other taxa, just as amphipods, snails, and tadpoles exhibited similar narcosis.

At the minimum recommended surfactant concentration, modeling showed 50 percent of exposed rainbow trout would be expected to die within one inch of the water depth (Smith *et al*. 2004). Mortality would decrease the deeper the fish were when exposed. Since juvenile trout and salmon are mainly surface oriented in the Delta to take advantage of food sources (drifting aquatic and terrestrial insects), it is expected that 50 percent of juvenile salmonids would be exposed to the surfactants and would die. The toxicity of the surfactants would decrease with depth and the further it disperses upstream (east of the log boom) due to tidal mixing. For fish exposed outside of the 4 acre application area in front of the RSFS, sublethal effects such as narcosis, erratic swimming, and difficulty breathing would be expected. Impaired rearing and feeding behavior would be also be expected, as predator avoidance and prey species are also impacted. The duration of effects are unknown, but are likely to last for at least 4 days after the initial application.

All of the herbicides proposed for use would be expected to have relatively low toxicity to surrogate taxa if applied at labeled concentration rates. Toxicity of these herbicides to listed species -- CCV steelhead, Chinook salmon, and green sturgeon -- is unknown. Green sturgeon, because of their preference for benthic prey species and greater residency in the Delta (1-3 years), may be more susceptible to effects of bioconcentration than the surrogate taxa tested. However, green sturgeon physiology and long life-span makes them relatively resilient to chemical toxins, indicating short-term exposure to contaminated sediments would only have a marginal effect. The probability is low that green sturgeon will bioaccumulate toxic herbicides from the Project due to the short term exposure. The existing benthic substrate is composed mostly of organic material and sand. A decrease in the organic matter available to detrital feeders, which are prey for green sturgeon, may temporarily alter the structure of the current foodweb in the action area. Subadult green sturgeon are more likely to be exposed to herbicides that accumulate in the foodweb than adults since they are more likely to be rearing in the action area. Subadult green sturgeon are likely to exhibit avoidance behavior due to the boat noise. The number of adult and subadult green sturgeon exposure to toxic chemicals is likely to be low due to the location in Rock Slough (end of a dead-end slough), and since the concentration of herbicides will be diluted by the tidal action, the duration of exposure is expected to be low.

In addition, the potential for negative effects to listed fish species are reduced somewhat because the herbicides would be applied to dense mats of vegetation on the surface of the water. These areas do not provide high quality habitat for listed fish species. The densities of listed fish species in areas where herbicide applications would occur is expected to be low due to the relatively poor habitat quality. Rock Slough is a relatively slow flowing, tidal waterway which ends at the Rock Slough Extension. Fish are drawn into Rock Slough and towards the RSFS due large tidal changes in flow. Therefore, Rock Slough does not provide a migratory route and would likely be avoided by most of the listed fish species passing through the Delta However, a small number of listed fish stray, or are falsely attracted to the RSFS by the water coming out of the Canal on the ebb tide.

Latent mortality of listed fish species could occur if these species were struck by a boat propeller during application of herbicides and died later from their injuries. Mortality of sturgeon struck by large vessels (freighters, container ships, and dredgers) in the deep water ship channels have been reported to have population level impacts (Gutreuter *et al.* 2003, Brown and Murphy 2010). However, small recreational boats with outboard engines are less likely to draw sturgeon towards their propellers as these boats are closer to the surface (Balazik *et al.* 2012). Physical injuries from propeller strikes may cause infection and greater risk for predation. However, the boat noise, motor vibration, and disturbance of the water may cause listed fish species to avoid or vacate the area during herbicide application. Therefore, injury followed by latent mortality from boat strikes is less likely to occur.

Invertebrates in Rock Slough could be negatively affected by the application of herbicides. Invertebrate mortality would have an indirect effect on listed fish species by reducing the amount of prey items available for consumption. According to the labels of, GreenClean® Liquid 2.0, and Phycomycin® SCP, the upper end (> 2 ppm) of concentrations required to control their intended target plant species are considered toxic to the invertebrates tested by Geer (2016; *i.e.*, *Hyalella azteca,* and *Ceriodaphina dubia*). Clearcast toxicity to the crustaceans tested (48-hr EC50) is 126,800 ppb; the concentration needed to control Brazilian elodea (the highest concentration required) is 200‑500 ppb, well below what is considered toxic to crustaceans. The concentration of GreenClean® Liquid 2.0 needed to treat filamentous algae is 0.5‑5 ppm; according to the MSDS, it is toxic to crustaceans (taxa not specified, 48-hr EC50) at 128 ppm, which is well above the application rate (Tables 3 and 12). Phycomycin® SCP is toxic to *Daphnia* (48-hr LC50) at 265 ppm. However, other studies (Geer 2016) have shown a 96-hr LC50 at 4.7 and 14.5 ppm for amphipods and crustaceans, respectively. The concentration of Phycomycin® SCP required to control filamentous algae is 0.3‑10.2 ppm, well below the level of toxicity stated in the MSDS (Tables 3 and 12). The label for Roundup Custom™ does not list application concentrations in ppm or ppb, however, the MSDS states that is practically non-toxic to the invertebrates tested with a 48-hr EC50 to *Daphnia* of 930 ppm (Roundup Custom™ MSDS).

Therefore, 2 of the 4 proposed herbicides are likely to cause mortality to invertebrates. Reductions in the amount of prey available in Rock Slough could reduce growth of juvenile salmonids especially during the spring months (March through June) when juvenile salmonids are likely to be present. The extent to which the herbicide will impact Rock Slough is unknown, but the dispersion rate will be slowed by the use of a block net under the log boom. The block net is covered in aquatic weeds which will absorb and slow the dispersion rate. The area that herbicides will be applied is approximately 4 acres in front of the RSFS. Juvenile salmonids and green sturgeon that stray into this area may encounter areas of reduced aquatic invertebrate prey species. Listed fish would be expected to avoid the area and feed in other areas of Rock Slough that are not impacted. The reduction will be short-term, lasting only a few weeks as the surrounding areas will recolonize the treated area with invertebrates (Oliver *et al.* 1977, Currie and Perry 1996, Watling *et al.* 2001, Merz and Chan 2005). Herbicides will be applied only by trained personnel familiar with the application rates, IPMP protocols, and Reclamation's standards (Reclamation Manual, undated). Therefore, it is unlikely that the labeled herbicide concentrations would be exceeded. In addition, all personnel are required to follow precautionary measures (BMPs) to prevent spills, therefore spills are unlikely to occur.

The rapid decay of aquatic plants following herbicide application can reduce the DO within Rock Slough. Low DO levels are known to cause fish kills and can interfere with salmonid migration (USDA and CDBW 2012a). Fish begin to experience oxygen stress and exhibit avoidance at levels below 5 ppm. Toft (2000) found that DO levels under water hyacinth canopies are typically lower than surrounding waters. Removal of water hyacinth should, over time, result in increased DO levels. Low DO levels can reduce the water quality to the point that salmonids and green sturgeon would avoid areas under hyacinth canopies. It can also temporarily deplete the abundance of prey species for salmonids and increase the abundance of introduced predators (*i.e*. largemouth bass, striped bass, and other centrachids) that tolerate lower DO and prefer the shaded area under weed beds (Toff *et al.* 2003).

The extent of the area of potential indirect effects beyond the area of herbicide application is difficult to determine. Hydrological and environmental data for each herbicide are not available for the specific environment around the Project. Because the herbicides selected by CCWD are relatively non-toxic to surrogate fish and invertebrate taxa, it is assumed that the area of direct and indirect effects is similar to the area of application (Figure 15). The area of application would be 1.2 acres in the RSFS afterbay behind the fish screens, 2.5 acres in the Rock Slough Extension, and approximately 1.5 acres in front of the RSFS to the log boom. Herbicide will be applied on a flood tide when the direction of flow will be into the Canal and not Rock Slough. Most of the herbicides will dissipate within 24 hours, depending on how fast they are absorbed by the aquatic vegetation. Roundup is known to bind with the sediments on the bottom and persists for up to 10 weeks after the application. The total area of herbicide application in Rock Slough would be 4.0 acres (Rock Slough Extension + area in front of RSFS). The recoverability of aquatic vascular plants in Rock Slough is very fast due to the shallow warm water (see baseline for spread of aquatic weeds in Delta). Areas in Rock Slough treated with herbicides or mechanical harvesters have recovered in a matter of months during the summer (CCWD 2007, USDA and CDBW 2012a; 2012b). To limit the indirect effect of reduced DO concentrations, herbicides will be applied according to label instructions, which include provisions to allow fish passage through treated areas of low DO (*e.g*., allow untreated strips, buffer areas, or apply to 30 percent of the total area).

Overall, the exposure of listed species to Clearcast®, GreenClean® Liquid 2.0, Phycomycin® SCP, and Roundup Custom™ poses a low risk to fish mortality and reduction in fish growth. Reproduction is not impacted because it occurs later in time and Project effects are so short-term as to allow recovery before spawning. Although the chronic toxicity data for rainbow trout indicated that the application of glyphosate in Roundup Custom™, as proposed, may have potential negative chronic effects (low to moderate toxicity by USEPA criteria) on juvenile salmonids, the potential chronic effect is deemed low enough to have a minimal impact, considering; (1) the aquatic half-life of the herbicides, (2) the small size of the treatment area (4 acres), and (3) the speed with which juvenile salmonids migrate through the Delta. The proposed use of the herbicides poses a low risk to the habitat for salmonids and sDPS green sturgeon in Rock Slough. Although the use of Clearcast® may negatively affect non-targeted aquatic vascular plants, the potential effect is deemed minimal considering the dissipation half-life of the herbicides, recoverability of affected aquatic vascular plants, and the small size of the treatment area.

2.5.3 Transfer of RSFS O&M Responsibility

Reclamation will retain ownership of the Federal property within the action area (*i.e.*, Canal and RSFS), therefore, the responsibility to manage pursuant to existing ESA requirements and future consultation remains with Reclamation. Reclamation assumes liability for any ESA consultation involving private landowners performing O&M activities (*e.g*., pump replacement, valve work, and access to the afterbay). CCWD will continue to maintain and operate the Canal and RSFS under an existing operating agreement with Reclamation. The impacts of facility O&M activities are considered below in Section 2.5.4.

2.5.3.1 Land Area Encroachment

Land acquisition and/or land use authorization activities that Reclamation may implement as part of this Project are administrative in nature (*e.g.,* transfer of land from CCWD to Reclamation, transfer from Reclamation to private landowners, access to WAPA powerlines, access to irrigation pumps) and will not impact ESA-listed species. Reclamation still maintains ownership of the Canal and RSFS, as described above under Transfers.

Those activities associated with land acquisition and/or land use authorization that may impact listed species are irrigation system improvements (see Section 2.5.1.6 above) and land encroachment repairs. Land encroachment repairs involves re-aligning the fence boundary on the northwest corner of the RSFS Facility (see Figures 7, 9, 11). One acre of land (500 feet x 85 feet) terminates into a wetland area that drains into the Rock Slough Extension (west of the RSFS). Reclamation is negotiating moving the fence line which would require restoration activities such as re-contouring 1.85 acres, removal of 10,000 CY of material, re-aligning the existing 500 feet of ditch, and moving an 18-inch concrete culvert. The culvert work would require placement of a U-shaped 40-foot long cofferdam in the Rock Slough Extension which has the potential to impact listed fish species.

Negative impacts of the land encroachment repairs to listed fish species would be expected from turbidity and re-suspended sediments caused by the removal of 10,000 CY of material and construction of a cofferdam. Listed fish are likely to avoid the area during construction due to the turbidity and noise. The impact of underwater noise from pile driving will be minimized with use of vibratory hammers, however, sound above 187dB can cause barotrauma injuries, and above 206 dB death, for all fish greater than 2 grams (Hastings and Popper 2005, Popper and Hastings 2009, Halvorsen *et al.* 2012). Repairs to the encroached land and cofferdam construction in Rock Slough would take place during the in-water work window, July 1 through October 31, when listed fish species are not likely to be present, as shown in the fish monitoring data (Table 2). The Rock Slough Extension is typically covered in aquatic weeds from May through November, making it difficult for listed fish to get close enough to the construction to be harmed by turbidity or noise. The thick mat of vegetation (approximately 300 feet long) will also dampen the impacts of underwater noise exceeding 187dB and injuring fish in Rock Slough. If listed fish were present in the Rock Slough Extension, they would likely first be eaten by predators or die from the low DO and high water temperatures at the end of the slough before being impacted from the proposed construction activities. Overall, the negative impacts (*i.e*., turbidity, underwater noise, re-suspended sediments), associated with land encroachment repairs are not likely to reach any listed fish species in Rock Slough.

2.5.4 RSFS Operation and Maintenance (O&M) Activities

Of the 41 proposed O&M activities listed to occur at the RSFS, Reclamation determined that 26 activities could potentially negatively impact listed fish species (Table 8). The other activities described under the O&M activities will occur on land, and are not expected to impact listed salmonids and green sturgeon. The operation of the rakes, debris removal, platform and boat ramp construction, irrigation system, use of aquatic herbicides, log boom placement, and land transfers/land area encroachments have already been analyzed above. The following O&M activities have the potential to directly or indirectly impact listed species. The corresponding numbers from the BA are listed in parenthesis.

1) Spraying herbicides or pesticides on terrestrial areas (8,14,16)
2) Mechanical weed harvesting (13)
3) Mudjacking or injecting grout (15)
4) Placement of rip-rap (20)
5) Bridge and cable maintenance (24,25)
6) Facility inspections and minor repairs (32,33,36,43)
7) Stilling well maintenance (44)
8) Facility painting, turnouts, headworks, flood isolation structure (49)
9) Bridge cleaning and fish screen removal (50)
10) Canal desilting (53)

2.5.4.1 Spraying herbicides or pesticides on terrestrial areas (8, 14, 16)

CCWD proposes to use 3 pre-emergent terrestrial herbicides: (1) Dimension® 2 EW, (2) Dimension® Ultra 40WP, and (3) Capstone®, to control annual weeds and grasses along the Canal banks and roadways. Listed fish species could be negatively impacted by herbicide treatments and pesticides applied to the vegetated banks of the Canal and terrestrial areas around the RSFS structure. If herbicides are spilled, spray drifts, or precipitation causes run-off to carry the active ingredients into the Canal or Rock Slough, listed fish and their prey species could be harmed. In addition, the use of pesticides could lower the abundance of insects that are a food source for listed fish species and bioaccumulate in the food chain. The use of these chemical treatments is expected to be limited to spot treatments around buildings or structures (*e.g.*, bridges, fish screens, headworks, *etc*.).

Commercial formulations of two commonly used insecticides, bifenthrin and fipronil, were found to be more toxic than the pure active ingredients, suggesting that increased toxicity due to inert ingredients should be considered in risk assessments and regulation of insecticides. Beggel *et al.* (2010) found significant sublethal effects on fish (larval fathead minnow) swimming performance or growth were observed at 10-20 percent of the concentrations that kill 10 percent of exposed fish (LC10).

The use of IPMP protocols, Environmental Awareness Training, BMPs, and personal training in proper application is expected to reduce the chance of accidental spills or spray drifting over water. CCWD will follow procedures to ensure that no insecticides enter the waters of the Canal or Rock Slough (Reclamation 2016). The labeled application rates include restrictions on applying herbicides or pesticides if rain is forecasted. Due to the limited terrestrial areas to be sprayed and adherence to the IPMP protocols, it is unlikely that listed fish species would be directly or indirectly impacted. The waters of the Canal are blocked by the RSFS, therefore, listed fish would not come in contact with herbicides or pesticides that enter Canal, unless the treated water travels out on the ebb tide. Since most listed fish species spend very little time rearing in Rock Slough the short-term exposure is likely to be minimal.

2.5.4.2 Mechanical weed harvesting (13)

Potential direct and indirect effects to listed fish species from mechanical weed harvesters include mortality or injury from harvester strikes, entanglement in weeds lifted from the water, reduction of aquatic prey species, and temporary disturbances to listed fish species. However, salmonids and green sturgeon are not expected to be present during the June 1 through October 31 in-water work window. This is shown by the fish monitoring conducted before construction of RSFS (Table 2). In the 11 years of weekly sampling 1999–2009, no juvenile salmonids or green sturgeon were collected from the headworks (Reclamation 2016). CV spring-run and CCV steelhead were collected in the spring (March, April, and May), and winter (January and February). Rock Slough is located far from the main migration routes for salmonids, and water temperatures June–October typically approach 70°F (Figure 13). The recommended optimal temperature for growth of juvenile steelhead range from 57°F to 66°F (McCullough *et al.* 2001).

Mechanical harvesting in the 2-acre afterbay would not be expected to impact listed fish species, since the area is behind the RSFS. Prior to mechanical harvesting in Rock Slough, one side of the log boom and block net would be released from the anchor and the boom and the net would be pulled to the shoreline to allow any fish to leave the area. Mechanical harvesting would begin closest to the Rock Slough Extension and would proceed past the fish screen, and continue approximately 100–200 feet beyond the location of the log boom (Figure 11). Increased boat noise and disturbance of the water during harvesting, the slow speed of the harvester (approximately 2 miles per hour), and beginning harvesting closest to the Extension and moving east in Rock Slough would allow fish to move into the eastern part of Rock Slough. Based on mechanical harvesting in June of 2016, monitoring of the aquatic weeds and fish removed showed no listed fish were caught in the weeds harvested. A total of 473 CY of vegetation was removed and sorted for fish. Only 43 fish were recovered and all were non-native species. Harvesting offshore of the RSFS is anticipated to take approximately 4 days (1 day per acre for 4 acres). Behavioral avoidance, reduction in prey species, and disturbance to listed species from mechanical harvesting are short term, localized, and temporary. The method outlined above allows fish free passage out of the area during the disturbance.

Monitoring of the fish species removed by mechanical harvesting in Rock Slough showed that only non-listed fish species were entangled in the removed weeds (Tenera 2016). Mechanical harvesting is preferred over chemical treatment and is not likely to negatively impact listed fish species during the June 1–October 31 season due to the lack of listed fish presence in Rock

Slough during that time of year (as shown in monitoring data), and unsuitable water quality conditions.

2.5.4.3 Mudjacking or injecting grout (15)

The in-water work would only occur behind the RSFS in the afterbay where listed fish species are not able to reach. A small section of concrete liner upstream of the Headworks would be repaired by injecting grout or mudjacking (*i.e.,* injecting liquefied clay into cracks or holes) in the Canal liner and/or rip rap. Larval smelt could be impacted, but juvenile salmonids and green sturgeon would be excluded from the area by the fish screens' 3/32" openings. Reclamation determined that there would be no impact to salmonids or green sturgeon from this activity.

2.5.4.4 Placement of rip-rap (20)

The placement of rip-rap or rock on banks can have direct impacts to listed fish from mortality or injury due to fish being struck or buried under falling rock, and temporarily displaced by heavy equipment disturbance. The placement of rip-rap in the Canal behind the RSFS would not likely impact listed fish species since they are not present in the afterbay. Placement of rip-rap in Rock Slough near the RSFS structure would be above the mean high tide line or at low tide when contact with the water would be minimal (similar to boat ramp construction). Therefore, listed fish species would likely avoid the direct impacts of being struck by rocks. However, noise from equipment working near the water could cause listed fish species to avoid the area. There also might be a localized increase in turbidity and change in water quality due to the new rip-rap being added. Sediment and particulate matter could enter Rock Slough as run-off from the site during rain events. These slight changes in water quality and the addition of particulate matter would be short-term, temporary, and localized within Rock Slough. The volume of water entering Rock Slough as run-off at the work site is very small in comparison to the total volume of water in Rock Slough. Therefore, turbidity impacts are expected to be dissipated by the large volume of tidal movement in the action area. NMFS expects the placement of rip-rap would have minimal effect and not negatively affect listed species.

2.5.4.5 Bridge and cable maintenance (24, 25)

Negative impacts to listed fish species from bridge[3] and cable maintenance includes mortality or injury from exposure to paint, lubricants, and pressure wash water that may enter the Canal and Rock Slough. Also, increased turbidity and disturbance of prey species may occur during removal and replacement of support pillars. Wash water and accidentally spilled paint or lubricants entering Rock Slough or the Canal could result in temporary changes to water quality; however, the amount of paint, lubricants, and wash water that could enter the water is very small relative to the volume of Rock Slough and the afterbay. Paint will only be applied by brush, roller, or by hand, and only small amounts of paint (*i.e.*, < 1 gallon) could accidentally be spilled into the water. Containment booms would be used when painting over water such as on the RSFS. Changes to water quality would be temporary, short term, and localized, and therefore mortality of or injury to listed fish species is not anticipated from painting, pressure washing, or lubricating activities.

[3] The word bridge in this case refers to the Canal Headworks, Flood Isolation Structure, and the RSFS structure itself.

The increased turbidity from removal and replacement of support pillars and increased sound from driving pillars could also negatively impact listed fish species. CCWD will remove and place support pillars during the in-water work window from August 1 through October 31, when listed fish species are not expected to be in the vicinity (Table 2). Therefore, mortality and injury to listed fish would likely be avoided. Any listed fish present would likely be disturbed by the noise and turbidity and avoid the area during the construction. No impacts to any life stage of listed salmonids and green sturgeon would be anticipated when work is conducted at the Headworks or the Flood Isolation structures (bridges) because these species are not present on the Canal side of the RSFS.

2.5.4.6 Facility inspections and minor repairs (32, 33, 36, 43)

This group of O&M activities includes facility inspections, graffiti removal, repair of ladders/safety nets/floats/log boom, and sign repair/replacement. All of these have similar negative impacts to listed fish species from mortality or injury when boats are used in the water and from accidental spills of paint or sandblasting material. Indirect impacts may occur to prey species as well. Listed fish species could be killed from propeller strikes and disturbed by boat noise. Turbidity may be increased during sandblasting from sand entering Rock Slough and the afterbay. Accidental spills of paint could contaminate waterways. However, these activities are short term, localized, and temporary. Inspections and repairs are likely to occur once or twice per year. Currently, negative impacts to listed fish are not anticipated from graffiti removal since the RSFS facility is surrounded by an alarmed security fence. For work conducted at the Headworks or Flood Isolation structure, no mortality or injury to listed species is anticipated because they are not present in the RSFS afterbay. Ambient conditions in Rock Slough are expected to return shortly after the activities. Indirect impacts to prey species are not expected to reach the level where growth or feeding would be reduced in listed fish. CCWD will operate boats at slow speeds which should allow listed fish to avoid the area where workers are present. Routine minor repairs will occur during the summer months when listed fish species are less likely to be present. Accidental spills of paint (< 1 gallon) are not expected to cause significant impacts due to the volume of water in Rock Slough, use of containment booms, and adherence to BMPs that reduce the chance of an accidental spill. Therefore, negative impacts from these activities are considered short-term and minimal. The effect is not expected to result in negative effects to juvenile or adult life-stages of the listed anadromous fish species.

2.5.4.7 Stilling well maintenance (44)

CCWD has not yet installed stilling wells at the RSFS, however, they plan to install two 24-inch diameter wells, vertically, one on either side of the fish screens (Seedall 2017). CCWD proposes to back flush or hand clean the wells with a hose from the fish screens. This activity can occur monthly or annually depending on the need. Negative impacts to listed species include mortality or injury from increased turbidity and disturbance of listed fish species and their prey species. Increased turbidity can clog a fish's gills, making it difficult to breathe and locate prey.

Studies on fish have shown that suspended sediments can cause changes in respiration rates, choking, coughing, abrasion and puncturing of body structures, and reduced responses to physical stimuli (Anchor 2003, Newcombe and Jensen 1996, Waters 1995). Increased turbidity from suspended sediments has also been shown to alter the feeding and foraging behavior of juvenile salmonids (Harvey and White 2008). Suspended sediments have been shown to impair escape behavior, which likely increases susceptibility to predators (Korstrom and Birtwell 2006). However, the negative impacts of increased turbidity from cleaning the stilling wells are anticipated to be temporary, localized, and short term. Ambient conditions are expected to return shortly after the back flushing is completed. Since the area impacted at the RSFS is very small, few if any listed species are likely to be close enough to the stilling wells to be exposed to the increased turbidity. Therefore, mortality of or injury to listed fish species from increased turbidity is unlikely to occur. Since the turbidity and suspended sediments is expected to be dissipated by the large tidal movement in the action area, these impacts are expected to be extremely unlikely to occur.

2.5.4.8 Facility painting at turnouts, headworks, and flood isolation structure (49)

Routine painting and washing of the Rock Slough side of the fish screens could cause mortality and injury of listed fish species through use of motorized boats, turbidity, and accidental spills. O&M activities may also disturb listed fish species in the immediate area of the RSFS. For work conducted at the Headworks or the Flood Isolation structure, no mortality of listed salmonids or green sturgeon is anticipated since these species/life stages can no longer occur in the RSFS afterbay. The noise and slow speed of the boats is expected to allow listed fish species time to avoid the work area. Turbidity may increase in Rock Slough due to the wash water from pressure washing prior to painting. However, since the work area in Rock Slough is very small, few if any listed species are likely to be close enough to be exposed to the wash water. Water quality in Rock Slough is expected to return to ambient conditions within a matter of hours due to tidal flows. CCWD will take precautions to avoid paint being spilled into the water. Accidental spills of paint (< 1 gallon) are not expected to cause significant impacts due to the volume of water in Rock Slough, use of containment booms, and adherence to BMPs that reduce the chance of an accidental spill. Changes to water quality would be temporary, short term, and localized, and therefore mortality or injury to listed fish species is not anticipated from facility painting and pressure washing. Negative impacts to juvenile or adult life stages of listed fish species from these activities are expected, but have a low likelihood of occurrence.

2.5.4.9 Bridge cleaning and fish screen removal (50)

Negative impacts to listed fish species from washing bridges and fish screens may include mortality of or injury to listed fish species from contact with the fish screens, screen blanks, or replacement panels during removal and installation for routine cleaning. Fish screens are cleaned monthly or more often depending on the debris load and algae that clogs the openings (causes head differential that can lead to structural failure).

Increased turbidity and contaminants may enter Rock Slough during the cleaning process. Fish screen panels are removed for pressure washing and solid panels (blanks) or replacement screens are put in place. Although unlikely, this action could result in a listed fish being crushed or swimming into the afterbay where they would be eventually lost (no way out). However, the noise and disturbance in the water is expected to cause fish to temporarily avoid the area. For work conducted at the Headworks Structure, no mortality of listed salmonids and green sturgeon is anticipated since these species/life stages no longer occur in the RSFS afterbay.

Pressure washing the screens may increase turbidity and introduce wash water and contaminants into Rock Slough and the afterbay that could negative impact listed fish species by clogging their gills, increasing respiration, altering feeding, and increasing susceptibility to predators (Anchor 2003, Newcombe and Jensen 1996, Harvey and White 2008, Korstrom and Birtwell 2006). Although, the screen panels will be washed on the deck facing the afterbay,wash water could be carried with the tide through the fish screen into Rock Slough. The tidal action in Rock Slough is expected to dissipate the turbidity plume and water quality is expected to return to ambient conditions within a matter of hours. Due to the short time period of the work, indirect impacts to prey species are not expected to reach the level where growth or feeding would be reduced in listed fish. These O&M activities are expected to be short term, localized, and temporary, therefore, negative impacts to listed species are not expected to occur.

2.5.4.10 Canal desilting (53)

A suction pump is used to desilt portions of the Canal (turnouts, wasteways, lateral drains). Suction cleaning is proposed along the concrete apron in front of and behind the RSFS. Desilting is done as frequently as monthly depending on the need. Silt is flushed from the Canal and may enter Rock Slough. Additionally, heavy equipment such as back hoes or drag lines are used to remove sediment from the bottom of the Canal and afterbay. Due to restrictions for giant garter snake, desilting work is proposed from May 1 through October 1. Negative impacts to listed fish may include mortality or injury from entrainment into the suction pump and from increased turbidity and suspended sediments entering Rock Slough. Prey species could also be impacted by the reduced water quality caused by desilting. For work conducted in the Canal and afterbay, no mortality of listed salmonids and green sturgeon is anticipated since these species/life stages no longer occur in the RSFS afterbay. However, sediments will pass through the RSFS into Rock Slough on the out-going ebb tide.

Increased turbidity during desilting can clog gills, cause body abrasions, and make it difficult for fish to locate prey. Studies have shown that suspended sediments can increased fish respiration rates, choking, coughing, abrasion and puncturing of body structures, and reduced responses to physical stimuli (Anchor 2003, Newcombe and Jensen 1996). Turbidity may cause reduced feeding and foraging in salmonids (Harvey and White 2008), and impair escape behavior, which may increase susceptibility to predators (Korstrom and Birtwell 2006). Studies have documented that many fish species, such as chum salmon, juvenile steelhead, and juvenile coho salmon, avoid areas that have increased turbidity (Nightingale and Simenstad 2001, Sigler *et al.* 1984, Servizi and Martens 1990, and Gregory 1993).

Desilting activities occurring on the afterbay side of the RSFS will not impact listed fish species since no listed fish species are found in the afterbay and Canal, so no impacts would occur in that area. However, silt and suspended sediments could travel through RSFS into Rock Slough. Increased turbidity and suspended sediments could negatively impact listed fish on the Rock Slough side of the fish screen when tides move water from the afterbay through the RSFS. There could be a loss or movement of prey species away from increased turbidity that could indirectly affect listed species. However, since listed fish species are not expected to be present during the desilting operations, temporary changes in prey species are not expected to have a significant impact. The negative impacts of increased turbidity and suspended sediments are anticipated to be short term, localized, and temporary. Ambient conditions in Rock Slough are anticipated to return within hours after desilting activities cease. Therefore, the negative impacts to listed species associated with desilting activities are expected to be minor.

In summary, negative impacts from O&M activities are temporary, short-term (lasting < 5 days), but repeated continuously on a monthly or annual basis. The majority of impacts are from increased turbidity, suspended sediments, and contaminants entering the waters of Rock Slough. However, O&M activities have a low likelihood of impacting listed fish species, or their prey species, due to the minimization measures proposed (*e.g*., in-water work windows, silt curtains, containment booms, block net, IPMP protocols, BMPs, and work at low tide or during flood tide). Some impacts may even be beneficial, such as the expected improvement in DO and reduction in predators in Rock Slough from mechanically harvesting the aquatic weeds.

2.6 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 consultation 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 2.4).

2.6.1 Agricultural Practices

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 Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may have a negative effect on salmonid reproductive success and survival rates (Dubrovsky *et al*. 1998, 2000; Daughton 2003).

Numerous assessments, such as the U.S. Geological Survey (USGS) National Water Quality Assessment Program (NAWQA), and the CDPR have found high concentration of contaminants in both the San Joaquin and Sacramento rivers and their tributaries (NMFS 2010b). In the San Joaquin Basin, seven pesticides -- diuron, trifluralin, azinphos-methyl, carbaryl, chlorpyrifos, diazinon, and malathion -- exceeded the USEPA criteria for aquatic life. The cumulative impacts from these threats continue to affect CCV steelhead. NMFS (2011d) found the herbicides 2,4-D, Diuron, and Chlorothalonil are likely to destroy or adversely modify critical habitat for 28 listed salmonids. NMFS considers pesticides and herbicides to be a high risk to winter-run, CV spring-run, and CCV steelhead in the Central Valley due to the agricultural practices found there and to have population level consequences to winter-run and CCV steelhead (NMFS 2010b, NMFS 2011e). These activities are expected to continue to degrade the habitat conditions in the Delta for ESA-listed species.

Grazing activities occur along both sides of the Canal, Rock Slough, RSFS, and within the Encroachment Lands described in the BA. Agricultural pumps and valves from the adjacent landowners are located within the action area and the replacement of these are part of the Project. Aerial spraying of herbicides and pesticides from adjacent agricultural lands can drift over the action area and contaminate the water within the Canal and Rock Slough. Cattle from adjacent ranches have been observed wading and lying dead in the waters of the Rock Slough Extension.

2.6.2 Increased Urbanization

The Delta region, which include portions of Contra Costa, Solano, San Joaquin, and Sacramento counties, is one of the fastest growing regions in California. The population is growing by approximately one percent per year, adding 348,000 people in 2015 (California Department of Finance 2016). Many of these people are settling in the Central Valley. Some of the fastest growing cities are located near the Delta (*e.g.,* Brentwood, Lathrop, and Elk Grove). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth has already placed 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 well away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization is also expected to result in increased recreational activities in the Delta. 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 will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Boat wakes and propeller wash also stir up benthic sediments, thereby potentially resuspending 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 Delta is anticipated to result in greater contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the Delta.

Urbanized areas are being developed along the eastside of the unlined portion of the Canal (*i.e.,* 1,246 acres) from the Cypress Road to RSFS Facility. The development of the East Cypress Preserve Project (NMFS 2016c) will bring housing development *(e.g.,* 2,400 homes, schools, and roads) up to the RSFS fence line that borders the Canal. Currently, groundwater from the adjacent urban areas mixes with the surface waters in the unlined portion of the Canal exceeding salinity requirements.

2.6.3 Global Climate Change

In Section 2.4 (environmental baseline), NMFS discussed the potential impact of global climate change on listed fish species. Anthropogenic activities, most of which are not regulated or poorly regulated, will lead to increased emissions of greenhouse gasses. It is unlikely that NMFS will be involved in any review of these actions through an ESA section 7 consultation. Winter-run Chinook are considered the most 'at risk' salmonid due to their unique life history which includes spawning and incubation during the summer when water temperatures are at their highest, making them susceptible to climate change and drought (Moyle *et al.* 2008). However, CV spring-run, CCV steelhead, and sDPS green sturgeon also depend on cold water for spawning and rearing. As water temperature rise in the future it is likely that fish that depend on cold water to spawn or rear will impacted to a greater degree than introduced non-native species (*e.g*., striped bass and largemouth bass). This shift in fish community has already taken place in the Delta as largemouth bass have become one of the most abundant species (Brown and Michniuk 2007). Other likely impacts of climate change include: altered flood-plain connectivity, increased salinity, decreases in spawning cues, and the establishment of non-native species (USEPA and USGS 2016). As water temperatures increase in the southern Delta, it is likely that habitat in the action area will become less suitable for listed fish. The negative effects of the Project will worsen as the growth of aquatic weeds increase due to warmer temperatures, which will require more frequent mechanical and herbicide treatments. O&M activities will increase as the facility ages and the capacity of the existing rake system is exceeded. Within the context of the time over which the proposed Project is scheduled to be operated (*i.e.*, 3 years for improvements, 50 years for O&M activities), the impact of global climate change is likely to result in an increase in the negative effects of this Project..

2.7 Integration and Synthesis

2.7.1 Summary of Current Conditions and Environmental Baseline

The *Status of Species* and *Environmental Baseline* sections show that past and present impacts to the Sacramento and San Joaquin river basins and the Delta have caused significant habitat loss, fragmentation, and degradation throughout the historical and occupied areas for these species. These impacts have created the environmental conditions that have led to substantial declines in the abundance and long term viability of their populations in the Central Valley. As a result, NMFS has determined in its most recent 5-year reviews (NMFS 2015a, 2016a, 2016b, and Williams 2016) that the listings are still warranted, and that the current status of these fish has continued to decline.

Alterations in the geometry of the Delta channels (straightening), wetland loss, construction of armored levees for flood protection, changes in river flow created by diversions (including CVP and SWP diversions, and municipal entities), changes in fish communities, and the influx of contaminants from agricultural and urban dischargers have substantially reduced the functionality of the aquatic habitat within the action area.

The multi-year drought conditions in California from 2012 through 2016 have negatively affected winter-run, CV spring-run, and CCV steelhead, exacerbating the conditions that led to the species being listed. Lethal water temperatures below the Central Valley rim dams have reduced the viability of eggs in the gravel for winter-run and CV spring-run, and have made tributaries excessively warm over the summer and fall seasons due to a lack of snow and snow melt runoff. Early life stages of sDPS green sturgeon are expected to be less affected by the increased temperatures in the waters in which they spawn due to their higher thermal tolerances in the early life stages compared to salmonids.

2.7.2 Summary of Effects of the Proposed Action

The proposed improvements to the RSFS will start in June of 2018, and O&M activities of the RSFS Facility will continue on foreseeably for the next 50 years. The effects of the most of the O&M activities at the RSFS will be short term, temporary, and confined to a small local area (4 acres) at the end of Rock Slough and in the RSFS afterbay. Negative impacts associated with the Project will occur from the following:

- Increased turbidity and suspension of sediments in water
- Accidental spills of paint and other contaminants (*e.g.*, sand, wash water)
- Loss of habitat from boat ramp construction in Rock Slough
- Mortality of adult Chinook salmon and CCV steelhead from rake operations
- Mortality from herbicide use in the Canal and Rock Slough
- Contaminated runoff from facility parking lots and Canal access roads
- Minor disturbance of listed fish species and their prey from boats and equipment in water
- Small change in benthic community (prey species) from weed removal and herbicide use

The worst impacts are expected to occur from rake operations (direct mortality of adult salmon and CCV steelhead) and herbicide application. A small area (~0.02 acre) of benthic habitat will be permanently altered due to the construction of a boat ramp in Rock Slough. The boat ramp in the afterbay is not considered a loss of habitat since listed fish are not present behind the RSFS. This area has previously been mitigated for by Reclamation and CCWD during the construction of the RSFS. Reclamation is requesting incidental take coverage for the O&M activities at the RSFS in order to keep it functioning properly. The actual diversion of water through the RSFS was analyzed in a previous biological opinion (NMFS 2009).

The proposed Project has the potential to negatively impact winter-run, CV spring-run, CCV steelhead, and sDPS green sturgeon through its O&M activities. NMFS expects that some mortality/injury will result from construction (*i.e.*, increased turbidity, sediments, underwater sound, removal of fill and loss of habitat), exposure to herbicides, pesticides, contaminants (*i.e.,* fuel, oil, paints, wash water), equipment and propeller strikes, placement of rock rip-rap, changes in water quality, reduction in prey species, temporary disturbances, and altered flows through Rock Slough. Additional negative impacts will occur later in time, and include; latent mortality from exposure to herbicides, propeller strikes, reduced migration, reduced survival through changes in olfactory response, reduced growth and development, reduction in prey species, and bioaccumulation in the food chain. However, these impacts are expected to be minor in scope in relation to the species' respective populations, affecting a limited number of fish per year for each species. The negative impacts from implementing the proposed Project are not likely to reach the magnitude that would be expected to appreciably reduce the numbers, reproduction, or distribution of any of the listed species populations.

2.7.2.1 Sacramento River Winter-Run Chinook salmon

Juvenile winter-run are expected to be migrating through the waters of the action area during the proposed Project improvements and O&M activities. Adult winter-run are not expected to be present in Rock Slough at any time of year. NMFS estimates that very few juvenile winter-run will be encountered based on the fish monitoring data (Reclamation 2016) and the use of an in-water work window (June 1 through October 31) when winter-run are not likely to be present. The vulnerability of juvenile winter-run will be dependent on their abundance in the Delta and the number that are drawn from the mainstem Sacramento River towards the CVP and SWP export facilities.

In summary, a small number of juvenile winter-run may be harmed as a result of O&M activities in the spring or winter. These activities are expected to negatively impact only a very limited number (less than 5) of individuals per year. For example, no juvenile winter-run were reported collected from the Rock Slough Headworks during the 11 years (1999–2009) of weekly sampling before RSFS was constructed (Reclamation 2016). The loss of a few individuals is not expected to rise to the level where it would reduce appreciably the population's likelihood of survival and recovery.

2.7.2.2 Central Valley Spring-Run Chinook salmon

The risk to CV spring-run in relation to the negative impacts of the Project are slightly greater than for winter-run. This is due to their higher abundance in the south Delta and reintroduction activities in the upper San Joaquin River associated with the SJRRP (*e.g*., new rearing facility for CV spring-run below Friant Dam). As CV spring-run are re-introduced into the San Joaquin River annually, it is likely that greater numbers of both adults and juveniles could enter Rock Slough as they migrate through the Delta. Marked juvenile CV spring-run (n = 149) were collected in 2016 at the CVP and SWP Facilities on Old River. Since fall-run Chinook have been killed by the rake operations (Table 9) and shown to be attracted to the flows coming out of the RSFS on ebb tides (Table 10), it is likely that CV spring-run adults could be attracted and killed, as well. CV spring-run are more likely to encounter year-round RSFS rake operations and herbicide treatment in the spring (*e.g.,* earlier than June). For adults that encounter O&M activities at the RSFS, potential negative impacts include: death or injury due to rake operations, delayed mortality from contact with the rakes, delayed migration, death or injury from herbicide application in the spring, injury from boat strikes, avoidance behavior from noise and heavy equipment, and stress or latent mortality from accidental spills of contaminants (*e.g*., paints, lubricants, sand, and wash water). For juvenile CV spring-run, a small number (from 11 to 108 based on historical data) could be negatively impacted by the construction activity, increased turbidity, suspended sediments, herbicide treatments, and O&M activities. In addition, negative impacts to prey species from construction and herbicide treatment are expected to occur. However, these were determined to be minimal due to the short time (1-2 days) that juvenile CV spring-run are likely to spend in Rock Slough. Of the 41 routine O&M activities, 10 are likely to cause negative impacts to CV spring-run. Those activities that would likely have negatively impacts to CV spring-run are applications of herbicides, pesticides, Canal desilting, bridge repair, and facility painting. However, the impacts were considered to be minimal due to the short term, temporary, and local nature of the activity.

In summary, a small number of adult and juvenile CV spring-run may be killed or injured as a result of the RSFS improvements and O&M activities. No adult CV spring-run have been killed to date, but the potential exists based on fall-run Chinook mortalities. A total of 11 juvenile CV spring-run (Table 2) were captured at the Rock Slough Headworks prior to construction of the RSFS (1999–2009) and 108 juveniles were observed March–May pre-RSFS. These negative impacts are expected to occur only for a limited number of individual fish per year after June of 2019 (when improvements are completed). There are approximately 12 remaining spring-run populations in the Central Valley (NMFS 2016a). Adults and juveniles from any of these populations have the potential to end up in the action area where they could be impacted by the Project. However, the likelihood of more than 1 individual being negatively impacted from the same population is extremely unlikely to occur. Therefore, the loss of a few individuals is not expected to rise to the level where it would reduce appreciably the population's likelihood of survival and recovery.

2.7.2.3 California Central Valley Steelhead

Both adult and juvenile CCV steelhead are present in the Delta during the construction and O&M activities proposed for the Project. Unlike Chinook salmon, steelhead tend to spend more time migrating through and rearing in the Delta. No adult steelhead have been observed killed at the RSFS, however, one juvenile (254 mm) was found dead in the debris pit in March of 2012. Since both fall-run Chinook salmon and CCV steelhead have been killed by the rake operations (Table 9), it is likely that CCV steelhead will continue to be killed in the future.

Juvenile CCV steelhead have been captured from January through May at the Rock Slough Headworks before a fish screen was built (Table 2). Year-round RSFS rake operations and herbicide treatment from March through May are likely to kill or injury CCV steelhead. For adults that encounter O&M activities at the RSFS, potential negative impacts include: death or injury due to the rake operations, delayed mortality from contact with the rakes, delayed migration, death or injury from herbicide application, injury from boat strikes, avoidance behavior from noise and heavy equipment, and reduced growth or altered behavior from turbidity and loss of prey. For juvenile CCV steelhead a small number could be negatively impacted by the construction activity, increased turbidity, suspended sediments, herbicide treatments, and O&M activities. A total of 15 juvenile CCV steelhead (Table 2) were captured in 11 years (1999–2009) and 36 were observed in the Canal from 1994–1995 (CDFG 2002) before the RSFS was built. In addition, negative impacts to prey species from construction, loss of habitat, and herbicide treatment are expected to occur. However, these impacts were not expected to result in negative effects to the listed species due to the minimization measures and short time (1-2 days) that juvenile CCV steelhead are likely to spend in Rock Slough. Of the 41 routine O&M activities, 10 were considered to potentially cause negative impacts to CCV steelhead. Those activities that would likely have negatively impacts to CCV steelhead are applications of herbicides, pesticides, Canal desilting, bridge repair, and facility painting.

In summary, a small number of adult and juvenile CCV steelhead may be killed or injured as a result of the RSFS improvements and O&M activities. Additionally, O&M activities will reduce water quality and potential prey species availability in Rock Slough. Negative impacts are expected to impact only a limited number of adults (1-10) and juveniles (1-10) per year based on historical monitoring data (Reclamation 2016). There are 24 remaining steelhead populations in the CCV steelhead DPS (NMFS 2016b). Adults and juveniles from any of these populations have the potential to end up in the action area where they could be impacted by the Project. However, the likelihood of more than 1 individual being negatively impacted from the same population is extremely unlikely to occur. Based on the fish salvage data from 2013–2016, an average of 837 steelhead (hatchery and wild) are salvaged per season (CDWR 2013, 2014, 2015, 2016). However, not all of these fish would encounter the proposed Project (*e.g*., steelhead from the San Joaquin River are salvaged before they reach the Project). Based on the historical monitoring data from 0 to 10 juvenile steelhead/year were collected from the Rock Slough Headworks before 2009. In a worst case scenario, if a maximum of 10 juvenile steelhead were exposed to the negative impacts of the Project, this would represent approximately 0.01194 percent (*i.e.,* 10/837) of the average number salvaged per year from 2013–2016. Relative to the total juvenile production that enter the Delta, a loss of 10 individuals would represent approximately 0.0000193 percent (10/516,067) of the average number of wild steelhead that entered the Delta from 1998–2000 (Nobriga and Cadrett 2003). Therefore, the loss of these individuals is not expected to rise to the level where it would appreciably reduce the population's likelihood of survival and recovery.

2.7.2.4 Southern DPS Green Sturgeon

Since juvenile sDPS green sturgeon are assumed to reside in the Delta year-round, including within the action area, they could potentially be exposed to the negative impacts of the Project. However, sDPS green sturgeon (adults and subadults) are not likely to be found in Rock Slough due to unfavorable habitat conditions during the summer when improvements and O&M activities are proposed (*e.g.,* shallow depth, warm water temperatures, low DO, abundance of aquatic weeds, and distance from main migration routes). In 11 years (1999–2009) of weekly sampling, green sturgeon were never collected at the Rock Slough Headwork prior to the RSFS being built (Table 2). In addition, from 1993–1999, CDFW did not observe any green sturgeon during fish monitoring conducted in the Canal at the Pumping Plant 1 and the Headworks (CDFW 2001). Nevertheless, Rock Slough is open to the Delta and green sturgeon could find their way into the action area, as they have been collected at the SWP and CVP fish salvage facilities. Since the rake operations have been shown to kill adult salmon up to 20 lbs, it is possible for green sturgeon to be killed or injured. Green sturgeon could also experience delayed mortality or injury from contact with the rakes, delayed migration, death or injury from herbicide application, injury from boat strikes, avoidance behavior from noise and heavy equipment, and stress or latent mortality from accidental spills of contaminants (*e.g*., paints, lubricants, sand, and wash water). In addition, green sturgeon could be negatively impacted by the construction activity, increased turbidity, suspended sediments, herbicide treatments, and routine O&M activities. These activities could negatively impact prey species found in the benthic habitat. However, the majority of O&M activities were considered to be minimal due to the short term, temporary, and localized nature of the activity. Once the O&M activity is completed, conditions are expected return to those of the surrounding waters in Rock Slough within hours.

Currently, there is not a reliable measure of juvenile sDPS green sturgeon population abundance in the Delta, nor is there a reliable estimate of the relative fraction of the population utilizing the action area during implementation of the Project. Therefore, an unknown number of sDPS green sturgeon would be likely exposed to the negative impacts of the Project. Based on fish monitoring data from Rock Slough and the CVP/SWP fish salvage facilities, it is likely that very few sDPS green sturgeon would encounter deleterious conditions in Rock Slough caused by the Project.

In summary, adult and juvenile sDPS green sturgeon could be killed or injured from the RSFS rake operations and O&M activities. Recently, an annual run size has been estimated at 272 adults in the Sacramento River, with a total population size of 1,008 (Mora 2014). Although this estimate indicates that there are few fish relative to historic conditions, and that population size and distribution are reduced, the sDPS green sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent observations of adults in the Feather and the Yuba rivers indicate that their distribution in the Central Valley may be broader than previously thought. This suggests that the sDPS probably meets several viable species population criteria for distribution and diversity, and indicates that the sDPS green sturgeon faces a low to moderate risk of extinction (NMFS 2015a). The proposed Project could impact a limited number (1–3) of sDPS green sturgeon per year. If the negative impacts were to result in the mortality of one adult sDPS green sturgeon, it would represent approximately 0.0009 percent (1/1,008) of the estimated population. The loss of one individual adult, or juvenile, is not expected to rise to the level where it will appreciably reduce the sDPS green sturgeon numbers, reproduction, or distribution.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, 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: winter-run, CV spring-run, CCV steelhead, and sDPS green sturgeon.

2.9 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 ITS.

The measures described below are non-discretionary and must be undertaken by Reclamation so that they become binding conditions of any grant, permit, or operating agreement, issued to CCWD, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered in this ITS. If Reclamation: (1) fails to assume and implement the terms and conditions of the ITS; and/or (2) fails to require CCWD to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, grant, or agreement document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation and CCWD, or its permittees must report the progress of the action and its impact on the species to NMFS as specified in this ITS (50 CFR §402.14[i][3]).

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

NMFS anticipates that the proposed action may result in the incidental take of juvenile winter-run, and adult and juvenile CV spring-run, adult and juvenile CCV steelhead, and adult and juvenile sDPS green sturgeon. Incidental take associated with this action is expected to be in the form of mortality and injury. The O&M of the RSFS is expected to result in: (1) occasional mortalities of adult salmonids during the automated rake cleaning process; (2) exposure of listed fish species to herbicides and pesticide; and (3) periodic disturbance from boats, log-boom placement, block nets, and heavy equipment operated near or in-water (*e.g.,* back hoes, mechanical weed harvesters). The number of listed fish collected in the pre and post-construction RSFS monitoring has provided the basis for determining a quantifiable metric of incidental take of listed fish. Table 13 provides the incidental take limit for each species, by life history stage.

Table 13: Summary of incidental take by lifestage exempted for the proposed Project per year through normal O&M activities at the RSFS, Headworks, and Canal.

ESA-listed species	Lifestage	Lethal	Non-lethal	Total/Year
Winter-run	Juvenile[2]	2	3	5
CV Spring-run	Adult[1]	10	10	20
	Juvenile[2]	10	10	20
CCV steelhead	Adult[1]	5	5	10
	Juvenile[3]	5	5	10
sDPS green sturgeon	Adult[4]	1	1	2
	Subadults	1	1	2

[1] An adult Chinook salmon or CCV steelhead will be considered as any fish greater than 400 mm FL
[2] Run determined by the length-at-date classification (Delta model)
[3] For CCV steelhead, incidental take includes clipped (hatchery) and unclipped
[4] Adult sDPS green sturgeon are considered greater than 100 cm FL

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species.

2.9.3 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). NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of winter-run, CV spring-run, CCV steelhead, and sDPS green sturgeon resulting from implementation of the proposed action.

1. **Adaptively manage the RSFS to minimize take of ESA-listed species.**
2. **Monitor water quality in Rock Slough for the presence of herbicides.**
3. **Prioritize use of mechanical weed harvesters over herbicide treatments.**
4. **Isolate the area to be treated in Rock Slough during in-water herbicide treatments.**
5. **Monitor incidental take due to rake operations and O&M activities.**

2.9.4 Terms and Conditions

The terms and conditions (T&C) described below are non-discretionary, and Reclamation or CCWD must comply with them in order to implement the RPMs (50 CFR 402.14). Reclamation or CCWD 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 ITS (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.

1. **Adaptively manage the RSFS to minimize take of ESA-listed species.**

    a) Reclamation and/or CCWD shall adaptively manage the rake cleaning system at the RSFS to minimize take of listed fish species by implementing one or more of the following actions year-round:

        i varying the duration of rake cleaning (reduction in hours),
        ii operating rake system tidally (during flood tides only),
        iii operating rakes during daylight hours (salmon less likely to be entrained), or
        iv operate rake system when salmonids are not present using adult fall-run Chinook salmon as a surrogate for adult winter-run, spring-run, and CCV steelhead.

    b) Since listed salmonids cannot be visually identified to run, use fall-run Chinook salmon (identified by ad-clip or time of year) as a surrogate to determine the effectiveness of the modified rake cleaning actions above.

    c) Reclamation shall confer with NMFS after completion of the rake testing, or if conditions in the future change (*e.g.*, when Canal Encasement Project is completed). If fish monitoring shows no mortality of adult salmon for a period of 5 years, CCWD can resume rake operations without the actions listed in (a) above.

2. **Monitor water quality in Rock Slough for the presence of herbicides.**

    a) Reclamation and/or CCWD shall monitor water quality for the presence of glyphosates in Rock Slough pre- and post- application for one time during the first application of Roundup Custom™. Monitoring shall be conducted at 3 sites: (1) the application site, or mid-point of the RSFS, (2) at mid-channel upstream (east) of the log-boom, and (3) at mid-channel from the Delta Road Bridge. Sampling shall be conducted 24 hours before treatment, 48 hours after treatment, 4 days after treatment, and on 2 additional dates within 11 weeks of treatment (end of glyphosate half-life). Sampling will determine dispersion rate and potential environmental exposure.

b) Sampling results and a graph of the concentration rate at the 3 sampling sites shall be sent to NMFS, California Central Valley Office after the 48 hour and 4 day sampling. Selection of the 2 additional sampling dates will be decided by Reclamation and/or CCWD based on results from the 24 hr, 48 hr, and 4 day analysis. Sample site conditions shall also include reporting DO, water temperature, wind speed, herbicide quantity and concentration, surfactants used, acres treated, and tidal cycle.

3. Prioritize use of mechanical weed harvesters over herbicide treatments.

a) Reclamation and/or CCWD shall utilize mechanical means to harvest aquatic weeds first, before resorting to chemical treatments in Rock Slough.

b) For herbicide treatments before July 1, Reclamation or CCWD shall utilize the CVP/SWP daily salvage reports, as well as fish monitoring at RSFS, to determine whether juvenile salmonids may be present in Rock Slough. If juvenile salmonids are present in the fish monitoring data; do not conduct herbicide treatment until at least 3 days when no winter-run, CV spring-run, or CCV steelhead are reported.

4. Isolate the area to be treated in Rock Slough during in-water herbicide treatments.

a) Reclamation and/or CCWD shall implement two or more of the following actions, in order to reduce impacts to listed species and their prey:

i. install a block net under the log-boom across Rock Slough before treating with herbicides to slow the dispersion eastward into Rock Slough (a blocknet covered with aquatic weeds would act like a sponge to absorb herbicides);
ii. close the Flood Isolation Structure to slow the water movement between the Canal and the RSFS for 10 days following each treatment;
iii. restrict the application of Roundup Custom, to a maximum of ½ of the waterbody (2 acres) in front of the RSFS at any one time, to prevent fish kills from low DO in Rock Slough; and
iv. apply herbicides only on a flood tide and resume pumping within 48 hours of treatment to reduce dispersion upstream (eastward).

5. Monitor incidental take due to rake operations and O&M activities.

a) Any Chinook salmon, steelhead or green sturgeon found dead on the RSFS, in the trash pits, or in the aquatic weeds drying area shall be reported immediately to NMFS via fax or phone within 24 hours of discovery to:

Assistant Regional Administrator
NMFS California Central Valley Office
Phone: (916) 930-3600, or
Fax: (916) 930-3629

b) Any dead green sturgeon shall be measured (FL), weighed, and checked for tags before being placed in a cooler with ice and sent to: NMFS, Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060.

c) Any dead or live salmon and steelhead shall be measured (FL), weighed, and checked for marks (ad-clips).

   i. Unmarked salmon and steelhead shall be measured, placed in a cooler on ice or frozen before being sent to: NMFS, Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060.
   ii. Heads of ad-clipped salmon and steelhead shall be sent to: USFWS, 850 S Guild Ave, Lodi, California 95240. (Contact #209-334-2988).

d) Reclamation and/or CCWD shall keep records of RSFS O&M activities, rake operations, and the number of salmon, steelhead, and green sturgeon that are removed from fish screens, debris pits, or aquatic weed drying area (*e.g.,* salmon log).

e) By January 30 each year, Reclamation and/or CCWD shall provide a written report to NMFS containing a summary of:

   i. adaptively managed operations in T&C 1.a,
   ii. results of rake testing,
   iii. water quality monitoring for glyphosates, if applied,
   iv. results of mechanical harvesting,
   v. herbicide minimization measures used in T&C 4.a,
   vi. herbicide use, date of application, surfactants used, and environmental conditions encountered at RSFS during herbicide application],
   vii. the numbers of any salmonids or sturgeon observed on the RSFS, in the trash pits, or in the aquatic weeds drying area,
   viii. the number of salmonid or sturgeon mortalities by species and run,
   ix. the final disposition of any salmonids or sturgeon transported from the RSFS for identification elsewhere, and
   x. a record of any marine mammals observed near the log-boom, block net, or RSFS.

   The report shall be sent to:

   Assistant Regional Administrator
   California Central Valley Office
   National Marine Fisheries Service
   650 Capitol Mall, Suite 5-100
   Sacramento, California 95814

f) CCWD shall make records/log books available to any personnel from NMFS's Office or CDFW Offices, upon request for review of compliance with these terms and conditions.

g) Staff shall carry a copy of this Incidental Take Statement at all times while transporting dead specimens.

2.10 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).

1) Reclamation and CCWD should work towards completing the Contra Costa Canal Encasement to the Rock Slough Headworks structure as soon as possible. Reducing the tidal flows through the RSFS are expected to reduce the attraction of the flows through the RSFS to adult salmonids, which will minimize mortalities from rake cleaning system.

2) Reclamation and CCWD should consider utilizing the Flood Isolation Structure to control flows on the ebb tides that attract adult salmonids.

3) Reclamation should participate in priority one restoration projects in the south Delta that further the goals of the CV Recovery Plan (NMFS 2014a).

4) Reclamation and CCWD should consider a removable log boom, or one that allows recreational boats access to the Rock Slough Extension.

2.11 Reinitiation of Consultation

This concludes formal consultation for the *Rock Slough Fish Screen Facilities Improvement Project*.

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 ITS 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 on 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 RESPONSE

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.

Based on our review of the material provided, and the best scientific and commercial data currently available, NMFS has determined that the proposed action would adversely affect EFH for Pacific Coast Salmon. EFH within the action area would be adversely affected by the construction of boat ramps, herbicide applications, mechanical weed harvesters, increased turbidity, increased sedimentation, loss of habitat, and reduction in prey species. Approximately, 4 acres of EFH will be temporarily blocked to adult Chinook salmon that stray into Rock Slough. This action is considered beneficial since it prevents adult salmon from being entrained on the RSFS. The blocked area is available for juveniles that might be rearing in the Delta. The proposed action includes adequate measures (described in the ESA section 7 Consultation, Section 1.2 above) to avoid, minimize, or otherwise offset the adverse effects to EFH. In addition, there are no Habitat Areas of Particular Concern (HAPC) as described in Pacific Fisheries Management Council [PFMC (2014)] within the action area. Therefore, HAPC will not be impacted by the proposed Project.

Due to the conservation measures proposed and the terms and conditions, NMFS is not providing any EFH Conservation Recommendations at this time and the Federal action agency is not required to provide a written response under section 305(b)(4)(B) of the MSA and Federal regulations (50 CFR 600.920(k)). However, if there are revisions to the project description that could result in adverse effects to EFH, Reclamation will need to re-initiate EFH consultation.

This analysis is based, in part, on the EFH assessment provided by Reclamation in the BA and descriptions of EFH for Pacific Coast salmoncontained in the Fishery Management Plans (PFMC 1998, 2014) developed by the PFMC and approved by the Secretary of Commerce.

4. 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.

4.1 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 are Reclamation and CCWD. Other interested users could include the USFWS, USACE, CDFW, CDWR, CDBW, and the SWRCB. Individual copies of this opinion were provided to Reclamation, CCWD, USFWS, and CDFW. This opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 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.

4.3 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 and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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