Proposed 2-Gate Fish Protection Plan

August 2008

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ACRONYMS

°F	degrees Fahrenheit
°C	degrees Celsius
af	acre-feet
af/yr	acre-feet per year
BA	biological assessment
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CCFB	Clifton Court Forebay
CDFG	California Department of Fish and Game
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second

cm	centimeters
CMARP	Comprehensive Monitoring and Research Program
COA	Coordinated Operation Agreement
Corps	U.S. Army Corps of Engineers
cpm	catch per minute
CPUE	catch per minute effort
CRD	Contract Rate of Delivery
CRR	Cohort Replacement Rate
CVOO	Bureau of Reclamation’s Central Valley Operations Office
CVP	Central Valley Project
CVPA	Central Valley Project Act
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
CWT	coded-wire-tag
D-1485	SWRCB Decision 1485
DAT	CVPIA Section 3406 (b)(2) Data Assessment Team
DBEEP	Delta-Bay Enhanced Enforcement Program
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DMC	Delta Mendota Canal
DO	dissolved oxygen
DOI	Department of the Interior
DOSD	Division of Safety of Dams
DSDT	delta smelt decision tree
DSM2	Delta Simulation Model 2
DSWG	Delta Smelt Working Group
DW	dewatered at some point throughout the year
DWR	(California) Department of Water Resources
EA	Environmental Assessment
E/I Ratio	Export/Inflow Ratio
EBMUD	East Bay Municipal Utility District
EC	Electrical Conductivity
EID	El Dorado Irrigation District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERIR	Existing Resource Information Reports
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
EWA	Environmental Water Account

EWAT	Environmental Water Account Team
FESA	Federal Endangered Species Act
FRWA	Freeport Regional Water Authority
FRWP	Freeport Regional Water Project
ft/s	feet per second
FWS	Fish and Wildlife Service
HCP	Habitat Conservation Plan
ID	Irrigation District
IEP	Interagency Ecological Program
IFIM	Instream Flow Incremental Methodology
Interior	U.S. Department of the Interior
IPO	Interim Plan of Operations
ITP	Incidental Take Permits
ITS	Incidental Take Statements
Jones	Central Valley Pumping Plant
JPOD	Joint Point of Diversion
kW	kilo-watt
KCWA	Kern County Water Agency
LADWP	Los Angeles Department of Water and Power
LFC	low-flow channel
LOD	Level of Development
LP	linear programming
M&I	municipal and industrial
maf	million acre feet
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
mg/l	milligrams per liter
mgd	millions of gallons per day
MIDS	Morrow Island Distribution System
MILP	mixed integer linear programming
mm	millimeters
mmhos/cm	millimhos per centimeter
MOU	Memorandum of Understanding
mS/cm	millisiemens per centimeter (an indication of salinity)
msl	mean sea level
MW	megawatt
MWD	Metropolitan Water District of Southern California
NBA	North Bay Aqueduct
NCCPA	California Natural Community Conservation Planning Act
NCWA	Northern California Water Association
NDO	Net Delta Outflow
NEPA	National Environmental Policy Act (NEPA)

NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NMIPO	New Melones Interim Plan of Operation
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration Fisheries (formerly National Marine Fisheries Service [NMFS])
NOD	North of Delta
NOI	Notice of Intent
NOP	Notice of Preparation
NOI	Notice of Intent
NRC	National Research Council
NWSRFC	National Weather Service River Forecast Center
O&M	Operations and Maintenance
OCAP	Operations Constraints and Objectives
OFF	Operations and Fisheries Forum
OID	Oakdale Irrigation District
OMR	Old and Middle River
ONCC	Oregon/Northern California Coast
Ops Group	CALFED Operations Coordination Group
PBA	Plan Biological Assessment
PCB	Polychlorinated biphenyls
PCWA	Placer County Water Agency
PEIS	Programmatic Environmental Impact Statement
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas & Electric Company
PHABSIM	Physical Habitat Simulation
PIT	passive integrated transponder
ppm	parts per million
ppt	parts per thousand
PREs	Potentially Regulated Entities’
QA/QC	Quality Assurance/Quality Control
QSS	Quantitative Study Site
RBDD	Red Bluff Diversion Dam
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RRDS	Roaring River Distribution System
RST	rotary screw fish trap
RWQCB	Regional Water Quality Control Board
SA	Settlement Agreement
SAFCA	Sacramento Area Flood Control Agency
SCDD	Spring Creek Debris Dam

SCE	Southern California Edison
SCWA	Sacramento County Water Agency
SCVWD	Santa Clara Valley Water District
SDFF	South Delta Fish Facility Forum
SDIP	South Delta Improvement Project
SDTB	South Delta Temporary Barriers
SJR	San Joaquin River
SJRA	San Joaquin River Agreement
SJRTC	San Joaquin River Technical Committee
SJRWR	San Joaquin River water rights
SL	sloped dam
SMPA	Suisun Marsh Preservation Agreement
SFPUC	San Francisco Public Utilities Commission
SLDMWA	San Luis and Delta Mendota Water Authority
SMSCG	Suisun Marsh Salinity Control Gates
SMUD	Sacramento Municipal Utilities District
SOD	South of Delta
SRBS	Stanislaus River Basin Stakeholders
SRI	Sacramento River Index
SRPP	Spring-Run Chinook Salmon Protection Plan
SRTTG	Sacramento River Temperature Task Group
SSJID	South San Joaquin Irrigation District
SVI	Sacramento Valley Water Supply Index
SWRCB	(California) State Water Resources Control Board
SWP	State Water Project
SWPOC	State Water Project Operations Criteria
SWRCB	State Water Resources Control Board
T&E	threatened and endangered
taf	thousand acre feet
TCCA	Tehama-Colusa Canal Authority
TCD	temperature control device
TDS	total dissolved solids
TFCF	Tracy Fish Collection Facility
TFFIP	Tracy Fish Facility Improvement Program
TNS	Townet Survey
TRD	Trinity River Division
TU	temperature units
USBR	U.S. Bureau of Reclamation
UN	unscreened diversion
USACE	U.S. Army Corps of Engineers
U.S.C	United States Code

USFWS	U.S. Fish and Wildlife Service
USFWS	United States Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
Western	Western Area Power Administration
Westlands	Westlands Water District
WTP	Water Treatment Plant
WOMT	Water Operations Management Team
WQCP	Water Quality Control Plan
WRESL	Water Resources Engineering Simulation Language
WUA	weighted usable spawning area
WWD	Westlands Water District
WY	water year
YOY	young-of-the-year
Zone 7	Alameda County Flood Control and Water Conservation District, Zone 7 Water Agency

Introduction

Operation of the State Water Project (SWP) and Central Valley Project (CVP) pumps causes flow reversals in the Sacramento-San Joaquin Delta (Delta) on the Old and Middle rivers in the vicinity of the export pumps. Salinity and turbidity conditions conducive to Delta smelt are conveyed by these reverse flows towards the pumps, resulting in the entrainment of Delta smelt during export operations. Delta smelt is a federally and state-listed threatened species, and both the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) are considering petitions to change its status to endangered.

The 2-Gate Fish Protection Plan (2-Gate Plan) is a mitigation and avoidance measure intended to reduce the take of Delta smelt and other listed species, in compliance with the federal Endangered Species Act, although it also would benefit other aquatic species. The 2-Gate Plan provides a means of controlling a portion of the Old River branch of the San Joaquin River restricting and direct entrainment of fish from the western Delta toward the export pumps. This would be accomplished by the installation and operation of operable gates in key channels in the central Delta. These structures would provide additional control of tidal and non-tidal flows, thereby modifying the predominant path of freshwater flow through the Delta. Hydrodynamic and particle tracking computer modeling has shown that these changes would substantially reduce (by 72 percent) unintended effects of export pumping on the estuarine ecosystem, thereby minimizing or avoiding salvage of Delta smelt and potentially enhancing Delta smelt populations in the western and central Delta while allowing for the export of water to meet critical water needs.

The 2-Gate Plan is consistent with long-term mitigation and avoidance measures to reduce the incidental take of listed species. It could be operated in a manner compatible with any long-term Delta conveyance solution.

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Section 1: Proposed Actions

1.1 OVERVIEW

The 2-Gate Plan would involve the installation and operation of a gate system on the Old River between Holland and Bacon islands and on Connection Slough near Middle River (Figure 1). It would be implemented in two phases. The first phase would involve the installation and operation of one or more commercially available cargo barge modules with top-mounted butterfly gates. The second phase would involve the installation and operation of a floatable Obermeyer or equivalent gate system. Both the Phase 1 and Phase 2 gate installations would be functional under tidal operations (closed on the flood tide and open on the ebb tide) or non-tidal operations (closed during control of San Joaquin River flow reversals or other flow conditions necessary for fish [e.g. Delta smelt] protection). The Old River and Connection Slough gates (Figure 1a) would provide effective separation of Old and Middle River flows and would be operated in a manner to allow for vessel passage.

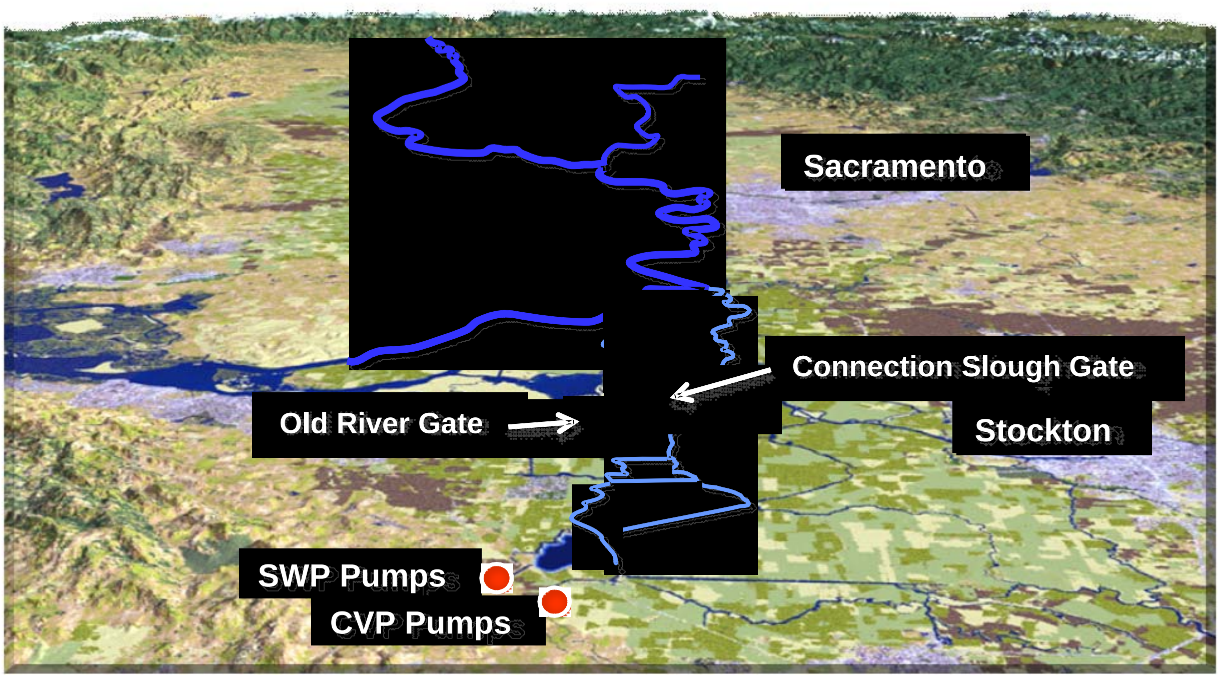

Figure 1 Regional Location of the 2-Gate Plan Facilities

1.2 FACILITY CONSTRUCTION AND OPERATION

1.2.1 Phase 1

1.2.1.1 Overview

Phase 1 would last up to five years and include the installation of cargo barge modules with top-mounted butterfly gates in early 2009. This early installation would provide prompt protection to Delta smelt, and other pelagic and estuarine organisms, and would allow the effectiveness of the gate system to be evaluated while minimizing the loss of critical water supplies from the Delta. Temporary butterfly gates would be installed on top of one or more commercially available cargo barge modules, floated to the site, and ballasted to the river bottom. Pre-installed sheet pile abutment panels would be attached to the ends of the barges. Rock would be placed at both ends of the grounded barge to anchor it to the river banks. The conceptual layout of the operational gate system is shown in Figure 2, and cross sections of the gate structure on the Old River are shown in Figure 3. The project design is further illustrated by Figure 4, which shows the conceptual layout of the operable gates system on the Old River near Bacon. A similar layout would occur at Conception Slough, although it would be modified as needed to reflect differing site conditions. The self-installing floatable base supporting an operational gate system would ease the process of installation and removal, minimize the impacts to the river channel, and provide a completely portable gate system.

Under normal water conditions, the barrier gates would not be submerged completely because the gate frames rise above the gates and would be visible under all tide stages. Although the Old River and Connection Slough are not primary flood flow conveyance channels, all in-channel structure would be designed to withstand over-topping. This would accommodate unanticipated flood events. They could be overtopped to accommodate 100-year flood flows, but would be open and not needed during such a time. The operable gates are designed to have a maximum 3-foot differential water surface elevation on either side of the barrier. When open, the gates would be wide enough to allow the passage of a vessel with a 60-foot beam.

Figure 1a Old River Site

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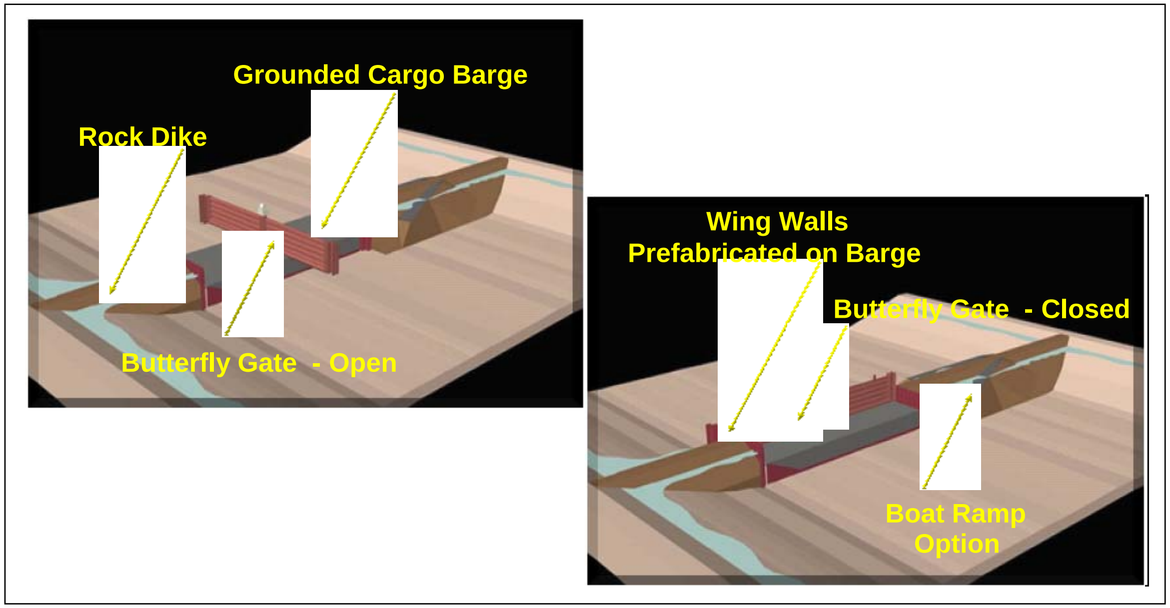

Figure 2 Conceptual Design of the Phase 1 Barrier Systems

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Figure 3 Old River Site Plan

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Figure 4 Conceptual Layout of the Operable Gates System on the Old River near Bacon

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1.2.1.2 Construction Materials

The operational gate systems would be composed of readily available materials, including appropriately sized rock, sheet and plate steel, a cargo barge, and control systems. Quantities of rock fill and ramp fill materials are included on Figure 4. The rock would be transported to the sites on commercial cargo barges or in road-legal transport trucks. This material would be stored on the commercial barge or on a designated site adjacent to the installation sites. The barge-mounted butterfly gate system would be fabricated off-site and transported to the installation site on the barge. Other materials (e.g., sheet pilings and control systems) that are not included in the barge-mounted gate system would be transported to the site on road-legal trucks and stored in the adjacent staging area.

1.2.1.3 Installation/Removal Methods

Dredging and installation of the rock dikes at Old River and Connection Slough would take place prior to the arrival of the barge/butterfly gate fabrications. All of the equipment used for dredging and barrier installation would be typically available, diesel-powered mechanical construction equipment. It is expected that channel bottom material would need to be removed to provide appropriate structural conditions to support the proposed facilities. It is assumed that unconsolidated peat materials would be present to approximately 25 feet below mean sea level. These materials (up to approximately 48,000 cubic yards) would be removed from underneath the area where the barge mounted butterfly gate system and adjacent rock dikes would be installed. Materials under the gently sloping “sturgeon ramps,” visible in Figure 3, would not be dredged. Dredged material would be deposited on a barge and transported to nearby site (TBD) on one of the Delta islands for disposal.

Temporary butterfly gates would be installed on top of one or more commercially available cargo barges, floated to the site, and ballasted to the river bottom. A gravel sub-base foundation material composed of approximately 6-inch-wide rock would be installed to provide a consistent seal to water flow and a foundation beneath the barge/butterfly gate system. Pre-installed sheet pile abutment panels would be attached to the ends of the barges. Approximately 24-inch-wide rock would be placed at both ends of the grounded barge to anchor it to the river banks and provide a barrier to water and fish movement. These rock dikes on either side of the barge/butterfly gate system would be armored with larger rock. If necessary, a steel skirt would be added to the edge of the barge and into the gravel foundation material to ensure water would not flow under the barge.

The gate system is designed to facilitate its installation and removal. It would be installed in a one- to two-week period. Initial removal would be completed within one month. In subsequent years, the installation and removal operations would be carried out more quickly because the steel base supports would be stored in close proximity to the project area, no dredging would be required, and less material would have to be moved because the rock base already would be in place.

Marine support equipment consisting of derrick barges, flat barges, and tugboats would be required for the installation and removal of the gate barrier system. The minimum draft required for all support vessels and gate facilities is approximately 10 feet.

1.2.1.4 Provisions for Flood Safety – Armoring and Over-Topping

Implementation of the 2-Gate Plan would restrict flows on the Old River and Connection Slough whether those flows are derived from runoff from the San Joaquin River watershed, operation of the export pumps or by tidal action. When the operational gates were closed, flows near Bacon Island would be restricted to nearly 100%. When the operational gates were open, flow would be restricted to approximately 60% of the currently available amount by the abutments and other structures. When the gates, abutments and rock dikes are removed, flow capacity would by approximately the same as currently available. These changes in water conveyance capacity would result in changes in flow on Old and Middle Rivers, and the San Joaquin River.

1.2.1.5 Timing

The submersion of the barges, completion of rock installation and completion of the barrier system would be carried out prior to the development of conditions leading to increased Delta smelt populations in the central Delta (approximately early to mid-December in each year). The sunken barges would be de-ballasted and floated from the Old River and Connection Slough sites after periods of higher Delta smelt densities in the central Delta (approximately June 30 in each year), and the rock dikes would be removed. Timing could be modified as needed to better meet the intended purposes of the 2-Gate Plan.

1.2.1.6 Procedures to Safely Accommodate Vessel Traffic

The operational gate systems would require navigation markers, lights, buoys and published information for recreational boaters and commercial marine traffic at Old River and Connection Slough on both sides of the gate barriers. Given 24-hour advance notice, gates could be opened to allow for vessel traffic with a total overall beam of up to approximately 60 feet by pivoting the gates. The gates would take approximately ten minutes to open or close. Recreational traffic could be accommodated in the same manner, or vessels up to 24 feet long could be accommodated by a portage system of launching ramps and trailers (Figure 3). Procedures for gate passage would be coordinated with levee districts, property owners, and stakeholders.

1.2.2 Phase 2

Phase 2 would involve a more sophisticated floatable base with an Obermeyer or equivalent gate system installed on the base (Figure 5). Similar to Phase 1 installation, floatable base/gate modules would be towed into place and control-flooded to ballast and lower the modules to the bottom of the river channel. Foundation caissons would be attached below the corners of each module. After the base was lowered to the channel bottom, these caissons would be forced down into the soil using electric- or hydraulic-powered pumps to reduce the pressure inside the foundation caissons, allowing the external pressure of the water to drive the caissons into the river bottom. This method of installation provides the ability for quick response without the need for pile drivers, using tugs, crane barges and work barges carrying electrical generators. The base would be floated into place, controlled initially by tugs and then moored to anchors on the shore. Controlling the depth and stability of the base as it is ballasted to the bottom, can be accomplished with the assistance of cranes or through the use of stabilizing buoyancy columns attached to the base modules. Once installed the Obermeyer grates would remain in place for the duration of Phase 2.

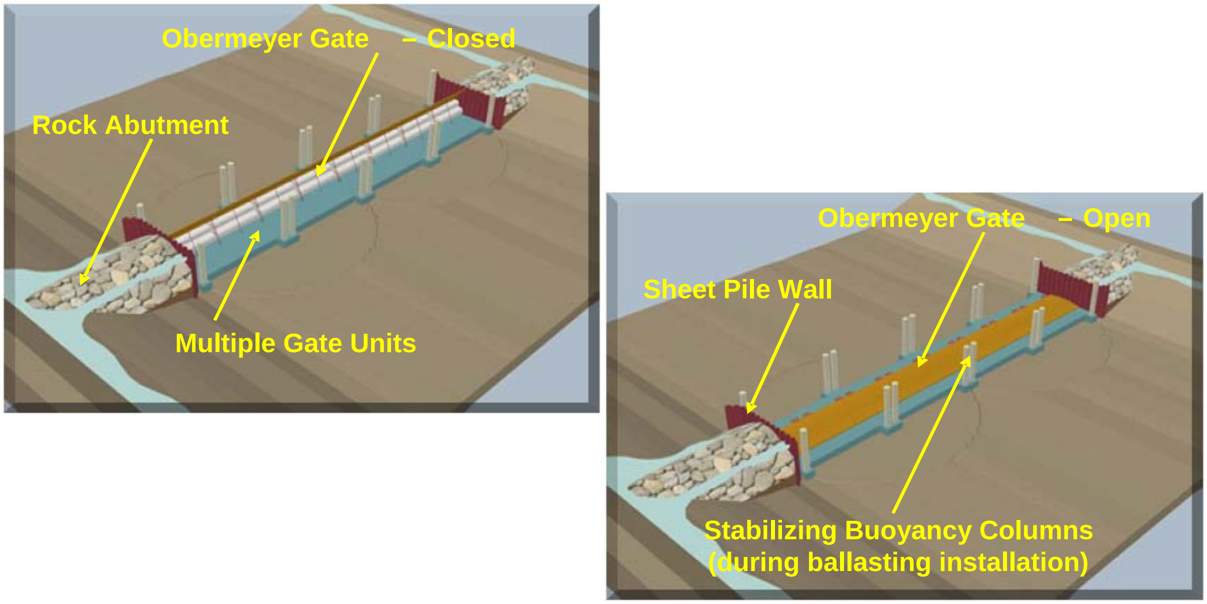

Figure 5 Conceptual Design of the Phase 2 Barrier Systems

The Obermeyer gate provides the operational flexibility for this field application. It is a bottom-hinged gate, raised by a pneumatically controlled bladder beneath the gate. The gate has a thin profile in a fully deflated position to efficiently pass flood flows and debris. Steel gate panels overhang the air bladders in all positions, protecting the bladders from floating logs and other debris. These air bladders use clean, dry, compressed air for actuation. No hydraulic fluid or other potential water contaminants are used. By controlling the pressure in the bladders, the elevation maintained by the gates can be infinitely adjusted within the system control range (full inflation to full deflation) and accurately maintained at user-selected set points.

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Section 2: Operational Criteria

2.1 OPERATIONAL PROCEDURES

2.1.1 Operations

The development of the operational criteria of the 2-Gate plan is based on observations regarding the correlations between turbidity, salinity, and the presence of adult Delta smelt. The control of water flow from the western and north-central Delta in the Old River, when turbidity and salinity condition are expected to support upstream movement of Delta smelt is critical to the avoidance and minimization of entrainment of Delta smelt (and other pelagic species) by the export pumps. The operation of the 2-Gate barrier system would substantially reduce or eliminate direct upstream water flow on the Old River (either by tidal action or from operation of the export pumps) from the areas of highest concentrations of Delta smelt in the West and Central Delta or Suisun Bay. The development of turbidity and salinity conditions is positively correlated with the onset of winter storm and runoff events on the Sacramento and San Joaquin rivers.

Operational decisions would be made based on monitoring of Delta conditions. Operations of the gates will rely on monitoring of turbidity, salinity, water temperature, flow, dissolved Oxygen (DO), and CDFG's monthly Spring Kodiak Trawl and new biweekly 20mm survey. More information regarding the key monitoring parameters is provided in Section 1.3.2, below.

Gate operations would be conducted to avoid and minimize the entrainment of delta smelt and other pelagic estuarine organisms in the export pumps in the south. Both gates could be opened or closed within minutes of a trigger criteria being met, to protect fish or to avoid degradation of water quality. Once closed, the gates are anticipated to remain closed for 24 hours a day for several days or a few weeks until conditions hydrodynamic conditions become desirable.

Using the real time monitoring data collected, the gates would be operated based on the following criteria:

- Gates would remain open if Old and Middle River flows are >-3000 cfs.
- Gates would be closed whenever a continuous band of suitable salinity and turbidity conditions for smelt forms or is about to form extending from Jersey Point to the eastern edge of Franks Tract or smelt populations are known to be moving upstream toward the gates based on available delta smelt survey data, continuous salinity and turbidity monitoring data, and results of analytical techniques such as particle tracking. Gates would be closed when:
  - Daily turbidity was >12 NTU, indicating the onset of a turbidity event conducive to the upstream movement of delta smelt.
  - Daily electrical conductivity >400 umhos, indicating the onset of salinities conducive to the presence of delta smelt.

Or

- The latest CDFG fish surveys and smelt distribution model analyses indicated delta smelt catches were emerging upstream of the confluence in the San Joaquin River and into the Franks Tract area (described in Section 1.3.2).

The two gates will be reopened whenever OMR flows rise above -3000 cfs, or whenever the areas downstream of the gate locations (e.g., within the Franks Tract Area) no longer represent suitable conditions for smelt. Thus, high flows on the Sacramento or the San Joaquin might depress salinity in the Franks Tract area. Similarly, low flow levels might lead to a reduction in turbidity levels.

The gates would be reopened when the following conditions have been met, indicating that few, if any, delta smelt were vulnerable to entrainment:

- Daily average turbidity is <12 NTU, indicating a decline in the turbidity event that had been conducive to the presence of delta smelt.
- Daily average electrical conductivity is <400 umhos, indicating salinities were no longer conducive to the presence of delta smelt.
- The latest CDFG fish surveys and smelt distribution model analyses indicated most of the delta smelt are seaward of the confluence.
- No delta smelt were salvaged for five consecutive days, indicating that they were not being drawn up Old River or otherwise moving into the area.

The operational gate system also has the flexibility to be operated to allow for vessel passage. Vessels that need to move through this area of the central Delta while the gates are closed could be accommodated by opening the gate to allow passage.

The operational gate system also has the flexibility to be operated to test alternative water management and fish protection strategies. During April – June in each year the gates could be closed if particle tracking analysis indicates that a greater fraction of the larval and juvenile smelt population will be subject to entrainment with the gates open than closed. Such analysis would take into account the most recent data on smelt distribution, and flow and export levels. The operational gate system installations could also be functional under tidal operations (closed on flood-tide and open on ebb-tide) thereby testing the concept of Delta smelt upstream migration on flood tides. While not a part of this action, and not evaluated in the report, the Old River gate could be operated in conjunction with potentially modified Delta Cross Channel gate operations or upstream reservoir releases to provide additional flow to the San Joaquin River, and help push conditions conducive to smelt in a seaward direction.

2.1.2 Environmental Monitoring and Control Actions

2.1.2.1 Introduction

The environmental monitoring component is critical to the effective operations of the 2-Gate Fish Protection Plan. It is designed to provide the environmental and habitat information predictive of delta smelt habitat or presence, upon which to base timely gate operational decisions and to acquire related information on aquatic ecosystem health. These actions are expected to restrain conditions conducive to delta smelt in the central and western Delta, considerably downstream of water export facilities, minimizing impacts to delta smelt and other estuarine species.

The 2-gate Plan will utilize the existing DWR, USGS, and USBR monitoring stations and real-time monitoring network (see http://www.delta.dfg.ca.gov/baydelta/monitoring/) and will supplement existing designated monitoring sites with additional monitoring equipment and constituent measurement capabilities. New monitoring stations would be provided in close proximity to the 2-gates and equipped with equipment and capabilities equivalent to that provided at the existing stations. The above agencies would continue to monitor existing stations under the 2-Gate Fish Protection Plan. At new station locations, monitoring would be conducted by the USGS or DWR.

The objective of the monitoring program is to detect when triggers are reached for closing or opening the 2-gates to protect smelt while also observing salmon and sturgeon movements. The operational procedures in Section 1.3.1 describe these criteria, or triggers, for operating the gates as informed with monitoring data. Further, by continuously monitoring salinity, turbidity, temperature, dissolved oxygen, and chlorophyll-a in selected regions of the Delta, the monitoring program provides important information to assess habitat conditions in real-time, during both operation and non-operation of the gates.

The monitoring for the 2-gates is adaptable as conditions and concerns warrant. If additional monitoring is needed either beforehand or during operations, such monitoring can be conducted. Further, if conditions change in the Delta around the gates, the gates can be opened within minutes, and be removed if deemed necessary.

The monitoring program will also provide information about potential effects on listed fish when the two gates are closed. This information will address degrading water quality, adverse effects of hindering fish passage when the gates are closed and open, and if the base of the gates may be a potential barrier for sturgeon. However, water quality and fish monitoring will be in place to detect triggers for closing or opening the two gates and for avoiding adverse effects on fish, as explained below.

2.1.2.2 Ongoing and New Monitoring Parameters

Flow: Flow conditions on the Sacramento and San Joaquin Rivers, and Old and Middle Rivers will be monitored and the gates operated based on flow conditions. For example, gates are expected to remain open if Old and Middle River flows are >-3000 cfs. Flows would also be monitored for oncoming turbidity events. Flows in Old and Middle Rivers (OMR) and elsewhere would be monitored by USGS.

Electrical Conductivity: Electrical conductivity (a water quality measure) >400 umhos is positively correlated to the presence of smelt, and is a particularly important measure in the central and western Delta region downstream of the gates. Along with certain turbidity levels cited below, these conditions would suggest delta smelt approaching the 2-gates and trigger gate closure.

Turbidity: Turbidity >12 NTU is positively correlated to the presence of smelt, and is an important measure in the central and western Delta region downstream of the gates. Along with electrical conductivity levels cited above, these conditions would suggest delta smelt approaching the 2-gates and trigger gate closure.

Water Temperature: Since water temperature is an important metric for delta smelt, and other pelagic and anadromous fish, it would be measured at all locations where monitoring takes place for the 2-gates.

Dissolved Oxygen: Dissolved oxygen (DO) will be monitored in the temporary tidal backwaters to watch for degradation as indicated by low DO, which could suffocate fish or block their movements.

Chlorophyll-a: Chlorophyll- a will be monitored due to concern about potential nuisance levels of algae.

Daily Salvage of Delta Smelt and Longfin Smelt:

- Skinner Fish Facility
- Tracy Fish Facility

Adult Delta Smelt: California Department of Fish and Game (CDFG) would monitor adult delta smelt in the catch of Spring Kodiak Trawl (SKT) tows near the gates, particularly at stations 902, 914 and 915, which are closest to the two gates. Presence at Stations 914 or 915 would indicate higher risk of entrainment into the pumps and alerts to watch for increased salvage. Larval and juvenile longfin smelt would be monitored by the CDFG's winter 20mm survey, particularly at stations 902, 914, and 915, which are closest to the 2-gates. Presence at Stations 914 or 915 would indicate higher risk of entrainment into the pumps and is an alert for the onset of increased salvage.

Salmon: USGS studies during the winter of 2008/09 will release about 5,000 radio-tagged juvenile salmon into the north-central Delta. Some of these fish may travel to the vicinity of the gates, in which case existing listening stations will record their location and timing. Along the way, existing listening stations will record their location and timing (Figure 7). In particular, these fish would pass from Sacramento River through the Delta Cross Channel into Mokelumne River, or into Georgiana Slough and then into Mokelumne River. The fish would serve as surrogates for naturally spawned or hatchery-reared salmon emigrating from the Mokelumne River upstream of the Delta.

Listening devices would detect these radio-tagged fish in the lower Mokelumne. Monitoring data would then be collected on subsequent movements into San Joaquin River and either seaward or into Old or Middle rivers and nearer to the gates. Data would also be collected on the number, if any, and portion of those fish exiting the Mokelumne that entered Old or Middle rivers. Whether the gates were open of closed would depend on conditions of the moment.

Existing Monitoring Stations

Much of the monitoring in support of the 2-Gate Plan is ongoing as part of various monitoring programs. Data would be downloaded from the web and put into reports relating to trigger levels. Additional constituent measurement to meet the needs of 2-gate monitoring would be added to the ongoing monitoring stations (see Table 1-1). Compilations and analysis of data at these stations would occur during December through March. More limited use of the 2-gates from April through June would require data collection and analysis, as well.

The following stations would be monitored as part of ongoing programs at locations with gear and data acquisition and reporting systems already installed or with new equipment, data acquisition, and telemetry systems at the same location. As a part of the 2-gate monitoring program, existing stations will be monitored for electrical conductivity, turbidity, temperature, dissolved oxygen and chlorophyll-a. Two stations would be specifically monitored for flow. Daily salvage would continue to be monitored at the Skinner and Tracy Fish Facilities. The following are the existing monitoring locations, as well as existing and proposed monitoring capabilities:

Flows:

- Sacramento River at Freeport
- Sacramento River at Verona (Yolo Bypass)

Electrical Conductivity, Turbidity, Temperature, Dissolved Oxygen, and Chlorophyll-a:

- Sacramento River at Verona
- Sacramento River at Freeport
- Sacramento River at Hood
- Sacramento River at Collinsville
- Delta Cross Channel
- Georgiana Slough
- San Joaquin River at Jersey Point
- San Joaquin River at Prisoners Point
- False River
- Holland Cut
- Old River at Quimby Island
- Old River at Franks Tract
- Old River at Bacon Island
- Middle River at Columbia Cut
- Middle River at Bacon Island
- Victoria Canal
- Clifton Court Gates
- San Joaquin River at Mossdale

New Monitoring Stations and Needs: 2-Gate Fish Protection Plan

New monitoring stations will be installed as deemed critical to the data needs for opening and closing of the gates, and monitoring aquatic ecosystem conditions. New stations would involve channel bottom-sensing equipment and cable connections to data gathering and telemetry equipment concealed at the shoreline to provide reliable off-site monitoring. The following new stations and capabilities would be provided:

Flows:

- San Joaquin River at Oulton Point

Electrical Conductivity, Turbidity, Temperature, Dissolved Oxygen, and Chlorophyll-a:

- San Joaquin River at Oulton Point
- Downstream of Old River Gate
- Upstream of Old River Gate
- Downstream of Connection Slough Gate
- Upstream of Connection Slough Gate

Sturgeon and Predators: DIDSON cameras would be used to address any concerns with sturgeon passage. The DIDSON cameras would be installed on the downstream side of each gate to monitor two conditions:

- Whether sturgeon pass the gate whether it is open or closed, or if they persist there when a gate is closed
- Predator fish accumulation behind the gate abutments

One DIDSON would be installed on each side of one abutment for each gate, for a total of two DIDSON cameras for sturgeon monitoring per gate.
Salmon tracking – Continuously recording listening devices will be installed on both sides of each gate to detect the immediate presence of any radio-tagged salmon that exited Mokelumne River. A listening device will also be installed in Old River at the south end of Bacon Island to detect salmon passing upstream or entering from the south.

2.1.2.3 Monitoring Locations

Figures 6 and 7 and Table 1-1 provide key monitoring locations in the Delta operated by DWR, USBR and USGS for fisheries, water supply and water quality purposes. The monitoring program for the 2-Gate Fish Protection Plan would utilize or supplement monitoring capabilities of existing stations, or add new stations with specific data gathering capabilities. The locations of current monitoring stations operated by DWR, USGS, and USBR are shown in Figure 6. Data receiving locations for radio-tagged juvenile salmon under the North and Central Delta Salmon Outmigration Study are shown on Figure 7. A number of the monitoring stations in Figures 6 and 7 are collocated.

2.1.2.4 Schedule

An aggressive program would be undertaken to both add new monitoring equipment to existing stations operated by DWR, USGS, and USBR and to install new monitoring stations and relate equipment. The costs of installing this equipment would come through the 2-gate program. Installation would be conducted as follows:

- September through mid-October: Acquire rented or purchased additional monitoring gear.
- November: Set up ongoing monitoring data processing and reporting specifically for the 2-gates.
- Mid-October through November: Install and start operating additional monitoring gear.
- December through June: Operate and maintain all monitoring gear.

Table 1-1 Locations and Capabilities of Monitoring Stations Supporting Operations of the 2-Gate Fish Protection Plan

Existing or New Monitoring Locations	USBR	DWR	USGS	USGS NCDSOS	Flow	Electrical Conductivity	Turbidity	Water Temp	Dissolved Oxygen	Chlorophyll -a
EXISTING MONITORING STATIONS										
Sacramento River at Verona			X		Exist		Exist			
Sacramento River at Freeport (FPT)					Exist		Exist			
Sacramento River at Hood			X		Exist		Exist			
Sacramento River at Collinsville	X					Exist	New	New	New	New
Delta Cross Channel (DCC)				X		Exist	New	New	New	New
Georgiana Slough (GEO)			X	X	Exist	Exist	New	New	New	New
San Joaquin River at Jersey Point (JPT)			X	X	Exist	New	Exist	New	New	New
San Joaquin River at Prisoners Point (PRI)	X		X		Exist	Exist	Exist	Exist	New	Exist
False River (FAL)			X	X	Exist	New	Exist	Exist	New	New
Holland Cut (HOL)	X		X	X	Exist	Exist	Exist	Exist	New	New
Old River at Franks Tract (OSJ)			X	X	Exist	Exist	New	Exist	New	New
Old River at Quimby Island (ORQ)			X	X	Exist	Exist	New	Exist	New	New
Old River at Bacon Island (OLD)		X				Exist	Exist	New	New	New
Middle River at Bacon Island (MID)	X		X		Exist	Exist	New	New	New	New
Middle River at Columbia Cut (MRC)			X		Exist	Exist	New	New	New	New
Victoria Canal (VIC)	X		X		Exist	Exist	Exist	Exist	New	New
Clifton Court Gates (CCG)				X		Exist	New	New	New	New
San Joaquin River at Mossdale		X				Exist	New	New	New	Exist
NEW MONITORING STATIONS										
San Joaquin River at Oulton Point						New	New	New	New	New
D/S of Old River Gate						New	New	New	New	New
U/S of Old River Gate						New	New	New	New	New
D/S of Connection Slough Gate						New	New	New	New	New
U/S of Connection Slough Gate						New	New	New	New	New

Figure 6. Locations of DWR, USBR, and USGS Monitoring Stations in the Delta

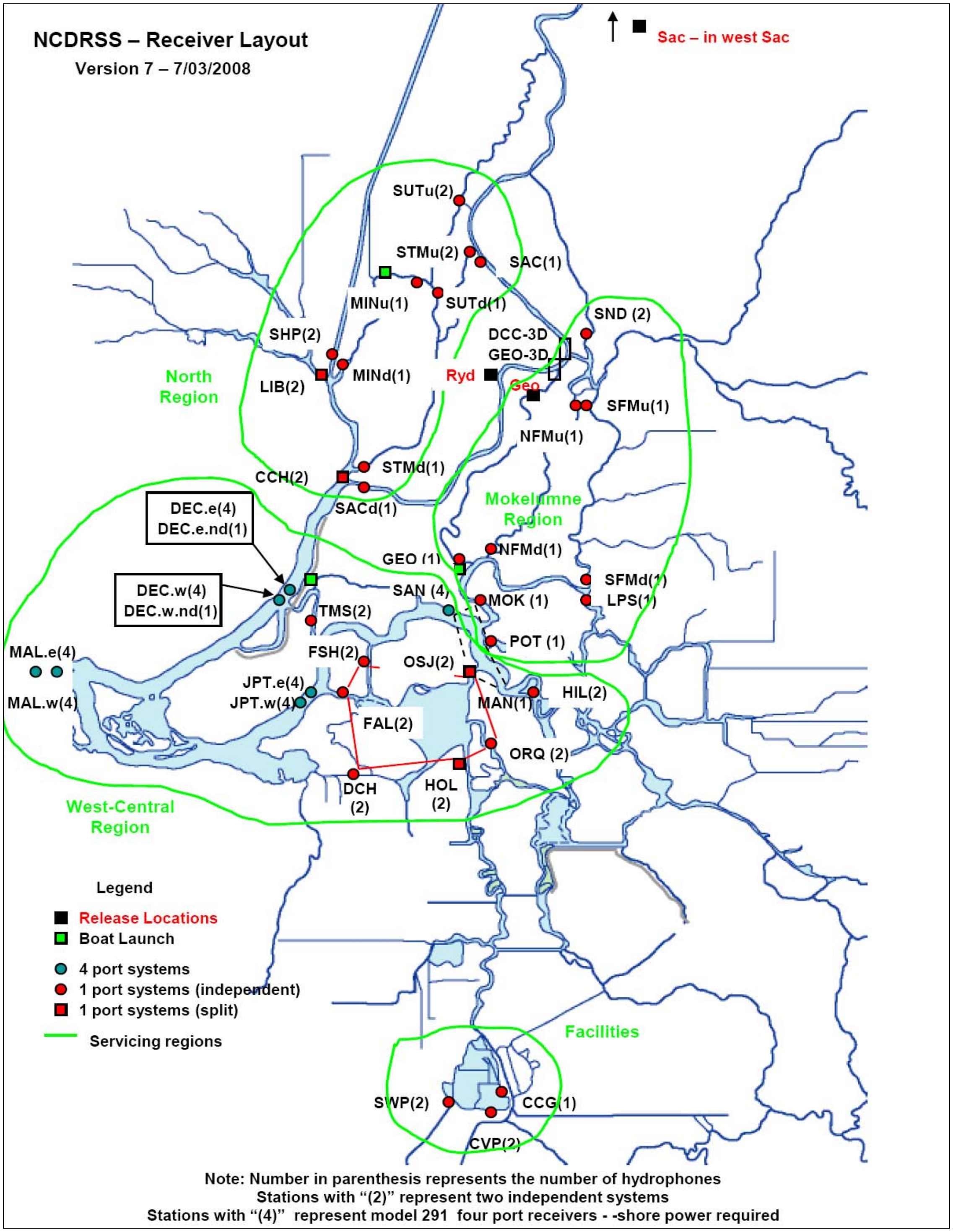


Figure 7.

Figure 7. USGS Monitoring Stations for Juvenile Salmon Migration Study in Winter 2008/09

2.2 OPERATIONS EFFECTS

2.2.1 Flood Flows and Dynamics

The analysis of the 2-Gate Plan facilities performance was based on the following preliminary design criteria:

- The system must maintain a high degree of flood neutrality. Therefore, there may not be a greater than 0.1-ft increase in flood stage for the 100-yr flow, and all flood events less than 100-yr event must not exceed the 100-yr flood stage.
- The design operating head differential on the gate must be less than 3-feet. Therefore, for a high flow condition with a low-tide, or a low flow condition with a high-tide, the difference in water surface profile must not exceed 3-feet on either side of the structure.

2.2.1.1 Flood Flow Analysis Methodology

The crest elevation of the barrier-gate must be high enough to substantially obstruct tidal flows on a reliable basis. Further, the difference in water surface elevation (head differential) both upstream and downstream of the barrier-gate must not exceed the maximum 0.1 feet for representative flow and tidal conditions.

The flood flow analysis is based on a review of survey data for the site and available gage data collected by the USGS on the Old River. The preliminary analysis of the selection of a gate structure crest height of 7-ft, the exceedance probabilities for high tides greater than mean highest high water (MHHW) was analyzed using 21 years of NOAA predicted tide data for the Old River at Orwood station. The cross-section information for this analysis is shown in Table 2-1.

Based on this analysis, a high tide of 7-ft was determined to have an exceedance probability of 0.003%, while a high tide of 6.6-ft has an exceedance probability of 0.4%. The MHHW elevation of 6.1-ft has an exceedance probability of 3.7%.

- The cross-sectional area remaining unobstructed for flood conveyance was then assessed with the gate structure crest elevation set to 6.6-ft and the 90-ft wide gate open:
  - Between the elevation of 6.1 ft (MHHW) and the 100-yr Flood elevation of 9.7 ft., the structure maintains 87% of the existing flow area unblocked.
  - Between the elevation of 2.4 ft mean lowest low water (MLLW) and the 100-yr Flood elevation of 9.7 ft., the structure maintains 50% of the existing flow area unblocked.

Based on this analysis selection of the structure crest elevation to 6.6-ft versus 7-ft still provides for a very high degree of tidal obstruction, less than a 1% exceedance probability, while reducing the impact on the flood stage profiles upstream of the structure.

HEC-RAS simulations were performed using multiple flow-rates, with the 100-yr Flood Stage, MHHW, and MLLW as downstream boundary conditions, to determine a potential range of head differentials on the proposed gate structure.

2.2.1.2 Predicted Effects on Flow Flows and Levels

Table 2-3 and Table 2-4 detail the resultant head differentials and flow velocities for the simulations with a downstream condition of 100-yr Flood Stage, MHHW and MLLW, respectively. All of the head differentials in these simulations were below the 3-ft design criteria.

It should be noted that there is the potential for high velocities through the gate during the initial moments of gate operations when there is a head differential greater than roughly 0.5-ft. However, the results in Table 2-2, Table 2-3, and Table 2-4 are theoretical instantaneous conditions, and head differential will most likely be dissipated more gradually during the process of opening the gates.

Based on HEC-RAS simulation, a high flow-rate of 17,000 cfs and a downstream water surface of 6.1-ft (MHHW) results in a maximum water surface elevation upstream of the structure of 6.86-ft, which constitutes an increase in water surface profile of 0.76-ft. This water surface change is accommodated within existing freeboard, leaving approximately 2-ft of freeboard remaining above the maximum water surface. As well, under many flow and tidal conditions, the head differential was less than 0.1 feet.

Table 2-1 Old River Barrier Cross-Section Geometry

Water Surface Elevation (ft NAVD88)	Cross-Sectional Area (sq.ft)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Top-Width (ft)
0	11,371	756	15.0	745
1	12,121	766	15.8	755
2	12,881	776	16.6	765
2.4	13,187	780	16.9	768
3	13,650	786	17.4	774
4	14,429	796	18.1	784
5	15,218	806	18.9	793
6	16,016	816	19.6	803
6.6	16,499	820	20.1	807
7	16,824	826	20.4	813
8	17,642	836	21.1	822
9	18,469	846	21.8	832
9.7	19,051	846	22.5	840
10	19,306	856	22.6	842

Table 2-2 Flow Velocities through the Gate with 100-yr Downstream Water Surface

Discharge (cfs)	Downstream Boundary Condition (ft NAVD88)	Upstream WSEL (ft NAVD88)	Head Differential (ft)	Velocity through Gate (ft/s)	Velocity 30-ft Upstream of Gate (ft/s)	Existing Condition Velocity (ft/s)
500	9.7	9.7	0	0.12	0.03	0.03
1,000	9.7	9.7	0	0.23	0.05	0.05
5,000	9.7	9.71	0.01	1.16	0.26	0.26
10,000	9.7	9.75	0.05	2.34	0.52	0.52
15,000	9.7	9.81	0.11	3.56	0.78	0.79
20,000	9.7	9.91	0.21	4.86	1.04	1.05

Table 2-3 Flow Velocities through the Gate with a MHHW Downstream Water Surface

Discharge (cfs)	Downstream Boundary Condition (ft NAVD88)	Upstream WSEL (ft NAVD88)	Head Differential (ft)	Velocity through Gate (ft/s)	Velocity 30-ft Upstream of Gate (ft/s)	Existing Condition Velocity (ft/s)
500	6.1	6.1	0	0.29	0.03	0.03
1,000	6.1	6.1	0	0.58	0.06	0.06
5,000	6.1	6.16	0.06	2.92	0.31	0.31
10,000	6.1	6.34	0.24	5.93	0.61	0.62
15,000	6.1	6.68	0.58	9.16	0.91	0.91
20,000	6.1	7.23	1.13	12.84	1.18	1.24

Table 2-4 Flow Velocities through the Gate with a MLLW Downstream Water Surface

Discharge (cfs)	Downstream Boundary Condition (ft NAVD88)	Upstream WSEL (ft NAVD88)	Head Differential (ft)	Velocity through Gate (ft/s)	Velocity 30-ft Upstream of Gate (ft/s)	Existing Condition Velocity (ft/s)
500	2.4	2.4	0	0.36	0.04	0.04
1,000	2.4	2.4	0	0.72	0.08	0.08
5,000	2.4	2.50	0.10	3.64	0.38	0.38
10,000	2.4	2.80	0.40	7.51	0.74	0.76
15,000	2.4	3.44	1.04	12.03	1.07	1.14
20,000	2.4	5.19	2.79	19.32	1.30	1.52

2.2.2 Hydrodynamic Analysis

A hydrodynamic analysis (evaluating flow and salinity) was completed using the DSM2 modeling package. This analysis provided daily average discharge (in cubic feet per second - cfs) and daily average salinity (in umohs per cubic centimeter – umhos/cm) information for a period from October 1, 2000 through September 30, 2003. These data provide an initial evaluation of the changes in flow and water quality throughout the Delta.

2.2.2.1 Changes in Flow Paths and Volumes

The historic monthly average flow was estimated for 34 different locations in the Delta based on DSM2 model runs, as shown in Table 1.4-1. Similarly, Table 1.4 –2 displays the same results for operations with the 2-Gate Plan in place. Table 1.4-3 compares the difference between the historic flow rates (displayed in Table 1.4-1) and anticipated flow rates (shown in Table 1.4-2) with the operation of the 2-Gate Plan. The overall hydrologic effects are summarized in Table 1.4-4.

Generally, the following trends were observed with the operation of the 2-Gate Plan compared to historic flow rates. Each observation is matched with a representative chart for these locations showing plots of the historic, 2-Gate Plan and the difference in projected flow values. Additional figure depicting flow rates at various locations are presented in Appendix F.

- Water flow in the Sacramento River and near the confluence of the Sacramento and San Joaquin rivers is little affected by the operations of the 2-Gate Plan. Figure 1.4-1 – showing the flow values at Dutch Slough near Jersey Island
- Reverse flows in the Old River downstream of the barrier would be reduced during the operational period and unaffected at other times. Figure 1.4 -2 showing flow values at the Old River and Holland Cut
- Reverse flows in the Old River upstream of the barrier would be significantly reduced during the operational period and unaffected at other times. Figure 1.4-3 – showing the flow values on the Old River at Highway 4
- Reverse flows in the Middle River continue and be marginally increased. Figure 1.4-4 – showing the flow values at Tracy Blvd
- Flow near the confluence of the Mokelumne and San Joaquin rivers would be reduced but would remain positive. Figure 1.4-5 – showing the flow values at Venice Island

Table 1.4-4. General Trends in change in Flow with the Operation of the 2-Gate Plan

Location	Pre-Operations Aug-Nov	Early Winter Operation Dec-Mar	Late Operations April-June
Dutch Slough at Jersey Island	No Effect	Positive	Positive
Dutch Slough near Bethel Island	No Effect	Positive	Positive
Piper Slough NE of Bethel Island	No Effect	Slight Positive	Slight Negative
Piper Slough north of Bethel Island	No Effect	Slight Positive	Slight Negative
Threemile Slough at San Joaquin River	No Effect	Minimal Mixed	Minimal Mixed
Mokelumne River at San Joaquin River	No Effect	Negative	Negative
San Joaquin River at Prisoner's Point	No Effect	Negative	Negative
San Joaquin River at Venice Island	No Effect	Positive	Positive
San Joaquin River between Turner/Columbia	No Effect	Negative	Negative
South Fork Mokelumne at Statten Island	No Effect	Slight Positive	Minimal Mixed
Sacramento River at Collinsville	No Effect	Slight Positive	Minimal Mixed
Sacramento River at Emmaton	No Effect	Minimal Mixed	Minimal Mixed
Sacramento River at Rio Vista	No Effect	Minimal Mixed	Minimal Mixed
San Joaquin River at Antioch	No Effect	Minimal Mixed	Minimal Mixed
San Joaquin River at Jersey Point	No Effect	Slight Negative	Slight Negative
Old River at Head	No Effect	Slight Positive	Slight Positive
Sacramento River at Martinez	No Effect	Minimal Mixed	Minimal Mixed
Sacramento River at Port Chicago	No Effect	Slight Positive	Slight Positive
Sacramento River at Mallard Island	No Effect	Minimal Mixed	Minimal Mixed
Sacramento River at Pittsburg	No Effect	Minimal Mixed	Minimal Mixed
Old River at Highway 4	No Effect	Positive	Positive
Old River at Clifton Court Ferry	No Effect	Positive	Positive
Old River Upstream of Clifton Court	No Effect	Positive	Positive
Old River Downstream of Temp Barrier	No Effect	Positive	Positive
Old River at Tracy Road	No Effect	Positive	Positive
Middle River at Tracy Blvd	No Effect	Slight Negative	Slight Negative
Middle River at Mowry Bridge	No Effect	Slight Negative	Slight Negative
Middle River at Old River	No Effect	Slight Negative	Slight Negative
Old River at Holland Cut	No Effect	Positive	Negative in May
Old River at Rock Slough	No Effect	Positive	Positive
Grant Line Canal East	No Effect	Positive	Positive
Victoria Canal	No Effect	Positive	Positive
Middle River upstream of Mildred	No Effect	Negative	Negative
Middle River at Borden Hwy	No Effect	Negative	Negative

Table 1.4-5 displays the monthly average flows that result from reduction in diversions consistent with the Wanger decisions. Table 1.4-6 compares the difference between the reduced export flow rates (displayed in Table 1.4-5) and anticipated flow rates (shown in Table 1.4-2) with the operation of the 2-Gate Plan. The overall hydrologic effects are summarized in Table 1.4-7.

Generally, the following trends were observed with the operation of the 2-Gate Plan compared to historic flow rates:

- To be provided

2.2.2.2 Changes in Salinity

Changes in salinity were also evaluated using DSM2. The historic salinity at 15 sampling locations in the Delta is shown in Table 1.4-8. The average monthly salinity with the implementation of the 2-Gate Plan is shown in Table 1.4-9 and the comparison of these modeled values (both in absolute terms and as a percentage of the historic value) in shown in Table 1.4-10. Figures 1.4-6, -7, -8 and -9 show the anticipated values of salinity at four key locations in the Delta and compare the anticipated values for historic, two variations of reduced exports in compliance with the Wanger decree and the 2-Gate Plan. Additional salinity figure are presented in Appendix F.

Operation of the 2-Gate Plan would:

- Reduce the salinity in the southern Delta near the export pump, especially during the period of operation of the barrier systems
- Increase the salinity in the central Delta downstream of the barriers
- None of the anticipated changes in salinity would be expected to result in substantial changes to the uses of water in the Delta

Table 1.4-11 compares the monthly average salinity of the operation of the 2-Gate Plan and those from reduction in diversions consistent with the Wanger decisions. Generally, the following trends were observed with the operation of the 2-Gate Plan compared to historic flow rates:

Figure 1.4-6. Salinity Projections at the Banks Pumping Plant

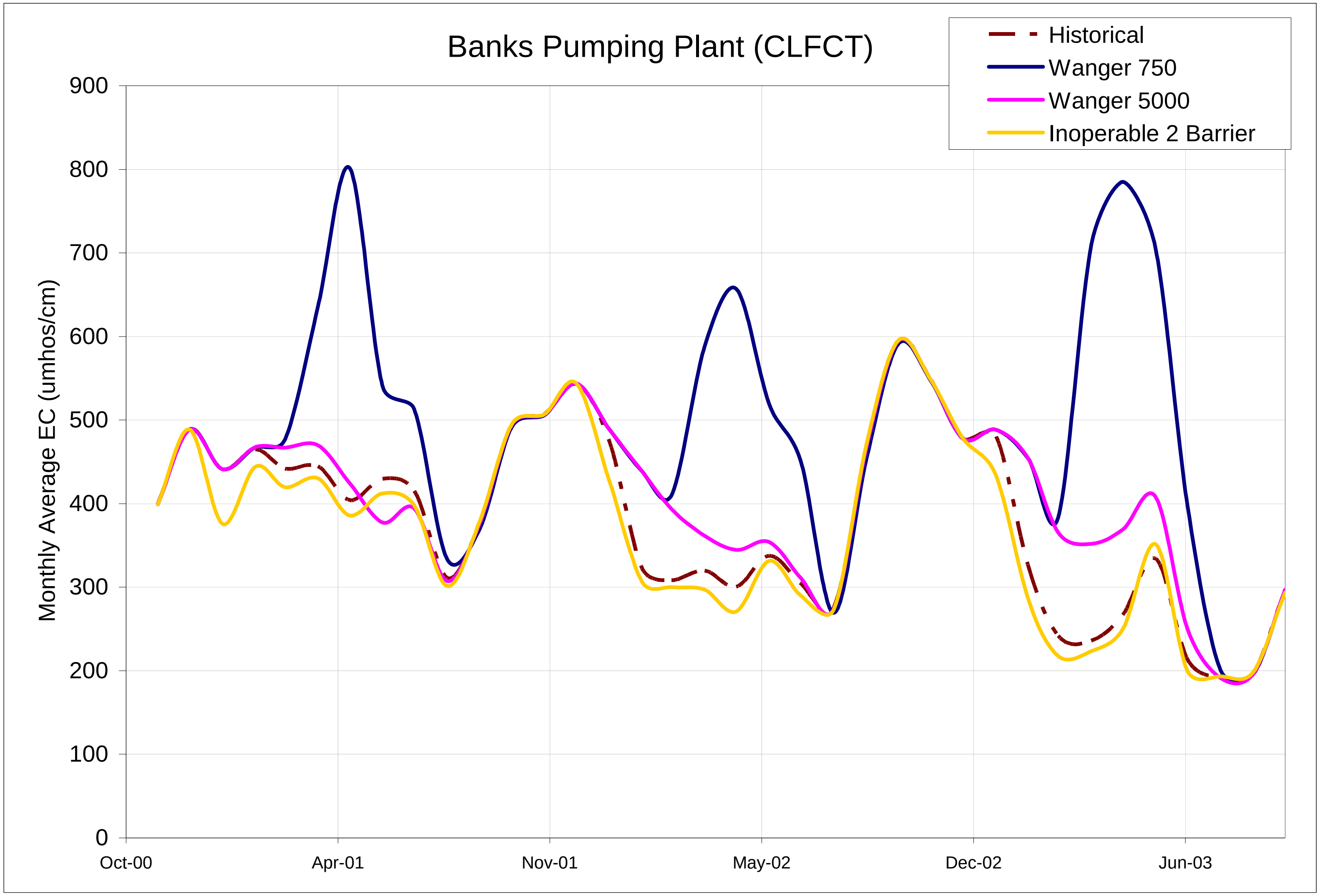


Figure 1.4-7. Salinity Projections at the Rock Slough Pumping Plant

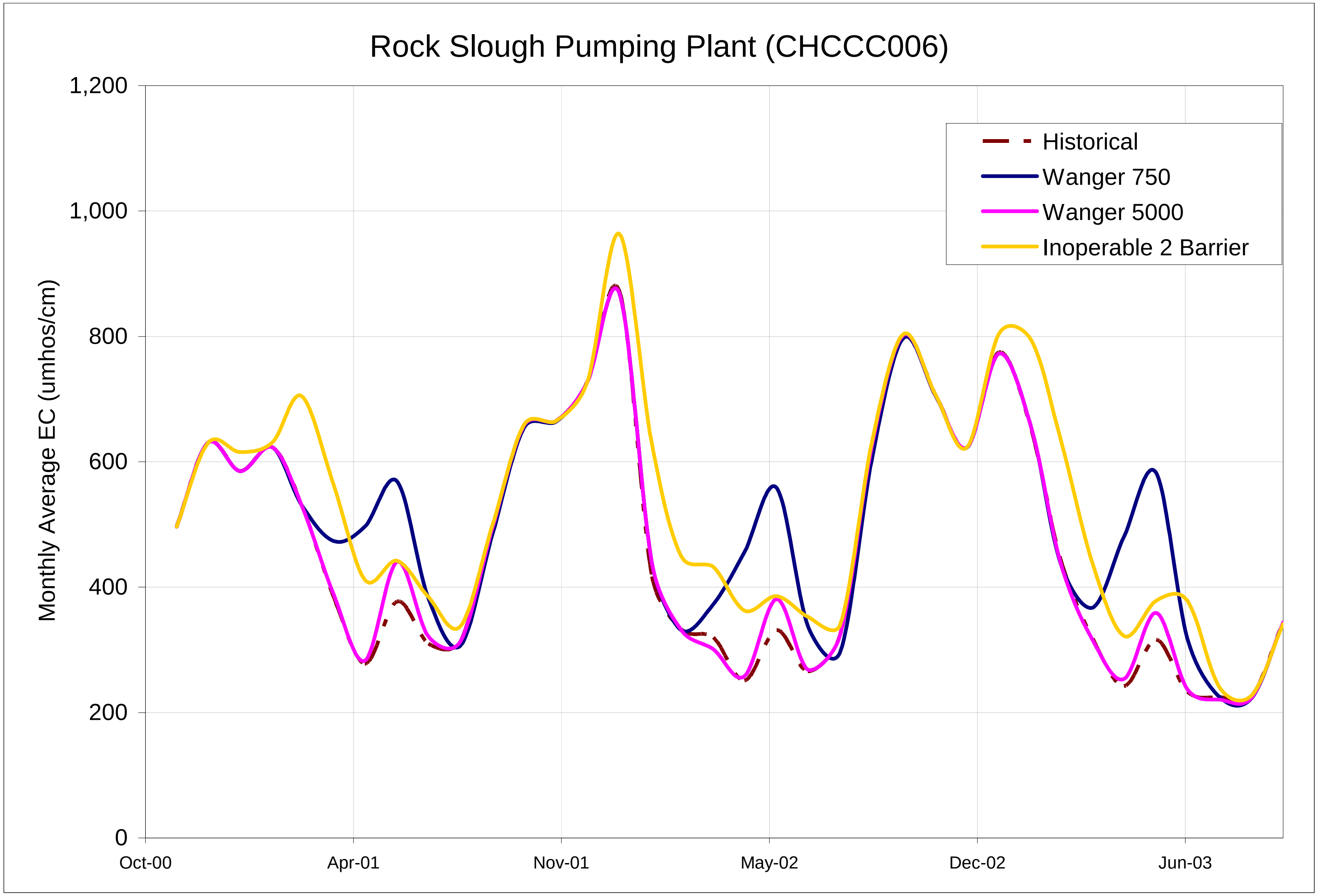


Figure 1.4-8. Salinity Projections on the San Joaquin River at Jersey Point

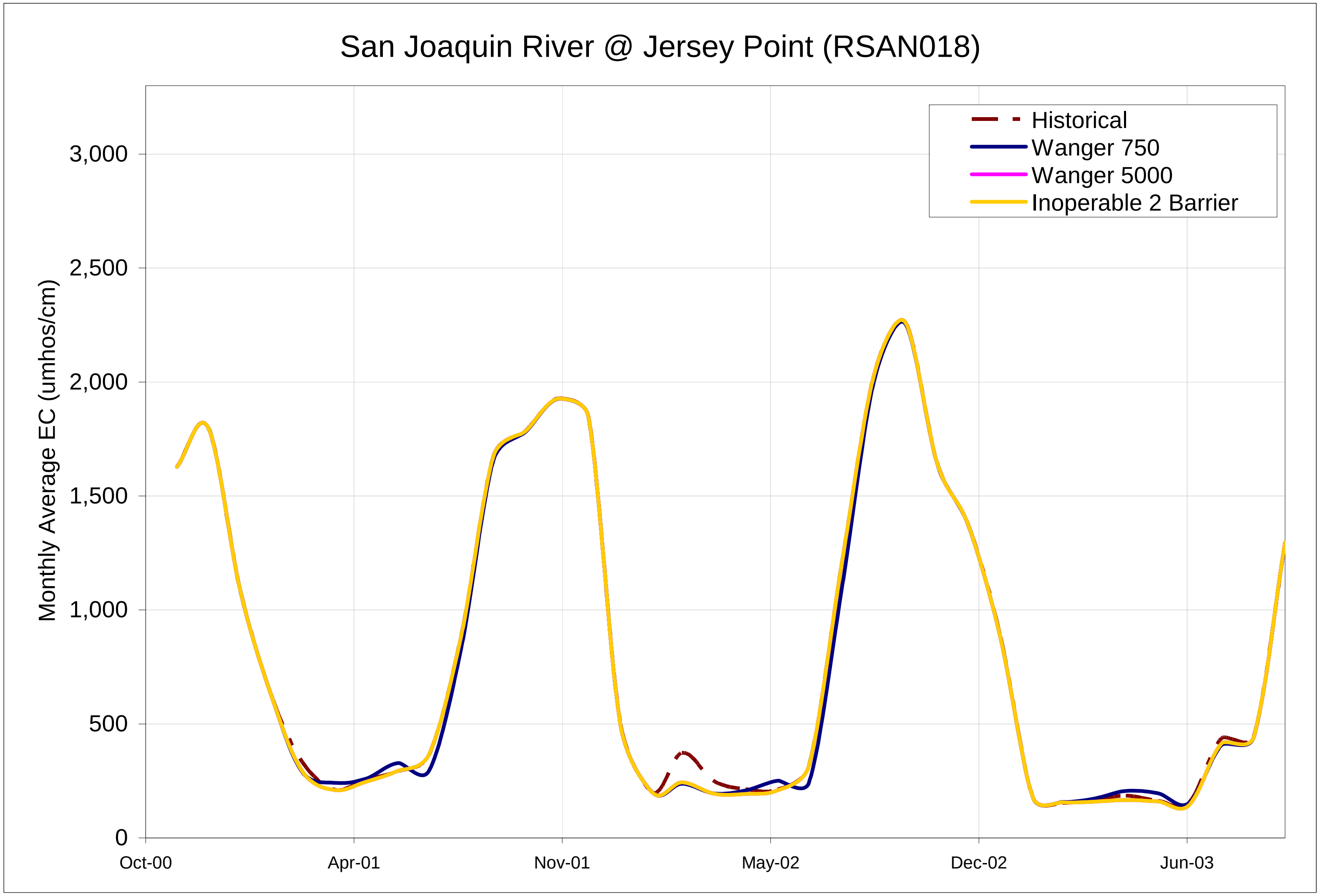


Figure 1.4-9. Salinity Projections on the Sacramento River near Rio Vista

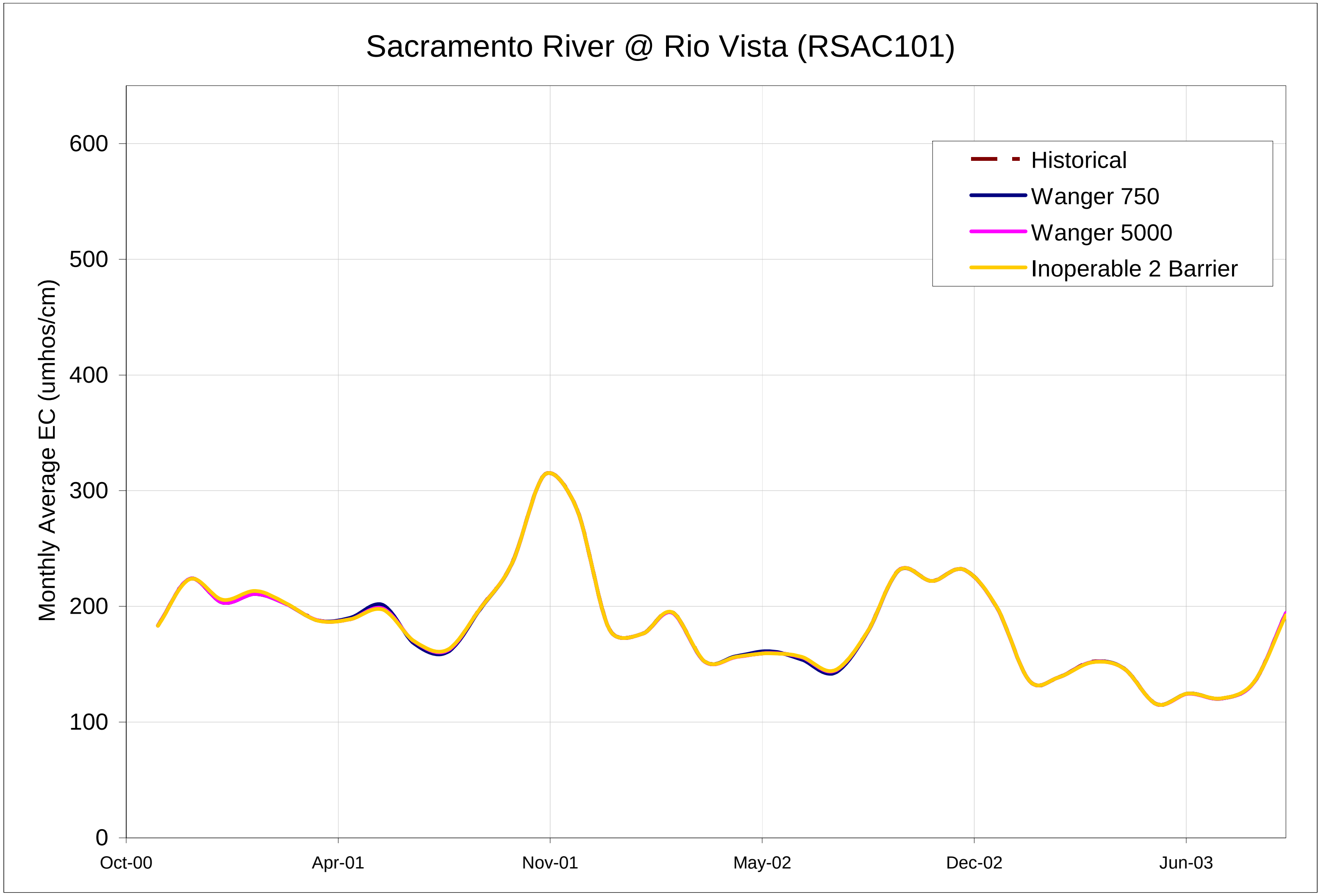


Figure 1.4-10. Salinity Projections at the old River near Highway 4

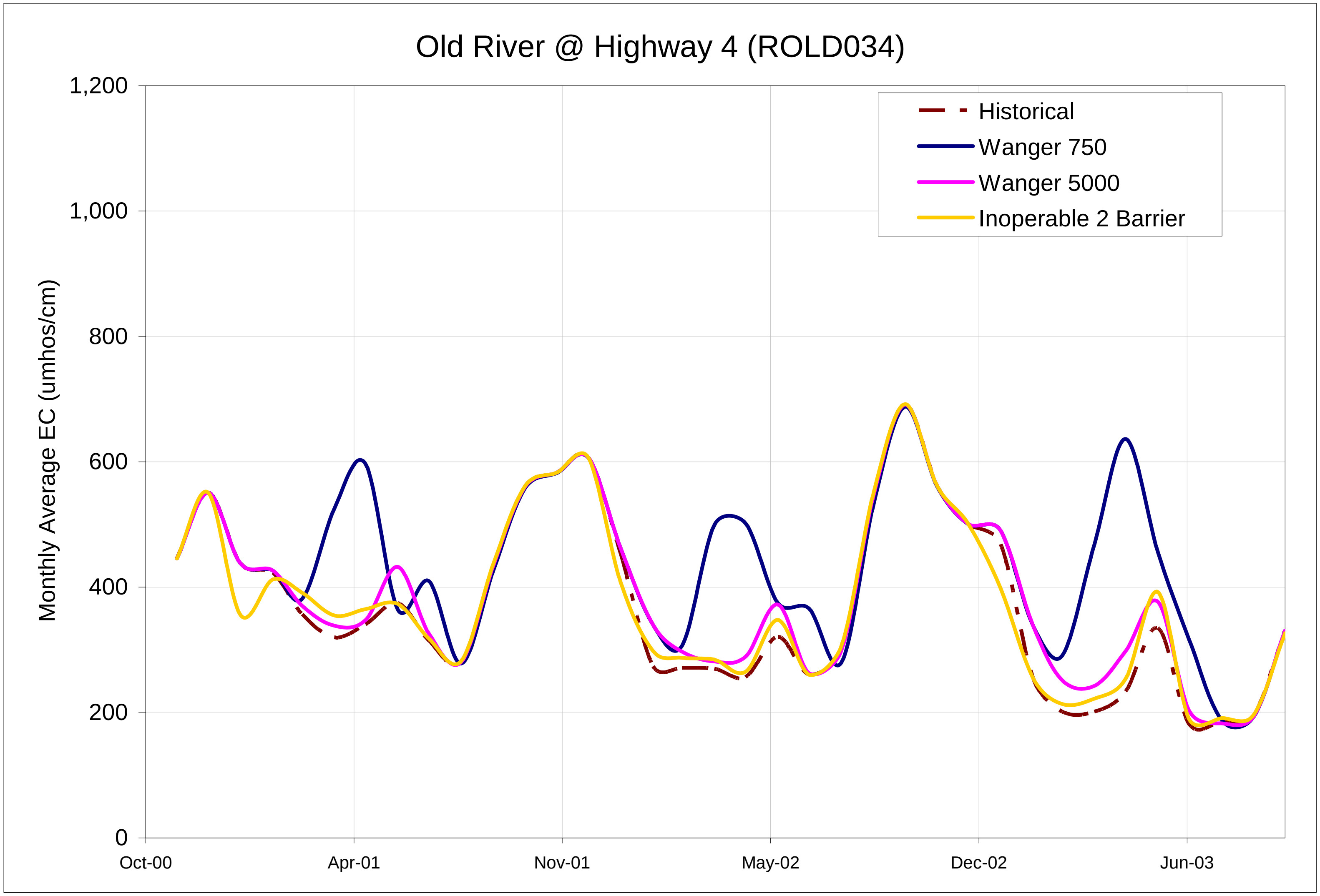


Figure 1.4-1. Predicted Flows at Dutch Slough

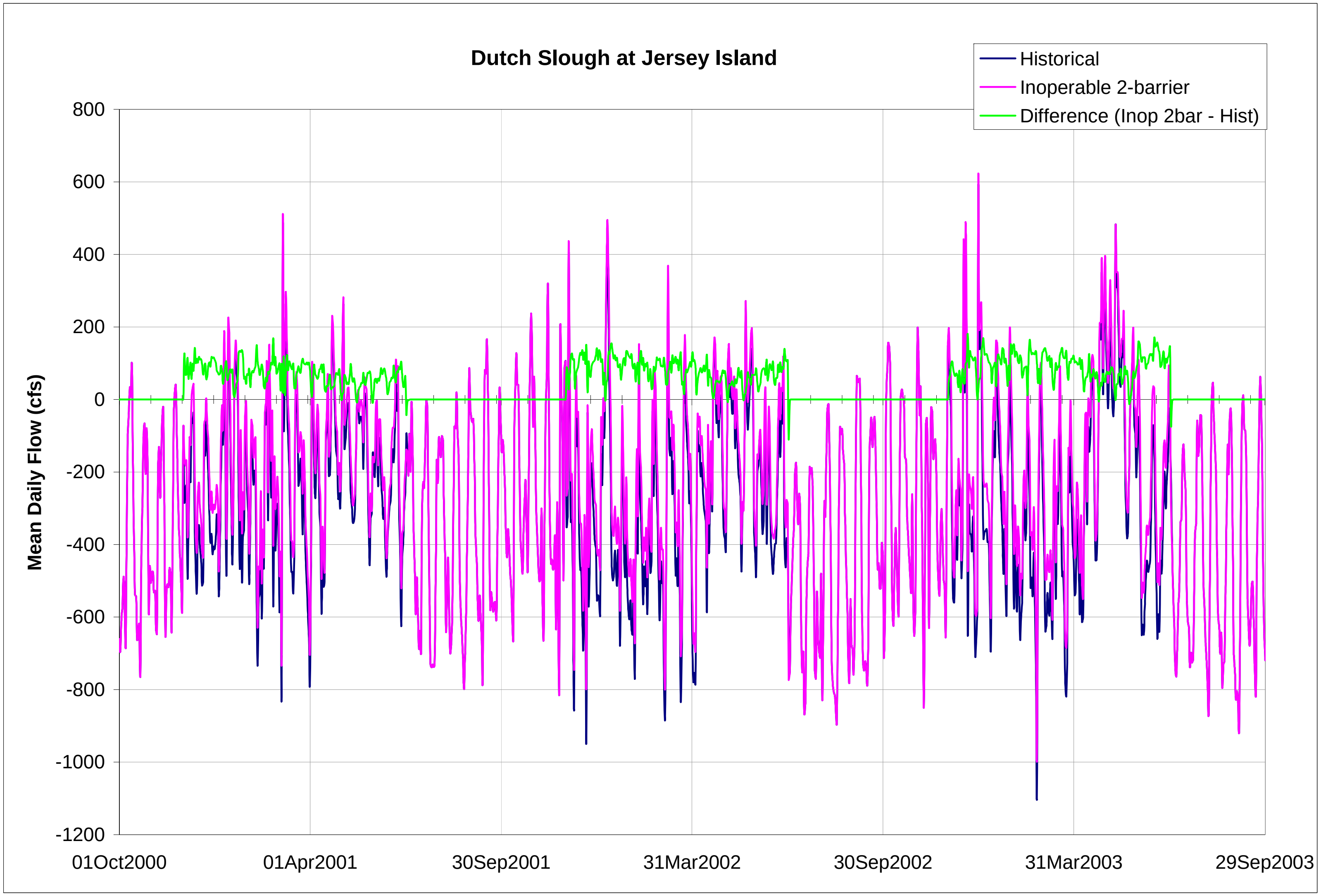


Figure 1.4- 2 - Predicted Flows on the Old River downstream of the 2-Gate Barrier

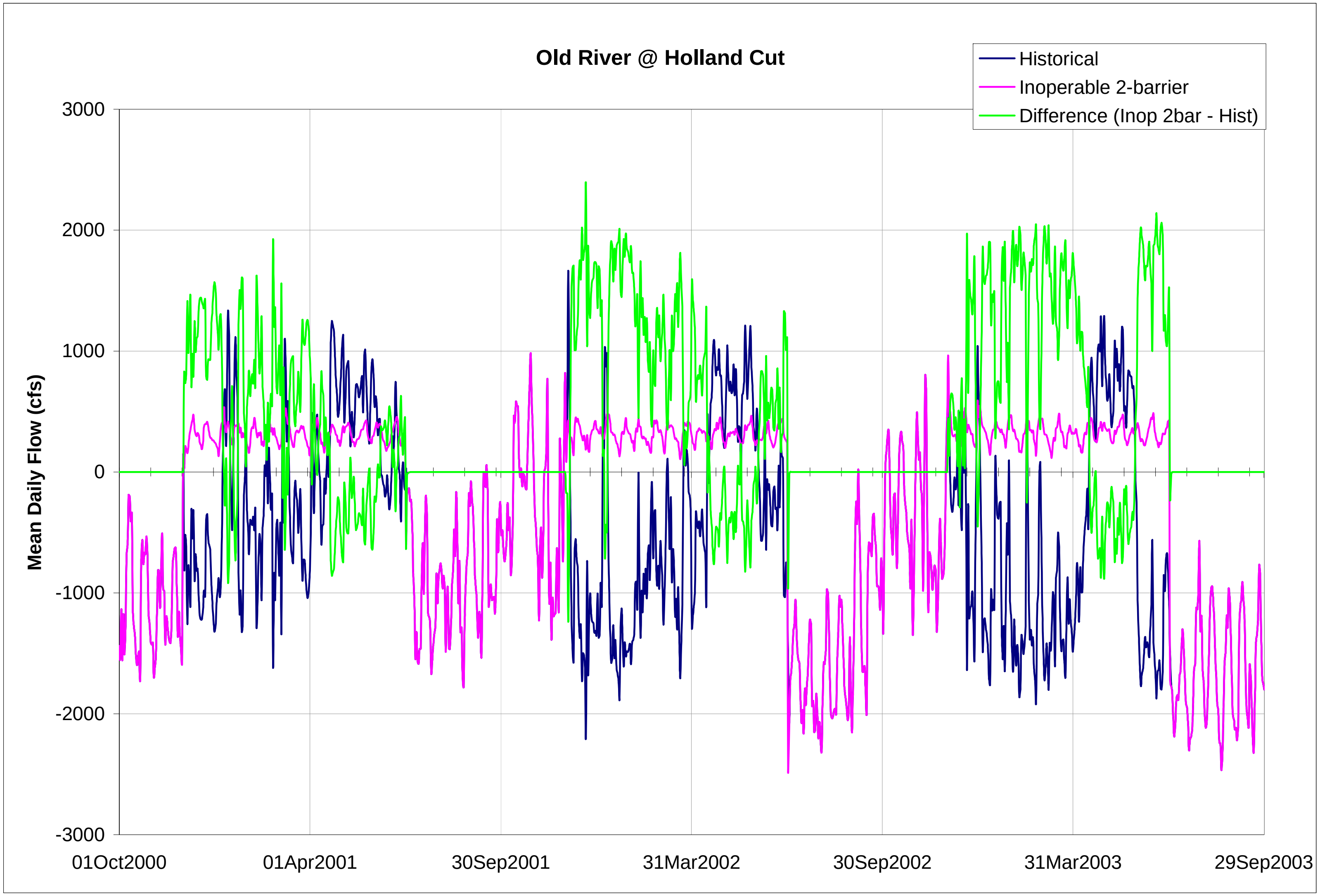


Figure 1.4- 3 - Predicted Flows on the Old River at Highway 4

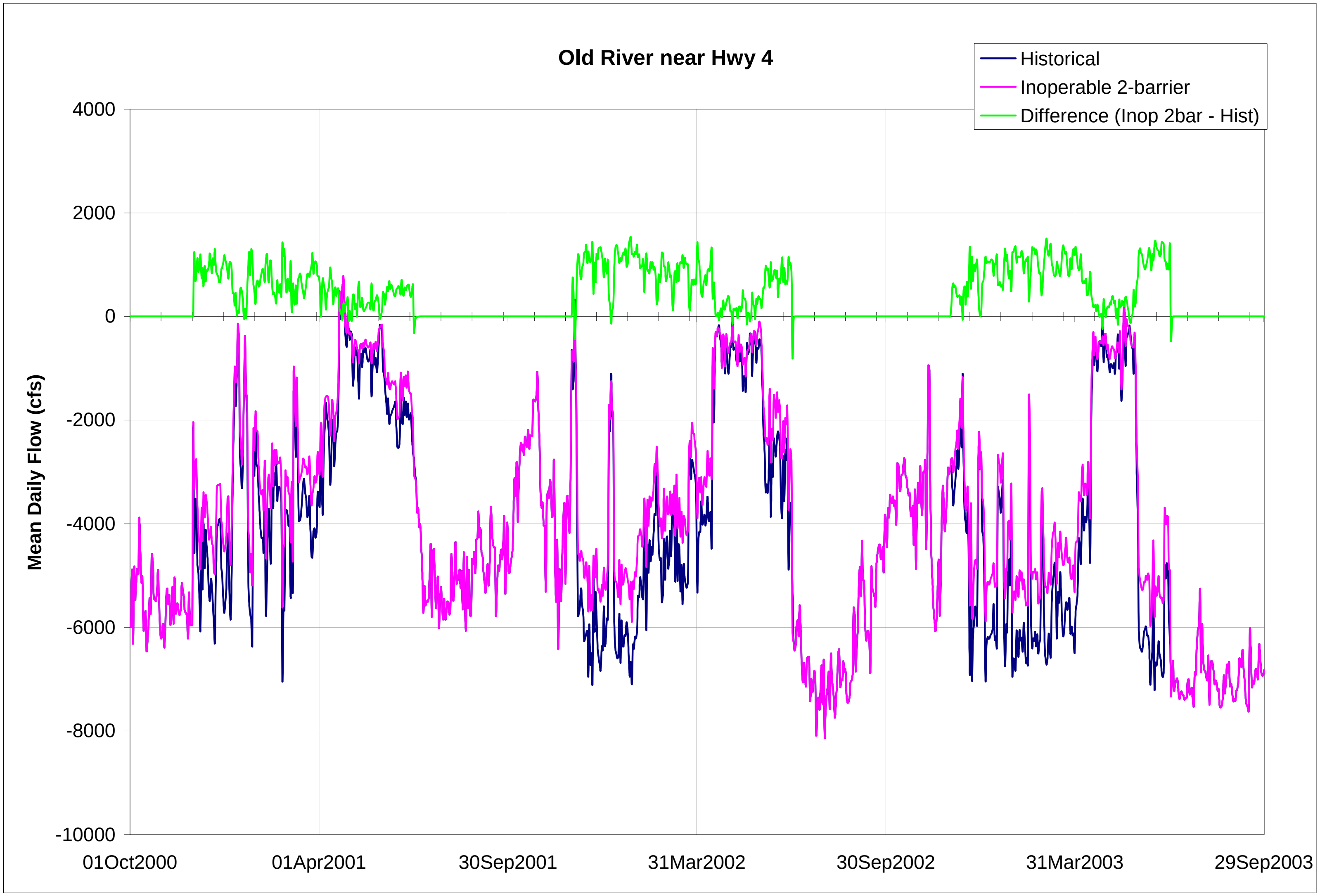
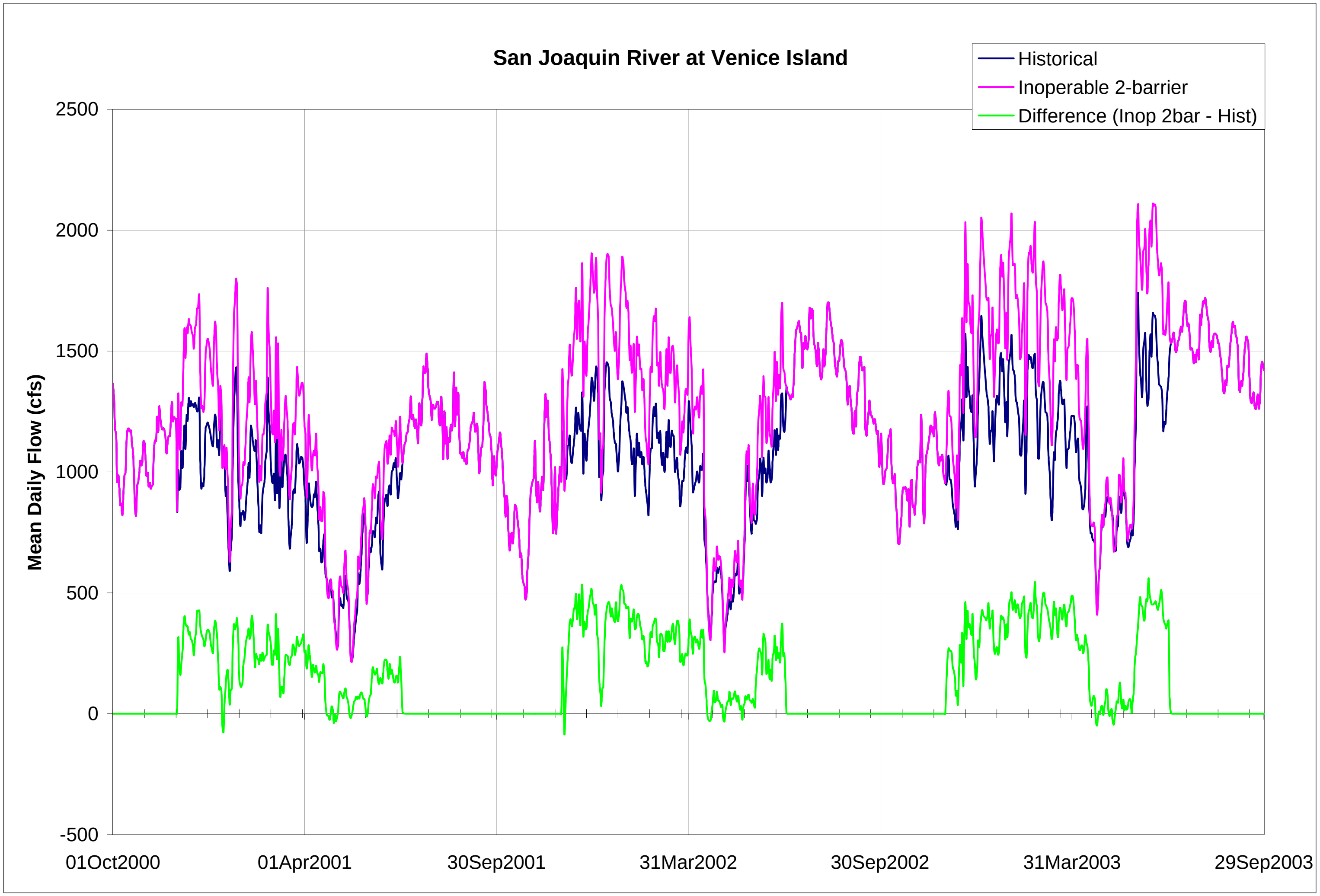


Figure 1.4- 4- Predicted Flows on the Middle River at Tracy Blvd


San Joaquin River at Venice Island
Historical
Inoperable 2-barrier
Difference (Inop 2bar - Hist)
Mean Daily Flow (cfs)
2500
2000
1500
1000
500
0
-500
01Oct2000
01Apr2001
30Sep2001
31Mar2002
30Sep2002
31Mar2003
29Sep2003

2.2.3 Particle Tracking and Analysis

2.2.3.1 Summary

Hydrodynamic and particle entrainment analyses were performed to simulate the effects of these facilities on weak swimming fish (like Delta smelt) in the Delta. Additional modeling analyses were completed to compare alternative water supply management approaches to achieve reduced level of particle entrainment reduction at the south Delta pumps. Water quality modeling analyses were also performed.

2.2.3.2 Model description and assumptions

Baseline conditions are those required by the interim remedy order by Judge Wanger on December 14, 2007. The most recent historic DSM2 simulation available from the Department of Water Resources (DWR) was used for the analyses. The flow results from the three year (WY 2001 – WY 2003) historic DSM2 simulation were used to describe the baseline for the comparative analysis.

2.2.3.3 Analyses and Results

Historic Operations

The reduction in the particle entrainment (and by inference waters occupied by Delta smelt) at the pumps was quantified for the two scenarios from the Wanger order. Using the particle tracking module (PTM) in DSM2, particles were inserted at two locations: (1) Old River upstream of Quimby Island (also upstream of the planned location of gates) and (2) San Joaquin River downstream of Big Break. One thousand particles were inserted evenly over a 5-day period on March 2nd 2003 and were tracked for 45 days from the insertion date. Since the difference between the two Wanger scenarios is expected only during the Action 3, March was selected for the PTM simulations. Further, March of 2003 was selected because a QWEST reversal occurred during this period and is believed to be representative of conditions that contribute to entrainment.

Historic conditions result in average annual combined SWP and CVP exports of 5,467 TAF. Under historic conditions, 30% of particles inserted on the San Joaquin River downstream of Big Break were entrained at the pumps. Similarly, 95% of particles inserted on Old River upstream of Quimby Island were entrained at the pumps.

Table 2-5 shows the summary of percent reduction in particle entrainment from historic conditions at the CVP/SWP export pumps for the two reduced flow simulations.

Table 2-5 Summary of average annual exports and percent particle entrainment at export pumps for the Baseline and the two Old and Middle River reverse flow simulations

Option	Average Annual Export Reduction (TAF)	% Reduction in Particle Entrainment at Banks and Jones Pumping Plants	
		San Joaquin River downstream of Big Break Insertion	Old River upstream of Quimby Island Insertion
Old and Middle River Flow (> -5000 cfs)	630	82%	8%
Old and Middle River Flow (> -750 cfs)	1,400	100%	90%

Anticipated Future Operations

The 2-Gate project was assessed using the same analytical tools (DSM2/PTM) and assumptions used to derive the values in Table 1-6. For particles released in the central Delta, the implementation of the 2-Gate project resulted in a 72% reduction in particles at the exports pumps using historic pumping criteria. This was accomplished with no export reduction. These results are shown in Table 1-7. Based on these results, the 2-Gate Project importantly reduces the entrainment of neutrally buoyant particles (and poor swimming fish) at the export pumps via the Old River.

Table 1-7 Summary of average annual export reduction and percent reduction in particle entrainment at export pumps with the 2-Gate Plan

Option	Average Annual Export Reduction (TAF)	% Reduction in Particle Entrainment at Banks and Jones Pumping Plants	
		San Joaquin River downstream of Big Break Insertion	Old River upstream of Quimby Island Insertion
2-Gate Plan (non-tidal operations)	0	17%	72%

Sample Complimentary Operations (not a part of the 2-Gate Fisheries Protection Plan)

A number of complimentary flow control actions (which were not a part of the 2-Gate Fisheries Protection Plan) were assessed to observe the benefit of combining 2-Gate and flow control measures using the same analytical tools (DSM2/PTM) and assumptions described above. An example is provided in Table 2-6 showing the effects of adding San Joaquin River flow through export reductions equivalent to Qwest >0 cfs. When added to the 2-Gates, this resulted in a reduction in entrainment at the pumps from historical of 82% for particles inserted in the central Delta. As well, for particles inserted on the San Joaquin River near Dutch Slough, these combined actions resulted in a 75% reduction in entrainment at the pumps. Maintaining a continuous operation of this type from December through June resulted in export reductions of 286 TAF.

Table 2-6 Summary of average annual export reduction and percent reduction in particle entrainment at export pumps with the 2-Gate Plan + Qwest >0 cfs

Option	Average Annual Export Reduction (TAF)	% Reduction in Particle Entrainment at Banks and Jones Pumping Plants	
		San Joaquin River downstream of Big Break Insertion	Old River upstream of Quimby Island Insertion
2-Gate Plan (non-tidal) + Qwest >0 cfs	286	75%	82%

2.2.3.4 Results of Particle Tracking Studies from Mokelumne System

A representative fraction of the particle tracking results for particles inserted on the Mokelumne River system are shown in Table 2-7. Results of the 2-Gate (Non-Tidal-Op) + Qwest >500 cfs combined actions are compared to historic conditions. Particles were inserted on the Mokelumne River downstream of Georgiana Slough, on the Mokelumne downstream of the Cosumnes River and on Little Potato Slough.

As a general rule, particles passing Chipps Island under the project condition are substantially greater than historic conditions in an above normal year (2003) and slightly less than historic conditions in a dry year (2002), suggesting generally increased downstream flow for most year types, which is expected to be beneficial to salmonids. As a general rule, particles reaching the pumps in the project condition are significantly less than the historic condition in an above normal year (2003), and slightly more than historic conditions in a dry year (2002), suggesting less flow toward pumps for most year types and generally favorable conditions for salmonids.

Table 2-7 Results of Particle Tracking Studies from the Mokelumne System

Location	Mokelumne d/s Georgiana		Mokelumne d/s Cosumnes		Little Potato Slough	
	Historic	2-Gate (Non-Tidal) + Qwest >500 cfs	Historic	2-Gate (Non-Tidal) + Qwest >500 cfs	Historic	2-Gate (Non-Tidal) + Qwest >500 cfs
March 2003 Insertion						
To CVP Exports	15.9	11.6	30.6	13.7	30.5	22.4
To SWP Exports	32.1	25.7	58.2	37.3	59.5	58.2
Past Chipps Island	1.5	2.2	4.2	21.5	0.0	1.7
April 2002 Insertion						
To CVP Exports	3.6	4.6	20.8	21.3	26.7	27.1
To SWP Exports	1.1	1.1	14.3	15.3	15.1	28.0
Past Chipps Island	12.6	10.2	21.6	18.1	3.7	2.2

2.2.4 Other Water Quality Effects

Installation of the barriers would result in an increase in suspended solids immediately adjacent to the construction sites. This increase would occur for the period of excavation (approximately 10 days) and during the installation of the rock foundation and dike materials (an additional 10-14 day period). Based on other similar dredging activities in the Delta, it is anticipated that the increased in suspended sediments would persist for approximately one day after the end of active excavation and construction.

The 2-Gate project would have minimal influence on other water quality parameters in the Delta. Waters near Bacon Island would temporarily have reduced tidal influence. Since the 2-Gate project barriers are temporary and incomplete barriers to flow it is unlikely that water temperatures, dissolved oxygen, salinity and other important water quality parameters in these waters would be adversely affected. Further, installation of facilities and the operation of the 2-Gate project would not result in an exceedance of any of the water quality criteria in the Delta.

2.2.5 Export Pumping

The addition of flow to the San Joaquin River, and the Old and Middle Rivers complement 2-Gate operations by helping isolate turbidity and salinity events conducive to Delta smelt downstream of the gates or avoiding and minimizing entrainment of smelt (and other pelagic species) at the export pumps. Potential operations such as partial opening Delta Cross Channel gates or the operation of the gates through diurnal operations (open during the day and closed at night), the conduct of export reductions or upstream reservoir releases, add flow to the San Joaquin River and influence movement of smelt away from the export pumps without any water export reduction. Experimental operations at the Delta Cross Channel are being evaluated through the North Central Delta Salmon Outmigration Study starting in October 2008.

2.3 RECREATIONAL BOATING

2.3.1 Existing Conditions

This section assesses the affects of the proposed 2-Gate plan to recreational boating on the Delta. The affects identified are general, as specific data related to impacts have not been collected. The Delta provides a wide variety of public recreational opportunities including motorized boating, fishing, camping, sailing, hunting, windsurfing, and waterskiing. The Delta accommodated approximately 6.5 million user days in 2000 while visitation was projected to be about 8-million user days in 2020 (Cal Boating 2002). A statewide survey of registered boat owners found 30 to 40 percent of boaters who visit the Delta, recreate in the winter months, compared with over 80 percent in the summer. Roughly two-thirds of those interviewed recreated in the Delta during the spring. The Delta is notable for the distance boat owners can travel while recreating. Almost 60 percent of large boat owners travel for up to 50 miles on connected waterways while about one-quarter travel between 50 and 100 miles (Cal Boating 2002). Duck hunting is a popular activity on the weekends and holidays in the area in the fall and early winter; there is also some hunting on the weekdays at hunting clubs (CDFG 2008).

The existing condition allows for boat passage between Bacon and Holland Islands and between Bacon and Mandeville Islands throughout the year. The proposed gates are in what Cal Boating defines as the West Zone (one of six recreation zones), although the proposed gate proximate to Mandeville Island is close to the East Zone. Over half of the total acres of navigable waters in the Delta are in the West Zone, which encompasses the Old River and portions of the Middle River. This zone contains approximately 152 linear miles of navigable waterways, and is considered the water recreation hub of the Delta. About 15% of the total visitation in the Delta is in the West Zone while also containing over one-half of the 95 marinas along with the greatest number of boats on the water. The zone is noted for fishing, sailing, and windsurfing while waterskiing is not as popular compared to other zones in the Delta (Cal Boating 2002).

Although the general area appears to be popular with boaters, no specific visitation information is available for the areas directly proximate to the proposed gate sites. Also, there is no specific information available on the travel routes Delta boaters travel when in the area.

2.3.2 Effects

The primary effect to recreation boating in the area would be due to the boating obstruction created by the gates. During abutment construction, the channel passage would be impaired and likely closed while the barge is being sunk. This would certainly impact recreational boating for those who plan to pass through the affected channels.

Closing the two gates would likely affect recreational boaters and duck hunters in the area as the gates could potentially increase the distance boaters would need to travel to reach their desired location. For people who live aboard boats, the closure of the two gates would severely restrict movement between areas directly south of the gates and Frank’s Tract because the detour required would add to travel time and gas consumption. Adequate notice and information would be needed to avoid or reduce conflicts and reroutes for recreational boaters during the gate closure time. For trailerable boats, the Department of Water Resources could install boat ramps at both locations for use during these times. However, it is unlikely many boaters (other than those using smaller boats) would use these ramps. The closures would overlap with the end of waterfowl season and hunters who wish to pass through the effected areas may be impacted. Additionally, there may be impaired passage over the barge when the gates are open. In order to warn boaters before they enter the channel, it may be necessary to post signs.

Further information would be necessary to better assess the effects to boaters in the area. It is clear that the gates would create an impediment for certain travelers, but to what extent is not clear unless information about travel patterns is obtained or on-site observations are made. Further, some visitors are likely to be disproportionately affected, such as those who depart from Discovery Bay and whose travel distances to Franks Tract would be increased. Closure of these two gates would also restrict boats from transiting the shorter central Delta route between Stockton toward Franks Tract

It is also not clear how the boaters will respond to this closure, existing survey data about Delta visitors is general and inferring their views about the gates is not possible. In general, visitors are more accepting of management actions under the following two conditions: (1) they have been made aware of the closures ahead of time; (2) they understand the rationale for the change. Further, input from boaters or other stakeholders (such as marina operators) would likely prove useful in determining methods to operate the gates while minimizing the impact on the visitors.

Therefore, it is very likely the gate closures will affect recreational boating on the Delta. Further potential mitigation efforts would include a comprehensive Interpretation and Education program, which would provide information about the closure and other potential routes; this program would require working with both public and private recreation providers in the area.

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Section 3: Effects on Aquatic Species and Critical Habitat

3.1 ENVIRONMENTAL BASELINE

Refer to BA for this section.

3.2 EFFECTS OF THE ACTION

3.2.1 Approach to the Assessment

This section assesses the effects of the proposed action on endangered species and their designated critical habitat.

The “Description of the Proposed Action,” section provides an overview of the action under consideration. The “Status of the Species and Critical Habitat” and “Environmental Baseline,” sections, provides an overview of the threatened and endangered species and critical habitat considered in this assessment, first overall (e.g. ESU or DPS wide) and then in the action area appropriate for the action under consideration.

> Regulations that implement section 7(b)(2) of the ESA require an evaluation of the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action. This is necessary to determine if the proposed action would be expected to appreciably reduce the likelihood of survival and recovery of listed species in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require a determination if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. 1536).

This effects analysis is approached in a series of steps. First, a determination, based on the project description of the direct and indirect physical, chemical, and biological effects of the proposed action on individual members of listed species or aspects of the species’ environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species’ environment - such as reducing a species’ prey base, enhancing populations of predators, altering spawning substrate, altering ambient temperature regimes; or adding something novel to a species’ environment - such as introducing exotic competitors or noise disturbance). Second, once the effects of an action have been identified, an evaluation of the available evidence to identify the probable response (including behavioral responses) of listed species to those effects is conducted. This is important to determine if the anticipated project effects could reasonably be expected to reduce a listed species’ reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). Finally, the evidence available is used to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, this assessment examines: 1) effects associated with the construction (both installation and removal) of the proposed project features; 2) effects associated with the operation and maintenance of the proposed project features; and 3) effects associated with any proposed or potential conservation measures, designed to avoid or minimize adverse effects to listed species.

These effects are evaluated for the following species:

- Delta smelt
- Steelhead
- Winter-run Chinook salmon
- Spring-run Chinook salmon
- Fall/Late Fall-run Chinook salmon
- Green sturgeon
- Longfin smelt
- Pacific lamprey
- Striped bass

The 2-gate structure is designed such that the butterfly gates can be open or closed depending on environmental conditions and the potential to entrain fish. For example, following large storm events, it may be of value to open the gates on the ebb tide to allow water to pass through while keeping fish such as Delta smelt on the north side of the gates. Further, a ramp has been added to the design scheme to accommodate passage of the bottom dwelling sturgeon if the gates are opened. However, this effects analysis has not attempted to evaluate to what extent the gates will be open during any given operation event. To this end, effects analysis for all species are based upon the gates being closed during their entire operation from December through March. This closed during the entire operational period assumption yields the greatest effect to water quality (salinity and DO) and interception of normal fish movement patterns. The table below summarizes levels and concerns in regard to the evaluated species.

The primary information used in this assessment is described in Section 1.2, above, and in the 2008 CVP/SWP OCAP BA. Detailed modeling information is included in Appendix A, below.

Table 3-1 Levels of Effect

	Delta Smelt	Steelhead	Green Sturgeon	Winter Run Chinook	Spring-run Chinook	Fall/Late Fall Chinook	Longfin smelt	Pacific Lamprey	Striped Bass	Avoidance and Mitigation Measures
Construction (Nov)										
Dredge										Dredging, sediment Analysis Plan
Mortality, injury	1	1	1	3	2	2	1			Monitoring Plan
Turbidity	1	1	1	2	2	3	1			
Contaminants	1	1	1	1	1	1	1			
D.O.	1	2	1	2	2	3	1			
Activity	1	1	1	1	1	1	1			
Rock Placement										
Mortality, injury	1	1	1	2	2	2	1			
Turbidity	1	1	1	2	2	3	1			
Loss of habitat	1	1	1	1	1	1	1			
Change in benthic community	1	1	1	1	1	1	1			
Loss of riparian habitat (small)	1	0	1	1	1	1	1			
Barge										
Entrainment	1	1	1	1	1	1	1			
Crushing	1	0	1	1	1	1	1			
Contaminants	1	1	1	1	1	1	1			
O&M										
Removal (Mar)										
Noise	1	2	2	2	2	2	1			
Activity	2	1	2	2	2	2	1			
Contaminants	1	1	1	1	1	1	1			
Replace (Nov)										
Noise	1	1	1	1	1	1	1			
Activity	1	1	1	1	1	1	1			
Contaminants	1	1	1	1	1	1	1			
Hydraulic connectivity (Dec-Mar)										
Fish passage	3	2	2	1	1	3	2			
Water Quality	1	1	2	1	1	2	1			
Predators	2	2	0	2	2	3	2			

0 = No effect - species not present
1 = Minor effect - few individuals, impacts to individuals are minor
2 = Moderate effect - either few individuals and moderate effect on individuals, or moderate abundance with minor effect on individuals; minor effect on population
3 = Major Effect - significant number of mortalities, or moderate effect occurring during periods of major abundance

3.3 DELTA SMELT

3.3.1 Biological Characteristics

The delta smelt is endemic to the Sacramento-San Joaquin Delta, including Suisun Bay, but are generally most abundant in the western Delta and eastern Suisun Bay (Honker Bay) (Moyle, et al. 1992). Distribution varies seasonally with freshwater outflow. Generally, the species inhabits areas where inflowing fresh water from the Delta system meets salt water from the Pacific Ocean via San Francisco Bay, usually upstream of the 2 ppt isohaline (X2). This area meets specific requirements for freshwater inflow, salinity, water temperature, and shallow open water habitat. They spawn widely throughout the Delta, but their spawning distribution varies from year to year. Spawning has been reported as occurring from December through July (USFWS 1994) or late February through June (Bennett 2005), with a peak in April and May according to both sources. The species generally lives about one year, although a small proportion of the population may live into its second year. UC Davis researchers proposed that increased winter exports are entraining early spawning delta smelt. The early spawners tend to be the largest and most robust individuals. Increased entrainment of the most robust members of the delta smelt population may be weakening the population in concert with other factors (Bennett 2005, Brown and Kimmerer 2002). Delta smelt are zooplanktiverous throughout their lives, feeding mainly on copepods, cladocerans and amphipods (Moyle et al. 1992, Bennett 2005). Eggs are demersal and adhere to the substrate or plant over which they are spawned. They hatch after 9 to 14 days. Fish absorb their yolk sac and develop jaws over the next 4 – 5 days after which they begin to feed exogenously. From this point forward they are expected to drift with the predominant currents, perhaps exercising some control through vertical migrations in the water column (Bennett 2005). They become post-larvae about a month later, and juveniles about one month after that (Bennett 2005). Upstream migration to spawning areas occurs between December and June.

The population of delta smelt has declined substantially since the late 1970s. Since 2000, their populations have been at or near historic low values. Their diminished abundance coincides with historic low populations of other pelagic species including longfin smelt, threadfin shad, and young-of-year striped bass. The simultaneous declines of these species have been termed the Pelagic Organism Decline (POD) (IEP 2005, Sommer 2007). A number of factors have been hypothesized to contribute to the decline of these species including pollutants, introduced species, and water operations. The importance of these factors in these declines is a topic of extensive research (Sommer 2007). A more complete description of the species life history and factors affecting its abundance and distribution can be found in the OCAP BA (Reclamation 2008).

LEGAL STATUS

The U.S. Fish and Wildlife Service (USFWS) listed the delta smelt as threatened effective April 5, 1993, based upon its dramatically-reduced abundance, threats to its habitat, and the inadequacy of regulatory mechanisms then in effect (USFWS 1993). The delta smelt was listed as threatened by California on December 9, 1993. In February 2007, the species was proposed for re-listing as endangered with both the USFWS and the California Fish and Game Commission (CBD 2006, CBD 2007). This re-listing was requested because of a substantial step decline in the abundance of this species beginning in 2002 from an already depressed population status, with no recovery in subsequent years, in spite of favorable hydrologic conditions.

Critical habitat for delta smelt was defined by the USFWS (1994) as:

> *"Areas and all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; and the existing contiguous waters contained within the Delta."*

The primary constituent elements in the Final Rule for the delta smelt (USFWS 1994) are defined as follows:

SPAWNING HABITAT

Delta smelt adults seek shallow, fresh, or slightly brackish backwater sloughs and edge-waters for spawning. To ensure egg hatching and larval viability, spawning areas also must provide suitable water quality (low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore Sloughs; the Sacramento River in the Delta; and tributaries of northern Suisun Bay. The spawning season may start as early as December and extend until July (USFWS 1994).

LARVAL AND JUVENILE TRANSPORT

To ensure that delta smelt larvae are transported from the area where they are hatched to shallow, productive rearing or nursery habitat, the Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance (e.g., sand and gravel mining, diking, dredging, and levee or bank protection and maintenance) and flow disruption (e.g., water diversions that result in entrainment and in-channel barriers or tidal gates). Adequate riverflow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Additionally, riverflow must be adequate to prevent interception of larval transport by the State and Federal water projects and smaller agricultural diversions in the Delta. To ensure that suitable rearing habitat is available in Suisun Bay, the 2 ppt isohaline must be located westward from the Sacramento-San Joaquin River confluence during the period when larvae or juveniles are being transported, according to the historical salinity conditions which vary according to water- year type. Reverse flows that maintain larvae upstream in deep-channel regions of low productivity and expose them to entrainment interfere with these transport requirements. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations. The specific geographic area important for larval transport is confined to waters contained within the legal boundary of the Delta, Suisun Bay, and Montezuma Slough and its tributaries. The specific season when habitat conditions identified above are important for successful larval transport varies from year to year, depending on when peak spawning occurs and on the water-year type. In the biological opinion for the delta smelt (USFWS 1995), USFWS identified where additional flows might be required in the July-August period to prevent delta smelt that were present in the south and central Delta from being entrained in the State and Federal Project pumps and to avoid jeopardy to the species.

REARING HABITAT

Maintenance of the 2 ppt isohaline, according to the historical salinity conditions described above and suitable water quality (low concentrations of pollutants) within the estuary is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. This placement of the 2 ppt isohaline also serves to protect larval, juvenile, and adult *delta smelt from entrainment in the State and Federal water projects. An area extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of tidal excursion when the historical salinity conditions described above are implemented. Protection of rearing habitat conditions may be required from the beginning of February through the summer.*

ADULT MIGRATION

Adult delta smelt must be provided unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries, including Cache and Montezuma Sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods.

3.3.2 Effects on Delta Smelt

3.3.2.1 Potential Plan Effects on Delta Smelt

As described in the project description, the proposed project is intended to prevent delta smelt and other species from moving into the South Delta through Old River and Connection slough. Fish entering the South Delta are highly vulnerable to entrainment at the pumps. The delta smelt prevented from entering the South Delta would need to find other areas to spawn, where they and their progeny would presumably be less subject to entrainment.

The proposed action could impact fish within the immediate area of the gates through construction activities (dredging, rock placement, barge placement, and removal of rock fill and the barge), and species in the broader action area through its effects on hydrodynamics (changes in flow patterns, tidal lags), water quality (turbidity, dissolved oxygen, contaminants, nutrients), and food web dynamics). The potential impacts of the action for Delta smelt are discussed below.

Construction

GATE INSTALLATION

Construction is scheduled to occur in October and November, with completion by December 1. During this time, delta smelt are generally located in Suisun Bay and are just beginning their upstream migrations, which can take several months. Few, if any, delta smelt are expected to be at the construction site at this time. Therefore, construction activities (dredging, rock placement, barge placement and their associated short-term affects on turbidity, contaminant availability, and other disturbance) would not affect individual delta smelt. The modification of the benthic community in the vicinity of the gates would be a long term effect, persisting into the times when delta smelt would be present. This would not have any substantial effect on delta smelt, however, as the area is small and this species is pelagic, feeding on zooplankton throughout its life.

GATE REMOVAL

The barges would be removed after July 1, with subsequent removal of the rock abutments. During this time, delta smelt would not be present in the area, and no impacts to this species are expected.

After the first year, the gates would be replaced on about December 1 and removed again beginning July 1. This subsequent placement would not involve any dredging, but would require replacement of the rock abutments and barge. The effects of these activities would be as described above under "Gate Installation." The removal of the gates in subsequent years would be as described under "Gate Removal," above

Operations

The gates would be operated between December 1 and June 30 based on the occurrence of water quality conditions that indicate delta smelt would be present in the vicinity of Frank's Tract or the presence of smelt in these locations (see Section 1.3). In addition, from April 1 through June 30 the gates would be closed when the PTM indicates that there would be a higher likelihood of delta smelt being entrained at the pumps with the gates open than with them closed. Historically, salvage densities for delta smelt have been highest during May and June. During the December to June timeframe, all lifestages of delta smelt would be present. Adults would predominate in December through February, and other lifestages would increase in abundance from February through May. Most adults die after spawning, so their numbers would tend to decrease after the peak of spawning (usually in April and May). Juveniles would increase in abundance through June. Placement of the gates is intended to prevent delta smelt from being carried from habitat within and adjacent to Frank's Tract into the conveyance channels leading directly downstream to the CVP and SWP pumps, where they would be subject to entrainment, predation and poor habitat conditions. The gates would reduce flows from the area around Frank's Tract toward the pumps. In the gates open position, flows would be reduced by about 60 percent compared to current conditions by the constriction associated with the gate structure. When the gates are closed, nearly all flow would be stopped (there would be minor seepage around the gates and through the abutments).

The results from particle tracking model simulations (conducted by CH2M Hill) indicate that closed gates would result in about a 72 percent reduction in the entrainment of neutrally buoyant particles originating from Frank's Tract and Big Break. This indicates a substantial benefit to larval and juvenile delta smelt originating in this area, assuming these individuals act as neutrally buoyant particles. Thus, a reduction in the loss of this species to entrainment is expected during the period when the gates are installed, even with the gates open. It is unknown where any displaced adults might spawn, once prevented from entering the South Delta. It is believed that the South Delta is not currently an important source for production of delta smelt, although it was used prior to the 1980s (CBD 2006). Under current operations, most progeny produced in the South Delta are presumably subsequently entrained at the pumps. Assuming that the adults blocked by the gates are able to successfully spawn elsewhere in the Delta and specifically in the San Joaquin River or areas north of the San Joaquin River, and their offspring survive to move downstream into Suisun Bay, this action would reduce entrainment losses during the December through June period and contribute to the maintenance and recovery of the species. If, however, the adults spawn in Frank's Tract and Big Break, then their offspring have a likelihood of being transported to the South Delta when the gates are opened, if strong reverse flows occur, unless sufficiently high flows occur on the San Joaquin River to move these individuals out of these areas and into Suisun Bay. It is estimated that flows of more than 12,000 cfs on the San Joaquin River or more than 80,000 cfs on the Sacramento River would be sufficient to move these individuals downstream.

The peak of spawning for delta smelt is reported to occur in April and May (Moyle 2002). Having the gates closed during this period would provide substantial protection from entrainment for delta smelt, assuming that the progeny produced were not drawn into the South Delta through other routes or when the gates are opened.

The gates would result in changes in the hydrodynamics of the South Central Delta. Dead-end sloughs would be created on either side of each closed gate. On the south side of the Old River Gate, the dead-end slough created (extending to Rock Slough) would likely receive reduced mixing that may result in degraded water quality, in the form of reduced oxygen concentrations and increased contaminant concentrations. While low dissolved oxygen concentrations have not been typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with agricultural returns from adjacent drains in the area has the potential to degrade water quality, but the likelihood of this occurring during a one or two week period gate closure period is low and the magnitude of this cannot be predicted at this time. This effect would be expected to resolve soon after the gates are opened. The net effect of this potential decrease in water quality on delta smelt is likely small, however. The dead-end slough on the north side of the Old River gate would likely receive adequate tidal mixing because other slough connections exist to help mix this area. The dead-end slough on the west side of the Connection Slough gate would receive reduced mixing when the gate is close, as the tidal volume that previously flowed past the gates would be greatly attenuated and there are few other channels in that area to facilitate mixing. The dead-end slough on the Middle River side of the Connection Slough gate would be short and very close to Middle River and Mildred Island and would still receive tidal mixing.

Flows in Old River south of the gate would continue to be towards the pumps, particularly south of Rock Slough and Railroad Cut but less so than under current conditions, and would not carry along delta smelt and other fish from the area around Franks Tract. Based upon modeling results, reverse flows would increase in the San Joaquin River between Prisoners Point and Turner. Reverse flows would also increase in Middle River and in Columbia and Turner cuts and other interconnecting channels between the San Joaquin River and Middle River. The increased flows towards the pumps in these other areas may pull more fish toward the pumps from these areas. These are areas of lower delta smelt abundance under historic conditions.

The closure of the gates could result in delta smelt and other forage species accumulating in the dead-end sloughs against the gates. This may in turn attract predators to the area, which may result in higher predation rates, than might occur in other areas. The magnitude of this effect cannot be predicted.

The gates would also delay the movement of nutrients and food items between the South Delta and Franks Tract and Suisun Bay. The importance of this delay is unknown, but presumably most of this transport is towards the pumps based on the strong reverse flows that occur under existing conditions. The gates may result in more of the productivity being retained in the western Delta, rather than pulled into the export facilities.

3.3.2.2 Effects on Critical Habitat

Spawning

Delta smelt adults would be cut off from spawning habitat in the Delta south of the gates. While this area was used for spawning prior to the 1980s, it is believed that the South Delta is not currently an important source for production of delta smelt (CBD 2006). Under current conditions, most progeny produced in the South Delta are presumably subsequently entrained at the pumps. Shifting this spawning away from the South Delta to other areas where the progeny are more likely to survive would benefit the species.

Larval and Juvenile Transport

Larval and juvenile transport depends on the provision of sufficient flows in the Sacramento and San Joaquin rivers to move these individuals downstream to the low salinity zone in Suisun Bay. Additionally, "flows must be sufficient to prevent interception of larval transport b y the State and Federal water projects and smaller agricultural diversions in the Delta" (USFWS 1994). The gates would reduce the number of larval and juvenile fish being drawn south towards the pumps and entrained. The benefit to delta smelt would depend on whether the shifted spawning described above occurred in areas that remain susceptible to entrainment after the gates are opened. If the larvae and juveniles remained in the vicinity of Frank's Tract, then they would be drawn towards the pumps when the gates are opened, and the benefit may be muted. If however, this production occurs on the San Joaquin River or areas to the north of the San Joaquin, then this action may provide substantial benefit. Once these larvae and juveniles move downstream to Suisun Bay, they are much less subject to entrainment at the pumps. It is possible, the gates may increase reverse flows in portions of the San Joaquin River itself, which would interfere with this transport.

Rearing Habitat

Rearing habitat is tied to the location of X2 (the location of the 2 ppt isohaline). When X2 is further west, rearing habitat is enhanced. The CVP and SWP are required to maintain X2 at various points depending on water year type by SWRCB Decision 1641. These requirements would remain in place when the gates were in operation. Thus the gates are not expected to affect rearing habitat.

Adult Migration

Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their tributaries (USFWS 1994). Adult delta smelt begin migrating up the Sacramento and San Joaquin Rivers and their tributaries in December, when the gates would be in operation. The proposed action is not expected to change flows on the Sacramento River or its tributaries. Flows in the San Joaquin River between Prisoners Point and Turner Cut would experience increased or reverse flow by the gate operations, as export water would be drawn into the South Delta towards the pumps through Middle River, Columbia Cut and Turner Cut. This would have an adverse effect on critical habitat for adult migration in this area.

3.3.2.3 Cumulative Effects

3.3.2.4 Effects on Recovery

The proposed action would increase the likelihood of species recovery for the reasons cited above. The potential adverse effects associated with the proposed action are small relative to the potential benefit. It is uncertain where spawning would occur when adult fish can no longer access the South Delta below the gates. However, most of the production from the fish accessing this area is currently expected to be lost to entrainment at the pumps, so any recruitment from these displaced adults would be beneficial to the recovery of the species.

3.4 GREEN STURGEON (ACIPENSER MEDIROSTRIS)

3.4.1 Biological Characteristics

A brief description of green sturgeon (*Acipenser medirostris*) is provided below. A more detailed description can be found in the OCAP BO (Reclamation 2008)

3.4.1.1 Listing Status

On April 7, 2006, NOAA's National Marine Fisheries Service (NMFS) issued a final rule listing the Southern distinct population segment (DPS) of the North American green sturgeon (*Acipenser medirostris*) (green sturgeon) as a threatened species, which took effect on June 6, 2006 (71 FR 17757). Included in this listing is the green sturgeon population that spawns in the Sacramento River and lives in the Sacramento River, the Sacramento-San Joaquin Delta, and the San Francisco Bay Estuary. This listing occurred subsequent to several status reviews, described below.

NMFS conducted a status review of green sturgeon in 2002 (Adams et al., 2002). Upon completion of this review, NMFS determined that the green sturgeon is comprised of two DPSs that qualify as species under the ESA, but that neither warranted listing as threatened nor endangered (68 FR 4433). Uncertainties in the structure and status of both DPSs led NMFS to add them to the Species of Concern List (69 FR 19975). The "not warranted" determination was challenged on April 7, 2003. NMFS produced an updated status review on February 22, 2005, and reaffirmed that the northern green sturgeon DPS only warranted listing on the Species of Concern List, however proposed that the Southern DPS should be listed as threatened under the ESA.

3.4.1.2 Description

Green sturgeon has a cartilaginous skeleton and possesses a few large ossified plates, called scutes, instead of scales. This species is among the largest of the bony fish. Adults have a maximum fork length of 2.3 m and body weight of 159 kg (Moyle et al. 1992). Based upon data collected in the Klamath River, individuals of this species can live at least 60 years (Emmett et al. 1991). They are highly adapted for preying on benthic organisms (e.g. clams, shrimp, etc.), which they detect with a row of extremely sensitive barbells on the underside of their snouts.

3.4.1.3 Life History and Ecology

Green sturgeon rely on riverine, estuarine, and marine habitats and are the most marine of all sturgeon, returning to rivers mainly to spawn (Moyle 2002). This species spends the majority of its life in the ocean following a one to three year freshwater rearing period (Nakamoto et al.1995). Green sturgeon spawning has only been documented in the Klamath, Sacramento (Moyle et al. 1992) and Rogue rivers (Erikson et al. 2001, Rien et al. 2001) during recent times. Spawning occurs from March to July, with a peak in mid-April to mid-June (Moyle et al. 1992). They are thought to broadcast eggs over large cobbles but preferred spawning habitat can range from clean sand to bedrock. Larvae grow fast, but green sturgeon is a long-lived, slow-growing species as are all of the sturgeons (Nakamoto et al. 1995, Farr et al. 2002).

Little is known about green sturgeon feeding other than general information. Adults captured in the Sacramento-San Joaquin delta are benthic feeders on invertebrates including shrimp, mollusks, amphipods, and even small fish (Houston 1988, Moyle et al. 1992). One 100-cm green sturgeon from the Sacramento-San Joaquin estuary was examined in Fall 2001 and opisthobranch mollusks (*Philline* sp.) were the most common prey, but there was also one bay shrimp (*Crangon* sp.) and overbite clams (*Potamocorbula amurensis*). Juveniles in the Sacramento River delta feed on opossum shrimp, *Neomysis mercedis*, and *Corophium* amphipods (Radtke 1966).

3.4.1.4 Ocean Residence

Green sturgeon disperses widely in the ocean after their out-migration from freshwater and before their return spawning migration into freshwater (Moyle et al. 1992). Tagged fish from the Sacramento River are primarily captured to the north in coastal and estuarine waters. Genetic evidence may suggest that Columbia River green sturgeon is a mixture of fish from the Sacramento, Klamath, and Rogue Rivers (Israel et al. 2002).

3.4.1.5 Distribution

Green sturgeon is the most widely distributed of the acipenseridae. They are confined to the temperate waters of the northern hemisphere and range from the inshore waters of Baja California to the Bering Sea. Only green and white sturgeon (*A. transmontanus*) is found in California (Moyle 2002). Two green sturgeon DPSs were identified based on evidence of spawning site fidelity and on molecular genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams et al. 2002)

San Francisco Bay and its associated river systems contain the southern-most reproductive green sturgeon population. The species was first described here by Aryes (1854). Green sturgeon are not common, but they are taken in a white sturgeon trammel net monitoring program most years in numbers ranging from 5 to 110. An abundance estimate is produced by CDFG from white sturgeon monitoring (Adams et al. 2002).

Green sturgeon juveniles are found throughout the Delta and San Francisco Bay, mostly in small numbers but sometimes as many as one hundred as indicated by fish taken in trammel net sampling, small boat trawls, presence in striped bass sampling, and entrainment by water export facilities. Green sturgeon adults and juveniles occur throughout the upper Sacramento River, based upon observations incidental to winter-run chinook monitoring at the Red Bluff Diversion Dam (RBDD), Tehama County. Green sturgeon reportedly spawns in the Feather River, but this has not been substantiated. Green sturgeon spawning occurs predominately in the upper Sacramento River. Juvenile sturgeon is taken annually at trapping operations at the RBDD (1995-2001) and Glenn-Colusa Irrigation District (GCID) pumping plant (1986-2001). It is assumed that all larval and juvenile sturgeon caught at these locations is green sturgeon because 136 juveniles collected here and grown to identifiable size were all this species (Adams et al. 2002).

There is no documentation of green sturgeon spawning in the San Joaquin River, but it is likely that there was spawning before construction of large-scale hydropower and irrigation development. Young green sturgeon have been taken occasionally in the Santa Clara Shoal area in the San Joaquin delta, but these fish may have originated somewhere else (Adams et al. 2002).

3.4.2 Plan Effects on Green Sturgeon

3.4.2.1 Potential Plan Effects on Green Sturgeon

Green sturgeon, mostly juveniles, is found in the Delta throughout the year. They migrate up the Sacramento River to spawn in March and larvae are transported down-river in June and July. Construction and operation activities will occur November through March, when sturgeon is present.

Construction

Construction is scheduled for November and is expected to last for approximately one month. During this time, green sturgeon is found throughout the Delta and may potentially be affected by this action. Construction activities include dredging, rock placement, and barge placement. All of these activities have the potential to cause either direct harm to green sturgeon or reduction in their habitat quality or quantity.

Dredging

Dredging will be used to excavate mud and peat from the channel bed for rock placement to serve as the foundation for the 2 gate structure and barge. This action will occur in November and last for approximately one week when green sturgeon juveniles are present in the system. Dredging of the bottom material has the potential to cause direct mortality or harm through entrainment or injury caused by collision with equipment and/or construction boats.

Indirect effects of dredging include the potential release of additional sediment and contaminants into the water column during the dredging process and associated increases in surface contaminants and noise from construction boats.

Increased sediment disturbance could affect water quality factors by increasing turbidity and reducing dissolved oxygen (DO). Highly elevated suspended sediments can adversely affect green sturgeon in the area by impairing gill structures and disrupting normal behavior. Increases in contaminants in the water column could occur following resuspension of contaminated sediments. Green sturgeon that encounters the sediment plume, even at low turbidity levels could be affected. Lipophilic compounds in the fine organic sediment, such as toxic PAHs, can be preferentially absorbed through the lipid membranes of gill tissue, providing an avenue of exposure to green sturgeon within the sediment plume (Newcombe and Jensen 1996). Dredging will be limited in scope to a relatively small area (less than 4 acres) directly below the gate placement area. It is therefore not expected to increase turbidity over a large area long-term. Additionally, the temporary increase in sediment during this time-period is not expected to affect spawning which occurs well upstream in tributaries to the Delta from March through July, or to offspring development occurring in the following months.

The sturgeon diet is heavily composed of benthic species. Adults captured in the Sacramento-San Joaquin delta are benthic feeders on invertebrates including shrimp, mollusks, amphipods, and even small fish (Houston 1988, Moyle et al. 1992). These benthic species are prone to uptake of contaminants found in the substrate and an increase in contaminants into the water column could lead to some uptake and ultimate accumulation into the green sturgeon diet. Levels of contaminants in the construction area are not considered high relative to areas of similar habitat across the Delta (Deamovic et al. 1996). To this end, overall, it is expected that this activity may increase slightly the contaminant load in the potential sturgeon diet, but not substantially so when considering the short time-frame of the activity and area of disturbance.

Construction boats may lead to surface contaminants due to runoff of oil-based materials during boat operations and an increase in noise and general disturbance. Surface contaminants produced by boats will be addressed in a Spill and Pollution Prevention Plan which will outline actions to reduce impacts from this activity and address responses to potential spills. Noise and general disturbance from boat traffic may deter green sturgeon from using the area during construction. Juveniles may be present in the area and this action would limit habitat available for foraging. However, it is anticipated that most juvenile and adult green sturgeon (if present) would move away from construction activities and into adjacent habitat of similar quality.

Rock Placement

Rock placement is necessary for building the foundation, abutments, and ramp. The placement of the large volumes of rock and gravel necessary for construction of the gates places fish at risk of being crushed or injured by the falling rock. Direct mortality or harm to green sturgeon may also occur during rock placement due to direct collision with associated machinery. Existing habitat will be modified in areas where rock is placed. The total amount of habitat modified due to rock placement is approximately 4 acres.

Rock placement is expected to generate underwater noise from both terrestrial and underwater sources. These activities may generate sharp transient noises from metal components (buckets, scoops, etc.) striking rock that will propagate into the water column.

Rock placement and positioning will disturb the bottom of the riverbed, resulting in increased siltation, and sedimentation. Highly elevated suspended sediments can adversely affect green sturgeon in the area by impairing gill structures

Replacement of the soft bottom sediment with rock to create the foundation will result in an alteration of bottom habitat from mud and peat to rock. This in turn, could affect the benthic community. Species adapted to the soft peat and mud habitat will be replaced, in this particular area, with those more adapted to a firm surface. This change and/or loss to some of the benthic community potentially reduce the total foraging habitat for green sturgeon.

Loss of riparian habitat due to rock placement in the development of the abutments could lead to a loss of emergent vegetation near the levees or riparian vegetation that may be growing on the Holland, Bacon or Mandeville islands. However, these islands are ringed by levees and the amount of riparian vegetation at the gate sites is likely very limited.

Barge Placement

Barge placement may cause direct harm or mortality to green sturgeon due to entrainment during the placement of the barge or capture of individuals as the barge is ballasted and sunk. Indirect effects include disturbance associated with construction boats and contaminants on the water surface as construction boats transfer and put the barge in place. As with the rest of the construction activities, surface contaminants produced by boats will be addressed in a Spill and Pollution Prevention Plan, which will outline actions to reduce impacts from this activity and address responses to potential spills.

Gate Removal

Removal of the gate each year will occur in March. This action has the potential to effect migratory patterns of sturgeon as they move upstream to spawn (as discussed above). Effects of gate removal are similar to those identified for construction, but to a lesser degree. This action has the potential to increase sediment load temporarily and cause general disturbance due to increased boat traffic (barges, tug boats, etc.). Contaminants may enter the water surface from construction boats. The estimated time necessary to remove the gate is approximately one month in the first year and one week in subsequent years. Therefore, there is potential for disturbance during the beginning of the spawning season each year. However, it is expected that the sturgeon will have sufficient opportunity to move around the gate if necessary.

Gate Replacement

Replacement of the gate each November will potentially affect green sturgeon similarly to the initial construction but to a lesser degree. For example, unlike the initial construction activities, replacement of the gate will not require dredging or the same degree of rock placement. This action has the potential to increase sediment load temporarily, and cause general disturbance due to increased construction boat traffic (barges, tug boats, etc.). Contaminants may enter the water surface from construction boats. Replacement of the gate in the fall is not expected to take more than a week and disturbance to green sturgeon that may be in the area should be relatively minor.

3.4.2.2 Operation

Fish Passage

The gate is expected to be closed from December through March. Closures will occur from April through June but less frequently. Therefore, operation of the gate has the potential to impede sturgeon movement as they forage throughout these months and may affect their movement during the beginning of their spawning season in March. Proposed operational criteria that allows periods of openings will lessen the effect of the operation.

It has been documented that juvenile fish are found in the Delta throughout the year (Reclamation 2008). Evidence for this is based in part on the estimates of numbers of green sturgeon taken at the pumping stations. Estimates of the average number of fish (2001–2007) at the CVP Tracy Fish Collection Facility annually are 53, and 20 at the SWP Skinner Fish Facility (Reclamation 2008). Fish captured at these sites include mostly juvenile fish (one to three years of age) that have remained in the freshwater system following their larval development (Adams et al. 2002). It is possible, therefore, that the presence of the gate could impede fish movement and limit direct access to portions of their foraging habitat. However, neither structure prevents access to any site; green sturgeon can move around the gates by swimming back to the San Joaquin River, then east to the Middle River confluence and then south into the South Delta. It is unlikely, therefore, that the presence of the structures will limit the amount of foraging habitat available to green sturgeon.

Green sturgeon spawning occurs well upstream of the Delta from March to July, with a peak in mid-April to mid-June (Moyle et al. 1992). The gate structure remains in place until the end of March which overlaps with the beginning of the spawning period. Green sturgeon spawning in this area has only been documented in the Sacramento River (Moyle et al. 1992, CDFG 2002). Green sturgeon has never been documented in the San Joaquin River or its tributaries (CDFG 2002). However, two unidentified juvenile sturgeon were caught at Woodbridge on the Mokelumne River (rkm 63) in 2003. This is the first confirmation of sturgeon reproduction in the San Joaquin River system (Adams et al 2002).

Individuals migrating to spawn in March during proposed operations and from April through June (during a period of less frequent closures) will not be prevented from moving up into the Sacramento River, the San Joaquin River, or elsewhere throughout the system to access upstream spawning habitat. Rather, the gates impede movement directly into and out of the Old and Middle River and collectively provide one of the two main routes up the San Joaquin River where spawning is not known to occur. The 2-gate plan is therefore not expected to directly affect green sturgeon access to spawning habitat.

Water Quality

The presence of the gate structure itself is designed to affect the hydrology and may therefore have effects on water quality on either side of the structure. A potential effect of changing features of the hydrology is a change in water quality parameters such as flow rate, DO, turbidity, contaminants, and nutrient dynamics. Water temperature is not expected to be influenced by operation of the structures. Other water quality factors such as increased turbidity, decreased DO, and changes in salinity regime all have the potential to affect all life stages of sturgeon.

The presence of the gates will reduce flow in the channels on either side of the gates because the local tidal prism (the volume of water available for movement during tidal cycles) will have been reduced. Both sides will continue to be tidally influenced, but at a reduced rate with the gates closed. The channels near the gates will function much like dead-end sloughs with tidal pumping driving water toward the gates then retreating on an ebb tide. Velocities nearest the gates are very low and as distance from the gate increases, the cumulative channel volume increases and tidal velocities increase as well. Therefore, particles in the water will tend to accumulate on either side of the gate. With each junction of another slough or channel, tidal influence increases and the propensity for stagnation would be reduced. This reduction in water movement nearest the gates could lead to a decrease in DO or change in nutrient dynamics. Changes in nutrient dynamics have the potential to affect the aquatic community, particularly the benthic community on a shorter time-scale. Increased nutrients can lead to harmful algal blooms or changes in algal community and changes in forage base for filter feeders. These effects in turn could affect the forage base for green sturgeon.

Proposed operational criteria that provides for periodic gate openings will lessen the overall effects of the operation on water quality.

Predators

The presence of the gate structure with rock abutments may cause predatory fish such as striped bass or channel catfish to accumulate in the rock crevasse. The closed gates may accumulate fish that might otherwise continue to move through the channels on the other side of the structure. An increased number of fish may lead to increase in the number of potential predators at the site.

At the age of 45 days green sturgeon are 70 to 80 mm (2.8 – 3.1 in) in length (Deng et al. 2002). Juveniles grow rapidly and can reach 300 mm (11 in) in the first year (Nakamoto et al 1995). Assuming individuals are between 70 and 300 mm (2.8 – 11 in) when the gates are in place, it is possible that some juveniles may be prone to predation pressures by species such as striped bass, channel catfish, or largemouth bass.

Proposed operational criteria that provides for periodic gate openings will lessen the overall effects of the operation on predation by creating flow through channels to disperse predators.

3.4.2.3 Effects on Critical Habitat

Critical Habitat has not been designated for this species

3.5 CENTRAL VALLEY STEELHEAD

3.5.1 Biological and Life History Characteristics

3.5.1.1 Status of Species and Critical Habitat

Central Valley steelhead (CVS) DPS (*Oncorhynchus mykiss*) are listed as threatened (January 5, 2006, 71 FR 834). The Distinct Population Segment (DPS) consists of naturally spawned anadromous populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, as well as two artificial propagation programs: the Coleman NFH, and Feather River Hatchery steelhead hatchery programs. Very limited information makes it difficult to estimate historic Central Valley steelhead run sizes, but they may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001) and currently the Central Valley DPS has been reduced to small, remnant populations both inside and outside the action area. Spawner surveys and incidental catch of steelhead during Chinook monitoring indicate that steelhead retain a broad distribution throughout (Moore 2001, NMFS 2003b). More recently, Lindley et al. (2006) predict a highly extensive historic distribution of CVS based on habitat suitability and clustering. One difficulty in assessing the success of steelhead spawning in the upper Sacramento River is the difficulty in distinguishing steelhead from the resident trout population that has developed as a result of managing for cold water all summer.

Critical habitat includes 2,308 miles of stream habitat in the Central Valley including the Sacramento River and tributaries and San Joaquin Rivers east side tributaries up to the Merced River and an additional 254 square miles of estuary habitat in the San Francisco-San Pablo-Suisun Bay complex. Most all main South/Central Delta waterways adjacent to the project area are designated Critical Habitat.

3.5.1.1 General Life History, Distribution and Population Characteristics

Steelhead life histories are one the more complex of the salmonids. Central Valley steelhead populations are found in the Sacramento River and its tributaries, including the Feather, Yuba, and American Rivers, and many small tributaries, such as Mill, Deer, west side tributaries (including Clear, Cottonwood, Putah, Cache, Stony, Thomes, Alamo, and Ulatis Creeks), and Butte Creeks. The Cosumnes and Mokelumne Rivers also support steelhead. Below is a brief description of CVS general life history but several variations of period of use in freshwater, estuarine and nearshore habitats can be expected. Further life history details can be acquired from Reclamation (2008), Quinn (2005), McEwan and Jackson (1996), and Moyle (2002).

River entry for CVS occurs from July through May with peaks in September and February. Spawning takes place from December through April (McEwan and Jackson 1996, Busby et al. 1996). The iteroparous steelhead historically used upper stream reaches and small tributaries but now are confined to lower stream reaches below dams. After about 2 months of intra-gravel development, fry emerge from the egg pockets and associate with stream margin and stream bottom habitat. Yearling steelhead feed on various aquatic insects adjusting their seasonal diets to other aquatic and terrestrial insects or salmonid eggs. Juvenile steelhead emigrate from natal streams volitionally or during fall through spring freshets and use tidal and non-tidal marshes, and shallow Delta areas prior to seaward emigration. Sacramento River juveniles migrate downstream most of the year, predominantly in spring (Hallock et al. 1961). Steelhead juvenile rearing during the summer takes place primarily in higher velocity areas in pools and young-of-the-year also are abundant in glides and riffles. Some older juveniles move downstream to rear in large tributaries and main stem rivers (Nickelson et al. 1992).

Central Valley Steelhead migrate to the ocean after spending one to three years in freshwater (McEwan and Jackson 1996). Once in the ocean, CVS remain one to four years growing before returning to their natal streams to spawn. Rearing and ocean-emigrating CVS use the lower reaches of the Sacramento River and the Delta including tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas.

Central Valley steelhead populations are found in the Sacramento River and its tributaries, including the Feather, Yuba, and American Rivers, and many of the smaller tributaries, such as Mill, Deer and Antelope and Butte creeks and west side tributaries (including Clear, Cottonwood, Putah, Cache, Stony and Thomes Creeks, steelhead have been documented from the Stanislaus River (Cramer 2000) on the San Joaquin River. Steelhead are also known to run in the East Bay Tributaries east of the Carquinez Straits including Alamo and Ulatis Creeks). The Cosumnes and Mokelumne Rivers also support steelhead and steelhead have also sporadically been collected from the Calaveras River. Productivity for steelhead is dependent on freshwater survival and over summering habitat which has been reduced by 95 percent in the baseline. Estimates based on juvenile production indicate that the wild population may number in the average of 3,628 female spawners (Busby et al. 1996). Spatial structure for steelhead is fragmented and reduced by elimination or significant reduction of the major core populations (i.e. Sacramento River, Feather River, American River) that provided a source for the numerous smaller tributary and intermittent stream populations like Dry Creek, Auburn Ravine, Yuba River, Deer Creek, Mill Creek, and Antelope Creek. Tributary populations can likely never achieve the size and variability of the core populations in the long-term generally due to the size and available resources of the tributaries.

3.5.1.2 Action Area Life History, Distribution, and Habitat Considerations

San Joaquin River steelhead begin moving upstream around January and continue migrations into June. The main routes for migration up the San Joaquin River include the main stem San Joaquin River past Stockton to Mossdale, the main stem San Joaquin to False River, then up Old River to rejoin the San Joaquin at the Head of Old River (near Mossdale), through Connection Slough into the Middle River, or up Middle River and then through various channels either back into the main San Joaquin River or into Old River and back to the San Joaquin at the head of Old River.

The Delta may provide rearing habitat for juvenile steelhead (McEwan and Jackson 1996). This is based on an understanding that other coastal estuaries do provide important rearing habitat. However, the historical and current role of the Delta as steelhead rearing or nursery habitat is unknown. Historical Central Valley steelhead salvage data (1968-2002) from the State Water Project and Central Valley Project provide seasonal relative abundance information for the South Delta area. This is based on the assumption that fish movements in the South Delta channel network are influenced by pump-induced reverse flows. Salvage data indicate a high relative abundance of steelhead juveniles from February through May, moderate abundance in June and October – January, and minimal to no abundance from July – September. Juvenile steelhead rear and forage in the South Delta or use the area for transit during seaward migration. Shoreline areas and associated vegetation are important habitat for foraging and cover from predators. Simplified channel habitats, especially those managed primarily for water conveyance and recreation; do not provide the most suitable habitats for maximum productivity. However, water movement through tidally-influenced slough habitat does provide a mechanism for foraging with minimal energy expenditures by foraging fish.

For the purposes of this analysis, the action area is considered steelhead adult migratory, juvenile rearing, smolt outmigration, and kelt rearing habitat.

3.5.2 Plan Effects on Steelhead

As described in the project description, the proposed action could impact fish within the immediate area of the gates through construction activities (dredging, rock placement, barge placement, and removal of rock fill and the barge), and species in the broader action area through its effects on hydrodynamics and hydraulic connectivity (changes in flow patterns, tidal lags, effects on water quality, nutrient and food web dynamics). The potential impacts of the action for steelhead are discussed below.

3.5.2.1 Effects on Steelhead

Construction

Construction is scheduled to occur in November, with completion by December 1 and consists of dredging, rock placement, barge placement. Relative to peak months of salvage, relatively few juvenile steelhead are found during November and December at the SWP and CVP export facilities indicating the presence of some steelhead in the South-Central Delta project area during this time. Migratory adults will also be present in the action area during the construction period. Construction activities and the associated short-term effects of turbidity, contaminant availability, and construction disturbance may affect juvenile steelhead. Adult migration may be temporarily delayed or adults may choose alternate routes.

Reduction in water quality may occur during construction through a variety of factors. Dredging of soft peat material and rock placement have the potential to release additional sediment and contaminants into the system. Reduction in water quality may also occur following barge placement, which has the potential to release petroleum-based lubricants into the system. Increased sediment disturbance could affect water quality factors such as turbidity and dissolved oxygen (DO). Mechanical dredging would be short-term, occur only once, and be limited in scope to a relatively small area directly below the gate placement area. It is therefore not expected to reduce water quality over a large area for the long-term. Sediment will be tested prior to dredging to quantify contaminants already present in the substrate. If high contaminant loads are detected, the gate placement area will be relocated to a more suitable site. Contaminant disturbance during construction is therefore not expected to have a substantial affect on steelhead. Oil-based contaminants and any additional debris will be washed from the barge prior to placement to reduce contaminants. Monitoring of water quality during construction will allow for early detection and clean-up of any released contaminants during barge placement. An increase in commercial boat traffic (derricks, tugs barges) is expected to occur during construction activities. Increased noise and activity may disturb individuals and prevent them from utilizing this portion of the channel during the construction period. This potential disturbance may temporarily reduce habitat available for foraging. Additionally, individuals are potentially at risk of collision with boat traffic especially at increased turbidity levels when avoidance behaviors are altered (inferred from Rowe et al. (2003) in a study on reaction distance and prey recognition).

Salmonids experience a loss of habitat by avoiding turbid water. Increased turbidity (most recent literature reports Total Suspended Solids, which can include tannins, algae, and micro-organic material) may cause avoidance behaviors or interfere with foraging/rearing in the short periods of suspended material (Carter 2006, Newcombe and MacDonald 1991, Newcombe and Jensen 1996). Any contaminants mobilized may cause evacuation of the habitat. The modification of the benthic community in the vicinity of the gates would be a long term effect. Juvenile steelhead typically associate with gravel substrate for cover and foraging so they should be only minimally impacted by displacement from the abutment area. This area loss should not have any substantial effect on steelhead.

Changes to dissolved oxygen as a result of the construction cannot be predicated accurately. Release of nutrients and organics could provide a resource for algal response, but the construction period is past the season where substantive algal growth would be expected. Hyporheic connectivity of the affected area and tidal influxes should maintain good circulation during the construction period.

Rock placement could cause physical injury or mortality to a fish by striking or burial. Underwater release of rocks should minimize this potential effect. Barge placement effects, if slow lowering and placement technique is used, will have negligible direct and indirect effects of sediment entrainment, contaminant mobilization, and fish strike by equipment.

Commercial vessel traffic would be increased at each site during construction and removal activities (derricks, tug boats, barges). Increased noise and activity may disturb individual steelhead that may be in the project area. Juvenile steelhead will likely be encountered in November during construction and significantly more in March during removal. This increased boat activity could temporarily confuse or disorient migrating steelhead or there is a small likelihood of causing physical injury or death if they come into contact with moving equipment.

Overall, the effects of these construction activities are expected to be relatively small with the implementation of the avoidance measures that are provided at the end of the effects analysis. Sacramento River and Mekelumne River origin juveniles and migratory adults will be less affected than San Joaquin River origin fish since their migratory pathways give them a lower likelihood of using South Delta habitats.

Removal

The barges would be removed around March 1, with subsequent removal of the rock abutments. February through April is the period of highest salvage numbers at the SWP and CVP export facilities so juvenile steelhead are highly likely to be present in the action area and adult steelhead could also be present during this time of year. Removal of the barge would result in some disturbance of sediment. No other effects from re-floating and removal of the barges are foreseen. This is not expected to adversely affect steelhead.

Removal of the rock abutments could result in direct injury or mortality of steelhead as rock is removed from the channel using a clam shell dredge. Steelhead could be struck by the dredge or entrained by being caught in the dredge and moved out of the channel, or struck by falling rock. The number of fish that could be impacted is unknown. Removal of the rock abutments would also result in increased turbidity. This increase is expected to be minimal, since this rock would have been placed in the channel only a few months previously and would likely not affect steelhead juveniles or out-migrants. The noise and activity associated with removal of the barriers may result in steelhead avoiding the immediate area which may displace them from the immediate action area temporarily. This should not affect productivity since there are adjacent, similar habitats capable of accommodating juveniles and out-migrants. They may move to non-preferred habitats or to areas where they could be more susceptible to predation.

Overall, the effects of these removal activities are expected to be relatively small with the implementation of the avoidance measures that are provided at the end of the effects analysis. Sacramento River and Mokelumne River origin juveniles and migratory adults will be less affected than San Joaquin River origin fish since their migratory pathways give them a lower likelihood of using South Delta habitats.

Operation

The gates would be in place and operated from December 1 through March based on the operational criteria described in Table 1.1. Conditional openings during this period will lessen the potential affects of the gates on migration. During this time, adult steelhead are in their spawning migration period. Most adults are headed for the Sacramento and Mokelumne River tributaries would not encounter these sites. Adults headed up the San Joaquin River tributaries would be expected to use the main San Joaquin River channel for their upstream migration, and some adults may use the other major pathway up Old River before reconnecting with the San Joaquin River at the Head of Old River. There are other deviations that occur and can result in adult fish moving throughout the interior channels of the south-central Delta. Encountering the gates would delay the arrival of adults to the spawning grounds until the gates are re-opened or would be delayed by the amount of time it would take the fish to seek out other routes.

During this time steelhead juveniles are likely to be present. Juveniles from the Feather, American, Mokelumne and Stanislaus rivers would move downstream through the Delta from November through June. Steelhead salvage at the pumps occurs from November through June with a peak in February to March. Juvenile outmigration on the San Joaquin River peaks from March through May. Based on this information, juvenile steelhead would be expected to be within or passing through the project area during operation

Feather, American and other Sacramento River out-migrants are unlikely to be affected by gate operations since a majority of the fish move down the Sacramento River channel. Some fish may move down Georgiana Slough or the DCC when its open. Under historic conditions, when the DCC is open - drawing water from the Sacramento River south via the Mokelumne River to the Delta pumping facilities, the probability of juvenile steelhead entrainment increases (Bowen et al. 1998). Results of hydrodynamic modeling indicate that flow conditions in Georgiana Slough, the Mokelumne River, the San Joaquin River between Middle River and the confluence with the Sacramento are not changed substantially by gate operations. The proportion of those smolts that enter the DCC or Georgiana Slough would experience conditions also encountered by steelhead smolts from the Mokelumne River.

As a surrogate for how the Two-Gate operation would affect steelhead outmigrating from the Mokelumne River system, a particle tracking model was run for particles inserted on the Mokelumne River system. Particles were inserted on the Mokelumne River downstream of Georgiana Slough, on the Mokelumne downstream of the Cosumnes River and on Little Potato Slough under conditions of the 2-Gate (Non-Tidal-Operation) with Qwest >500 cfs combined actions and compared to historic conditions.

As a general rule, particles passing Chipps Island under the project condition are substantially more than historic conditions in an above normal year (2003) and slightly less than historic conditions in a dry year (2002), suggesting generally increased downstream flow for most year types, which is expected to be beneficial to salmonids.

As a general rule, particles reaching the pumps in the project condition are significantly less than the historic condition in an above normal year (2003), and slightly more than historic conditions in a dry year (2002), suggesting less flow toward pumps for most year types and generally favorable conditions for salmonids.

A proportion of Stanisluas River steelhead use Old River as a migratory corridor during the out-migration. This segment of the population would be especially affected when the gates are closed. Juvenile fish that move west into the head of Old River would face more difficult conditions. Downstream flows will carry them to the CVP and SWP intakes, and if they successfully negotiate these sites, they would be facing near-constant reverse flows in Old and Middle Rivers. Those fish that take the Old River route and are not salvaged at the pumps would be exposed to stronger reverse flows in Middle River and weaker tidal currents in Old River north of the pumps during gate closure. Those fish that stay in the San Joaquin River past Stockton would be exposed to more reverse flow conditions in the San Joaquin River and channels leading into the south Delta between Turner Cut and Middle River during gate closure in February and March. Flow in the San Joaquin River between Prisoners Point and Turner Cut would be more strongly influenced by reverse flow and may impair the ability of Stanislaus River steelhead from successfully leaving the Delta.

Because of the longer path these fish would be required to take to navigate back into the San Joaquin River, the project may effect some outmigrating steelhead from the Stanislaus River, but the magnitude of this effect cannot be determined.

The gates would result in changes in the hydrodynamics of the South-Central Delta. Dead-end sloughs temporarily would be created on either side of each gate. On the south side of the Old River Gate and the west side of the Connection Slough gate, the dead-end sloughs created would likely receive much reduced mixing and thus may suffer from impaired water quality, in the form of reduced oxygen concentrations and increased contaminant concentrations. While low dissolved oxygen concentrations have not been typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with agricultural returns in the area could create this type of problem. The magnitude of this cannot be predicted at this time. The net effect of this potential decrease in water quality on steelhead is likely small, however, as fish in this area would soon navigate away from the area along another route. The net effect of this potential decrease in water quality on juvenile steelhead south of the Old River gate is also likely to be small, however as fish in this area would likely be lost to entrainment at the pumps or predation, even without the water quality effects.

Flows in the Old River south of the gate would continue to be towards the pumps, but less so north of Rock Slough and Railroad Cut, and reverse flows in Old River would increase with each connecting channel with Old River.

The project is not expected to change the number of fish moving from the Sacramento River into the Central Delta via the Delta Cross Channel or Georgiana Slough. It will however, mostly eliminate reverse flows in Old River between the gate location and the San Joaquin River that may attract these fish into the area of Frank's Tract. Even if these fish enter the area near Frank's Tract, they would be blocked from moving down Old River by the gates. Severing the direct route between the San Joaquin River near the mouth of the Mokelumne and the pumps may provide a benefit to this species. Reverse flow conditions in the San Joaquin River between Middle River and Turner Cut would increase. It is unknown how steelhead may respond to these changes in flow patterns. If they follow the flow, the direction the initial direction they take upon entering the San Joaquin River may depend on what the tidal stage is when they enter the river. Because of the physical barriers across Old River and the longer path these fish would be required to take to the pumps, the 2-gate plan would provide some benefit to steelhead, but the magnitude of this benefit cannot be determined.

Juvenile steelhead are expected to be foraging or distributing downstream through the Delta during this period and, as a result, may be more susceptible to the impacts of pumping during the months of operation. Juvenile steelhead are likely to be affected as a result of increased predation in the vicinity of the gates, as predatory fish are known to congregate around man-made barriers in rivers. The gates temporarily would prevent the movement of nutrients and food items between the Delta channels and Franks Tract and Suisun Bay. The importance of this transport is unknown, but presumably most of this transport is towards the pumps based on the strong reverse flows that occur under existing conditions.

Overall, the effects of the operation activities are expected to be mostly associated with hindered spawner migration, juvenile foraging habitat accessibility, and potential increased reverse flow effects on juveniles rearing or outmigrating throughout the south Central Delta from the Woodward Canal north the confluence of Middle River and the San Joaquin River.

Replacement

Abutment reconstruction and barge placement will be the same as the construction effects. There will be no dredging and rock replenishment for the gate pad will be minimal.

Hydraulic Connectivity

Gate closure temporarily will change several aspects of the hydrologic regime. Gate presence will influence tidal effects by possible salinity reduction at the south side of Old River Gate and the East side of Connection Slough Gate. The south side of Old River Gate may experience possible decrease in DO due to reduced flows and nutrient entrapment. In addition, the water quality effects of spring pumping of nutrient-laden agricultural drains from winter fallow fields into the sloughs in close proximity of the gates temporarily may be exacerbated due to reduced tidal action. Orthophosphate levels in the Central Delta are typical compared to natural levels (State of CA 2006 and preceding year reporting) however, alteration/reduced force of the tidal influx for an extended period may allow accumulation of this biologically-available phosphorous. This will be somewhat more readily available in the dead-end slough portion of Old River available in the early spring. High orthophosphate levels, with available nitrogen, can trigger rapid algal production in waterways. The potential effect of algae blooms affecting the available dissolved oxygen may be only localized and temporary until the hydrologic regime is restored.

There is a potential that steelhead could become stranded behind closed gates (east or south of the gates and in close proximity to the structure). It is likely that steelhead would be able to use other channels and re-establish their migration, or it may be possible that juveniles could swim through gaps in the gates or structures and continue on seaward with only minor delays. Steelhead could potentially become disoriented behind the gates and then follow the main downstream flow component to the SWP or CVP intake. Delays in steelhead outmigration may also cause an increase in exposure to predation in Delta channels by striped bass and other predators.

Anytime the gates are open from Dec1 – March 1, the effects on migration, foraging, predation susceptibility and water quality are reduced. Closures in April and June would impede outmigration of San Joaquin River steelhead smolts. Sacramento and Mokelumne River-origin smolts will be less affected by gate closures from April - June.

3.5.2.2 Effects on Critical Habitat

Critical habitat for steelhead salmon includes those areas possessing the Primary Constituent Elements essential to the conservation of this species. The final rule for the determination of critical habitat for Central Valley Steelhead (CVSH) (Federal Register 2005) provides details on these constituent elements. The Action Area contains some of the following constituent elements. Within these areas, the primary constituent elements essential for the conservation of these ESUs are those sites and habitat components that support one or more life stages, including:

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

(2) Freshwater rearing sites with:(i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

(4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The Affected Area contains all of these habitat components except for spawning areas. Channel blockage will affect expectation of migration free corridors and the blockage may also concentrate predators. Alternate routes will still be available but the changing hydrodynamics due to the gates may inhibit predator avoidance or foraging opportunities for juveniles. Riparian disturbance will occur during the placement process and the abutments will create a de-vegetated zone for a total of 400’ for both gates.

3.5.2.3 Cumulative Effects

The degree of project benefits for emigrating juveniles is interdependent on operations of the Delta Cross Channel gates, which are also operated during winter months to reduce straying of emigrating juveniles from the Sacramento River into the Central Delta.

The project is expected not to have significant cumulative effects on water quality factors that would affect Central Valley Steelhead because operations would occur in winter (when water temperatures and dissolved oxygen conditions are not near critical levels) and the duration of operations is not sufficient to result in long-term stagnation of waters in central Delta channels. Cumulative effects with agricultural operations would be minimal through the winter because in-Delta farms are not diverting only discharging if substantial rainfall is occurring during the winter. However, typical field draining practices in February, combined with affected area waterways reduced circulation, may create a situation where nutrient dynamics make the dead-end slough portions of the waterway susceptible to earlier-than-normal algal productivity. This potential effect has not been evaluated in-depth and greater consideration can be made with updated flow modeling.

3.6 SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON

3.6.1 Biological Characteristics

The listing history and status of Sacramento River winter-run Chinook salmon is described in detail in the OCAP BA (Reclamation 2008). The following summary description, focused on the action area within the Delta, is developed largely from that document. Please refer the OCAP BA and to the Sacramento River winter-run Chinook salmon Recovery Plan (NOAA Fisheries 1997a) for additional details.

3.6.1.1 Status of the Species and Critical Habitat

The Sacramento River winter-run Chinook salmon ESU consists of only one population that is confined to the upper Sacramento River in California’s Central Valley. The ESU was listed as threatened in November 1990 (55 FR 46515). They were reclassified as endangered on January 4, 1994 (59 FR 440). NMFS completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and concluded that the species’ status should remain as previously listed (June 28, 2005, 70 FR 37160).

NOAA Fisheries designated critical habitat for winter-run Chinook salmon on June 16, 1993, (58 FR 33212). Critical habitat area was delineated as the Sacramento River from Keswick Dam, (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento- San Joaquin Delta, including Kimball Island, Winter Island, and Brown’s Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. The critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration and protection. Further description of critical habitat characteristics within the action area will be discussed below, in association with the project effects evaluation.

3.6.1.2 General Life History, Distribution and Population Characteristics of the ESU

The Sacramento River winter-run Chinook salmon ESU consists of a single population that is currently confined to spawning habitat below Keswick dam in the Sacramento River. The population utilizes rearing and migration habitats in the Sacramento River, Delta and San Francisco Bay, and the coastal waters of California. Chinook salmon run characteristics generally are thought to be related to local freshwater, estuarine, and marine environmental conditions such as water temperature and flow regimes. Sacramento River winter-run Chinook salmon exhibit a combination of stream- and ocean-type life history characteristics . The winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only four to seven months of river life (ocean-type) (Myers et al. 1998, Healey 1991, Groot and Margolis 1991).

Sacramento River winter-run Chinook salmon sub-adult and adult ocean rearing takes place primarily in the nearshore marine waters along the central and northern California coast. The winter-run Chinook salmon generally mature between 2 and 4 years of age (NOAA Fisheries 1997a). Adult spawning migration through San Francisco Bay and the Delta occurs from November through June. Spawning occurs in the upper Sacramento River below Keswick dam from late-April through mid-August. Fry emergence occurs from mid-June through mid-October, with peak dispersal from natal habitat in September and October. Winter-run juveniles emigrate into the Delta from October into June with peak juvenile salmon abundance generally from January to April. Distinct emigration pulses of both young of year (YOY) and yearling outmigrants appear to coincide with high precipitation and increased turbidity, which are correlated with high Sacramento River flows. Only the adult and juvenile (parr and smolt) life stages occur in the action area and these life history stages will be discussed in more detail below.

3.6.1.3 Action Area Life history, Distribution, and Habitat Considerations

Juvenile winter-run Chinook salmon generally occur in the Sacramento-San Joaquin Delta from October through early May based on data collected from trawls, beach seines, and salvage records at the CVP and SWP pumping facilities (DFG 1998), (ENTRIX 2008). Emigration into the Delta may extend from October through into June with peak juvenile salmon abundance generally from January to April. Upon arrival in the Delta, winter-run Chinook salmon tend to rear in the more upstream freshwater portions of the Delta for about the first two months.

Within the Sacramento-San Joaquin Delta, juvenile Chinook salmon are reported to forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). Juvenile Chinook salmon in general have been observed to follow the tidal cycle in their movements within the estuarine habitat, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982; Levings 1982; Healey 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982; Sommer *et al.* 2001; MacFarlane and Norton 2002). Shallow water habitats are reported to be more productive than the main river channels, supporting higher growth rates, due to more favorable environmental conditions and higher prey consumption rates, (Sommer *et al.* 2001).

As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tide into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle et al. (1986) reported that Chinook salmon YOY outmigrants tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson et al. (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific ocean (Spaar 1988), as cited in Reclamation (2008).

MIGRATION OF ADULT WINTER-RUN CHINOOK SALMON THROUGH THE DELTA

Adult immigration of winter-run Sacramento River Chinook salmon through the Sacramento-San Joaquin Delta generally occurs during November through June.

3.6.2 Effects of Action on Winter-Run Chinook Salmon

3.6.2.1 Construction

Construction activities include dredging, rock placement, and barge placement. All of these activities have the potential to cause either harm to juvenile winter-run Chinook and reduce the quality and quantity of their habitat. Adult winter-run Chinook are not believed to utilize the project action area to any significant degree. The potential for project effects on adult winter-run Chinook are, therefore, believed to be insignificant and discountable. Construction is scheduled for November and is expected to last for approximately one month. Juvenile winter-run Chinook are found throughout the Delta during this period and may potentially be affected the action.

3.6.2.2 Dredging

Dredging will be used to excavate approximately 48,000 cy of channel bed sediments and peat (down to -25 ft) to prepare the site for placement of the rock fill foundation of the gate structure. This action would occur in November and last for approximately one week. Juvenile winter-run Chinook would be present in the area and the dredging has the potential to cause direct mortality or harm through entrainment or injury caused by collision with the equipment. Additionally, direct harm could potentially occur from exposure of juveniles to the releases sediments and contaminants into the water column, and associated potential reductions in dissolved oxygen, during the dredging operations. However, dredging will be limited in scope to a relatively small area (less than 4 Ac) directly below the gate placement area. It is therefore not expected to increase turbidity or decrease DO over a large area or a long time span. The potential for exposure is therefore limited to very few individual fish and they are expected to be able to largely avoid adverse conditions. It has been shown that juvenile salmon can adapt when exposed to short term increased suspended sediment TSS concentrations. When salmon where experimentally exposed to TSS concentrations of 2,000to 4,000 mg/l for several days, indicators of stress increased immediately and then returned to background levels within 5 days after exposure ended. Juvenile salmonids may also be at increased risk for bacterial or viral induced mortality following exposure to turbidity (Reeding and Scheck 1987). It seems highly unlikely that the project could expose any juvenile winter-run Chinook to conditions reported to cause this effect (2,000 to 3,000 mg/l for 7 to 8 days) (Reeding et al. 1987). Duration of exposure has been demonstrated to play a more dominant role than concentration and the project would be considered to be a short-term exposure duration relative to those demonstrated to induce effects (Anderson et al. 1996) and fish in the area of higher suspended sediment concentrations have the ability to move to waters with lower concentrations. Indirect effects of dredging include the re-suspension of sediment-bound contaminants into the water column. Oram & Melwani (2006) demonstrated that the potential impact of dredging on contaminant levels in resident biota is 100 times greater at the dredge site than in the near-field. In their San Francisco Bay located study, impacts to biota in the mid- and far-fields were negligible, with predicted percent increases in contaminant levels less than one percent. Therefore, any contaminants that do re-enter the water column are unlikely to pose a hazard any distance from the project site.

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The modification of the benthic community in the vicinity of the gates, resulting from releases of contaminants, would be a long term effect on juvenile winter-run Chinook throughout their September through June rearing and period of occurrence in the Delta (ENTRIX 2008). This is not expected to have significant potential for effects on juvenile winter-run Chinook, however, as the area is small and the pathway through epibenthic prey base it represents an insignificant opportunity for exposure.

3.6.2.3 Rock Placement

Rock placement will be used to construct the foundation, abutments and ramp. This action will occur in November and last for approximately two weeks. Juvenile winter-run Chinook would be present in the area and may be exposed to direct harm during rock placement through collisions of rock materials and machinery with fish that are on site that do not avoid the activities. Placement of rock may also cause an increase in turbidity. However, rock placement is expected to release a small amount of sediment. Relative to the dredging, minimization of turbidities exceeding salmonid thresholds for predator avoidance and physical injury effects (200 mg/L) would entirely avoid potential turbidity effects for rock placement (Nightingale and Simenstad 2001).

Replacement of the soft bottom sediment with small to moderate sized (6’’ to 24”) angular rock. rock to create the foundation, abutments and ramps will result in a conversion of the benthic community in an area of less than approximately 4 acres. . Species adapted to the soft peat and mud habitat will be replaced, in this particular area, with those more adapted to a firm surface. A portion of the rock fill will be temporarily covered with the sunken barge and a small portion of the abutments will above water rock fill. This change and/or loss in area of the benthic community potentially reduces the total foraging habitat for juvenile winter-run Chinook

Construction of the abutments with rock fill will disrupt existing emergent or riparian vegetation and habitat resulting in reduced shoreline vegetation and any riparian function it may have in supporting juvenile winter-run Chinook that utilize the area. Reductions in functions may include loss of shading and stabilization of sediments and loss of insect prey items for juvenile Chinook (Toft et al. 2004). However, the existing riparian function is already degraded and very small in relation to what is available in the Delta and is not expected to have a significant impact on these mobile and opportunistic animals.

3.6.2.4 Gate Structure Placement

Barge placement on the foundation may cause harm to juvenile winter-run Chinook by entrainment of individuals as the barge is sunk. Disturbance associated with construction activities and potential contaminant releases may also occur as the barge is put in place. As with the rest of the construction activities, releases of contaminants would be addressed in a Spill and Pollution Prevention Planning , which will outline actions to reduce impacts and address responses to potential spills.

3.6.2.5 Gate Removal

The barges would be removed around June 30, with subsequent removal of the rock abutments taking perhaps several days in early July. Juvenile winter-run Chinook salmon are not expected to be present in the area. The barge and rock removal is, therefore, not believed to pose any potential to cause harm.

3.6.2.6 Gate Reinstallations

Seasonal reinstallation of the abutments and gate structure will have the sane effects as those described above for the rock and gate placement activities.

3.6.2.7 Operations

The gates would be in place and operated as described above from December 1 through June 30. During this time juvenile winter-run Chinook salmon are likely to be present. Adult winter-run Chinook migrate through the Delta during the operation period but are not believed to occur in the affected area.

The operation of the 2-Gate barrier system is characterized as substantially reducing or eliminating direct upstream water flow on the Old River from the West and Central Delta. The overall effect of that change is expected to be that juvenile winter-run Chinook salmon encountering the gates or lack of flow on the Frank’s Tract side will be redirected toward the northwest, a positive effect for their probability for survival over baseline conditions. Interactive operation of the gates during April through June utilizing particle tracking and other indicator data to reduce delta smelt entrainment is also expected to have a neutral to positive effect on survival probabilities for juvenile winter-run Chinook salmon.

The gates would result in changes in the hydrodynamics of the South Delta. Dead-end sloughs could be temporarily created on either side of each gate. On the south side of the Old River and the west side of the Connection Slough Gate, the dead-end slough created would likely receive reduced mixing and thus may suffer from impaired water quality, in the form of reduced oxygen concentrations and increased contaminant concentrations. While low dissolved oxygen concentrations have not been typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with agricultural returns in the area could create this type of problem. The magnitude of this cannot be predicted at this time. The net effect of this potential decrease in water quality on juvenile winter- run Chinook salmon is likely small, as juveniles would exhibit avoidance reactions to regions of low water quality, especially when DO levels are low (Carter 2005; Whitmore et al. 1960).

Juvenile winter-run Chinook salmon are likely to be affected more as a result of increased predation in the vicinity of the gates, as predatory fish are known to congregate below manmade barriers. See the discussion on predation in the fall run section below for documentation on this potential effect, and for associated references to the NMFS Temporary Barriers Program BO (2008).

The project is not expected to change the number of fish moving from the Sacramento River into the Central Delta via the Delta Cross Channel or Georgiana Slough. It will however, mostly eliminate reverse flows in Old River between the gate location and the San Joaquin River that may attract these fish into the area of Frank’s Tract. Even if these fish enter the area near Frank’s Tract, they would be blocked from moving down Old River by the gates. Severing the direct route between the San Joaquin River near the mouth of the Mokelumne and the pumps may provide a benefit to this species. Flow in the San Joaquin River between the mouth of the Mokelumne and Turner Cut is strongly influenced by tides. Flows are positive (toward Suisun Bay) during the ebb tide and negative (away from Suisun Bay) during the flood tide. The project would increase reverse flows in the San Joaquin River between the Mokelumne River confluence and Turner Cut during the flood tide. Reverse flows would also increase in Middle River and in Columbia and Turner cuts and their connecting channels between the San Joaquin River and Middle River. It is unknown how Chinook salmon may respond to these changes in flow patterns. If they follow the flow, the direction the initial direction they take upon entering the San Joaquin River may depend on what the tidal stage is when they enter the river. Because of the physical barriers across Old River and the longer path these fish would be required to take to the pumps, the 2-gate plan would provide some benefit to Chinook salmon, but the magnitude of this benefit cannot be determined.

The gates would also prevent the movement of nutrients and food items between the South Delta and Franks Tract and Suisun Bay. The importance of this transport is unknown, but presumably most of this transport is towards the pumps based on the strong reverse flows that occur under existing conditions. The gates may result in more of the productivity being retained in the western Delta, rather than pulled into the export facilities. This could result in an improvement in prey densities for juvenile winter-run Chinook.

3.6.3 Cumulative Effects

The degree of project benefits for emigrating juvenile winter-run Chinook is interdependent on operations of the Delta Cross Channel gates, which are also operated during winter months to reduce straying of emigrating juveniles from the Sacramento River into the Central Delta.

The project is not expected to have significant cumulative effects on water quality factors that would affect juvenile spring-run Chinook salmon because operations would occur in winter (when water temperatures and dissolved oxygen conditions are not near stressful levels) and the duration of operations is not sufficient to result in long-term stagnation of waters in South-central Delta channels. Cumulative effects with agricultural operations would be minimal because in-Delta farms are not diverting water during the operating period unless this is during periods of substantial rainfall. Discharges may occur late in the winter and these may need to be monitored and evaluated to determine whether they may pose a threat of short-term degradation of water quality that may be exacerbated by operation of the gates in late February. Depending on the location and magnitude of local municipal wastewater discharge (e.g. Discovery Bay or Brentwood), there could be potential for localized water quality problems in the receiving waters due to reduced flushing.

3.6.4 Effects on Winter-Run Chinook Critical Habitat

The project is not within the designated critical habitat for Sacramento winter-run Chinook salmon and, therefore, would not affect winter-run Chinook critical habitat.

3.7 SACRAMENTO RIVER SPRING-RUN CHINOOK SALMON

3.7.1 Biological Characteristics

The listing history and status of Sacramento River spring-run Chinook salmon is described in detail in the OCAP BA (Reclamation 2008). The following summary description, focused on the action area within the Delta, is developed largely from that document. Please refer the OCAP BA [cite] for additional details.

3.7.1.1 Status of the Species and Critical Habitat

Central Valley spring-run Chinook salmon ESU consists of spring-run Chinook salmon occurring in the Sacramento River Basin. The ESU was listed as threatened on September 16, 1999 (50 FR 50394). NMFS completed an updated status review of 16 salmon ESUs, including Central Valley spring-run Chinook salmon, and concluded that the species' status should remain as previously listed (June 28, 2005, 70 FR 37160).

NOAA Fisheries designated critical habitat for Central Valley spring-run Chinook salmon on Sept. 2, 2005 (70FR52488 - 52627). Critical habitat area was delineated as the Sacramento River and specific tributaries occupied by spawning and rearing spring-run Chinook, as well as the Sacramento Delta Hydrologic Unit within the Sacramento- San Joaquin Delta. The critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration and protection. Further description of critical habitat characteristics within the action area will be discussed below, in association with the project effects evaluation.

3.7.1.2 General Life History, Distribution and Population Characteristics of the ESU

Central Valley spring-run Chinook salmon ESU consists primarily of three populations in three tributary systems (Mill, Deer, and Butte Creeks) and also the Feather River and Clear Creek, all within the Sacramento River Basin. The population utilizes rearing and migration habitats in the Sacramento River Basin Delta and San Francisco Bay, and off shore ocean waters.

Chinook salmon run characteristics generally are thought to be related to local freshwater, estuarine, and marine environmental conditions such as water temperature and flow regimes. Sacramento River spring-run Chinook salmon exhibit a combination of stream- and ocean-type life history characteristics. The Spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months (stream-type). However, unlike many spring-run Chinook salmon, juvenile age at emigration is highly variable for this ESU and is comprised of both YOY and yearling migrants (Myers et al. 1998, Healey 1991, Groot and Margolis 1991).

Sacramento River spring-run Chinook salmon sub-adult and adult ocean rearing takes place, as with other spring-run Chinook stocks, primarily in offshore marine waters. The spring-run Chinook salmon generally mature between 2 and 4 years of age [cite]. Adult spawning migration through the Delta occurs from February through July(ENTRIX 2008). Spawning occurs in Sacramento River tributaries from late-April through mid-April. Fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al.* 1981). Spring-run Chinook salmon juveniles have been observed rearing in the lower part of non-natal tributaries and intermittent streams during the winter months (Maslin *et al.* 1997; Snider 2001). Spring-run Chinook salmon emigration is highly variable (DFG 1998). Some juveniles may begin outmigrating soon after emergence, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (DFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of young-of-the-year (YOY) outmigrants passing through the lower Sacramento River and Sacramento-San Joaquin Delta during this period (DFG 1998). Emigration appears to coincide with high precipitation and high Sacramento River flows. Little is known about estuarine residence time of spring-run Chinook salmon. Spring-run Chinook yearlings are larger in size than fall-run Chinook and ready to smolt upon entering the Delta; therefore, the yearling outmigrants are expected to spend little time rearing in the Delta. The YOY outmigrant spring-run Chinook salmon are generally similar in size at entry into the Delta as YOY outmigrants of the other the other Chinook runs and the duration of rearing within the Delta is therefore expected to be similar.

3.7.1.3 Action Area Life History, Distribution, and Habitat Considerations

EMIGRATION OF JUVENILE SPRING-RUN CHINOOK SALMON THROUGH THE DELTA

The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of young-of-the-year (YOY) outmigrants passing through the lower Sacramento River and Sacramento-San Joaquin Delta during this period (DFG 1998). Juvenile spring-run Chinook salmon are reported to generally occur in the Sacramento-San Joaquin Delta from November through June based on data collected from trawls, beach seines, and salvage records at the CVP and SWP pumping facilities (ENTRIX 2008).

Within the Sacramento-San Joaquin Delta, juvenile Chinook salmon are reported to forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). Juvenile Chinook salmon in general have been observed to follow the tidal cycle in their movements within the estuarine habitat, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982; Levings 1982; Healey 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982; Sommer *et al.* 2001; MacFarlane and Norton 2002). Shallow water habitats are reported to be more productive than the main river channels, supporting higher growth rates, due to more favorable environmental conditions and higher prey consumption rates, (Sommer *et al.* 2001).

As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tide into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle et al. (1986) reported that Chinook salmon YOY outmigrants tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson et al. (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific ocean (Spaar 1988), as cited in Reclamation (2008).

MIGRATION OF ADULT SPRING-RUN CHINOOK SALMON THROUGH THE DELTA

Adult immigration of spring-run Sacramento River Chinook salmon through the Sacramento-San Joaquin Delta generally occurs during February through July.

3.7.2 Effects of Action on Spring-Run Chinook Salmon

3.7.2.1 Construction

Construction activities include dredging, rock placement, and barge placement. All of these activities have the potential to cause either harm to juvenile spring-run Chinook and reduce the quality and quantity of their habitat. Adult spring-run Chinook are not believed to utilize the project action area to any significant degree. The potential for project effects on adult spring-run Chinook are, therefore, believed to be insignificant and discountable. Construction is scheduled for November and is expected to last for approximately one month. Juvenile spring-run Chinook are found throughout the Delta during this period and may potentially be affected the action.

DREDGING

Dredging will be used to excavate approximately 48,000 cy of channel bed sediments and peat (down to -25 ft) to prepare the site for placement of the rock fill foundation of the gate structure. This action will occur in November and last for approximately one week. Juvenile spring-run Chinook will be present in the area and the dredging has the potential to cause direct mortality or harm through entrainment or injury caused by collision with the equipment. Additionally, direct harm could potentially occur from exposure of juveniles to the releases sediments and contaminants into the water column, and associated potential reductions in dissolved oxygen, during the dredging operations. However, dredging will be limited in scope to a relatively small area (less than 4 Ac) directly below the gate placement area. It is therefore not expected to increase turbidity or decrease DO over a large area or a long time span. The potential for exposure is therefore limited to very few individual fish and they are expected to be able to largely avoid adverse conditions. It has been shown that juvenile salmon can adapt when exposed to short tem increased TSS concentrations. When salmon where experimentally exposed to TSS concentrations of 2,000to 4,000 mg/l for several days, indicators of stress increased immediately and then returned to background levels within 5 days after exposure ended. Juvenile salmonids may also be at increased risk for bacterial or viral induced mortality following exposure to turbidity. It seems highly unlikely that the project could expose any juvenile spring-run Chinook to conditions reported to cause this effect (2,000 to 3,000 mg/l for 7 to 8 days) (Reeding et al. 1987) Duration of exposure has been demonstrated to play a more dominant role than concentration and the project would be considered to be a short-term exposure duration relative to those demonstrated to induce effects (Anderson et al. 1996).

The modification of the benthic community in the vicinity of the gates, resulting from releases of contaminants, would be a long term effect on juvenile spring-run Chinook throughout their September through June rearing and migration period (ENTRIX 2008). This is not expected to have significant potential for effects on juvenile spring-run Chinook, however, as the area is small and the pathway through epibenthic prey base is represents an insignificant opportunity for exposure.

ROCK PLACEMENT

Rock placement will be used to construct the foundation, abutments and ramp. This action will occur in November and last for approximately two weeks. Juvenile spring-run Chinook will present in the area and may be exposed to direct harm during rock placement through collisions of rock materials and machinery with fish that are on site that do not avoid the activities. Placement of rock may also cause an increase in turbidity. However, rock placement is expected to release a small amount of sediment. Relative to the dredging, Minimization of turbidities exceeding salmonid thresholds for predator avoidance and physical injury effects would entirely avoid potential turbidity effects for rock placement. Nightingale and Simenstad (2001) reported a threshold of 200 mg/L in estuarine and marine waters.

Replacement of the soft bottom sediment with small to moderate sized (6'' to 24") angular rock. rock to create the foundation, abutments and ramps will result in a conversion of the benthic community in an area of less than approximately 4 acres. . Species adapted to the soft peat and mud habitat will be replaced, in this particular area, with those more adapted to a firm surface. A portion of the rock fill will be temporarily covered with the sunken barge and a small portion of the abutments will above water rock fill. This change and/or loss in area of the benthic community potentially reduces the total foraging habitat for juvenile spring-run Chinook Construction of the abutments with rock fill will disrupt existing riparian vegetation and habitat resulting in reduced riparian function supporting juvenile spring-run Chinook that utilize the area. Reductions in functions may include loss of shading and stabilization of sediments and loss of insect prey items for juvenile Chinook (Toft et al. 2004). However, the area of reduced riparian function is very small in relation to the available riparian habitat and is not expected to have a significant impact on these mobile and opportunistic animals.

GATE STRUCTURE PLACEMENT

Barge placement on the foundation may cause harm to juvenile spring-run Chinook by entrainment of individuals as the barge is sunk. Disturbance associated with construction activities and potential contaminant releases may also occur as the barge is put in place. As with the rest of the construction activities, releases of contaminants will be addressed in a Spill and Pollution Prevention Planning , which will outline actions to reduce impacts and address responses to potential spills.

GATE REMOVAL

The barges would be removed around June 30, with subsequent removal of the rock abutments taking perhaps several days in early July. Juvenile spring-run Chinook salmon are not expected to be present in the area. The barge and rock removal is, therefore, not believed to pose any potential to cause harm.

GATE REINSTALLATIONS

Seasonal reinstallation of the abutments and gate structure will have the sane effects as those described above for the rock and gate placement activities.

OPERATIONS

The gates would be in place and operated as described above from December 1 through June 30. During this time juvenile spring-run Chinook salmon are likely to be present. Adult spring-run Chinook migrate through the Delta during the operation period but are not believed to occur in the affected area.

The operation of the 2-Gate barrier system is characterized as substantially reducing or eliminating direct upstream water flow on the Old River from the West and Central Delta. The overall effect of that change is expected to be that juvenile spring-run Chinook salmon encountering the gates or lack of flow on the Frank's Tract side will be redirected toward the northwest, a positive effect for their probability for survival over baseline conditions. Interactive operation of the gates during April through June utilizing particle tracking and other indicator data to reduce delta smelt entrainment is also expected to have a neutral to positive effect on survival probabilities for juvenile spring-run Chinook salmon.

The gates would result in changes in the hydrodynamics of the South Delta. Blind sloughs would be temporarily created on either side of each gate. On the south side of the Old River Gate, the blind slough created would likely receive reduced mixing and thus may suffer from impaired water quality, in the form of reduced oxygen concentrations and increased contaminant concentrations. While low dissolved oxygen concentrations have not been typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with agricultural returns in the area could create this type of problem. The magnitude of this cannot be predicted at this time. The net effect of this potential decrease in water quality on juvenile winter- run Chinook salmon is likely small, as juveniles would exhibit avoidance reactions to regions of low water quality, especially when DO levels are low (Carter 2005; Whitmore et al. 1960).

Juvenile spring-run Chinook salmon are likely to be affected more as a result of increased predation in the vicinity of the gates, as predatory fish are known to congregate below manmade barriers. See the discussion on predation in the fall run section below for documentation on this potential effect. And for references to the NMFS Temporary Barriers Program BO (2008).

The project is not expected to change the number of fish moving from the Sacramento River into the Central Delta via the Delta Cross Channel or Georgiana Slough. It will however, eliminate reverse flows in Old River that may attract these fish into the area of Frank’s Tract. Even if these fish enter the area near Frank’s Tract, they would be blocked from moving down Old River by the gates. Severing the direct route between the San Joaquin River near the mouth of the Mokelumne and the pumps may provide a benefit to this species. Flow in the San Joaquin River near the mouth of the Mokelumne is strongly influenced by tides. Flows are positive (toward Suisun Bay) during the ebb tide and negative (away from Suisun Bay) during the flood tide. The project would increase reverse flows in the San Joaquin River between the Mokelumne River confluence and Turner Cut during the flood tide. Reverse flows would also increase in Middle River and in Columbia and Turner cuts between the San Joaquin River and Middle River. It is unknown how Chinook salmon may respond to these changes in flow patterns. If they follow the flow, the direction they move in the San Joaquin River may depend on when the tidal stage when they enter the river. If, on the other hand, the fish are following a salinity gradient by this time, they may continue on toward Suisun Bay and the ocean, regardless of the flow. Because of the longer path these fish would be required to take to the pumps, it is expected that the project would provide some benefit to Chinook salmon, but the magnitude of this benefit cannot be determined.

The gates would also prevent the movement of nutrients and food items between the South Delta and Franks Tract and Suisun Bay. The importance of this transport is unknown, but presumably most of this transport is towards the pumps based on the strong reverse flows that occur under existing conditions. The gates may result in more of the productivity being retained in the western Delta, rather than pulled into the export facilities. This could result in an improvement in prey densities for juvenile spring-run Chinook.

3.7.3 Cumulative Effects

The degree of project benefits for emigrating juvenile spring-run Chinook is interdependent on operations of the Delta Cross Channel gates, which are also operated during winter months to reduce straying of emigrating juveniles from the Sacramento River into the Central Delta.

The project is not expected to have significant cumulative effects on water quality factors that would affect juvenile spring-run Chinook salmon because operations would occur in winter (when water temperatures and dissolved oxygen conditions are not near stressful levels) and the duration of operations is not sufficient to result in long-term stagnation of waters in central Delta channels. Cumulative effects with agricultural operations would be minimal because in-Delta farms are not diverting water during the operating period. Discharges may occur late in the winter and these may need to be monitored and evaluated to determine whether they may pose a threat of short-term degration of water quality that may be exacerbated by operation of the gates in late February. Depending on the location and magnitude of local municipal wastewater discharge (e.g. Discovery Bay or Brentwood), there could be potential for localized water quality problems in the receiving waters due to reduced flushing.

3.7.4 Effects on Spring-Run Chinook Critical Habitat

The project is not within the designated critical habitat for Sacramento spring-run Chinook salmon and, therefore, would not affect spring-run Chinook critical habitat.

3.8 SACRAMENTO RIVER FALL-RUN / LATE FALL-RUN CHINOOK SALMON

3.8.1 Biological Characteristics

3.8.2 Legal Status.

The fall-/late fall-run of Central Valley Chinook salmon are considered by NMFS to be within the same ESU. The ESU includes all naturally spawned populations of fall-/late-fall run Chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California (64 FR 50394). On September 16, 1999, after reviewing the best available scientific and commercial information, NMFS determined that listing Central Valley fall-/late fall-run Chinook salmon was not warranted. On April 15, 2004, the Central Valley fall-/late fall run Chinook salmon ESU was reclassified as a Species of Concern (69 FR 19975). No critical habitat has been determined for this species.

3.8.2.1 Life History.

Central Valley fall/late fall-run Chinook salmon are native to the Delta region (Moyle 2002). Fall-run Chinook salmon occur in the Sacramento River and its tributaries, Suisun Marsh, the San Joaquin River and five east-side tributaries to the San Joaquin including the Merced, Tuolumne, Stanislaus, Mokelumne, and Cosumnes Rivers. Late fall-run Chinook salmon occur mainly in the Sacramento River and its tributaries (Moyle 2002). The Central Valley ESU is considered the southernmost native spawning population of Chinook salmon. Fish barriers (typically dams) on many streams and rivers currently limit upstream habitat.

Fall-run Chinook are currently the most numerous of the Central Valley runs (Myers *et al.* 1998) and the only race that regularly spawns in the San Joaquin Basin. Late-fall-run Chinook are generally the second least numerous run in the Sacramento River (after winter-run). Their population in the Sacramento River appears to be stable, despite its low abundance. However, it is unclear if these populations are self-sustaining, because at least 20 to 40 percent of the spawners are of hatchery origin (NMFS 2008). In addition, 40 to 50 percent of late fall-run Chinook spawning and rearing habitats in the region have been lost or degraded (NMFS 2008).

Adult Migration and Spawning Habitat

Fall-run Chinook are fully mature as they move up from the ocean in late summer and early fall into tributaries of the Sacramento Basin and San Joaquin Basin, typically spawning within days or weeks of reaching their spawning grounds (Moyle 2002) between late August and early October. Fall-run Chinook salmon spawn in tributaries of the Sacramento River and San Joaquin River between late August and early October. Adult late fall-run Chinook migrate into Sacramento Basin tributaries during the late fall/winter (mid-October through December) and typically spawn after a delay of 1-3 months of holding in the river (Moyle 2002).

Rearing Habitat

Fall-run juveniles emerge from the gravel in spring and disperse downstream within a few months to rear in main river channels or the estuary before heading out to sea. Fall-run fry and juveniles use the Delta for rearing habitat between January and June, although it is not known what fraction of juvenile production rears in the Delta. Since the fall-run produces the most progeny, Chinook salmon smolts observed at the Tracy Fish Collection Facility (TFCF) TFCF usually peak in May each year (Bowen et al. 1998). Young fish feed on zooplankton and other invertebrates. Late fall-run juveniles rear for 7-13 months in main river channels, growing rapidly - feeding on invertebrates, before migrating to the ocean (Moyle 2002) during November through March.

Juvenile Outmigration

The majority of fall-run juveniles emigrate through the Delta from the Sacramento and San Joaquin Rivers from February through June during the first few months following emergence, although some may remain in freshwater and migrate as yearlings. Following their long freshwater residence time, late-fall run juveniles emigrate from the Sacramento River through the Delta during November through March.

A more complete description of the species life history and factors affecting its abundance and distribution can be found in the OCAP BA (Reclamation 2008).

3.8.3 Potential Plan Effects on Fall-/Late Fall-Run Chinook Salmon

As described in the project description, the proposed action could impact fish within the immediate area of the gates through construction activities (dredging, rock placement, barge placement, and removal of rock fill and the barge), and species in the broader action area through its effects on hydrodynamics and hydraulic connectivity (changes in flow patterns, tidal lags, effects on water quality, nutrient and food web dynamics). The potential impacts of the action for fall/late fall-run Chinook salmon are discussed below.

3.8.3.1 Construction Effects

Construction is scheduled to occur in November, with completion by December 1. During this time, fall-run Chinook salmon are concluding their upstream migration to spawning grounds in the Sacramento Basin and through the Delta to San Joaquin Basin while the upstream migration of late fall-run Chinook salmon spans the entire construction period.

Because spawning grounds are located much further upstream than the construction site, there are not expected to be many fall-run Chinook salmon present in the immediate construction area. However, it is possible that late migrants, ascending the San Joaquin River, could be present in the vicinity during the time of construction. Therefore, although construction activities (dredging, rock placement, barge placement and their associated short-term affects on turbidity, contaminant availability, and other disturbance) are unlikely to directly affect the bulk of the adult migrating population, late adult migrants could be directly impacted. No juvenile fall-run Chinook salmon would be present during this time.

The majority of the late fall-run Chinook salmon population spawns in the Sacramento River Basin (Moyle 2002). Therefore few adults are expected to migrate through the Central Delta. However, individuals straying into the San Joaquin River Basin could be present in the vicinity during the time of construction. Therefore, although construction activities (dredging, rock placement, barge placement and their associated short-term affects on turbidity, contaminant availability, and other disturbance) are unlikely to directly affect the bulk of the migrating population, it is possible that some of the population could be directly impacted. Although juvenile late fall-run Chinook salmon may be emigrating from the Sacramento River during the time of operations, based on their route of migration and tidal dynamics, they are not expected to enter the Central Delta.

Individuals present at the time of construction could be affected by increased turbidity in the water column caused by dredging and the placement of rock abutments. Identified dredging effects include entrainment of organisms, increased turbidity at the dredging site, fish injury associated with exposure to suspended sediments and decreased dissolved oxygen, and fish behavioral effects due to the effects of noise (Nightingale & Simenstad 2001). Nightingale & Simenstad (2001) reported that fish gill injury from exposure to high suspended sediment loads is likely the principle mechanism of injury from dredging activities, but to what extent is uncertain and deserves further analysis. Additionally, an increase in turbidity could result in decreased predator avoidance among juvenile salmonids (Nightingale & Simenstad 2001). Increased sediment disturbance could affect water quality factors by increasing turbidity and reducing dissolved oxygen (DO) levels. However, dredging will be limited in scope to a relatively small area (less than 4 acres) directly below the gate placement area. Therefore, it is not expected to cause a long term increase in turbidity or decrease DO over a large area long-term. Indirect effects of dredging include the re-suspension of sediment-bound contaminants into the water column. Oram & Melwani (2006) demonstrated that the potential impact of dredging on contaminant levels in resident biota is 100 times greater at the dredge site than in the near-field. In their San Francisco Bay located study, impacts to biota in the mid- and far-fields were negligible, with predicted percent increases in contaminant levels less than one percent. Therefore, any contaminants that do re-enter the water column are unlikely to pose a hazard any distance from the project site.

Rock placement could cause physical injury or mortality to a fish by striking or burial. The preferred operational technique of underwater release and settling should minimize this potential effect. Barge placement effects - provided proper lowering and placement techniques are used, will minimize direct and indirect effects of entrainment, contaminant mobilization, and fish strike by equipment. It is possible that barge placement may cause physical injury or mortality to Chinook salmon due to entrainment during barge placement or capture of individuals as the barge is sunk. Indirect effects include disturbance associated with construction boats and contaminants on the water surface due to barge transport and placement by construction boats. Surface contaminants produced by boats will be addressed in a Spill and Pollution Prevention Plan, which will outline actions to reduce impacts from this activity and address responses to potential spills.

The modification of the benthic community in the vicinity of the gates would be a long term effect. This would not have any substantial effect on fall-run Chinook salmon however, as the area is small and well downstream of the species freshwater rearing habitat.

3.8.3.2 Operational Effects

The gates would be in place from December 1 through June. The operation would be conducted in two phases. During the first phase (December 1 through March 31) the gates would be closed when the criteria described in Table 1-1 are met. During the second phase (April through June) the gates would usually remain open but would close when analyses indicate that a greater fraction of the larval and juvenile smelt population would be subject to entrainment with the gates open than closed. Juvenile emigration for the Sacramento/San Joaquin River fall-run Chinook salmon occurs between February and June. Although Sacramento River out-migrants are unlikely to be affected, out-migrants from the San Joaquin River would be affected by the gate operation. Therefore, during the time of operation, juvenile fall-run Chinook salmon from the San Joaquin River are likely to be present, especially during April through June. This is supported by historical data from the Tracy Fish Collection Facility: salvage of juvenile fall-run Chinook, presumably of San Joaquin River origin, at the pumps, peaks in May (Bowen et al. 1998).

Adult fall-run Chinook are finishing their migration in December so few adults would be expected during the period of operations. It is unlikely that adult or juvenile late fall-run Chinook salmon would be affected by the gate operations because, as discussed above, most would be expected to be within the Sacramento River basin.

When closed, the gates would act as complete barriers and thus prevent direct movement of fish through Connection Slough or Old River. However, most adults would be expected to use the main river channel for their upstream migration and, in doing so, avoid the gates. The gates would only pose as an obstacle to adults migrating through the Central Delta. Such individuals would be forced to navigate upstream through another route. In these cases, the gates could delay the arrival of adults to the spawning grounds on the San Joaquin River and its tributaries.

The gates would result in changes in the hydrodynamics of the South Delta. When closed, dead-end sloughs would be created on either side of each gate. On the south side of the Old River and the west side of the Connection Slough Gate, the dead-end slough created would likely receive much reduced mixing and thus may suffer from impaired water quality, in the form of reduced oxygen concentrations and increased contaminant concentrations. While low dissolved oxygen concentrations have not been typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with agricultural returns in the area could create this type of problem. The magnitude of this cannot be predicted at this time. The net effect of this potential decrease in water quality on juvenile winter- run Chinook salmon is likely small, as juveniles would exhibit avoidance reactions to regions of low water quality, especially when DO levels are low (Carter 2005; Whitmore et al. 1960). When opened, although the effects described above would be lessened, the gates would still impact the hydrodynamics of the South Delta: the rock abutments and sunken barge would result in a 60 percent channel flow confinement when compared to the baseline flow.

Juvenile salmon are likely to be affected more as a result of increased predation in the vicinity of the gates, as predatory fish are known to congregate near manmade barriers in rivers. One study (Merz [no date] as cited in NMFS Temporary Barriers Program BO 2008) observed predation by striped bass on fall-run Chinook salmon on the Mokelumne River below the Woodbridge Irrigation Dam. Striped bass were found to be highly concentrated immediately below the dam during the spring out-migration of fall-run Chinook salmon. It was estimated, by stomach content analysis, that approximately 11 to 28 percent of the fall-run Chinook salmon smolts passing the dam were consumed by the striped bass congregating below the structure. This value rose to almost 50 percent when unidentified, but suspected Chinook salmon smolt remains were included in the analysis (Merz [no date] as cited in NMFS Temporary Barriers Program BO 2008).

The project is not expected to change the number of fish moving from the Sacramento River into the Central Delta via the Delta Cross Channel or Georgiana Slough. It will however, mostly eliminate reverse flows in Old River between the gate location and the San Joaquin River that may attract these fish into the area of Frank’s Tract. Even if these fish enter the area near Frank’s Tract, they would be blocked from moving down Old River by the gates. Severing the direct route between the San Joaquin River near the mouth of the Mokelumne and the pumps may provide a benefit to this species. Flow in the San Joaquin River between the mouth of the Mokelumne and Turner Cut is strongly influenced by tides. Flows are positive (toward Suisun Bay) during the ebb tide and negative (away from Suisun Bay) during the flood tide. The project would increase reverse flows in the San Joaquin River between the Mokelumne River confluence and Turner Cut during the flood tide. Reverse flows would also increase in Middle River and in Columbia and Turner cuts and their connecting channels between the San Joaquin River and Middle River. It is unknown how Chinook salmon may respond to these changes in flow patterns. If they follow the flow, the direction the initial direction they take upon entering the San Joaquin River may depend on what the tidal stage is when they enter the river. Because of the physical barriers across Old River and the longer path these fish would be required to take to the pumps, the 2-gate plan would provide some benefit to Chinook salmon, but the magnitude of this benefit cannot be determined.

Flow in the San Joaquin River between Turner Cut and the Mokelumne River would be more strongly influenced by reverse flow and may impair the ability of San Joaquin River fall-run fish from successfully leaving the Delta. A proportion of San Joaquin fall-run Chinook utilize Old River as a migratory corridor during the out-migration. This segment of the population would be especially affected when the gates are closed. Such juvenile fish that move west into the head of Old River would also face more difficult conditions. Downstream flows will first carry them to the CVP and SWP intakes, and if they successfully negotiate these sites, they would be facing near-constant reverse flows in Old and Middle Rivers. Fish that remain the Old River channel could encounter a closed gate until June and may remain trapped in the south Delta until the gates re-open and subject to predation or may be more susceptible to the impacts of pumping (entrainment) during the months of operation. Fish that remain in Middle River could be confused by the constant reverse flows. Because of the longer path these fish would be required to take to navigate back into the San Joaquin River, the project may effect some early outmigrating Chinook salmon from the San Joaquin River, but the magnitude of this effect cannot be determined.

The project is not expected to change the number of fish moving from the Sacramento River into the Central Delta via the Delta Cross Channel or Georgiana Slough. It will however, eliminate reverse flows in Old River that may attract these fish into the area of Frank’s Tract. Even if these fish enter the area near Frank’s Tract, they would be blocked from moving down Old River by the gates. Severing the direct route between the San Joaquin River near the mouth of the Mokelumne and the pumps may provide a benefit to this species. Flow in the San Joaquin River near the mouth of the Mokelumne is strongly influenced by tides. Flows are positive (toward Suisun Bay) during the ebb tide and negative (away from Suisun Bay) during the flood tide. The project would increase reverse flows in the San Joaquin River between the Mokelumne River confluence and Turner Cut during the flood tide. Reverse flows would also increase in Middle River and in Columbia and Turner cuts between the San Joaquin River and Middle River. It is unknown how Chinook salmon may respond to these changes in flow patterns. If they follow the flow, the direction they move in the San Joaquin River may depend on when the tidal stage when they enter the river. If, on the other hand, the fish are following a salinity gradient by this time, they may continue on toward Suisun Bay and the ocean, regardless of the flow. Because of the longer path these fish would be required to take to the pumps, it is expected that the project would provide some benefit to Chinook salmon, but the magnitude of this benefit cannot be determined.

The gates would also prevent the movement of nutrients and food items between the South Delta and Franks Tract and Suisun Bay. The importance of this transport is unknown, but presumably most of this transport is towards the pumps based on the strong reverse flows that occur under existing conditions. The gates may result in more of the productivity being retained in the western Delta, rather than pulled into the export facilities.

3.8.3.3 Gate Removal Effects

The barges would be removed in July, along with the removal of the rock abutments. During this time, juvenile fall-run Chinook salmon could be present but it is unlikely that any adults would be present in July.

Removal of the barge would result in some disturbance of sediment, although this would likely be minor, as the barges would be placed on the rock fill foundation. No other effects from re-floating and removal of the barges are foreseen. This is not expected to adversely affect Chinook salmon. Removal of the rock abutments could result in direct injury or mortality of Chinook salmon as rock is removed from the channel using a clam shell dredge. Fish could be struck by the dredge, caught in the dredge and moved out of the channel, or struck or crushed by falling rock. The number of fish that could be impacted is unknown. Removal of the rock abutments would also result in increased turbidity. This increase is expected to be minimal, as this rock would have been placed in the channel only a few months previously. This would likely not affect Chinook salmon. The noise and activity associated with removal of the barriers may result in Chinook salmon fleeing from or avoiding these areas. They may move to non-preferred habitat or to areas where they were more susceptible to predation.

3.8.3.4 Gate Replacement Effects

The rock abutments and barges would be replaced in November of the following year to be operational from December 1. During this time, fall-run Chinook salmon are concluding their upstream migration to spawning grounds in the Sacramento Basin and through the Delta to San Joaquin Basin. The upstream migration of late fall-run Chinook salmon spans the entire replacement period. The effects of abutment reconstruction and barge placement will be similar to those described in the construction effects. There will be no dredging and rock replenishment for the gate pad will be minimal.

3.8.4 Effects on Critical Habitat

Critical Habitat has not been designated for this species

3.8.5 Cumulative Effects

The degree of project benefits for emigrating juveniles is interdependent on operations of the Delta Cross Channel gates, which are also operated during winter months to reduce straying of emigrating juveniles from the Sacramento River into the Central Delta.

The project is not expected to have significant cumulative effects on water quality factors that would affect fall-/late fall-run Chinook salmon because the majority of the operations would occur in winter (when water temperatures and dissolved oxygen conditions are not near critical levels) and the duration of operations is not sufficient to result in long-term stagnation of waters in Central Delta channels. Cumulative effects with agricultural operations would be minimal because in-Delta farms are not diverting or discharging during the winter except following substantial rainfall. Depending on the location and magnitude of local municipal wastewater discharge (e.g. Discovery Bay or Brentwood), there could be potential for localized water quality problems in the receiving waters due to reduced flushing.

Table 3-2 Potential Effects of Project on Chinook Salmon by Month

Month	Project	Chinook Salmon Run	Life Stage in Delta	Historic salvage	Potential Project Effects
Jan	Operate gates	Winter-run	Adult immigration to Sacto R		Limited effect (migrate north to Sacramento River)
			Juvenile emigration	Peak salvage at facilities	**Potential benefit** by reducing flow cues toward central Delta that juveniles might follow
		Spring-run	Juvenile emigration	No salvage at facilities	<u>Limited benefit</u> by reducing flow cues toward central and south Delta
		Late-fall run	Adult immigration		Limited effect (adults migrate north to Sacramento River)
			Juvenile emigration	Salvage	<u>Limited benefit</u> by reducing flow cues toward central and south Delta
		Fall-run	Juvenile rearing (Delta and SJR)	Salvage	
Feb	Operate gates	Winter-run	Adult immigration to Sacto R		Limited effect (adults migrate north to Sacramento River)
			Juvenile emigration	Peak salvage at facilities	**Potential benefit** by reducing flow cues toward central Delta
		Spring-run	Adult immigration to Sacto R		Limited effect (migrate north to Sacramento River)

Table 3-2 Potential Effects of Project on Chinook Salmon by Month

Month	Project	Chinook Salmon Run	Life Stage in Delta	Historic salvage	Potential Project Effects
			Juvenile emigration	No salvage at facilities	Limited benefit by reducing flow cues toward central and south Delta
		Late-fall run	Adult immigration		Limited effect (adults migrate north to Sacramento River)
			Juvenile emigration	Salvage	
		Fall-run	Juvenile rearing (Delta and SJR)	Salvage	
			Juvenile emigration	Salvage	San Joaquin juveniles ….
Mar	Remove gates	Winter-run	Adult immigration to Sacto R		Limited effect (migrate north to Sacramento River)
			Juvenile emigration	Peak salvage at facilities	Limited effect as gates are removed, slight reduction in flow cues toward central/south Delta
		Spring-run	Adult immigration to Sacto R		Limited effect (migrate north to Sacramento River)
			Juvenile emigration		Limited effect as gates are removed, slight reduction in flow cues toward central/south Delta
		Late-fall run	Juvenile emigration	Salvage	Limited effect as gates are removed, slight reduction in flow cues toward central/south Delta
		Fall-run	Juvenile rearing (Delta and SJR)	Salvage	
			Juvenile emigration	Salvage	Limited effect as gates are removed
Apr – Sep	No project				
Oct	Install gates	Winter-run	Juvenile emigration	No salvage	
		Spring-run	None present	No salvage	none
		Late-fall run	Adult immigration	No salvage	
		Fall run	Adult immigration to Sacto & SJR	No salvage	
Nov	Install gates	Winter-run	Adult immigration to Sacto R	No salvage	Limited effect (migrate north to Sacramento River)
			Juvenile emigration	No salvage	
		Spring-run	Juvenile emigration	No salvage	
		Late-fall run	Adult immigration	No salvage	
			Juvenile emigration	Salvage at facilities	
		Fall run	Adult immigration to Sacto & SJR	No salvage	
Dec	Operate gates	Winter-run	Adult immigration to Sacto R	No salvage	Limited effect (migrate north to Sacramento River)
			Juvenile emigration	Salvage at facilities	
		Spring-run	Juvenile emigration	No salvage	
		Late-fall run	Adult immigration to Sacto R	No salvage	
			Juvenile emigration	Salvage at facilities	
		Fall run	Adult immigration to Sacto & SJR	No salvage	

3.9 OTHER AQUATIC SPECIES

3.9.1 Longfin Smelt Baseline and Effects

3.9.1.1 Biological Characteristics

A brief description of longfin smelt is provided in the following text. For a full life history description refer to the OCAP BA (Reclamation 2008).

Longfin smelt are a native, pelagic and anadromous species capable of living in freshwater, brackish and marine environments over their 2-year life-cycle. Longfin smelt are one of seven osmerid fish species occupying habitats in California estuaries and coastal waters (Moyle 2002).

In the Bay-Delta Estuary, longfin smelt adults are generally 90-110 mm SL at maturity, but some individuals may grow up to 140 mm SL (Baxter 1999; Moyle 2002).

Presently, the largest and southern-most self-sustaining longfin smelt population of the Pacific Coast is in the Bay-Delta Estuary (Moyle 2002). Longfin smelt complete the majority of their life-cycle in brackish to marine waters, with most juveniles occurring in the Bay-Delta Estuary within a salinity range of 15 to 30 ppt (Baxter 1999), and are not commonly found in waters above 20°C (Moyle 2002). Maturity is reached at Age 2. Female longfin smelt may live a third year but it is not certain if they spawn again. Longfin smelt eggs are adhesive and are probably released over a firm substrate (Moyle 2002). Young juvenile longfin smelt feed primarily on copepods, while older juveniles and adult longfin smelt feed principally on opossum shrimp, *Neomysis americana*, *Acanthomysis* sp. and *Neomysis mercedis* when available (Hobbs et al. 2006).

LEGAL STATUS

Longfin smelt, one of the species associated with the Pelagic Organism Decline (POD), is not currently listed under the Federal ESA; however, the species is listed under CESA as a species of special concern. During spring of 2008, the CDFG sought stakeholder input to the process of drafting a Section 2084 regulation to protect longfin smelt during August 2008 through February 2009. A “final draft” regulation will go to the Fish and Game Commission in early August 2008. Because the species is not listed, there is no designated critical habitat; however, suitable spawning and rearing habitat for longfin smelt occurs throughout the Delta as summarized below.

SPAWNING

Adult longfin smelt tend to aggregate in Suisun Bay and the western Delta in late fall, and then spawn in freshwater areas immediately upstream during winter and early spring with the peak period occurring between February and April (Reclamation 2008), within a temperature range of 7 to 14.5°C (Bay Institute et al. 2007). According to the Fall Midwater Trawl, Winter Midwater Trawl, and Spring Kodiak Trawl surveys conducted by CDFG at various times of the year, only a very small fraction of the subadult and adult longfin smelt appear in the southeast Delta in Old and Middle Rivers. The exact spawning areas are unknown for longfin smelt, but the general spawning region is considered to be between the confluence of the Sacramento and San Joaquin Rivers up to Rio Vista on the Sacramento River and Medford Island on the San Joaquin River (refer to Figure X) (Moyle 2002). Spawning probably also occurs in the eastern portion of Suisun Bay and in some years the larger sloughs of Suisun Marsh (Bay Institute et al. 2007).

LARVAL AND JUVENILE TRANSPORT

Longfin smelt larvae are buoyant and abundant in the upper portion of the water column usually from January through April. Larvae are frequently caught upstream of the Sacramento-San Joaquin River confluence in the Delta around Sherman Island (Baxter 1999; Dege and Brown 2004). Juveniles migrate further downstream to Suisun Bay and low salinity habitats for growth and rearing (Moyle 2002).

REARING

During their first year, juveniles disperse broadly throughout the western Delta around Sherman and Browns Islands towards Honker Bay. Rearing habitat for longfin smelt is typically open water, away from shorelines and vegetated inshore regions.

3.9.1.2 Effects on Longfin Smelt

CONSTRUCTION IMPACTS

Construction is scheduled to be completed by the end of November and is expected to last for approximately one month. During this time, longfin smelt would be found throughout the western Delta and may potentially be affected by this action.

Dredging of a portion of the bottom channels in Old River and Connection Slough would temporarily increase channel depth and disturbance of substrate in these areas. Longfin smelt adults typically migrate upstream from Suisun Bay (western Delta) to spawn in the lower reaches of Sacramento and San Joaquin Rivers during late autumn through winter. Dredging could entrain and injure migrating adult longfin smelt if present in these channels during time of construction; however, the number of adults likely to be present during November in these areas would be small.

Indirect effects of dredging include the potential release of additional sediment and contaminants into the water column during the dredging process and associated increases in surface contaminants and noise from construction equipment in the vicinity of the gate locations. Increased sediment disturbance could affect water quality factors by increasing turbidity and reducing dissolved oxygen (DO). However, dredging will be limited in scope to a relatively small area (less than 4 acres in each channel) directly below the gate placement area. It is therefore not expected to increase turbidity or decrease DO over a large area long-term. Additionally, the temporary increase in sediment during this time-period is not expected to affect spawning habitat nor longfin smelt spawning which typically occurs between December and April (Reclamation 2008).

Construction vessels may lead to surface contaminants due to release of oil-based materials during operations and an increase in noise and general disturbance. Best Management Practices (BMPs) such as development of a spill prevention plan and/or hazardous materials management plan, and environmental training could be developed and implemented prior to and during construction activities to avoid and minimize potential impacts to the listed fish species. Thus, potential effects to adult longfin smelt from contaminants would be minimal with the implementation of such BMPs and measures.

The same direct and indirect effects to adult longfin smelt would result with the activities associated with the placement of rock for the barge foundation, the shoreline abutments and rock ramps. Rock placement may increase turbidity by disturbing fine organic and inorganic particulates from the bed of the channel and increase turbidity levels. This action would be short-term and would occur in a relatively restricted area and/or directly down current of the disturbance area. The temporary increase in suspended material during this time period is not anticipated to affect adult longfin smelt.

The potential effects to fish species from rock placement would be the change in bottom habitat composition. Replacement of the soft bottom sediment with rock to create the foundation will result in the loss of the peat/muck habitat. This in turn will affect the benthic community structure. Species adapted to the soft peat and muck habitat will be replaced, in this particular area, with those more adapted to a firm surface. Adult longfin smelt feed primarily on opossum shrimp and copepods so effects to the benthic invertebrate habitat as a result of rock placement activities should not affect food availability for longfin smelt.

Barge placement may cause direct harm or mortality to adult longfin smelt due to entrainment in pumps used to ballast the barge, if adult longfin smelt were present in these areas at the time of barge placement. However, the area of construction is small relative to the other channel areas which provide similar habitat quality for longfin smelt in the south Delta. Also, most adult smelts would move away from construction activities and into adjacent habitat of similar quality. Thus, potential direct effects to adult longfin smelt from barge placement activities would be minimal.

Similar to dredging, indirect effects of barge placement include the potential release of additional sediment and contaminants into the water column during placement of the barge and associated increases in surface contaminants and noise from construction equipment in the vicinity of the gate locations. However, this action would be very short-term (days) and would occur in a relatively restricted area that was recently disturbed for rock placement. The temporary increase in suspended material during this time period is not anticipated to affect adult longfin smelt. Once the construction activities are completed, turbidity levels would return to pre-disturbance levels. Some contaminants may be released during barge placement as the barges are ballasted, the voids flooded with water and sunk. To avoid or minimize potential effects to the fish species, barges would be inspected and cleaned, if necessary, after the gates have been installed and prior to moving them to the site.

Removal of the barge and barrier rock wing walls would occur in July. During this time, longfin smelt are unlikely to occur near the area of the gates because of warm water temperatures, and thus would not be affected by removal of the gates.

Replacement of the gate in November could potentially affect adult longfin smelt, if present in these channels during construction, but to a lesser degree. For example, unlike the initial construction activities, replacement of the gate will not require dredging or the same degree of rock placement. This action has the potential to increase sediment load temporarily, and cause general disturbance due to increased boat traffic (barges, tug boats, etc.). Contaminants may enter the water surface from construction boats. Replacement of the gate in the fall is not expected to take more than a week and the potential disturbance to adult longfin smelt should be relatively minor.

OPERATIONAL IMPACTS

The gates would be in operation from December 1 through June 30. During this time adult longfin smelt, eggs, and larvae could be present in Old River and Connection Slough. When the gates are closed, the structures will also prevent longfin smelt (i.e., spawners and offspring), like delta smelt, from the Franks Tract area to being moved into the conveyance channels of Old and Middle Rivers and being carried directly downstream into the vicinity of the CVP and SWP pumps, where they are subject to entrainment, predation and poor habitat conditions.

For longfin smelt, entrainment at these pumps relates to subadults and spawners salvaged in the late fall and winter, and larvae and juvenile longfin smelt salvaged January through June. Current salvage and trawl data indicate that the South Delta is not used extensively by longfin smelt (Baxter et al. 2007). However, if longfin smelt were to concentrate on the north side of the Old River gate and on the west side of the Connection Slough gate when closed and then opened when certain conditions were met (refer to Table 1-X), then there would be an increased risk of entrainment of longfin smelt larvae and juveniles at the pumps.

Longfin smelt typically migrate upstream from Suisun Bay and the western Delta to spawn in the lower reaches of Sacramento and San Joaquin Rivers during late autumn through winter. The gates, when closed, would prevent direct movement of fish past these gates into Old and Middle Rivers from the Franks Tract area. If adult longfin smelt were to encounter the closed gates during their migration, then these smelt would have to move about the Delta following other routes, but these direct connections between Franks Tract and the pumps would be severed. It is unknown how longfin smelt distribution might change if the gates were put in place.

The presence of the gate structures when closed would create dead-end sloughs on either side of each gate resulting in changes to local hydrodynamics and may therefore have effects on water quality parameters such as flow rate, DO, turbidity, and nutrient dynamics in these areas. On the south side of the gate in Old River and the west side of the gate on Connection Slough (refer to Figure X), the dead-end sloughs created would likely receive much reduced tidal mixing and thus may develop impaired water quality, in the form of reduced oxygen concentrations and/or increased contaminant concentrations. While low DO concentrations are not typical in this part of the Delta, especially at this time of year, the reduced mixing, combined with discharge of agricultural returns in the area could create such a problem. The magnitude of impairment cannot be predicted at this time. However, the net effect of the potential decrease in water quality on longfin smelt adults, eggs or larvae is likely small. The other dead-end sloughs would likely receive sufficient tidal mixing and are not expected to develop poor water quality conditions. These conditions would have negligible effects on the forage base of longfin smelt.

Flows in Old and Middle Rivers south of the gates would continue in reverse and toward the pumps. Flows in Old River between the gate, Rock Slough and Railroad Cut would be less so, but the magnitude of reverse flow in Old River would increase at the Woodward and Victoria Canals. Reverse flows would likely increase slightly in the San Joaquin River between the Mokelumne River confluence and Turner Cut including into Middle River, Columbia and Turner Cuts and connecting channels from the San Joaquin River. The increased reverse flows in this wider area may draft more fish toward the pumps. However, these are areas of lower longfin smelt abundance.

Delays in longfin smelt migration, when the gates are closed, may also cause an increase in exposure to predation in Delta channels. The gate structures have the potential to increase the density of predator species (i.e., striped bass, largemouth bass, catfish, etc.) and predation on both sides of the gates. Concentrations of disoriented fish increase prey availability and create predator habitat. Predation associated with the installation of the gates could cause a small and likely negligible increase in mortality of longfin smelt individuals.

3.9.1.3 Effects on Critical Habitat

No critical habitat for longfin smelt occurs within the Delta.

3.9.2 Pacific Lamprey

Listing Status

In December 2004, the US Fish and Wildlife Service determined that Pacific lamprey (Lampetra tridentata) was not warranted for a listing based on available information (USFWS 2004). They are a Federal and California Species of Concern. The Service requested the public to begin assembling information. Pacific lamprey species management units (SMUs) are being established by regulatory and fishery management agencies throughout the Pacific Coast. A Sacramento-San Joaquin SMU management unit has not been defined although preliminary assessment efforts have occurred (Hanni et al. 2006). Lack of adequate information on status, distribution, and genetic composition will complicate defining a SMU. West-coast wide, much of the effort concerning Pacific lamprey includes population, abundance, and fish passage research.

Description

The Pacific lamprey is a very primitive, eel-like fish. Adult Pacific lampreys are characterized by the presence of 3 large sharp teeth (cusps) and posterior teeth on the oral disc (Wydoski and

Whitney 2003; Moyle 2002). The two dorsal fins are slightly separated and the second dorsal fin is continuous with the caudal fin. The anal fin, distinctive in females, is lacking in males. The ammocoetes at age 5 ranges in size from approximately 4 to 8.5 inches (9.5 to 22 centimeters), depending on the geographic area (Wydoski and Whitney 2003).

Life History and Ecology

Anadromous Pacific lampreys live in the ocean as adults where they feed on the blood and bodily fluids of marine mammals and fish. After spending 1 to 3 years in the marine environment, Pacific lampreys return to freshwater between February and June (Kostow 2002; Moyle 2002). They are thought to overwinter and remain in freshwater habitat for approximately 1 year before spawning. In freshwater they may shrink in size up to 20 percent (Beamish 1980). Pacific lampreys primarily migrate upstream at night and adult size at the time of migration ranges from about 15 to 24.5 in (38 to 62 cm). They spawn between March and July, depending upon location within their range (Beamish 1980). Lampreys construct nests in small gravel primarily by moving rocks with their mouth forming a small redd where they lay their eggs. Fecundity is high but variable, with females producing between 20,000 and 200,000 eggs (Moyle 2002). After the eggs are fertilized and deposited in the nest, embryos hatch in approximately 19 days at 59° F (15° C). Larvae enter the drift and establish residents in sand, silt and mud habitats in backwater, channel margins or eddies. The blind ammocoetes are filter feeders on algae and detritus. Once the ammocoetes reach about 6 in (15 cm), they begin metamorphosis into macropthalmia (Moyle 2002; Wydoski and Whitney 2003). The macropthalmia stage migrates out to the ocean and begins a parasitic lifestyle as an adult growing to about 2 feet in length.

In the Sacramento-San Joaquin System and Delta incidental capture data for lamprey adult and ammocoetes indicate their presence from March through October on the mainstem of the San Joaquin River and within the Mokelumne River. Few data are available for adult lamprey on the Tuolumne, but the species has been documented from February - June (Hanni et al. 2006, CDGF unpublished data). Table 3-3 suggests an overview of Pacific lamprey life history.

Table 3-3 Timing of Life History Stages for Pacific Lamprey

Life Stage	Period and Notes
Ammocoetes	Present year round in tributaries, mainstem and Delta. During winter/spring storm events, flushed into saline portions of Delta and detected in Chipps Island Trawl
Adult Migration	February through June
Adult Freshwater Pre-Spawn Rearing	Year round
Spawning	March through July
Incubation	March through August
Adult Marine Rearing	Year round
Adult Freshwater Rearing	Complete lifecycle observed in freshwater areas of difficult downstream passage

Distribution and Abundance

Pacific lampreys are found in streams from Hokkaido Island, Japan, and along the Pacific Rim, including Alaska, Canada, Washington, Oregon, Idaho, and California to Punta Canoas, Baja California, Mexico. Pacific lampreys are the most widely distributed

lamprey species on the west coast of the United States (U.S.). Their distribution includes major river systems such as the Fraser, Columbia, Klamath-Trinity, Eel, and Sacramento-San Joaquin Rivers. They no longer exist above dams and other impassable barriers in west coast streams, including many larger rivers throughout coastal Washington, Oregon, and California, and above dams in the upper Snake and Columbia Rivers. The lamprey has been captured mostly in the upper portion of the Sacramento-San Joaquin estuary and its tributaries. Ammocoetes and newly transformed adults have been collected in plankton nets in Suisan Bay, Montezuma Slough, and throughout Delta sloughs as far east as Chipps Island and among open estuary shorelines (CDGF unpublished data, Hanni, pers. comm, Brown and Muchniuk 2007) and additional San Joaquin distribution information is provided by Brown and Moyle (1993).

Only in the past decade have fish resource agencies begun to determine the current status in relation to historic abundance. Lampreys have declined for some of the same reasons that steelhead and salmon have (water diversions, channelization and dams that affect migration and rearing conditions). Lamprey abundance varies among Pacific coast regions (Columbia River, Oregon), but available data indicates that Pacific lampreys have declined in abundance throughout the Columbia River basin and southern California (Froese and Pauley 2002) generally far below historical abundance - and trends continue downward. Lampreys have declined for some of the same reasons that steelhead and salmon have (water diversions, channelization and dams that affect migration and rearing conditions).

3.9.3 Plan Effects on Pacific Lamprey

3.9.3.1 Potential Plan Effects on Pacific Lamprey

Pacific lamprey ammocoetes and adults are present in the Delta, mainstem Rivers and tributaries year round. Adults migrate up the Sacramento and San Joaquin River to spawn and larvae are transported down-river in subsequent months after emerging from redds. Construction and operation activities will occur November through March, when ammocoetes are present in the action area.

Construction

Construction is scheduled for November and is expected to last for approximately one month. During this time, lamprey ammocoetes are found throughout the Delta and may potentially be affected by this action. Construction activities include dredging, rock placement, and barge placement. All of these activities have the potential to cause either direct harm to lamprey or reduction in their habitat quality or quantity.

DREDGING

Dredging will be used to excavate mud and peat from the channel bed for rock placement to serve as the foundation for the 2 gate structure and barge. This action will occur in November and last for approximately one week when lamprey ammocoetes are present in action area.

Dredging of the bottom material has the potential to cause direct mortality or harm through entrainment.

Indirect effects of dredging include the potential release of additional sediment or displacement of ammocoetes and contaminants into the water column during the dredging process. Entrained ammocoetes would become susceptible to predators during entrainment.

Increased sediment disturbance could affect water quality factors by increasing turbidity and reducing dissolved oxygen (DO). Increases in contaminants in the water column could occur following re-suspension of contaminated sediments. Effects are unknown for ammocoetes that encounter the sediment plume during entrainment. Dredging will be limited in scope to a relatively small area (less than 4 acres) directly below the gate placement area. It is therefore not expected to increase turbidity over a large area long-term. Additionally, the temporary increase in sediment during this time-period is not expected to affect sediment-dwelling ammocoetes.

The ammocoete diet is composed of epibenthic miscroscopic plant and animal materials. These benthic feeders are prone to uptake of contaminants found in the substrate and an increase in contaminants into the water column could lead to some uptake and ultimate accumulation into their diet. Ammocoetes may already be incorporating contaminants through their filter feeding; however, the dredging will activate deeper sediments. Levels of contaminants in the construction area are not considered high relative to areas of similar habitat across the Delta (Deamovic et al. 1996). Overall, it is expected that this activity may increase slightly the contaminant load in the potential ammocoete diet, but their association with the substrate makes this exposure effect negligible.

Boat traffic, noise, and general disturbance from construction will have no effect on ammocoetes and the effects to adult migratory or freshwater rearing lamprey are unknown. At a minimum, migration may be hindered due to the construction- related disturbance. Adult lamprey would likely move away from construction activities and into adjacent habitat of similar quality.

ROCK PLACEMENT

Rock placement is necessary for building the foundation, abutments, and ramp. The placement of the large volumes of rock and gravel necessary for construction of the gates place direct mortality or harm risk to ammocoetes and adults via striking or burial. Existing habitat will be modified in areas where rock is placed. The total amount of habitat modified due to rock placement is approximately 4 acres.

Rock placement is expected to generate underwater noise from both terrestrial and underwater sources. These activities may generate sharp transient noises from metal components (buckets, scoops, etc.) striking rock that will propagate into the water column.

Rock placement and positioning will disturb the bottom of the riverbed, resulting in increased siltation, and sedimentation. Highly elevated suspended sediments will have negligible effects on the silt-burrowing ammocoetes but may deter adults from passage or habitat use.

Replacement of the soft bottom sediment with rock to create the foundation will result in an alteration of bottom habitat from mud and peat to rock. This in turn, could affect the benthic community. Ammocoete habitat will be removed causing a loss of 4 acres of silt-mud bottom habitat. There is uncertainty about the time scale of this habitat loss. Over time, tidal influx, bank erosion and sediment transport should cause these areas to become soft bottom again, especially with the barriers in place that will stop the currents.

Loss of riparian habitat due to rock placement in the development of the abutments could lead to a loss of emergent vegetation near the levees or riparian vegetation that may be growing on the Holland, Bacon or Mandeville islands. However, these islands are ringed by levees and the amount of riparian vegetation at the gate sites is likely very limited.

BARGE PLACEMENT

Prior dredging would have removed sediments with lamprey ammocoetes so barge placement may cause direct harm or mortality to adults due to entrainment during the placement of the barge or capture of individuals as the barge is ballasted and sunk. Indirect effects include disturbance associated with construction boats and contaminants on the water surface as construction boats transfer and put the barge in place. As with the rest of the construction activities, surface contaminants produced by boats will be addressed in a Spill and Pollution Prevention Plan, which will outline actions to reduce impacts from this activity and address responses to potential spills.

GATE REMOVAL

Removal of the gate each year will occur in March. This action has the potential to effect migratory patterns of adult lamprey as they move upstream to spawn (Feb – June). Effects of gate removal are similar to those identified for construction, but to a lesser degree. This action has the potential to increase sediment load temporarily and cause general disturbance due to increased boat traffic (barges, tug boats, etc.). Contaminants may enter the water surface from construction boats. The estimated time necessary to remove the gate is approximately one month in the first year and one week in subsequent years. Therefore, there is potential for construction-related disturbance during the beginning of the migration season each year.

GATE REPLACEMENT

Initial construction created the most effect related to habitat loss. Therefore, gate replacement will have little to no effect on ammocoetes. Replacement of the gate in the fall is not expected to take more than a week and disturbance to adult lamprey that may be in the area should be relatively minor.

Operation

FISH PASSAGE

The gate is expected to be closed from December through March. Lamprey spawning occurs well upstream of the Delta from March to July. The gate structure remains in place until the end of March which overlaps with the beginning of the spawning period. Therefore, operation of the gate has the potential to impede the early part of adult lamprey movement and general movement of ammocoetes entrained from upstream areas due to flood events. There is limited information about how common the use of Central and South Delta auxiliary pathways are used for spawning migration but warm Delta water temperatures may inhibit successful year-round adult rearing, suggesting that the adult lamprey that rear for one year in freshwater prefer upstream tributaries and mainstem validated by Hanni et al (2006), Hanni (pers. comm.) and unpublished trapping data from EMUD (Mokelumne River) and CDFG (Tuolumne River).

Individuals migrating to spawn in March will not be prevented from moving up into the Sacramento River, the San Joaquin River, or elsewhere throughout the system.

WATER QUALITY

The presence of the gate structure itself is designed to affect the hydrology and may therefore have effects on water quality on either side of the structure. A potential effect of changing features of the hydrology is a change in water quality parameters such as flow rate, DO, turbidity, contaminants, and nutrient dynamics. Water temperature is not expected to be influenced by operation of the structures. Other water quality factors such as increased turbidity, decreased DO, and changes in salinity regime all have the potential to affect ammocoetes.

The presence of the gates will reduce flow in the channels on either side of the gates because the local tidal prism (the volume of water available for movement during tidal cycles) will have been reduced. Both sides will continue to be tidally influenced, but at a reduced rate with the gates closed. The channels near the gates will function much like dead-end sloughs with tidal pumping driving water toward the gates then retreating on an ebb tide. Velocities nearest the gates are very low and as distance from the gate increases, the cumulative channel volume increases and tidal velocities increase as well. Therefore, particles in the water will tend to accumulate on either side of the gate. With each junction of another slough or channel, tidal influence increases and the propensity for stagnation would be reduced. This reduction in water movement nearest the gates could lead to a decrease in DO or change in nutrient dynamics. Changes in nutrient dynamics have the potential to affect the aquatic community, particularly the benthic community on a shorter time-scale. Increased nutrients can lead to harmful algal blooms or changes in algal community and changes in forage base for filter feeders. These effects in turn could affect the productivity for ammocoetes, mostly related to stress from lower oxygen.

PREDATORS

The presence of the gate structure with rock abutments may cause predatory fish such as striped bass or channel catfish to accumulate in the rock crevasse. The closed gates may accumulate fish that might otherwise continue to move through the channels on the other side of the structure. An increased number of fish may lead to increase in the predation rate on ammocoetes.

3.9.3.2 Effects on Critical Habitat

Critical Habitat has not been designated for this species

3.9.4 Striped Bass

To be provided

Section 4: Effects on Terrestrial Species and Critical Habitat

4.1 ELDERBERRY LONG-HORN BEETLE

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) was listed as a threatened species with critical habitat on 8 August 1980 (USFWS 1980). On 2 October 2006, the USFWS announced its recommendation to remove the valley elderberry longhorn beetle from the endangered species list.

According to the USFWS listing notice (USFWS 1980) and recovery plan (USFWS 1984), the valley elderberry longhorn beetle is very closely associated with the elderberry host plant (*Sambucus* spp., primarily *S. mexicana* and *S. caerulea*). Female valley elderberry longhorn beetles lay their eggs in bark crevices on the elderberry. The larvae bore into the wood of the host plant and feed on the central pith of stems. The adult eventually emerges through an exit hole, and adults are able to fly from shrub to shrub.

The elderberry shrubs used by this species occur in riparian forests throughout the Central Valley. Although they occasionally occur outside of riparian areas, those shrubs supporting the greatest beetle densities are located in areas where the shrubs are abundant and interspersed among dense riparian forest (Barr 1991, Collinge *et al.* 2001). Isolated elderberry shrubs separated from contiguous habitat by extensive development are not typically considered high-quality habitat for valley elderberry longhorn beetles (Collinge *et al.* 2001).

The valley elderberry longhorn beetle occurs in portions of the California Central Valley below about 3000 feet elevation. Originally thought to be very rare when it was listed in 1980, the species has since been recorded in approximately 190 locations (USFWS 2008).

Habitat of the valley elderberry longhorn beetle has been reduced and fragmented by clearing for agriculture, development, flood control, and construction of levees and dams. Habitat fragmentation also threatens the valley elderberry longhorn beetle; development isolates small patches of riparian forest and may prevent genetic flow between occupied areas of habitat, isolating metapopulations (Collinge *et al.* 2001). Non-native invasive species and over-grazing in riparian areas also represent threats to the valley elderberry longhorn beetle.

The objectives of the recovery plan (USFWS 1984) are to protect occupied habitat; to conduct surveys to better determine the locations of the species so that occupied habitat can be protected; to restore habitat, including the removal of nonnative plants; and to minimize the use of herbicides and insecticides, removal of riparian vegetation, and prevent riprapping of longhorn beetle habitat. Since the valley elderberry longhorn beetle was listed in 1980, numerous distributional studies have been conducted (summarized in Barr 1991, Halstead and Oldham 2000), and the species has been found to be more widespread than previously thought. On

October 2, 2006, the USFWS announced its recommendation to remove the valley elderberry longhorn beetle from the endangered species list.

Although there are no CNDDB records of the valley elderberry longhorn beetle in the Delta proper, this species could occur in elderberry shrubs, if present along the levees and in riparian habitat near the 2 barriers project sites. Riparian woodland is absent from the project sites, thus, the potential for valley elderberry longhorn beetle to be present on or adjacent to the project sites is low.

Critical habitat for the valley elderberry longhorn beetle has been designated, but is restricted to small areas in Sacramento County (USFWS 1980), outside the 2 barriers project sites.

4.1.1 Habitat Modification

The 2 barriers project could result in the loss of elderberries on which this beetle depends due to clearing, grading, excavation, placement of fill for the rock dikes or berms, movement of heavy equipment, vehicles, and project personnel, and other project-related activities. However, given the absence of riparian woodland in proximity to the 2 barriers project sites and the apparently low abundance of the valley elderberry longhorn beetle from the majority of the Delta and Yolo Bypass (based on CNDDB records), it is unlikely that the project would result in the loss or disturbance of more than isolated elderberry shrubs. Mitigation of impacts to habitat are identical to those described below for loss of individuals.

The restoration of riparian habitats elsewhere in the OCAP project area will benefit the species by providing extensive natural riparian habitat restoration, as suitable conditions for elderberry shrubs at the upper edges of restored marshes and in floodplains will increase.

4.1.2 Loss of Individuals

Installation and removal of the barriers could result in the mortality of individual longhorn beetles as a result of clearing, grading, excavation, placement of fill for levees or berms, trampling by heavy equipment and project personnel, and trampling by vehicles accessing construction or monitoring areas if occupied valley elderberry longhorn beetle habitat is present within 100 feet of the 2 barriers project sites. Adult valley elderberry longhorn beetles could be injured or killed if construction activities occur within 100 feet of occupied elderberry shrubs during the adult flight season between March 1 and June 30. Larvae could be injured or killed if occupied elderberry shrubs are damaged or killed, or if construction activities that generate dust depress the vigor of occupied shrubs.

A survey to determine the presence of suitable elderberries (diameter at ground level of 1.0 inch or greater) within 100 feet of the construction sites should be conducted by a qualified biologist prior to construction, and any elderberries present should be inspected for the presence of exit holes indicative of the presence of the beetle. If suitable elderberries are detected, the following mitigation measures shall be observed:

- Fence and flag a no-disturbance buffer not less than 20 feet around suitable elderberries, implement a training program for construction personnel and contractors advising them on the presence of valley elderberry longhorn beetle and its host plant, and post signs every 50 feet along the edge of the buffer perimeter. The signs should state: “This area is habitat for the Valley Elderberry Longhorn Beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment." The signs should be clearly readable from a distance of 20 feet, and must be maintained for the duration of construction; and

- Transplant suitable elderberries that are located within 20 feet of the construction area to a suitable on- or off-site conservation area consistent with the measures described in the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999); and
- Restore any damage to the buffer area within 100 feet of elderberries that occurs as a result of site disturbance activities, including the provision of erosion control and revegetation with native plants; and
- Secure an on- or off-site mitigation area, protect it in perpetuity, revegetate it with the required numbers of elderberries and associated natives as described in the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999), as well as occupied elderberry shrubs relocated from the construction site, and monitor it annually for a minimum period of 10 years to demonstrate that the habitat restoration is successful; or
- Purchase VELB conservation credits at a USFWS-approved conservation bank whose service territory includes the project site, and relocate any occupied elderberry shrubs within 20 feet of the construction site to the conservation bank.

4.1.3 Effects on Valley Elderberry Longhorn Beetle Critical Habitat

Critical habitat for the valley elderberry longhorn beetle has been designated, but is restricted to small areas in Sacramento County (USFWS 1980) outside the action area. Therefore, these actions will not result in the adverse modification of designated critical habitat for this species.

4.1.4 Effects Associated with Project Operation and Maintenance

Operations and maintenance activities include the annual installation and removal of the barriers, closure of the gates for 10-20 days for several times between December and March, and land or water based maintenance activities. Maintenance could include repair of the rock levees or gate structure with equipment and personnel mobilized either from access roads or by boat. Operations and maintenance are not expected to affect valley elderberry longhorn beetle since occupied elderberries within 20 feet of the construction site will be relocated and mitigation provided as described above. A no disturbance buffer protecting other suitable elderberries within 100 feet of the construction site and adherence to the measures described above will prevent impacts during operations and maintenance.

4.1.5 Effects Associated with Proposed or Potential Conservation Measures

Removal of any occupied elderberry shrubs from within 20 feet of the project area would reduce the habitat for this species in direct proximity to the project site. Transplanting elderberries that are or could be occupied could adversely affect individual valley elderberry longhorn beetles as a result of plant stress or mortality during or after the transplanting process. However, conservation of suitable habitat on- or offsite is expected to benefit the species.

4.1.6 Cumulative Effects

The potential effects of the project on valley elderberry longhorn beetle are expected to be minimal, given the absence of records of the species in the Delta and the lack of riparian woodland which provides suitable habitat. Therefore, the project is not expected to contribute to cumulative effects upon the species.

4.2 GIANT GARTER SNAKE

On October 20, 1993, the giant garter snake was listed as threatened by the U.S. Fish and Wildlife Service due to habitat loss from urbanization, flooding, and agricultural activities, as well as contaminants and introduced predators (Sorenson 1993). Previous to that ruling, it was listed as threatened by the California Fish and Game Commission (Jennings 2004).

The giant garter snake is a large (37-65 inches total length) aquatic snake that is never found far from water. The dorsal coloration is highly variable—brown to olive with a cream, yellow, or orange dorsal stripe and two light-colored lateral stripes (Stebbins 2003). Some individuals have a checkered pattern of black spots between the dorsal and lateral stripes or completely lack any dorsal stripes at all. The maximum number of dorsal scale rows is 21 or 23 and the number of subralabial scales is 8 (Rossman and Stewart 1987).

It is closely related to the western aquatic garter snakes (*Thamnophis atratus*) and the Sierra garter snake (*T. couchii*), and was elevated to species status by Rossman and Stewart (1987). The taxonomy of garter snakes in California has been subject to numerous revisions over that past century (e.g., see Van Denburgh and Slevin 1918, Fitch 1940, Fox and Dessauer 1965, and Lawson and Dessauer 1979). However, most herpetologists now agree that this snake is a valid species (USFWS 1999).

4.3 LIFE HISTORY AND ECOLOGY

The giant garter snake inhabits both agricultural wetlands and natural waterways including irrigation canals, drainage ditches, rice lands, marshes, sloughs, ponds, small lakes, low gradient streams, and riparian corridors (USFWS 1999). This species is closely tied to water and seems to require freshwater aquatic habitat during the spring and summer months, and estivation habitat (small mammal burrows or rock piles) in the dry uplands during the fall and winter months (Brode 1988). Juvenile and adult giant garter snakes appear to be most active when air temperatures reach 90°F; however, they can be observed during any month of the season when the sun is out and air temperatures are over 70°F (Hansen and Brode 1980, Brode 1988).

The species is relatively inactive during the winter, typically over wintering in burrows and crevices near active season foraging habitat. Individuals have been noted using burrows as far as 164 feet from marsh edges during the active season, and retreating as far as 820 feet from the edge of wetland habitats while over wintering, presumably to reach hibernacula above the annual high water mark (USFWS 1999). After emerging from over wintering sites, adult giant garter snakes breed during the spring (March to May) and 10-46 young (average 8.1 inches total length) are born alive during the months of late July through early September (Hansen and Hansen 1990). Giant garter snakes feed on a wide variety of fishes and amphibians, including both native and introduced fishes and Pacific tree frogs (*Hyla regilla*) and introduced bullfrogs (*Rana catesbeiana*). They seem to take prey items that are most abundant. Young snakes grow rapidly and reach maturity within about 3-5 years (USFWS 1999).

Historically, giant garter snakes were widespread throughout the lowlands of the Central Valley (except for a midway historic gap) from the vicinity of Chico in Butte County south to Buena

Vista Lake in Kern County (Stebbins 2003). Today, the species has disappeared from approximately 98% of its historic range and is largely confined to the rice growing regions of the Sacramento and San Joaquin Valleys (USFWS 1999). The process of rice farming fairly closely coincides with the biological needs of the giant garter snake. During the summer, giant garter snakes use flooded rice fields as long as sufficient prey is present. During the late summer, rice fields provide important nursery areas for newborn giant garter snakes. In the later summer and fall as the rice fields are drained, prey items become concentrated in remaining water bodies and giant garter snakes often gorge themselves on this food supply before going into hibernation (USFWS 1999).

According to the USFWS (1999) and CNDDB (2008), there are several historic occurrences of giant garter snakes in the general vicinity of eastern Solano County and southwestern Yolo County in South Fork Putah Creek near Davis and the western Cache Slough Complex region of the Yolo Basin. There is also a single record of the giant garter snake within 5 miles of the 2 barriers project sites in the CNDDB (2008). This latter location is a snakeskin that was detected in 1996 at the southwest end of Medford Island, approximately 5 miles northeast of the Old River barrier site and approximately 1.7 miles northeast of the Connection Slough barrier site. However, it is currently unknown if this represents a resident individual or a waif that was washed downstream during the previous winter flood season (USFWS 1999).

Giant garter snakes were probably historically restricted to aquatic marshland with salinities less than 5,000 mg/l. Although salinities above this level are not harmful to garter snakes, salinities above this level generally have a negative effect on developing amphibian embryos (e.g., see Jennings and Hayes 1994). Since amphibians are an important food source for giant garter snakes (especially gravid female snakes), then the lack of amphibians in an ecosystem over time would probably preclude giant garter snakes as well.

Also, tidal areas are generally subject to repeated flooding and historically, the lower portions of the Delta probably contained few locations of suitable garter snake hibernacula that were safe from the high water levels during the winter. Since then, the creation of levees and other suitable giant garter snake hibernacula, coupled with water conveyance systems have created more suitable conditions in the Delta for giant garter snakes to live.

Connectivity between regions where giant garter snakes are currently present and adjacent areas where they could colonize is important for providing access to available habitat and for potential genetic interchange. In the agricultural matrix of the Central Valley floor, giant garter snakes rely largely upon the network of canals and ditches that provide irrigation and drainage to provide this connectivity.

Giant garter snakes are generally found in aquatic habitats with the following characteristics:

- Enough water during the snake’s active season (typically early spring through mid-fall) to provide cover and food such as small fish and amphibians
- Emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Schoenoplectus* spp.)
- Vegetated banks for basking and foraging habitat and escape cover during the active season

- Upland refugia (*e.g.*, bank side burrows, holes, and crevices) near aquatic habitat during the active season
- High ground or upland habitat above the annual high water mark to provide cover and refuge from flood waters during winter (Hansen and Brode 1980)

Critical habitat has not been designated for the giant garter snake. Potential effects of the 2 barriers project on the giant garter snake are described below.

4.3.1 Habitat Modification

The 2 barriers project area may include wetlands that could currently provide habitat for the giant garter snake. Within these areas, modification of habitat for this species could occur in several ways. Localized loss of habitat for the giant garter snake could result from grading, excavation, placement of fill for the rock dikes, movement of heavy equipment, vehicles, and project personnel, and other project-related activities, although the extent of habitat that may be impacted by these activities would be limited. .

Restoration and conservation actions in the Delta and the Yolo Bypass implemented for the OCAP could potentially enhance habitat for the giant garter snake, particularly where farmland or other upland habitat will be converted to extensive marshland providing a diverse mosaic of wetland habitats. Such effects would be beneficial to the species. Additionally, the creation of elevated mounds of dirt with rocky substrates could be placed in the vicinity of the project area to create suitable upland winter retreats and basking habitats for giant garter snakes.

4.3.2 Loss of Individuals

During construction and removal of the 2 barriers, individual snakes could be destroyed as a result of grading, excavation, placement of fill for levees or berms, trampling by heavy equipment and project personnel, trampling by vehicles accessing construction or monitoring areas, and other project-related activities.

4.3.3 Effects Associates with Project Operation and Maintenance

Gate operations would occur from December through February and would occur when all giant garter snake individuals are in the middle of hibernation in underground retreats. Thus, gate operations—in theory—would have no ill effects on the species. However, there is a small potential for flooding at the gates if water discharges are too high to easily pass through the gates (such as during an El Niño event) or debris gets temporarily caught in the gates and temporarily floods parts of the adjacent levees. If this were to happen, then giant garter snake hibernation habitats could be flooded and snakes potentially killed by drowning. It is expected that proper maintenance should prevent any debris from causing flooding on the gates. If the area floods due to natural events, then the entire area would be flooded whether the gates are there or not. In such cases, the “take” of giant garter snakes would be due to natural conditions, not the presence of the water passage gates.

4.3.4 Effects Associated with Proposed or Potential Conservation Measures

Construction of the rock barriers is scheduled for October and November and placement of the ballasted barge with butterfly gates would be completed by December 1. By fencing off the terrestrial construction areas with silt fencing, removing all vegetation, and then checking each open small mammal burrow for snakes within the construction areas within 1 month of the start of work, the chance of harming or killing any giant garter snakes is reduced to zero. The checking of burrows can be done with an endoscope and such checked burrows can be excavated with hand tools after clearance by the onsite biologist. Any snakes found during the endoscope check of small mammal burrows could be immediately released unharmed over the silt fence into other open suitable small mammal burrows in the area. This technique is suitable for the area until daily high air temperatures fall under 70°F (which is usually late October or early November). After the site has been fenced, cleared, and any snakes removed, installation of the project would have no effect on giant garter snakes in the area because they are expected to be hibernating underground during this time of year.

After March 1, two operational scenarios are proposed. The gates would remain open and the barges and the rock structures would remain in place or the barges would be removed and remaining rock structure would be removed by the end of March. During this time of year any giant garter snakes coming out of hibernation would not be able to enter the construction site due to the presence of the perimeter silt fence. The silt fence could then be removed after all the construction work has been completed. If the barges remained year round, then the silt fence would have to maintained year around as well.

4.3.5 Cumulative Effects

The project is not expected to harm any giant garter snakes during construction and normal operation of the gates. In fact, the project is expected to enhance small native fish populations, which would presumably enhance the food resources for giant garter snakes in this part of the Delta. If the project works as designed, then many levee structures and corresponding aquatic habitats should become much more suitable over time for all live stages of giant garter snakes.

4.4 OTHER TERRESTRIAL SPECIES

Other special-status animals with potential to occur in proximity to the 2 barrier project site include burrowing owls (*Athene cunicularia*), a California Species of Special Concern and Swainson’s hawk (*Buteo swainsoni*), listed under the California Endangered Species Act as threatened in 1983.

4.5 SWAINSON’S HAWK

The Swainson’s hawk (*Buteo swainsoni*) is a medium-sized hawk with relatively long, pointed wings and a long, square tail. Adult females weigh 28-34 ounces and males 25- 31 ounces. Swainson’s hawks breeding in California may spend the winter in Mexico and South America. Central Valley birds appear to winter in Mexico and Columbia and hawks from northeastern California have been satellite-transmitter tracked to Argentina. The diet of the Swainson’s hawk is varied with the California vole being the staple in the Central Valley. A variety of bird and insect species are also taken. Over 85 percent of Swainson’s hawk territories in the Central Valley are in riparian systems adjacent to suitable foraging habitats. Swainson’s hawks often nest peripherally to riparian systems of the valley as well as utilizing lone trees or groves of trees in agricultural fields. Valley oak, Fremont cottonwood, walnut, and large willow with an average height of about 58 feet, and ranging from 41-82 feet, are the most commonly used nest trees in the Central Valley. Swainson’s hawks require large, open grasslands with abundant prey in association with suitable nest trees. Suitable foraging areas include native grasslands or lightly grazed pastures, alfalfa and other hay crops, and certain grain and row croplands. Unsuitable foraging habitat includes crops such as vineyards, orchards, certain row crops, rice, corn and cotton crops. Suitable nest sites may be found in mature riparian forest, lone trees or groves of oaks, other trees in agricultural fields, and mature roadside trees.

Swainson's hawks were once found throughout lowland California and were absent only from the Sierra Nevada, north Coast Ranges, Klamath Mountains, and portions of the desert regions of the state. Today, Swainson's hawks are restricted to portions of the Central Valley and Great Basin region where suitable nesting and foraging habitat is still available. Central Valley populations are centered in Sacramento, San Joaquin, and Yolo counties. During historical times (ca. 1900), Swainson's hawks may have maintained a population in excess of 17,000 pairs. Based on a study conducted in 1994, the statewide population was estimated to be approximately 800 pairs. Although more recent surveys have been planned to revise this estimate, there has been inadequate funding available to carry out the research. However, surveys in 1998 and 1999 in the Owens Valley area of the state revealed a larger population (about 20 pairs) than previously documented, centered around alfalfa fields in the area.

The loss of agricultural lands to various residential and commercial developments is a serious threat to Swainson's hawks throughout California. Additional threats are habitat loss due to riverbank protection projects, conversion of agricultural crops that provide abundant foraging opportunities to crops such as vineyards and orchards which provide fewer foraging opportunities, shooting, pesticide poisoning of prey animals and hawks on wintering grounds, competition from other raptors, and human disturbance at nest sites.

4.5.1 Habitat Modification

The California Natural Diversity Database (CNDDB 2008) contains seven records of Swainson's hawk nests, ranging from 2.8-6.6 miles from the project sites, in the vicinity of the project area on the Woodward Island and Bouldin Island topographic quadrangles. Trees suitable for nesting may be present within 0.5 mile of the project sites. However, project activities are not expected to affect any trees so no direct effects to Swainson's hawk nesting habitat (i.e., nest trees) are anticipated.

4.5.2 Loss of Individuals

Installation and removal of the 2 barriers is unlikely to affect nesting activities of Swainson's hawks because the nesting season, beginning in mid-March, is after the barriers are scheduled to be removed or operations discontinued. However, in years when nesting commences early, or removal of the gates is delayed, construction activities have the potential to disturb nesting activities. The potential for construction activities to adversely affect the reproductive success of a nest decreases with the distance between the nest and construction disturbance. The potential for adverse effects is high if construction directly impacts active nest trees while the potential for adverse effects is substantially reduced if construction activities are greater than 200 yards from an active nest.

Avoidance and minimization measures for Swainson's hawk include conducting focused surveys consistent with the Swainson's Hawk Technical Advisory Committee (May 31, 2000) if construction or removal activities are conducted between March 20 and June 10, and trees suitable for nesting are present within 0.5 mile of the project sites. If occupied nests are detected within 0.5 mile of the project site during barrier construction or removal, the California Department of Fish and Game shall be notified. If occupied nests are present within 200 yards of the construction site, construction activities will be delayed until after the young are more than 10 days old.

3.4 BURROWING OWLS

The burrowing owl (*Athene cunicularia*) is a semi-fossorial bird that inhabits flat grassland, prairie, savanna, desert and other open areas (Haug *et al.* 1993, Zarn 1974, Grinnell and Miller 1944). Burrowing owls often occur in human-altered and disturbed environments such as livestock grazing lands, margins of agricultural fields, airport infields (Barclay 2007), edges of athletic fields and golf courses, in irrigation canal banks, and vacant lots (Thomsen 1971, Zarn 1974). Burrowing owls rarely dig their own burrows in the western United States, but typically use burrows dug by fossorial mammals such as ground squirrels (*Spermophilus* spp.), badgers (*Taxidea taxus*), and prairie dogs (*Cynomys* spp.) (Zarn 1974).

Burrowing owls are primarily monogamous and commonly nest in loose colonies of 4-10 pairs (Zarn 1974). The nesting season in California generally runs from February through August with peak activity from mid-April to mid-July (California Burrowing Owl Consortium 1993, Zeiner et al. 1990, Thomsen 1971). Breeding tends to be earlier in central and southern parts of the state. Burrowing owls usually produce one clutch per year averaging seven to nine eggs which are laid in a slightly enlarged chamber of the nest burrow (Zarn 1974, Bent 1938). The female incubates the eggs for four weeks (Zarn 1974). The nestlings stay in the burrow for the first two weeks when they are brooded and fed by the female. Beginning about two weeks of age, the young owls begin venturing outside the nest burrow. As they mature they spend more time outside the burrow and they remain near the nest burrow for the next few weeks as they mature and begin to fly (Thomsen 1971).

There are no CNDDB records of burrowing owls in the Bouldin Island or Woodward Island topographic quads surrounding the project area.

4.5.3 Habitat Modification

Installation and removal of the 2 barrier structures in aquatic habitat in Old River and Connection Slough will not affect burrowing owl habitat. However, site disturbance in adjacent upland habitat necessary for the installation and removal of the structures could affect burrowing owl habitat if the upland areas contain burrows suitable for burrowing owls. Operations such as clearing, grading, excavation, placement of fill, movement of heavy equipment, and storage of rock and other materials necessary to construct the gates could affect burrows and result in temporary and permanent loss of grassland habitat.

Construction activities that destroy or damage burrows by soil compaction, such as the movement of heavy machinery, or cover over suitable burrows in upland grassland or on the levees, such as the storage of rock or deposition of dredged material, could cause burrowing owl fatalities by entombing owls inside burrows. This effect can be first addressed by following the procedures in the California Burrowing Owl Survey Protocol (California Burrowing Owl Consortium 1997) which calls for a survey to determine if suitable burrows (>3.5 inches diameter) are present in all areas of ground disturbance. If no burrows suitable for burrowing owls are present in areas of ground disturbance then no other activities are necessary to avoid effects to individuals.

If suitable burrows are present in the project area then all areas of ground disturbance (including vehicle travel on access roads) should be surveyed for occupancy by burrowing owls within 30 days of initial ground disturbance. The California Burrowing Owl Survey Protocol (CBOC 1997) calls for up to four surveys on four separate days to determine burrowing owl presence or absence.

If areas of ground disturbance are found to contain burrows suitable for occupancy by burrowing owls or if burrowing owls are present within 250 feet of the disturbance area, then owls should be prevented from using such burrows for nesting by placing one-way doors in suitable burrows within 30 days of initial ground disturbance that is scheduled for October through January. All burrows in planned work areas and within 250 foot (75 m) buffers should be closed no later than March 1 for any ground disturbing activity that is scheduled to begin after March 1 to ensure that there are no nesting burrowing owls in areas that will not be initially disturbed until after March 1.

The California Burrowing Owl Consortium's Burrowing Owl Survey Protocol and Mitigation Guidelines (1997) and the California Department of Fish and Game Staff Report on Burrowing Owl Mitigation (1995) state that mitigation actions should be carried out from September 1 to January 31. These documents explain that reproductive timing may vary with latitude and climatic conditions, therefore the Staff Report states that the time frame to carry out mitigation activities should be adjusted accordingly.

4.5.4 Loss of Nesting Pairs

No effects to nesting burrowing owls are anticipated because materials staging and initial construction of the 2 barrier structures is scheduled for October and November. Removal of the barriers and associated activities in March could affect nesting burrowing owls if owls were nesting near project activities. Effects to nesting burrowing owls could be avoided by surveying all barrier removal activity areas for suitable burrows in February. Should suitable burrows be present, effects to nesting burrowing owls can be avoided by installing one-way devices in burrows in project activity areas and within 250 feet to discourage burrowing owls from establishing nesting territories in or near project activity areas in March of each year.

4.5.5 Mitigating Effects to Burrowing Owl Habitat

Construction of the 2 gates structures could result in the loss of burrows occupied by burrowing owls in the levees adjacent to each structure. The movement of heavy machinery, storage of rock, deposition of dredged material and other associated construction activities in upland areas may cause temporary and long-term effects to burrowing owl habitat. Temporary effects in the form of destruction of grassland plant communities can be mitigated by restoring the vegetation communities in impacted areas to pre-project vegetation conditions, including species composition and vegetation structure.

Long-term effects to occupied burrowing owl habitat could also occur in the form of destruction of burrows used by burrowing owls or from the intentional closure of burrows used by burrowing owls (see Habitat Modification, above). Loss of burrows could occur in levees adjacent to each structure site and/or in upland grassland habitats affected by project activities.

The loss of burrows documented to have been used by burrowing owls in levee structures could be mitigated by installing two artificial burrows (Barclay 2008) for each natural burrow destroyed or intentionally closed. The number of occupied burrows that may have to be closed is expected to be relatively small; therefore it should be practical to mitigate this effect by installing artificial burrows. Artificial burrows installed to mitigate effects to occupied natural burrows should be installed as near as practical to the burrows that were lost and in vegetation similar in structure to the habitat around the occupied burrows.

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