Delta Islands and Levees

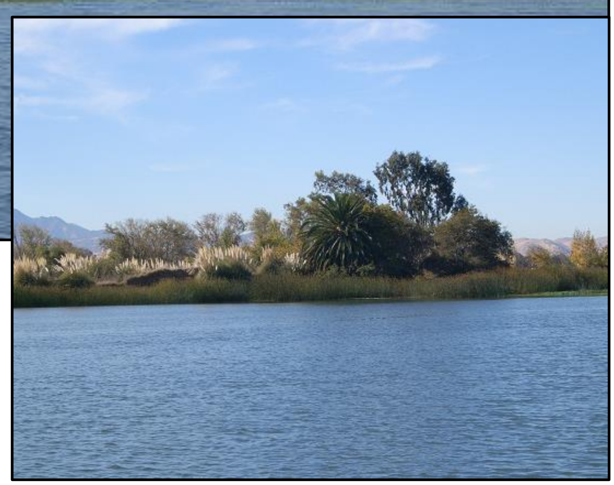
Sacramento – San Joaquin River Delta, California

Interim Integrated Feasibility Report/ Environmental Impact Statement

FINAL REPORT

Sacramento District
South Pacific Division

September 2018



US Army Corps of Engineers®
Sacramento District

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Sacramento and San Joaquin River Delta

U.S. Army Corps of Engineers,
Sacramento District

September 2018

Delta Islands and Levees Sacramento – San Joaquin River Delta, California
Interim Integrated Feasibility Report/
Environmental Impact Statement

July 2018

Type of Statement: Final Environmental Impact Statement

Lead Federal Agency: U.S. Army Corps of Engineers, Sacramento District

Lead State Agency: California Department of Water Resources

Proposed Action: The U.S. Army Corps of Engineers (USACE) and the California Department of Water Resources (DWR) propose to restore approximately 340 acres of intertidal marsh habitat in the Sacramento-San Joaquin River Delta (Delta). The restoration work would involve placing dredged material into the shallow open water of a flooded Delta island and planting aquatic vegetation over an estimated 10-year period to create 340 acres of intertidal marsh in an area now lost to land subsidence.

Abstract: USACE initiated the Delta Study in 2006 at the request of the DWR, the non-Federal sponsor for the study. USACE is the lead agency for the Feasibility Study and is also the lead under the National Environmental Policy Act (NEPA). This report: (1) identifies flood risk management and ecosystem restoration problems and opportunities in the Delta; (2) develops and evaluates measures to solve identified problems; (3) formulates and compares alternatives for ecosystem restoration; and (4) identifies a Recommended Plan (RP) for implementation. A draft of this FR/EIS was concurrently released for public review, internal policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The present report has been updated based on comments received during these reviews and finalized to present the RP for eventual authorization.

The RP is the most reasonably efficient contribution to the Delta, restoring 340 acres of intertidal marsh habitat in the Delta at a cost of $25M. The RP provides a unique opportunity to restore intertidal marsh, habitat which is now greatly reduced in this ecosystem of national significance. The RP links the proposed ecosystem restoration actions to historic and ongoing USACE navigation projects, providing a cost effective mechanism to implement otherwise costly subsidence reversal goals. This action would restore habitat for multiple Federally listed species, notably salmonids and Delta smelt. The restored habitat would also benefit millions of migratory fowl on the Pacific Flyway as they travel through the Delta.

Public Review and Comment: The public review period for the final FR/EIS will begin on September 21, 2018 and close on October 21, 2018. Questions and comments may be sent to: U.S. Army Corps of Engineers, Sacramento District, Attn: Mr. Robert Kidd, 1325 J Street, Sacramento, California 95814; phone: (916) 557-5100; or email: deltastudy@usace.army.mil.

EXECUTIVE SUMMARY

This report: (1) identifies flood risk management and ecosystem restoration problems and opportunities in the Sacramento – San Joaquin River Delta (Delta); (2) develops and evaluates measures to solve identified problems; (3) formulates and compares alternatives for ecosystem restoration; and (4) identifies a Recommended Plan (RP) for implementation that is an efficient and cost effective method of disposing of dredged material. This integrated Feasibility Report/Environmental Impact Statement (FR/EIS) describes the planning process followed to identify the Federal interest in the RP and serves as the environmental compliance document under the National Environmental Policy Act (NEPA). This final FR/EIS was revised in response to public review, internal policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR), and has been finalized to present the recommended plan for eventual authorization.

Background

USACE initiated the Delta Islands and Levees Feasibility Study (Delta Study) in 2006 at the request of the California Department of Water Resources (DWR), the non-Federal sponsor for the study. USACE is the lead agency for the Feasibility Study and is also the lead under NEPA. DWR, the lead agency under the California Environmental Quality Act (CEQA), will initiate the CEQA process upon Federal authorization for the design and construction of a project. Numerous other agencies, organizations, and individuals have participated in the study including the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the East Bay Regional Park District.

The Delta (Figure ES-1) is part of the largest estuary on the West Coast of the United States and is home to hundreds of species of fish, birds, mammals and reptiles. The Delta is considered an ecosystem of national significance. Farm land irrigated by Delta water contributes billions of dollars in agricultural production to the Nation. Two deep water ports in the Delta serve as important marine terminals for vessels transporting bulk agricultural and industrial cargos through the Delta's deep draft navigation channels to world markets. Delta levees protect thousands of acres of orchards, farms, and vineyards as well as critical infrastructure including state and interstate highways, major rail lines, natural gas fields, gas and fuel pipelines, water conveyance infrastructure, drinking water pipelines, and numerous towns, businesses and homes.

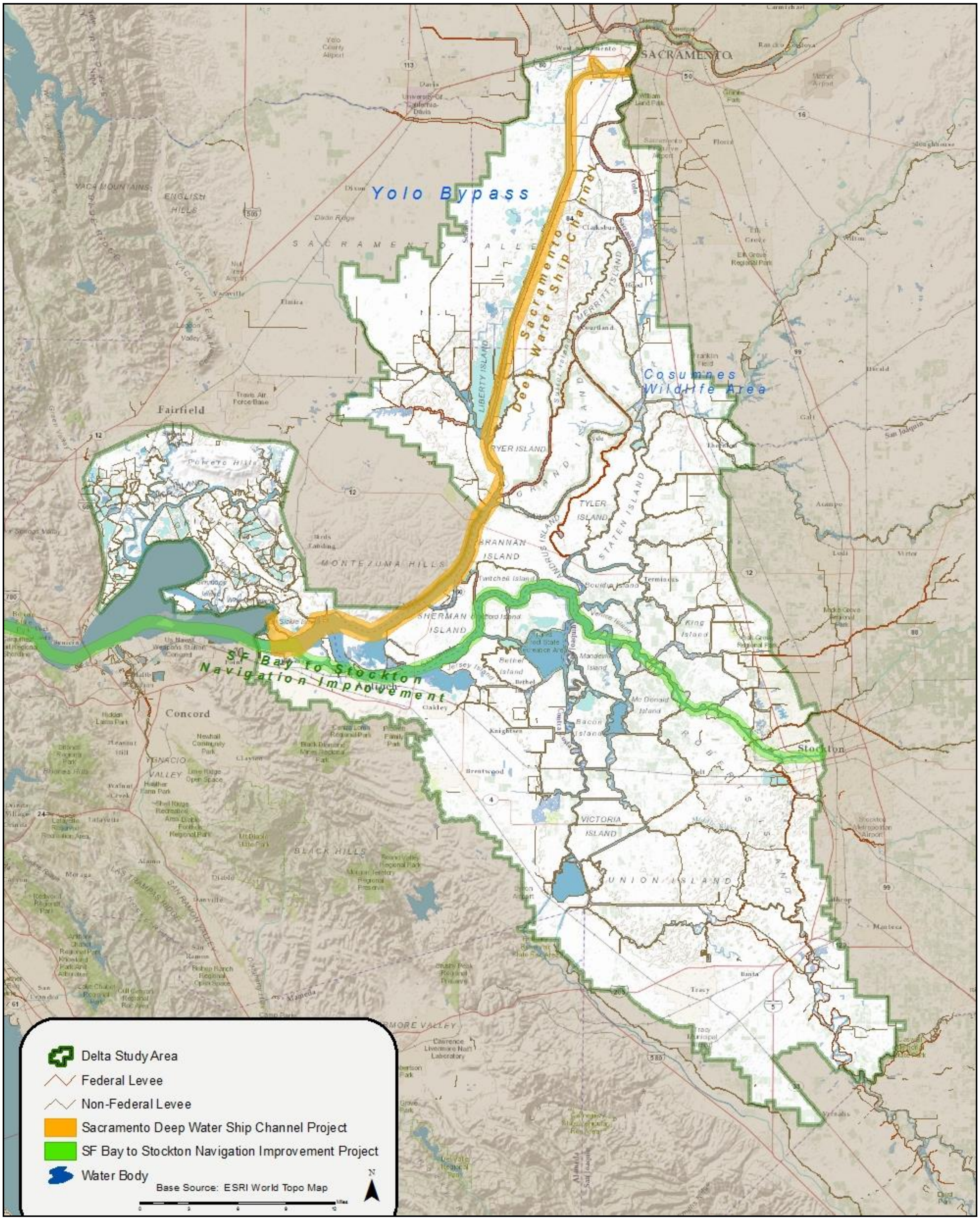

Figure ES-1. The Delta Study Area

The Delta is a web of channels and reclaimed islands at the confluence of the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras Rivers. Forty percent of California's land area lies within the watersheds of these five rivers. The Delta consists of about 738,000 acres of agricultural and developed lands, wetlands and tidal marshes segregated into 80 tracts and islands by 1,100 miles of levees and a labyrinth of navigation channels, rivers, tributaries, streams, sloughs, waterways and shallow open water expanses. The land protected by these levees is predominantly agricultural (corn, wheat, vineyards, stone fruit, cattle) and waterways provide recreational outlets for nearby urban areas and important habitat for fish and wildlife, including Federally listed species under the Endangered Species Act. The Delta is also the largest single source of California's water, providing 25 million Californians with drinking water and irrigating millions of acres of farmland in the Central Valley. In addition, more than 500,000 people live within the Delta and rely upon it for water, recreation, and livelihood. The majority of that population is in the greater Sacramento and Stockton areas and is the focus of other USACE Flood Risk Management studies; however, there are communities within the Delta. Several Delta towns, known as "legacy communities," are listed in the National Registry of Historic Places.

Historically, the Delta was defined by tidal wetlands, primarily comprised of peat soils. The Swamp and Overflow Land Act of 1850 transferred ownership of all Federally owned swamp and overflow land, including Delta marshes, from the Federal Government to private parties agreeing to drain the land and turn it to productive, presumably agricultural, use. Passage of this Act stimulated the reclamation of wetlands in the Delta through the construction of levees and drainage channels, typically by the new land owners. The majority of levees in the Delta are still privately owned and maintained. As a consequence of these reclamation efforts, nearly 95 percent of the Delta's historic wetland habitat has been converted to agricultural and urban uses.

Consideration of Alternative Plans

During the feasibility study, the Federal planning process for development of water resource projects was followed to identify a RP for implementation. Following the identification of ecosystem restoration and flood related problems and opportunities, specific planning objectives and planning constraints were identified. Various management measures were then identified to maximize the planning objectives and minimize the planning constraints. Management measures were screened based on how well they met the study objectives and their cost effectiveness. After initial screening, several categories of measures were dropped from further consideration, including structural flood risk management measures, since no Federal interest in such measures could be identified. The retained management measures were combined to form alternative plans, each focused on restoration of intertidal marsh habitat. Alternative plans were then compared through cost effectiveness and incremental cost analyses based on costs and outputs.

Recommended Plan

The recommended National Environmental Restoration (NER) plan (Alternative 3) is the most reasonably efficient contribution to the California Delta, an ecosystem of national significance, restoring 340 acres of intertidal marsh habitat in the Delta at a cost of $25 million. The RP (Figure ES-2) provides a unique opportunity to restore intertidal marsh, a habitat which is now greatly reduced in this ecosystem of national significance. Prior to levee construction in the late 19th and early 20th centuries, the Delta consisted almost solely of tidal marsh. As levees were constructed and marsh bottoms pumped dry for agricultural production, floodplains were disconnected from the waterways and land began to subside and compact as it was farmed and developed for human use. Delta lands are now as much as 20 feet below sea level. This is too low for tidal marsh habitat formation without the incorporation of subsidence reversal strategies (importing of fill material), but the volume of material typically needed is cost prohibitive. For this reason, restoration of tidal marsh has been very limited throughout the central Delta in particular, where subsidence is most extensive and also where tidal marsh was historically most prevalent. The RP gets over this barrier by linking the proposed ecosystem restoration actions to historic and ongoing USACE navigation projects. This provides a cost effective source of imported fill putting restoration of habitat for multiple Federally listed species, notably salmonids and Delta smelt, within economic reach. The restored habitat would also benefit the millions of migratory fowl on the Pacific Flyway as they travel through the Delta, which is part of the largest estuary on the West Coast.

The national significance of the Delta has been demonstrated many times through decades of Federal authorizations and partnerships. The CALFED Bay-Delta Program, which was formulated in answer to the water crises of the 1990s, is a unique collaboration among 25 State and Federal agencies to improve California's water supply and the ecological health of the Bay-Delta. The San Francisco Estuary Partnership is a coalition of resource agencies, non-profits, citizens, and scientists working to protect, restore, and enhance water quality and fish and wildlife habitat in the Bay-Delta. Most recently, the 2009 California Bay-Delta Memorandum of Understanding Among Federal Agencies named the *Bay-Delta "among the most important estuary ecosystems in the Nation*" and committed the Federal agencies to work in partnership with the State and stakeholders to carry out the vision of "*a healthy and sustainable Bay-Delta ecosystem that provides for a high-quality, reliable, and sustainable long-term water supply for California, and restores the environmental integrity and sustainability of the system*." The RP recommends Federal action to restore 340 acres of nearly extirpated intertidal marsh habitat at a cost of $25 million in this ecosystem of national significance.

The principle feature of the RP is the placement of 1,000,000 cubic yards of fill material into Big Break from Operations and Maintenance dredging of the Stockton Deep Water Ship Channel to restore tidal habitat elevations. A Monitoring and Adaptive Management Plan has been developed and included in the final report. Monitoring and Adaptive Management costs are included in project first costs.

In addition to the above, USACE recommends continued flood risk communication and flood warning and preparedness planning efforts, as described in Chapter 3.

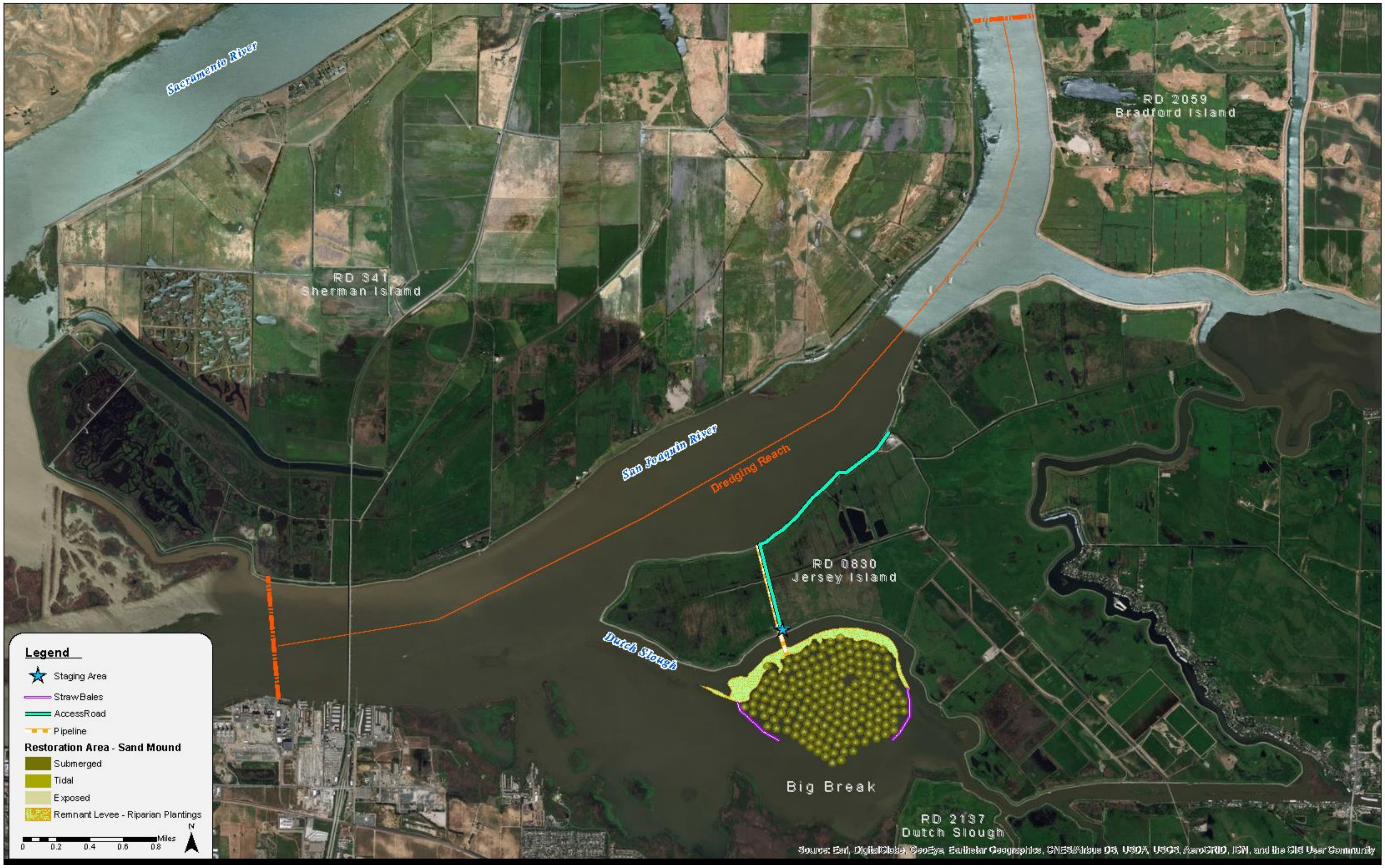

Figure ES-2. The Recommended Plan.

Environmental Effects

The effects to the environment have been considered throughout the study and opportunities have been evaluated to provide environmental restoration, as described above. The proposed alternatives, while providing long-term benefits to the Delta, would also have short-term adverse effects on some resources. Various minimization measures have been considered including construction timing, location of fill material placement, material source selection sites, and avoidance of certain areas. A summary of impacts, minimization measures, and level of impacts is provided in Table ES-1.

In all cases, the potential adverse environmental effects would be reduced to a less-than-significant level through project design, construction practices, preconstruction surveys and analysis, regulatory requirements, and best management practices. No compensatory mitigation would be required for any of the alternatives. A National Pollutant Discharge Elimination System general construction permit would be required. A Storm Water Pollution Prevention Plan and Spill Prevention Control and Countermeasures Plan would be developed by the contractor prior to construction.

The proposed footprint of the RP is currently open water habitat, which is a jurisdictional Water of the U.S. under Section 404 of the Clean Water Act. A Section 404(b)(1) analysis has been conducted for the RP (Alternative 3) to analyze potential effects that could occur from the placement of dredged materials in open water habitat (Appendix H). Potential adverse impacts to vegetation communities and special status species have been greatly reduced through construction design. Direct impacts to nesting birds and other sensitive species would be avoided by implementing preconstruction surveys and scheduling of construction activities. USACE has determined that the RP is likely to have adverse short-term effects to Delta smelt; however, the project would provide long-term benefits to the smelt once the intertidal marsh habitat is established. The RP is not likely to adversely affect listed salmonids, green sturgeon, the giant garter snake and other special status species that may occur in the project area. Coordination with USFWS and NMFS has been ongoing throughout the study. Biological assessments were prepared for the listed terrestrial and aquatic species and submitted to USFWS and NMFS to initiate formal consultation. A final Biological Opinion was received from the USFWS on June 14, 2018, and a concurrence letter was received from NMFS on June 15, 2018.

Impacts to agricultural land would be minimized by avoiding active farm lands when placing temporary pipelines. If any land is temporarily disturbed during construction, it would be returned to agricultural production after construction. The RP is located in an estuary area where urban populations are not present. Because of the lack of population in the area, the project would have no adverse effect on socioeconomics, environmental justice, noise, aesthetics, or public utilities and services. Because the RP proposes to create tidal marsh lands and therefore does not contribute to occupancy, modification, or development of flood plains it complies with Executive Order 11988, Flood Plain Management.

Table ES-1. Summary of Potential Effects and Mitigation Measures for both Alternatives 2 and 3

Potential Effects	Minimization Measures	Level of Significance
VEGETATION AND WILDLIFE		
Construction related habitat or wildlife disturbance, or increased invasive species spread	1 –Removal of invasive species and establishment of riparian vegetation at existing remnant levee. 2 – Implementation of BMP’s.	Less than Significant/ Beneficial
SPECIAL STATUS SPECIES		
Construction related disturbance affecting habitat, growth, survival or reproductive success of special status plants or wildlife	1 – Preconstruction surveys for special status plants. 2 – Preconstruction species surveys. 3 – Timing work windows between migratory and mating/spawning patterns, as practicable.	Less than Significant/ Beneficial
WATER QUALITY		
Placement of dredged material could degrade surface water quality, affect salinity, and/or alter erosion and sedimentation rates in the project area	1 – Placement of silt curtains, hay bales, or similar methods to contain dredged material. 2 – Implement a Storm Water Pollution Prevention Plan. 3 – Conduct water quality monitoring during construction.	Less than Significant
AIR QUALITY		
Temporary increase of criteria pollutants during construction	1 – Implement Bay Area Air Quality Management District basic construction emission control practices. 2 – Implement fugitive dust mitigation measures. 3 – Use electric equipment when possible.	Less than Significant
CLIMATE CHANGE		
Temporary increase in GHG emissions during construction	1 – Use electric vehicles and equipment when possible. 2 – Follow Bay Area Air Quality Management District recommended greenhouse gas reduction measures.	Less than Significant
TRANSPORATION AND NAVIGATION		
Temporary disruption to Dutch Slough channel and temporary increases on surface streets in Oakley from commuter vehicles.	1 – Any in-water pipes will be weighted to the channel bottom to ensure necessary clearance for boats. If necessary, detours will be coordinated with the appropriate parties.	Less than Significant

Potential Effects	Minimization Measures	Level of Significance
	RECREATION	
Temporary boat detour required at Dutch Slough. Reduction of bass fishing & recreational boating acreage.	1 – Preconstruction coordination with the U.S. Coast Guard to keep water sport activities safe. 2 – Preconstruction coordination with local recreation facilities to inform boaters and anglers of construction. 3 – Provide project safety information including maps of any restricted access areas. 4 – Create a "kayak trail" through the restoration site.	Less than Significant
	CULTURAL RESOURCES	
Any adverse effects on cultural resources that are listed or eligible for listing in the National Registry of Historic Places (NRHP) (i.e., historic properties) are considered to be significant impacts. Effects are considered to be adverse if they alter, directly or indirectly, any of the characteristics of a cultural resource that qualify that resource for the NRHP so that the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association is diminished.	1 – All accessible areas of the Area of Potential Effects (APE) have been inventoried, and it has been determined that no eligible cultural resources exist within it. A small section of Jersey Island where a pipeline and road crossing are proposed to go will require pedestrian survey. Access to this location has not been granted therefore, the Corps will follow 36 CFR 800.4 [b][2] which allows for phased identification and evaluation if access to properties is not available. 2 – Surface pipeline placement will be subject to archaeological monitoring to ensure that no previously unknown archaeological sites are impacted. 3 – If previously unidentified cultural resources are discovered during ground disturbing activities, all construction in the vicinity of the find would be halted immediately and USACE would follow the procedures outlined under 36 CFR 800.	Less than significant

Areas of Controversy and Issues Raised by Agencies and the Public

Based on the comments received, USACE did not identify any major areas of controversy; however, there were many comments expressing public concern about salinity and water quality, and associated potential impacts on drinking water. The proposed restoration is not anticipated to result in changes in the salinity content of the area. The project area is primarily fresh water, and the dredged material is being acquired by a localized reach of the river that has approximately the same salinity content as the restoration area.

Issues to be Resolved

There are no significant issues that need to be resolved from the public involvement process. Some uncertainties that remain that would require additional consideration during preconstruction design include:

- Variability in the quantity of dredged material available in a given construction season and associated adaptive management of construction;
- Design considerations for a “kayak trail” through the restoration site; and,
- Changes in the on-site conditions, such as changes in the active use of Jersey Island for agriculture, or additional recruitment of non-native vegetation beyond the current assumptions.

Estimated Cost and Cost Sharing

Investment cost accounts from the draft Micro Computer-Aided Cost Engineering System (MCACES) cost estimate for the RP are displayed in Table ES-2 below. The project first cost was estimated based on October 2018 price levels and amounts to $25,041,000. Table ES-2 shows this cost by primary project feature. Estimated average annual costs were based on a 2.75 percent interest rate, a period of analysis of 50 years, and physical construction ending in 2029.

Table ES-2. Estimated Costs of Recommended Plan (October 2018 Price Levels)

MCACES Account[2]	Description	Total First Cost[1] ($1,000s)
01	Lands and Damages	1,140
02	Relocations[3]	0
06	Fish and Wildlife	6,125
17	Beach Replenishment Preservation	12,523
30	Planning, Engineering, Design	3,621
31	Construction Management	1,632
	Total First Cost	**25,041**

[1]Based on October 2018 price levels; includes escalation of 2.1% for 01, 02, 06, and 17 Accounts, and 3.9% for 30 and 31 Accounts.
[2]Micro Computer-Aided Cost Engineering System.
[3]No relocations required in TSP.

A summary of costs and benefits of the RP is presented in Table ES-3. Federal costs are capped at 65% of the NER plan.

Table ES-3. Economic Costs and Benefits of Recommended Plan

Item	Costs ($1,000s)	Benefits
Investment Cost		
First Cost[1]	25,041	
Interest During Construction[2]	8,172	
Total	33,213	
Annual Cost		
Interest and Amortization[3]	1,230	
OMRR&R[4]	5	
Subtotal	1,235	
Annual Benefits Non-monetary (Ecosystem)		111.44 AAHU's

[1] October 2018 price level.
[2] 2.75% over 15 year construction period
[3] 2.75% over 50 year period of analysis
[4] Operation, Maintenance, Repair, Replacement, and Rehabilitation.

Table ES-4. Summary of Cost-Sharing Responsibilities of the Recommended Plan (October 2018 Price Levels)

Item	Federal	Non-Federal	Total Project First Costs ($1,000s) [1]
Fish & Wildlife Facilities	$6,125	$0	$6,125
Beach Replenishment	$12,523	$0	$12,523
Lands and Damages	$107	$1,033	$1,140
Planning, Engineering, & Design	$3,621	$0	$3,621
Construction Management	$1,632	$0	$1,632
Subtotal	*$24,008*	*$1,033*	*$25,041*
Additional Cash Contribution	-$7,731	$7,731	
Subtotal	*$16,277*	*$8,764*	*$25,041*
Percentage	*65%*	*35%*	

[1]Based on October 2018 price levels.

Major Conclusions

The recommendation is that the report be finalized based on results of public review, internal policy review, ATR, and IEPR of this final FR/EIS, and if warranted, recommended for authorization for implementation as a Federal project. The estimated first cost of the RP is $25,041,000 and the estimated annual OMRR&R cost is $5,000. The Federal portion of the estimated first cost, based on October 2018 price levels, is $16,277,000. The estimated fully funded Federal first cost, based on projected inflation rates specified by USACE budget guidance is $17,275,000. The non-Federal sponsor portion of the estimated first cost is $8,764,000. The non-Federal sponsor’s share of the fully funded first cost is $9,292,000.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Note: The draft Flood Risk Management Appendix that circulated with the draft FR/EIS is available upon request.

ACRONYMS AND ABBREVIATIONS

AAHU	average annual habitat units
AEP	annual exceedance probability
AQMD	air quality management district
APCD	air pollution control district
APE	area of potential effects
ARPA	Archaeological Resources Protection Act
BAAQMD	Bay Area Air Quality Management District
BDCP	Bay Delta Conservation Plan
CAA	Clean Air Act
CAR	Coordination Act Report
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
CNEL	Community Noise Equivalent Level
CNDBB	California Nature Diversity Data Base
CTR	California Toxics Rule
CVP	Central Valley Project
CVFPP	Central Valley Flood Protection Plan
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
dB	decibels
dBA	A-weighted decibels
Delta	Sacramento-San Joaquin River Delta
DO	dissolved oxygen
DPC	Delta Protection Commission
DPS	distinct population segment
DRMS	Delta Risk Management Study
DWSC	deep water ship channel
DWR	California Department of Water Resources
EAD	expected annual damages
EBRPD	East Bay Regional Park District
ECTM	Economic Consequences Technical Memorandum
EFH	Essential Fish Habitat
EIS/EIR	environmental impact statement/environmental impact report
EO	executive order
ER	ecosystem restoration
ESA	environmental site assessment

FESA	Federal Endangered Species Act
FHWA	Federal Highway Administration
FRM	flood risk management
FWCA	Fish and Wildlife Coordination Act
FWOP	future without project
GCID	Glenn-Colusa Irrigation District
GCR	General Conformity Rule
GHG	greenhouse gas
HAP	hazardous air pollutant
HEC-FDA	Hydrologic Engineering Center's Flood Damage Analysis
HEP	Habitat Evaluation Procedures
HFC	hydrofluorocarbon
HFE	hydrofluorinated ether
HTRW	hazardous, toxic, and radiological waste
HU	habitat units
IITM	Impact to Infrastructure Technical Memorandum
IWR	Institute for Water Resources
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
MBTA	Migratory Bird Treaty Act
MLLW	mean lower low water
MY	model year
N/A	not applicable
N_2O	nitrous oxide
NAAQS	national ambient air quality standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NF_3	nitrogen trifluoride
NMFS	National Marine Fisheries Service
NOD	Notice of Determination
NOI	notice of intent
NOP	Notice of Preparation
NO_X	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NRHP	National Register of Historic Places
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyls
PDT	project delivery team
PFC	perfluorocarbon
PM_{10}	particulate matter smaller than or equal to 10 microns in diameter
$PM_{2.5}$	particulate matter smaller than or equal to 2.5 microns in diameter
ROD	Record of Decision
ROG	reactive organic gases

SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SO_2	sulfur dioxide
SWP	State Water Project
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TSP	tentatively selected plan
ULSD	ultra-low sulfur diesel
UPL	Urban Project Levee
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
VELB	valley elderberry longhorn beetle
WQCP	Water Quality Control Plan
WRDA	Water Resources Development Act

CHAPTER 1 – INTRODUCTION

1.1 Purpose and Need

The purpose of the proposed study is to provide ecosystem restoration in the Sacramento – San Joaquin River Delta (Delta). The communities and ecosystem within the Delta rely on an existing levee network to contain flows in the Sacramento and San Joaquin Rivers. The 1,100 mile levee network is a mix of Federal and non-Federal levees, many of which do not meet current U.S. Army Corps of Engineers (USACE levee construction standards and could fail at water levels well below top of levee. The levee network holds water back from flooding the subsided islands/tracts during daily tidal fluctuations. Native habitat and natural river functions in the study area have suffered extensive degradation over more than a century of levee construction and conversion of the floodplain to agricultural and rural development, as well as management of the system for municipal, industrial, and agricultural water supplies.

This report presents the findings of the Sacramento – San Joaquin Rivers Delta Islands and Levees, California, Feasibility Study (Feasibility Study). The purpose of the Feasibility Study is to determine whether a Federal interest[1] exists in providing Flood Risk Management (FRM) and Ecosystem Restoration (ER) improvements to the Delta. ER was determined to be the only Federal interest for the proposed project, as is discussed later in this report. This report integrates plan formulation with documentation of environmental effects. This report will also serve as an Environmental Impact Statement (EIS), by providing documentation and analysis required by the National Environmental Policy Act (NEPA) of 1969, as amended.

The report: (a) describes the flooding, ecosystem, and related water resource problems and opportunities in the Delta; (b) expresses desired changes as planning objectives; and (c) analyzes alternative plans to achieve these objectives. These alternative plans include a plan of no action and various combinations of individual management measures[2]. The economic, social, and environmental effects of the alternative plans are described and a feasible plan is selected for recommendation. The report also details the roles of USACE and the non-Federal sponsor (California Department of Water Resources (DWR)) in implementing the Recommended Plan (RP). The non-Federal sponsor is responsible for compliance with the California Environmental Quality Act (CEQA). The report concludes with a recommendation for Congressional authorization of the Recommended Plan, pending public review, policy reviews, and subsequent revisions. Due to the limited scope of this study, this report will serve as an interim response to the study authority, which is stated below.

[1] A project is said to be in the **Federal interest** if it is consistent with the mission of USACE and the project benefits are in excess of the project costs.
[2] A **management measure** is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives.

1.2 Study Authority

Authority for this investigation has roots in longstanding flood control laws. The foundation for this investigation's authority comes from the Flood Control Act of 1936 (Public Law [P.L.] 74-738). Section 2 of this Act states:

> *"[T]hat, hereafter Federal investigations and improvements of river and other waterways for flood control and allied purposes shall be under the jurisdiction of and shall be prosecuted by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers…".*

Section 6 of the 1936 Flood Control Act further states:

> *"The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control at the following named localities…Sacramento and San Joaquin River Valleys, California…Provided further, That after the regular or formal reports made as authorized on any examination, survey, project, or work under way or proposed are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law or by resolution of the Committee on Flood Control of the House of Representative or the Committee on Commerce of the Senate."*

The Chief of Engineers completed a report based on the above authority. House Document No. 367, 81st Congress, dated October 13, 1949, is a letter from the Secretary of the Army on the Sacramento-San Joaquin Basin Streams, California, which states in part:

> *"A Letter from the Chief of Engineers, United States Army, Dated July 27, 1948, submitting a report, together with accompanying papers and illustrations, on preliminary examinations and surveys of Sacramento-San Joaquin River Basin Streams, California. For Flood Control and allied purposes listed in the Report. This investigation was authorized by the Flood Control Acts of June 22, 1936 and June 28, 1938."*

Following this Report, Congress directed additional studies to be made of this region in 1964. As mentioned above, Section 6 of the 1936 Flood Control Act expressly permits additional reports to be authorized by House Resolution. Consistent with that statutory delegation a House Resolution, adopted May 8, 1964, authorized USACE to pursue further reviews of the Agency's report contained in House Document No. 367, referenced above. Specifically the May 8, 1964 House Resolution states:

> *"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report on the Sacramento-San Joaquin Basin Streams, California, published as House Document No. 367, 81st Congress, 1st Session, and other reports, with a view to determining whether any modifications of the*

recommendations contained therein are advisable at this time, with particular reference to further coordinated development of the water resources in the San Joaquin River Basin, California."

Conference Report 108-357 accompanied the Energy and Water Development Appropriations Act of 2004 (P.L. 108-137) and provided both further congressional direction and funding relative to this study. Conference Report 108-357 states:

"The conferees have provided $1,100,000 for the Sacramento-San Joaquin Delta, California, study including $350,000 for a reconnaissance study to evaluate environmental restoration, flood protection, recreation, and related purposes for the California Bay-Delta Authority North Delta Improvements project, and $500,000 to initiate and complete a reconnaissance study to prioritize and evaluate environmental restoration, flood protection and related purposes for the Delta Islands and Levees. The remaining funding is provided for the Delta Special Study."

About this time Congress also passed the CALFED Bay-Delta Authorization Act of 2004 (P.L. 108-361). Section 103(f)(3) of the Act specifically authorized USACE participation in the CALFED Program. Accordingly, the Sacramento District conducted a reconnaissance level study of the CALFED Levee Stability Program. USACE sent its report to Congress entitled "CALFED Levee Stability Program, California" in May 2006, recommending that USACE perform a feasibility study of Delta Islands and Levees to define a long-term strategy for Delta levee system improvements.

Section 3015 of the Water Resources Development Act (WRDA) of 2007 amended Section 103(f)(3) of P.L. 108-361, which in part authorized this feasibility report. Section 3015 modified the geographic scope of the authority, clarified project justification requirements, clarified the definition of the levee design standard, and increased the total authorized cost of the levee stability program. USACE issued implementation guidance for Section 3015, WRDA 2007 on August 11, 2008.

1.3 Study Area

The study area (Figure 1-1) includes the entire Sacramento – San Joaquin River Delta and Suisun Marsh, comprising parts of Sacramento, San Joaquin, Solano, Contra Costa, Alameda, and Yolo Counties, California. The area extends south from the City of Sacramento to the cities of Stockton and Tracy, and west from approximately Interstate Highway 5 to and including Suisun Bay, an eastward extension of the San Francisco Bay. The Delta consists of about 738,000 acres of agricultural and developed lands, wetlands and tidal marshes segregated into some 80 tracts and islands by 1,100 miles of levees and a labyrinth of navigation channels, rivers, tributaries, streams, sloughs, waterways and shallow open water expanses.

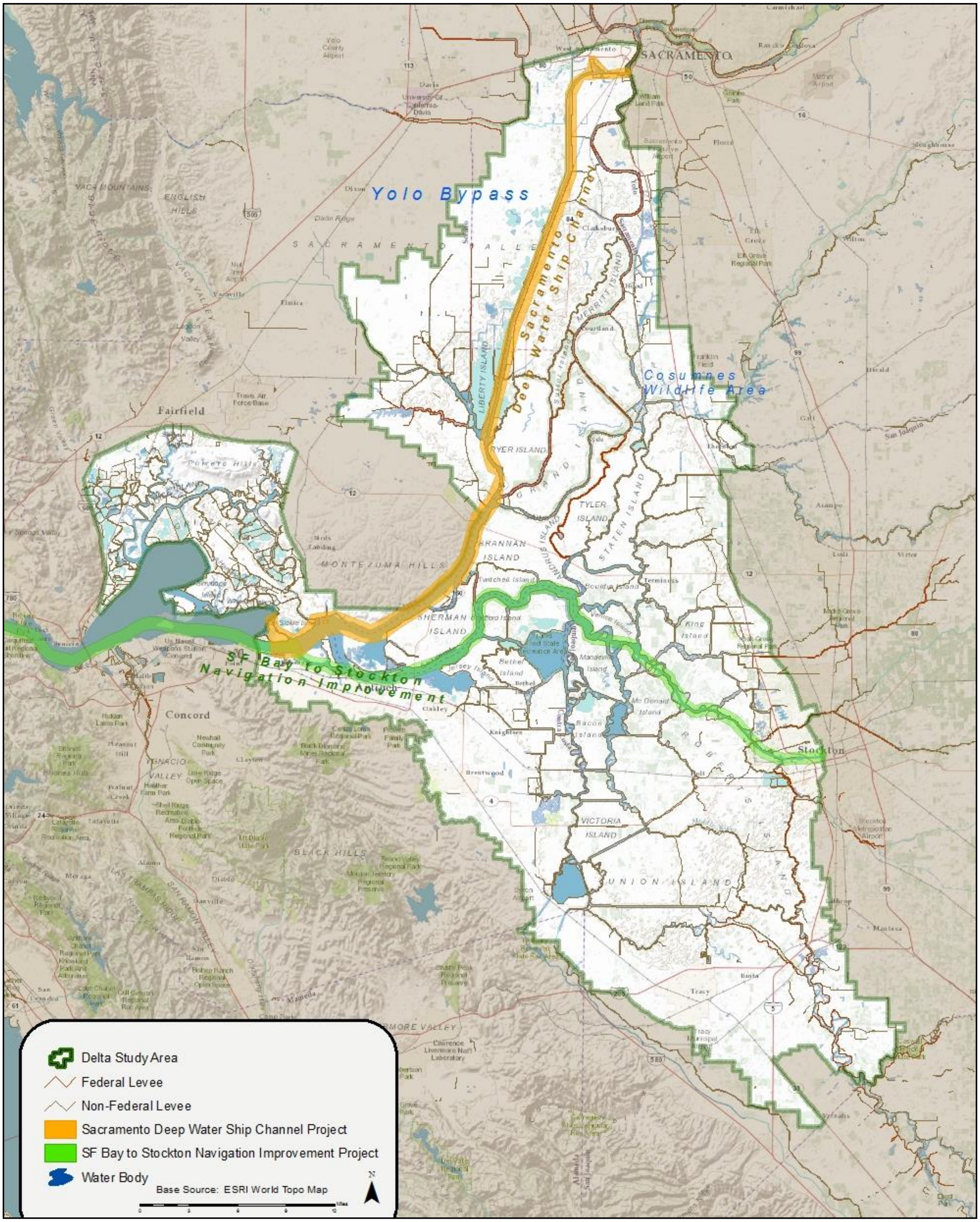

Figure 1-1. Delta Study Area

1.4 Study Sponsor and Participants

USACE initiated the Feasibility Study at the request of DWR, the non-Federal sponsor for the study. USACE and DWR are the lead agencies in the Feasibility Study and share the cost of the study equally (50% /50%), pursuant to the Feasibility Cost Sharing Agreement (FCSA) executed by the parties on May 25, 2006, and subsequent amendments. The East Bay Regional Parks District has also expressed their support in becoming a non-Federal sponsor as the land-owning agency for the project. No cooperating agencies were formally identified under NEPA regulations.

Numerous agencies, organizations, and individuals participated in the study including the U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (USEPA), East Bay Regional Parks District (EBRPD), California Department of Fish and Wildlife (CDFW), Sacramento County, San Joaquin County, Contra Costa County, Yolo County, Alameda County, Solano County, numerous levee maintaining agencies, local landowners and residents.

1.5 Existing Programs, Studies, and Projects

There are many ongoing water resources related programs, studies, and projects that could affect flooding and ecosystem conditions in the study area. Those efforts that pertain directly to this feasibility study are summarized below.

1.5.1 Programs

Bay Delta Conservation Plan (BDCP)/California WaterFix and California EcoRestore

The BDCP was a part of California's overall water management portfolio. It was being developed as a 50-year habitat conservation plan with the goals of restoring the Delta ecosystem and improving California water supply reliability. The BDCP proposed to address California's water supply reliability by building new water delivery infrastructure and operating the system to improve the ecological health of the Delta. The BDCP also proposed to restore or protect approximately 150,000 acres of habitat to address the Delta's environmental challenges.

On April 30, 2015, the State announced that it would separate the BDCP's conveyance facility and habitat restoration measures into two separate efforts: California WaterFix and California EcoRestore.

The California WaterFix focuses on the State Water Project water delivery system infrastructure in the Central Valley and is part of California's overall water management portfolio. The Governor's WaterFix planning effort is overseen by the California Natural Resources Agency and DWR. California EcoRestore, the habitat restoration program, is overseen by the California Natural Resources Agency and implemented under the California Water Action Plan. California EcoRestore is an initiative implemented in coordination with State and Federal agencies to advance the restoration of at least 30,000 acres of Sacramento-San Joaquin Delta (Delta) habitat by 2020.

Concurrently, the California Department of Fish and Wildlife (CDFW) is working with Federal, State and local agencies and Delta stakeholders to develop a 25-year, high-level conservation framework for the Delta, Yolo Bypass and Suisun Marsh. The Delta Conservation Framework will serve as the long-term continuation of the California EcoRestore program focused on accelerating conservation actions by 2020. These efforts are a direct reflection of public comments and fulfill the requirement of the 2009 Delta Reform Act to meet the co-equal goals of water supply reliability and ecosystem restoration.

DWR and the USBR prepared a partially Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) that addresses the impacts of the California Water Fix. The RDEIR/SDEIS includes portions of the DEIR/DEIS (for the BDCP) that were amended or supplemented in answer to public comments received, and includes changes made to the impact analysis warranting another public review prior to publication of final documents.

On July 21, 2017 DWR certified the California WaterFix Final EIR/EIS, which was released the report on December 22, 2016. On January 23, 2018 DWR submitted a CEQA Addendum to the Final EIR/EIS. The Final EIR/EIS describes the alternatives, discusses potential environmental impacts, and identifies mitigation measures that would help avoid or minimize impacts. The California Water Fix preferred alternative includes the construction and operation of Delta intakes and tunnel conveyance facilities. It also provides responses to all substantive comments received on the 2013 Draft EIR/EIS and 2015 RDEIR/SDEIS.

CALFED Bay-Delta Program (CALFED)

CALFED was established in May 1995 as a cooperative effort among the State and Federal agencies that handle management and regulatory responsibilities in the Sacramento – San Joaquin Delta. CALFED's mission is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta. In July 2003, the State of California formalized the cooperative effort by creating the CALFED Bay-Delta Authority, a State agency responsible for overseeing implementation of the Bay-Delta Program. The State's CALFED program was transitioned to the Delta Stewardship Council under the 2009 Delta Reform Act (see below).

Central Valley Flood Protection Plan (CVFPP)

In 2012, the California Central Valley Flood Protection Board adopted the CVFPP, a comprehensive new framework for system-wide flood management and flood risk reduction in the Sacramento and San Joaquin River Basins. California's Central Valley Flood Protection Act of 2008 requires the CVFPP to be updated every five years. The Central Valley Flood Protection Board adopted the 2017 update to the CVFPP on August 25, 2017.

Central Valley Integrated Flood Management Study (CVIFMS)

USACE, in conjunction with DWR, jointly developed CVIFMS to define a long-range program for the Sacramento and San Joaquin River Basins and the corresponding level of Federal participation. The CVIFMS Watershed Plan, released in December 2016, identified opportunities to reduce flood risk by improving the flood capacity of the system while restoring and protecting floodplain and environmental features, including wetlands and other fish and wildlife habitat.

Delta Stewardship Council – Delta Plan

The Delta Plan is a comprehensive, long-term management plan for the Delta. Required by the 2009 Delta Reform Act (California Water Code Division 35), it creates new rules and recommendations to further the state's coequal goals for the Delta: improvement of statewide water supply reliability, and protection and restoration of a vibrant and healthy Delta ecosystem, all in a manner that preserves, protects and enhances the unique agricultural, cultural, and recreational characteristics of the Delta. The Delta Plan became effective with legally-enforceable regulations on September 1, 2013, but is being amended in response to changes (such as the State's decision to modify BDCP into California WaterFix/EcoRestore) since its adoption.

Sacramento River Bank Protection Program

This is a long-term joint program implemented by USACE and the California Central Valley Flood Protection Board, as authorized by Section 203 of the Flood Control Act of 1960 to enhance public safety by maintaining the integrity of the Sacramento River Flood Control Project from erosion. It provides protection to existing levees of the Sacramento River Flood Control Project through the implementation of bank protection, setback levees, or other features that address the effects of erosion on the Flood Control System.

1.5.2 Studies

American River Common Features General Reevaluation Report

USACE, the Central Valley Flood Protection Board, and the Sacramento Area Flood Control Agency conducted a comprehensive study to investigate further improvements to the flood risk reduction system throughout the Sacramento region. The recommended plan, which included levee improvements for the American River, Sacramento River south of the confluence with the American River, Natomas East Main Drainage Canal, Arcade Creek, and Magpie Creek and the widening of the Sacramento Weir and Bypass, was authorized by Congress in the Water Resources Development Act of 2016 (WRDA 16) and is currently undergoing Preconstruction Engineering and Design (PED). Now referred to as the American River Common Features WRDA 16 project, USACE estimates that construction will begin in 2020. The Sacramento Area Flood Control Agency is currently constructing the Arcade Creek levee improvements as an early implementation local action during the summer of 2018.

Delta Long-Term Management Strategy

USACE, DWR, the California Bay-Delta Authority, the Delta Protection Commission (DPC), the State Water Resources Control Board (SWRCB), and the Central Valley Regional Water Quality Control Board (CVRWQCB) are developing a long-term management strategy for sediment management in the Delta, including dredging and dredged material placement and reuse.

Dutch Slough Tidal Marsh Restoration Project

The Dutch Slough Tidal Marsh Restoration area was formerly slated for urban development, but will soon become 1,178 acres of critically needed habitat for fish and wildlife in the Delta. This state project is located in the western Delta near Oakley. In an area where soil types and lack of subsidence offer an opportunity to create a large area of tidal marsh and complex intertidal channels favored by native Delta species. Shaded channels, native grasslands, and riparian forests will be restored in the upland portions of the site. The restored habitats are like those that historically dominated the Delta, and their restoration is considered a critical action to increase numbers of native sensitive species and improve general ecological health of the Delta. The public comment period for the Supplemental Environmental Impact Report (EIR) was January 21, 2014 through March 07, 2014. The project is expected to begin construction in spring 2018. The first phase of construction is anticipated to take two years with subsequent plantings, and the second phase of construction will likely begin in 2020.

Lower San Joaquin River Feasibility Study

USACE and its non-Federal sponsors, the San Joaquin Area Flood Control Agency and the State of California Central Valley Flood Protection Board, propose to reduce flood risk along the Lower San Joaquin River by improving and constructing levees along the San Joaquin River, Calaveras River, Mosher Slough, and the Delta Front and by constructing and operating closure structures. The Final Integrated FR/EIS/EIR was released for public review in January 2018 and the Chief's Report is undergoing review at USACE Headquarters.

Sacramento Deep Water Ship Channel (DWSC) Project

USACE and the Port of West Sacramento are conducting a study to investigate Federal investment in providing for more efficient and safe commodity transport along the existing deep draft navigation route extending from the Port of West Sacramento to New York Slough, thereby affording the Port of West Sacramento improved access to San Francisco Bay Area harbors and the Pacific Ocean. The deepening of the Sacramento DWSC from 30 to 35 feet was authorized by Congress in 1986. A limited reevaluation study (now called a validation study) of the authorized project by the USACE San Francisco District has been on hold since 2014 pending increased economic demand for shipping.

San Francisco Bay to Stockton Navigation Improvement Project

USACE, the Port of Stockton, and Contra Costa County Water Agency are conducting a study to evaluate the efficiency of the movement of goods along the existing deep draft navigation route extending from the San Francisco Bay to the Port of Stockton. The project includes the John F. Baldwin and Stockton Ship Channels, and will focus on the reach west of Avon.

USGS Subsidence Research on Twitchell Island

DWR and the U.S. Geological Survey (USGS) constructed approximately 15 acres of managed wetlands in 1997 to evaluate land surface elevation changes and carbon accretion due to the accumulation and decay of plant materials. Ongoing research at this facility has shown that land surface elevation increases 1.3 to 2.2 inches per year, while surrounding areas used for agricultural purposes lost elevation due to subsidence. Decaying organic matter reverse subsidence through utilization of appropriate land management practices. Research of this issue is ongoing.

West Sacramento General Reevaluation Report

USACE, the Central Valley Flood Protection Board, and the West Sacramento Area Flood Control Agency (WSAFCA), conducted a study to provide flood damage reduction to West Sacramento by improving the levees that surround the city. The recommended plan was authorized by Congress in WRDA 2016, and is awaiting appropriations to begin PED.

WSAFCA is currently constructing the Southport Sacramento River Levee Improvement Project, a local early implementation effort, with construction of the Southport setback levee estimated for completion in late 2018.

1.5.3 Projects

Antioch Dunes Restoration

This project is being implemented by USFWS, CDFW, the Port of Stockton, and USACE to benefit three endangered and endemic species—two plants and one butterfly. Material dredged through annual operations and maintenance dredging is being placed in the project area to restore dune habitat. Construction is underway and will continue for approximately ten years.

California State Water Project (SWP)

The California SWP is a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. Its main purpose is to store water and distribute it to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. Of the contracted water supply, 70 percent goes to urban users and 30 percent goes to agricultural users. The SWP makes deliveries to two-thirds of California's population. It is maintained and operated by DWR. The SWP is also operated to improve water quality in the Delta, control Feather River flood waters, provide recreation, and enhance fish and wildlife.

Central Valley Project (CVP)

The CVP is a Federal water management project in the State of California under the supervision of the Bureau of Reclamation. It was devised in 1933 in order to provide irrigation and municipal water to much of California's Central Valley—by regulating and storing water in reservoirs in the water-rich northern half of the state, and transporting it to the water-poor San Joaquin Valley and its surroundings by means of a series of canals, aqueducts and pump plants, some shared with the California SWP. Many CVP water users are represented by the Central Valley Project Water Association.

Donlon Island and Venice Cut Mitigation for the 1987 Widening and Deepening of the Stockton Deep Water Ship Channel

In 1987, USACE and the Port of Stockton completed widening and deepening the Stockton DWSC. Dredging and other construction techniques resulted in the movement of considerable volumes of dredged materials and some losses of existing marsh and riparian vegetation. The final design of the project included features selected to mitigate for habitat losses caused by the construction activities and to enhance fish and wildlife values beyond those present before modification of the channel. Dredged materials were used to create approximately 81 acres of new shallow water, wetland, and upland habitats within two flooded islands, Donlon Island and Venice Cut Island. The resulting dredged-material islands were the first created in the Delta specifically to benefit fish and wildlife. The newly created islands are used by a wide variety of birds, and the number of species generally increased proportionally with the extent and complexity of the habitats available. These findings have been translated into design guidelines that can be used with increased confidence to design new habitat using dredged material.

Sacramento River Flood Control Project

Congress directed the California Debris Commission in 1910 to prepare a flood management plan for the Sacramento River system. The proposal incorporated the leveed bypass concept, which became the basis of the present project. This major project was authorized by the 1917 Flood Control Act and was sponsored by The Reclamation Board (now called the Central Valley Flood Protection Board). The Sacramento River Flood Control Project consists of a comprehensive system of 1,000 miles of levees, 5 major overflow weirs, 2 sets of outfall gates, 3 major drainage pumping plants, 95 miles of bypass floodways, overbank floodway areas, and channel enlargement in the lower reach of the Sacramento River. The levees constructed for this project are known as "project levees."

Lower San Joaquin River and Tributaries Project

The Lower San Joaquin River and Tributaries Project was authorized by the federal Flood Control Act of 1944. The project includes: (a) Federal levee and channel improvement and bank protection along the Lower San Joaquin River from the mouth of the Merced River to the Delta; (b) the preservation of natural overflow lands upstream of the mouth of the Merced River by the acquisition of flowage easements by the State of California, and/or by the construction of levees at specified locations by responsible local interests at no cost to the Federal Government; (c) Federal flood control storage on the Stanislaus River at the New Melones site; (d) the provision of flood control storage on the Tuolumne River by local interests with payment therefore by the United States; and (e) operation of the existing Federal Friant Reservoir for flood control.

1.6 Public Involvement

On January 31 2013, USACE published a notice of intent (NOI) in the *Federal Register* (Vol. 78, No. 921) to prepare an EIS for the Delta Study. In February 2013, two scoping meetings were held to educate the public about the study efforts and to garner input on the proposed scope, in accordance with NEPA. Table 1-1 describes the correlations between the USACE planning and NEPA processes.

The meetings were open-house style workshops at which attendees could read and view information about the two projects and interact with project staff, including representatives of USACE and DWR.

The agenda for the scoping meeting is summarized as follows:

- Clarifications on data and history of the Delta;
- Concerns of siltation in Delta channels;
- Recommendation for coordination with other agencies and efforts in the Delta; and,
- Recommendation to evaluate environmental effects of alternatives to water supply, water quality, and aquatic and terrestrial biology.

The draft Feasibility Report/Environmental Impact Statement (FR/EIS) was circulated for a 45 day review from April 18 to June 2, 2014 to Federal, State, and local agencies; organizations; and individuals who have an interest in the project. A notice of availability of the draft EIS was published in the *Federal Register* (79 FR 21917). Public workshops were held during the public review period to provide additional opportunities for comments on the draft document. These meetings were held at the following times and places:

- Wednesday May 7, 2014, 5 p.m. to 7 p.m. at the Old Sugar Mill in Clarksburg, California.
- Friday May 9, 2014, 2 p.m. to 4 p.m. at the Sheraton Grand Hotel in Sacramento, California.

During the FR/EIS public review period, a total of 7 comments were received from the public, including 2 Federal agencies, 3 State agencies and 2 local agencies and organizations. Comments received were primarily focused on: (1) consistency with Delta land use plans; (2) permitting requirements; (3) air quality considerations; and (4) salinity and water quality modeling. All comments received during the public review period were considered and incorporated into the final EIS, as appropriate.

For more detail on comments received, information available at the meetings, and a summary of key issues that were raised, see Appendix A which contains the Public Involvement Appendix. USACE will ensure all agencies, organizations, and individuals who provided comments will be provided a copy of the final integrated FR/EIS.

1.7 Report Organization

The planning process consists of six major steps: (1) Specification of water and related land resources problems and opportunities; (2) Inventory, forecast and analysis of water and related land resources conditions within the study area; (3) Formulation of alternative plans; (4) Evaluation of the effects of the alternative plans; (5) Comparison of the alternative plans; and (6) Selection of the recommended plan based upon the comparison of the alternative plans.

This report documents the study process. It also serves as the EIS for compliance with NEPA. The chapter headings and analysis presented in this report generally follow the outline of an EIS. The report chapters relate to the six steps of the planning process as shown in Table 1-2.

Table 1-1. USACE Planning and NEPA Process

USACE Planning Process	Delta Islands and Levees Feasibility Study	NEPA Process
Step 1. Identify Problems and Opportunities	Scoping Charrette: Federal Interest Decision	Publish Notice of Intent (NOI)[a]
Step 2. Inventory and Forecast		Conduct scoping process[b]
		Prepare Statement of Purpose and Need/Project Objectives Describe existing conditions and affected environment
Step 3. Formulate Alternatives	Milestone 1: Alternatives	Identify reasonable alternatives
Step 4. Evaluate Alternatives		
Step 5. Compare Alternatives		Evaluate impacts and potential mitigation
		Compare alternatives
Step 6. Select Alternative	Milestone 2: Tentatively Selected Plan	Draft EIS: public notice and 45-day public review
	Milestone 3: Agency Decision	Final EIS: respond to public comments
	Milestone 4: Senior Leader Briefing	Final EIS: public notice and 30-day public review
	Milestone 5: USACE Chief's Report ASA(CW) Transmits Chief's Report to OMB ASA(CW) Transmits Chief's Report to Congress Congressional Authorization	Record of Decision (ROD)

Notes: [a] On January 31, 2013 USACE published a NOI in the *Federal Register* (Vol. 78, No. 21).
[b] Public Scoping Meetings were held by USACE on February 19, 2013 and February 20, 2013.
ASA(CW) = Assistant Secretary of the Army (Civil Works)
OMB = Office of Management and Budget.

Table 1-2. Steps in the USACE Planning Process

Chapter	Step(s) in the Planning Process
2. Need for and Objectives of Action	1. Specification of water and related land resources problems and opportunities
3. Alternative Plans [a]	3. Formulation of alternative plans 5. Comparison of alternative plans 6. Selection of the recommended plan based upon the comparison of the alternative plans
4. Affected Environment	2. Inventory, forecast and analysis of water and related land resources in the study area
5. Environmental Consequences	4. Evaluation of the effects of the alternative plans
6. Compliance with Federal Laws and Executive Orders	N/A
7. Public and Agency Involvement and Review	N/A
8. Recommended Plan	N/A
9. Recommendations	N/A
10. List of Preparers	N/A
11. References	N/A
12. Index	N/A

Note: [a] This chapter is the heart of the report and is therefore placed before the more detailed discussions of resources and effects. In addition, at the end of the chapter, a project description is provided for the purposes of the NEPA analysis.

CHAPTER 2 – NEED FOR ACTION

2.1 Background

The Sacramento – San Joaquin River Delta (Figure 1-1) is part of the largest estuary on the West Coast of the United States. The Delta is home to hundreds of species of fish, birds, mammals and reptiles; and is considered an ecosystem of national significance. Agricultural land irrigated by Delta water contributes billions of dollars in production for the Nation. Two deep water ports in the Delta serve as important marine terminals for dry bulk cargo vessels transporting agricultural products through the Delta's deep draft navigation channels to world markets. Delta levees protect thousands of acres of orchards, farms, and vineyards as well as critical infrastructure including state and interstate highways, major rail lines, natural gas fields, gas and fuel pipelines, water conveyance infrastructure, drinking water pipelines, and numerous towns, businesses and homes.

In terms of geography, the Delta is a web of channels and reclaimed islands at the confluence of the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras Rivers. Forty percent of California's land area is contained within the watersheds of these rivers. The Delta covers about 738,000 acres and is interlaced with hundreds of miles of waterways. Much of the land is below sea level and protected by a network of 1,100 miles of levees which have been constructed over the past 150 years to manage the flow of water through the Delta.

The land behind the levees is predominantly agricultural (corn, wheat, vineyards, cattle). Nearly 95 percent of the historic wetland habitat in the Delta has been converted to agricultural and urban uses. Waterways provide recreational outlets for nearby urban areas and essential habitat for fish and wildlife, including Federally listed species under the Endangered Species Act (FESA). The Delta is also the largest single source of California's water supply, providing 25 million Californians with drinking water and irrigating millions of acres of farmland in the Central Valley. In addition, more than 500,000 people live within the Delta and rely upon it for water, recreation, and livelihood. The majority of that population is in the greater Sacramento and Stockton areas and is the focus of other USACE FRM studies, though there are communities within the Delta. Several Delta towns, known as "legacy communities," are listed in the National Register of Historic Places.

Historically, the Delta was defined by tidal wetlands, primarily comprised of peat soils. The Swamp and Overflow Land Act of 1850 transferred ownership of all Federally owned swamp and overflow land, including Delta marshes, from the Federal Government to private parties agreeing to drain the land and turn it to productive, presumably agricultural, use. This Act began the reclamation of wetlands in the Delta through the construction of levees and drainage channels, typically by the new land owners. The majority of levees in the Delta are still privately owned and maintained. Nearly three-fourths of the Delta is now in agriculture.

2.2 Problems and Opportunities

A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable. Within the context of solving the problems, opportunities contribute to the overall beneficial outcome of the project. The purpose of this feasibility study is to develop an implementable and acceptable plan to improve future environmental conditions by addressing specific water and related land resources problems and opportunities in the Delta and Suisun Marsh.

Problems and opportunities to be addressed were identified in several ways. Based upon a review of plan formulation efforts for the BDCP, the Delta Risk Management Study (DRMS), the Delta Vision (Blue Ribbon Task Force), the CVFPP, USACE Special Study, USACE 180 Day Report to Congress, and other related State planning efforts, two general types of problems were identified—Flood Risk and Ecological—as well as corresponding opportunities and objectives. Problems and opportunities related to conveyance of water supply have been identified and will be qualitatively discussed as they relate to flood risk and ER; but these elements are peripheral to plan formulation for this study. Two Federal Deep Draft Navigation studies are also underway within the study area and will be discussed as they relate to this study. In addition to the review of the aforementioned references, several workshops and brainstorming meetings were held to help define the existing conditions and identify problems and opportunities for this study. Participants in these meetings included:

- U.S. Army Corps of Engineers
- California Department of Water Resources
- Delta Stewardship Council
- Delta Conservancy
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- California Department of Fish and Wildlife
- U.S. Bureau of Reclamation
- Sacramento County
- San Joaquin County
- Contra Costa County
- Yolo County
- Alameda County
- Solano County
- Yolo Basin Foundation
- City of Stockton

- Various Reclamation District Engineers

The problems and opportunities addressed in the feasibility study are defined in the following sections.

2.2.1 Flood Risk Problems

Delta levees protect critical infrastructure such as State highways, rail lines, natural gas fields, gas and fuel pipelines, drinking water pipelines, and numerous businesses and towns. Delta inhabitants are primarily located on six islands, although portions of Sacramento and Stockton are located in the Delta. Flood risk reduction for Sacramento and Stockton is the focus of other USACE studies. These studies are being closely coordinated to ensure assumptions, scopes, and alternative plans are compatible.

Flood risks in the Delta are largely due to the potential for levee failure and overtopping. These risks increase as a result of climate change, sea level change, subsidence (as much as 25 feet below sea level), and seismic risk. In particular:

- Population centers [such as those at Walnut Grove (1,542), Isleton (804), Locke (600), Courtland (355), Bethel Island (2,137), Hood (271), and Ryde (142)] and surrounding agricultural lands are located in deep floodplain areas, the flooding of which could result in loss of life and flood damages;
- Highways 4, 12, 5, and 160, as well as major railroads, are located in deep floodplain areas, the flooding of which could disrupt critical transportation routes for people and goods, as well as emergency evacuation and response;

  Critical infrastructure including aqueducts, natural gas transmissions, oil and gas wells, and high power transmission lines are located in deep floodplain areas, the flooding of which could cause damages and service disruptions.

About two-thirds of the Delta levees were constructed without engineering specifications and are non-Project levees, while only 385 miles of these levees are part of the Sacramento River Flood Control Project or the Lower San Joaquin River and Tributaries Project. Inherent weaknesses in Delta levees and foundations, due to construction practices, encroachments, abandoned pipes, and burrowing by various mammals, commonly result in seepage distress, internal erosion, and occasional levee failure and island inundation. Oxidation and loss of peat soils (which occurs due to a number of factors, such as agriculture use) have caused many of the reclaimed islands to subside below sea level. The phenomenon also causes levee foundations and levees for a majority of Delta islands to consolidate which, in combination with interior island subsidence, causes uneven settling and further weakening of the levees. It is apparent by the frequency of historical flood events (over 168 instances in the past 100 years) that the current Delta levees do not have a high level of performance for the 500,000 people living behind them.

A single island failure can result in the “domino effect” of multi-island failures due to the extensive network of unstable levees. A breach on one levee system may overload an adjacent levee system resulting in a larger flooding event.

Focus of BDCP/California WaterFix/EcoRestore

Ecological issues in the Delta and flood risk problems specific to water quality may be addressed through the implementation of California’s WaterFix/EcoRestore. These problems are described below to provide a general understanding of the study area; however, this report will only qualitatively discuss these problems and the likely solutions under consideration by others. Solutions under consideration by the California WaterFix include a dual water conveyance system, which would create options to move water through the Delta’s interior or around the Delta through an isolated conveyance facility (tunnel).

The impacts associated with the failure of fragile Delta levees can reach beyond the Delta and disrupt the water supply for 25 million Californians reliant on drinking water that passes through the Delta, and billions of dollars of agricultural production that is reliant on Delta water. By reducing the volume of tidal exchange in the Delta, reclaimed islands and land tracts act as a barrier between fresh and salt water, preventing sea waters from the San Francisco Bay and Pacific Ocean from entering into the State and Federal Water Project intake structures. A multi-island failure could result in the saltwater contamination of water supplies and could take a year or longer to rectify. In addition, insufficient emergency response plans and resources for some areas in the Delta could prolong recovery of these water supplies for the San Joaquin Valley and Southern California in the event of multiple levee failures.

2.2.2 Ecosystem Problems

The Delta, an ecosystem of national significance, is a critical link in the Pacific Flyway, a major north-south route of travel for migratory birds in America, and is protected through the Migratory Bird Treaty Act (MBTA) of 1918. Natural resource specialists agree that the remaining ecosystems in the Delta no longer maintain the functions and richness that defined the pre-channelized system, and that its ecological health and value for many species beyond migratory birds will continue to decline without preventive action. For example, continued decline in the Delta smelt population been attributed to reduced Delta outflows, entrainment losses to water diversions, changes in food organisms, toxic substances, disease, competition and predation by non-native species, and potential crossbreeding with the non-native wakasagi. Native splittail populations have been adversely affected by loss of floodplain attributable to levees and channelization (Moyle 2002). Populations of salmonids, a commercially, recreationally, and culturally important fish species in the Delta are also in decline. Chinook salmon, steelhead, and green sturgeon populations have also experienced sharp declines as a result of natural and human-related factors including blockage by dams from spawning and rearing habitat, deleterious water temperature, and altered flows and flow fluctuations (Busby et al. 1996; Good et al. 2005).

Many of the defining characteristics of the Delta's pre-channelized ecosystem (spatial extent, habitat heterogeneity, and dynamic storage) have either been lost or substantially altered as a result of land use and water management practices during the past 100 years in California. Nearly 95 percent of the historic wetland habitat in the Delta has been converted to agricultural and urban uses (The Bay Institute 1998).

Pesticides, channelization, exotic and non-native invasive species, water supply diversions, agricultural and urban runoff, and wastewater discharges have all been identified as contributors to the decline of the Delta's ecological health. Specifically, channelization of rivers and streams through the construction of levees has resulted in the widespread loss of tidal marsh, shaded riverine aquatic habitat, open water habitat, and the disconnection of floodplains from waterways, which has greatly reduced the amount of shallow, gentle sloping near shore areas. If this loss of Delta habitats and disconnection from floodplains continues, the current substantial declines in the Delta's fisheries could result in the extinction of culturally and economically important species.

The conversion of the Delta for urban and agricultural uses, including levee construction, has resulted in:

- Substantial loss (95%) and fragmentation of historic intertidal and tidal habitat areas and linkages for native plants and wildlife, including over 35 Federal and State listed Threatened and Endangered species;
- Subsidence in the Delta and Suisun Marsh, which can cause significant adverse ecological impacts due to deeper flooding;
- Introduction and propagation of non-native invasive species;
- Separation of historic floodplains from natural hydrologic flooding events through channels within the Delta; and
- Degraded water quality conditions from various stressors.

Central Valley Project and California State Water Project

Current operation of the CVP and California SWP, as well as other export operations and diversions that result in consumptive losses, supply water to 25 million Californians and 4.5 million acres of irrigated land. But these water resource operations can have a damaging effect on the plants and animals inhabiting the Delta. For example, the operation of pumping facilities is known to alter flow patterns, affecting the migration of salmonids passing through the river system. Delta smelt are drawn into the flow of water to the pumping facilities and can be entrained, resulting in the mortality of this Federally-listed species. The altered hydrology and operation of the State, Federal, and local water projects have resulted in:

- Altered natural water flows through the Delta and to Suisun Marsh and San Francisco Bay;
- Mortality of native species in/adjacent to water control structures (primarily delta smelt and salmonids);
- Changes to timing, volume and/or distribution of water throughout the Delta which has adversely affected the ecosystem and the habitat requirements of many native species; and
- Reduction in seasonal variability in the migration and concentrations of saline water.

2.2.3 Opportunities

The Delta Islands and Levees Feasibility Study provides an opportunity to:

- Restore, enhance, preserve, create, and maintain aquatic, riparian, and adjacent terrestrial habitats in the Delta for native plants and wildlife, including Federal and State threatened, endangered, and special-status species, with the potential secondary benefit to recreation;
- Manage invasive and non-native species for the benefit of native plant and wildlife species, with the potential secondary benefit to recreation;
- Restore floodplain functions and contiguous habitat in the Delta;
- Reduce flood risk in the Delta to protect people, property, agriculture, habitat, and infrastructure, with the potential secondary benefit to recreation and navigation;
- Address seismic and sea-level change risks to levees in the Delta that protect population centers, highways, railroads, and critical infrastructure;
- Improve emergency management and response throughout the Delta;
- Incidentally, improve water quality in the Delta; and
- Beneficially reuse available dredged materials.

2.3 Federal and Sponsor Objectives

The specific objectives for this feasibility study were derived from the identification of the study problems and opportunities and are discussed in Section 2.4.

The Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders (EO), and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units that would accrue in the planning area and the rest of the nation as a result of project implementation.

USACE has added a second national objective for Ecosystem Restoration (ER) to contribute to the Nation's ecosystems (or National Ecosystem Restoration (NER)) by restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Contributions to NER are defined as increases in ecosystem value and productivity provided by an ecosystem restoration project and are measured in non-monetary units such as acres or linear feet of habitat, average annual habitat units (AAHU), or increased species number or diversity.

DWR, as the non-Federal sponsor, has flood risk and ER objectives similar to the national NED and NER objectives. Additionally, DWR has water supply objectives that it seeks to meet through other related initiatives.

2.4 Planning Goals and Objectives

The planning objectives developed specifically for this study are more specific than the Federal and non-Federal objectives; they seek to address the identified problems and opportunities in the Delta Study area and help define the study's purpose. They also represent desired positive changes in the future without-project conditions.

The planning objectives for the Delta Study would be attained within the period of analysis for the study, a 50-year timeframe beginning in 2020, pending identification of Federal interest and inclusion in a selected plan. All of the objectives focus on activity within the study area.

The goal of the feasibility study is to develop a range of alternative plans that balance the objectives and avoid conflicts or, where necessary, demonstrate the tradeoffs between conflicting objectives, enabling decisions to be made. The Federal objective is to maximize net NED and NER benefits. Because of this, it is not appropriate to identify targets within objectives. For example, no target level of flood risk, minimum acreage of habitat, or minimum habitat value was identified for the project. Rather, the planning process includes formulation of alternative plans designed to maximize NED and NER benefits relative to costs.

Goal 1 - Restore sustainable ecosystem functions in the Delta.

Ecosystem Restoration Objective 1—Increase area, connectivity, and diversity of native tidal and non-tidal aquatic, riparian, and related habitats within the study area during the period of analysis.

Goal 2 - Improve flood risk management in the Delta.

Flood Risk Management Objective 1a – Reduce the probability and consequences and annual damages associated with flood risk in the study area during the period of analysis**.**

Flood Risk Management Objective 1b – Improve resiliency and reduce the chance of loss of life and key infrastructure (transportation corridors, aqueducts, pipelines/wells, etc.)**.**

Flood Risk Management Objective 2 – Reduce risks to life loss within the study area during the period of analysis, focusing on areas with the greatest potential life loss impacts (such as areas with the greatest inundation).

2.5 Planning Constraints

A constraint is a restriction that limits the extent of the planning process. It is a statement of things the alternative plans should avoid. Constraints are designed to steer project alternatives away from undesirable changes between without and with-project future conditions.

In the development of the alternatives, the following constraints were identified to direct plan formulation efforts so that beneficial effects would be maximized and adverse effects would be minimized:

- Must not impede the BDCP/California WaterFix/California EcoRestore; and
- Must not be dependent upon the BDCP/California WaterFix/California EcoRestore.

CHAPTER 3 – ALTERNATIVE PLANS

3.1 Plan Formulation Process

Formulation, evaluation, and comparison of alternative plans comprise the third, fourth, and fifth steps of the USACE planning process. These steps are often referred to collectively as plan formulation. Plan formulation is an iterative process that involves cycling through the formulation, evaluation, and comparison steps several times to formulate a range of alternative plans and then narrow those plans down to a reasonable array of plans that are technically and economically feasible. Ultimately, a single plan can then be identified as the best alternative for implementation.

3.2 Planning Criteria

Planning criteria are used to formulate, screen, evaluate, and compare measures and alternative plans. Four specific formulation criteria are required in USACE water resource studies, as described in the Principles and Requirements for Federal Investments in Water Resources, March 2013: completeness, effectiveness, efficiency, and acceptability. These criteria are useful in narrowing down the array of possible alternative plans. With the exception of completeness, these criteria are also useful in screening potential measures.

- **Completeness.** Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree to which the outputs of the plan are dependent upon the actions of others. Plans that depend upon the actions of others to achieve the desired output were dropped from consideration.
- **Effectiveness.** Effectiveness is the extent to which a measure or alternative plan achieves the planning objectives. Measures or alternative plans that clearly make little or no contribution to the planning objectives were dropped from consideration.
- **Efficiency.** Efficiency is a measure of the cost effectiveness of the plan expressed in net benefits. Benefits can be both monetary and non-monetary. Measures or alternative plans that provided little benefit relative to cost were dropped from consideration.
- **Acceptability.** Acceptability is a measure of the ability to implement a measure or alternative plan. In other words, acceptability means a measure or plan is technically, environmentally, economically, and socially feasible. Unpopular plans are not necessarily infeasible, just unpopular. Measures or plans that were clearly not feasible were dropped from consideration.

Measures and plans that pass the screening criteria are evaluated and compared against more specific evaluation criteria. Evaluation criteria are described later in this chapter. Evaluation criteria can include costs, outputs, or effects and reflect the planning objectives or constraints. Some or all of the evaluation criteria may be used at various stages in the plan formulation process to compare alternative plans. Effective evaluation criteria must be measurable and reveal differences or trade-offs between alternative plans.

3.3 Future Without-Project Condition

Through the 2009 Delta Reform Act, the State of California has established “two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.” The Act also established the Delta Stewardship Council as a new, independent state agency tasked with delineating how to meet these goals through the development and implementation of the Delta Plan, which became effective with legally-enforceable regulations on September 1, 2013. While the Delta Plan serves as a management plan for the Delta, the primary state planning effort in place at the time of plan formulation for this study is the Bay Delta Conservation Plan (BDCP). This large-scale plan would result in a vastly changed Delta system, posing a significant risk to this study regarding the uncertainty of future Delta conditions. In order to reduce this risk, this study includes the BDCP in the future without project (FWOP) conditions to ensure that a recommended plan is successful if and when the BDCP is implemented, now most likely through two related efforts: California WaterFix and California EcoRestore.

Recognizing that realization of the habitat restoration/conservation measures outlined in these plans is uncertain, study constraints for this interim report have been put in place to minimize study risk associated with these assumptions. These study constraints, described in Section 2.5, limited plan formulation from considering any measures that would impede or be dependent upon the BDCP and Delta Plan. These assumptions and constraints apply only to this interim report and would be revisited in any future follow-on feasibility studies. The purpose of these assumptions and constraints is to allow successful plan formulation for this interim report, independent of progress on the BDCP efforts. Even though those State planning efforts have continued to evolve, there is no conflict between the selected plan identified in USACE’s 2014 draft feasibility report and the State’s current planning efforts. Therefore, it was not necessary to revise and repeat the USACE plan formulation process for this final feasibility report based on the current status of the State’s continuing planning efforts. Consequently, in the following discussion of the FWOP conditions assumed by USACE during plan formulation, some specific information is based on the status of the BDCP and Delta Plan at the time of the original plan formulation process. The current status of the BDCP (California WaterFix and EcoRestore) and the Delta Plan are described in Section 5.11.2.

The FWOP condition includes all authorized and funded projects, as well as the recommended plans from the BDCP, as shown in Figure 3-1. For the purposes of this study, it is assumed that implementation of the State of California Delta Reform Act would occur 10 to 15 years after the final report. The assumptions regarding this future scenario are:

- 50-year period of analysis for future conditions; 100-year planning horizon for sea level rise and climate change conditions.
- Include the large-scale BDCP which would drastically alter the study area upon implementation.
    - Dual conveyance system in place to convey water from the Sacramento River to Clifton Court Forebay in the south Delta for transfer to the CVP (Federal water management project) and the California SWP. The proposed dual conveyance system includes the existing through-Delta pathway and a new alternative conveyance system with three 3,000 cubic feet per second (cfs) pumping stations. Existing through-Delta conveyance (shown as the Armored Pathway in Figure 3-1) for water supply would continue to be armored/improved through levee improvements funded through DWR's Delta Levees Maintenance Subventions Program and Delta Levees Special Flood Control Projects.
    - Mitigation, habitat conservation, and ER features would be implemented (145,000 acres to be implemented over 50 years) in the proposed "restoration opportunity areas" shown in Figure 3-1.

      In the 2016 FEIR/EIS for California WaterFix, the number and size of Restoration Opportunity Areas (ROAs) were reduced from those shown in Figure 3-1 and the proposed amount of restoration/mitigation was also significantly reduced. Specific locations for habitat mitigation for California WaterFix have not been identified and the project has not received final approvals, so locations and amounts of mitigation are subject to change. Most of the ROAs in Figure 3-1 are also identified as Recommended Areas for Prioritization and Implementation of Habitat Restoration Projects in the Delta Plan and/or include restoration projects under the California EcoRestore program.
    - California WaterFix/EcoRestore is being developed in compliance with the existing laws, biological opinions, and regulations governing the management of salinity that balance the sometimes-conflicting salinity levels for the environment, with-sometimes conflicting needs between endangered species such as Delta smelt and salmonids, Delta water exports, and in-Delta water use/rights. Salinity management would continue based on these existing laws, biological opinions, and regulations.
- Ecosystem functions would be improved by restoration and conservation efforts focused along the perimeter of the Delta (BDCP); however, system-wide ecosystem dynamics would continue to be impaired, affecting:
    - 47 special status species;
    - Multiple essential fish habitat areas;

- Multiple critical habitat areas (Delta smelt, Winter and Spring run salmon, Central Valley Steelhead, and Green Sturgeon);
- Migratory birds;
- Tidal, intertidal, and riparian wetlands; and
- Water quality.

- Population centers within the Delta would remain at risk of flooding; however, the greater metropolitan areas extending from the cities of Sacramento and Stockton are being evaluated through other mechanisms and those efforts will not be duplicated through this study.
- State and regional population growth would increase demands on Delta infrastructure (i.e. transportation, power transmission, water conveyance); however, water conveyance infrastructure would be improved through the implementation of the BDCP.
- Development would continue to be limited by the Delta Protection Act.
- Agricultural practices would continue.
- Recovery from catastrophic failure of Delta levees would be undertaken by the State of California, if necessary, to manage salinity for the environment and human use, which would also protect the brackish Suisun Marsh. As described in DWR's Delta Flood Emergency Facilities Improvement Project, the State is working to ensure that it has the appropriate infrastructure and supplies in the Delta to respond to and recover quickly and effectively from major flood or earthquake disasters in the Delta. Locations of storage and transfer sites for stockpiled flood fight materials are shown in Figure 3-1 and include the following features and actions:
  - Establish two new material storage and transfer facility sites:
    - Stockton West Weber Avenue; and
    - Brannan Island State Park.
  - Modify an existing material storage facility at Rio Vista.
  - Establish new flood fight supply facilities at all three locations.
  - Make site preparations to support Incident Command Posts at Stockton West Weber Avenue and Brannan Island State Recreation Area.
  - In addition to the 223,000 tons of quarry rock stockpiled by DWR at Rio Vista and within the Port of Stockton, DWR would also stockpile up to 40,000 tons of quarry rock material of variable gradations less than 24-inch-minus at Stockton West Weber Avenue and Brannan Island, and 20,000 tons of sand in Rio Vista for a total additional increment of 100,000 tons.

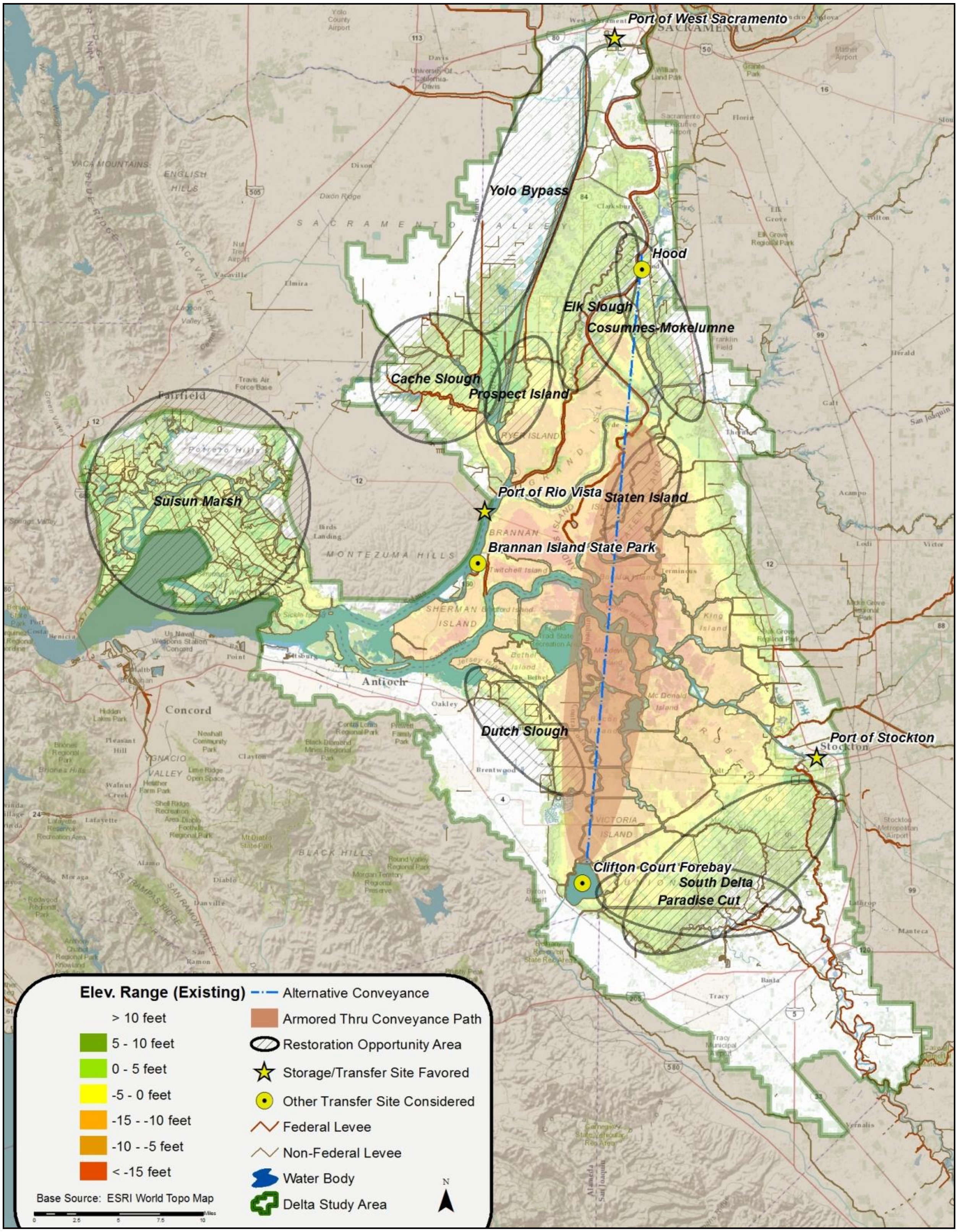

Figure 3-1. Future Without-Project Condition

- Flood risk in the Delta would persist, if not increase, notwithstanding ongoing operations and maintenance activities and scattered FRM projects, namely DWR's Delta Levees Maintenance Subventions Program and Delta Levees Special Flood Control Projects.
    - Probability for multiple levee failures from a seismic event would increase.
    - Subsidence of reclaimed lands would continue to separate water and land elevations, further increasing the hydraulic load on Delta levees within dry, leveed islands and tracts.
    - Seepage issues would continue.
    - Climate change would put additional stress on Delta levees (DWR, 2008):
        - Projected climate change analyses indicate that the climate of the Central Valley of California, including the Delta, will likely become warmer and wetter overall in the future, with more extreme flood events and droughts. This could lead to periods of reduced water supply, and therefore reduced water quality and increased salinity. This analysis applies to all measures within the final array of alternatives.
        - Mean water levels in the Delta would increase as sea level rises;
        - Peak river inputs to the Delta would likely increase due to stronger winter river flows, as well as possible increases in mean precipitation rates and single-day precipitation amounts; and
        - In-Delta wind speeds may also increase, due to predicted increases in the large-scale temperature and pressure gradients that drive these flows.
- Subsidence would not occur on submerged lands, consistent with current conditions.
- Nonstructural FRM would continue through efforts of the State of California Delta Protection Commission (DPC), to include:
    - Emergency preparedness and response planning.
    - Land use management to manage growth in Delta floodplains.

3.4 Identification and Screening of Measures

A measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Table 3-1 lists the various general measures identified for this study and identifies the individual objectives to which they contribute.[3] Measures are the building blocks that are grouped together to form alternative plans. The wide variety of measures listed below was screened to determine whether each measure should be retained for use in the formulation of alternative plans. Descriptions of the measures and the decision to retain or drop each measure from further consideration are presented next. These general measures were screened, as shown below, based on:

- Opportunity for implementation under future without-project conditions;
- Effectiveness at achieving an objective;
- General efficiency; and
- General acceptability.

3.4.1 Flood Risk Management (FRM) Measures

These measures primarily achieve FRM objectives in the study area, but may also contribute to the ER objectives. FRM measures can be nonstructural or structural. Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding. Nonstructural measures accomplish damage reduction by changing the use of the floodplains, or by accommodating existing uses to the flood hazard zone. In contrast, structural measures alter the nature or extent of flooding. Structural measures accomplish FRM by modifying the magnitude, duration, extent, or timing of flooding. The general FRM measures considered in this study are:

- *Protect Utility/Highway Corridor(s).* Identify and reduce risk to a specific area/corridor that contains the largest portion of utilities and highways in the study area. This concept will be applied to other FRM measures through the evaluation process. This measure will be further developed through economic analysis of levee improvements. It is a reasonable measure for consideration to achieve FRM objectives, and will be carried forward.
- *Levee Improvements.* Reduce risk to life and assets through improvements to existing levees. This is a reasonable measure for consideration and will be carried forward.

[3] House Report 108-357 (Conference Report accompanying the Energy and Water Development Appropriations Act, 2004, P.L. 108-137) urged the Secretary of the Army to incorporate locally preferred options that provide protection to agricultural lands and residential properties. Measures considered include such options.

- *Ring Levees.* Reduce risk to life and assets through construction of ring levees. This is a reasonable measure for consideration and will be carried forward.
- *Emergency Response Planning and Coordination.* Reduce risk to life loss through emergency response planning and coordination. This is a reasonable measure for consideration and will be carried forward.
- *Raise/Floodproof Communities.* There is no opportunity for this measure as a method of reducing flood damages due to the deep floodplains of the Delta. This measure will be dropped from further consideration.
- *Raise/Floodproof Individual Structures.* There is no opportunity for this measure as a method of reducing flood damages due to the deep floodplains of the Delta. This measure is therefore dropped from further consideration.
- *Relocate Community.* This measure is considered unacceptable because communities would have to be relocated outside the Delta, as there are no flood-free areas within the Delta. Additionally, it would not be possible to truly relocate entire communities, but rather purchase estates and allow individual entities within the communities to relocate to a location of their choosing. Delta communities would be disbanded and scattered to various locations outside of the Delta. Implementation of this measure would impact the preservation of Delta history and eliminate the culture of the Delta, which has been proposed as a National Heritage Area. For these reasons, this measure is dropped from further consideration.
- *Relocate Individual Structures.* This measure is considered unacceptable because structures would have to be relocated outside the Delta, as there are no flood-free areas within the Delta. Delta communities would be severely impacted and would likely be disbanded and scattered to various locations outside of the Delta. Implementation of this measure would impact the preservation of Delta history and the culture of the Delta, which has been proposed as a National Heritage Area. For these reasons, this measure is dropped from further consideration.
- *Enhance Flood Risk Communication.* Retained for further consideration. Due to the large six county area, many agencies would be involved in a large scale response effort. Opportunity may exist to improve flood risk communications.
- *Reoperation and Transbasin Diversion.* Reoperation of upstream reservoirs and transbasin diversions in order to reduce flood risk. Although this measure would likely reduce risk to the areas upstream of the tidal influence of the Delta, it would not contribute to reducing flood risk to the largely tidal Delta. This measure does not contribute to an objective and is therefore not effective. This measure is therefore dropped from further consideration.

Table 3-1. Screening of Measures

Category	General Measures	Opportunity *	Effectiveness – Ecosystem Restoration Objective: Increase Habitat Area**	Effectiveness – Ecosystem Restoration Objective: Increase Habitat Connectivity	Effectiveness – Ecosystem Restoration Objective: Increase Species Diversity	Effectiveness – Flood Risk Management Objective: Reduce Consequences and Annual Damages	Effectiveness – Flood Risk Management Objective: Reduce Risk to Life	Efficiency	Acceptability	Retained (R) or Dropped (D)
ER	Restore Native Riparian Habitat	H	X	X	X			X	X	R
ER	Creation of New Channels to Connect Habitats	H	X	X				X	X	R
ER	Invasive Species Management	M			X			X	X	R
ER	Restore In-Channel Islands and Floodplains	M	X	X				X	X	R
ER	Restore Historic Marshes	M	X	X	X			X	X	R
ER	Salinity Management	L			X					D
Multi	Construct Habitat Friendly Levees	H	X	X		X	X	X	X	R
Multi	Setback Levees (Tidal/Riparian)	H	X	X	X	X	X	X	X	R
Multi	Controlled Flooding of Appropriate Subsided Areas	M	X			X	X	X	X	R
Multi	Create Bypasses	M	X	X	X	X	X	X	X	R
NONSTRUCTURAL FRM / FRM	Protect Utility/Highway Corridor(s)	H				X		X	X	R
NONSTRUCTURAL FRM / FRM	Levee Improvements	H				X	X	X	X	R
NONSTRUCTURAL FRM / FRM	Ring Levees	H				X	X	X	X	R
NONSTRUCTURAL FRM / FRM	Emergency Response Planning and Coordination	H					X	X	X	R
NONSTRUCTURAL FRM / FRM	Relocate Community	L				X	X	X		D
NONSTRUCTURAL FRM / FRM	Relocate Individual Structures	L				X	X	X		D
NONSTRUCTURAL FRM / FRM	Enhance Flood Risk Communication	H					X	X	X	R
NONSTRUCTURAL FRM / FRM	Raise/Floodproof Community	L				X	X			D
NONSTRUCTURAL FRM / FRM	Raise/Floodproof Individual Structures	M				X	X			R
NONSTRUCTURAL FRM / FRM	Reoperation and Transbasin Diversion	L							X	D

* H indicates a high likelihood of potential opportunity; M indicates a medium likelihood of potential opportunity; L indicates a low likelihood of potential opportunity. This qualitative assessment was based on professional judgment by the project delivery team.
**X indicates the measure contributes to that objective, is efficient, or is acceptable.

Criteria were established to further screen the specific measures based on reduced risk to life loss, reduced annual damages, reduced infrastructure at risk, and if a measure was included in the FWOP condition. Measures were qualitatively assessed and rankings of "High-Medium-Low" were assigned based on professional judgment. These specific measures and criteria are shown below in Table 3-2. An overall ranking of "High-Medium-Low" is indicated by the "Green-Yellow" color scheme, respectively. "High" ranking measures ranked "high" for at least two criteria. "Medium" ranking measures ranked "medium" or "high" for at least one criterion. No measures ranked as "Low" overall; therefore all measures were retained through this screening process.

Table 3-2. Screening of Flood Risk Management Measures

Measure	Reduce Risk to Life Loss	Reduces Annual Damages	Reduce Infrastructure at Risk	Included in FWOP?
Levee Improvements	H	H	H	N
Ring Levees	H	H	M	N
Protect Utility/Highway Corridor(s)	L	L	H	N
Emergency Response Planning and Coordination	M	L	L	N*
Enhance Flood Risk Communication	M	L	L	N*

*measure included in future without-project condition, but opportunity remains

Structural Flood Risk Management

Once general measures were screened for effectiveness, efficiency, and acceptability, the remaining general measures were refined to a greater level of detail. Locations were identified for consideration of application of measures based on the following.

Ratio of Total Inundation Repair Costs to Upgraded Levee Costs

To calculate the ratio of total inundation repair costs to upgraded levee costs, information was taken from both phases of DWR's Delta Risk Management Strategy (DRMS). The total inundation repair costs values are from the DRMS Phase I Impact to Infrastructure Technical Memorandum (IITM); these costs represent the repair cost for each asset on a particular Delta island, based on inundation depths, the percent damage incurred, and the original value of the asset. The assets considered in the IITM include: a) points assets: structures and buildings (and their contents), bridges, marinas, natural gas fields/storage areas, natural gas wells, commercial and industrial buildings, residences, and pump stations and b) linear assets: railroads, highways, shipping channels, transmission lines, aqueducts, and gas and petroleum pipelines. Since inundation repair costs are similar to the USACE concept of damages it was determined to be an appropriate numerator value for a screening criterion ratio. The upgraded levee costs were taken from DRMS Phase II report Upgraded Delta Levees (Section 4); these costs consist of upgrading non-project Delta Levees to DWR's Delta specific "P.L. 84-99" levee standard or Urban Project Levee (UPL) standards. In DRMS, levees protecting urban centers were selected for UPL upgrades and Delta specific "P.L. 84-99" levee standard upgrades were assumed for all other areas. The higher the relative ratio of total inundation repair costs to upgraded levee costs for a particular Delta island the higher the rating for this criterion.

Life Loss Risk

Life loss risk is based entirely on Delta island population data obtained from the DRMS Economic Consequences Technical Memorandum (ECTM). Delta islands that have higher populations were considered to have a greater potential for life safety issues and thus a higher rating for this criterion.

Significance of Statewide Importance

A measure's significance of statewide importance was determined qualitatively by using the findings contained in the ECTM. If a Delta island contained an asset that would impact the region or state during and after a flood event, then that island was rated with a "Yes", otherwise the island was rated with a "No." The categories of statewide significance include: deep water ship channels, electric transmission lines, highways, natural gas transmission, Mokelumne Aqueduct, oil and gas wells, railroads, wastewater facilities, eight western islands, and legacy communities.

For criteria one and two, each Delta island was assigned a rating of high, medium, or low. For criterion three, each island was given a rating of Yes or No. The location measures that were assigned a "high" rating are generally populated areas with relatively higher economic values and therefore are likely to be included in the final array of measures as a more comprehensive, whole island levee improvement. The measures that were assigned a "medium" rating are generally somewhat populated with more limited economic values and therefore are likely to be included in the final array of measures as a more limited structural or non-structural solution. The measures that were assigned a "low" rating are sparsely populated areas with limited to no infrastructure/economic value and were therefore dropped from further considerations.

This qualitative assessment was based on existing data from the DRMS and is summarized below in Table 3-3 and shown in Figure 3-2. Developed by DWR and completed in two phases, the overall purpose of the DRMS was to assess the performance of Delta and Suisun Marsh levees and evaluate the economic, environmental, and public health and life loss consequences of levee failures to California as a whole (Phase I); and to develop and evaluate risk reduction strategies (Phase II). The DRMS was chosen because it is the only recent comprehensive analysis on the local and statewide consequences of Delta levee failures.

Table 3-3. Location Screening of Flood Risk Management Measures

Island Name	Total Asset Repair Costs/Construction Costs[4]	Life Loss Risk	Assets of Statewide Importance
Sacramento Urban Area	High	High	Yes
West Sacramento	High	High	Yes
Elk Grove	High	High	Yes
Shima Tract	High	Medium	Yes
Boggs Tract	High	Medium	Yes
Pescadero	High	Medium	Yes
Pico Naglee Tract	High	Medium	Yes
Sargent Barnhart Tract	High	Medium	Yes
Lincoln Village	High	Medium	Yes
Paradise Junction	High	Medium	Yes
Bethel Island	High	Medium	Yes
Walnut Grove	High	Medium	Yes
Smith Tract	High	Medium	Yes
Hotchkiss Tract	High	Medium	Yes
RD 17 (Mossdale)	High	Medium	Yes
Terminous Tract	High	Medium	Yes
Pierson District (aka Pearson)	High	Medium	Yes
New Hope Tract	High	Medium	Yes
Brannan-Andrus Island	High	Medium	Yes
Union Island	High	Medium	Yes
Bishop Tract	High	Medium	Yes
Tyler Island	High	Medium	No
King Island	High	Low	Yes
Walthall Tract	High	Low	Yes
Veale Tract	High	Low	Yes
Jones Tract	High	Low	Yes
Fabian Tract	High	Low	Yes
Canal Ranch	High	Low	No
Coney Island	High	Low	Yes
Rough and Ready Island	High	Low	Yes
Little Egbert Tract	High	Low	Yes
Victoria Island	High	Low	Yes
Roberts Islands	Medium	Medium	Yes
Netherlands	Low	Medium	Yes
Discovery Bay	Low	Medium	Yes
Libby McNeil Tract	Low	Medium	Yes
Twitchell Island	Medium	Low	Yes
Sherman Island	Medium	Low	Yes
Bacon Island	Medium	Low	No
Rindge Tract	Medium	Low	Yes

[4] Total Asset Repair Costs (Damages) in the event of a flood and the estimated Construction Costs to improve the existing levees are based on estimates from the Delta Risk Management Strategy Phase 1 Report. These two items were used as a proxy to rank islands in terms of potential benefit-to-cost ratio (BCR).

Island Name	Total Asset Repair Costs/Construction Costs[4]	Life Loss Risk	Assets of Statewide Importance
Woodward Island	Medium	Low	Yes
Glanville Tract	Medium	Low	Yes
Stark Tract	Medium	Low	Yes
McDonald Tract	Medium	Low	Yes
Empire Tract	Medium	Low	Yes
Bradford Island	Medium	Low	Yes
Grand Island	Low	Low	Yes
Merritt Island	Low	Low	Yes
Kasson District	Low	Low	Yes
Sutter Island	Low	Low	Yes
Prospect Island	Low	Low	Yes
Ryer Island	Low	Low	Yes
Webb Tract	Low	Low	Yes
McMullin Ranch-River Junction Tract	Low	Low	Yes
Hastings Tract	Low	Low	Yes
Lisbon District	Low	Low	Yes
Glide District	Low	Low	Yes
Lower Roberts Island	Low	Low	Yes
Byron Tract	Low	Low	Yes
Van Sickle Island	Low	Low	Yes
Stewart Tract	Low	Low	Yes
Palm Tract	Low	Low	Yes
Egbert Tract	Low	Low	Yes
Cache Haas Tract	Low	Low	Yes
Orwood Tract	Low	Low	Yes
Liberty Island	Low	Low	Yes
Middle Roberts Island	Low	Low	Yes
Decker Island	Low	Low	Yes
Medford Island	Low	Low	Yes
Holland Tract	Low	Low	Yes
Bouldin Island	Low	Low	Yes
Rio Blanco Tract	Low	Low	Yes
Wright-Elmwood Tract	Low	Low	Yes
Venice Island	Low	Low	Yes
Jersey Island	Low	Low	Yes
McCormack Williamson Tract	Low	Low	Yes
Mandeville Island	Low	Low	Yes
Quimby Island	Low	Low	Yes
Atlas Tract	Low	Low	Yes
Chipps Island	Low	Low	Yes
Weber Tract	Low	Low	Yes
Wetherbee Lake	Low	Low	Yes
Holt Station	Low	Low	Yes
Stewart-Mossdale	Low	Low	Yes
Ehrheardt Club	Low	Low	Yes

Island Name	Total Asset Repair Costs/Construction Costs[4]	Life Loss Risk	Assets of Statewide Importance
Yolano	Low	Low	Yes
Zone 122	Low	Low	No
SM-132	Low	Low	No
Zone 162	Low	Low	No
Zone 206	Low	Low	No
Water Zone 5	Low	Low	No
Zone 148	Low	Low	No
Zone 197	Low	Low	No
Zone 216	Low	Low	No
SM-202	Low	Low	No
Simmons-Wheeler Island	Low	Low	No
SM-49, SM-50	Low	Low	No
Water Zone 1	Low	Low	No
SM-48, SM-49	Low	Low	No
SM-43	Low	Low	No
SM-54	Low	Low	No
SM-60	Low	Low	No
SM-199	Low	Low	No
SM-198	Low	Low	No
SM-53	Low	Low	No
SM-84	Low	Low	No
SM-124	Low	Low	No
Zone 75	Low	Low	No
Zone 31	Low	Low	No
Zone 33	Low	Low	No
Bixler Tract	Low	Low	No
Zone 160	Low	Low	No
Water Zone 4	Low	Low	No
Water Zone 2	Low	Low	No
Water Zone 3	Low	Low	No
Holland Land	Low	Low	No
Pittsburg	Low	Low	No
Zone 38	Low	Low	No
Zone 64	Low	Low	No
Zone 78	Low	Low	No
Zone 120	Low	Low	No
Schafter-Pintail Tract	Low	Low	No
Zone 185	Low	Low	No
SM-59	Low	Low	No
Zone 158 (Smith Tract 2)	Low	Low	No
SM-52	Low	Low	No
SM-44	Low	Low	No
SM-55	Low	Low	No
Zone 37	Low	Low	No
Yolo Bypass	Low	Low	No

Island Name	Total Asset Repair Costs/Construction Costs[4]	Life Loss Risk	Assets of Statewide Importance
SM-123	Low	Low	No
SM-57	Low	Low	No
Zone 77	Low	Low	No
SM-46	Low	Low	No
Zone 36	Low	Low	No
Clifton Court Forebay Water Assets	Low	Low	No
Zone 81	Low	Low	No
Zone 69	Low	Low	No
SM-40	Low	Low	No
SM-58	Low	Low	No
Zone 65	Low	Low	No
SM-56	Low	Low	No
Fay Island	Low	Low	No
SM-39	Low	Low	No
Zone 79	Low	Low	No
Zone 207	Low	Low	No
Zone 80	Low	Low	No
Zone 90	Low	Low	No
Zone 74	Low	Low	No
Zone 171	Low	Low	No
SM-85-Grizzly Island	Low	Low	No
Honker Bay Club	Low	Low	No
SM-42	Low	Low	No
SM-41	Low	Low	No
Zone 155	Low	Low	No
Zone 82	Low	Low	No
Water Canal	Low	Low	No
Zone 14	Low	Low	No
Zone 186	Low	Low	No
Zone 214	Low	Low	No
Peter Pocket	Low	Low	No
Brack Tract	Low	Low	No
Staten Island	Low	Low	No
Shin Kee Tract	Low	Low	No
Dead Horse Island	Low	Low	No
Browns Island	Low	Low	No
Little Holland Tract	Low	Low	No
SM-133	Low	Low	No
SM-134	Low	Low	No
SM-47	Low	Low	No
SM-51	Low	Low	No

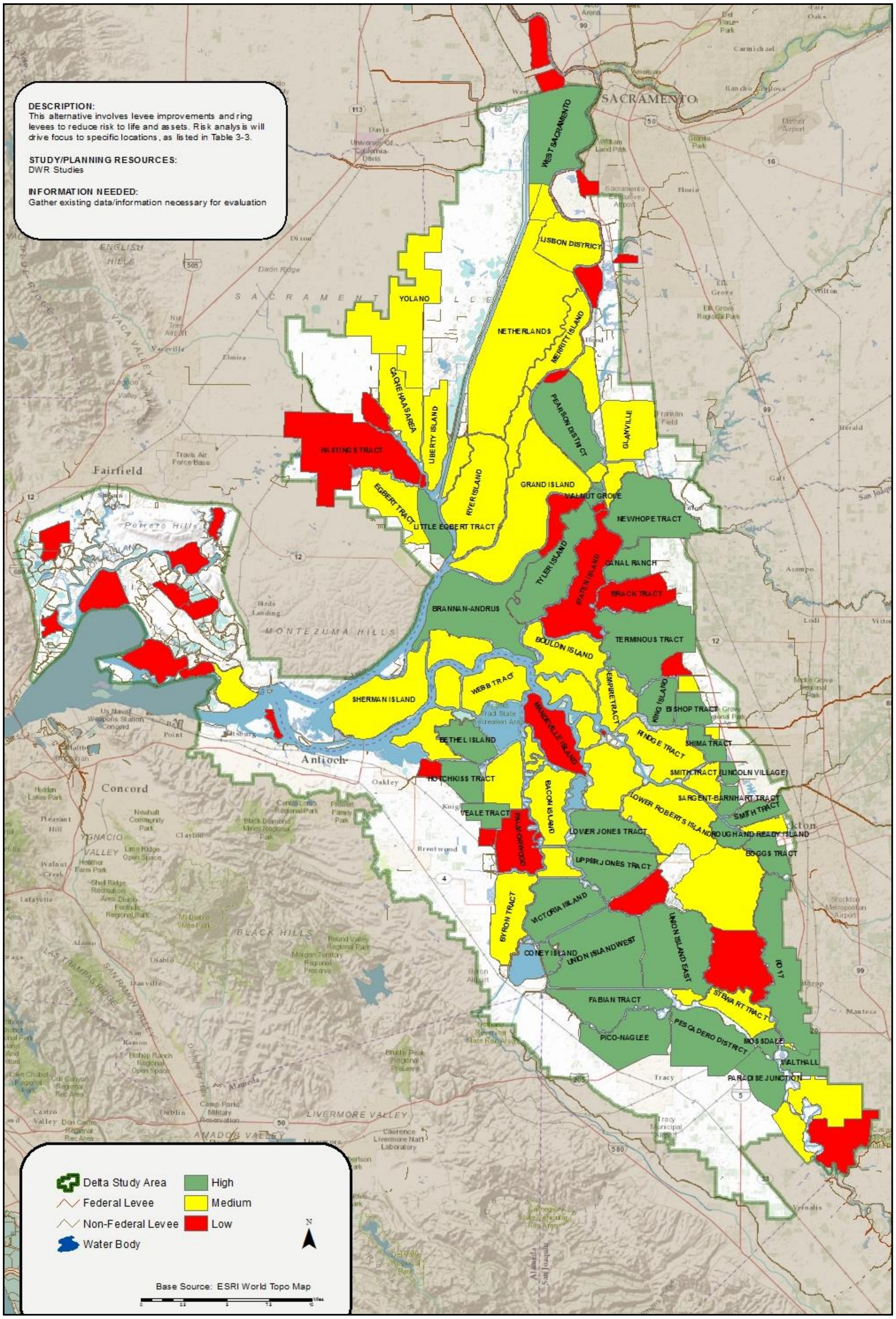

Figure 3-2. Specific Flood Risk Management Measures Considered – Locations

Benefit-Cost Ratio Screening Analysis Criteria on the Focused Array

The three Delta Islands with the highest ratio of total asset repair costs to total construction costs (from DRMS data) and not included in another current USACE study – Bethel Island, Walnut Grove, and Brannon-Andrus Island (containing the City of Isleton) - were considered for further screening level benefit-cost analysis. Based on suggestions from the local sponsor and its high population, a fourth island, Discovery Bay, was also considered for further analysis.

The main analytical tool used to perform the economic analysis was the USACE Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software. This program uses engineering data (hydrologic, hydraulic, and geotechnical) and economic data (structure/content inventory and depth-percent damage curves) to model flooding risk management problems and potential solutions in the study area. Through integration of the engineering and economic relationships HEC-FDA computes expected annual damages (EAD) and performance statistics. EAD is the metric used to describe the consequences of flooding on an annual basis considering a full range of flood events – from high frequency/small events to low frequency/large events over a long time horizon. Without project EAD by major damage area are reported in Table 3-4. All costs are based on the Fiscal Year 2013 Federal water resource discount rate of 3.75 percent.

Table 3-4. Without-Project Expected Annual Damages ($1,000, 2012 Prices)

Island	Autos	Commercial	Industrial	Public	Residential	Total
Bethel Island	1,497	208	96	132	15,526	**17,459**
Walnut Grove	37	209	233	113	544	**1,136**
Isleton	356	1,040	443	476	4,573	**6,888**
Discovery Bay	85	5	2	2	1,472	**1,566**

Annual exceedance probability (AEP) is a statistic used to describe the chance of flooding in any given year within a designated area. AEP is computed in HEC-FDA using engineering data; AEPs for the four islands are reported in Table 3-5.

Table 3-5. Annual Exceedance Probability – Without-Project Condition

Island	AEP
Bethel Island	0.2840
Walnut Grove	0.0481
Isleton	0.1596
Discovery Bay	0.1640

For this screening level analysis, there were no floodplains or other engineering data developed for with-project conditions. To develop estimates for with-project damages, two scenarios were considered: 1) zero with-project damages (or best case scenario), the USACE project would yield no residual damages, and 2) 25 percent remaining damages (or a typical case scenario); the USACE project would eliminate 75 percent of without-project damages. The zero with-project damages scenario is the highest level of FRM performance any USACE project could yield; whereas, the 25 percent remaining with-project damages are more in line with the FRM performance of a typical USACE project. The with-project EAD for both scenarios are reported in Tables 3-6 and 3-7.

Table 3-6. With-Project Expected Annual Damages (Zero Remaining Damages) ($1,000, 2012 Prices)

Island	Autos	Commercial	Industrial	Public	Residential	Total
Bethel Island	0	0	0	0	0	**0**
Walnut Grove	0	0	0	0	0	**0**
Isleton	0	0	0	0	0	**0**
Discovery Bay	0	0	0	0	0	**0**

Table 3-7. With-Project Expected Annual Damages (25% Remaining Damages) ($1,000, 2012 Prices)

Island	Autos	Commercial	Industrial	Public	Residential	Total
Bethel Island	374	52	24	33	3,882	**4,365**
Walnut Grove	9	52	58	28	136	**284**
Isleton	89	260	111	119	1,143	**1,722**
Discovery Bay	21	1	1	1	368	**392**

Average annual FRM benefits for each island were determined by taking the difference between without-project EAD and with-project EAD. These results are shown in Tables 3-8 and 3-9.

Table 3-8. Expected Annual FRM Benefits (Zero Remaining Damages) ($1,000, 2012 Prices)

Island	Autos	Commercial	Industrial	Public	Residential	Total
Bethel Island	1,497	208	96	132	15,526	**17,459**
Walnut Grove	37	209	233	113	544	**1,136**
Isleton	356	1,040	443	476	4,573	**6,888**
Discovery Bay	85	5	2	2	1,472	**1,566**

Table 3-9. Expected Annual FRM Benefits (25% Remaining Damages) ($1,000, 2012 Prices)

Island	Autos	Commercial	Industrial	Public	Residential	Total
Bethel Island	1,123	156	72	99	11,645	**13,094**
Walnut Grove	28	157	175	85	408	**852**
Isleton	267	780	332	357	3,430	**5,166**
Discovery Bay	64	4	2	2	1,104	**1,175**

Parametric cost estimates for each island and measure were used. Annual FRM construction costs are shown in Table 3-10.

Table 3-10. Annual FRM Costs ($1,000, 2012 Prices)

Island/Measure	FRM Related Construction Costs
Bethel Island- Measure A	30,424
Walnut Grove- Measure A	4,408
Walnut Grove- Measure B	4,665
Isleton- Measure A	9,080
Discovery Bay- Measure A	5,737

Net Benefits

Net benefits are determined as the difference between the annual benefits and the annual costs. The net benefits and BCRs for each island and measure under both with-project scenarios are shown in Table 3-11. All island measures have negative net benefit; also, there is no island measure that has a BCR above unity; the highest BCR is 0.76 for the Isleton Measure A under the zero percent remaining damages with-project scenario.

Table 3-11: Delta Islands FRM Annual Net Benefits and BCRs ($1,000)

Island/Measure	Net Benefits Zero Percent Remaining Damages	Net Benefits 25 Percent Remaining Damages	BCR Zero Percent Remaining Damages	BCR 25 Percent Remaining Damages
Bethel Island- A	-12,965	-17,330	0.57	0.43
Walnut Grove- A	-3,272	-3,529	0.26	0.19
Walnut Grove- B	-3,556	-3,813	0.24	0.18
Isleton- A	-2,192	-3,914	0.76	0.57
Discovery Bay- A	-4,171	-4,563	0.27	0.20

Structural FRM Summary

The four Delta islands that have the highest potential for structural FRM measures (based on the DRMS data) have negative net benefits and BCRs significantly below unity (with the highest being 0.76). Consideration of future sea level rise or climate change would not change this outcome because the benefits would not increase significantly in the near future. In light of these results, no Federal Interest in structural FRM in the Delta can be found at this time, based on applicable costs, water resources discount rate, and USACE policy.

Nonstructural FRM

Nonstructural measures retained through previous screenings include emergency response planning, emergency response coordination, and enhancements to flood risk communication. All of these nonstructural measures are included in the FWOP condition through ongoing actions. In addition to these valuable ongoing efforts, there is an opportunity for additional multi-agency response planning and public outreach in the Delta. This report recommends that DWR, the DPC, USACE, and other Federal, state, and local agencies develop preparedness plans, stockpile flood fight materials, and communicate flood risk through public outreach. Advanced flood warning systems should also be considered for the Delta, as very little warning time exists for much of the region due to the nature of the isolated tidal levee systems and deep floodplains. The existing USACE Floodplain Management Services (FPMS) authority, Planning Assistance to States (PAS) and Silver Jackets Programs provide an opportunity for the state and local governments to request Federal assistance with these efforts. Therefore, these measures are provided as general recommendations and will not be included in a recommended plan for action, as sufficient authority exists to further explore these recommendations.

3.4.2 Ecosystem Restoration Screening of Measures

ER measures, described below, were developed to achieve ER objectives in the study area[5]. The ER measures address the critical nature of the ecological health of the Delta, address the cause of habitat degradation, and re-establish some of the critical ecosystem structure and functions. Addressing habitat degradation improves the overall ecosystem by reducing the negative stressors that have depleted the ecosystem functions, thereby allowing the natural processes to restore some ecosystem structure and functions, improving the overall health of the ecosystem. Reviving ecosystem function typically involves actively restoring key hydrologic and geomorphic processes through physical modifications and reestablishing native vegetation to start the recovery process. The general ER measures considered in the study were:

[5] Due to the integrated nature of levees and habitat in the Delta, some ER measures may also incidentally contribute to FRM objectives.

- *Restore native riparian habitat.* Restoration of natural riparian habitat by active means such as re-sloping banks, planting vegetation, or controlling invasive species. In most, if not all cases, riparian habitat restoration would be connected to the levee and would involve work within the levee prism. Due to the potential for significant habitat gains from increased riparian habitat, this measure was retained for further consideration.
- *Creation of new channels to connect habitat.* Creating new channels would involve dredging or otherwise creating new channels to improve stream connectivity and resulting connections for aquatic and terrestrial species. Creation of new channels would be connected to levees and would involve work within the levee prism. This measure would be consistent with and improve the integrated nature of levees and habitat in the Delta, therefore, this measure was retained for further consideration.
- *Invasive species management.* This measure would include removal of non-native plant species from existing or restored habitats. Generally, removal and continued management of invasive species is costly and significant habitat gains are not realized by this type of measure alone. Therefore, this measure will be dropped from further consideration as a standalone measure, but the concept may be incorporated into other restoration areas.
- *Restore in-channel islands and floodplains.* This measure includes the reconnection of floodplains to adjacent waterways through the partial or full removal of levees or setting back of levees, along with re-sloping and contouring as necessary. Work associated with this measure has the potential to realize significant habitat benefits. Therefore, this measure was retained for further consideration by this study.
- *Restore historic marshes.* This measure includes the creation of intertidal marsh habitat to benefit native aquatic and terrestrial species. This measure is included in the future without-project condition (which assumes BDCP/CA WaterFix/EcoRestore implementation) for areas throughout the Delta that are currently of the appropriate elevation (range of depths) for this habitat type; therefore, little opportunity would exist under the assumed future conditions to implement this measure without incorporation of subsidence reversal. Additionally, opportunities may exist within already flooded islands, most of which are currently deep water (as opposed to marsh) due to subsidence that occurred prior to levee failure and subsequent flooding[6]. Subsidence reversal in conjunction with restoration of tidal and intertidal habitat provides an opportunity for restoration of historic marshes in areas not considered for BDCP/CA WaterFix/EcoRestore implementation.
- *Salinity Management.* This measure would alter salinity patterns through the operation of a salinity control gate in the Delta or modifying upstream reservoir operations. Salinity management currently occurs in the Delta through a complex system of laws, biological opinions, and regulations that balance the sometimes

[6] Subsidence largely results from the oxidation of peat during dry conditions; therefore, subsidence does not occur on flooded areas and/or submerged lands. Subsidence of flooded lands, as mentioned, occurred while those lands were dry/leveed.

conflicting salinity requirements for the environment (with sometimes conflicting needs between endangered species such as Delta smelt and salmonids), Delta water exports, and in-Delta water use/rights. The BDCP/CA WaterFix/EcoRestore is being developed in compliance with the existing laws, biological opinions, and regulations governing salinity; therefore, salinity management is included in the future without-project condition for this study and will be dropped from further consideration as an ER measure.

- *Construct habitat friendly levees.* This measure would include constructing or modifying levees to include features such as benches for establishing native vegetation. This measure could include setback levees or other measures. Due to the connection between levees, floodplains, and associated habitat establishment, it was determined that as a standalone measure, habitat friendly levees would not provide as much ecosystem benefit as it would when combined with other measures. Therefore, this measure will be dropped from further consideration as a standalone measure. It will be incorporated into other restoration measures.
- *Setback levees (tidal/riparian).* This measure would include constructing setback levees that allow for tidal/riparian habitat to be restored in the area between the existing levee and the setback levee. This measure may require landside levee sloping and notching of the existing levee to allow for water to get to the restoration area. This measure would require work within the levee prism, and has potential to provide incidental FRM benefits and achieve significant habitat benefits. Therefore, this measure was retained for further consideration.
- *Controlled flooding of appropriate subsided islands.* This measure includes degrading/removing/notching levees to allow restoration of the floodplain. Due to subsidence, flows would have to be managed in order to create habitat suitable for native species and prevent fish strandings. This measure would require work within the levee prism, and has potential to be combined with FRM measures and achieve significant habitat benefits. Therefore, this measure was retained for further consideration.
- *Create bypasses.* This measure includes creating bypasses with riparian and intertidal habitats. Work may require levee modifications, removal, or minor channel construction. This measure has a high potential for aquatic restoration benefits associated with listed species for various life-stage functions. Therefore, this measure was retained for further consideration.

Ecosystem Restoration Measures Developed in Detail

Measures that were carried forward through the initial screening process were refined to a greater level of detail and locations were identified for consideration. In order to ensure that only implementable measures with a reasonable chance of achieving a significant increase in habitat value at a reasonable cost were included in the final array of alternatives, the following criteria were established to further screen detailed measures:

- Areas considered for restoration must not coincide with restoration considered as part of the future without-project condition. BDCP/CA WaterFix/EcoRestore Restoration Opportunity Areas were excluded from ER analysis in order to avoid planning constraints. As these potential restoration areas are fairly extensive, this criteria greatly reduced the geographic footprint available for consideration within this study; however, these limitations were put into place for this interim report in order to reduce study risk and allow plan formulation to take place regardless of uncertain future conditions. Again, it should be noted that these assumptions and constraints apply only to this interim report and will be revisited in any follow-on feasibility studies.
- Location selection should favor areas in closer proximity to potential fill material necessary to restore elevations to the appropriate range for habitat, when possible.
- Location selection should favor areas where potentially less fill material would be required.
- Location selection should avoid impacts to population centers and infrastructure.
- Location selection should avoid impacts to islands in the western Delta that are considered critical for salinity management – known as the "eight western islands." The functionality of the eight western islands is to restrict flow of more saline water from the San Francisco Bay into the Delta for purposes of water supply. While several open water areas such as Big Break lie in close proximity to the eight western islands, these flooded, open water areas do not provide this same functionality. It should be noted that there is no official designation of the "eight western islands" in the Delta; but rather, this is common terminology used to highlight the importance of these areas for purposes of maintaining appropriate salinity in the Delta for water supply."
- Location selection should favor areas which provide connectivity to existing habitat, when possible.

Figure 3-3 provides a geographic representation of the limitations these criteria pose on the geographic extent of restoration considered.

Once locations were identified, increments (or scales) of measures were developed, when possible, in order to evaluate and determine the most cost effective scale of restoration necessary to achieve the study objectives. Descriptions of these detailed ER measures follow.

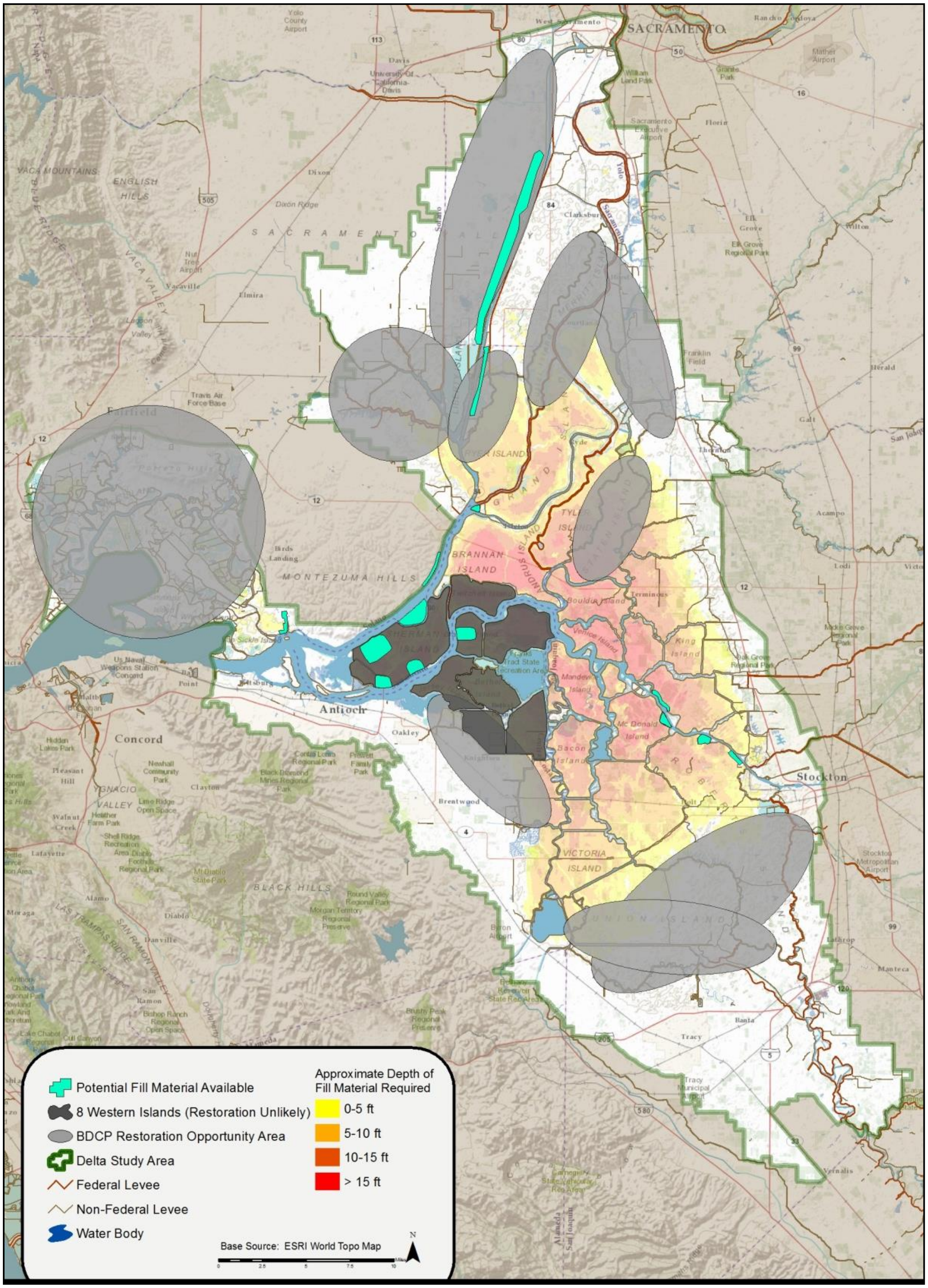

Figure 3-3. Geographic Limitations of Opportunities for Ecosystem Restoration

Note: BDCP Restoration Opportunity Areas are approximate representations. Typically, these do not extend into open water areas.

Restore Intertidal Habitat with Subsidence Reversal at Big Break (see Figure 3-4)

Restore habitat value to native species through subsidence reversal and subsequent restoration of intertidal habitat in the flooded Big Break Island. This location was selected because it is in close proximity to potential fill material, would likely require less fill material than other locations in the vicinity, would have no impacts to population centers or infrastructure, and could provide connectivity to existing habitat. Big Break is owned and managed by the East Bay Regional Park District as part of Big Break Regional Shoreline. Two scales of this measure were included for evaluation:

- Increment 1– The minimal restoration considered at Big Break would include 62 acres of tidal habitat restoration along the northern remnant levee adjacent to Jersey Island. In-water placement of material would be required to increase elevations to tidal range. Increment 1 is shown below in orange.
- Increment 2 – The larger scale of restoration considered would include the remaining 621 acres at Big Break. In-water placement of material would be required to increase elevations to tidal range. Increment 2 is shown below in purple.

Figure 3-4. Big Break Measure

Restore Intertidal Habitat with Subsidence Reversal at Little Franks Tract and Franks Tract (see Figure 3-5)

Restore habitat value to native species through subsidence reversal and subsequent restoration of intertidal habitat in the flooded Little Franks Tract and Franks Tract. This location was selected because it is in close proximity to potential fill material, would likely require less fill material than other locations in the vicinity, and would have no impacts to population centers or infrastructure. Three scales of this measure were included for evaluation:

- Increment 1 – The minimal restoration considered would include 319 acres of tidal habitat restoration at Little Franks Tract. In-water placement of material would be required to increase elevations to tidal range. Increment 1 is shown below in orange.
- Increment 2 – The next larger scale of restoration considered would include 862 acres along the remnant levee on the northern edge of Franks Tract. In-water placement of material would be required to increase elevations to tidal range. Increment 2 is shown below in purple.
- Increment 3 – The largest scale of restoration considered would include the remaining 2,595 acres of Franks Tract. In-water placement of material would be required to increase elevations to tidal range. Increment 3 is shown below in blue.

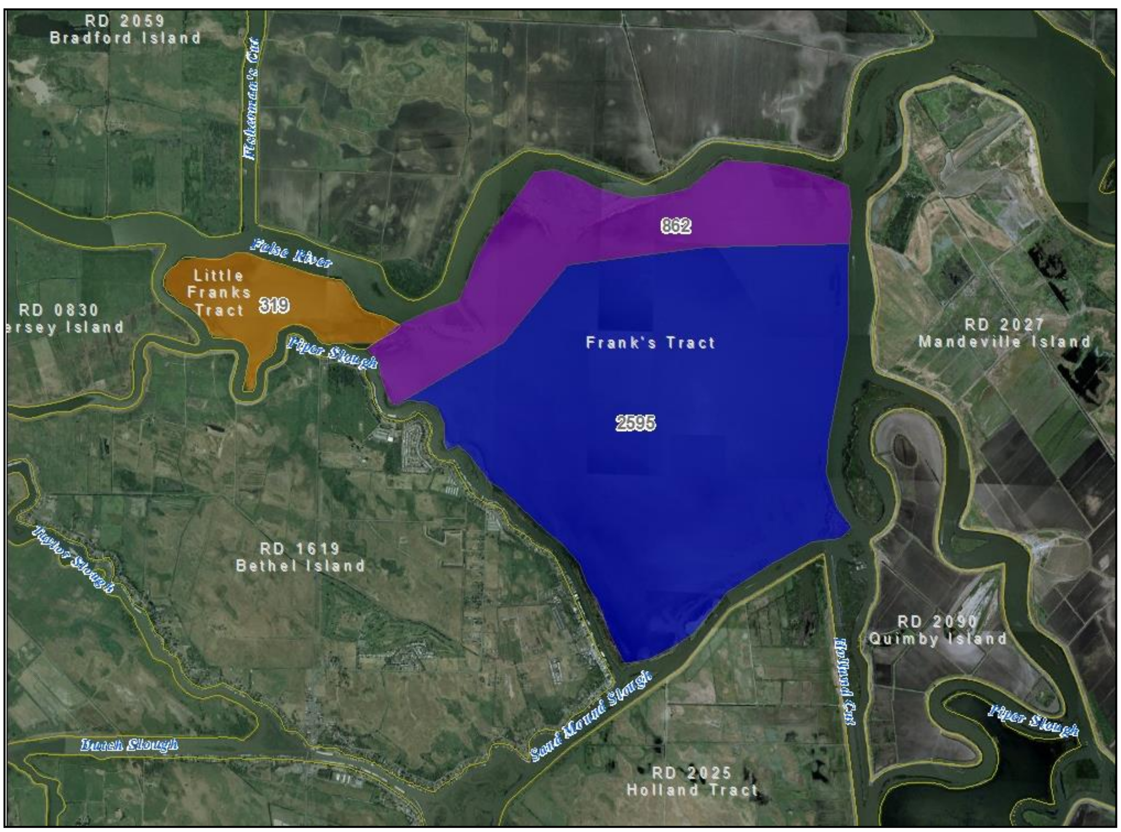

Figure 3-5. Little Franks Tract and Frank's Tract Measure.

Restore Stream Connectivity and Riparian Habitat with Setback Levees at Steamboat and Sutter Sloughs (see Figure 3-6)

Restore connectivity/habitat to improve channel margin habitat through floodplain restoration including setback levee construction. This location was selected because it is in close proximity to (likely more limited) potential fill material, could require less fill material than other locations in the vicinity, and would have limited impacts to population centers or infrastructure. Four scales of this sub-measure were included for evaluation:

- Increment 1 – The minimal restoration considered at Steamboat and Sutter Sloughs would include 0.4 miles of setback levee on the northern most tip (at the southern extent of the Elk Slough restoration) of Sutter Island to improve connectivity between Sutter and Steamboat Sloughs and the Sacramento River through the restoration of 66 acres of riparian habitat. Increment 1 is shown below in orange.
- Increment 2a – This configuration of the next larger scale of restoration would include the adjacent 1,967 acres of Sutter Island (extending from the north to just south of Miner Slough), 732 acres on the southern tip of Netherlands (on the north bank of Miner Slough), and 1,217 acres on the northern tip of Ryer Island (on the south bank of Miner Slough). This 3,916 acre increment would connect the Elk Slough restoration to Steamboat Slough and Miner Slough, as well as existing and planned habitat areas on Prospect Island. This increment would require a 0.6 mile setback levee across Sutter Island, a 2.1 mile levee across the southern tip of Netherlands, and a 1.9 mile setback levee on the northern tip of Ryer Island. Increment 2a is shown below in purple hatch.
- Increment 2b – This configuration of the next larger scale of restoration would include all of Sutter Island (an additional 2,449 acres in addition to the 66 acres in Increment 1), as well as a 956 acre corridor (approximately 1,000 ft wide) along Steamboat Slough on Ryer Island requiring 7 miles of setback levee. This 3,405 acre increment would connect the Elk Slough restoration to Steamboat Slough and the Sacramento Deep Water Ship Channel (DWSC) at their confluence with the Sacramento River, restoring a corridor which could serve as an alternative migratory pathway for endangered salmon and Delta smelt. Increment 2b is shown below in purple hatch.
- Increment 3 – The maximum restoration considered would be implemented in conjunction with Increment 2b and would increase the restoration corridor on Ryer Island by 2,197 acres, requiring a 5.6 mile of setback levee. Additionally, 2,251 acres would be restored on the opposite bank of Steamboat Slough on Grand Island, requiring a 6.6 mile setback levee. This 4,448 acre increment would provide additional acres of restored habitat and connect the restoration to existing and planned restoration on the southwest tip of Grand Island at the confluence of the Sacramento River. Increment 3 is shown below in blue.

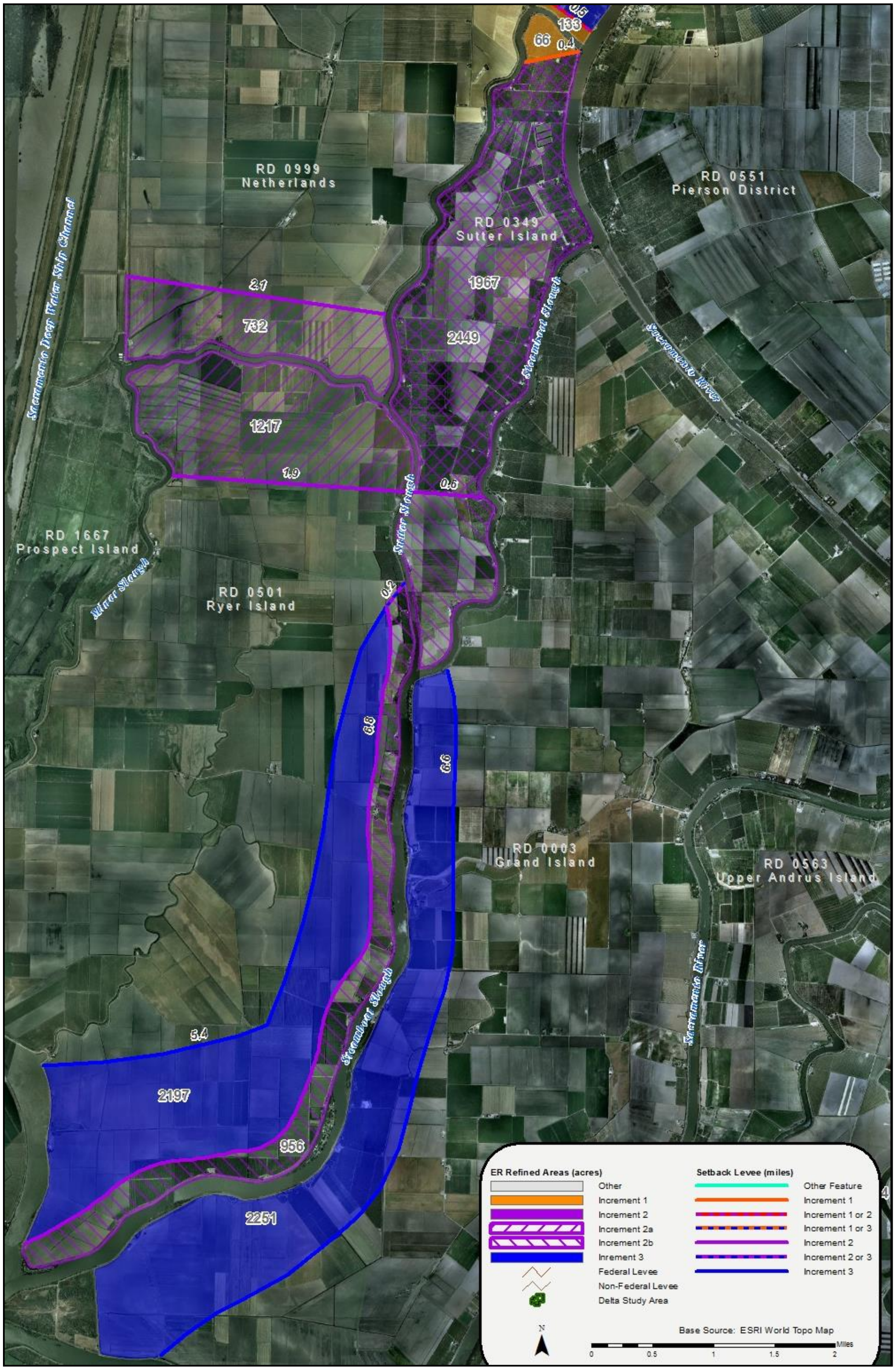

Figure 3-6. Steamboat and Sutter Sloughs Measure

Restore Riparian/Intertidal Habitat, Floodplain Access, and Subsidence Reversal along the South Mokelumne River (see Figure 3-7)

Increase floodplain connectivity through the use of gates or setback levees. This location was selected because it would have limited impacts to population centers or infrastructure and could provide connectivity to existing habitat. Four scales of this measure were included for evaluation:

- Increment 1 – The minimum restoration considered for this measure includes 3,530 acres of riparian/intertidal habitat along the South Mokelumne River, requiring 7.3 miles of setback levees on four tracts. This increment would extend other existing and planned adjacent habitat areas to the north (Cosumnes Preserve, McCormack-Williamson Tract, Staten Island, and other BDCP/CA WaterFix/EcoRestore proposed habitat areas). Increment 1 is shown below in orange. Portions of the following tracts would be included in this increment:
    - New Hope Tract – 563 acres of riparian/intertidal habitat, 2.4 miles of setback levee.
    - Canal Ranch – 868 acres of riparian/intertidal habitat, 2 miles of setback levee.
    - Brack Tract – 1216 acres of riparian/intertidal habitat, 1.4 miles of setback levee.
    - Terminous Tract – 883 acres of riparian/intertidal habitat, 1.5 miles of setback levee.
- Increment 2 – The next increment under consideration would extend Increment 1 south toward the San Joaquin River and would add an additional 1,217 acres of riparian/intertidal habitat, requiring 3.7 miles of three setback levees on two tracts. Two separate setback levees would be constructed on Terminous Tract. The eastern Terminous Tract habitat area would span 118 acres and would require a 0.5 mile setback levee. The southern Terminous Tract habitat area would encompass 471 acres and would require a 1.3 mile setback levee. The third habitat area in this increment includes the 628 acres on the eastern most portion of Empire Tract and would require a 1.9 mile setback levee. Increment 2 is shown below in purple.

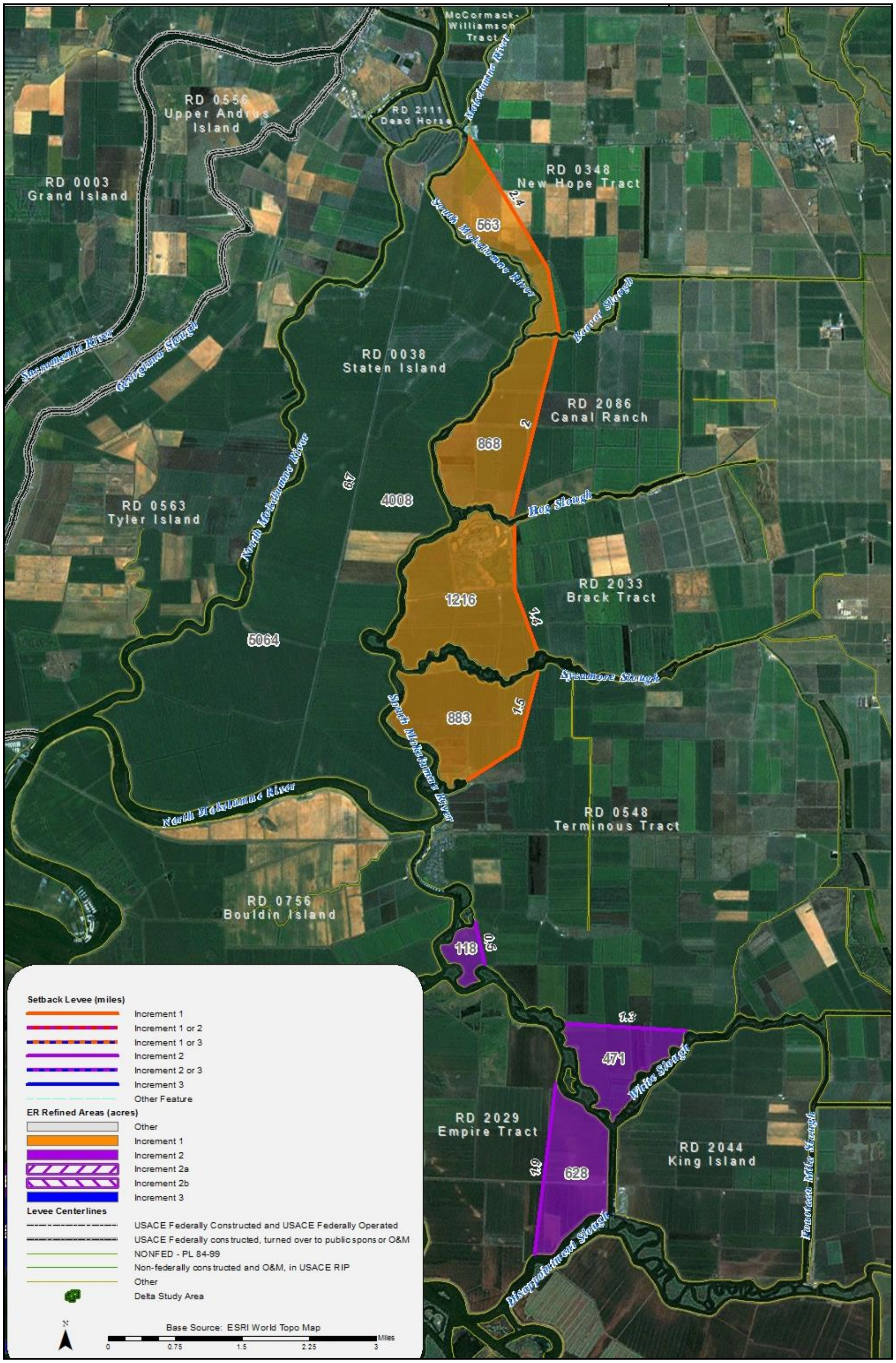

Figure 3-7. South Mokelumne River Measure

Restore Riparian/Intertidal Habitat and Floodplain Access with Subsidence Reversal at Medford Island (see Figure 3-8)

Increase floodplain habitat through subsidence reversal and subsequent restoration of riparian and intertidal habitat. This location was selected because it is in relatively close proximity to potential fill material, would have limited impacts to population centers or infrastructure, and could provide connectivity to existing habitat. Two scales of this measure were included for evaluation:

- Increment 1 – The minimum restoration considered for this measure includes 14 acres of subsidence reversal and subsequent restoration of intertidal and riparian habitat on the southeastern portion of Medford Island surrounded by an existing mitigation habitat area/preserve (approximately 200 acres). Increment 1 is shown below in orange.
- Increment 2 – The maximum restoration considered for this measure would include subsidence reversal and subsequent restoration of intertidal and riparian habitat on an additional 664 acres of Medford Island. This increment would restore Medford Island in its entirety, as approximately 512 acres of the island have already been restored through mitigation efforts. Increment 2 is shown below in purple.

Figure 3-8. Medford Island Measure

Additional Ecosystem Restoration Measures Considered

The following site-specific measures were considered, but dropped from further evaluation for the reasons noted.

- *Restore Stream Connectivity and Riparian Habitat with Setback Levees at Elk Slough.* Restore connectivity/habitat to improve channel margin habitat through floodplain restoration including setback levee construction. Upon investigation, it was determined that this action is currently under consideration in the BDCP/CA WaterFix/EcoRestore and is therefore part of the future-without project condition. For this reason, it was dropped from further consideration.
- *Restore Floodplain/Bypass at Paradise Cut.* Widen access to floodplain to increase capacity and improve hydraulic conditions to benefit native species (consideration must be taken to avoid migration of fish into State and Federal Water Projects due to the proximity to these facilities). Upon investigation, it was determined that this action is currently under consideration in the BDCP/CA WaterFix/EcoRestore and is therefore part of the future-without project condition. For this reason, it was dropped from further consideration.
- *Creation of Bypass at Prospect Island.* Increase floodplain connectivity through the use of gates or setback levees. Upon investigation, it was determined that this action is currently under consideration in the BDCP/CA WaterFix/EcoRestore and is therefore part of the future-without project condition. For this reason, it was dropped from further consideration.
- *Restore Intertidal/Riparian Habitat, Floodplain Access, and Subsidence Reversal at Staten Island: Mokelumne River*. Increase floodplain connectivity through the use of gates or setback levees. Upon investigation, it was determined that this action is currently under consideration in the BDCP/CA WaterFix/EcoRestore and is therefore part of the future-without project condition. For this reason, it was dropped from further consideration.
- *Restore Intertidal/Riparian Habitat, Floodplain Access, and Subsidence Reversal at 8 Western Islands.* Increase floodplain connectivity through the use of gates or setback levees. Although this general measure would contribute to the ER objective, the location of the 8 western islands was discussed due to its importance to the water delivery system rather than ER objectives. Other areas were identified for more suitable application of this general measure. Therefore, this site-specific measure was dropped from further consideration.
- *North Delta Bypass: Glide District and Netherlands.* Increase floodplain connectivity through the use of gates or setback levees to connect the shortest reach of landscape between the Sacramento River and the Yolo Bypass and include crossing the Sacramento Deepwater Ship Channel. This measure could provide flood risk benefits for the city of West Sacramento, the Pocket area and Sacramento downtown, and potentially Clarksburg, Hood, Courtland, Walnut Grove, Ryde, and

Isleton on the Sacramento River downstream of the bypass and would provide additional access and connectivity to the floodplains of Yolo Bypass under specific flood conditions. Although this measure could contribute to the ER objective under certain operation criteria, the primary formulation objective would be for FRM for areas outside of the study area. For this reason, this site-specific measure was dropped from further consideration.

Screening of Ecosystem Restoration Measures

In order to ensure that only implementable measures with a reasonable chance of achieving a significant increase in habitat value at a reasonable cost were included in the final array of alternatives, criteria were established to further screen these detailed measures. The criteria used to screen detailed ER measures are described below:

- *Land Availability Concerns.* Due to high value agricultural crops, competing land uses and interests in the Delta, and the ongoing land issues associated with the BDCP/CA WaterFix/EcoRestore project, land availability is a major concern for implementing ER. Some areas have been in agriculture for generations, with the owners having no interest in selling even a portion of the land. Short of exercising eminent domain, these lands will not be available in the foreseeable future. Use of eminent domain to acquire large areas of private land for single-purpose ER that could be implemented elsewhere is generally not considered to be acceptable. Additionally, some very high value crops lands (i.e. vineyards) would be cost prohibitive to acquire even if there were willing sellers. A qualitative risk ranking of High (not likely to have a willing seller), Medium (likely to have a willing seller), or Low (public/state ownership) has been assigned to each measure based on input from non-Federal sponsor staff with extensive experience concerning Delta land acquisition and availability.
- *Likely Effects on Water Rights.* For any of the measures that involve diverting water or creating fish passage facilities or setback levees, an evaluation of water rights will be required for any additional water that would be needed during the non-flood season. Most of the water in the Sacramento River is either Federal CVP water or SWP water and there may not be "extra" water from the river for restoration or fish passage purposes.
- *Impacts to Existing Habitat.* In order to implement restoration, modifications to the existing habitats would likely occur. In some cases, good to high quality habitat along the slough's edge that could be adversely impacted through the restoration activities. In order to avoid these impacts, a qualitative ranking of High (likely to adversely impact existing habitat), Medium (may adversely impact existing habitat), or Low (not likely to adversely impact existing habitat) has been assigned to each measure based general information about the sites and input from the non-Federal sponsor.

- *Gross Relative Real Estate Cost.* The acquisition cost for necessary property rights is likely to represent a major element of overall project costs. . In order to avoid unrealistic consideration of areas for restoration with unrealistic real property acquisition costs, a general ranking of High (purchase of private lands with likely exponentially higher costs), Medium (purchase of private lands required), or Low (public/state ownership of lands) has been assigned to each measure based on general land use information and input from the non-Federal sponsor.
- *Gross Relative Construction Cost.* Construction costs vary greatly between the measures under consideration, largely driven by the necessity of setback levees at some locations and distances from sources of dredged material. In order to screen out measures that would have exponentially higher construction costs for similar benefits, parametric cost estimates were developed for each measure. Costs included active restoration costs and levee construction costs, as these were anticipated to be the drivers in relative costs per acre (other costs were anticipated to be relatively similar for each site). A summary of these parametric cost estimates is shown in Table 3-12.
- *Likely to Require Mitigation for Flood Impacts.* Changes to the system hydraulics would likely result from some ER measures under consideration. Some measures would have a higher likelihood of resulting in upstream or downstream impacts that would require hydraulic mitigation that could increase costs without providing additional ER benefits. In order to screen out measures that would most likely have high hydraulic mitigation costs for similar benefits, a general ranking of High (extensive levee work likely required), Medium (some levee work likely required), or Low (not likely to require hydraulic mitigation) has been assigned to each measure based general information about the site.

Table 3-12. Relative Parametric Costs of Detailed Ecosystem Restoration Measures

Site	Increment	Acres	Volume (CY)	Total Subsidence Reversal Costs (1,000s)	Levee Costs (1,000s)	Contouring and Revegetation Costs (1,000s)	Total (1,000s)	Total Cost Per Acre	Annualized Cost Per Acre
Big Break	1	62	231,347	$11,567	$0	$1,008	$12,575	$202,823	$9,000
Big Break	2	621	2,317,204	$173,790	$0	$10,091	$183,881	$296,105	$13,000
Little Franks Tract	1	319	1,701,435	$127,608	$0	$5,184	$132,792	$416,276	$19,000
Franks Tract	1	862	4,782,997	$358,725	$0	$14,008	$372,733	$432,405	$19,000
Franks Tract	2	2,595	14,398,928	$1,439,893	$0	$42,169	$1,482,062	$571,122	$25,000
Medford	1	14	225,867	$11,293	$0	$228	$11,521	$822,929	$37,000
Medford	2	664	10,712,533	$1,071,253	$0	$10,790	$1,082,043	$1,629,583	$73,000
Steamboat/Sutter	2a	3916	63,178,133	$6,317,813	$517,253	$346,540	$7,181,606	$1,833,914	$82,000
Mokelumne	1	3530	56,950,667	$5,695,067	$624,694	$375,450	$6,695,211	$1,896,660	$85,000
Steamboat/Sutter	3	4448	71,761,067	$7,176,107	$1,120,377	$533,120	$8,829,604	$1,985,073	$88,000
Steamboat/Sutter	2b	2449	39,510,533	$3,951,053	$551,842	$299,185	$4,802,080	$1,960,833	$87,000
Mokelumne	2	1217	19,634,267	$1,963,427	$279,433	$153,105	$2,395,965	$1,968,747	$88,000
Steamboat/Sutter	1	66	1,064,800	$79,860	$23,373	$9,716	$112,949	$1,711,348	$76,000

2012 price level; annualized at FY2013 discount rate (3.75%; 50-yr.)

The applications of these screening criteria to the detailed measures are shown below in Table 3-13. All measures not showing an "L" for "Low Risk" in each of the six listed criteria are dropped from further consideration. Restoration of flooded islands (Big Break, Little Franks Tract, and Franks Tract) clearly ranked the highest of all ER measures against these criteria and will be retained for further evaluation.

Table 3-13: Screening of Detailed Ecosystem Restoration Measures

Measure	Land Availability Concerns	Likely Effects to Water Rights	Impacts to Existing Habitat	Gross Relative Real Estate Cost	Gross Relative Construction Cost	Likely to Require Mitigation for Flood Impacts
Restore Intertidal Habitat with Subsidence Reversal at Big Break	L	L	L*	L	L	L
Restore Intertidal Habitat with Subsidence Reversal at Little Frank's Tract	L	L	L*	L	L	L
Restore Intertidal Habitat with Subsidence Reversal at Frank's Tract	L	L	L*	L	L	L
Restore Riparian/Intertidal Habitat, Floodplain Access, and Subsidence Reversal at Medford Island	H	M	L	M	M	L
Restore Riparian/Intertidal Habitat, Floodplain Access, and Subsidence Reversal along the South Mokelumne River	H	H	L	M	H	M
Restore Stream Connectivity and Riparian Habitat with Setback Levees at Steamboat and Sutter Sloughs	H	H	M	H	H	M

* Although restoration of these flooded islands would restore native habitat, it should be noted that the area currently is popular for (invasive) bass fishing; restoration would require coordination with interested parties

Final Ecosystem Restoration Measures

The following three ER measures were retained as viable candidates after conclusion of all screenings: restoration of intertidal habitat with subsidence reversal at Big Break, or Franks Tract, or Little Franks Tract. Detailed descriptions and final increments of these measures follow. Costs developed for screening purposed were refined; therefore, costs shown in subsequent report sections will vary from those shown in Table 3-12.

Prior to levee construction circa 1900, Big Break, Franks Tract, and Little Franks Tract were comprised of intertidal marsh. Levees were constructed to drain the lands for agricultural use, resulting in subsidence of the land surface due to compaction, oxidation, and wind erosion. Multiple levee failures occurred in the early to mid-20th Century and these areas were eventually not reclaimed (Big Break in 1928, Franks Tract in 1938, and Little Franks Tract in 1983); however, enough subsidence had already occurred that these open water expanses now function ecologically as lakes, providing no value to native species. As these areas are no longer dry, subsidence has essentially halted.

The primary action required to restore habitat value to native species at Big Break, Franks Tract, and Little Franks Tract is the reversal of subsidence that occurred while the lands were dry/reclaimed. Similar restoration actions were undertaken by USACE in the 1990s at nearby Venice Cut and Donlon Island. This restoration has demonstrated that subsidence reversal to restore land surface to intertidal elevations, along with minimal plantings, can produce successful restoration of intertidal marsh with 80 percent vegetation coverage within 2 years. Historical subsidence was reversed at these sites through the placement of dredged material; further subsidence has not taken place. Measures considered at Big Break, Franks Tract, and Little Franks Tract are based on the success of these reference sites. Donlon Island provides a physical model that shows the proposed plan is physically feasible, reducing the need for further advanced modeling and quantitative analysis during feasibility level design. Numeric and computer modeling could be performed during the Preconstruction, Engineering, and Design (PED) phase to design the project, using Donlon Island as an example.

Subsidence Reversal

Studies conducted on reference sites at Donlon and Venice Cut Islands indicate that optimum intertidal marsh habitat (i.e., where vegetative cover is greater than 75 percent) is found at elevations ranging from approximately -1 ft to + 1 ft mean tide level (~3 ft to 5 ft North American Vertical Datum of 1988 (NAVD)). Therefore, using a conservative approach for estimating quantity of fill, a target elevation of +0.5 ft mean tide level (4.5 feet NAVD) was initially assumed in order to estimate fill quantities for comparison of alternative sites.

Current elevations vary from site to site, resulting in differing requirements for volume of material per acre to reach the target elevation. Intertidal marsh restoration at Big Break (1,064 acres of marsh with an additional 15 percent of open water) would require 12.7 million cubic yards of material, or 9,400 cubic yards of material per acre. Intertidal marsh restoration at Little Franks Tract (273 acres of marsh with an additional 15 percent of open water) would require 4.6

million cubic yards of material, or 16,800 cubic yards of material per acre. Intertidal marsh restoration at Franks Tracts (2,470 acres of marsh with an additional 15 percent of open water) would require 42.6 million cubic yards of material, or 17,200 cubic yards of material per acre.

Increments were developed for each site based on availability and proximity of fill material, as this is the primary driver in restoring ecological function and the primary driver of cost. Based on monitoring results from the Donlon Island and Venice Cut reference sites, placement of fill material to the appropriate elevations, followed by minimal plantings are expected to be the only required actions needed to restore intertidal marsh. As elevations are relatively constant within each site, calculations were made to determine the volume of fill needed per acre at each site. Volumes of available material were matched to the most efficient potential site. Potential sources of material include:

- *Direct placement from Operations and Maintenance dredging of the Stockton DWSC* – assumes normal hydraulic dredging operations with suspended material directly placed into the restoration area(s) via pipeline and contained in an enclosed area surrounded by either existing high ground (remnant levees) or sacrificial hay bales and silt curtains to allow suspended material to settle and water to filter through the silt curtains prior to exiting the site back into the waterways;
- *Pumping previously dredged material from nearby stockpiles* – use previously dredged material in nearby stockpiles by creating a slurry that can be pumped into the restoration area(s) via pipeline and contained in an enclosed area surrounded by either existing high ground (remnant levees) or sacrificial hay bales and silt curtains to allow suspended material to settle and water to filter through the silt curtains prior to exiting the site back into the waterways; and
- *Trucking and/or barging material from borrow sites within a 30 mile radius* – truck and/or barge material from borrow sites within a 30 mile radius and place material into the restoration area(s) either directly from trucks (where possible) or via excavators on barges into an enclosed area surrounded by either existing high ground (remnant levees) or sacrificial hay bales and silt curtains to allow suspended material to settle and water to filter through the silt curtains prior to exiting the site back into the waterways.

Vegetation

The planting design includes installing bulrush (*Schoenoplectus* spp.) which will be suitable to develop intertidal marsh habitat. The particular species of native bulrush selected for planting will be determined by expert examination of local wild plants during detailed design. Plants will be locally harvested and inspected for health, vigor, and correct identification. Plantings will be installed at 3 feet on center over 10 percent of the intertidal marsh area. The plant material may be nursery grown, or collected from nearby sources and directly planted at the site.

Vegetation monitoring surveys at Donlon Island, a similar beneficial use dredged material intertidal marsh restoration project 1.5 miles west of the proposed project, confirmed an 80 percent or greater survival/establishment rate of intertidal marsh vegetation within two years. The intertidal marsh vegetation at the Donlon project was naturally recruited and included cattails as dominant species (USACE and USFWS, 1990). As a result, it is assumed that cattails would also naturally recruit at the restoration site and would not need to be planted.

Additionally, 50 acres of the adjacent existing levee will be treated to remove nonnative vegetation, such as Himalayan blackberry (*Rubus armeniacus*), pampas grass (Cort*aderia selloana*), and, and pepper weed (*Lepidium latifolium*). Following nonnative treatment, the remnant levee would be planted with native riparian vegetation.

Increments

Increments of restoration at each site were developed based on an acre grid system. Available fill material calculations were used to determine the size of increments, i.e., how many grid cells each increment included. It should be noted that the first increments at each site are relatively small, with a large increment for the remainder of the site. This sizing is a product of cost breakpoints associated with available fill material. The smaller increments were developed based on available material that could be transported to the site without major modifications (e.g., construction of a bridge, multiple transfers between trucks and barges, etc.). The larger increment includes the remainder of each site for which a more efficient source of available material could not be identified. Locations of increments are general within each site and are based on proximity to fill material, proximity to remnant levees for improved constructability, and connectivity to existing habitat. Figures 3-9 through 3-11 show increments and available fill material. Table 3-14 provides a summary of all final increments/measures under consideration.

Table 3-14. Final Increments/Measures

BIG BREAK					
INCREMENT	**ACREAGE**	**VOLUME (CY)** [1]	**DEPTH (FT)**	**SOURCE**	**METHOD**
1a	41.9	500,000	6.9	O&M	DIRECT PLACEMENT
1b	41.9	500,000	6.9	O&M	DIRECT PLACEMENT
2	10.4	124,023	6.9	McCORMICK	PUMPING
3	17.6	209,992	6.9	SCOUR	PUMPING
4	0.9	11,263	6.9	AUG. PIT	PUMPING
5	10.4	124,500	6.9	DECKER	PUMPING
6	4.2	49,500	6.9	RIO VISTA	PUMPING
7	978.5	11,666,297	6.9	VARIOUS	TRUCKING/BARGING
TOTAL SUM (1-7)	1105.8	13,185,575			

FRANKS TRACT					
INCREMENT	**ACREAGE**	**VOLUME (CY)**	**DEPTH (FT)**	**SOURCE**	**METHOD**
1	19.7	339,020	10.3	ROBERTS 2	PUMPING
2	119.3	2,053,084	10.3	ROBERTS 1	PUMPING
3	2,331.0	40,255,878	10.3	VARIOUS	TRUCKING/BARGING
TOTAL SUM (1-3)	2,470.0	42,647,982			

LITTLE FRANKS TRACT					
INCREMENT	**ACREAGE**	**VOLUME (CY)**	**DEPTH (FT)**	**SOURCE**	**METHOD**
1	9.2	153,115	9.9	BRADFORD	PUMPING
2	263.9	4,414,248	9.9	VARIOUS	TRUCKING/BARGING
TOTAL SUM (1-2)	273.0	4,567,363			

[1] Volume estimates vary in level of detail based on available historic and projected data. O&M direct placement is projected based on historic volumes placed. Existing placement site volume estimates are based on historic volumes placed.

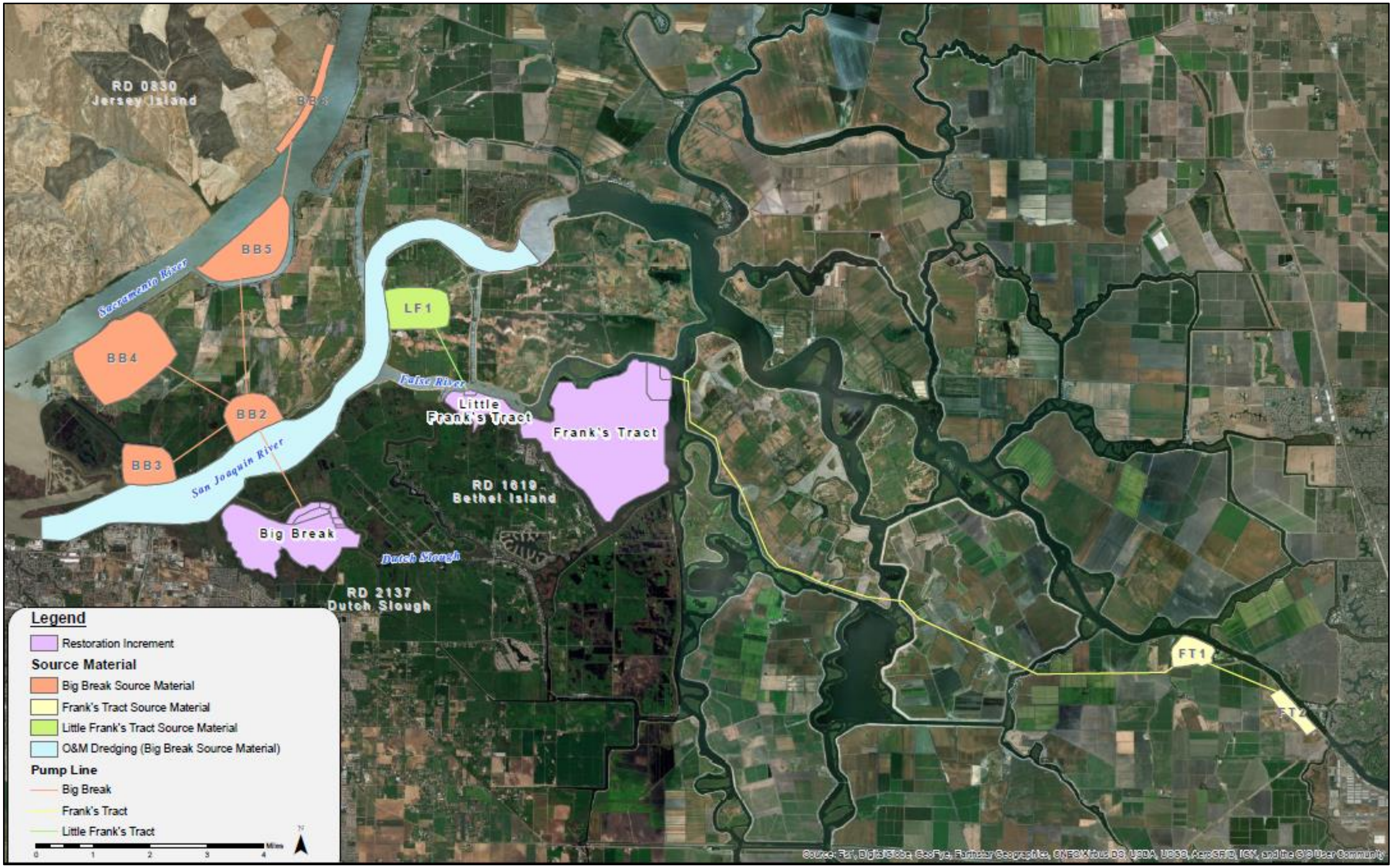

Figure 3-9. Map of Material Availability

Figure 3-10. Map of Big Break Increments

Figure 3-11. Map of Frank's Tract and Little Franks Tract Increments

Preliminary Costs

The overall strategy for generating preliminary costs was to use historical construction methodologies and current day prices for labor, equipment and materials. There are several important assumptions that were used to create the costs, and generally served to create a less conservative estimate of the cost, but were reasonably accepted to be true. The most influential assumptions are related to direct placement dredging: all costs associated with direct placement alternatives up to a distance of 15,000 feet of dredged material pumping are excluded from the cost estimate and will be funded by Federal O&M funds (assume 100,000 cubic yards per year O&M dredging direct placement). Direct placement dredging relative to the O&M measures are not stand alone projects and require full cooperation and partnership with other programs or projects.

The highest level of risk from these assumptions lies in the expectation of a low likelihood of any potential water quality compliance costs to offset or mitigate turbidity that these construction techniques could cause. It is assumed that the deployment of stacked hay bales, or similar technology, will be sufficient and cost effective at the point of placement to prevent a significant increase in water quality compliance costs. The hay bale/silt curtain method is not a complicated methodology, but in tidal conditions, even the assumed robust cross sectional design may not be able to withstand the tidal forces, and may require an even more robust and costly plan. Fortunately, the cost of water quality compliance is 4 to 10 percent of the total project cost, depending on the dredge/pumping increment and will not prohibitively alter the “per acre” cost or the weighted contingency. There is also potential risk to cost increases in trucking/barging material sourcing and water quality compliance for pumping from existing dredged material storage sites.

The second most influential assumption is that moving the slurry pipeline’s discharge point is the only practical means of placing slurried fine-grain material in desired locations. Limited leveling of sand mounds at discharge points may be required if fine sands are also present in the material. Essentially, this reduces the scope of the earthwork to outflow pipe management. These assumptions reduce the exposure to costs for all in water placement through pumping outflow and are considered conservative based upon Project Delivery Team (PDT) discussion. A relatively low contingency of 25 percent was used, which is considered reasonable due to the low complexity of the project's features of work.

The construction methodologies used to generate the cost estimate follow standard industry practices for standard wet and dry earthwork conditions. Earthwork crews were developed in the Micro-Computer Aided Cost Estimating System (MCACES MII) with production quantities pulled from the Cost Engineering Section ProdQuant.xls spreadsheet. The dry earthwork techniques rely primarily on heavy earthmoving equipment including: dozers, scrapers and hydraulic excavators. Pumping costs were generated from an MCACES MII model refined with bid information from multiple contractor proposals for similar work in the immediate area. Pumping techniques require pipes to be laid over land and secured to the river channel bottom as needed to maintain the most direct, cost efficient, and lowest environmental and local impact. The material source sites placing at Big Break are assumed to be dependent on the McCormick dredged material storage site pumping operation in order to create cost savings by utilizing McCormick's infrastructure following completion of its pumping operation. The outflow of the pipe is considered mobile and would be repositioned regularly in order to form sand/silt mounds materials throughout the site. Some leveling of deposited material may be required.

3.5 Formulation of Alternatives

As explained earlier in this chapter (section 3.4.1), the study did not carry forward structural or non-structural FRM measures. Thus, the array of alternatives was formulated for the single purpose of ER. Based on the screening of measures described in previous sections, all increments included in the final array are focused on restoration of intertidal marsh using various forms of subsidence reversal. The formulation strategy is a process of scaling of alternatives. The following Plan Formulation principles were used in development of alternatives:

- Avoid the need for compensatory mitigation
- Keep land acquisition to a minimum
- Maintain Federal participation in monitoring and adaptive management consistent with Federal law and USACE policy. (Section 2039 of WRDA 2007 requires monitoring to determine ecological success and allows for up to 10 years of Federal cost-sharing for monitoring.)

3.5.1 Ecosystem Restoration Alternative Formulation

USACE Institute for Water Resources (IWR) Planning Suite was used to formulate alternatives based on the final increments/measures. Increments/measures were developed and screened such that all measures meet planning objectives and avoid planning constraints. Cost effectiveness and incremental cost analyses (CE/ICA) were performed and generated 9 Best Buy Plans (alternatives) in addition to the no action alternative:

Alternative 1 is the No Action Plan and assumes no Federal action is taken as the result of this study.

Alternative 2 is the restoration of 42 acres of intertidal marsh habitat at Big Break (increment 1a). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 500,000 cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of five years. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $11 million.

Alternative 3 is the restoration of 84 acres of intertidal marsh habitat at Big Break (increments 1a and 1b). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, one million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $23 million.

Alternative 4 is the restoration of 126 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5 and 6). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 1.5 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $61 million.

Alternative 5 is the restoration of 126 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5 and 6) and 10 acres of intertidal marsh habitat at Little Frank's Tract (increment 1). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 1.7 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $69 million.

Alternative 6 is the restoration of 126 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5 and 6), 10 acres of intertidal marsh habitat at Little Frank's Tract (increment 1), and 139 acres of intertidal marsh habitat at Frank's Tract (increments 1 and 2). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 4 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $224 million.

Alternative 7 is the restoration of 1,063 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5, 6 and 7), 10 acres of intertidal marsh habitat at Little Frank's Tract (increment 1), and 139 acres of intertidal marsh habitat at Frank's Tract (increments 1 and 2). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 15.2 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $1,387 million.

Alternative 8 is the restoration of 1,063 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5, 6 and 7), 10 acres of intertidal marsh habitat at Little Frank's Tract (increment 1), and 2,470 acres of intertidal marsh habitat at Frank's Tract (increments 1, 2 and 3). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 55.5 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $6,697 million.

Alternative 9 is the restoration of 1,063 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 5, 6 and 7), 273 acres of intertidal marsh habitat at Little Frank's Tract (increments 1 and 2), and 2,470 acres of intertidal marsh habitat at Frank's Tract (increments 1, 2 and 3). The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 59.9 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $7,253 million.

Alternative 10 is the restoration of 1,063 acres of intertidal marsh habitat at Big Break (increments 1a, 1b, 2, 3, 4, 5, 6 and 7), 273 acres of intertidal marsh habitat at Little Frank's Tract (increments 1 and 2), and 2,470 acres of intertidal marsh habitat at Frank's Tract (increments 1, 2 and 3). Note, Increment 4 adds less than one acre due to small quantity of available dredged material at Augusta Pit. The primary measure included in this alternative is subsidence reversal in order to restore historic elevations appropriate for intertidal marsh habitat. In order to do so, 59.9 million cubic yards of fill material would be placed via direct placement of dredged material from yearly O&M dredging from the Stockton DWSC for a period of ten years and via pumping of previously dredged material. Upon completion of subsidence reversal, the area would be planted with native tidal marsh vegetation (bulrush). The total cost of this alternative is $7,257 million.

A summary of alternatives is provided in Table 3-15.

Table 3-15. Final Array of Alternatives

			Increment												
			Big Break								Frank's Tract			Little Frank's Tract	
	No Action	AAHU *	1A	1B	2	3	4	5	6	7	1	2	3	1	2
Alternative 1	X	0													
Alternative 2		41.3	X												
Alternative 3		82.6	X	X											
Alternative 4		124.5	X	X	X	X		X	X						
Alternative 5		133.5	X	X	X	X		X	X					X	
Alternative 6		270.3	X	X	X	X		X	X		X	X		X	
Alternative 7		1233.5	X	X	X	X		X	X	X	X	X		X	
Alternative 8		3528.2	X	X	X	X		X	X	X	X	X	X	X	
Alternative 9		3787.9	X	X	X	X		X	X	X	X	X	X	X	X
Alternative 10		3788.8	X	X	X	X	X	X	X	X	X	X	X	X	X

Legend (cell shading):
- Direct Placement from O&M Dredging** (columns 1A, 1B)
- Pumping Previously Dredged Material** (Big Break 2–6, Frank's Tract 1–2, Little Frank's Tract 1)
- Trucking and/or Barging from Available Sources** (Big Break 7, Frank's Tract 3, Little Frank's Tract 2)

3.6 Evaluation of Final Array of Alternative Plans

All increments used to formulate alternatives, and therefore all alternatives, were determined to meet Completeness and Acceptability criteria. All alternatives have varying levels of Effectiveness and Efficiency; therefore, cost effectiveness and incremental cost analysis were used to evaluate and compare alternatives, as follows.

A standard Habitat Evaluation Procedure (HEP) was used to quantify outputs for the CE/ICA. The Habitat Suitability Model for the Marsh Wren was used to assess outputs of each alternative. The marsh wren requires emergent herbaceous vegetation, typically cattails and bulrushes for nesting and cover in water greater than 15 centimeters. The intertidal marsh habitat being proposed would meet typical marsh wren requirements and is a scarce habitat type within the Delta. This model was selected because it is a USACE-approved blue book model that has been used in other projects in the area, is focused on the target habitat type, and has been coordinated with the USFWS. USACE planning guidance requires ecosystem models which are certified through the USACE Ecosystem Planning Center of Expertise. The USACE Ecosystem Planning Center of Expertise confirmed that the model has been approved for use. Although the Marsh Wren model provided an appropriate indicator of relative ecosystem outputs for comparison of alternative sites, the Marsh Wren is not the only target species for intertidal marsh restoration.

Model assumptions were developed as the basis for the assessment. The assumption regarding existing and future without-project conditions is that little to no intertidal marsh habitat is or will be present at the sites; therefore, AAHUs without-project are projected at zero. The future with-project assumption is that elevations are restored to support a robust intertidal marsh habitat. HEP outputs are shown in Table 3-16.

Table 3-16. Summary of HEP Outputs by Alternative

ALT	AAHU Without Project	AAHU With Project	Net Change in AAHU
1	0	0.0	0.0
2	0	41.3	41.3
3	0	82.6	82.6
4	0	124.5	124.5
5	0	133.5	133.5
6	0	270.3	270.3
7	0	1233.5	1233.5
8	0	3528.2	3528.2
9	0	3787.9	3787.9
10	0	3788.8	3788.8

3.7 Comparison of Alternative Plans

3.7.1 Cost Effectiveness and Incremental Cost Analysis

Alternatives were compared based on costs and outputs, as well as other criteria such as contribution to planning objectives, environmental factors, completeness, effectiveness, efficiency, and acceptability; all were relatively consistent between alternatives. This comparison was made using IWR Planning Suite to conduct cost effectiveness and incremental cost analysis based on costs (dollars, October 2018 price level) and outputs (marsh wren AAHU). Incremental costs per unit of output were used to identify major breakpoints in cost efficiency among the alternatives. These outputs are shown in Table 3-17 and Figures 3-12 and 3-13[7]. Additional details on cost can be found in the Plan Formulation Appendix.

[7] Figure 3-13 is an enlargement of Figure 3-12, Alternatives 1-8.

Table 3-17. Incremental Cost and Outputs of Alternatives

ALT	Marsh Wren Habitat Output (AAHU)	Total Annual Cost ($1,000)	Average Cost per AAHU ($1000/HU)	Incremental Annual Cost ($1,000)	Incremental Output (AAHU)	Incremental Annual Cost Per AAHU ($1000)
1	0	$0	$0.0	$0	0	$0.0
2	41.3	$434	$10.5	$434	41.3	$10.5
3	82.6	$875	$10.6	$441	41.3	$10.7
4	124.5	$2,320	$18.6	$1,445	41.9	$34.5
5	133.5	$2,634	$19.7	$314	9	$34.9
6	270.3	$8,547	$31.6	$5,913	136.8	$43.2
7	1233.5	$52,671	$42.7	$44,124	963.2	$45.8
8	3528.2	$254,189	$72.0	$201,518	2294.7	$87.8
9	3787.9	$277,876	$73.4	$23,687	259.7	$91.2
10	3,788.80	$278,027	$73.4	$151	0.9	$167.9

October 2018 price level; annualized at FY2018 discount rate (2.75%; 50-yr.)

3.7.2 Contribution of Alternatives to Planning Objectives

All action alternatives achieve the first ER planning objective of increasing area, connectivity, and diversity of native tidal aquatic and related habitats within the study area during the period of analysis. None of the alternatives achieve the second objective, which was to increase area, connectivity, and diversity of non-tidal or riparian habitats, as an effective opportunity did not exist under the assumed future without-project condition. The extent to which alternatives increase area of tidal habitat is the discriminating factor between alternatives. Historically, the Delta was comprised almost entirely of about 350,000 acres of tidal marsh, yet less than 5 percent of this remains. Any contribution to restoring tidal habitat would be seen as beneficial in this ecosystem of national significance. Although more habitat area would be viewed as better from an ecological perspective, the extent of Federal investment will be driven by incremental costs necessary to achieve those additional outputs.

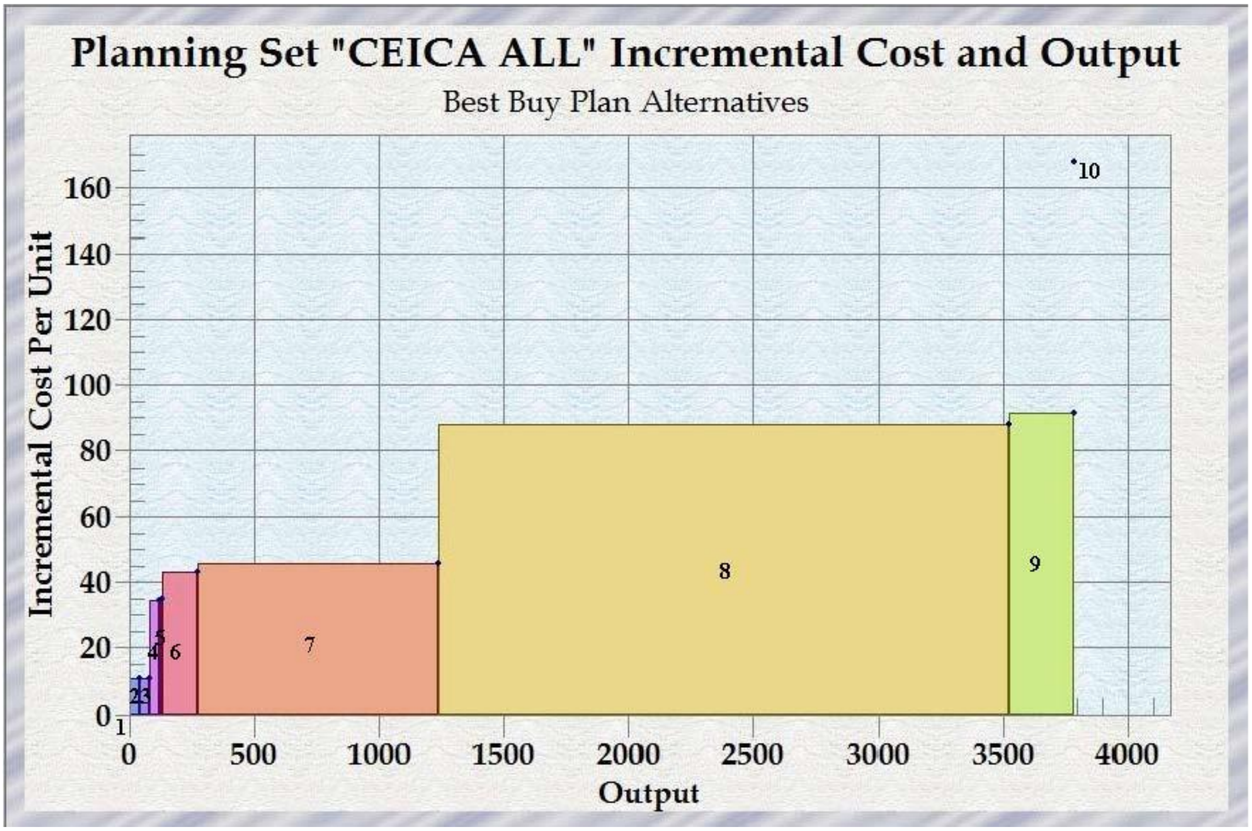

Figure 3-12. Incremental Cost and Outputs of Alternatives 1-10

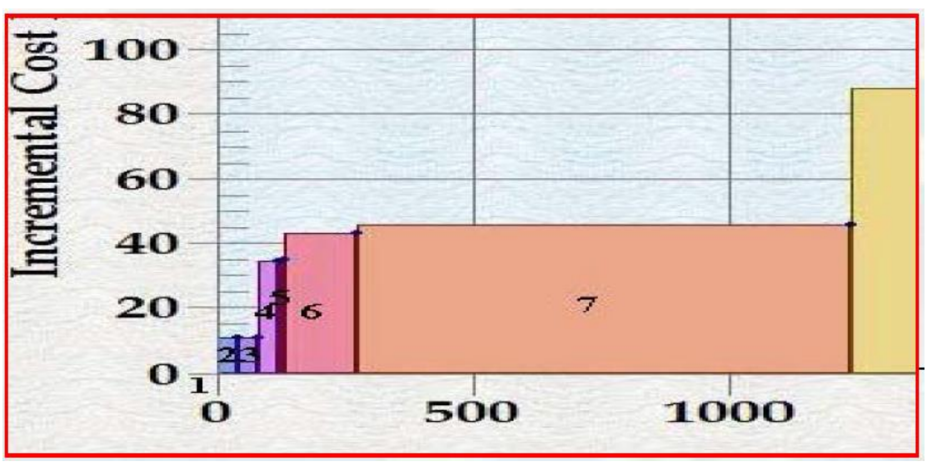

Figure 3-13. Incremental Cost and Outputs of Alternatives 1-8

3.8 Recommended Plan

3.8.1 Plan Selection

A recommendation for plan selection was made by identifying the plan that reasonably maximizes environmental outputs relative to costs while meeting planning objectives and avoiding planning constraints. As all alternatives are cost effective, every alternative achieves the greatest number of outputs for a given cost; therefore, incremental costs per output were used to identify the NER Plan. Plan selection also considered the effects of future sea level rise/climate change on the project, but this was not a distinguishing factor among the alternatives. As all alternatives propose to do similar actions in similar locations, inland hydrology and sea level rise would equally affect all alternatives under consideration.

Outputs increase as alternatives progress (1-10); however, these outputs are achieved at increasingly higher incremental costs. Breaks in incremental cost are found at Alternatives 3, 7, and 9; therefore, these alternatives were identified as the most logical candidates for plan selection. The incremental annual cost increase per AAHU is from $10,700 for Alternative 3 to $45,800 for Alternative 7. This increase is considered to be unreasonable for the outputs achieved. For these reasons, Alternative 3 is the recommended plan. Alternative 3 would consist of restoration of intertidal marsh at Big Break using approximately 1,000,000 cubic yards of maintenance-dredged material from the Stockton DWSC. The area of the restored marsh was initially estimated as 84 acres, but the restoration area was expanded to 340 acres during feasibility level design (see explanation below, at Section 3.8.1).

3.8.2 Feasibility Level Design

Upon selection of the recommended plan, designs and costs were developed to a greater level of detail, as described in Appendix C. Two factors were of particular importance throughout this process. First, additional data and information regarding the composition of dredged material to be used in the recommended plan indicated that the material will be comprised primarily of sand, rather than silt as previously assumed. Sandy material is expected to perform differently during placement than silty material. For example, sandy material is heavier than silty material, so it is expected to settle much faster than silt, which indicates that there would likely be a significantly reduced concern over induced turbidity during placement than previously assumed. Additionally, sandy material will retain its form when placed rather than settling into a fluid, slurry mixture that would require containment in order to secure a plantable elevation for marsh restoration. The sandy material will form into mounds when placed via hydraulic dredging, which allowed the design of the recommended plan to be altered to incorporate varying topography and interwoven channels to provide a greater range of benefits for sensitive species of National importance in the Delta.

Second, building off of the change of substrate and the ability to incorporate interwoven channels into the designs, the target design elevation was refined from the assumptions used in the draft report. The draft report incorporated a target elevation that considered optimizing marsh wren HEP outputs consistent with the design approaches from Donlon Island. Since the change in substrate enabled more control and flexibility over the design approach, the team conducted a review of design considerations with a goal of ensuring that the feasibility level of design would be developed using a more diverse, multi-species, ecosystem approach. The considerations reviewed included looking at the optimal elevation for establishing marsh vegetation, a review of the lessons learned from Donlon Island, a review of the HEP criteria for marsh wren, and a review of appropriate target elevations for various life stage uses for Delta smelt and juvenile salmonid and sturgeon, Federally-listed fish species of National significance in the Delta. Ultimately, in reviewing these data a decision was reached to decrease the initial overall target elevations.

Specifically, the design elevation was decreased to provide Delta smelt spawning habitat, juvenile salmonid and sturgeon foraging habitat, and to ensure that aquatic marsh vegetation species will adequately establish throughout the site. In addition, the primary criticism of the Donlon Island monitoring reports was noting a need to provide more water circulation through the site in order to provide for better water quality and conditions less optimal for non-native aquatic vegetation establishment.

These factors described above would apply equally to all alternatives under consideration in this study; therefore, previous evaluations and comparisons of alternatives were not revisited. The alternatives include three sources of material for subsidence reversal: direct placement from O&M dredging operations, previously dredged stockpiled material, and a gross assumption of trucking/barging similar material from a 30 mile radius. All material sourced from direct placement from O&M dredging operations is included in the Recommended Plan. The ultimate source of stockpiled material under consideration in the array of alternatives is dredging of the same channels; therefore, the material type would be similar to that of direct placement from O&M dredging operations. Although there could be some detailed differences in these materials due to settlement at the placement site, etc., the assumption that these material types are generally similar is a reasonable assumption for alternative selection. The third material source (trucking/barging) generally assumes that the same type of material utilized for the other restoration increments would be sought in order to restore a continuous habitat with similar design. Because material types are the same, expansion in footprint due to the detailed designs would be proportional to all other alternatives under consideration. Additionally, target elevations would apply to all areas under consideration for all alternatives.

These refined design characteristics resulted in an increase in the size of the restoration area from 84 acres to 340 acres due to the varying topography, interwoven channels, and decrease in target elevations. Of the 340 acres, 90 acres would be planted with marsh vegetation species and the remaining 250 acres would be interwoven channels providing shallow water habitat benefits to fish species. The HEP outputs for the Recommended Plan have been quantified as 111.44 average annual habitat units (AAHUs) with the marsh wren model;

however, it should be noted that the marsh wren model does not quantify the benefits associated with the shallow water habitat benefits for fish species, which accounts for 250 of the 340 acres. These benefits are described further in the Special Status Species analysis in Section 5.3, as well as the Regional Benefits discussion in Section 8.1.2.

The estimated first cost of the Recommended Plan has changed from $23M to $25M; however, the annual cost per acre has decreased from $274,000 to $74,000 due to these design refinements. The remainder of this report is based on the feasibility level design. Figure 3-14 shows the revised footprint of the recommended plan based on feasibility level design.

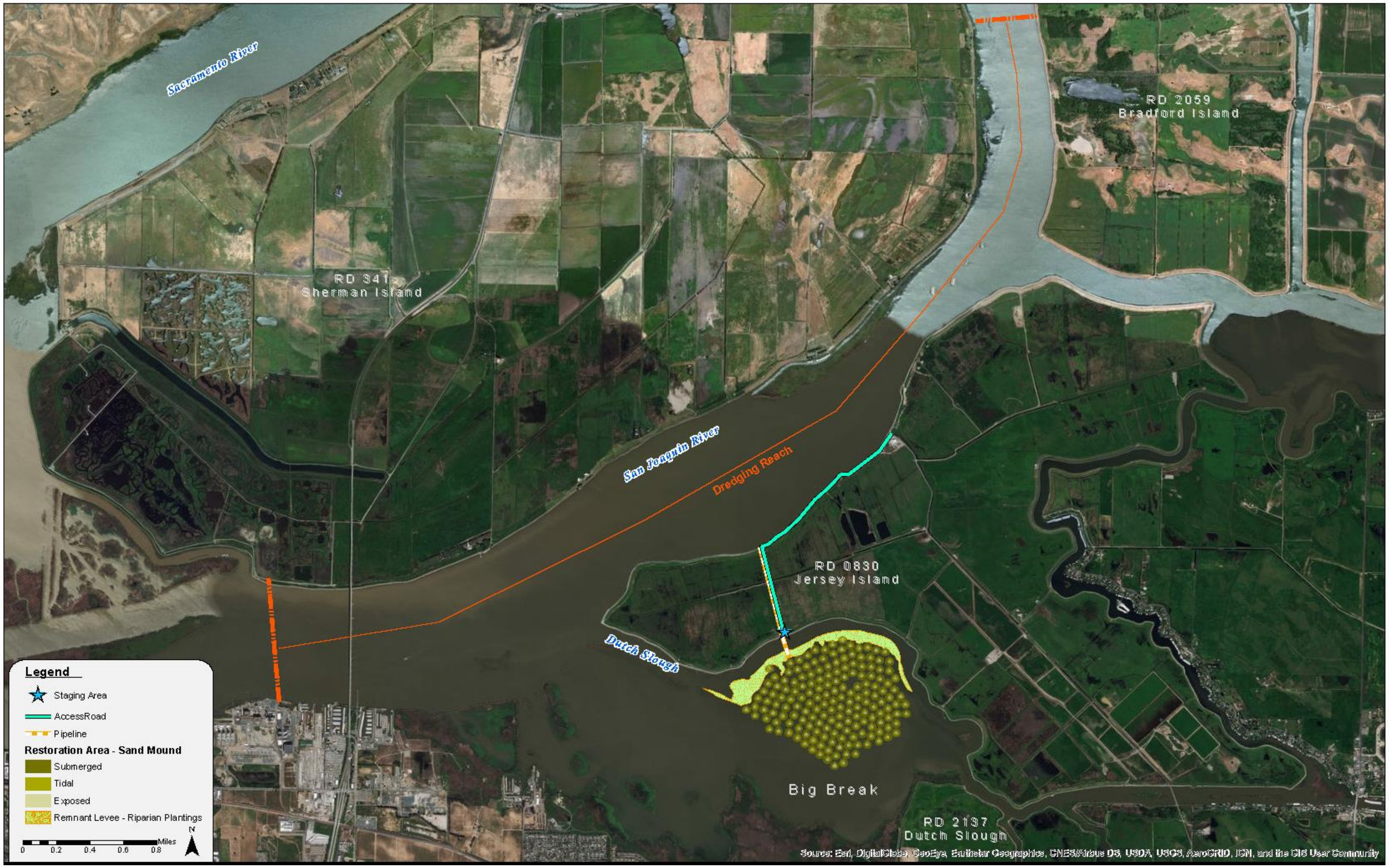

Figure 3-14. Recommended Plan (Alternative 3)

3.9 NEPA Project Description

NEPA compliance requires a greater level of detail than plan selection in order to fully analyze the potential effects of the proposed alternatives on the natural and human environment. Chapter 4 includes a description of the affected environment in the study area, followed by Chapter 5, which includes a discussion of the potential environmental effects of the proposed alternatives that are described below.

3.9.1 Alternatives not Considered in Detail

While the final array of alternatives for the CE/ICA was developed using preliminary design assumptions, the feasibility level design described above was only applied to Alternatives 2 and 3. As a result, the remaining alternatives have been screened from consideration in the final NEPA analysis, including the former preferred alternative from the draft EIS.

Alternatives 4 through 10 were eliminated through the CE/ICA process, because material acquisition from the land-based dredged material placement sites was cost prohibitive. As a result, the remaining alternatives in the NEPA analysis include Alternative 1 (No Action), Alternative 2 (160 acres of restoration), and Alternative 3 (340 acres of restoration). Alternative 3 is the Selected Plan and is also the Environmentally Preferred Alternative.

3.9.2 NEPA Action Alternatives

<u>Alternative 1 – No Action</u>

Under the no action alternative, USACE would not participate in ER in the project area as part of the Delta Islands and Levees Feasibility Study. Dredged material would continue to be placed at the dredged material placement sites on dry land and would not be beneficially used. The ecosystems of the Delta, as represented by the project area, could continue to degrade over time, with the associated decline and loss of Delta habitats and species. The no action alternative would not meet the planning goal to restore sustainable ecosystem functions in the Delta.

As discussed in Section 3.3, this feasibility study currently assumes that the features of the California WaterFix and EcoRestore as proposed by the State in concert with other State, Federal, and local agencies would be in place. WaterFix and EcoRestore involve implementing ER activities throughout the Delta to offset habitat losses and declines. The cumulative benefits of those restoration and mitigation activities would benefit the greater Sacramento-San Joaquin Delta region. However, no specific State restoration activities are proposed for the action area discussed in this study.

Ecological characteristics, such as spatial extent, habitat heterogeneity, and dynamic storage, could remain substantially altered as a result of past and present land use and water management practices in the Delta. Fragmentation and loss of shallow open waters, tidal marsh, and shaded riverine aquatic habitats due to past channelization and construction of levees are likely to remain, as would the separation of historic floodplains from natural hydrologic flooding events through the channels in the Delta.

This continuing loss and fragmentation of habitats could provide reduced habitat values, thus supporting fewer numbers and types of both plant and animal species. Native species, including Federally listed threatened, endangered, and proposed species, such as Antioch Dunes evening-primrose, Delta smelt, and salmonids, are likely to decline in overall health and numbers due to degraded soil and water quality conditions. In addition, degraded conditions have led to the introduction and propagation of non-native invasive species such as egeria and water hyacinth that out-compete and replace native species for limited resources.

Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Alternative 2 includes only Big Break increment 1a using O&M dredging over a five year period to create approximately 160 acres of intertidal marsh habitat. Of the 160 acres, approximately 45 acres would be planted with aquatic vegetation, and the remaining 112 acres would be shallow water habitat for aquatic fauna species. Dredged material would be acquired from O&M activities in the San Francisco Bay to Stockton DWSC between approximately station points 400+00 and 850+00 (Figure 3-15). Big Break is owned and managed by the East Bay Regional Park District as part of Big Break Regional Shoreline. Dredged material would be directly pumped to the restoration site, rather than the usual land-based dredged material placement sites. A chemical and granular composition analysis of the materials would be conducted in advance of placement. For the purposes of the NEPA analysis, project construction is estimated to begin in the fall of 2020.

The environmental effects of the hydraulic dredging and the piping of material to a placement site are an ongoing USACE maintenance operation that is covered under the Stockton DWSC Maintenance Dredging and Bank Protection Project, California (O&M Dredging Project). USACE is currently updating the NEPA analysis for the O&M Dredging Project, with a draft environmental analysis anticipated to be released for public review in 2018. In addition, USACE has updated its programmatic consultation with both USFWS and NMFS under section 7(b) of the Endangered Species Act (FESA) of 1973 (16 U.S.C §1531 et seq. and implementing regulations at 50 C.F.R. Part 402). NMFS issued a final 10-year programmatic biological opinion (BO) on June 3, 2016 (Refer to NMFS No: WCR-2016-4548, Division Chon File: ARN#151422-WCR2015-SA00150). USFWS issued a final 5-year programmatic BO on July 31, 2017 (Refer to USFWS File # 08FBDT00-2017-F-0098). In addition, annual permitting occurs with the Central Valley Regional Water Quality Control Board (CVRWQCB) and California Department of Fish and Wildlife (CDFW) prior to each dredging season.

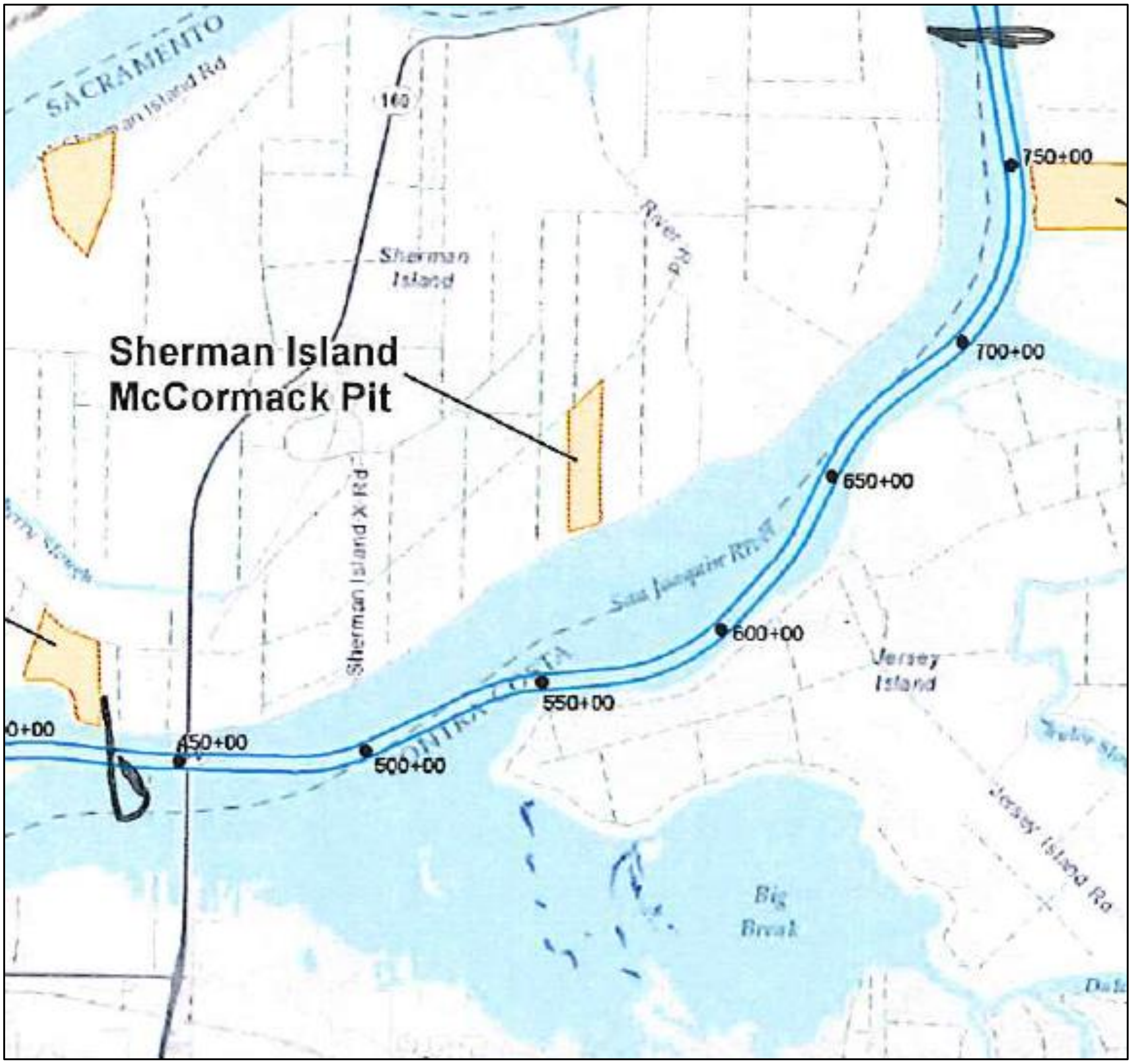

Figure 3-15. Dredging Reaches for Big Break Placement

The Stockton DWSC O&M Dredging program is a preexisting action that would occur regardless of implementation of the proposed beneficial reuse restoration project, therefore impacts associated with the dredging are not assessed as part of the action alternatives. The proposed actions under both Alternatives 2 and 3 include the redirection of the hydraulic dredging pipeline from the Stockton DWSC land disposal sites to Big Break, which in turn includes the placement of a temporary pipeline across Jersey Island. Additionally, each action alternative includes the placement of dredged material into Big Break, vegetation installation at the restoration area, associated long-term maintenance actions, and monitoring and adaptive management.

Direct Placement of O&M Dredged Material

A hydraulic suction dredge would be used to acquire material under the existing O&M Dredging Project. Dredging rates vary depending on the type of material being dredged, but production rates of 300 to 600 cubic yards per operational hour are typical. It is estimated that approximately 100,000 cubic yards of material would be available each year, for a total of approximately 500,000 cubic yards over the estimated 10 year construction period. If a different quantity of material is available in any given year, the overall construction schedule and footprint would be adjusted accordingly.

The dredging operations are expected to be conducted 24 hours per day, 7 days per week. Typically, approximately 18 hours per day are considered 'operational,' during which dredging occurs. Placement would occur over a five year period in the timeframe of August 1 to November 30, consistent with the current avoidance work windows for Delta smelt and salmonids established in the Biological Opinions for the O&M Dredging Project. Placement at Big Break is estimated to occur over approximately 15 days per work year.

Dredged material would be pumped from the dredging vessel directly to Big Break. Materials would be pumped to the proposed project areas through a floating 18 inch double wall high density plastic extrusion (HDPE) pipe. The piping system would be placed along the shoreline of the Stockton DWSC in the San Joaquin River. The pipeline would be submerged and anchored to the bottom to avoid navigation hazards. A floating diesel repeater pump station would be positioned every 3 miles as necessary to aid slurry flow; pump(s) would be installed on a floating platform with stakes to secure its position. Work boats would install and maintain the floating pipeline. An additional work boat and crew would tender the position of the outfall slurry pipe during pumping operations to ensure correct placement of materials.

The pipeline would access Big Break from the DWSC via a land-based crossing at Jersey Island. There is one dirt farm road running north/south on Jersey Island; the pipeline would be placed adjacent to the road above ground. Prior to installation of the pipeline, the dirt road would be improved for vehicular access and hauling. Gravel would be placed on the road at a width of 25 feet. After the haul road is improved, the pipe would be installed by placing 60-foot segments of pipe and welding the segments together. The pipeline would take 1 day to install each construction season and 1 day to remove. The removal process would be the same as the installation process. A 12 person work crew could complete this task in a 12 hour work day.

The pipeline would cross one farm road running east/west, in addition to two levee roads on the north and south shore of the island. Above-ground, culvert-style crossings would be installed at these intersections in order to avoid impacts to the farm fields. The proposed crossing location is shown on Figure 3-14 above. The Jersey Island crossing is not anticipated to need a booster pump on the island; however, a floating booster pump station would likely be installed adjacent to the north shore of Jersey Island.

In addition, a 1-acre staging area would be used each year on Jersey Island. The staging area would be located on the south shore of Jersey Island at the end of the haul road and pipeline crossing. The staging area would be improved, as needed, by placing gravel for vehicular use.

Material Placement

The hydraulic slurry would be discharged at the restoration sites at an assumed average rate of 450 cubic yards per hour or 8,100 cubic yards per day. Placement of the material will occur using baffle plates to dispel the energy and direct the sediment downward to create quasi-symmetrical sand mounds. Analysis of over 10 years of grain size distribution data for the 400+00 to 850+00 dredging reaches shows the material to be virtually completely fine sand. Since this sand will be falling in a hydraulic slurry, the sand is assumed to settle to a 1 on 20 slope below the mean tide level (MTL, which is 2 feet higher than the mean lower low water [MLLW] level) and to a 1 on 10 slope above the MTL. This placement process is similar enough to sand depositing in the navigation channel that no bulking of the placed dredged material is assumed and no consolidation of the placed material is assumed (i.e. one cubic yard taken from the channel is equal in volume to one cubic yard of a placed sand mound).

Sand mounds would be placed so that the mound toes do not overlap, leaving channels of varying sizes between the mounds. The intent is to ensure that the channel centerlines are never shallower than the existing condition (-3 to -4 feet MLLW). The goal of this placement plan is to create a diverse habitat that provides value to both shallow water aquatic fauna that require varying depths of soft bottom habitat, as well as terrestrial marsh species such as shore birds. In addition, based on lessons learned from Donlon Island, this design is intended to provide sufficient flow through the site to maintain water quality. A larger channel will be identified through the restoration site in the preconstruction engineering and design phase to provide a kayak trail to minimize the loss of recreational opportunities in the restoration footprint.

The bed material at Big Break is former agricultural land that was prone to subsidence upon drying, thus the material is assumed to be highly compressible. Table 3-18 lists assumptions that are thought to be reasonable but conservative for the compression of Big Break bed materials beneath hydraulically placed sand.

Table 3-18. Assumed Consolidation of Big Break Bed Sediments and Other Assumed Sand Mound Losses

Depth Interval		Assumed Placement Slope	Consolidation of Big Break Floor	Erosional/ Consolidation/ SLR losses
above MHHW		1 on 10	0 foot	1 foot
MTL	MHHW	1 on 10	2 feet	none
MLLW	MTL	1 on 20	1 foot	none
bottom	MLLW	1 on 20	none	none

In addition to "losses" of placed dredged material by the compression of underlying sediments (as a greater volume of sand is necessary to construct a mound of a given height above the sediment bed), other potential losses that could occur include:

- Wave wash erosion during storms;
- Unpredicted consolidation in excess of assumed amounts; and,
- Ineffective elevations due to sea level rise (SLR).

Table 3-18 also indicates a contingency amount of 1 foot of additional mound height losses due to some combination of these factors. Figures 3-16a and 3-16b display the initial placement (black line) and final geometry (red line, used for plantable area sizing calculations) of a sand mound placed at -3 feet MLLW and -4 feet MLLW, respectively. It is estimated that the sand mounds would require approximately 10 months for settlement following construction. Following the settlement period, aquatic vegetation would be installed, as described below.

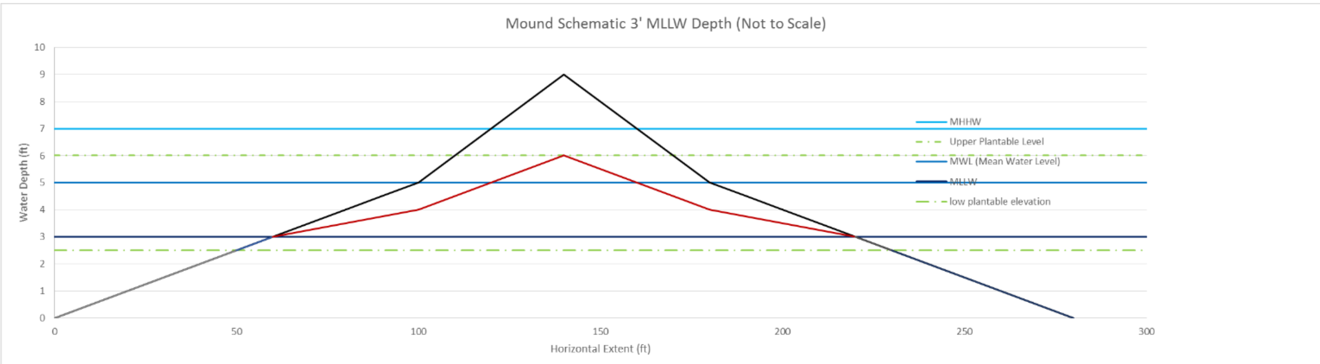

Figure 3-16a. Initial and Final Assumed Sand Mound Geometry at -3 feet MLLW

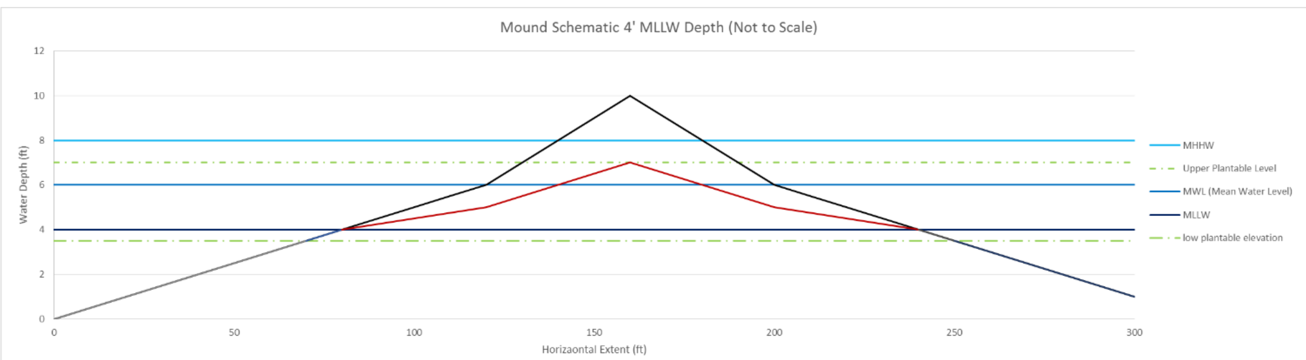

Figure 3-16b. Initial and Final Assumed Sand Mound Geometry at -4 feet MLLW

The bed level within the proposed footprint varies from -3 to -4 feet MLLW; mean tides within Big Break range from 0 feet MLLW to +4 feet MLLW. As a result, bed depths in the restoration area range from 3 feet during a mean lower low water tide to 8 feet during a mean higher high water tide. The proposed sand mounds would be constructed with a target elevation of +3 feet MLLW. Thus at high tide, sand mounds will be approximately 1 foot below the water surface level; and at low tide, the top of the vegetated sand mounds would be exposed.

Sacrificial hay bales will be placed to provide barriers to the predominant flow paths to allow for sediment settling and sand mound stability. Hay bales are anticipated to persist 1 to 2 years, giving sufficient time for vegetative establishment, after which vegetation is assumed to provide adequate erosion resistance. Sacrificial hay bales would be used to aid in compliance with water quality requirements. Hay bale lines are not anticipated to be fully enclosing; however, should enclosure become a possibility, the top of the sacrificial hay bale line would be set at mean low tide level to allow fish an opportunity to escape the work area. If unanticipated quantities of fine-grained material are present in dredged sediments, turbidity curtains can be used in combination with sacrificial hay bales and would float slightly above the bottom allowing aquatic species to escape entrapment.

Construction of the sand mounds would require approximately six workers. Approximately 12 employee trips per day of 20 miles each way would be typical for access to and from the site. Equipment anticipated for construction includes three generators/motors, one lift pump, and two work boats.

Plantings

Plantings would be installed during two separate periods: the aquatic vegetation would be installed in the spring and the terrestrial vegetation would be installed in the fall. Following planting is the initial establishment period, which starts when all the plants have been installed and accepted. The establishment period would be for three continuous years. Seed collection would occur in the spring or summer. The seeds would then be propagated in a nursery for approximately 1 year prior to installation. Table 3-19 identifies species generally conductive to the project region.

Table 3-19. Terrestrial and Aquatic Plant Species Native to the Study Area

Botanical Name	Common Name	Botanical Name	Common Name
Salix exigua	Sandbar willow	*Bidens laevis*	Devil's beggarstick
Salix lasiolepis	Arroyo willow	*Schoeneoplectus californicus*	Giant bulrush
Salix gooddingii	Black willow	*Schoeneoplextus tabernaemontanii*	Soft bulrush
Alnus rhombifolia	White alder	*Typha angustifolia*	
Populus fremontii	Fremont cottonwood	*Typha latifolia*	Common cattail
Acer negundo	Acer negundo	*Typha domingensis*	
Cephalanthus occidentalis	Button willow	*Polygonum persicaria*	Smartweed
Artemisia douglassiana	Mugwort	*Cyperus eragrostis*	Flatsedge
Baccharis salicifolia	Mule fat	*Juncus effuseus*	Common rush
Rubus ursinus	California blackberry	*Juncus balticus*	Rush
Rosa californica	California wildrose	*Eleocharis macrostachya*	Common spike-rush
Salicornia subterminalis	Pickleweed	*Salicornia virginica*	Common pickleweed

Riparian Planting

Prior to construction, the existing remnant levee would be treated to remove existing invasive vegetation. Invasive vegetation would be removed using a gas-powered hedger. The cuttings would be raked-up using pitchforks, and the cuttings would be chipped. The chips would be spread over the ground as mulch. The exposed residue rootstock would be treated with three treatments of herbicide, spaced one month apart. The herbicide would be approved for use near water bodies. This treatment is necessary to ensure the desirable planted grass and terrestrial vegetation would establish without competition. This would give native vegetation a head start, and make it harder for the nonnative vegetation to return. Native grass would be seeded following initial invasive removal to provide both habitat and soil stabilization while the remnant levee is being monitored to ensure that the invasive treatment is successful. Invasive treatment of the remnant levee is expected to occur the summer before the first dredged placement occurs.

Terrestrial riparian species would be planted in the fall of the first construction season on the remnant levee at 235 plants per acre, protected and maintained for 3 years until their roots have established. Ground water is relatively close to the ground level, so survival is expected to be high and would easily achieve a goal of 141 plants per acre, or 60% of all installed plants. The ultimate goal is to promote root growth and enable the plants to achieve self-sufficiency by the end of the 3 year establishment period. The plantings are considered self-sufficient when a plant is developed and adapted sufficiently to its setting and is able to sustain itself in its current environment without artificial or human support.

Terrestrial riparian planting would be installed by a crew of up to eight workers for 12 hour work days. Equipment needs for riparian planting, establishment, and monitoring is estimated to include a boat, a truck, a hedger, a tractor, and a weed whacker.

Aquatic Planting

Following dredged material placement and the 10-month settlement period, vegetation would be installed on the sand mounds. Based on experience from the nearby Donlon Island restoration project, the plantable zone on the placed sand mounds is assumed to be from -2.5 to + 1 feet MTL (or, -0.5 to +3 MLLW). Desirable aquatic vegetation would be planted to pioneer a source for colonization before undesirable exotic vegetation could develop. The plant material may be nursery grown or collected from nearby sources and directly planted at the site. For the purposes of this analysis, it is assumed that the plant material would be nursery grown.

Bulrush (*Schoenoplectus* spp.) and cattail (*Typha* spp.) are two desirable prominent aquatic species that are expected to colonize the mounds. Other aquatic species to be planted are rushes, sedges and spike rushes. However, since cattail is a dominate colonizer and bulrush is slow to colonize, bulrush will be planted to give it a head start. Ten percent of the target area would be planted with bulrush spaced at 3 feet on center, which averages out to approximately 45 plants per acre, with natural recruitment assumed over time. Bulrush will be installed in the mid elevation of the aquatic planting elevation zone.

Aquatic plant installation would be conducted using a crew of approximately 4 workers. Equipment needs are estimated to require 2 boats and a truck for approximately 11 days of work (standard daylight work hours) each planting year.

Monitoring & Adaptive Management

Riparian Plant Monitoring & Adaptive Management

Maintenance activities as part of the riparian plant establishment process would begin after all installation is complete and would continue through the duration of the 3-year establishment period. Watering and weeding would ensure that individual plants are kept moist and free from competition. Mowing would ensure that the site and plants are accessible while minimizing undesirable seedhead development and potential fire danger. Spraying would reduce undesirable herbaceous competition, allowing the native grasses a greater opportunity to establish. Any herbicides used would be in compliance with water quality standards.

During the establishment period, all riparian plants would be surveyed in the fall before they lose their leaves. All dead terrestrial plants would be identified and replaced that same fall for the first two years of establishment. Based on historical data, it is expected that mortality would be below 20% for each of the first two years. Replacement plants would be with the same species that it is replacing, using the same size container as was originally planted, unless it is determined that another species would be more appropriate to the site. Where it becomes evident a particular species is not conducive to the site, a different species would be substituted to ensure success.

A riparian plant survival survey would be performed at the end of each establishment year and a report would be prepared. The report would include the monthly maintenance records, plant survey totals, and observations and recommendations of how to improve the site. As-builts would be prepared and kept current of what was planted, how much was planted, and where it was planted.

A monitoring and adaptive management plan is included as Appendix D. The monitoring plan establishes the methods and data that would be collected annually in order to determine restoration success. In addition, adaptive management measures are proposed to address challenges in meeting restoration success (i.e., lack of vegetative growth, increased turbidity, etc.) Monitoring reports and records would be required to document planting processes and progress. Since the purpose of the riparian restoration on the remnant levee is to reduce the potential for invasive species to overtake the marsh habitat, the riparian plantings would be monitored for the percent cover of invasive plant species versus native plant species. This process begins at the completion of the establishment period.

<u>Aquatic Plant Monitoring and Adaptive Management</u>

It is anticipated that the aquatic plantings would not require maintenance. Based on past experience on similar marsh restoration projects, the vegetation has established very quickly, typically within one year. During the 10 year construction period, the Corps would monitor the marsh habitat to ensure that it is performing as expected. If needed, adjustments would be made to the construction techniques on a year-to-year basis to apply lessons learned and adapt the plan to achieve maximum success.

The marsh habitat would be monitored following construction of each segment for 5 years to ensure success via percent cover of aquatic species. If needed, invasive plant species would be removed during the annual monitoring period. If the habitat is not meeting the success criteria in the timeframe anticipated, then contingency measures would be applied in order to ensure success. This could include the installation of more plantings, or an adjustment in the plant selection if the selected species are not conducive to the site.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. These reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). The reports would also document the results of the percent cover measurements, the proportional abundance of different habitat types, and the estimated natural recruitment versus planted habitats. Recommendations for additional adaptive management measures, as needed, would also be identified in the reports.

Operation and Maintenance

Following the establishment period, the project would be turned over to the non-Federal sponsor for long-term operation and maintenance. The restoration site would not require significant long-term maintenance beyond the establishment period. Soil accretion and vegetative recruitment have historically aided plantings on restored intertidal marsh habitats. Plantings typically survive and reach desired density within 2 years. Long term maintenance would primarily consist of replacement of any lost habitat due to damage; however, such a scenario is not considered to be highly likely, and it is anticipated that the habitat would be independently successful in perpetuity.

Alternative 3 – 340 Acres of Intertidal Marsh Restoration (Selected Plan)

Alternative 3 includes Big Break Increments 1a and 1b, using O&M dredging over an approximately 10 year period to create approximately 340 acres of intertidal marsh habitat. Of the 340 acres, approximately 95 acres would be planted with riparian and aquatic vegetation, and the remaining 245 acres would be shallow water habitat for aquatic fauna species. The annual construction activities, including O&M dredging, material placement, plantings, monitoring, and adaptive management would all be conducted consistently with the description for Alternative 2, above, except that it would occur over a 10 year period rather than a 5 year period. Alternative 3 is the Selected Plan and is also the Environmentally Preferred Alternative, as defined in the Clean Water Act Section 404(b)(1) Analysis (Appendix H).

CHAPTER 4.0 – AFFECTED ENVIRONMENT

This section describes the existing conditions of the environmental resources in the project area. In Chapter 5.0, these existing conditions are compared to the with-project conditions in order to determine the effects of the proposed project. Resources less likely to be adversely affected by the project are described first, followed by the resources that may be affected by the alternatives. Although all resources are subject to some change over time, most of these resources are not expected to change significantly during the period of analysis for this study. Thus for most of the resources in the affected environment existing conditions are assumed in this environmental analysis to be the future without-project conditions as well. Excepted resources which are likely to experience significant changes due to implementation of one of the proposed alternatives include vegetation and wildlife, special status species, land use, socioeconomics, and traffic and circulation. These resources are described in greater detail in Section 4.2 below.

4.1 Resources Not Considered In Detail

Initial evaluation of the effects of the project indicated that there would likely be little to no effect on several resources. These resources are discussed in Sections 4.1.1 through 4.1.5 to add to the overall understanding of the area, and to identify why it has been determined that they do not need to be evaluated in detail.

4.1.1 Hydrology and Hydraulics

The Delta watershed includes the tributary rivers that flow into the Delta from the Sacramento River and the San Joaquin River basins (Figure 2-1). In general, the Delta watershed is represented by the drainage of the Central Valley except for the Tulare Lake area. Areas outside of the Delta that receive Delta water include Tulare Lake, San Francisco Bay, Central Coast, and Southern California. The project area is not isolated and subject to the overall hydrologic and hydraulic processes, both natural and human, which are present in the Delta.

Analysis of available gauge and flow data and hydrodynamic modeling results suggests that it is highly unlikely the proposed Ecosystem Restoration (see C-4 Geotechnical and C-6 Civil Design for material and design specifics) to have a measurable increase in stage in the Big Break area. Following the SMART Planning process and the tenants of Risk-Based Decision Making, the risk of adverse impacts to the floodplain and the omission of detailed hydrodynamic modeling of the with-project condition is deemed to be low by the Project Delivery Team (PDT); this risk has been added to the Project's Risk Register. Should more detailed study in Preconstruction Engineering and Design suggest a necessity for detailed hydrodynamic modeling, that modeling can be accomplished in that phase of the project.

Delta Hydrology

The hydrologic function of the Delta involves the interaction of streamflow runoff from the major rivers and tidal inflow of salt water from the Pacific Ocean. Two major rivers supply the majority of the freshwater: the Sacramento River from the north and the San Joaquin River from the south. The runoff of the Sacramento River is greater, accounting for 80 percent of the freshwater runoff by volume. The water in the San Joaquin River and its tributaries has been highly diverted for agricultural use, and much of the runoff is diverted upstream of the Delta. At their junction, runoff from the Sacramento River channel near Sherman Island flows southward to create a freshwater barrier across the mouth of the San Joaquin; without this barrier, it is postulated that saltwater inflow to the south-central Delta would increase significantly. The south-central delta is closer to the San Francisco Bay, hence salt water intrusion is more likely in the event of reduced freshwater flows in this tidally influenced area. Flow in the Delta channels can change direction as a result of tidal exchange, ebbing and flooding with the two tides per day, which is a major factor of Delta hydrodynamics. The daily, seasonal, and year-to-year differences in source water contributions to various locations throughout the Delta affect salinity in the Delta (Contra Costa Water District, 2010).

Sacramento River Basin

The Sacramento River flows generally north to south from its source near Mount Shasta to the Delta. The Sacramento River receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin, including the Feather River, Yuba River, and American River. In addition, Putah and Cache Creeks flow into the Yolo Bypass, which subsequently flows into the Cache Slough complex prior to entering the Sacramento River upstream of Rio Vista. The Sacramento River basin topography ranges in elevation from approximately 14,000 feet above sea level on Mount Shasta to approximately 1,070 feet at Shasta Dam, to sea level in the Delta. Generally, precipitation occurs in the form of snow during winter and early spring at elevations above 5,000 feet. The snowmelt generally occurs in April and May.

San Joaquin River Basin

The San Joaquin River originates in the Sierra Nevada and then flows west into the San Joaquin Valley through Millerton Lake at Friant. The San Joaquin River turns north near Mendota and flows through the San Joaquin Valley and into the Delta near Vernalis. The San Joaquin River receives contributing flows from the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes Rivers. The Calaveras, Mokelumne, and Cosumnes Rivers flow into the San Joaquin River within the boundaries of the Delta. When Kings River in the Tulare Lake hydrologic region floods, the San Joaquin River also receives flood waters as high as 5,000 cfs from the Kings River via Fresno Slough.

The San Joaquin River basin topography ranges in elevation from over 10,000 feet above sea level in the Sierra Nevada to sea level in the Delta. Generally, precipitation occurs in the form of snow during winter and early spring at the upper elevations, and snowmelt occurs in the late spring and early summer months. Flows in the San Joaquin River are regulated by operation of Friant Dam, which diverts water into the CVP Friant Division. The Friant Division conveys water in the Madera Canal to the north and the Friant-Kern Canal to the south for irrigation and municipal and industrial water supplies, and releases water in the San Joaquin River to meet downstream water rights and instream flow requirements. Hydropower generation facilities in the upper reaches of the San Joaquin River influence water flows into Millerton Lake (formed by Friant Dam). There are numerous other diversions from the San Joaquin River associated with the CVP and SWP that influence the river’s flows, including the Delta-Mendota Canal and the Mendota Pool.

Delta Hydraulics

The Delta is a complex network of over 700 miles of tidally influenced channels and sloughs. Four strong forcing mechanisms drive circulation, transport, and mixing of water in the Delta: (1) freshwater river flow from drainages to the Delta; (2) tides from the west propagating from the Pacific Ocean through San Francisco Bay; (3) SWP and CVP water supply facilities operating in the Delta; and (4) collective effects of in-Delta agricultural diversions (USGS 2005).

Influence of Delta Inflows

The Sacramento River is the primary contributor to Delta inflows. The San Joaquin River is the second biggest contributor to Delta inflows. Finally, east side streams (Mokelumne, Cosumnes, and Calaveras Rivers) provide inflow to Delta annually that join from east and flow towards west.

Influence of Delta Tidal Flows

Tidal flows have a major influence on Delta hydraulics and vary with the extent of high and low tides. On average, tidal inflows to the Delta are approximately equal to tidal outflows. All tidal flows enter and leave the Delta along the San Joaquin River at Chipps Island. Water levels vary greatly during each tidal cycle, from less than one foot on the San Joaquin River near Interstate 5 to more than five feet near Pittsburg. Sea level rise is another factor that has a notable influence on Delta hydraulics. Factors affecting sea level rise include tidal variations, storm surges, large-scale changes in water temperature and wind forces, and climate-related changes.

Influence of the State Water Project and Central Valley Project on Delta Operations

The withdrawal rates at the south Delta intakes influence Delta hydraulics and can change the direction of flow of some waterways in the south Delta. The most influential effects occur on Old and Middle Rivers. Reverse flows also occur in False River in the western Delta and Turner Cut in the San Joaquin River.

South Delta hydraulics are influenced by several channels that have been widened or connected and by barriers to reduce connectivity between other channels to protect agricultural water uses or aquatic resources. Operations of these facilities affect operations of the SWP/CVP south Delta intakes (DWR 2009a).

Influence of Delta Agricultural Diversions

There are over 1,800 diversions in the Delta area that are estimated to siphon away up to 5,000 cfs during peak summer months. Most of these diversions are related to agricultural operations. Surface water in the Delta also is influenced by consumptive use of groundwater by agricultural crops and by seepage from the surface water into the interior of the islands and tracts. A substantial portion of the water diverted from the Delta or that seeps into the islands and tracts is returned to the Delta surface water by agricultural and drainage flows and seepage that is pumped from the islands and tracts into the Delta (DWR 2009b).

The creation of intertidal marsh habitat in the Delta estuary would not have an effect on hydraulic or hydrologic processes. The project is very small relative to the entire Delta system. The placement area at Big Break is hydraulically contiguous with the material source, the Stockton DWSC. Removal of material from the DWSC and placement at Big Break would occur in real time. By inspection, there can be no impact to water levels in the Delta at large. Similarly, existing hydrodynamic modeling and gauge data shown in Appendix C – Engineering show that flows through Big Break are incredibly low when compared to those of the Sacramento and San Joaquin Rivers and are virtually solely tidally influenced. The placement of dredged material in the slackwater area of Big Break can by inspection be determined not to affect Delta hydrodynamics at large. Because the project would only include the placement of fill material into open waters to create intertidal marsh habitat surface water, flood plain boundaries, flood characteristics, or flood control structures (such as levees) adjacent or downstream of the action area are not expected to change.

4.1.2 Land Use and Agriculture

Land Use

Big Break is located in Contra Costa County, California. The majority of the land use surrounding Big Break is privately owned and designated for agriculture (58%). The remaining land uses include industrial (16%), residential (15%), recreation (5%), marina (2%) and public education facilities (1%). Big Break is interior tidal open water area owned by the East Bay Regional Park District as part of the East Bay Regional Shoreline.

The subsections below identify a number of land use plans that were reviewed as part of this study. Information regarding the regulatory guidelines of these plans are discussed below; however, it should be noted that the proposed alternatives assessed in this EIS are consistent with the local land use plans. Restoring historical tidal marsh habitat and reversing subsidence in the Delta is a consistent goal included in all local land use plans that incorporate the Delta region within its policies.

Contra Costa County General Plan and Delta Land Use and Resource Management Plan

A comprehensive update to the Contra Costa County General Plan 2005–2020 was adopted on January 18, 2005, to guide future growth, development, and resource conservation through 2020 (Contra Costa County 2005). Amendments to the general plan occurred in 1996 and 2005 to reflect changes to the land use map and the incorporation of the city of Oakley, and the Housing Element was updated in 2009 (Contra Costa County 2013a).

The Contra Costa County General Plan has developed its land use policies to be consistent with the Delta Land Use and Resource Management Plan for the Primary Zone of the Delta at the county level. The Primary Zone lands generally are designated for agriculture or special Delta resources in their respective general plans. The zoning codes allow a variety of uses in the Primary Zone: agriculture and agriculturally oriented uses; outdoor recreation; wildlife habitat; public facilities; and limited areas for commercial, industrial, and rural residential development. The parcel sizes specified in the general plans and zoning codes range from 5 to 160 acres, with most of the Primary Zone in the 20 to 80 acre minimum parcel sizes. General plan policies relevant to specific resource areas (e.g., aesthetics, cultural resources, minerals, visual resources, transportation) are discussed in the sections corresponding to those resources.

The area within Contra Costa County potentially affected by the action alternatives is largely agricultural and recreational. The applicable general plan policies related to agriculture that are potentially affected by the action alternatives specifically address farmland of importance, habitat preservation, open space creation, and providing Delta recreation opportunities. Recreation is discussed separately in Sections 4.2.9 and 5.8.

The Delta Plan

The Delta Plan was previously described in Section 1.5.1. The Delta Plan was developed by the Delta Stewardship Council (DSC) and adopted on May 16, 2013. It became effective, with legally-enforceable regulations, on September 1, 2013. It is a long-term, comprehensive management plan designed to meet the co-equal goals of providing a more reliable water supply for California and protecting, restoring and enhancing the Delta ecosystem. The Delta Plan generally covers five topic areas and goals: (1) increased water supply reliability; (2) restoration of the Delta ecosystem; (3) improved water quality; (4) reduced risks of flooding in the Delta; and (5) protection and enhancement of the Delta. The DSC does not propose constructing, owning or operating any facilities related to these topic areas. Rather, the Delta Plan sets forth regulatory policies and recommendations that seek to influence the actions, activities and projects of cities, counties, State, Federal, regional and local agencies toward meeting the goals in the 5 topic areas.

San Francisco Estuary Project Comprehensive Conservation and Management Plan

The San Francisco Estuary Project Comprehensive Conservation and Management Plan (CCMP) was developed to guide the management of the San Francisco Estuary, an estuary of national significance established under the National Estuary Program. The San Francisco Estuary consists of the San Francisco and Suisun Bays, the Suisun Marsh, and the Sacramento and San Joaquin River Delta. The San Francisco Estuary program is managed by the USEPA, State of California, and locally by the San Francisco Estuary Partnership. The CCMP presents a blueprint to restore and maintain the chemical, physical, and biological integrity of the Bay and Delta within its urban context. The CCMP identifies five critical program areas of environmental concern: (1) decline of biological resources; (2) pollutants; (3) freshwater diversions and altered flow regime; (4) dredging and waterway modification; and (5) intensified land use.

East Bay Regional Park District Master Plan

The East Bay Regional Park District (EBRPD) Master Plan (2013) establishes the mission and vision for the EBRPD, the land owner and manager of Big Break Regional Shoreline. The Master Plan establishes policies to guide the stewardship and development of the Parks, with a goal of maintaining balance between resource protection and conservation and recreation opportunities.

Big Break Land Use Plan

The Big Break Land Use Plan was prepared by the EBRPD in 2001. The purpose of the plan was to establish appropriate resource management guidelines for protecting the habitat and species in the Big Break area. Additionally, the plan set up the process for establishing access and facilities at Big Break for recreational use. The Big Break Land Use Plan establishes the need to protect the existing habitat at Big Break, but also recommends that the EBRPD consider opportunities for marsh restoration.

The proposed alternatives involve restoring the open water habitat of sunken islands to their historic tidal marsh condition, which would create habitat value for numerous Delta wildlife species. The created marshlands would offer new recreation possibilities while not hindering the existing land use practices established in the plans described above. There would be no changes in land use policies associated with any of the proposed alternatives. All restoration work would be consistent with local plans and policies. As a result, there would be no effect to land use and no mitigation would be required.

Agriculture

The California Department of Conservation administers the Farmland Mapping and Monitoring Program (FMMP) to characterize the types and amounts of agricultural land in an area. The only agricultural lands in the action area are on Jersey Island adjacent to Big Break. The land on Jersey Island is characterized in the FMMP as:

- Prime farmland: Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion (7 USC 4201[c][1][A]).
- Additional farmland of statewide or local importance: Land identified by state or local agencies for agricultural use, but not of national significance (7 USC 4201[c][1][C]).

The pipe used to transport dredged material from the Stockton DWSC to Big Break would cross Jersey Island. The pipes would be placed along the existing farm road, with culverts or other crossing designs incorporated to allow access across the pipeline so that no impacts to important farmland would occur. Habitat restoration is not proposed on land designated as important farmland, and no farmlands would be converted to other land uses. As a result, there would be no impacts to agriculture and no mitigation would be required.

4.1.3 Socioeconomics and Environmental Justice

There are no populations living within the action area, including low income or minority communities. There is one occupied farm house along the access route to Jersey Island to install the pipeline crossing. During installation of the pipeline and any associated preconstruction surveys, there would be a slight increase in traffic along Jersey Island Road. However, this traffic is a minor, temporary impact and would not require any mitigation.

The economy of the Delta is rooted in agriculture. Major crops grown in the Delta include asparagus, pears, and grapes. Agriculture became the primary economic driver in the Delta because of its rich, peaty soil, ample water supply, and proximity to urban markets. As discussed above in Section 4.1.3, with the implementation of crossing locations for access over the temporary dredged material slurry pipeline, there would be no effects to agriculture, and no mitigation would be required.

The alternatives are located in open water sites within Big Break. Construction activities and equipment placement would not result in disturbance to existing population centers or individuals. Therefore the alternatives would have no disproportionate and adverse human health or environmental effects on minority and low-income populations. The alternatives would have no adverse effects on the local, regional, state, or national economies.

4.1.4 Noise

This section describes the existing noise environment in the study area. This includes local, Federal, and State criteria; sources and levels of noise; and noise-sensitive land uses and receptors. Noise can be defined as unwanted sound, and effects are interpreted in relationship to noise level criteria for Contra Costa County.

Federal and State criteria for evaluating traffic effects on noise are contained in the Federal Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CFR 772) and the California Department of Transportation (CalTrans) Traffic Noise Analysis Protocol dated October 1998. The Category B criterion in these documents applies to residences, churches, schools, recreation areas and similar uses, and is an hourly sound level that approaches or exceeds 67 dBA L_{eq}. There are no criteria for undeveloped land or construction noise. The Federal Highway Administration (FHWA) and Caltrans consider traffic to have an effect on noise if predicted peak-hour traffic noise levels approach or exceed the noise abatement criteria. Caltrans defines “approach or exceed” as noise levels within 1 dBA of noise abatement criterion, meaning 66 dBA for Category B. In addition to the criterion sound levels described above, the FHWA and Caltrans consider traffic to have an effect on noise predicted sound levels "substantially" exceed existing noise levels. Caltrans defines "substantial" as an increase of 12 dBA over existing peak-hour noise levels. Caltrans and FHWA policies dictate that noise abatement measures must be considered when effects on noise are identified.

The Noise Element of the Contra Costa County General Plan (2005-2020) contains guidelines for Land use Compatibility for Community Noise Environments. Guidelines that would be relevant to the Delta Study include:

- If an area is currently below the maximum "normally acceptable" noise level, an increase in noise up to the maximum should not be allowed necessarily.

- Public projects shall be designed and constructed to minimize long-term noise impacts on existing residents.
- Construction activities shall be concentrated during the hours of the day that are not noise-sensitive for adjacent land uses and should be commissioned to occur during normal work hours of the day to provide relative quiet during the more sensitive evening and early morning periods.

Noise sources in Big Break are primarily related to recreational boat use and agricultural activities on Jersey Island. Land uses near project components are primarily rural. As such, existing noise levels are in the range of 40 to 50 dBA. The only noise associated with project activities are from the pumps transporting dredged material through the pipeline and from the dredged material being directly placed in the restoration site. Temporary increases in ambient noise would be minimal, would not reach regulatory levels, and would not harm wildlife. There would be a temporary impact to the one farm house on Jersey Island, as worker vehicles would pass the house to access the staging area; however, this effect would not raise noise levels above regulatory levels and therefore would not be considered an effect.

4.1.5 Hazardous, Toxic, and Radiological Waste

Naturally Occurring Hazards

Historic geologic conditions in the study area have led to the formation of peat and other organic soils with thicknesses of up to approximately 55 feet on the western side of the Delta; peat deposits are not commonly found on the eastern side. The thick organic soils and peat have the potential to generate flammable gases such as methane that can pose hazards to workers during deep excavations and tunneling.

Hazards from Agricultural Practices

Agriculture has been the primary land use in the study area for more than a century. Approximately 538,000 acres of the 738,000 acres of agriculture land potentially affect the waters adjacent to the project areas.

A wide variety of pesticides, including insecticides, herbicides, and fungicides, have been used throughout the agricultural lands surrounding the project area for decades; and those chemicals still may be present in and near agricultural lands. While some pesticides that were used in 1974 were still in use in 2008 (e.g., sulfur, petroleum oils, 1,3-dichloropropene, diuron, and carbaryl), a number of new pesticides, such as chloropicrin, chlorpyrifos and propanil, are available and in use currently. Notably, a number of pesticides prevalently used in the 1970s are no longer prevalently used: dinoseb, chlordane, dibromochloropropane, ethylene dibromide, parathion, and toxaphene.

The wide variety of pesticides that has been applied, the numerous crops grown in the region, and the fact that predominant land use across the Delta supports agriculture indicate that pesticides and their residues are likely to be found in the soils throughout the Delta. No comprehensive area-wide soil or sediment sampling program is known to have been conducted to evaluate pesticide residues from agricultural use.

Hazards from Historical Mercury Mining

Mercury has been identified as a chemical of concern in Delta area sediments, resulting from gold and mercury mining operations in the watersheds upstream of the Delta. Mercury was used extensively upstream of the study area in mining to extract gold from ores and placer gravel deposits. Mercury released into the environment by historic gold mining practices has been flowing into the study area via water, primarily from the Sacramento River watershed, and sediments since the mid-1800s and is expected to continue to enter the study area. An unknown amount of mercury is present in sediments within the project area, but estimates of mercury flowing into the Delta area, mainly associated with suspended sediment (Alpers et al. 2008), range from approximately 200–400 kg/yr (CVRWQCB 2008).

Urban, Residential, and Recreational Land Use

In general, hazardous materials released from cities and towns are associated with stormwater runoff and primarily affect water bodies. Cities and towns account for approximately 9% of the total study area. Urban stormwater discharges are generally characterized by varying levels of metals and hydrocarbons that can accumulate in river sediments over time. Historically, polychlorinated biphenyls (PCBs) have been associated with urban discharge, and these contaminants have been detected in fish tissues in San Francisco Bay.

Urban areas have many facilities with the potential for hazardous materials releases, including gas stations, dry cleaners, automotive repair facilities, and, in larger towns, manufacturing facilities. Stockton, for example, has large shipping and port facilities, as well as Federal facilities with a history of hazardous materials use, storage, and releases. Antioch and Oakley, located on the south side of the San Joaquin River near the project areas, have major power-producing facilities and several active or former industrial facilities with known groundwater impacts. Possible contaminants of concern from urban land uses are extensive, but the most common contaminants in soil and groundwater are petroleum and associated compounds (typically gasoline and diesel releases from USTs as the source), chlorinated solvents and degreasers (from dry cleaning and vehicle repair facilities), and various heavy metals, such as arsenic and lead. Marinas typically include bulk fuel storage and overwater fueling, various boat repair/maintenance facilities, stores, boat storage, and camping facilities. Typical chemicals associated with marinas include fuels, lubricants, cleaners, anti-fouling paints, and fiberglass components.

Project construction activities are not expected to disturb existing hazardous, toxic, and radiological waste (HTRW) sources that could lead to contamination of environmental resources. The placement of material into the sites would not cause disruption of the areas under the sites because placement would be directly on top of the existing soil. Additionally, the pipes that would carry any material to the placement sites would be placed directly on top of existing land or floated on the surface of the water and not disturb any bed material. The dredged material being used to create intertidal marsh habitat would be tested prior to any processing of the material. Only material meeting baseline criteria would be used and therefore no affects to HTRW would occur from use or transport of this material. Because no HTRW material or sites would be affected by the project, no impacts to HTRW would occur with implementation of the project.

4.2 Resources Considered in Detail

Sections 4.2.1 through 4.2.10 describe the Federal Regulations and existing conditions for those resources that are more likely to be affected by implementation of the proposed alternatives.

4.2.1 Geologic Resources

Regulatory Setting

There are no Federal laws established that are applicable to this study.

Affected Environment

Geology

The Delta and Suisun Marsh lie within California's Central Valley, which is approximately 465 miles long and 40 to 60 miles wide. The valley is bounded by the Sierra Nevada on the east and the Coast Ranges on the west. Paleogeographic reconstructions of this region indicate that Miocene sedimentation was similar to a modern fore-arc basin (a sea floor depression between a subduction zone and an associated volcanic arc), shedding arkosic (granular quartz and feldspar or mica), and volcanoclastic sediments westward from the continent. In the mid-Pliocene Epoch, a shift in plate tectonics triggered uplift of the Coast Ranges, which gradually closed the southern marine outlet to the basin. By the late Pliocene, sub-aerial conditions prevailed throughout the valley, resulting from marine regression (i.e., when the oceans were regressing seaward over land) and sedimentation from the west. During Pleistocene Epoch, the valley separated from the Pacific Ocean and developed internal drainage, the modern outlet being the Carquinez Strait, through which the Sacramento River flows to the San Francisco Bay (Lettis and Unruh 1991).

The historical Delta evolved at the inland margin of the San Francisco Bay Estuary as two overlapping geomorphic units. The Sacramento River Delta comprises about 30 percent of the total area and was influenced by the interaction of rising sea level and river floods that created channels, natural levees, and marsh plains. During large river flood events, silts and sands were deposited adjacent to the river channel, forming natural levees above the marsh plain. In contrast, the larger San Joaquin River Delta—located in the central and southern portions of the Delta and having relatively small flood flows and low sediment supply—formed as an extensive, unleveed freshwater tidal marsh dominated by tidal flows and organic soil (peat and muck) accretion (Atwater and Belknap 1980). Because the San Joaquin River Delta had less well defined levees, sediments were deposited more uniformly across the floodplain during high water, creating an extensive tule marsh with many small branching tributary channels. As a result of the differential amounts of inorganic sediment supply, the peats and mucks of the San Joaquin River Delta grade northward into peaty mud and then into mud as it approaches the natural levees and flood basins of the Sacramento River Delta (Atwater and Belknap 1980). The proposed alternatives are small-scale ER projects that would restore the proposed locations to historic conditions. As a result, the project would have no effect on the geologic features in the project area.

Soils

Soils in the study area are extremely variable in texture and chemical composition. The soil composition of the islands surrounding the study are a combination of peat beds in the center of islands with relatively coarse textured inorganic sediments deposited in the channels and along the margins of the islands. Soils in perimeter marsh areas around islands are comprised of peat beds that accumulated and were preserved under anoxic conditions (lack the presence of oxygen). In contrast, soils in channels and along the higher energy channel margins of islands tend to be comprised primarily of mineral sediment. The peat soils have been largely drained, resulting in oxidation of organic matter and subsequent large-scale land subsidence on Delta islands (Deverel, S. J., and S. Rojstaczer. 1996). The soils that would be used as part of the proposed alternatives are dredged materials that originate from the waterways within the study area. Reusing this soil to create intertidal marsh habitat would not have any impact on the existing soils in the study area.

Seismicity

The California Coast Ranges physiographic province lies along the complex boundary between two tectonic plates: the North American Plate and the Pacific Plate. The geologic and tectonic conditions in the Delta and Suisun Marsh have been, and continue to be, controlled primarily by the interaction of these two massive blocks of the Earth’s crust. Under the current tectonic regime, the Pacific Plate moves northwestward relative to the North American Plate at a rate of about 1.57 inches (40 millimeters) per year (Working Group on California Earthquake Probabilities 2003). Although relative motion between these two plates is predominantly lateral (strike-slip), an increase in convergent motion along the plate boundary within the past few million years has resulted in the formation of mountain ranges and structural valleys of the Coast Ranges province.

The San Andreas Fault system dominates the seismicity of the region, and it comprises several major faults including the San Andreas, Hayward–Rodgers Creek, Calaveras, Concord–Green Valley, and Greenville faults. In addition to these major faults, many other named and unnamed regional faults accommodate relative motion between the plates and relieve compression stresses that also act along the plate boundary.

The Delta and Suisun Marsh are in the eastern portion of the greater San Francisco Bay region, one of the most seismically active areas in the United States. Since 1800, several earthquakes with magnitudes greater than 6.5 have occurred in the immediate San Francisco Bay Area, including the 1868 magnitude 6.8 earthquake on the Hayward Fault, the 1906 magnitude 7.9 San Francisco earthquake on the San Andreas Fault, and the more recent 1989 magnitude 6.9 Loma Prieta earthquake that occurred in the Santa Cruz Mountains.

The proposed alternatives are small-scale ER projects in rural areas. There are no permanent structures associated with the proposed alternatives that would require compliance with State seismic laws and regulations. Since the proposed restoration area at Big Break is approximately 50 miles inland from the Pacific Ocean it is highly unlikely to be impacted by a tsunami resulting from a major earthquake. Additionally the Big Break area is not in a California Department of Conservation Tsunami Inundation Hazard Zone (CDC, 2018). Wave wash erosion, which could result from earthquake ground shaking, has been accounted for in the project designs. As a result, the proposed alternatives would not be impacted by seismicity within the project area.

Topography

Soils formed in the Delta as the result of geologic processes over approximately the past 7,000 years. These processes produced landward accumulation of sediment behind the bedrock barrier at the Carquinez Strait, forming marshlands comprising approximately 100 islands that were surrounded by hundreds of miles of channels (Weir 1950). Generally, mineral soils formed near the channels during flood conditions and organic soils formed on marsh island interiors as plant residues accumulated faster than they could decompose.

Prior to the mid-1800s, the Delta was a vast marsh and floodplain, under which peat soils developed to a thickness of up to 30 feet in many areas (Weir 1950), with a thickness of approximately 55 feet in the vicinity of Sherman Island (Real and Knudsen 2009). The tidal portion of the Delta consisted of backwater areas, tidal sloughs, and a network of channels that supported highly productive freshwater tidal marsh and other wetland habitats (CALFED Bay-Delta Program 2000).

In the mid to late 1800s, much of the Delta was reclaimed for agricultural use, including the study area. Big Break was once a leveed estate, with the levees believed to have been constructed sometime between 1876 and 1910. There are records indicating that Big Break was in agricultural use and that asparagus was grown there in the 1920s. However, the levee broke in 1921 and Big Break was flooded. There are some records indicating that the entire area did not all flood immediately, but by 1928 when the levees broke again, no further agricultural production occurred on the land (EBRPD 2018).

Today, Big Break has subsided to approximately 3 to 4 feet below MTL. The area is open shallow water that is tidally influenced. The only remaining terrestrial land is the remnant levees along the northern edge of Big Break adjacent to Jersey Island.

4.2.2 Aesthetics

Regulatory Setting

There are no Federal or State laws regulating aesthetics.

Affected Environment

The statutory Delta encompasses 738,000 acres and consists of largely undeveloped islands and low-lying tracts of land surrounded by waterways and levees. Historically, more than 40% of the state's runoff flowed to the Delta through the Sacramento, San Joaquin, and Mokelumne Rivers (California DWR 1993). In addition to the natural waterways, the area contains a variety of water development facilities such as levees, aqueducts, and intake structures. The construction of levees resulted in the conversion of wetlands, riparian corridors, and open water to agricultural lands characterized by elevated and vegetated levees surrounding low-lying areas of farmland. Construction of these levees, completed before World War II, also allowed for urbanization, commercial shipping to the Ports of Stockton and West Sacramento, recreational boating, and marina development within the Delta (SacDelta 2009).

Lands contributing to the visual resources of the study area include waterways, recreation areas, agricultural production, wildlife refuges and preserves, marinas, and shoreline recreation facilities.

Agricultural lands account for the primary land use in the Delta. The extensive tracts of agricultural land shape the Delta's visual character. A wide mixture of crops, land management practices, and agricultural infrastructure create a pastoral visual landscape composed of a variety of colors, textures, and views from different distances. Vegetation, agricultural crops, and land use patterns vary according to the time of year and farming activities. For instance, a particular field may be fallow through winter and early spring and yet exhibit substantial vegetative growth through summer. Often stubble or crop remnant can be seen in fall after harvest.

Approximately 1,000 miles of waterways traverse the Delta, making them a defining and dominant feature of the landscape (Delta Science Center 2009a). Many of the waterways follow natural courses, while others have been constructed for navigation, flood control, water supply, and drainage. The predominant features constraining and defining these waterways are artificial levees. The Delta's waterways are unique in their diversity and wide range of distribution and abundance, adding substantially to the region's visual characteristics. Most Delta waterways have a general scenic quality that attracts and contributes to varied types of recreation. The three general types of Delta waterway visual landscapes consist of open river, channels and sloughs, and marsh.

The open river is a visual landscape dominated by a singular, expansive waterway. This landscape type is a common sight along Delta roadways that closely parallel the Sacramento and other rivers and offer views of the river corridor. In the study area where former islands have been inundated (Big Break), the open-river landscape expands broadly, creating an open-water visual landscape. Numerous channels and sloughs wind through the Delta as the large Sacramento and San Joaquin Rivers mingle with smaller rivers that drain the Sierra Nevada and Coast Ranges (Delta Science Center 2009b). Sloughs meander through the landscape in a curvilinear fashion, while engineered waterways that have been channelized and diverted for agriculture and water conveyance tend to carve straighter paths. The marsh landscape type consists of intermixed open water and wetland vegetation. It is characterized by fluctuating water levels and/or seasonal flooding from tidal action, rain, and management actions.

The greater Delta study area includes a number of public parks, conservation areas, and other areas of scenic importance. However, in the action area, the only aesthetic resource of this type is Big Break Regional Park. There are no designated Wild and Scenic Rivers in the study area.

4.2.3 Vegetation and Wildlife

This section describes the existing vegetation, wildlife, and habitats which occur in the study area. Biological resources such as plants and animals are important because they influence ecosystem functions and values, have intrinsic value, and are subject to a number of statutory and regulatory requirements.

Regulatory Setting

Federal

Fish and Wildlife Coordination Act. The Fish and Wildlife Coordination Act (FWCA) requires USACE to coordinate with the USFWS on water resources development projects to obtain their views toward preservation of fish and wildlife resources and mitigation of unavoidable impacts.

Migratory Bird Treaty Act (MBTA) and EO 13186, Conservation of Migratory Birds. The MBTA states that it is unlawful to kill, capture, collect, possess, buy, sell, trade, or transport any migratory bird, nest, young, feather, or egg in part or in whole, without a Federal permit issued in accordance with the MBTA’s policies and regulations. Under EO 13186, Federal agencies are directed to evaluate the impacts of their actions on migratory birds in NEPA documents and to conserve migratory birds, giving priority to species of concern (listed by USFWS), and their important habitats.

EO 13112, Invasive Species. Dated February 3, 1999, this EO directs Federal agencies to expand and coordinate their efforts to combat the introduction and spread of "invasive species" (i.e., noxious plants and animals not native to the U.S.). Non-native flora and fauna can cause significant changes to ecosystems, upset ecological processes and relationships, and cause harm to our nation's agricultural and recreational sectors. Those species that are likely to harm the environment, human health, or economy are of particular concern.

National Estuary Program. The National Estuary Program was created by Congress in the 1987 amendments to the Clean Water Act. The Program consists of 28 local estuary programs, managed Federally by the USEPA, with a focus of improving the waters, habitats, and living resources of estuaries of national significance. The National Estuary Program is a non-regulatory program. The San Francisco Estuary, consisting of the San Francisco and Suisun Bays, the Suisun Marsh, and the Sacramento and San Joaquin River Delta, is one such estuary. The San Francisco Estuary program is managed by the USEPA, State of California, and locally by the San Francisco Estuary Partnership. Management of the estuary is guided by the San Francisco Estuary Project Comprehensive Conservation and Management Plan (CCMP), which includes an action plan to manage the resources of the San Francisco Estuary.

Affected Environment

Big Break was historically tidal marsh before levees were constructed to reclaim the land for agriculture. Big Break's lands then became submerged when the levees failed. Before land reclamation for agriculture and flood control activities around the turn of the 20th century, the Delta supported a complex network of rivers and sloughs with in-channel islands and vast expanses of tidal marsh. Much of the vegetation of the Delta (approximately 380,000 acres; 1,538 square kilometers) was dominated by tidal marshes (Atwater 1980; Institute 1998). By 1930, island reclamation was complete, and by 1980, only about 16,000 acres (65 square kilometers) of marshes remained (Atwater 1980; The Bay Institute 1998). Today, these areas of former tidal marshes consist primarily of channelized waterways surrounding highly productive row-cropped agricultural islands that are protected from flooding by over 1,300 miles (2,093 kilometers) of levees.

Despite the loss of more than 95 percent of historic tidal marsh habitat in the Delta (The Bay Institute 1998), fish and wildlife diversity is high, with an estimated 200 species of birds, 55 species of fish, 22 species of reptiles, 58 species of mammals, and 9 species of amphibians occurring in the Delta (California DWR et al. 2013).

Freshwater intertidal marsh is the vegetation type and habitat proposed for restoration under the current alternatives. Other planning efforts in the Delta are also underway, including the Delta Vision Strategic Plan, the Delta Plan, the California WaterFix (formerly BDCP), and California EcoRestore, to restore tidal marsh and improve the ecological health of the Bay-Delta Ecosystem. The proposed Dutch Slough Tidal Restoration Project, adjacent to and east of Big Break, will restore tidal wetlands and other habitats on 1,166 acres of land owned by DWR in eastern Contra Costa County near Oakley. The former dairy lands were slated for residential development, but were instead purchased by the State so that declining natural habitats of the Delta could be restored to the site. Restoration at Big Break and Dutch Slough would in combination create a large continuous block of restored habitat which would be important for dispersal of plant and wildlife populations and those species requiring large habitat blocks.

General Description of Habitat Types in the Study Area

This section describes the habitat types in the project area and the wildlife that occupy these habitats. The description of existing conditions is based on a literature review, field visits, and coordination with resource agencies.

Tidal Perennial Aquatic

The tidal perennial aquatic natural community is the dominant habitat cover type within the flooded islands. This aquatic community in the Delta is identified as deep water aquatic (greater than 10 feet MLLW), shallow aquatic (less than or equal to 10 feet MLLW) and non-vegetated intertidal (mudflat) zones of estuarine bays, river channels, and sloughs (CALFED Bay-Delta Program 2000). However, the only habitat that is present in the immediate project area is shallow aquatic habitat with a shallow band of emergent vegetation and an upland/riparian combination located on the remnant levee. Under present water operation conditions in the project area, tidal perennial aquatic is mainly freshwater, with brackish and saline conditions occurring at times of high tides and low freshwater inflows.

Vegetation. The tidal perennial aquatic natural community is largely unvegetated. Where vegetation exists, it can be separated into two categories: submerged aquatic vegetation and floating vegetation (both rooted and non-rooted) (Cowardin et al. 1979). The geographic extent of this vegetation is highly dynamic because it is largely dependent on physical factors that are highly variable, such as depth, turbidity, water flow, salinity, substrate, and nutrient with a nitrogen fixing bacteria that lives within its tissues (Armstrong 1979). Invasive water hyacinth (*Eichhornia crassipes*) grows in dense mats that can have harmful effects on native fish and plant species.

Wildlife. Zooplankton in the foodweb of the tidal perennial aquatic natural community consume phytoplankton and detritus, and are fed upon by other consumers, such as fish and macroinvertebrates. Water salinity is a major factor that influences the distribution of zooplankton species in the tidal perennial aquatic natural community. In the brackish portions of the project area, calanoid copepods (*Calanoida spp.*), and cyclopoid copepods are the primary zooplankton species, and mysid shrimp (*Mysida spp.*) is the dominant macrozooplankton. In freshwater regions, cladocerans (*Cladocera*) and calanoid copepods are the dominant zooplankton present (Kimmerer and Orsi 1996; Kimmerer 2004; Gewant and Bollens 2005; Winder and Jassby 2010). It is used as habitat by fish for foraging, spawning, egg incubation and larval development, juvenile nursery areas, and migratory corridors. Most species spend their entire lives in the community while others may spend certain seasons or part of their lives in habitats outside of the tidal perennial aquatic natural community depending on the state of physical factors such as salinity, turbidity, dissolved oxygen (DO), flow rates, and water temperature. The terrestrial species known to forage in tidal perennial aquatic habitat include Townsend's big-eared bat (*Corynorhinus townsendii*), California least tern (*Sterna antillarum browni*), and giant garter snake (*Thamnophis gigas*).

In addition to its value as habitat for fish, the tidal perennial aquatic natural community provides reproduction, feeding, and resting habitat for many species of mammals and birds. Open water areas supply habitat for rest and foraging by water birds, especially during heavy winter storms when open coastal waters become rough. Bird species that use the inland open water include loons (*Gavia* spp.), gulls (*Laridae* spp.), cormorants (*Phalacrocoracidae*), and diving ducks (*Aythyinae*) (CALFED Bay-Delta Program 2000).

<u>Tidal Freshwater Emergent Wetland</u>

The tidal freshwater emergent wetland natural community is typically a transitional community between the tidal perennial aquatic, and valley/foothill riparian and various terrestrial upland communities across a range of hydrologic and edaphic conditions. In the study area, the tidal freshwater emergent wetland natural community often occurs at the shallow, slow-moving or stagnant edges of freshwater waterways in the intertidal zone and is subject to frequent long duration flooding.

The tidal freshwater emergent wetland natural community is distributed in narrow, fragmented bands along island levees, in-channel islands, shorelines, sloughs, and shoals. Channelization, levee building, removal of vegetation to stabilize levees, and upstream flood management have also reduced the extent of this community and altered its ecological function through changes to flooding frequency, inundation duration, and quantity of alluvial material deposition.

The tidal freshwater emergent wetland natural community occurs along a hydrologic gradient in the transition zone between open water and riparian vegetation or upland terrestrial vegetation such as grasslands or woodlands. In the project area, there are often abrupt transitions to agricultural habitats and managed wetland natural communities and also along the boundaries formed by levees and other artificial landforms. The environmental conditions that support the tidal freshwater emergent wetland natural community are dynamic with frequent flooding disturbances and geomorphologic changes (i.e., alluvial deposition and scouring). Its constituent species composition and ecosystem functions are consequently variable in space and time (The Bay Institute 1998). As a result of the different sources of variability and the anthropogenically restricted area in which it can occur, the community vegetation may be distributed in small patches or in occasional large areas.

Soils underlying the tidal freshwater emergent wetland natural community are heavily influenced by inundation period, water flow, and alluvial deposition. They are hydric soils and when mineral based, their texture can vary from clay to sand; and when based on organic material, can form peat beds (Goman and Wells 2000; Hitchcock et al. 2005; Drexler et al. 2009a). The soils are typically anaerobic due to frequent or permanent saturation with slow decomposition rates resulting in the accumulation of organic debris in various stages of decomposition. The composition of the vegetation is limited to relatively few dominant species that are tolerant of inundation and anaerobic soil conditions and typically are not tolerant of saline or brackish conditions (Holland and Keil 1995).

Although the project area at Big Break provides adequate habitat for emergent wetlands, there is not any significant source of this habitat type within the Big Break area. However, if successful, the proposed alternatives would provide this habitat type, therefore it is still discussed in detail in this analysis.

Vegetation. The tidal freshwater emergent wetland natural community is characterized by erect herbaceous hydrophytes (Holland and Keil 1995). The typical vegetation of this type, as mapped by CDFW and adopted for vegetation mapping purposes, is dominated by tall, perennial monocots that reproduce by seed as well as vegetatively through rhizomes. However, the CDFW vegetation classification was based on vegetation structure and species composition and did not consider ecosystem functions such as location within or above the intertidal region along drainages. In many areas of what is functionally tidal freshwater emergent wetland, woody species, especially willows (*Salix* spp.), occur in the intertidal region and co-dominate the vegetation (Atwater 1980; Watson 2006; EDAW 2007a; Watson and Byrne 2009). These intertidal areas with woody vegetation were not distinguishable in the CDFW data set.

Cattails dominate the vegetation of this community along the Sacramento River; while throughout the San Joaquin River area, bulrushes, tules, and common reed are more often the dominant species (Atwater 1980; Watson 2006; EDAW 2007a; Hickson and Keeler-Wolf 2007; Watson and Byrne 2009). In the far western portion of the Delta, where tidal waters are generally fresh but may be brackish during periods of low outflow, saltgrass (*Distichlis spicata*) becomes common (Boul and Keeler-Wolf 2008). Numerous native and nonnative dicots and rooted aquatics also commonly occur in the tidal freshwater emergent wetland natural community.

Wildlife. The tidal freshwater emergent wetland natural community provides productive habitat for wildlife. Its vegetation and associated waterways provide food and cover for numerous species of birds (e.g., waterfowl, wading birds), mammals, reptiles, emergent aquatic insects, and amphibians. Fish such as salmonid species use tidal freshwater emergent wetland habitat for foraging, juvenile rearing, and refugia. Terrestrial species that rely on tidal freshwater emergent wetland for habitat include Townsend's big-eared bat, California black rail (*Laterallus jamaicensis*), Suisun song sparrow (*Melospiza melodia*), tricolored blackbird (*Agelaius tricolor*), giant garter snake, western pond turtle (*Actinemys marmorata*), California red-legged frog (Rana draytonii), delta mudwort (*Limosella australis*), Delta tule pea (*Lathrus jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), and Suisun marsh aster (*Symphyotrichum lentum*).

Although the remaining areas of tidal freshwater emergent wetlands in the project area are highly altered, they remain critical wintering grounds for migratory birds. A small number of wetland associated species, such as waterfowl and egrets, have successfully adapted to foraging on some types of croplands that were converted from historical wetland areas (CDFG 2005). Many of the species of fish that use the tidal perennial aquatic natural community for habitat will also use the tidal freshwater emergent wetland natural community as habitat. Younger stages (e.g., larvae and fry) of some salmonid species rear in shallow waters that support emergent vegetation. Many fish species use emergent vegetation as refuge from predation and high flows (Bay Institute 1998).

Existing Vegetation Types in the Project Area

The dominant vegetation types in the project area include emergent tidal marsh, riparian scrub/woodland, and submerged and floating aquatic vegetation. Big Break is currently characterized by vast expanses of open water habitat. Although Big Break has been flooded for a number of years, it has not accumulated enough sediment to support the reestablishment and expansion of tidal marsh vegetation. Vegetation cover types for the Big Break area is shown on Figures 4-1.

Big Break is subject to daily tidal fluctuations and is at a sufficient distance from the Bay that the tidal waters inundating this area have minimal salinity levels. A remnant levee runs along the northern border of the area. Riparian scrub vegetation dominated by arroyo willow and Himalayan blackberry (*Rubus armeniacus*) grows along the upper portions of this levee, but the lower elevations of the levee support a low cover of tidal marsh vegetation. Extensive stands of perennial emergent marsh are present within the open water habitat. Different elevations have created a mosaic of emergent species in this perennial freshwater marsh with common three-square in shallowly inundated areas, cattail and tule in deeper waters, and California bulrush (*Schoenoplectus californicus*) in the deepest waters (Vollmar 2000).

Flats along the shore support large stands of arroyo willow scrub. Riparian habitats also support small stands of tree species such as Fremont cottonwood (Populus fremontii), Goodding's willow (*Salix gooddingii*), northern California black walnut (*Juglans hindsii*), coast live oak (*Quercus agrifolia*), California wild rose (*Rosa californica*) and red alder (*Alnus rubra*).

A portion of the Big Break study area supports upland habitat. This upland area is located in the southwestern corner of the study area and primarily supports alkali grassland. Alkali grassland is dominated by perennial grasses including saltgrass and creeping wildrye (*Leymus tritcoides*). Associated species are predominantly nonnative annual grasses and forbs such as perennial pepperweed (*Lepidium*), wild oats (*Avena fatua*), ripgut brome (*Bromus diandrus*), telegraph weed (*Heterotheca grandiflora*), and spring vetch (*Vicia sativa*).

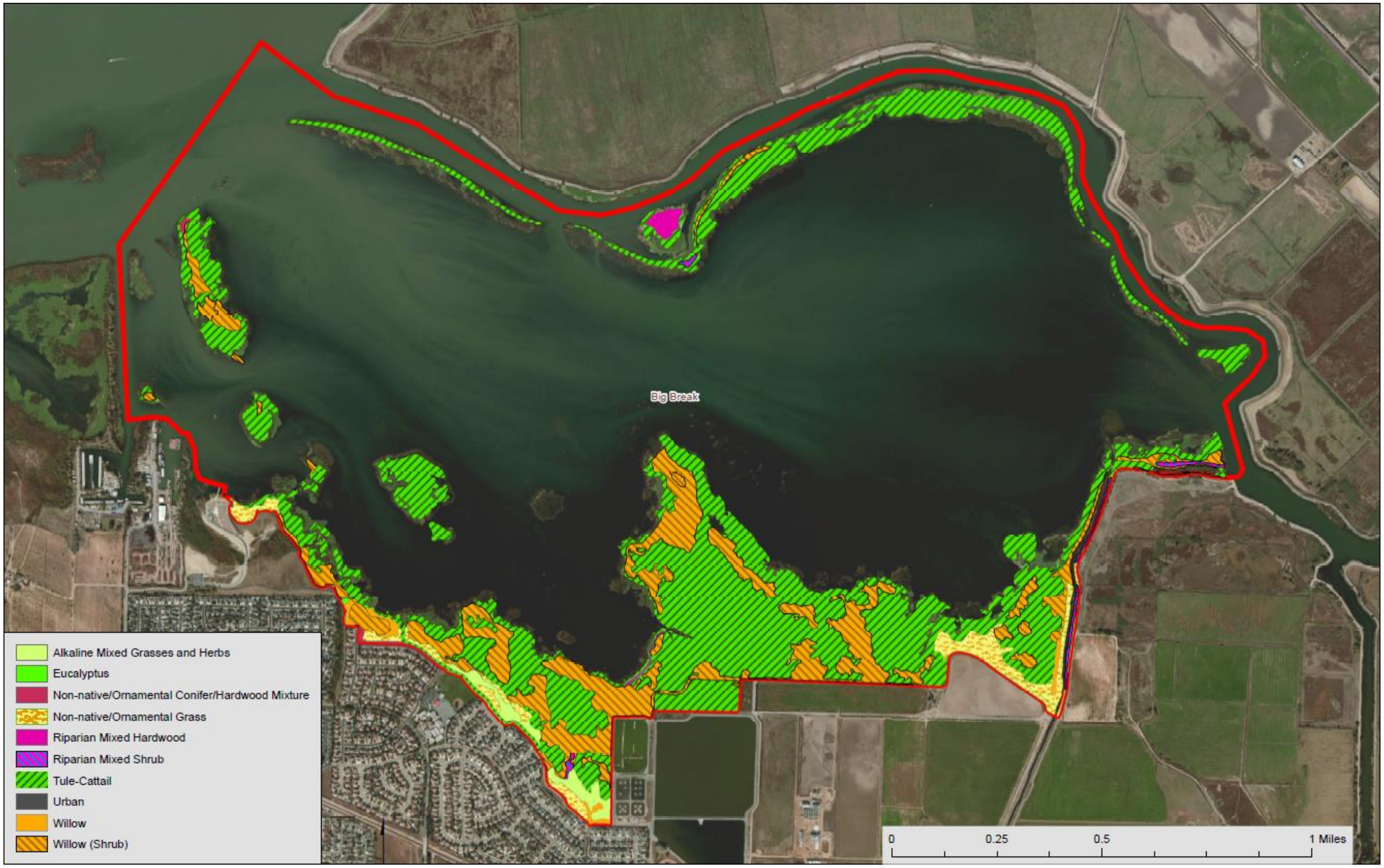

Figure 4-1. Big Break Vegetation Map

Other upland habitats present at this location include nonnative tree stands and disturbed or developed areas. The scattered stands of nonnative trees are dominated by black locust (*Robina pseudoacacia*), tree of heaven (*Ailanthus altissima*), and white poplar (*Populus alba*). Isolated individual trees are predominantly nonnative species such as eucalyptus (*Eucalyptus globulus*) and tamarisk (*Tamarix*). Disturbed/developed areas are dominated by nonnative and invasive plant species or support buildings and/or paved roads. Infestations of *Egeria* and water hyacinth are present within the extensive open water habitat of Big Break.

4.2.4 Special Status Species

This section describes special status species that either occur or have the potential to occur in the project area that may be potentially impacted by the project.

Regulatory Setting

Federal

Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c)

This Act provides protections for bald and golden eagles and requires a permit from the Secretary of the Interior for any actions that may result in take of these species. The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb”. This Act also covers impacts that result from human alterations initiated around previously used nest sites.

Federal Endangered Species Act (16 U.S.C. 1531 et seq.)

The FESA requires that any action authorized by a Federal agency not be likely to jeopardize the continued existence of a threatened or endangered species, or result in the destruction or adverse modification of habitat of such species that is determined to be critical. Section 7 of the FESA, as amended, requires Federal agencies to consult with the USFWS and NMFS to ensure that project actions do not jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of the critical habitat of these species.

Migratory Bird Treaty Act (16 U.S.C. §703-712)

This act implements treaties that the United States has signed with a number of countries to protect birds that migrate across national borders. The act makes unlawful the taking, possessing, pursing, capturing, transporting, or selling of any migratory bird, its nest or its eggs.

Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801) (Magnuson-Stevens Act)

The Magnuson-Stevens Act establishes a management system for national marine and estuarine fishery resources. This legislation requires that all Federal agencies consult with the NMFS regarding all actions or proposed action permitted, funded, or undertaken that my adversely affect "essential fish habitat". Essential fish habitat (EFH) is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The legislation states that migratory routes to and from anadromous fish spawning grounds are considered EFH. The phrase "adversely affect" refers to the creation of any impact that reduces the quantity or quality of EFH.

Affected Environment

Information on special status species that may be affected by the project was gathered from various sources:

- The USFWS online services species list (USFWS, accessed on 19 March 2018); and
- CDFW's California Natural Diversity Database (CDFW 2018).

The USFWS query was run using the Information for Planning and Consultation (IPaC) system based off of a polygon of the project area. The query has been run a number of times over the course of the study including in September 2011, August 2016, January 2018, and May 2018. The database query from CDFW was done using the CNDDB system based off of all species occurring in Contra Costa County. The resulting queries are included in Appendix G. All lists were reviewed; habitat preferences for each species were compared with the affected areas and project site description. Those Federally listed special status species known to occur, or with suitable habitat, in or near the project area are identified in Table 4-1 and discussed in detail below.

The following species were identified on the IPaC list, but were eliminated from consideration under this study. The reasons for their elimination are also listed below.

- Clapper Rail: Habitat for the clapper rail is salt marsh found directly along the coast and the San Francisco and Suisun Bays. The inland freshwater portion of the Delta does not provide suitable habitat for this species.
- California Red-legged frog: The frog spends most of their lives in and near sheltered backwaters of ponds, marshes, springs, streams, and reservoirs. Deep pools with dense stands of overhanging willows and an intermixed fringe of cattails are considered optimal habitat. This is distinctly not the habitat found in Big Break.
- California Tiger salamander: The salamander's habitat is restricted to grasslands and low foothills with pools or ponds that are necessary for breeding. The habitat within the project area is tidal open water, tidal marsh and edge riparian, and is not suitable for this species.

- Delta Green Ground Beetle: This beetle is known to only inhabit the Jepson Prairie Preserve in Solano County, south of Dixon, California.
- San Bruno Elfin Butterfly: This butterfly inhabits rocky outcrops and cliffs in coastal scrub on the San Francisco Peninsula. There is no suitable habitat in Big Break for this species.
- Vernal pool fairy shrimp: This species only inhabits is freshwater vernal pools. There are no vernal pools at Big Break.
- Vernal pool tadpole shrimp: This species only inhabits is freshwater vernal pools. There are no vernal pools at Big Break.
- Soft bird's beak: Soft bird's beak habitat is the upper reaches of salt grass/pickleweed marshes. It is widely scattered populations in the San Pablo Bay and Suisun Bay areas. It does not occur within Big Break.

Table 4-1. Federally Listed Species with Potential to Occur at Big Break

Common Name ***Scientific Name***	**Status[1]**
Plants	
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *Howellii*	E
Wildlife	
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T
Giant garter snake *Thamnophis gigas*	T
Fish	
North American green sturgeon southern Distinct Population Segment (DPS) *Acipenser medirostris*	T
Delta Smelt *Hypomesus transpacificus*	T
Steelhead, Central Valley DPS *Oncorhynchus mykiss*	T
Chinook salmon, Central Valley spring-run ESU *Oncorhynchus tshawytscha*	T
Chinook salmon, Sacramento River winter-run *Oncorhynchus tshawytscha*	E

[1] Status:
E = Listed as endangered under the FESA
T = Listed as threatened under the FESA

In addition to the above species that were identified on the IPaC list, but would not be affected by the proposed alternatives, the San Francisco Bay-Delta Distinct Population Segment (DPS) of the longfin smelt (*Spirinchus thaleichthys*) was not identified on the IPaC list, but has the potential to occur in the action area and has the potential to be affected by the proposed alternatives. The longfin smelt is a candidate species under the FESA, which means that it does not currently have protections under the Act, but assessing potential effects to this species is encouraged and recommended under NEPA. The longfin smelt tend to be more associated with the San Francisco Bay than with the freshwater portion of the Delta; however, there have been occurrences of longfin smelt entrainment during O&M dredging. While there is the potential for construction of the proposed alternatives to impact longfin smelt, this species is very similar in habitat requirements and potential impacts from the action to the Delta smelt; therefore the below description for Delta smelt habitat and the impact assessment for Delta smelt in Chapter 5 are both applicable to this species as well. Longfin smelt is not discussed further in this document as a result.

Special Status Plant Species

The Delta is home to many plant species, many of which are endemic. One Federally listed special status plant species has been reported in the Big Break project area (Table 4-1). The records search of CNDDB (2018) reports populations of the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) at or in the vicinity of Big Break. There were number of plant species that were listed in the CNDDB database query; however, the only Federally listed species is the Antioch Dunes evening-primrose. Information on these additional species is in Appendix G.

Special Status Wildlife Species

Eight special-status wildlife species were identified from database queries and literature searches as having potential to occur in the study area (Table 4-1). Out of the eight Federally listed species that have the potential to occur in the project area, most of these species were eliminated from further consideration since the alternatives are outside of the species range or no suitable habitat is present. The species that have the potential to occur are further discussed below.

<u>Valley Elderberry Longhorn Beetle</u>

Status. The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB) is Federally listed threatened is Federally listed as threatened. The USFWS has designated critical habitat for VELB along the American River Parkway and in an area within the Sacramento metropolitan area (54 FR 48229). The species has no State status.

Distribution and Habitat. The VELB is endemic to the Central Valley and is found in riparian habitats and associated uplands where the elderberry (*sambucus* spp.), the beetle's food plant, grows. The beetle is a pith-boring species that depends on elderberry plants during its entire life cycle. Larvae feed on tree pith, while adults eat the foliage and possibly the flowers of the plants. The adult stage of the VELB is short-lived, and most of the life cycle is spent in the larval stage. The adults are active from early March through early June with mating occurring in May. Eggs are laid singly, or in small groups, in crevices in elderberry bark and hatch in about 10 days. Larvae bore into the pith of elderberry roots, branches, and trunks to create an opening in the stem within which they pupate, remaining in this stage for one to two years before emerging as adults. After metamorphosing into an adult, the VELB chews a circular exit hole through which it emerges, sometime during the period of late March to June. It appears that VELB occupancy of elderberry shrubs is determinant upon a number of variable such as shrub condition, water availability, elderberry density, and the health of the overall riparian habitat; however, VELB have a tendency to stay within a general clumped distribution of shrubs (USFWS 2017.

Potential for Occurrence in Project Area. There are no CNDDB records in the project area. Elderberry shrubs are not likely to be present in the project area.

Giant Garter Snake

Status. The giant garter snake is Federally and State-listed as threatened.

Distribution and Habitat. The giant garter snake is endemic to wetlands in the Sacramento and San Joaquin valleys (Hansen and Brode 1980). The current distribution extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County.

Rice fields and their adjacent irrigation and drainage canals and ditches serve an important role as aquatic habitat for the snakes. During the summer, some snakes use the flooded rice fields as long as their prey is present in sufficient densities. In late summer, rice fields provide important nursery areas for newborns. In late summer/fall, water is drained from the rice fields and the snakes prey items become concentrated in the remaining pockets of standing water, which allow the snakes to gorge before the winter their period of winter inactivity (USFWS 1999). It appears that the majority of the snakes move back into the canals and ditches as the rice fields are drained, although a few may overwinter in the fallow fields, where they hibernate within burrows in the small berms separating the rice checks (Hansen 1998).

Potential for Occurrence in Project Area. A giant garter snake was found on Webb Tract (adjacent to Franks Tract to the North) during April, 2002, near the ferry dock. One giant garter snake was found in 1998 near Sherman and Decker Islands, but it is not known whether this snake represented a resident population in the western Delta or was washed into the Delta from high-water flows in the winter. Another garter snake was observed at the north end of the Antioch Bridge before the mid-1980s (IES 2000). Sherman Island (adjacent to Lower Sherman Island to the east) has been identified for recovery efforts in the Draft Recovery Plan for Giant Garter Snakes (USFWS 1999).

Intensive trapping surveys conducted within Contra Costa County independently by Eric Hansen and by Biological, Inc. have failed to detect giant garter snake (Contra Costa County, 2006). Likewise, Swaim intensively trapped in regions northeast of Oakley in 2003 and 2005, including Marsh Creek, Big Break, and Contra Costa Canal, without success (Swaim 2004, Swaim 2005a-f, Swaim 2006).

Giant garter snake may potentially be using drainage and irrigation channels near the overland pipeline layout over Jersey Island. A single giant garter snake was sighted in 2015 on the east side of Jersey Island, outside of the proposed action area. Based on the studies discussed above, giant garter snakes have the potential to be present in the action area.

Special Status Fish Species

The Bay–Delta estuary, including the Delta flooded islands, serves as habitat for a variety of special status fish species, several of which have been listed for protection under the FESA. California Central Valley steelhead trout are present seasonally within the Delta. Green sturgeon inhabit Suisun Bay and the Delta. Delta smelt and juvenile Chinook salmon identified as winter-run and spring-run Chinook salmon have been collected within Suisun Bay and the Delta, including the flooded islands.

Chinook salmon, (winter-run and spring-run) and steelhead, (Central Valley Evolutionary Significant Unit or ESU use the Delta in the vicinity of Big Break as a migratory corridor. In addition, Delta smelt, have been documented within the waters of Suisun Bay and the Delta, including the flooded islands. Big Break is in the area designated as EFH for managed species, including Pacific salmon. Table 4-1 shows the listed species that have the potential to occur within the project area.

Southern Distinct Population Segment (sDPS) Green Sturgeon

Status. Southern DPS green sturgeon are listed as a Federally threatened species under the FESA (75 FR 30714).

Distribution and Habitat. Southern DPS green sturgeon are the most marine species of sturgeon, making extensive oceanic migrations and only coming into freshwater rivers to spawn. Adults migrate into rivers to spawn from April to July, with May to June being the peak season. Southern DPS green sturgeon first reach sexual maturity at age 15 for males and 17 for females, with spawning thought to occur every 3 to 5 years (Tracy 1990 in Adams et al. 2002). Preferred spawning substrate likely is large cobble but can range from clean sand to bedrock (Moyle 1992 in Adams et al. 2002). Eggs are broadcast and externally fertilized in relatively fast water and probably in depths greater than 3 meters (about 10 feet). Specific water quality requirements are unknown, but a small amount of silt is known to prevent the eggs from adhering to each other, thus increasing survival (Moyle 2002).

Young sDPS green sturgeon grow rapidly, reaching 74 millimeters (about 3 inches) 45 days post-hatching. Based on trapping data from the Red Bluff Diversion Dam (RBDD) and the Glenn-Colusa Irrigation District (GCID) trap, juvenile sDPS green sturgeon average 29 millimeters in length during June and July at RBDD, and 36 millimeters in July at GCID. Juvenile sDPS green sturgeon may spend between 1 and 3 years in fresh water before migrating to the ocean (Adams et al. 2002), but may spend time near estuaries at first to rear (Moyle 2002, 111). Juvenile sDPS green sturgeon have been collected in the Sacramento River, near Hamilton City, and in the Delta and San Francisco Bay. According to Kohlhorst et al. (1991), juveniles inhabit the estuary until they are approximately 4 to 6 years old, when they migrate to the ocean.

Adult and juvenile sDPS green sturgeon are benthic (bottom) feeders, but may also take small fish. Juveniles in the Sacramento–San Joaquin Estuary feed primarily on opossum shrimp and amphipods (Moyle 2002).

Southern DPS green sturgeon adults occur in the project area on the Sacramento River when migrating to and from upstream spawning habitat. Juveniles may occur in the project area during downstream migration. Juveniles also may rear in the area. The general behavior and distribution patterns indicate that the earliest life stages (larvae and post-larvae) rear upstream of the project area in the Sacramento River for several months before migrating to the Delta and estuary. Salvage and trawling records from the Delta suggest that most juveniles in the project area are likely to be more than 200 millimeters long and at least 9 months old. Juveniles move downstream in the Sacramento River from May to August (Beamesderfer et al. 2007).

Population abundance information concerning the Southern DPS of green sturgeon is described in the NMFS status reviews (Adams et al. 2002; NMFS 2005). Limited population abundance information comes from incidental captures of North American green sturgeon from the CDFW white sturgeon monitoring program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFW provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish in 1993 to more than 8,421 in 2001, and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFW does not consider these estimates reliable since the population estimates are based on small sample sizes, intermittent reporting, and inferences made from white sturgeon catches. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile Southern DPS of green sturgeon per year (Adams et al. 2002).

Potential for Occurrence in Project Area. Southern DPS green sturgeon may occur seasonally within Big Break as juveniles and adults. The area may allow the upstream passage of adults and the downstream emigration of juveniles (NMFS 2006).

Delta Smelt

Status. Delta smelt are listed as a threatened species under the FESA (58 FR 12854).

Distribution and Habitat. Delta smelt are endemic to the Sacramento–San Joaquin Delta estuary. Delta smelt inhabit the freshwater portions of the Delta and Sacramento and San Joaquin rivers and the low-salinity portions of Suisun Bay. They typically are found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt have relatively low fecundity and most live for 1 year. They feed on planktonic copepods, cladocerans, amphipods, and insect larva (Moyle 2002).

Adult Delta smelt migrate upstream into channels and sloughs of the eastern Delta during fall and winter in preparation for spawning. Delta smelt live their entire life cycle in the Sacramento–San Joaquin Delta. USFWS has prepared a recovery plan for Delta smelt that identifies criteria for evaluating the status of the Delta smelt population (USFWS 1996). These criteria include annual indices of abundance and geographic distribution in the estuary as determined through CDFW's fall mid-water trawl surveys. Indices of abundance and geographic distribution of Delta smelt have improved in recent years. USFWS continues to evaluate the available scientific information regarding the status of Delta smelt and the performance of various management actions designed to improve protection, reduce mortality, and enhance habitat quality and availability within the estuary.

Potential for Occurrence in Project Area. As a result of their life history and geographic distribution, Delta smelt may occur seasonally within Big Break as eggs, larvae, juveniles, and adults. Larval, juvenile, and adult Delta smelt are most abundant in the vicinity of Big Break during spring, summer, and fall (CDFW unpublished data).

Sacramento River Winter-run Chinook Salmon

Status. Winter-run Chinook salmon is Federally listed as an endangered species (70 FR 37104). The NMFS designated critical habitat for Sacramento River winter-run Chinook salmon in 1993 (58 FR 33212). The critical habitat designation includes the Delta and the Sacramento River.

Distribution and Habitat. Sacramento River winter-run Chinook salmon spend 1 to 3 years in the ocean. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from December through July, with peak migration in March. Adults spawn from mid-April through August, and egg incubation continues through October (Moyle 2002). The primary spawning habitat in the Sacramento River is above the RBDD at river mile (RM) 243, although spawning has been observed downstream as far as RM 218 (NMFS 2001). Spawning success below the Red Bluff Diversion Dam may be limited primarily by warm water temperatures (Yoshiyama et al. 1998). Sacramento River winter-run Chinook salmon smolts (i.e., juveniles that are physiologically ready to enter seawater) may migrate through the Delta and bay to the ocean from November through May (Yoshiyama et al. 1998). In general, juvenile abundance in the Delta increases in response to increased Sacramento River flow (Brandes and McLain 2001).

Potential for Occurrence in Project Area. Juvenile winter-run Chinook salmon are found in the Sacramento-San Joaquin Delta from October through early May based on data collected from trawls, beach seines, and salvage records associated with both State and Federal water projects (CDFG 1998). Juveniles arrive in the upper Delta from January to March, and rear in freshwater areas for the first 2 months (Kjelson et al. 1981, 1982). As they grow, fry and fingerlings tend to rear in the downstream portions where the ambient salinity is roughly 1.5 to 2.5 parts per thousand (Healey 1980, 1982; Levings et al. 1986).

Winter-run Chinook salmon critical habitat, encompassing the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0), the Carquinez Straight, Suisun, Honker, Grizzly and San Pablo Bays, and San Francisco Bay north of the Oakland Bay Bridge, has been designated by NMFS. In addition to the water and channel bottom, critical habitat includes the adjacent riparian zone, which provides “cover and shade to the near-shore aquatic areas” (58 CFR 33212). Big Break is within the region identified as EFH for Pacific salmon (*Oncorhynchus* species), including the winter-run Chinook, spring-run Chinook, and fall/late fall-run Chinook.

Central Valley Spring-run Chinook Salmon

Status. The Central Valley spring-run Chinook salmon ESU was Federally listed as threatened on 16 September 1999 (64 FR 50394). Their threatened status was reaffirmed in the NMFS final listing determination issued on 28 June 2005 (70 CFR 37160). Critical habitat for Central Valley spring-run Chinook salmon was designated by NMFS on 2 September 2005 (70 FR 52488). Designated critical habitat includes the San Francisco Bay-Delta estuary, mainstem Sacramento River upstream to Keswick Dam, and most of the Sacramento Valley's perennial tributaries with established spring salmon runs, including the Feather River and Feather River Hatchery.

Distribution and Habitat. Spring-run Chinook salmon were historically widely distributed and abundant within the Sacramento and San Joaquin River systems (Yoshiyama et al. 1998). Spring-run Chinook salmon historically migrated upstream into the upper reaches of the main-stem rivers and tributaries for spawning and juvenile rearing (Moyle 2002). Construction of major dams and reservoirs on these river systems eliminated access to the upper reaches for spawning and juvenile rearing, and completely eliminated the spring-run Chinook salmon population from the San Joaquin River system (Moyle 2002). Spring-run Chinook salmon abundance has declined substantially (NMFS 2009), and the geographic distribution of the species in the Central Valley has also declined substantially. Spring-run spawning and juvenile rearing currently occur consistently in only a small fraction of their previous geographic distribution, including populations inhabiting Deer, Mill, and Butte Creeks, the main-stem Sacramento River, several other local tributaries on an intermittent basis, and the lower Feather River (Moyle 2002). Recent genetic studies show that spring-run Chinook salmon returning to the lower Feather River are genetically similar to fall-run Chinook salmon. Hybridization between spring-run and fall-run Chinook salmon, particularly on the Feather River where both stocks are produced within the Feather River hatchery, is a factor affecting the status of the spring- run Chinook salmon population. NMFS is in the process of developing a recovery plan for Central Valley spring-run Chinook salmon.

Probability of Occurrence in Project Area. Central Valley spring-run Chinook salmon occur in the Delta either as adults migrating upstream to their spawning habitat, or as juveniles, rearing and migrating towards the ocean. Spring-run Chinook salmon have the potential to occur in the study area due to the presence of rearing and migratory habitat. Although the majority of adult spring-run Chinook salmon migrate upstream in the main-stem Sacramento River passing Sherman Lake, there is a probability, although low, that adults may migrate into the central Delta. The occurrence of adult spring-run Chinook salmon in the western and central Delta in the vicinity of Big Break, although expected to be very low, would be limited to the late winter and spring adult upstream migration.

California Central Valley (CCV) Steelhead

Status. The CCV steelhead Distinct Population Segment (DPS) (formerly ESU) was Federally listed as threatened on 19 March 1998 (63 FR 13347) and its threatened status was reaffirmed in the NMFS final listing determination on 5 January 2006 (71 FR 834). Critical habitat for California Central Valley steelhead was designated on 2 September 2005 (70 FR 52488), and includes all river reaches accessible to steelhead in the Sacramento and San Joaquin Rivers and their tributaries.

Distribution and Habitat. CCV steelhead historically migrated upstream to the high gradient upper reaches of Central Valley streams and rivers for spawning and juvenile rearing. Construction of dams and impoundments on most Central Valley rivers has created impassable barriers to upstream migration and substantially reduced the geographic distribution of steelhead. Although quantitative estimates of the number of adult steelhead returning to Central Valley streams to spawn are not available, anecdotal information and observations indicate that population abundance is low. Steelhead distribution is currently restricted to the main-stem Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, the American River downstream of Nimbus Dam, the Mokelumne River downstream of Comanche Dam, and a number of smaller tributaries to the Sacramento River system, Delta, and San Francisco Bay. The project areas within the San Joaquin River system serve as EFH for managed species, including Pacific salmon. Big Break supports juvenile rearing and migration.

Steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents of the species are referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead. The California Central Valley steelhead population is composed of both naturally spawning steelhead and steelhead produced in hatcheries.

In the Sacramento River, adult CCV steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March. Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April. Individual steelhead may spawn more than once, returning to the ocean between each spawning migration. Juvenile CCV steelhead rear a minimum of 1 year, but typically spend 2 or more years in fresh water before migrating to the ocean during smoltification, which is the process of physiological change that allows ocean survival. Juvenile migration to the ocean generally occurs from December through August. The peak months of juvenile migration are January to May (McEwan 2001).

Potential for Occurrence in Project Area. CCV steelhead occur in the Delta as adults, migrating upstream to their spawning habitat, and as juveniles and smolts rearing and migrating toward the ocean. CCV steelhead have the potential to occur in the study area due to the presence of rearing and migratory habitat. Although the majority of adult CCV steelhead migrate upstream in the main-stem Sacramento River, there is a probability that adults migrate through the central Delta and would be present seasonally in the vicinity of Big Break. The occurrence of adult steelhead within the Delta, and potentially within Delta flooded islands, would be limited to the winter and early spring adult upstream migration.

Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. § 1801 et seq.), pursuant to Section 305(b), require the identification of EFH for Federally managed fishery species and the implementation of measures to conserve and enhance this habitat (50 CFR § 402.14(j)). EFH is the aquatic habitat (water and substrate) necessary to fish for spawning, breeding, feeding, or growth to maturity that would allow a level of production needed to support a long-term, sustainable commercial fishery and contribute to a healthy ecosystem (NMFS 2002).

Because the project has the potential to adversely affect EFH for the following fishery management plan (FMP), the Corps requested consultation pursuant to Section 305(b) of the MSA for:

- Pacific Salmon FMP (Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central valley fall-/late fall-run Chinook salmon) (*O.tshawytscha*)

Necessary elements of EFH for spawning, rearing, and migration include sufficient substrate composition; water quality; water quantity, depth, and velocity; channel gradient and stability; food (invertebrates); cover and habitat complexity; space; access and passage; and habitat connectivity. The EFH components that may be influenced by dredged material placement are adult migration and juvenile migration and rearing (Corps and EPA 2003).

Critical Habitat

The Sacramento and San Joaquin Rivers and the Bay–Delta estuary serve as a migration corridor for anadromous salmonids, sDPS green sturgeon, and delta smelt which have been listed for protection under the FESA. Listed salmonids that occur seasonally in the Delta in the vicinity of the flooded islands include winter-run Chinook salmon, spring-run Chinook salmon, and CCV steelhead as well as the Federally listed delta smelt. The Sacramento River and Bay–Delta estuary are designated as critical habitat by NMFS for winter-run and spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. The Bay–Delta estuary, including the flooded islands, has been designated as critical habitat by USFWS for Delta smelt.

4.2.5 Water Quality

This section describes the existing surface and groundwater water resources and quality, and jurisdictional wetlands in the project area. Water quality analysis is divided into conventional pollutants and bioaccumulation potential. For this analysis, conventional pollutants analyzed are:

- pH;
- Turbidity;
- Total dissolved solids (TDS);
- Dissolved oxygen (DO);
- Nutrients, including total organic carbon (TOC), nitrogen, and phosphorus;
- Trace elements including arsenic, cadmium, chromium, copper, lead, nickel, zinc; and
- Mercury.

Regulatory Setting

Clean Water Act

The Clean Water Act (CWA) is the primary Federal law governing water quality. It established the basic structure for regulating discharges of pollutants into waters of the U.S. and gives the USEPA the authority to implement pollution control programs, such as setting wastewater standards for industries (USEPA 2002). In some states, such as California, the USEPA has delegated authority to regulate Section 401 and 402 of the CWA to state agencies.

Section 401 of the CWA regulates the water quality for any activity that may result in any in-water work or discharge into navigable waters. These actions must not violate Federal water quality standards. The Central Valley RWQCB administers Section 401 in California, and either issues or denies water quality certifications that typically include project-specific requirements established by the RWQCB to ensure attainment of water quality standards.

Section 404 of the CWA requires that a permit be obtained from USEPA and USACE when an action will result in discharge of dredged or fill material into wetlands and waters of the U.S. Under Section 404, USACE regulates such discharges and issues individual and/or general permits for these activities. Before USACE can issue a permit under Section 404, it must determine that the project is in compliance with the CWA Section 404(b)(1) guidelines. The 404(b)(1) guidelines specify that "no discharge of dredged or fill material shall be permitted if there is a practical alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR 230.10[a]). USEPA has "veto" authority over permits issued by USACE.

When conducting its own civil works projects, USACE does not issue permits to themselves. Rather, USACE would comply with the guidelines and substantive requirements of the CWA, including Section 404, and Section 401. The discharge of fill material would be required to comply with 404(b)(1) guidelines with the inclusion of appropriate measures to minimize pollution or adverse effects on the aquatic ecosystem. A Section 401 water quality certification will be required from the Central Valley RWQCB prior to construction.

The project would also require a National Pollution Discharge Elimination System (NPDES) permit since it would disturb 1 or more acre of land and involves possible storm water discharges to surface waters. Prior to construction, the contractor would be required to prepare a SWPPP and then submit a Notice of Intent (NOI) for a Construction General Permit (CGP) form to the Central Valley RWQCB, requesting approval of the proposed work. This storm water plan would identify best management practices to be used to avoid or minimize any adverse effects of construction on surface waters. Once the work is completed, the contractor would submit a Notice of Termination (NOT) in order to terminate coverage by the CGP permit.

Affected Environment

Primary Factors Affecting Water Quality

Primary factors affecting water quality in the project area include patterns of land use in the upstream watersheds and the Delta, operations of the SWP and CVP. The CVP is operated by the Bureau of Reclamation; it is one of the world’s largest water storage and transport systems. The CVP is a Federal water management project under the supervision of the U.S. Bureau of Reclamation. The CVP provides irrigation and municipal water to much of California's Central Valley by regulating and storing water in reservoirs in the water-rich northern half of the state, and transporting it to the water-poor San Joaquin Valley by means of a series of canals, aqueducts and pump plants, some shared with the SWP.

Point and nonpoint pollutant sources include historic and recent drainage from inactive and abandoned mines and related debris/sediment, industrial and municipal wastewater treatment plant discharges, agricultural drainage, urban stormwater runoff, atmospheric deposition, recreational uses, and metabolic waste (e.g., pathogens) from wildlife. Other major point sources consist primarily of municipal wastewater treatment plants and nonpoint sources consist of urban stormwater runoff of pollutants. Natural erosion and instream sediments, atmospheric deposition, and geothermal inputs also affect Delta water quality. The principal contaminants and conditions affecting water quality in the Delta are as follows (CALFED Bay-Delta Program 2000).

- Historical drainage and sediment discharged from upstream mining operations in the late 1800s and early 1900s has contributed metals, such as cadmium, copper, and mercury.
- Stormwater runoff can contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (salts), petroleum products, and other chemical residues.
- Wastewater discharges from treatment plants can contribute salts, metals, trace organics, nutrients, pathogens, pesticides, organic carbon, personal care products, pharmaceuticals, and oil and grease.
- Agricultural irrigation return flows and nonpoint discharges can contribute salts (including bromide and selenium), organic carbon, nutrients, pesticides, pathogens, and sediment.
- Large dairies and feedlots can contribute nutrients, organic carbon, and pathogenic organisms.

- Water-based recreational activities (such as boating) can contribute hydrocarbon compounds, nutrients, and pathogens.
- Atmospheric deposition can contribute metals, nutrients, pesticides, and other synthetic organic chemicals, and may lower pH.
- Miscellaneous contaminants and conditions from the San Joaquin River include selenium and low DO.

Water quality can vary seasonally in response to winter spring runoff and summer-fall lower flow periods, and can also vary from year to year as a result of precipitation and snow pack levels in the upper watersheds, and the resulting releases from upstream reservoirs for water supply, flood management, and environmental obligations (e.g., fish flows, Delta water quality objective compliance), operations of the Delta Cross Channel, and seasonal and annual variations in SWP and CVP pumping rates.

As defined by USEPA, water quality standards consist of: (1) the designated beneficial uses of a water segment; (2) the water quality criteria (referred to as objectives by the state) necessary to support those uses; and (3) an antidegradation policy that protects existing uses and high water quality. Each Regional Water Board's Basin Plan identifies numeric and narrative water quality objectives, together with the beneficial uses assigned to water bodies and the state anti-degradation policy.

The latest version of the Section 303(d) list for California issued by the State Water Resources Control Board (approved April 6, 2018) identifies impaired status for waterways in the study area, including the San Joaquin River and Stockton DWSC. The Stockton Deep Water Ship Channel portion of the San Joaquin River is being addressed by a Total Maximum Daily Load (TMDL) for dissolved oxygen (DO). TMDLs were initiated for organophosphorous pesticides (i.e., diazinon and chlorpyrifos), salinity and boron and selenium in the San Joaquin River watershed and for total dissolved solids (TDS) and mercury in Delta channels. The proposed alternatives would be required to comply with the TMDL thresholds established for the Delta and the other area waterways discussed above.

Water Quality Control Plan for the Delta Estuary

The Bay-Delta WQCP identifies beneficial uses of water in the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives. The State of California is currently in the process of updating the plan including the area where the project would occur. Unless otherwise indicated, water quality objectives cited for a general area, such as for the south Delta, are applicable for all locations in that general area, and specific compliance locations are used to determine compliance with the cited objectives within the area.

The established water quality objectives provide reasonable protection for fish and wildlife. The beneficial uses in the Bay-Delta Estuary include the following:

- Shellfish Harvesting – Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.
- Commercial and Sport Fishing – Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
- Navigation – Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.
- Warm Freshwater Habitat – Uses of water that support warm water ecosystems including, but not limited to, preservation of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
- Cold Freshwater Habitat – Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancements of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
- Migration of Aquatic Organisms – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.
- Spawning, Reproduction, and/or Early Development – Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.
- Estuarine Habitat – Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g. estuarine mammals, waterfowl, shorebirds).
- Wildlife Habitat – Uses of water that support estuarine ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
- Rare, Threatened, or Endangered Species – Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as being rare, threatened, or endangered.

Water Quality Control Plan for Sacramento and San Joaquin River Basins

The Basin Plan for the Sacramento and San Joaquin Rivers defines the beneficial uses, water quality objectives, implementation programs, and surveillance and monitoring programs for waters of the Sacramento and San Joaquin River basins. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies, or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, electrical conductivity (EC), TDS, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. Narrative water quality objectives also serve as the basis for the development of detailed numerical objectives.

Mercury

Mercury occurs in the Delta as a result of both natural and anthropogenic sources and continually cycles through the aquatic environment. Mercury occurs naturally in the environment regardless of human influence. Natural mercury exists in the Delta; however, it is difficult to determine the balance of natural to unnatural sources because there is so much regional variability and historic degradation in the Sacramento River watershed. Forest fires in Northern California contribute some mercury to the environment, in addition to an ongoing load of some magnitude associated with historic gold mining. Concentrations of mercury in inflowing rivers to the Delta greatly exceed rivers in comparable regions without local mercury sources (Jones and Slotten 1996).

In 1990 the Central Valley Water Board identified the Delta as impaired by mercury because fish had elevated levels of mercury that posed a risk for human and wildlife consumers. In addition, the San Francisco Bay mercury control program identified Central Valley outflows from the Delta as one of the principal sources of total mercury to San Francisco Bay (CVRWQCB, 2010). Methyl mercury production and accumulation in fish can then be ingested by fish-eating birds, animals and people. In addition, methyl mercury generally comprises a relatively greater percentage of the total mercury content at higher levels. Accordingly, mercury exposure and accumulation is of particular concern for animals at the highest trophic levels in aquatic food webs and for animals and humans that feed on these organisms (EPA 1997).

There are a number of ongoing studies in the Delta assessing the effects associated with open water or marsh restoration projects on methyl mercury production throughout the system. These studies are required to report their findings to the CVRWQCB in October 2018. Based on the progress reports submitted in 2015, there are some uncertainties associated with the overall effect of these restoration actions. Tidally influenced sites tend to produce less mercury than sites than remain consistently flooded. Some vegetation, including native marsh species, have been found to contribute mercury to the Delta system. Other restoration actions have had no noticeable impact on the mercury conditions in the Delta, with most monitoring results remaining consistent with offsite conditions. (CVRWQCB, 2018)

Salinity

Salinity concentrations within the Delta are primarily a function of the location of high-salt content ocean water with daily tidal action, freshwater inflow to the Delta, and the hydrodynamic processes in the Delta channels that govern channel flow conditions and mixing of water sources with variable salt content. During winter and early spring, freshwater inflows to the Delta are usually above the minimum required to control salinity. However, at least for a few months in summer and fall of most years when freshwater inflows to the Delta have declined, Delta salinity conditions must be carefully monitored and controlled. Broad-scale salinity control actions are taken in the Delta because its channels are at or below sea level and unless repelled by continuous seaward flow of fresh water, seawater can advance into the western Delta and adversely affect compliance with water quality objectives and beneficial uses provided by Delta water resources.

Additional influential factors of the Delta salinity conditions include the San Joaquin River inflow, in-Delta agricultural drainage, and other miscellaneous inputs (e.g., municipal wastewater, urban runoff, connate groundwater). San Joaquin River inflows are particularly influential to salinity conditions in the southern Delta after winter rainfall and runoff from the Sierra Mountains have ceased and the river is influenced primarily by drainage return flows from the San Joaquin Valley floor. High concentrations of salts are carried by the San Joaquin River into the Delta and much of the salt load represents recirculation and increased salt content of water diverted to the San Joaquin Valley via the CVP. Salinity problems in the western Delta result primarily from the incursion of saline water from the San Francisco Bay when freshwater inflow from the Delta to the bay is low. However, it should be noted that compared to historical conditions, Delta salinity during low-flow periods is much lower since the construction of the major dams on Delta tributaries in the Sierra Mountains and foothills, which allow storage and fresh-water releases during the summer to repel tidal seawater intrusion. For the Sacramento River in the north Delta, which is not substantially affected by sea-water intrusion due to the large flow of the Sacramento River, concentrations of all salinity parameters are uniformly much lower than other Delta locations.

4.2.6 Air Quality

This air quality section describes the existing air quality conditions in the project vicinity. The section first explains the air quality regulatory environment the existing physical air quality environment, including the area's climate and atmospheric conditions, the air pollutants of most concern, air quality conditions, and sensitive receptors in the project area.

Regulatory Setting

Air quality management and protection are regulated by Federal, state, and local levels of government. The primary Federal statute that establishes ambient air quality standards and regulatory authorities to enforce attainment is the Federal Clean Air Act (CAA). Applicable air quality regulations and responsible agencies are described below.

Federal

Clean Air Act

The Federal 1970 CAA authorized the establishment of national health-based air quality standards, and also set deadlines for their attainment. The Federal CAA Amendments of 1990 (1990 CAAA) made major changes in deadlines for attaining National Ambient Air Quality Standards (NAAQS) and in the actions required of areas of the nation that exceeded these standards. Under the CAA, state and local agencies in areas that exceed the NAAQS are required to develop state implementation plans (SIP) to show how they will achieve the NAAQS for nonattainment criteria pollutants by specific dates. SIPs are not single documents; rather, they are a compilation of new and previously submitted plans, programs (such as monitoring, modeling, permitting, etc.), district rules, state regulations and Federal controls. The USEPA is responsible for enforcing the NAAQS primarily through reviewing SIPs that are prepared by each state.

As required by the Federal CAA, the USEPA has established and continues to update the NAAQS for specific criteria air pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), inhalable particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), and lead (Pb). The NAAQS for these pollutants are listed under "Federal Standards" in Table 4-2 and represent the upper-bound levels of pollutant concentrations deemed necessary by the USEPA to protect the public health and welfare with an adequate margin of safety.

General Conformity Rule and *de minimis* Levels

Pursuant to CAA Section 176(c) requirements, USEPA promulgated the General Conformity Rule (GCR), which applies to most Federal actions, including the selected plan. The GCR is used to determine if Federal actions meet the requirements of the CAA and the applicable SIP by ensuring that pollutant emissions related to the action do not:

- Cause or contribute to new violations of a NAAQS.
- Increase the frequency or severity of any existing violation of a NAAQS.
- Delay timely attainment of a NAAQS or interim emission reduction.

A conformity determination under the GCR is required if the Federal agency determines: the action will occur in a nonattainment or maintenance area; that one or more specific exemptions do not apply to the action; the action is not included in the Federal agency's "presumed to conform" list; the emissions from the proposed action are not within the approved emissions budget for an applicable facility; and the total direct and indirect emissions of a pollutant (or its precursors), are at or above the *de minimis* levels established in the General Conformity regulations.

An action will be determined to conform to the applicable SIP if the action meets the requirements of 40 CFR 93.158(c). In addition, Federal activities may not cause or contribute to new violations of air quality standards, exacerbate existing violations, or interfere with timely attainment or required interim emissions reductions toward attainment.

Table 4-2. National Ambient Air Quality Standards

Pollutant	Averaging Time	National Primary Standard[a]	Violation Criteria
			National
CO	8 hour	9 ppm	Not to be exceeded more than once per year
	1 hour	35 ppm	Not to be exceeded more than once per year
NO_2	Annual	0.053 ppm	If exceeded
	1 hour	0.100 ppm	The 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 0.100 ppm.
O_3	Annual	0.070 ppm	The ozone standard is attained when the 4th highest 8-hour concentration measured at each site in a year, averaged over 3 years, is equal to or less than the standard.
PM_{10}	24 hour	150 µg/m3	The 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than one.
$PM_{2.5}$	Annual	12 µg/m3	The 3-year average of the weighted annual mean must not exceed
	24 hour	35 µg/m3	The 24 hour standard is attained when 98% of the daily concentrations, averaged over three years, are equal to or less than the standard
SO_2	Annual	0.03 ppm	Not to be exceeded more than once per year
	24 hour	0.14 ppm	N/A
	1 hour	0.075 ppm	The 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 0.075 ppm.
Pb	Quarter	1.5 µg/m3	Not to be exceeded more than once per year
	3 month	0.15 µg/m3	Not to be exceeded more than once per year

Source: CARB, 2012
[a] 40 CFR 50.4 through 50.13
µg/m3 micrograms per cubic meter
ppm parts per million
N/A Not Applicable; Federal Standards do not exist.

Local

The focused project area encompasses the Bay Area Air Quality Management District (BAAQMD). The BAAQMD is responsible for implementing Federal and State regulations at the local level, permitting stationary sources of air pollution, and developing the local elements of the SIP. Emissions from indirect sources, such as automobile traffic associated with development projects, are addressed through the BAAQMD's air quality plans, which is the air quality district's contribution to the SIP. In addition to permitting and rule compliance, air quality management at the local level is also accomplished through the BAAQMD imposition of mitigation measures on project environmental impact reports and mitigated negative declarations developed by project proponents under CEQA. Specific to project construction emissions, CEQA requires mitigation of air quality impacts that exceed certain significance thresholds set by the local AQMD.

Table 4-3 summarizes the applicable significance thresholds for the BAAQMD, as designated by the SIP.

Table 4-3. Local Air Quality Management District Conformity Thresholds

Agency	Maximum Daily Emissions, lb/day					
	NO_X	ROG	PM_{10}	$PM_{2.5}$	CO	CO_2
BAAQMD	54	54	82	54	NA	N/A

Environmental Setting

The study area for the project is located in the San Francisco Bay Area Air Basin, which is primarily regulated by the BAAQMD. Criteria air pollutants relevant to the project were determined based on the existing pollutant conditions in the BAAQMD. Toxic air contaminants (TAC) relevant to the project were determined based on the BAAQMD guidance and the project site conditions.

Criteria and Non-Criteria Air Pollutants

Pollutants are typically classified as either criteria or non-criteria pollutants. Federal and California regulators have established ambient air quality standards for criteria pollutants whereas no ambient standards have been established for non-criteria pollutants. For some criteria pollutants, separate standards have been set for different periods. Most standards have been set to protect public health. For some pollutants, standards have been based on other values such as protection of crops, protection of materials, or avoidance of nuisance conditions. A summary of Federal ambient air quality standards for criteria pollutants is shown in Table 4-2. Air pollutants relevant to the project and their health effects are discussed below and summarized in Table 4-4. In addition, sensitive receptors are defined and receptors near the project are identified.

Table 4-4. Summary of Air Pollutants of Concern for the Project

Pollutant Class	Pollutant	Existing Condition
Criteria Pollutants	CO, NO_2, O_3 (precursors: NO_X, ROG), PM_{10}, $PM_{2.5}$, and SO_2	The SFBAAB has NAAQS and/or CAAQS non-attainment designations for PM_{10}, $PM_{2.5}$, and O_3. The SFBAAB is also a maintenance area (formerly non-attainment) for CO. Consequently, PM_{10}, $PM_{2.5}$, CO, and ozone precursor (ROG and NO_X) emissions are the primary criteria pollutants of concern associated with the project.
TACs	DPM	The primary DPM sources associated with the project are diesel-powered on-road haul trucks and off-road construction equipment.

Criteria Pollutants

For criteria pollutants, NAAQS have been established to protect public health and welfare. Criteria pollutants include CO, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2. Ozone is a secondary pollutant that is not emitted directly to the atmosphere. Instead, it forms by the reaction of two ozone precursors – reactive organic gases (ROGs) and nitrogen oxides (NO_X) – in the presence of sunlight and high temperatures. The sources of these pollutants, their effects on human health and the nation's welfare, and their annual emission to the atmosphere vary considerably.

Toxic Air Contaminants

A TAC is defined by California law as an air pollutant that "may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health." The USEPA uses the term hazardous air pollutant (HAP) in a similar sense. HAPs can be defined as pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects (EPA, 2017). Controlling air toxic emissions became a national priority with the passage of the CAA Amendments, whereby Congress mandated that the USEPA regulate 187 air pollutants. HAPs can be emitted from stationary and mobile sources.

Air Quality Standards and Attainment Status

Ambient air quality standards are set to protect public health. There are currently both Federal and State ambient air quality standards by USEPA and state air quality agencies, CALEPA for California. California air quality standards are generally more stringent than Federal standards. The four designations are further defined as:

- Nonattainment—assigned to areas where monitored pollutant concentrations consistently violate the standard in question.
- Maintenance—assigned to areas where monitored pollutant concentrations exceeded the standard in question in the past but are no longer in violation of that standard.
- Attainment—assigned to areas where pollutant concentrations meet the standard in question over a designated period of time.
- Unclassified—assigned to areas were data are insufficient to determine whether a pollutant is violating the standard in question.

Table 4-5 summarizes the level of Federal pollutant attainment status for the study area.

Table 4-5. Federal Pollutant Attainment Status in the BAAQMD

Ozone (8 hr)	Nonattainment (Severe)
CO	Maintenance (Moderate)
PM_{10}	Maintenance (Moderate)
$PM_{2.5}$	Nonattainment

Sources: USEPA 2011b

Local Air Quality Management and Sensitive Receptors

Project site standards would follow those enforced by the BAAQMD. Air quality in each air basin is regulated by Federal, State, and regional agencies. The NAAQS apply at publicly accessible areas, regardless of whether those areas are populated. For the purposes of air quality analysis, sensitive land uses are defined as locations where human populations, especially children, seniors, and sick persons, are located and where there is reasonable expectation of continuous human exposure according to the averaging period for the air quality standards (e.g., 24-hour, 8-hour, and 1-hour). Typical sensitive receptors include residences, hospitals, and schools. There are no sensitive receptors in the study area.

4.2.7 Climate Change

Regulatory Setting

Federal

The USEPA is responsible for greenhouse gas (GHG) regulation at the Federal level. Key Federal GHG guidance and regulations relevant to the project are summarized below.

In Massachusetts v. U.S. Environmental Protection Agency, et al., 127 S.Ct. 1438 (2007), the United States Supreme Court ruled that GHGs fits within the CAA's definition of a pollutant, and that the USEPA has the authority to regulate GHGs.

On December 7, 2009, the Final Endangerment and Cause or Contribute Findings for Greenhouse Gases (endangerment finding), under Section 202(a) of the CAA went into effect. The endangerment finding states that current and projected concentrations of the six key well-mixed GHGs in the atmosphere, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFEs), threaten the public health and welfare of current and future generations. Furthermore, it states that the combined emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution which threatens public health and welfare (USEPA 2012a).

Under the endangerment finding, the USEPA is developing vehicle emission standards under the CAA. The USEPA and the Department of Transportation's National Highway Traffic Safety Administration have issued a joint proposal to establish a national program that includes standards that will reduce GHG emissions and improve fuel economy for light-duty vehicles in model years (MYs) 2012 through 2016. This proposal marks the first GHG standards proposed by the USEPA under the CAA as a result of the endangerment and cause or contribute findings (USEPA 2012b). These emission reductions were incorporated into the project analysis.

On February 18, 2010, the CEQ released draft guidance regarding the consideration of GHGs in NEPA documents for Federal actions. The draft guidelines include a presumptive threshold of 25,000 metric tons of carbon dioxide equivalent (CO_2e) emissions from a proposed action to trigger a quantitative analysis. CEQ has not established when GHG emissions are "significant" for NEPA purposes; rather, it poses the question to the public (CEQ 2010). On August 5, 2016, the CEQ published a Notice of Availability on how to consider greenhouse gas emissions and the effects of climate change in the document "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews". Most recently, this final guidance has been withdrawn for further consideration on March 28, 2017. The withdrawal of this final guidance does not change any law, regulation, or other legally binding requirements.

On March 19, 2015, President Obama signed EO 13693, Planning for Federal Sustainability in the Next Decade. While EO 13693 introduced new requirements and expanded upon previous requirements for consideration of climate change in Federal actions, this EO was since revoked.

Affected Environment

This section addresses the existing conditions of global climate change. Emissions of GHGs are a contributing factor, on a cumulative basis, to global climate change. Global climate change has the potential to result in sea level rise (which may result in flooding of low-lying areas), to affect rainfall and snowfall levels (which may lead to changes in water supply and runoff), to affect temperatures and habitats (which in turn may affect biological and agricultural resources), and to result in many other adverse effects. Although global climate change is inherently a cumulative impact, it is important to remember that any single project is unlikely to be able to generate sufficient GHGs by itself to have a significant impact on the environment. However, the cumulative effect of human activities has been clearly linked to quantifiable changes in the composition of the atmosphere, which in turn have been shown to be the main cause of global climate change.

Global Climate Trends and Sea Level Rise

Global warming is the name given to the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered by a vast majority of the scientific community to be unequivocal, based on observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC, 2007). Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history (IPCC, 2014).

Global mean surface temperatures have risen by 0.74 degrees Celsius (°C) ± 0.18°C when estimated by a linear trend over the last 100 years (1906 to 2005). On a global scale, the ocean warming is largest near the surface, warming by 0.11 [0.09 to 0.13] ℃ per decade over the period 1971 to 2010 (IPCC, 2014). The rate of warming over the last 50 years is almost double that over the last 100 years (0.13°C ± 0.03°C versus 0.07°C ± 0.02°C per decade). The causes of this measured warming have been identified as both natural processes and the result of human actions.

The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from preindustrial times to 1950 and had a small cooling effect afterward. However, since 1950, increasing GHG concentrations resulting from human activity such as fossil fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion (DWR, 2012).

Increases in GHG concentrations in the Earth's atmosphere are thought to be the main cause of human-induced climate change. GHGs naturally trap heat by impeding the exit of solar radiation that has hit the Earth and is reradiated back into space as infrared radiation. Some GHGs occur naturally and are necessary for keeping the Earth's surface habitable. However, increases in the concentrations of these gases in the atmosphere above natural levels during the last 100 years have increased the amount of infrared radiation that is trapped in the lower atmosphere, intensifying the natural greenhouse effect and resulting in increased global average temperatures.

The effects of warming of the Earth's atmosphere and oceans affect global and local climate systems. Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, in addition to temperature increases (IPCC, 2007). Based on growing evidence, there is high confidence that the following effects on hydrologic systems are occurring: (1) increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers; and (2) warming of lakes and rivers in many regions, with effects on thermal structure and water quality (IPCC, 2008).

There is very high confidence, based on increasing evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems, including such changes as geographic ranges, seasonal activities, migration patterns, abundances and species interactions in both plant and animal species (IPCC, 2014).

There is high confidence, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These include shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers (IPCC, 2007). In addition to direct detrimental effects to marine ecosystems (ocean acidification), over the period 10901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] meters, which has been larger than the mean rate during the previous two millennia (IPCC, 2014).

Changes in many extreme weather and climate events have been observed since approximately 1950 and some of these changes have been linked to human influences. Additionally, changes in the ocean and on land, including observed decreases in snow cover and Northern Hemisphere sea ice extent, thinner sea ice, shorter freezing seasons of lake and river ice, glacier melt, decreases in permafrost extent, increases in soil temperatures and borehole temperature profiles, and sea level rise, provide additional evidence that the world is warming (IPCC, 2014).

Climate Change Conditions in California

With respect to California's water resources, the most important effects of global warming have been changes to the water cycle and sea level rise. Over the past century, the precipitation mix between snow and rain has shifted in favor of more rainfall and less snow (Mote et al., 2005; Knowles et al., 2006), and snowpack in the Sierra Nevada is melting earlier in the spring (Kapnick and Hall, 2009). The average early-spring snowpack in the Sierra Nevada has decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage (DWR, 2008). These changes have major implications for water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the state.

Precipitation

Climate change can affect precipitation by changing the overall amount of precipitation, type of precipitation (rain versus snow), and timing and intensity of precipitation events. Changes to these factors propagate through the hydrologic system in California and have the potential to affect snowpack, runoff, water supply, and flood control.

Former State Climatologist James Goodridge compiled an extensive collection of longer-term precipitation records from throughout California. These data sets were used to evaluate whether there has been a changing trend in precipitation in the state over the past century (DWR, 2006). Long-term runoff records in selected California watersheds were also examined. Based on a linear regression of the data, the long-term historical trend for statewide average annual precipitation appears to be relatively flat (no increase or decrease) over the entire record. However, it appears that there might be an upward trend in precipitation toward the latter portion of the record. Precipitation in Northern California appears to have increased between 1 and 3 inches annually between 1890 and 2002 (DWR, 2006).

Snowpack

An increase in the global average temperature is expected to result in a decreased volume of precipitation falling as snow in California and an overall reduction in the Sierra Nevada's snowpack. Snowpack in the Sierra Nevada provides both water supply (runoff) and storage (within the snowpack before melting), which is a major source of supply for California. According to the California Energy Commission (CEC), the snowpack portion of the water supply has the potential to decline by 30 to 90 percent by the end of the 21st century (CEC, 2006). A study by Knowles and Cayan projects that approximately 50 percent of the statewide snowpack will be lost by the end of the century (Knowles and Cayan, 2002).

On average, California's annual snowpack has the greatest accumulations from November through the end of March. The snowpack typically melts from April through July. California's reservoir managers rely on snowmelt to fill reservoirs once the threat of large winter and early-spring storms and related flooding risks have passed.

An analysis conducted by DWR of the effect of rising temperatures on snowpack shows that a rise in average annual air temperature of 3°C (5.4°F) would likely cause snowlines to rise approximately 1,500 feet (DWR, 2006). This would result in the equivalent of approximately 5 million acre-feet of water per year falling as rain rather than snow at lower elevations.

Runoff

Runoff is directly affected by changes in precipitation and snowpack. If the amount of precipitation falling as rain rather than snow were to increase earlier in the year, flooding potential could increase. Water that normally would be held in the Sierra Nevada snowpack until spring would flow into the Central Valley concurrently with the rain from winter storm events. This scenario would place more pressure on California's flood control system (DWR, 2006).

Changes in both the amount of runoff and the seasonality of the hydrologic cycle also have the potential to greatly affect the heavily managed water systems of the western United States. The hydrology of the Sacramento River watershed is highly dependent on the interaction between Sierra Nevada snowpack, runoff, and management of reservoirs. Higher snow lines and more precipitation falling in the form of rain rather than snow will increase winter inflows to reservoirs. Higher winter inflows will also likely mean that a greater portion of the total annual runoff volume will occur in the winter, which would translate to higher flows in the Delta in the winter than those that currently occur.

Appendix C (Engineering) Attachment HH-B is a technical memorandum containing a policy compliant Inland Hydrology analysis. Results Based on National Standard Settings for each Hydrologic Unit Code-4 (HUC-4) watershed provide an indication of how vulnerable the watershed is to potential impacts of climate change relative to the other 201 HUC-4 watersheds in the United States. For the Sacramento River Watershed (HUC 1802), this tool shows that the ecosystem restoration line of business is vulnerable to climate change for two scenarios/epoch combinations (2085 wet and dry) compared to the other 201 HUC-4 watersheds in the nation (Table 13; Figure 42 - Figure 43). The indicator contributing the highest amount to the Weighted Order Weighted Average (WOWA) score under both scenarios is the at risk freshwater plants indicator. For the San Joaquin River Watershed (HUC 1804), this tool shows that the ecosystem restoration line of business is not vulnerable to climate change for any scenario/epoch combination relative to the other 201 HUC-4 watersheds in the nation (Attachment HH-B Table 13; Figure 42 -Figure 43).

The Recommended Plan location, although close to the confluence of the Sacramento and San Joaquin Rivers, is dominated by the San Joaquin River. Thus, the low vulnerability conclusion contained in Attachment HH-B is applied to the project location. Climate change-induced modifications to inland hydrology are not concluded to affect ecosystem restoration long-term performance or feasibility level designs.

Greenhouse Gas Emissions

As defined in Section 38505(g) of the California Health and Safety Code, the principal GHGs of concern are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). With the exception of NF_3, these are the same gases named in the USEPA's Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CCA. Each of the principal GHGs has a long atmospheric lifetime (one year to several thousand years), and is globally well mixed. In addition, the potential heat trapping ability of each of these gases varies significantly from one another. On a 100-year timescale, methane is about 25 times as potent as CO_2, nitrous oxide is about 298 times as potent as CO_2, and sulfur hexafluoride is about 22,800 times more potent than CO_2 (IPCC, 2007). Conventionally, GHGs have been reported as CO_2 equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that all emissions can be reported as a single quantity.

The primary human-made processes that release these gases include: (1) the burning of fossil fuels for transportation, heating, and electricity generation; (2) agricultural practices that release methane, such as livestock grazing and crop residue decomposition; and (3) industrial processes that release smaller amounts of high global warming potential gases, such as sulfur hexafluoride, PFCs, and HFCs. Deforestation and land cover conversion have also been identified as contributing to global warming by reducing the Earth's capacity to remove CO_2 from the air and altering the Earth's surface reflectance. The major sources of GHGs that are relevant to the study are transportation sources and construction emissions. These are discussed in greater detail below.

Transportation

Transportation is a major source of GHGs in California, accounting for 36 percent of the State's total GHG emissions in 2008 (CARB, 2011). Transportation emissions within California are generated primarily by combustion of gasoline, diesel, and some alternative fuels by mobile sources. The indicators of vehicular activity, and resulting GHG emissions, are vehicle miles traveled and the fuel economies of the individual vehicles composing the vehicular fleet. Vehicle miles traveled are associated with movement of people and goods on local, regional, and statewide scales.

Construction

Construction emissions are generated when materials and workers are transported to and from construction sites and when machinery is used for construction activities such as trenching, grading, dredging, paving, and building. Emissions from construction activities are generated for shorter periods than operational emissions; however, GHGs remain in the atmosphere for hundreds of years or more, so once released, they contribute to global climate change unless they are removed through absorption by the oceans or by terrestrial sequestration.

Construction emissions are not accounted for in a separate category in the California GHG inventory (or other inventories that use IPCC GHG emissions sectors for accounting purposes). However, based on the category "Transportation—Not Specified," which includes off-road vehicles and associated diesel fuel combustion, construction emissions accounted for a maximum of 0.4 percent of California's GHG inventory between 2000 and 2008 (CARB, 2011).

Greenhouse Gas Emissions Inventories

A GHG inventory is a quantification of GHG emissions and sinks within a selected physical and/or economic boundary over a specified time. GHG inventories can be performed on a large scale (i.e., for global and national entities) or on a small scale (i.e., for a particular building or person).

Many GHG emission and sink specifications are complicated to evaluate because natural processes may dominate the carbon cycle. Although some emission sources and processes are easily characterized and well understood, some components of the GHG budget (i.e., the balance of GHG sources and sinks) are not known with accuracy. Because protocols for quantifying GHG emissions from many sources are currently under development by international, national, state, and local agencies, ad-hoc tools must be developed to quantify emissions from certain sources and sinks in the interim. Table 4-6 outlines the most recent global, national, statewide, and local GHG inventories to help contextualize the magnitude of potential project-related emissions.

Table 4-6. Global, National, State, and Local GHG Emissions Inventories

Emissions Inventory	CO_2e (metric tons)
2004 IPCC Global GHG Emissions Inventory	49,000,000,000
2015 USEPA National GHG Emissions Inventory	6,587,000,000
2015 CARB State GHG Emissions Inventory	440,400,000
2013 Contra Costa County GHG Emissions Inventory	1,392450

Sources: IPCC 2007; Contra Costa County 2013c; USEPA 2015; CARB 2015

4.2.8 Transportation and Navigation

This section describes the existing transportation system within the study area shown in Figure 4-3. The existing system includes roadways, navigation channels, and bicycle and pedestrian facilities. In addition, roadway classification and annual daily traffic counts for various roadway segments in and near the study area are identified.

Regulatory Setting

Federal

U.S. Coast Guard

Title 14 of the USC, CFR Title 33 and other portions of the CFR, give the U.S. Coast Guard authority for maritime law enforcement on the navigable waters of the United States, as well as responsibilities for search and rescue, marine environmental protection, and the maintenance of river aids to navigation, among other roles. Specific to the Delta, 33 CFR 162 provides regulations for the navigation by both commercial and noncommercial vessels on the San Joaquin River DWSC (between Suisun Bay and Stockton) and the Sacramento River DWSC (between Suisun Bay and West Sacramento).

Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act of 1899 requires entities to seek authorization from USACE for impacts to navigable waters of the United States, including structures in or over waters, excavation or deposition of material in waters, and obstruction or alteration of waters. However, since USACE is the responsible agency for implementing this law, USACE could not issue a permit to itself, and instead would ensure that its projects are designed in compliance with this law.

Affected Environment

The subsections below describe the existing conditions of the roadways near the study area that could be used during construction of the proposed alternatives. Additionally, the local marine highways (i.e., the deep water ship channels) are described). There are no other transportation services in the vicinity that could be impacted by the study, including ferry routes. The closest airport to Big Break is the Byron Airport, a small local airport operated by Contra Costa County, which is located approximately 20 miles to the south of the study area.

Regional and Local Roadways

The main roadway and access route to the project areas and borrow sites is Highway 160. This two lane highway runs north to south through the Delta region. It provides access to most Delta cities while connecting Sacramento to Antioch. Highway 160 is used primarily by local travelers and some commuters who enjoy the tranquil setting of the Delta for traveling to and from the Bay Area. Vehicular access to Big Break and Jersey Island is possible using the existing two lane arterials which include Main Street, East Cypress Road, and Jersey Island Road in Oakley.

Table 4-7. Traffic Volumes on Roadways near the Project Area

Roadway	Segments	Classification	Average Daily Traffic
Highway 160	Three Mile Slough to Highway 4	Major 2 lane highway	13,300
Main Street	Highway 160 to East Cypress Road	2 lane arterial	22,065
East Cypress Road	Main Street to Bethel Island Road	2 lane arterial	10,036
Jersey Island Road	East Cypress Road to San Joaquin River	2 lane arterial	546

Sources: Caltrans 2016, City of Oakley 2013; City of Oakley 2009

Ferry Services

One public access ferry service operates within the study area transporting passengers to private islands. The ferry travels from Jersey Island to both Webb Tract and Bradford Island (Caltrans 2009).

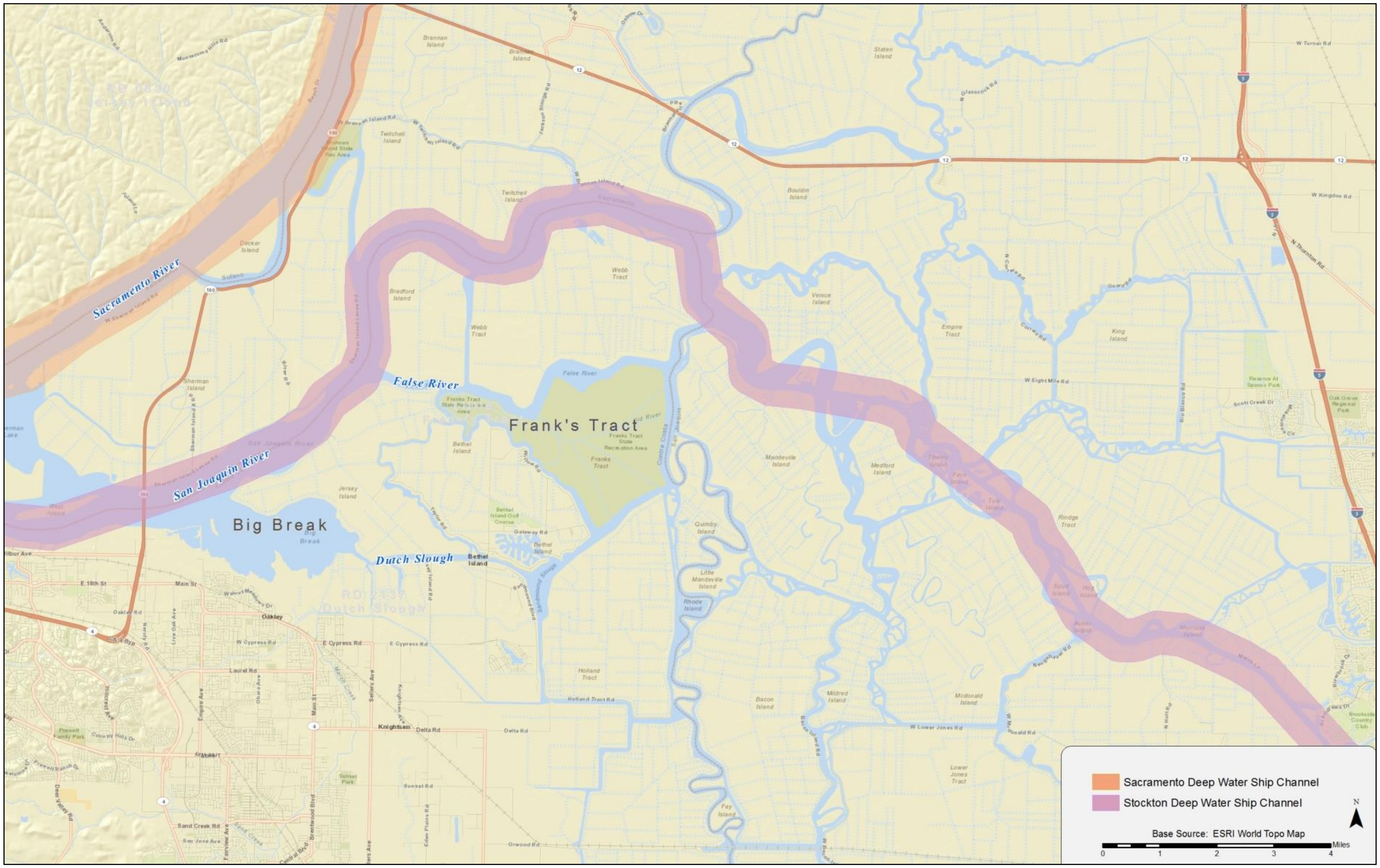

Figure 4-2. Transportation Infrastructure in the Study Area

Port of Stockton/Stockton DWSC

The Port of Stockton is located on the Stockton DWSC, 75 nautical miles due east of the Golden Gate Bridge. The port is a major transportation center with berthing space for 17 vessels, 1.1 million square feet of dockside transit sheds and shipside rail trackage, and 7.7 million square feet of warehousing served by rail. The Port of Stockton has the capacity to move cargo from vessels directly to truck and rail (Port of Stockton 2012). River access to the port is through the Suisun Bay, San Joaquin River, and the Stockton DWSC. The Stockton DWSC connects the Disappointment Slough with the Port of Stockton marine terminal facilities, a distance of approximately 14 miles (State Water Resources Control Board 2010). Stockton's DWSC has an average depth of 35 feet, and an average depth at high tide of 40 feet (Port of Stockton 2010).

Port of West Sacramento/Sacramento DWSC

The Port of West Sacramento is an inland port located within the Sacramento metropolitan area, about 79 miles northeast of San Francisco. The port is situated on the Sacramento DWSC, which flows into the San Francisco Bay and has a depth of 30 feet. Unlike most other ports in California, the Port of Sacramento does not receive container ships. The majority of the cargo transported through the port is agricultural, due to its location within the agricultural heartland of the Central Valley. Access to the Port of West Sacramento is related to the level of operation and maintenance of the Sacramento DWSC. As of FY 16, USACE had on hold a study evaluating the deepening of the Sacramento DWSC to 35 feet. If such deepening were to occur in the future, it would affect the cumulative impacts related to the Delta Study. However, the Sacramento DWSC is outside of the selected plan's impact area.

4.2.9 Recreation

Regulatory Setting

There are no Federal regulations associated with recreation in the action area.

Affected Environment

The Delta is a major destination for water based recreationists because of its climatic conditions, variety and abundance of fish, large maze of navigable waterways, and favorable water levels during summer. Activities in the Delta include cruising, waterskiing, wakeboarding, using personal watercraft, sailing, windsurfing, and kiteboarding, as well as fishing and hunting both from land and by boat.

Boating is the primary recreation activity in the Delta. Throughout the Delta, there are a variety of boat launching sites. Other recreation opportunities within the project area include hunting, fishing, hiking, day-use/picnicking, and wildlife observation. Boaters also participate in other related activities, such as boat camping (typically in houseboats or other large boats with sleeping accommodations). The area shelters more than 70 species of birds and a great variety of fish species. Winter temperatures range from 45 to 55 degrees. Summer days vary from 65 to 100 degrees. Cooling Delta breezes often gust to 25 mph, and tides can vary as much as six feet in one day (Department of Parks and Recreation 1997).

Big Break is a popular destination for wildlife viewing hiking/biking, boating, and fishing. The Big Break Regional Shoreline park facility offers the majority of recreational experiences within the Big Break area. General boating also takes place at Big Break estuary due to its accessibility to the rivers and sloughs of the Inland Coast. Numerous private marinas offer services to boaters and anglers. The facilities that exist in the Big Break area are shown on Table 4-8.

Table 4-8. Recreation Facilities in the Big Break Area

Name	Access	Site Amenities	Site Characteristics
Private Facilities			
Big Break Marina	Public access	Berthing, boat launching, guest docks, covered storage	Tidal marsh, industrial, agriculture, open water.
Driftwood Marina	Public access	Berthing, boat launching, guest docks, covered storage, fuel	Commercial, industrial, open water
Lauritzen Yacht Harbor LLC	Public access	Berthing, boat launching, guest docks, covered storage, fuel	Commercial, industrial, open water
New Bridge Marina Inc	Public access	Berthing, boat launching, guest docks, covered storage, fuel	Commercial, industrial, open water
County Facilities			
Big Break Regional Shoreline Park	Public access	Hiking, kayaking, interpretive center, nature watching	Vegetation consists of tidal marsh, wetlands, riparian.

Big Break Regional Shoreline is located in the City of Oakley and is operated by the East Bay Regional Park District (EBRPD). A visitor center on the southern edge of Big Break includes temporary displays about the Delta and is staffed by Park District naturalists who can give information about the park and specific activities in the area including wetland walks and adjoining trails. Big Break Regional Shoreline offers picnic and meadow areas, a small shaded amphitheater, and boat and kayak launch facilities. In addition, the 100-foot long Antioch-Oakley fishing pier is very popular with local anglers. The park includes covered, outdoor use areas for interpretive and educational exhibits and programs highlighting Delta ecosystems and wildlife. A 1,200 square foot interactive map of the Delta allows visitors to see how water flows through the region (EBRPD 2014). The Big Break Regional Trail, which runs along the southern edge of Big Break through the Ironhouse Sanitary District, provides access for hikers, bicyclists, and equestrians to the southeastern edge of the estuary. The trail connects to the northern end of the Marsh Creek Regional Trail, providing access to Brentwood and Oakley. The Marsh Creek Regional Trail connects to the Delta de Anza Regional Trail via West Cypress Road, providing access to Oakley, Brentwood, Antioch, Pittsburg, and Bay Point (EBRPD 2014).

Bass fishing is currently the most popular recreational activity at Big Break. While shore fishing offers less success, boaters offshore catch primarily largemouth bass and striped bass, with some white catfish, bluegill, sunfish, and sturgeon also caught. Over the years Oakley has hosted hundreds of angling tournaments (Big Break Marina 2014).

4.2.10 Cultural Resources

This chapter describes the environmental setting associated with cultural resources, assesses the effects to cultural resources that would result from implementation of the proposed program, and presents mitigation measures that would reduce these effects. The key sources of data and information used in the preparation of this chapter are listed below.

- A review of existing information.
- Consultation with interested parties.
- Archival research.
- Reconnaissance level surveys of the study area.

Cultural resources are defined in this chapter as prehistoric and historic archaeological sites, the historic built environment, and traditional cultural properties.

Regulatory Setting

National Historic Preservation Act

The proposed project would require that USACE comply with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulations (36 CFR 800, Section 106). Section 106 requires that, before beginning any undertaking, a Federal agency must take into account the effects of the undertaking on historic properties (cultural resources listed or eligible for listing on the National Register of Historic Places [NRHP]) and afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on these actions. Federal agencies may comply with Section 106 by either completing the management steps indicated in the regulations (36 CFR Part 800) or preparing an agreement document that describes the particular process an agency will use to complete the same steps for a specific set of undertakings, as described below.

Cultural resources are eligible for the NRHP if they have integrity and significance as defined in the regulations for the NRHP. A property may be significant if it displays one or more of the following characteristics (36 CFR 60.4): (1) It is associated with events that have made a significant contribution to the broad patterns of our history (Criterion A); (2) is associated with the lives of people significant in our past (Criterion B); (3) embodies the distinct characteristics of a type, period, or method of construction, or that represents the work of a master, or that possesses high artistic values, or it represents a significant and distinguishable entity whose components may lack individual distinction (Criterion C); (4) it has yielded, or is likely to yield, information important in prehistory or history (Criterion D).

Some types of cultural resources are not typically eligible for the NRHP. These resources consist of cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years. These property types may be eligible for the NRHP if they are integral parts of eligible districts of resources or meet the criteria considerations described in 36 CFR 60.4.

In addition to possessing significance, a property must also have integrity to be eligible for listing in the NRHP. The principle of integrity has seven aspects: location, design, setting, materials, workmanship, feeling, and association (36 CFR 60.4). To retain historic integrity, a property needs to possess several, and usually most, of these aspects (National Park Service 2002). The evaluation of a resource's integrity in relation to its significance will be conducted as prescribed in National Register Bulletin No. 15: How to Apply the National Register Criteria for Evaluation (National Park Service 2002).

The Section 106 review process typically consists of the following major steps.

- Identify the Federal agency undertaking.
- Identify the area of potential effects.
- Initiate Section 106 process.
- Identify historic properties.
- Evaluated effects to historic properties.
- Resolve adverse effects.

Study Area and Area of Potential Effects

The original study area focused on Big Break and Little Franks Tract to determine the effectiveness of placing dredged materials. The area of potential effects (APE) is a smaller area within the larger study area and encompasses any ground disturbing activities, staging areas, and access to the APE. This also includes the soil placement location at Big Break and a portion of Jersey Island where a road improvement will take place and a pipeline will cross the island to deliver the dredged materials. Areas not considered as part of the APE are the locations where the dredged materials will be taken from including McCormick, Scour, Decker, and Bradford disposal sites, as well as the Stockton DWSC. These areas are established dredge spoils deposition areas or ongoing maintenance activities and are comprised entirely of displaced material from maintenance dredging, and covered under their own consultation.

Affected Environment

The following Prehistoric, Ethnographic, and Historic Context sections, not including the specific history on Big Break and Little Franks Tract, are adapted from the following sources:

- Built Historical Resources Evaluation Report for the BDCP Project: Sacramento, Yolo, Solano, San Joaquin, Contra Costa, and Alameda Counties California (ICF 2012a)
- Archaeological Survey Report for the BDCP Project: Sacramento, Yolo, Solano, San Joaquin, Contra Costa, and Alameda Counties, California (ICF 2012b)
- Draft Environmental Impact Report/Environmental Impact Statement, BDCP: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties, California (Bureau of Reclamation et al 2013)
- The Central Valley: A View from the Catbird's Seat (Rosenthal et al 2007)

The first three reports were prepared as joint Federal and State documents for the BDCP and cover the entire Delta. More specific information concerning Little Franks Tract and Big Break follow the general overview.

Prehistoric Setting

Prior to the arrival of Europeans, inhabitants of the Delta occupied the riparian forest, marsh, alkali basins, oak savanna, and foothill woodland communities found throughout the Central Valley. In the Delta specifically, they located their main population centers on natural levees, mounds and other high spots. Their society developed a sophisticated material culture and established trade system involving a wide range of manufactured goods and raw materials, and their population and villages prospered in the centuries prior to historic contact (Rosenthal et al. 2007).

The following discussion uses a simple classification based on the three basic periods proposed by Fredrickson: the Paleo-Indian, Archaic, and Emergent (Fredrickson 1973, 1974). The Archaic period has been further divided into the Lower, Middle, and Upper Archaic based on newer radiocarbon dates, adjusted with modern calibration curves (Rosenthal et al. 2007).

Paleo-Indian

No evidence of the Paleo-Indian Period (11,550–8,500 BC) has been found in the Delta. However, basally thinned and fluted projectile points at three separate locations in the southern portion of the Central Valley show that people were present there during that time (Rosenthal et al. 2007). Meyer and Rosenthal have shown through geoarchaeological studies that periodic episodes of erosion and deposition during the Holocene have removed or buried large segments of the Late Pleistocene landscape (Rosenthal and Meyer 2004; White 2003a). Therefore, archaeological deposits associated with these ancient landforms have either been destroyed or are buried beneath more recent alluvial deposits (Rosenthal et al. 2007).

Lower Archaic

Evidence of the Lower Archaic Period (8,000–5,550 BC) is likewise rare in the Delta, but is characterized primarily by isolated finds, including stemmed points, chipped stone crescents, and early concave base points. Intact deposits are even rarer and only one Lower Archaic deposit has been found in the Central Valley.

Middle Archaic

The physical Delta itself truly formed during the beginning of the Middle Archaic (5,550–550 BC) as a result of warmer, drier conditions in the Central Valley, sea level rise, and the stabilization of fans and floodplains around 5,550 BC (Rosenthal et al. 2007). Around this time, two distinct settlement-subsistence adaptations operating in central California developed—one centering on the foothills and the other on the valley floor (Fredrickson 1994; Rosenthal and McGuire 2004). Population sites during this time appear to be increasingly sedentary, as indicated by refined and specialized tool assemblages and features, a wide range of non-utilitarian artifacts, abundant trade objects, and plant and animal remains indicative of year-round occupation (Moratto 1984; Ragir 1972; Schulz 1970, 1981; White 2003a, 2003b). Again, deposits dating to this time period are rare in the Central Valley. After about 2,500 BC, sites become much more abundant, and have elaborate material cultural, diverse technology, and dietary assemblages (Rosenthal et al 2007). Additionally, procurement patterns become logistically based and populations have increasing residential stability (Rosenthal et al 2007).

Upper Archaic

A cooler, wetter Upper Archaic (550 BC–AD 1,100) led to renewed fan and floodplain deposition and soil formation in the Central Valley (Rosenthal et al. 2007). People in the Upper Archaic developed new, specialized technologies and there was widespread use of decorative items including shell beads, *Haliotis* ornaments, and ceremonial blades (Bennyhoff and Fredrickson 1994; Moratto 1984; Rosenthal et al 2007). There is evidence of regionalized economies and a heavy reliance on acorns, salmon, fish and deer (Moratto 1984, Rosenthal et al 2007). Large villages also appeared during this time period (Lilliard et al 1939). Sites dating to this time typically contain large quantities of habitation debris and features (such as fire-cracked rock heaps, shallow hearths, house floors, and flexed burials) that reflect long-term residential occupation.

Emergent

The archaeological record for the Emergent/Historic Period (AD 1,000) is more substantial and comprehensive than those of earlier periods in the Central Valley, and the artifact assemblages are the most diverse (Bennyhoff 1977; Fredrickson 1974; Kowta 1988; Sundahl 1982, 1992). In part this is due to the increasingly complex societies developing in the Delta region; however, some of this may be because the rarity of earlier sites. The Emergent period can be divided into Lower and Upper periods. Aspects of culture include the reliance on acorn, pine nut, and Manzanita; the decentralization of bead production; use of Napa obsidian; and proliferation of baskets. Use of the bow and arrow also became common (Bennyhoff 1994). Village sites from the late Emergent were often used into the Ethnographic period.

Ethnographic Setting

Beginning with Euroamerican contact, at least two Native American cultural groups may have inhabited portions of the Study Area. These groups are the Plains, Bay or Eastern Miwok and Southern Patwin.

Plains Miwok

The Eastern Miwok, and more specifically the Plains or Bay Miwok, inhabited the lower reaches of the Mokelumne and Cosumnes Rivers, and the banks of the Sacramento River from Rio Vista to Freeport (Levy 1978). Although the Plains Miwok shared a common language subgroup, Utial, and cultural background, they were comprised of several separate, politically independent nations, or tribelets. The tribelet represented an independent, sovereign nation that defined and defended a territory. The tribelet chief, usually a hereditary position, served as the voice of legal and political authority in the tribelet (Levy 1978). Within the project area the people were likely part of the *Julpun* tribelet (Bennyhoff 1977).

The Miwok suffered exposure to diseases introduced through the arrival of Europeans, including trappers, gold miners, and other settlers to California. Hostilities between the Miwok and Europeans took an additional toll on the population. The Spanish mission system forcibly assimilated many Plains Miwok circa 1811 to 1836 (Bennyhoff 1977). After California was annexed by the United States, some Miwok were displaced to Central Valley locations, yet many remained on the rancherias established in the Sierra Nevada foothills. During the late nineteenth and early twentieth centuries, the Miwok living on the foothill rancherias adapted to new lifestyles, such as seasonal wage labor on ranches and farms, to augment subsistence through hunting and gathering (Levy 1978). Since the early twentieth century, many persons of Miwok descent survived and maintained strong communities and action-oriented organizations, including the Ione Band of Miwok and Wilton Rancheria (Bennyhoff 1977).

Southern Patwin

The Southern Patwin are a series of linguistically and culturally related tribelets that once occupied a portion of the lower Sacramento Valley west of the Sacramento River and north of Suisun Bay. The ethnographically documented villages nearest to the APE are *Aguasto* and *Tolenas,* both situated immediately north of San Pablo Bay to the west-northwest (Kroeber 1925, 1932).

The largest political unit for the Patwin was the tribelet. Patwin tribelets maintained their own autonomy and sense of territoriality and typically consisted of one primary and several satellite villages. Villages were located along waterways, often near the junction with another major topographic feature, such as foothills or another waterway (Kroeber 1925, 1932). While a common language unified these social units, the Southern Patwin language disappeared shortly after European contact, but may be related to a Wintuan language. Within the tribelet were several political and social distinctions, including a chief who oversaw village activities; this position was passed through inheritance from father to son (Johnson 1978).

The principal subsistence activities of the Patwin were hunting, fishing, and the gathering of wild plants. Along with the acorn, which was the primary staple, the Patwin gathered buckeye, pine nuts, berries, wild grapes, and other plants. Each village had its own location for these food sources, and the village chief oversaw the procurement of food for the village (Johnson 1978).

Population estimates for Patwin groups, from pre-contact until 1833, are more than 15,000 (Kroeber 1932; Cook 1955). The Patwin were in contact with the Spanish missions by the late eighteenth century, and some of the earliest historic records of the Patwin are found among mission registers of baptisms, marriage, and deaths of Native American neophytes. Mission San Jose, established in 1797, along with Mission Dolores, actively proselytized Patwin from their southern villages, and Mission Sonoma, built in 1823, also baptized neophytes, until the secularization of all missions by the Mexican government in 1832–1836. Afterward, many tribal territories were divided into individual land grants (Johnson 1978).

The U.S. conquest of California (1846–1848) was followed by a massive influx of American settlers into Patwin territory. To facilitate the development of ranching, agriculture, mining, and large settlements, the Patwin were usually moved to reservations. However, some Patwin assimilated themselves, at least partially, into white culture by working as ranch laborers (Johnson 1978). Today, some Patwin descendants live on the Colusa, Cortina, and Rumsey Rancherias; although many of the people living on these rancherias are of general Wintun descent.

Historic Era Setting

The historic setting is intended to illustrate general themes in the development of the Delta as a place. The Delta's history is steeped in land reclamation and development of agriculture, but also includes commercial activities such as fishing, canning, and industrialized produce processing. At Big Break activities were limited to agriculture. Large and small scale agriculture was facilitated by development of transportation routes, first focused on Delta waterways but eventually developing into land routes. The Delta's built environment has also been shaped by large-scale flood control and water management efforts, as well as recreational activities such as fishing and boating.

Spanish Era to Gold Rush

The first Spanish expedition to reach the Delta was led by Captain Pedro Fages in 1772; however, the Spanish presence in California remained concentrated mainly along the coastal strip of missions and *presidios*, the nearest of which was located west of the Delta. During the early nineteenth century, Spanish and Mexican soldiers would enter the Delta region on incursions to capture Native Americans who had fled missions. The Bay Miwok were the first to be missionized. When Mexico achieved independence from Spain in 1822, California became a territory of Mexico, but remained a remote frontier province. By the end of the decade, American fur trappers began to enter the San Joaquin Valley and the Delta after hearing reports of abundant beaver that circulated after Jedediah Smith's trapping expeditions through central California in 1827 and 1828. Fur trapping in and around the Delta resulted in a steep decline of beaver populations, and fur trappers introduced diseases in the region that heavily affected Native American tribes (Owens 1991; Sandos 2004; Thompson 1957).

By 1848, when gold was discovered at Sutter's Mill in Coloma, only a handful of people had settled in the Delta, but thousands of newcomers traveled Delta waterways en route to the foothill and mountain mines to the east. Some California newcomers chose to farm instead of mine. Farmers began to work land at the edge of the Delta, along the natural levees of the major rivers draining into it. Known as "rim landers," these early settlers built *shoestring levees* (3-5 feet tall) atop the natural levees to withstand the highest tidal rises. Later, more extensive levee construction downstream would transform the Delta (Paul 1973; Street 2004; Thompson 1957).

Land Reclamation

The Swampland Act of 1850 and creation of the State Board of Swamp Land Commissioners enabled the establishment of districts to reclaim land in the Delta. However, lack of cooperation among small landowners and later legislation allowed wealthy absentee owners to take over large portions of the Delta. The speculative, large-scale land reclamation brought thousands of Chinese workers to the Delta. They first helped with the construction of levees and then worked in the resulting agricultural fields (Garone 2011; Lund et al. 2007; Owens 1991; Thompson 1957). Chinese tenant farmers are known to have worked and lived within the once reclaimed lands of Big Break during the 1870s and 1880s (Busby 2001).

People reclaiming the Delta faced many challenges. Levees in the Delta have required constant and expensive maintenance and repair as they frequently failed and islands flooded. The beds of the Sacramento and San Joaquin Rivers and tributaries beds were raised and choked by tailings from hydraulic mining in the Sierra Nevada Mountains. The floors of the Delta's peat islands frequently underwent subsidence from farming and because they were no longer subject to deposition activities during annual inundation. Groundwater seepage increased, creating marsh areas. Irrigation for agriculture upstream caused saltwater intrusion deeper into the Delta.

New technology helped landowners build larger levees and move floodwater out more quickly. The introduction of clamshell dredges in 1879 enabled the construction of increasingly larger and more secure levees. Modern pumps and the introduction of electricity allowed for more efficient and thorough draining of flooded islands. By the early twentieth century, the rise of industrial agriculture across the Delta increased pressure for state and Federal action to protect and facilitate the region's agricultural economy through flood control efforts, transportation development, and large-scale water policy and development in the early twentieth century (Garone 2007; Thompson 1957; Thompson 2006). Subsidence and deteriorating levees are ongoing challenges today.

Agriculture

Agricultural activity in the Delta took place on higher lands near natural levees and rises along the Sacramento River, where farmers raised potatoes, onions, and beans, among other crops, and grazed cattle and sheep. From the 1860s through the 1880s, reclamation spread agriculture from alluvium lands upstream into the peat lands of the central Delta. With water access to a growing urban market in San Francisco, Delta agriculture boomed and crops were diversified (Lokke and Simmons 1980; Rawls and Bean 2002; Thompson 1957; Thompson 2006).

An ethnically diverse population farmed land created by large-scale speculative reclamation through time. These large land holdings were divided into smaller plots with a resident superintendent. Chinese, Italian, and Portuguese tenant farmers often specialized in garden or truck farming. Chinese agricultural laborers also became associated with row crops, especially nineteenth-century potato cultivation. In the twentieth century, Japanese farmers frequently engaged in potato and asparagus production. Beginning in the 1920s, Filipino and Mexican day laborers also worked Delta lands (Azuma 1994; Miller 1995; Thompson 1957).

Modern industrial farming in the Delta region began after World War I. Fuel-powered tractors became commonplace in the Delta, particularly among the large land companies. Although large acreage continued to be reclaimed, a good deal of island land was improved through the introduction of electric pumps. The sale of field crops by consignment to wholesale markets or shippers nurtured the rise of canneries and wholesale produce houses with product standards and field buyers. Urban factories were developed in the Delta during this period, which often employed ethnic laborers to help make sugar out of sugar beets or can fruit, asparagus, and other vegetables (Armentrout-Ma 1981; Thompson 1957).

Transportation Development

During the Gold Rush, most Americans who encountered the Delta did so as passengers of sailboats and steamers en route between San Francisco and the mines east of the Delta. A few trails and later roadways complemented the water traffic. Only after the start of the twentieth century did roads begin to dominate traffic in the Delta with the introduction of the automobile and truck. Ferries connected roads with agriculture on remote islands. Early trails evolved into roads traveled by stages hauling freight back and forth between the farms and the small towns that took shape behind recently constructed levees. Railroads also played an important role in the development of agriculture, especially after the beginning of the twentieth century. After 1900, county and state investment nurtured bridge construction, which in turn enabled the development of year-round roads serving Delta residents and visitors. During the 1910s and early 1920s, additional bridge construction and road development connected the era's increasing automobile traffic from the earlier established roads to new routes extending to Isleton and Rio Vista. No longer extant electric interurban railroads also extended into portions of the Delta during the early twentieth century (Blow 1920; Caltrans 1990; Thompson 1980).

Water Management

The Delta became a focal point of increasingly large-scale water engineering and management during the early twentieth century. Pressure to ameliorate ongoing flood threats due to the legacies of hydraulic mining led to 1917 legislation creating the first Federal flood control project. The plan included nearly two hundred miles of levees, several hundred miles of bypass channels, and ultimately the rerouting of floodwaters of the Sacramento, Yuba, and American Rivers. Large dredges in use in the Delta for decades were now employed to build new levees and create channels for flood control.

Numerous canals and straightened and widened river channels were by-products of the islands and levees created by Delta reclamation. These functioned as an important water source for irrigation and provided both recreational boating waterway and dredge access for levee construction and maintenance. Most Delta canals appear to have been opportunistically created rather than being formally engineered, hence no design or "as-built" drawings for early canals and levees have been located. Nevertheless, with Federal involvement in flood control after 1917, and especially in the 1920s, plans were drawn and implemented for standard levees and canals for the Sacramento Delta (Pisani 2002).

At the end of the 1920s, state engineer Edward Hyatt developed a State Water Plan to respond to growing water problems. In 1928 the state's voters approved a constitutional amendment that limited the holders of riparian water rights to reasonable use of their water, which opened the way for the state legislature to pass the Central Valley Project Act in 1933. Most of the CVP was completed by the early 1950s, including more than 500 miles of canals and 20 dams and reservoirs.

After World War II, the SWRCB began planning for additional large-scale water management projects. Then state engineer Arthur D. Edmonston developed a state water plan entailing major new water impoundment and conveyance development. Known as the SWP, Edmonston's plan promised to augment flows to the Delta during dry years and develop state-funded canals to convey additional water to the San Joaquin Valley and new supplies to Santa Clara and Alameda Counties. The plan also called for the development of pumps to transmit Delta water to what would become known as San Luis Reservoir and to a huge aqueduct conveying water south to be pumped over the Tehachapi Mountains into Southern California. In 1960, voters approved the financing for the project, and the first phase was implemented between 1962 and 1971 (Cooper 1968; Kahrl 1979; Rarick 2005).

Recreation

By the first decades of the twentieth century the Delta became a haven for sportsmen and by the 1920s, with the construction of year-round roads, bridges, hotels, and campsites, it had become a destination for the recreational driver, the car camper, and the sightseer. In the post-World War II era, the widespread development of tract housing bypassed the Delta, primarily due to land ownership patterns, limited transportation options, and the overabundance of water. At the same time, those factors helped to foster an increased demand for recreational opportunities and the proliferation of house and party boats. Recently, wetlands restoration has made the Delta a destination for bird watchers as several communities have embraced rare and endangered birds (Schell 1979; Gardner 1964; Steienstra 2012; Thompson 1957; Young 1969).

History of Big Break

The area currently known as Big Break was most likely occupied by peoples of the *Julpun* tribelet of the Plains or Eastern or Bay Miwok (Busby 2001) and is just east of what is considered to be the tribelet center of *Chupcan* at what is now Antioch (Bennyhoff 1977, Levy 1978). This village was first noted by Europeans visiting the area, including Captain Pedro Fages and Fray Juan Crespi in 1772, and Juan Bautista de Anza, Lt. Jose Moraga and Fray Pedro Font in 1776. A map by Jose de Carnizares noted that this village was abandoned in 1776 (Busby 2001). The *Julpunes* are thought to have occupied the islands and west bank of the San Joaquin River and may have moved their main village to the islands due to mission contact (Bennyhoff 1977). The Bay Miwok were among the earliest American Indians to be missionized and were primarily taken to Mission San Jose, although some were taken to Mission San Francisco (Beck and Haase 1974; Levy 1978; Milliken 1995).

Dredging along Dutch Slough between 1904 and 1910 connected Dutch Slough, Sandmound Slough, Taylor Slough and Piper Slough. The building of levees along the southern shore of Dutch Slough is largely undocumented in the available literature, but inferences can be made. Levees were built along the mouth of Marsh Creek, which forms the eastern boundary of the Big Break Regional Shoreline, as early as 1859, but the unleveed land south of Jersey Island was flooded by Marsh Creek in 1876 (Thompson 1957). The1910 Jersey Island USGS 7.5' topographic map shows levees along the southern shore of Dutch Slough. Therefore, it can be surmised that they were constructed between 1876 and 1910, and probably between 1904 and 1910 when Dutch Slough was being dredged. A clamshell dredge was likely used as they had come into widespread use during that time.

Agriculture was originally pursued in the APE; but not much is known about crops grown at Big Break, however, asparagus is reported to have been grown there (EBRPD 2014). According to a letter report prepared by Ward Hill for the EBRPD (2000), the property known as Big Break flooded in 1921 (Little Break). The levees broke again in 1928, flooding a 2.5 square mile area, which was never reclaimed, effectively ending any agricultural pursuits.

Howard Lauritzen acquired a 40 acre parcel of remaining uplands and the flooded area near Oakley in the 1930s through a trade with Pittsburg Steel. During the 1930s and 1940s, Lauritzen used this area to dismantle Navy pontoons and target barges as part of a scrap metal business. As many as 30 to 40 hulls are still present within the open water of the park area and along the San Joaquin River shoreline (Hill 2000; Moran 2013).

The property was most recently acquired by the East Bay Regional Parks District and currently is operated as the Big Break Regional Shoreline.

Methods for Resource Identification

In 2012, a record search for the entire Delta was completed at California Historic Resources Information Centers for the BDCP (ICF 2012b). A second search to update this information and retrieve survey data was completed in March 2014 at the North Central Information Center and the Northwest Information Center. Additional research was undertaken using in house records and those held by the East Bay Regional Park System, the State Lands Commission, and the NRHP.

For the original study the APE was almost completely submerged, and no pedestrian survey could be undertaken. However, a reconnaissance survey in the form of boat trips which included photographing the remnant levees and other features was undertaken to document the current condition of these resources.

The updated Area of Potential Effect now includes work on Jersey Island. A small section where a pipeline and road will cross Jersey Island requires pedestrian survey and updated consultation with the California SHPO and interested tribes. We are currently in compliance because 36 CFR 800.4 [b][2] allows for phased identification and evaluation if access to properties is not available. The survey will be conducted prior to project implementation, once access to the property is provided.

Known Cultural Resources

USACE has not surveyed the entire APE due to access limitations, but a records search and partial survey of the APE has identified one cultural resource within the APE: the remnant levee surrounding Big Break. The levee is described and evaluated for its eligibility for listing in the NRHP separately, below.

<u>Big Break</u>

The levee surrounding Big Break were recorded and evaluated by USACE in November of 2013. The levee is currently very degraded. Current (2012) aerial photos show that approximately 20,741 feet (3.9 miles) remains of the levee in at least 13 segments. As discussed above, the levees surrounding Big Break breached in 1928 and the land was never reclaimed. USACE has determined that while the levee was peripherally related to the themes of reclamation and agricultural development in the Delta, it does not retain enough integrity of location, setting, feeling, association, workmanship, materials, and design to be eligible under Criterion A. It is not associated with any person or persons significant to history (Criterion B). The levee likewise does not embody the distinct characteristics of a type, period, nor method of construction, nor represent the work of a master, nor do they possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). The levee has not yielded, nor is it likely to yield, information important in prehistory or history (Criterion D). Therefore, USACE has determined the levee is not eligible for listing in the NRHP.

Areas not Surveyed

Materials from existing dredge spoils locations are proposed to be piped from the Stockton DWSC, over Jersey Island, to the work area at Big Break. Because the alignment of this pipe was unknown, only a record search of potential alignments was performed. The Corps has not yet received permission to access Jersey Island so it has not been surveyed to date. The record search showed that only one known cultural resource is in the project APE: the Big Break remnant levee described above.

Consultation

Native American

Native American Tribes with interests in the Delta were contacted by USACE in May 2013. USACE received one response from the Wilton Rancheria with a request for more information and stated desire to continue to be involved. More detailed information was sent to every Tribe in March 2014. The Corps has consulted on the surveyed portions of the APE. 36 CFR 800.4 [b][2] allows for phased identification if access to a property is not possible. Once access limitations for Jersey Island are resolved, and a pedestrian survey of Jersey Island has been completed, the Corps will update tribal consultation for the project.

State Historic Preservation Officer

USACE determined that the proposed undertaking would result in no historic properties affected. Consultation with the State Historic Preservation Officer (SHPO) was initiated on May 15, 2014 and USACE received concurrence with their findings on May 29, 2014. Copies of the correspondence can be seen in Appendix J. The Corps will update SHPO consultation for the project once the survey of Jersey Island has been completed.

5.0 – ENVIRONMENTAL CONSEQUENCES

5.1 Introduction

This chapter discusses the potential effects of the alternative plans on the significant environmental resources described in Chapter 4. The present condition of each resource analyzed in this chapter is compared with the estimated future condition of the resource after the following alternative plans are in place:

- Alternative 1 – No Action
- Alternative 2 – 160 Acres of Intertidal Marsh Restoration
- Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Project effects on these significant environmental resources are measurable over the entire restoration footprint or over specific project areas depending upon the configuration of each resource.

Both beneficial and adverse effects are considered, including direct effects during construction and indirect effects resulting from the alternatives. Each section, where appropriate, contains a discussion of the methods used to analyze effects. In addition, the bases of significance (criteria) for each resource are identified to provide a basis for evaluation of the significance of any adverse effects. Finally, avoidance and minimization measures are proposed to reduce any significant adverse effects for each resource. A summary of the effects and their level of significance is included in Section 5.7, Irreversible and Irretrievable Commitment of Resources.

Engineer Regulation 1105-2-100, "Planning Guidance Notebook," April 2000, establishes the following significance criteria:

- Significance based on institutional recognition means that the importance of the effects is acknowledged in the laws, adopted plans, and other policy statements of public agencies and private groups. Institutional recognition is often in the form of specific criteria.
- Significance based on public recognition means that some segment of the general public recognized the importance of the effect. Public recognition may take the form of controversy, support, conflict, or opposition expressed formally or informally.
- Significance based on technical recognition means that the importance of an effect is based on the technical or scientific criteria related to critical resource characteristics.

For this EIS, the above three NEPA criteria apply to all resources and are not repeated under each resource section. The term "significant", as used in NEPA, requires considerations of both context and intensity:

- (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
- (b) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:
  - (1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.
  - (2) The degree to which the proposed action affects public health or safety.
  - (3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
  - (4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.
  - (5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
  - (6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
  - (7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
  - (8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or may cause loss or destruction of significant scientific, cultural, or historical resources.
  - (9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the FESA of 1973.

- (10) Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

5.2 Geologic Resources

This section evaluates the construction-related effects of the alternatives on geologic resources. This analysis considers short-term restoration effects within the project area at Big Break and discusses long-term beneficial effects.

5.2.1 Methodology and Basis of Significance

Methodology

As a part of feasibility level design, sediment sampling data from the Stockton O&M Dredging project was reviewed from the last decade to confirm the content of the sediment proposed for use. Additionally, historic data was reviewed and considered in this analysis. Two primary resources used included the Flooded Islands Feasibility Study Baseline Report prepared by DWR (DWR 2005) and the USACE Cultural Resources Survey Report (USACE 2014).

Basis of Significance

Adverse effects on topography were considered significant if implementation of an alternative plan would result in any of the following:

- Rupture of a known earthquake fault, strong seismic shaking, or seismic-related ground failure, including liquefaction;
- Landslides, substantial soil erosion, or permanent loss of topsoil;
- Locating the project on an unstable geologic unit, or on a geologic unit that would become unstable as a result of the project; and/or,
- Locating the project on expansive soil, as defined in the Uniform Building Code.

The proposed alternatives would not expose people or structures to substantial effects involving earthquakes, landslides, and expansive soils. Additionally, the proposed measures would not be located on unstable geographic units. As a result, these criteria are not discussed further in this section.

5.2.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the geologic resources encompassing Big Break would remain undisturbed. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. Big Break would remain in its current state and no sediment would be placed to reverse the existing subsidence occurring in the study area. As a result, Big Break would remain a sunken island and the open water condition would remain unchanged. Subsidence would continue, and over time the water would continue to get deeper as the soils compress, which would make it less likely that future restoration work could occur.

5.2.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Under Alternative 2, 160 acres of intertidal marsh restoration is proposed at Big Break. Restoration would be accomplished by placing dredged material to reverse subsidence and raise the elevation of the sunken island to promote marsh vegetation establishment.

The sediment proposed for use in reversing the impacts of subsidence would be acquired through the annual O&M Dredging for the Stockton DWSC. Analysis of over 10 years of grain size distribution data for the proposed dredging reaches shows the material to be virtually completely fine sand. Ultimately, the proposed project would not be creating mounds from outside sources or material, but rather moving sediment within the system from the engineered channel to the subsided island.

Under this alternative, the topography would be permanently altered due to the placement of dredged material throughout Big Break. Placement of dredged material would create a variable topography that at times would be submerged below the tidal level and at other times might be exposed vegetated sand mounds. The target elevations for the habitat include some contingency to account for potential additional subsidence, sea level rise, and wave wash erosion.

Therefore, while the proposed alternatives do involve reusing dredged materials to raise the elevation of these sunken islands, the purpose of the action is to restore these islands to historic conditions. As a result, the proposed alternatives would have effects due to the placement of sediment and change in topography throughout Big Break, but ultimately effects on geologic resources would be beneficial, because the project would be restoring the area to its historic condition.

5.2.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to geologic resources would be consistent with those described for Alternative 2.

5.2.5 Avoidance and Minimization Measures

Since the effects to geologic resources would be beneficial, there would be no avoidance or minimization measures are required.

5.3 Aesthetics

This section evaluates the construction-related effects of the alternatives on aesthetics. This analysis considers short-term restoration effects within the project area at Big Break and discusses long-term beneficial effects to aesthetics.

5.3.1 Methodology and Basis of Significance

Methodology

Evaluation of the potential impacts on aesthetics was based on a review of scenic vistas and landscapes that could be affected by project related activities. Changes to the visual resource are assessed by factoring the degree of change to the visual resource affected and viewer response to that change. Other elements, such as natural screening by vegetation or landforms, placement of project components in relation to existing structures, and likely viewer groups were also considered.

Basis of Significance

Adverse effects on aesthetics were considered significant if implementation of an alternative plan would:

- Have a substantial adverse effect on a scenic vista.
- Substantially damage scenic resources, including but not limited to, trees, rock outcroppings, and historic buildings.

- Substantially degrade the existing visual character or quality of the site and its surroundings.
- Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.

5.3.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in construction of the proposed project and the visual character of Big Break would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. As a result, Big Break would remain a sunken island and the open water condition would remain unchanged. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Therefore, overall, aesthetics in the study area would remain similar to existing conditions.

5.3.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Construction of Alternative 2 would create temporary and permanent changes in views of and from the Big Break restoration site. Construction would require staging of heavy equipment on Jersey Island and the use of a pipe that is large in size for adequate transport of dredged material into Big Break. Construction activities within the proposed action area would temporarily affect the local view due to the brief presence of various construction equipment and supplies and changes to the topography during the course of construction activities. Big Break is in a remote location with few surrounding residences or businesses, therefore the primary people that would be subjected to these temporary impacts would be intermittent recreational fisherman and kayakers using the area, wildlife viewers at Big Break Regional Park, and possibly drivers viewing Big Break from the Highway 160/Antioch Bridge.

Presence of construction equipment and pipe would temporarily degrade the visual quality of Jersey Island and the closely surrounding area. However, after the placement of dredged material is completed each season, the pipe and construction equipment would be removed from the project area, making this impact temporary, lasting approximately 2 weeks per year for 5 years.

Following construction, there would be a temporary impact to the visual character of the landscape that would last approximately 1 year, as the dredged material settles. During this time, the tops of the sand mounds would be exposed at low tide, which would be visible by the receptors discussed above. After the settlement period, vegetation would be planted at the restoration site, and the visual character would improve to a beneficial, natural-looking intertidal marsh habitat. This habitat would be a permanent change in the visual character of Big Break;

however, the changes would restore the area to a functional intertidal marsh habitat. The permanent change to the viewshed would improve the visual character of the restoration site, including the views of the restoration site from Jersey Island, Big Break Regional Park, and the Highway 160/Antioch Bridge, rendering this permanent change to aesthetics beneficial.

5.3.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to aesthetics under Alternative 3 would be consistent with those described for Alternative 2.

5.3.5 Avoidance and Minimization Measures

USACE would implement the following minimization measure to reduce potential impacts to aesthetics:

- Restore staging areas to pre-construction conditions to the degree practicable following each construction season and hydroseed the disturbed area with native grasses and forbs.

5.4 Vegetation and Wildlife

This section evaluates the effects of the proposed alternatives on vegetation and wildlife resources in the project area. Effects of the proposed alternatives were analyzed during coordination with the USFWS under the Federal FWCA and a final Coordination Act Report (CAR) was received on June 26, 2018 (Appendix L). Biological field surveys were conducted in the project vicinity by USFWS, NMFS, and USACE in November of 2013 to assess vegetation cover types, existing habitat for special status and wildlife species, and the presence of special status species and invasive plant species. A HEP analysis was conducted to quantify the ecological benefits of the proposed alternatives. A summary of the HEP analysis is included in Chapter 3 under the Plan Formulation discussion. The HEP analysis is included with the document as Appendix F.

5.4.1 Methodology and Basis of Significance

Methodology

Under NEPA, the significance of project impacts is a function of context and intensity. For biological resources, context refers to the importance (ecological, commercial, scientific, recreational, etc.) or regulatory (i.e. legally protected) status of the resource, and intensity refers to the magnitude – scale and duration – of the impact. Both beneficial and adverse impacts are recognized; either can be significant.

In the study area, the habitats of greatest importance are open water, tidal marsh, and tidal freshwater emergent wetlands. These habitats are most important because of their scarcity and high value to fish and wildlife species. Substantial long-term net reductions in the acreage and/or value of these habitats would represent significant adverse impacts, underscoring the importance to the ecosystem of the project's contribution of new intertidal marsh converted from lesser-valued open water or grassland habitat. Losses or gains of population and habitat for special status species may also be significant, depending on the magnitude of the impact relative to the population size and distribution of the species in the region. Finally, any impact leading to new introductions or the expansion of invasive species would also be considered significant in terms of potential far-reaching effects on the ecosystem of the project area.

Because the purpose of the project is habitat restoration, the habitat functions and values that would be provided upon maturity of the habitats proposed for restoration are also described. The project is designed to establish intertidal marsh habitat at the proposed restoration sites and that context was considered in evaluating the impacts to vegetation and wildlife.

Basis of Significance

Adverse effects on vegetation and wildlife were considered significant if implementation of an alternative plan would result in any of the following:

- Result in a substantial loss of native vegetation or species.
- Removal, or substantial disturbance of a sensitive natural community (wetlands, tidal marsh)
- Substantial reduction in the quality and quantity of important habitat or access to such habitat for wildlife species.

5.4.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the habitat condition of Big Break would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. As a result, Big Break would remain a sunken island and the open water condition would remain unchanged. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Therefore, overall, vegetation and wildlife in the study area are expected to remain similar to existing conditions.

5.4.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Under Alternative 2, 160 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water intertidal marsh habitat via the direct placement of O&M dredged material, as described in Section 3.9.2. It is anticipated that sensitive vegetative habitat types located on the periphery of Big Break such as existing tidal marsh and riparian vegetation, would eventually be improved by removing the existing invasive plant species on the remnant levee and replanting the levee with native riparian species. Placement of dredged material would not directly affect the tidal marsh or riparian vegetation because those construction activities would be restricted to open water, outside these habitats.

Habitat growth at Big Break would occur gradually over time as dredged material placement occurs. Because dredged material placement is dependent on annual O&M dredging, which is estimated to produce 100,000 cubic yards per year, project construction would require approximately 5 years. Only clean dredged material found suitable for direct placement for the purpose of habitat restoration, would be accepted at the project site. As the restoration site progresses over time, the restored intertidal marsh would become established in 2 to 3 years and provide valuable new habitat for fish and wildlife species.

The gain of higher value intertidal marsh habitat would more than offset the loss of open water habitat (Table 5-1). Accordingly, permanent loss of open water habitat would result in a less-than-significant impact. Because of uncertainties regarding the rate of intertidal marsh vegetation development to offset the temporary loss of habitat values, a monitoring plan is proposed as part the project to measure the establishment rate and the quality and quantity of habitat gained. No avoidance or minimization measures would be required because the project's conversion of open water habitat to intertidal marsh habitat would result in a net increase in ecological benefits over the life of the project, which is a positive environmental effect, and is consistent with the San Francisco Estuary Project Comprehensive Conservation and Management Plan, the Delta Plan, and other local land use plans in the Delta region. See Table 5-1 for net changes to habitat types.

Invasive plants are already present throughout the habitat types in the project area (Table 5-1). Construction activities could introduce new invasive plants to the project area or contribute to the spread of existing invasive plants to uninfested areas outside the project area. Invasive plants or their seeds may be dispersed by construction equipment if appropriate prevention measures are not implemented. The introduction or spread of invasive plants as a result of the project could have a significant effect on sensitive natural communities within and outside the project area by displacing native flora. However, there would be two separate actions taking place to deter the spread of invasive plants: aquatic vegetation plantings on the intertidal marsh habitat sand mounds and riparian habitat restoration on the remnant levee.

Table 5-1. Net Change in Habitat Types at Big Break under the Proposed Alternatives

	Alternative 1: No-Action Alternative	Alternative 2		Alternative 3	
Community or Habitat Type	**Acres**	**Acres**	**Net Change**	**Acres**	**Net Change**
Tidal perennial aquatic (open water)	1,490.0	1,330	-160	1,409.7	-340
Shallow water channels (within intertidal marsh)	0	112	112	245	245
Intertidal marsh	305.7	350.7	45	395.0	90
Valley foothill riparian	100.2	150.2	50	150.2	50
Annual grassland	19.3	19.3	0	19.3	0
Coastal Scrub	2.6	2.6	0	2.6	0

After dredged material placement and settlement, aquatic vegetation would be planted in the sand mounds that would make up the new intertidal marsh habitat placed throughout the open water area in Big Break. Plant material for the aquatic vegetation would be nursery grown or collected from acceptable nearby sources to be directly planted on the sand mounds, encouraging colonization before undesirable invasive/exotic vegetation to develop.

Prior to construction, removal of invasive plant species would occur on the remnant levee using a gas-powered hedger. The cuttings would immediately be chipped, spread over the ground as mulch, and exposed rootstock would then be treated with three treatments of herbicide (approximately a month apart) in order to ensure the native plantings could be established without competition. Riparian vegetation would be planted in place of the invasive plant species that are currently occupying the area. The purpose of the new riparian vegetation plantings would be to avoid the spread of invasive species into the newly created marsh habitat in Big Break.

In addition to the creation of aquatic vegetation and riparian habitat, implementation of the appropriate measures to avoid or minimize the spread or introduction of invasive plants would ensure that the proposed alternative would not have a significant adverse effect on sensitive natural communities from the introduction or spread of invasive plants. With implementation of the measures listed in Section 5.2.5 below to avoid and minimize the spread or introduction of invasive plant species, this would be a less-than-significant effect.

The permanent conversion of open water habitat to intertidal marsh habitat would result in a substantial improvement to the wetland functions and values on the project site for fish and wildlife, including special status species. The creation of intertidal marsh habitat within Big

Break would likely create high-quality habitat for common species of amphibians, reptiles, birds, and mammals. Common fish and wildlife species present within the study area may be directly or indirectly affected by construction. Direct impacts may include mortality or injury to wildlife present within the proposed sites due to dredged material placement, movement of heavy equipment, and construction noise. Indirect impacts would include alteration of habitat conditions after the completion of construction. The risk of a potential increase in the bioavailability of contaminants carried in dredged materials is addressed in the water quality section. Because the proposed restoration would benefit fish and wildlife species long-term, and because avoidance and minimization measures would be implemented to reduce the potential impacts associated with invasive species, the resulting effect is considered less than significant.

5.2.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. The change in acreages is displayed in Table 5-1 and compared to the no action and Alternative 2 scenarios. Effects to vegetation and wildlife under Alternative 3 would be consistent with those described for Alternative 2, with greater long-term benefits occurring over the life of the project.

5.2.5 Avoidance and Minimization Measures

The following measures would be implemented to reduce potential short-term impacts that could result from the introduction or spread of invasive plant species as a result of project construction:

- The adjacent remnant levee would be treated to remove invasive species and riparian vegetation would be established to prevent terrestrial invasive species from populating and out-competing the intertidal marsh restoration.
- Mowing and spraying would be implemented on the remnant levee to control and reduce continued weed growth.
- Invasive, noxious and/exotic plant species will be hand or mechanically collected from the intertidal marsh restoration area, removed from the site, and properly disposed.
- The Monitoring and Adaptive Management Plan (Appendix D) would be implemented to ensure restoration is successful.

5.3 Special Status Species

This section evaluates the effects of the proposed alternatives on special status species in the project area. Initial evaluation determined that several species have the potential to occur, or that suitable habitat exists, in the project area.

5.3.1 Methodology and Basis of Significance

Methodology

Special-status species are defined as animals that are legally protected under the FESA. Based on the USFWS (2018) species list and CNDDB (California Department of Fish and Wildlife 2018) records search in Contra Costa County for the affected area, eight special-status plant and wildlife species were identified as having potential to occur in the affected area, which are also included in Appendix G and Table 4-1:

- Antioch Dunes evening-primrose;
- Valley Elderberry Longhorn Beetle;
- Giant Garter Snake;
- North American green sturgeon southern DPS;
- Delta Smelt;
- Central Valley Steelhead DPS;
- Chinook salmon, Central Valley spring-run ESU; and
- Chinook salmon, Sacramento River winter-run.

Basis of Significance

Adverse effects on special status species were considered significant if implementation of an alternative plan would:

- Directly or indirectly reduce the growth, survival, or reproductive success of species listed or proposed for listing as threatened or endangered under the FESA.
- Directly or indirectly reduce the growth survival, or reproductive success of substantial populations of Federal concern.

5.3.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the habitat condition of Big Break would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. As a result, Big Break would remain a sunken island and the open water condition would remain unchanged. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Therefore, overall, conditions for special status species in the study area are expected to remain similar to existing conditions, and no long-term benefits would be realized from the restoration of intertidal marsh habitat at Big Break.

5.3.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Special Status Plant Species

The construction disturbance areas would be largely confined to open water, therefore there is a low potential for impacts to special-status plants, including the Antioch Dunes evening-primrose. However if this species is present on Jersey Island at the proposed staging area, or on the remnant levee, project construction could result in its removal. If there happen to be populations of the Antioch Dunes evening-primrose present on the remnant levee, invasive species removal activities has the potential to remove special status plants as well. However, removal of the existing invasive species would then provide more open habitat available for potential use by the native plantings that would be implemented. This newly created open habitat that is free of invasive species would create 50 acres of habitat, reducing competition for the native species and providing more suitable opportunities for special status plants to remain established. While there could be a potential negative effect to the Antioch Dunes evening-primrose during invasive plant removal, there would ultimately be a beneficial effect to special status plant species once existing invasive species are removed and native species are planted.

USACE would conduct surveys of the study area to document the presence of special status plants before project implementation. Qualified botanists would conduct a floristic survey that follows the CDFW botanical survey guidelines. If special status plant populations are detected where construction would have unavoidable impacts, USACE will modify the project design to avoid indirect or direct effects and/or prepare and implement avoidance and minimization coordination with USFWS or CDFW. Such plans may include salvage, propagation, on-site reintroduction in restored habitats, and monitoring. If there are no special status plant populations detected during the preconstruction surveys, then there would be no effects to special status plant species from implementation of Alternative 2.

<u>Special-Status Fish Species</u>

Effects of the proposed Project on special-status fish include both short- and long-term effects. Short-term effects include direct impacts from construction activities (e.g., increased suspended sediment and turbidity). Long-term or permanent impacts would result from the conversion of open water habitat to higher value intertidal marsh habitat.

Short-term Effects on Fish Habitat and EFH

Construction would occur over a 5-year period during the summer and fall of each year, a time when green sturgeon, delta smelt, and salmonid juveniles/smolts may be rearing and outmigrating through the Delta, and when adult fish are likely to be moving upstream through the Delta. Adult and juvenile fish primarily migrate upstream and downstream within the main-stem Sacramento and San Joaquin River. Juvenile fish may migrate from the Sacramento and San Joaquin River to the central Delta during their downstream migration and may also inhabit flooded islands as a temporary foraging area and migration pathway during the winter and early spring migration period. The occurrence of any of the listed fish species in the Delta would be expected to occur during late fall through early spring when Delta water temperatures would be suitable for migration. Most notably, Delta smelt could be present in Big Break year-round. Effects to juveniles and smolts during construction would be short-term during the two week construction period. These effects are described in detail in the paragraphs below. The project area is very small in comparison to the overall central Delta, and there is significant rearing and feeding habitat present in adjacent aquatic areas.

The majority of adult Chinook salmon migrate upstream in the Sacramento River, there is a probability, although low, that adults may migrate into the central Delta. The occurrence of Chinook salmon in the central Delta, including Big Break would be limited to winter and early spring adult upstream migration. Adult sDPS green sturgeon are not expected to be affected by construction activity, since sDPS green sturgeon are believed to migrate in the deepest portions of the channel (greater than 5 meters) and typically emigrate to the sea during the autumn and winter (Erickson et al. 2002). Although the likelihood of sDPS green sturgeon occurring in the Delta area low, every observation of green sturgeon juveniles or unidentified sturgeon larvae have been in the Delta downstream from Old River (Beamesderfer et al., 2004).

When fish migration timing coincides with the in-water work window, the presence of overhead equipment and the sound generated by construction activities could temporarily disrupt essential behavior patterns (e.g., feeding, escape from predators, migration) of adult and juvenile fish at the construction sites and the surrounding areas. Direct mortality of individuals could occur to fish present during construction during the direct placement of dredged material into the open water of Big Break. Placement of dredged sediment may also potentially disturb, injure, or kill any fish migrating though the area of the construction sites during construction. Noise effects may occur at the project site and general vicinity. Construction could result in elevated levels of suspended sediment, causing increased turbidity and potential sedimentation of benthic (bottom) habitat used by juvenile and adult fish for feeding, cover, and other essential behaviors. However, 10 years of dredged material sampling has shown that the material is primarily fine sand, which is known to settle without significant sedimentation, so it is unlikely that turbidity would occur at levels that would harm green sturgeon and salmonid species. Due to material characteristics (nearly all fine sand) turbidity would be limited (see Appendix C). An increase in turbidity and decrease in water clarity would have potential beneficial effects if delta smelt species are present. However, any turbidity effects would likely be minor in scope and addressed through proposed BMPs and the Section 401 Water Quality Certification process.

Slower moving benthic organisms that are food sources for fish would be buried by dredged material and potentially from placement and anchoring of the dredge pipelines. These areas affected should recover quickly after placement of the dredged material and removal of the pipelines as these areas are recolonized by benthic organisms. Survival studies at the nearby Donlon Island project demonstrated that benthic organisms recolonized within a two year period, providing sufficient primary productivity (food web) benefits (USACE and USFWS 1990).

Resulting short-term effects could include reduced feeding success, and compromised ability to escape from predators. Toxic substances used by construction equipment including gasoline and diesel, lubricants, and other petroleum-based products, could enter the waterways adjacent to the project site as a result of spills or leakage from machinery or storage containers. The contractor would be required to submit and adhere to a Storm Water Pollution Prevention Plan (SWPPP) and an in-water work plan subject to approval by the Central Valley RWQCB. The SWPPP and associated BMPs are discussed further in the Water Quality section (Section 5.4.5). Mortality or physiological impairment of fish or disruption of essential behavior patterns is possible if exposure to sufficient concentrations occurs.

Essential fish habitat encompasses all types of aquatic habitat where fish spawn, breed, feed, or grow to maturity. The National Marine Fisheries Service (NMFS) works with regional fishery management councils to identify EFH of every federally listed species and it has currently been identified for approximately 1,000 fish species (NMFS, 2018). The proposed project would be converting approximately 160 acres of open water habitat in Big Break to intertidal marsh habitat. Approximately 112 acres would become more shallow water habitat and the remaining acreage would be used for riparian habitat. The shallow water habitat would be created by coarse grained dredge slurry in the form of sand mounds throughout the open water. Shallow water habitat resulting from the sand mounds would range from the existing sediment bed currently existing at Big Break to the mean water elevation for 4 to 8 feet, depending on tides and outflows. Following dredged material placement and the creation of the sand mounds, vegetation would be plated to provide locations for native emergent marsh vegetation. The combination of sand mounds and vegetation would provide more habitat diversity and stability for juvenile Chinook salmon to continue their life cycles. Fish would be able to use the shallow waters for spawning and the vegetation as cover for increased protection. While there is the potential for short-term adverse effects, but long-term benefits to Pacific Salmon EFH, NMFS has indicated in their concurrence letter on June 15, 2018 that the proposed restoration is not likely to adversely affect Pacific salmon EFH.

Short-term direct impacts to special status fish would be considered significant, if construction were to occur outside of the species work windows. However, USACE would adhere to the specified species work windows from USFWS and NMFS for fish species. As a result, the project may affect, but not likely to adversely affect short term effects on fish habitat and EFH, as all work would be occurring outside of the species migration season.

Long-term Effects on Fish Habitat and EFH

The restoration of intertidal marsh habitat would increase instream structure and aquatic habitat complexity and the quality of EFH. Planted marsh vegetation would begin to colonize the shallow water habitat created by dredged material placement and gradually cover the site. These combined factors would provide high quality habitat for all life stages of all species present in the study area and most life stages of special status fishes. The intertidal marsh habitat would provide escape cover, creating ideal refugia from large predators for small larval and juvenile fishes. The intertidal marsh habitat would be especially valuable as holding and rearing habitat for all life stages of all special-status species. Inundated intertidal marsh habitat should also provide an increase in potential delta smelt spawning habitat. Overall, the proposed alternative would have a net long-term benefit for all life stages of all special-status species, which would result in less-than-significant long-term impacts.

Special Status Wildlife Species

A small number of special status wildlife species could occur on Jersey Island that have the potential to be affected by the pipeline crossing and staging area. Effects to special status wildlife species are discussed in the subsections below.

Effects to Migratory Bird Species

Noise, vibration, visual, and proximity-related disturbances associated with construction could adversely affect special status bird species if they are nesting on or adjacent to the restoration site during construction. Since construction would occur in the August 1 through October 31 time period outside of the spring nesting season, it is unlikely that nesting birds would be present. However, if individuals of these species nest during the construction period, construction disturbances could cause them to abandon their nests or young. The breeding success of these species could be diminished if disturbances reduce ability of adults to properly care for their young. Therefore this impact is considered significant. To reduce this impact to a less-than-significant level, avoidance and minimization measures, as discussed in Section 5.3.5 below, would be implemented.

Emergent intertidal marsh habitat, riparian habitat, and shallow water (less than 6 inches deep) are important foraging and resting habitat areas for both shorebirds and migratory bird species. The project has the potential to create mudflat habitat by the placement of dredged material before intertidal marsh vegetation becomes established, but the existing open water habitat and the newly created tidal marsh and riparian habitat would provide a beneficial impact to affected birds. The benthic organisms that colonize the potential mudflat and shallow open water areas would become prey for shorebirds and some migratory birds that use the open water for foraging aquatic species. With the creation of new intertidal marsh habitat from dredge placement and riparian habitat located on the remnant levee, there would be a long-term increase in diversity of all types of wildlife. This diversity would create an environment that harbors more prey for birds to forage and more habitat for birds to nest. Although there would not be any effects to migratory bird species long-term, the proposed project has the potential to have short-term negative effects to both shorebird and migratory bird species while construction activities are occurring. However, construction activities only occur for two weeks out of the year and overall there would be a beneficial long-term effect to bird species utilizing Jersey Island and Big Break once construction is completed.

Effects to Special Status Reptiles

Project activities on Jersey Island could potentially affect the Federally threatened giant garter snake. While this portion of the Delta has been considered to be a gap between giant garter snake populations in the past, in 2015 multiple giant garter snakes were observed on the east end of Jersey Island, as noted in the USFWS Biological Opinion (Appendix G). While there is the potential for occurrences of giant garter snake, no giant garter snake habitat would be affected by project implementation and no compensatory mitigation would be required.

Construction of the marsh restoration will be annually timed in accordance to the proposed dredging operation. The dredging schedule is heavily influenced by special status fish species work windows, locations of sediment that requires dredging, and scheduling the timing of the operation based on location within the channel (i.e., dredging operation begins downstream and moves upstream). Additionally, if there is a single contractor for both ship channels, the Sacramento DWSC must be dredged first due to Delta smelt entrainment concerns. As a result, it is not possible to schedule construction to incorporate the typical giant garter snake active window. However, there would be no ground disturbing activities (i.e., digging/excavation) associated with this action and work occurring outside of the active period would likely be less impactful to snakes. During the inactive period, snakes are expected to be hibernating in their burrows and would not be affected by project activities. If work occurs within the active window, there is the potential for construction-related effects to giant garter snakes.

Activities on Jersey Island that could potentially affect giant garter snake include construction of road improvements for hauling and vehicular access and installation and removal of the dredging pipeline alongside the edge of the haul road. These activities could potentially disturb, injure, or kill any snakes using the drainage ditches, staging area, or roadways on Jersey Island. Additionally, noise effects may occur in these areas to disturb any giant garter snakes that may be present. Installation and removal of the pipeline each year could potentially crush snakes that are present along the edge of the roadway.

Prior to each construction season, the roadway and staging area would be surveyed to ensure that no snakes are present. With preconstruction surveys and the other minimization measures discussed below, the project would reduce impacts to giant garter snakes to less than significant.

5.3.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase by 180 acres. Effects to special status species under Alternative 3 would be consistent with those described for Alternative 2, with greater long-term benefits occurring over the life of the project.

5.3.5 Avoidance and Minimization Measures

Special Status Fish Species

The following measures would be implemented to reduce short-term impacts to special status fish species, from construction of the proposed alternatives:

- During construction, stockpiling of construction materials, portable equipment, vehicles, and supplies would be restricted to the designated construction staging areas.
- A qualified biologist shall provide worker environmental awareness training to contractors and construction crews regarding all special status fish species known to potentially occur near the construction sites.
- A representative (onsite monitor) shall be appointed by USACE to be the point of contact for any worker who observes a dead, injured, or entrapped special status fish. Dead or injured fish shall be photographed and the photographs provided to USACE, NMFS, and USFWS. If a live specimen is captured in good condition, and a positive identification cannot be made in the field because of size or lack of other distinguishing characteristics, the fish shall be immediately returned to the river downstream of the construction site.
- Sacrificial straw bales would be placed to provide barriers to the predominant flow paths allowing for sediment to settle and sand mounds to stabilize. Straw bales are anticipated to persist for 1 to 2 years, giving sufficient time for vegetative establishment.

- No aquatic pesticides would be used to treat aquatic invasive species.
- Construction would occur within the scheduled work windows as much as practicable in order to avoid adverse impacts to special status species.

Migratory Bird Species

USACE would conduct surveys to locate nest sites for migratory bird species in suitable breeding habitats in the spring of each construction year. Surveys will be conducted by a qualified biologist using survey methods approved by USFWS. Survey results will be submitted to USFWS before construction is initiated. If nests or young of these species are not located, construction may proceed. If nest sites or young are located, USACE will consult with USFWS and CDFW to determine what avoidance and minimization measures could be implemented to avoid or reduce potential disturbance-related impacts to these species. Measures could include a no-disturbance buffer zone established around the nest site. The width of the buffer zone would be determined by a qualified biologist in coordination with the USFWS. No construction activities would occur within the buffer zone. The buffer zone would be maintained until the young have fledged (as determined by a qualified biologist).

Special Status Reptile Species

The following avoidance and minimization measures are proposed for the protection of the giant garter snake and its aquatic habitat:

- The construction area will be surveyed for giant garter snakes 24 hours prior to construction activities by a qualified biologist each construction season. Survey of the project area would be repeated if a lapse in construction activity of two weeks or greater occurs. If a giant garter snake is encountered during construction, then activities would cease until appropriate corrective measures have been completed or it has been determined that the snake would not be harmed.
- Construction personnel would receive environmental awareness training to instruct workers on how to recognize giant garter snakes and their habitat.

5.4 Water Quality

This section evaluates the effects of the proposed alternatives on the water resources, surface and ground water quality conditions, and jurisdictional wetlands in the project area. Qualitative effects on water quality were estimated based on construction practices and materials, location, and duration of construction. Standard pollution prevention measures including erosion and sediment control measures, proper control of non-stormwater discharges, and hazardous spill prevention and response measures would be implemented as part of the project design.

5.4.1 Methodology and Basis of Significance

Methodology

Effects on water quality resources were analyzed qualitatively based on existing water quality monitoring data associated with the annual Stockton DWSC O&M dredging project. Coordination with the CVRWQCB would occur prior to placement to determine if additional testing would be required. This coordination would evaluate the source material for hazardous substance thresholds as applied to in-water fill material and determine if project placement activities would affect water quality. In addition to reviewing water quality monitoring data, USACE reviewed sediment sampling data and determined that the dredged material primarily consists of fine sand, which is expected to result in less turbidity than previously anticipated during the draft EIS. As a result, the Corps has reassessed the water quality analysis and proposed BMPs since the draft report phase and adjusted accordingly.

Basis of Significance

Adverse effects on water quality were considered significant if implementation of an alternative plan would:

- Substantially degrade surface water quality such that it would violate criteria or objectives identified in the CVRWQCB basin plan or otherwise substantially degrade water quality to the detriment of beneficial uses.
- Adversely affect salinity flow patterns at water conveyance facilities (affect the X2 line).
- Disturb existing channel banks, channel beds, or levees to the extent that erosion and sedimentation could be accelerated.
- Remove, fill, or substantially disturb a jurisdictional wetland.

5.4.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the water quality condition of Big Break would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. As a result, Big Break would remain a sunken island and the open water condition would remain unchanged. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the water quality conditions in the Delta, rendering uncertainty in the future condition of the Delta. No long-term benefits would be realized from the restoration of intertidal marsh habitat at Big Break.

5.4.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

At the restoration site silt curtains, hay bales, or similar tools would be used to keep the dredged material contained within the placement zone and to direct flows, as needed, to best support the restoration. Prior to construction USACE would obtain a CWA Section 401 Certification from the CVRWQCB. The conditions set forth in the certification would be followed to prevent adverse effects to water quality. Water quality monitoring would occur during construction activities to ensure that the project is in compliance with the terms of the Section 401 Water Quality Certification. Section 401 Certifications for similar projects included monitoring to comply with the Basin Plan, reporting monitoring results, and maintaining low turbidity, pH, and DO levels. In addition, it would be likely be a requirement of the Section 401 Certification to monitor the 303(d) list pollutants for the area.

Coordination with the CVRWQCB would establish construction requirements to prevent violation of water quality standards set forth in the Basin Plan and to ensure that water quality is not substantially degraded through project activities. Standard dredging protocol for testing of material prior to dredging activities will be followed. This protocol includes the testing of materials before dredging begins to determine if they meet standards for placement in water and upland areas. If material being dredged meets the criteria, it would be used to create the intertidal marsh habitat. If material does not meet the water quality standards, it would be processed under the dredging standards and not used for this project. The placement of material to restore intertidal marsh habitat at Big Break would not affect salinity in the study area and would not affect the X2 line, which is typically downstream of the project area. Sediment acquired from the DWSC Dredging program would not contain salinity levels that would affect or adjust the salinity in the Big Break area or elsewhere in the Delta. No channel banks, channel beds, or levees would be altered in a way that would cause additional erosion. As a result, effects to water quality from implementation of Alternative 2 would be less than significant, with the implementation of the conditions of the Section 401 Certification.

5.4.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to water quality under Alternative 3 would be consistent with those described for Alternative 2.

5.4.5 Avoidance and Minimization Measures

The contractor would be required to obtain a Construction General Permit and prepare and implement Storm Water Pollution Prevention Plan (SWPPP) for upland work areas and an in-water work plan. The SWPPP and in-water work plan details actions that would be taken during construction to reduce the risk of discharge into waterway and avoidance and minimization measures that would be taken in the event of an unforeseen spill. The Section 401 Certification permit would be issued by the CVRWQCB prior to construction. USACE will review the terms and conditions of the 401 Certification and will implement them if they are within the authority of USACE to implement. The SWPPP and an in-water work plan would be implemented to minimize water quality impacts.

5.5 Air Quality

This section evaluates the effects of the proposed alternatives on air quality in the project vicinity. Both construction and operation emissions were estimated and then compared with Federal air quality criteria for the area. Based on the results of the comparison, avoidance and minimization measures are identified to offset and/or reduce air quality emissions from the project. Big Break is within the San Francisco Bay Area Air Basin, which is regulated by the Bay Area Air Quality Management District (BAAQMD).

5.5.1 Methodology and Basis of Significance

Methodology

To complete the analysis, information was collected on projected construction activities, duration, and timing, equipment use, and activities for the first construction year. Only the first construction year was modeled because, due to the addition of invasive plant treatment and riparian planting on the remnant levee, the first construction year would have a greater total output of emissions than any other construction year. As a result, since air quality impacts are considered on an annual basis, if the proposed alternatives are in compliance in year one, they would be in compliance for all construction years.

Emissions associated with vehicle exhaust for employee commute vehicles and delivery trucks were estimated using the Sacramento Metropolitan Air Quality Management District (SMAQMD) Road Construction Emission Model Version 8.1 (May 2016) (Appendix I). Emissions associated with marine equipment such as boats were estimated using the SMAQMD Harborcraft, Dredge, and Barge Emission Factor Calculator Version 1.0 (July 2017). Though the proposed alternatives are located in the BAAQMD, the SMAQMD tools were selected for use because the proposed construction is a linear, short-term action that is better suited for the Road Construction Emission Model. The Harborcraft Emission Calculator is a new tool recently developed by SMAQMD that is specifically geared toward construction projects involving boats, dredges, and barges, therefore since the majority of the study area is aquatic, it was ideal for this proposed construction scenario.

Construction equipment usage from similar projects was analyzed to estimate daily and annual exhaust emissions. Emissions are considered significant if emissions exceed the thresholds established by the applicable air quality agencies. Modeling assumptions for each project alternative and methodology are provided in Appendix I.

The following emission sources and activities were analyzed:

- On-site construction off-road equipment emissions (all criteria pollutants).
- Off-site worker vehicle emissions (all criteria pollutants.
- On-site pickup trucks and off-site worker vehicles entrained fugitive dust emissions for paved and unpaved road entrained dust (PM_{10} and $PM_{2.5}$).
- Emissions from marine vessels such as boats for construction and site access during post construction monitoring.

<u>Basis of Significance</u>

Adverse effects on air quality were considered significant if implementation of an alternative plan would:

- Conflict with or obstruct implementation of an applicable air quality plan.
- Violate any air quality standard or contributes substantially to an existing or projected air quality violation.
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project is in nonattainment under applicable Federal ambient air quality standards (including releasing emissions which exceed quantitative thresholds for ozone precursors).
- Expose sensitive receptors to substantial pollutant concentrations.
- Create objectionable odors affecting a substantial number of people.

State Implementation Plan and General Conformity *De Minimis* Thresholds

The USEPA developed the General Conformity Rule, which became effective on January 31, 1994, to implement Section 176c of the Federal CCA. The underlying principle of the General Conformity Rule is that Federal actions must not cause or contribute to any violation of a NAAQS. A conformity determination is required for each pollutant where the total of direct and indirect emissions caused by a Federal action in a nonattainment area could exceed *de minimis* threshold levels listed in the General Conformity Rule (40 CFR 93.153). If the total direct emissions associated with the project are below the *de minimis* levels indicated in Table 5-2, general conformity requirements do not apply, and the project is considered in conformity and would not result in an adverse effect.

Table 5-2. General Conformity *De Minimis* Thresholds

Pollutant	Federal Attainment Status	Threshold Values (tons/yr)[1]
Ozone precursor (NO_X)	Nonattainment: Severe	25 (metric tons)
Ozone precursor (ROGs)	Nonattainment: Severe	25 (metric tons)
CO	Maintenance	100
SO_2	Attainment	N/A
$PM_{2.5}$	Nonattainment	100
PM_{10}	Nonattainment: Moderate	100
Pb	No designation	N/A

Source: USEPA 2014
[1] Thresholds from 40 CFR Parts 51 and 93.

Federal actions need to demonstrate conformity to any SIPs of the regional air basin. Each action must be reviewed to determine whether it: 1) qualifies for an exemption listed in the General Conformity Rule (GCR); 2) results in emissions that are below GCR *de minimis* emissions thresholds; or 3) would produce emissions above the GCR *de minimis* thresholds applicable to the specific area. The General Conformity *de minimis* levels for this project are shown below (Table 5-2). These thresholds were applied to the project's estimated emissions and used to determine effect significance as detailed below.

Because the project region is in attainment for the criteria pollutants indicated in Table 5-2 except ozone (serious), PM_{10} (moderate), and $PM_{2.5}$ a conformity assessment must be completed. That assessment will evaluate whether the project's construction or operational emissions would exceed 25 tons per year of ROG or NO_X, or 100 tons per year of PM_{10} or $PM_{2.5}$.

BAAQMD Thresholds

The BAAQMD thresholds of significance were obtained from the CEQA Guide to Air Quality Assessment, which lists a threshold of 54 pounds per day or 10 tons per year for ROG, NO_X, and $PM_{2.5}$ construction emissions and a PM_{10} threshold of 82 pounds per day or 15 tons per year (BAAQMD 2010). Table 5.3 shows the thresholds for criteria pollutants for the BAAQMD. There are no quantitative thresholds for construction dust emissions; instead, impacts are considered less than significant if the BAAQMD Best Management Practices are employed to control dust during construction activities, including excavation.

The BAAQMD TAC threshold is an increased cancer risk of more than 10 in 1,000,000 for a person with maximum exposure potential and increased non-cancer risk of 1.0 Hazard Index (chronic or acute). The BAAQMD also has a concentration threshold of 0.3 µg/m3 for $PM_{2.5}$. These thresholds are applicable to both construction emissions and operations emissions. Unlike the volume-based thresholds for criteria air pollutants, the TAC thresholds are used for specific receptor locations when a risk analysis is required for specific project components, such as stationary sources or the use of diesel-powered equipment, including construction equipment. There are no sensitive receptors located in the vicinity of the Delta Study alternatives, therefore there would be no impacts associated with TAC exposures due to implementation of this project.

The 2010 BAAQMD CEQA Guidelines recommend analyzing localized CO concentrations for projects that would increase traffic volumes at affected intersections to more than 44,000 vehicles per hour. However, given the minimal increase in vehicle trips due to newly required maintenance activities, the proposed project would not affect local CO concentrations during operations. Therefore, CO concentrations have not been quantified in this analysis.

BAAQMD considers projects that exceed these criteria air pollutant standards also to result in a cumulatively considerable air quality impact upon the region. According to BAAQMD, no further cumulative analysis should be required beyond the analysis of whether a proposed project's impacts would contribute considerably to ambient levels of pollutants or GHGs. Analysis of effects from GHGs is included in the Climate Change section below (Section 5.6).

Table 5-3. BAAQMD Thresholds for Criteria Pollutants (lbs/day)

	NO_X	ROG	PM_{10}	$PM_{2.5}$	CO	CO_2
BAAQMD Threshold	54	54	82	54	N/A	N/A

Construction Schedule

Though the project has not been approved and funded, a tentative project construction schedule has been created for modeling and cost estimating purposes. The schedule applies to both alternatives. Alternative 2 requires O&M dredging source materials for years 2020 through 2024. Alternative 3 requires O&M dredging source materials for years 2020 through 2029.

5.5.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the air quality condition would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the air quality conditions in the Delta, rendering uncertainty in the future condition of the Delta. No long-term benefits would be realized from the restoration of intertidal marsh habitat at Big Break.

5.5.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Equipment exhaust emissions would be generated by worker vehicles, boats, pumps, and some off road construction equipment. Table 5-4 describes the potential emission sources and equipment list for Alternative 3.

Table 5-4. Alternative 3 Emission Sources and Equipment List

Emission Source	Equipment List
Haul Road and Staging Site Improvement	Loader (2) Blade (2) Roller (2) Crane (1)
Employee Commute Trips Per Contract Area	12 employee trips per day, 20 miles each way
Pumping Operation Boat Operations	Pump (1) Tug (7) Workboat (11) Barge (3) Johnboat (1) Safetyboat (1)
Eradicate Exotics/Soil Prep and Grass Seeding	Hedger (1) Tractor (2)
Mowing and Spraying	Tractor (3)
Bale Acquisition/Bale Loading and Placement	Pushboat (2)

Details of the equipment types or construction activities required for each project activity, as well as the resulting criteria pollutant emissions from these equipment types or construction activities, are provided in Tables 5-5 and 5-6. The primary sources of each criteria pollutant from this alternative's activities are:

Table 5-5. Annual Federal Emissions Summary Tables (in Tons per year)

Sources	Tons per Year									
	PM_{10}	$PM_{2.5}$	NO_X	ROG	CO	SO_2	CO_2	CH_4	N_20	CO_2e
On & Off Road Equipment and Vehicles[1]	47.4	9.9	1.6	0.1	0.6	0.0	279.5	0.00	0.00	254.6
Boats[2]	0.2	0.2	3.5	0.4	2.8	0.0	423.2	0.02	0.00	424.6
Total	47.5	10.0	5.1	0.5	3.5	0.0	702.7	0.03	0.01	679.2
De Minimis Threshold[3]	N/A	100	100	100	N/A	N/A	N/A	N/A	N/A	N/A
Exceed Threshold (Yes or No?)	N/A	No	No	No	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
1. Emissions were estimated using SMAQMD's Road Construction Emissions Model, Version 8.1.0
2. Boat emissions were estimated using SMAQMD's Harborcraft, Dredge and Barge Emissions Factor Calculator
3. United States Environmental Protection Agency. *De Minimis* Tables. Accessed at: http://www.epa.gov/general-conformity/de - minimis-tables

Table 5-6. Average Local Emissions Summary Tables (in Pounds per Day)

Sources	**Average Daily Pounds per Day**									
	PM_{10}	$PM_{2.5}$	NO_X	ROG	CO	SO_2	CO_2	CH_4	N_20	CO_2e
On & Off Road Equipment and Vehicles[1]	0.4	0.4	15.5	1.2	6.2	0.0	2740.2	0.1	0.03	2,495.7
Boats[2]	1.6	1.5	34.0	4.0	27.7	0.0	4,148.6	0.2	0.0	4,162.9
Total	2.1	1.9	49.6	5.2	33.9	0.1	6,888.9	0.3	0.1	6,658.6
BAAQMD Significance Thresholds[3]	82*	54*	54	54	N/A	N/A	N/A	N/A	N/A	N/A
Exceed Threshold (Yes or No?)	No	No	No	No	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
1. Emissions were estimated using SMAQMS's Road Construction Emissions Model, Version 8.1.0
2. Boat emissions were estimated using SMAQMD's Harborcraft, Dredge and Barge Emissions Factor Calculator
*Applies to construction exhaust emissions only.
3. Bay Area Air Quality Management District (BAAQM). CEQA Air Quality Guidelines. Accessed at: http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en

Separate tables were not generated for Alternative 3 because emissions would remain the same on an annual and daily basis. The only difference between alternatives is the increase in timeframe by five years; therefore the emissions table applies to both alternatives. Based on the emissions estimates summary in Table 5-4, Alternatives 2 and 3 would not exceed any of the BAAQMD air quality emissions thresholds. As a result, there would be no significant impact to air quality under either of the alternatives.

5.5.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to air quality under Alternative 3 would be consistent with those described for Alternative 2, except that the described annual emissions would occur for 10 years instead of 5 years. Long-term, there would be incidental benefits to air quality from the addition of 90 acres of vegetated marsh in the project area.

5.5.5 Avoidance and Minimization Measures

Based on the estimates shown in Tables 5-5 through 5-6, construction would result in the temporary increase in emissions of criteria pollutants. In order to reduce the emissions to less than significant, the contractor would be required to implement the BAAQMD avoidance and minimization measures. In addition, USACE would require the project's contractors to implement the additional BMPs to further reduce the emissions from the project. The Delta Study would not exceed any local air quality thresholds or the Federal *de minimis* thresholds.

BAAQMD Avoidance and Minimization Measures

In accordance with BAAQMD guidelines, all proposed projects should implement the avoidance and minimization measures listed below, whether or not construction-related emissions exceed applicable thresholds. These measures are expected to reduce emissions from fugitive dust, vehicles, and equipment below the emissions estimated in Table 5-5.

- All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.
- All haul trucks transporting soil, sand, or other loose material off-site shall be covered.
- All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
- All vehicle speeds on unpaved roads shall be limited to 15 mph.
- All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.
- Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points.
- All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator.
- Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.

Recommended Exhaust Emission Avoidance and Minimization Measures

The project will ensure that emissions from all off-road diesel powered equipment used on the project site do not exceed 40% opacity for more than three minutes in any one hour. Any equipment found to exceed 40 percent opacity (or Ringelmann 2.0) shall be repaired immediately. Non-compliant equipment will be documented and a summary provided to USACE and BAAQMD monthly. A visual survey of all in-operation equipment shall be made at least weekly, and a monthly summary of the visual survey results shall be submitted throughout the duration of the project, except that the monthly summary shall not be required for any 30-day period in which no construction activity occurs. The monthly summary shall include the quantity and type of vehicles surveyed as well as the dates of each survey.

Use of Electric Equipment

Construction equipment powered by electricity, rather than diesel fuel, eliminates criteria pollutant emissions from diesel combustion. USACE will encourage the use of electric equipment during construction.

5.6 Climate Change

This section identifies the basis of significance for impacts to climate change, discusses how these criteria are determined for NEPA, provides specific emissions standards, thresholds, or other measurements for the various pollutants and, as necessary, applicable avoidance and minimization measures.

5.6.1 Methodology and Basis of Significance

Methodology

The methods for evaluating impacts are intended to satisfy Federal and State requirements, including NEPA. As discussed in the air quality assessment (Section 5.2.4), emissions were estimated based on the type of equipment being used, the level of equipment activity, and the associated construction schedules.

Emissions associated with vehicle exhaust for employee commute vehicles and delivery trucks were estimated using the Sacramento Metropolitan Air Quality Management District (SMAQMD) Road Construction Emission Model Version 8.1 (May 2016) (Appendix I). Emissions associated with marine equipment such as boats were estimated using the SMAQMD Harborcraft, Dredge, and Barge Emission Factor Calculator Version 1.0 (July 2017). Though the proposed alternatives are located in the BAAQMD, the SMAQMD tools were selected for use because the proposed construction is a linear, short-term action that is better suited for the Road Construction Emission Model. The Harborcraft Emission Calculator is a new tool recently developed by SMAQMD that is specifically geared toward construction projects involving boats, dredges, and barges, therefore since the majority of the study area is aquatic, it was ideal for this proposed construction scenario.

In addition, the following four criteria were considered and incorporated into the GHG analysis:

- Is the design of the proposed project inherently energy efficient?
- Are all applicable BMPs that would reduce GHG emissions incorporated into the design of the proposed project?
- Would the proposed project implement or fund its fair share of a mitigation strategy designed to alleviate climate change?
- Would implementing the proposed project improve processes or efficiency, resulting in a net reduction of GHG emissions?

Basis of Significance

BAAQMD has established a GHG emissions threshold for land use development projects of 1,100 metric tons per year of carbon dioxide equivalent (CO2e) emissions and for stationary source projects of 10,000 metric tons per year of CO_2e. Additionally, the proposed project could result in significant impacts if it would:

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.

No existing threshold levels for GHGs have been developed at the Federal level for NEPA projects. USEPA has established a reporting threshold of 25,000 metric tons of CO_2 that applies to stationary sources that emit more than 25,000 metric tons per year. On February 18, 2010, the White House CEQ released draft guidance regarding the consideration of GHGs in NEPA documents for Federal actions. The draft guidelines include a presumptive threshold of 25,000 metric tons of CO2e emissions from a proposed action to trigger a quantitative analysis.

Sea Level Rise

A sea level rise assessment is included in the Engineering Appendix (Appendix C) and includes an assessment on how sea level rise would affect the future with project condition. The emergent marsh habitat constructed in the Recommended Plan is anticipated to be sustainable and resilient to sea level rise. Emergent marsh habitat accrues sediment through lowering flow velocities; as sea level and thus Delta water levels slowly rise, vegetation should adjust to the new water levels and continue to recruit sediments over time, raising the marsh level, and so on. ESA PWA and AECOM (2010) cite Orr et al. (2003) accretion rates for restored freshwater wetlands (low and mid marsh) in the Delta of 9 to 18 mm/yr across several decades.

Based on the sea level rise analysis (Appendix C Attachment HH-A) 50 yr and 100 yr sea level rise rates can be compared to the Orr et al. accretion rates.

Table 5-7. 50 year and 100 year SLR rates from Appendix C Attachment HH-A

Orr et al. (2003): 9 to 18 mm/yr sustained over several decades for freshwater marsh					
		50yr low	50yr med	50yr high	
Relative to 2022 start date	Δ	0.365	0.935	2.405	ft
	Δ	4.38	11.22	28.86	in
	Δ	111.252	284.988	733.044	mm
	□	2	6	15	mm/yr
	Begin	100yr low	100yr med	100yr high	
MLLW	2	2.68	4.28	8.79	ft
	Δ	0.68	2.28	6.79	ft
	Δ	8.16	27.36	81.48	in
	Δ	207.264	694.944	2069.592	mm
		2	7	20.7	mm/yr

Analysis of Table 5-7 shows that the low to high sea level rise rates in the 50 year planning horizon are less than the reference accretion rates, thus sea level rise is not expected to adversely affect project performance in the planning horizon. Table 5-7 also shows that only the high rate of SLR approaches the high accretion estimate for the 100 year horizon. If 1. unforeseen changes in SLR rates beyond current policy-determined high rate estimates and/or 2. accretion rates occurred such that accretion did not outpace or match relative changes in water surface elevation, then the zone currently attributed to Marsh Wren habitat would slowly transition to shallow water habitat for other species.

The existing condition of the site is open water with degraded habitat value provided in the varying elevation zones. The future with project habitat will provide significant variation and improvement upon the future without project throughout the different elevation zones. The future without project condition with sea level rise would be deeper open water with degraded habitat value, as the future without project conditions do not include the necessary parameters (i.e., restoration of marsh vegetation) to function as a sediment trap and organic material source. Research indicates that the future with project condition with sea level rise will result in sediment accretion rates of 9 to 18 mm/yr sustained over several decades (Orr et al., 2003; DWR

2010). Since sediment accretion is expected to occur at a sustained rate, the functional habitat in each elevation zone is also expected to be sustainable over the life of the project. As a result, the future with project condition will provide increased habitat value over the future without project condition.

5.6.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the climate change conditions would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the climate change conditions in the Delta, rendering uncertainty in the future condition of the Delta. No long-term benefits would be realized from the restoration of intertidal marsh habitat at Big Break.

5.6.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

During construction, GHG emissions would be emitted from the project due to fuel combustion from marine vessels and construction equipment, and workforce vehicles. Workers would commute from their homes to the construction site and park in one of the staging areas.

While the emissions associated with this alternative would not violate the local GHG reporting threshold of 1,100 metric tons per year, these emissions would still contribute to the overall cumulative GHG emissions, as discussed in the cumulative analysis discussion below (Section 5.10). As a result, USACE would implement avoidance and minimization measures, as discussed below, to increase this alternative's energy efficiency and further reduce the GHG emissions from this alternative. Consequently, this alternative's GHG emissions, with avoidance and minimization measures, would be reduced from the estimated emission levels.

Marshes are widely recognized as some of the most productive ecosystems on earth, with primary productivity that rivals industrialized agriculture (Mitch and Gosselink, 2000). Mature tidal marshes can produce up to 8,000 metric tons of plant material per year (Mitch and Gosselink 2000), a process by which plants continually remove CO_2 from the atmosphere and convert it to plant material. Marsh grasses and other macrophytes, microalgae on the mud surface, and phytoplankton are the three primary components of the natural community that remove CO_2. While some of this annual productivity will be consumed or decompose and therefore not stored for the long-term, some percentage of this carbon accumulates and is sequestered in tidal marsh soils. When stored in the soil, the carbon is taken out of the system as decomposition rates under anaerobic conditions are low. As a result, wetland soils are well-known as major carbon-storing ecosystems (Brigham, et al. 2006, Chmura, et al. 2003). Experiments on Twitchell Island resulted in the sequestration of an estimated 3 metric tons of CO_2 per acre of mature tidal marsh per year (USGS 2007). As a result, Alternative 2 has the potential to remove 135 metric tons of CO_2 per year following vegetation establishment to the point of maturity.

Carbon sequestration associated with the restoration of tidal marsh habitat would result in net avoided GHG emissions since the project is schedule to be constructed over 5 years. Based on a review of this alternative, the following can be determined:

- The construction-related and operational GHG emissions would not conflict with or be inconsistent with any current plan to reduce or mitigate GHGs.
- Emissions would not exceed 25,000 metric tons of CO2e per year.
- Implementation of the project has the potential to contribute to a lower carbon future.

Based on this evaluation, Alternative 2 emissions would likely be offset to a substantial degree by avoided future GHG emissions by a lower carbon future. This impact would be less than significant under NEPA especially with the application of avoidance and minimization measures.

5.6.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to climate change under Alternative 3 would be consistent with those described for Alternative 2, except that the described annual emissions would occur for 10 years instead of 5 years. Long-term, there would be incidental benefits to climate change from the addition of 90 acres of vegetated marsh in the project area. As described in the study of sequestered CO_2 above (USGS 2007), Alternative 3 has the potential to remove approximately 270 metric tons of CO_2 per year following vegetation establishment to the point of maturity for the full footprint.

As stated in Alternative 2, carbon sequestration associated with the restoration of tidal marsh habitat has the potential to offset GHG emissions produced from construction activities since the project is scheduled to be constructed over 10 years. Alternative 3 would not conflict with current plans to reduce GHG emissions, it would not exceed the local or federal threshold for GHG emissions, and it has the potential to contribute to a lower carbon future due to sequestration. Based on this evaluation, GHG impacts from the construction of Alternative 3 would be less than significant.

A sea level rise assessment describing how SLR would affect the future with project condition for the Recommended Plan is included in the Engineering Appendix (Appendix C).

The intertidal marsh habitat proposed for construction under the Recommended Plan (Alternative 3) is anticipated to be sustainable and resilient to sea level rise. Intertidal marsh habitat accrues sediment through lowering flow velocities; as sea level, and thus Delta water levels, slowly rise, vegetation should adjust to the new water levels and continue to recruit sediments over time, raising the marsh level. The non-Federal Partner, DWR, conducted a study regarding sediment accretion of tidal marsh habitat for the Dutch Slough Tidal Restoration Project and documented the results in their Revised Conceptual Plan (DWR 2010); the referenced 9 mm to 18 mm per year accretion rates thus give the project a continuum of adaptive capacity so that there is no threshold that affects performance. This study was used as a baseline reference for sediment accretion expected over the life of the project. DWR cites Orr et al. (2003) accretion rates for restored freshwater wetlands in the Delta of 9 to 18 mm/yr across several decades. Based on the sea level rise analysis (Appendix C Attachment HH-A) 50 yr and 100 yr sea level rise rates can be compared to the Orr et al. accretion rates (Table 5-7).

Additionally, SLR is not anticipated to degrade the Recommended Plan's habitat value beyond the future without project condition. The existing condition of the site is open water with degraded habitat value in the varying elevation zones. The future with project habitat under Alternative 3 would provide significant variation and improvement in habitat value throughout the elevation zones. Accounting for SLR under the future without project condition would result in deeper open water with continued degraded habitat value, as the existing condition does not include the necessary habitat parameters to function as a sediment trap and organic material source. As described above, the future condition with SLR of the Recommended Plan is anticipated to result in sediment accretion rates of 9 to 18 mm/yr sustained over several decades (Orr et al., 2003; DWR 2010). Since sediment accretion is expected to occur at a sustained rate, the functional habitat in each elevation zone is also expected to be sustainable over the life of the project. As a result, the Recommended Plan would provide increased habitat value over the future without project condition even under future SLR scenarios; therefore effects to the project from SLR would be less than significant.

5.6.5 Avoidance and Minimization Measures

USACE would implement the following avoidance and minimization measures to reduce potential impacts to climate change:

- Improve fuel efficiency of construction equipment by minimizing idling time either by shutting equipment off when not in use or reducing the time of idling to no more than 3 minutes (5 minute limit is required by the state airborne toxics control measure [Title 13, sections 2449(d)(3) and 2485 of the California Code of Regulations]. Provide clear signage that posts this requirement for workers at the entrances to the site.

The following avoidance and minimization measures are relevant to impacts, but will likely not be required by USACE due to the limited amount of hauling associated with the proposed construction. However the selected contractor will be encouraged to implement these measures where practical:

- Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated.
- Train equipment operators in proper use of equipment.
- Use the proper equipment size for the job.
- Use equipment with new technologies (repowered engines, electric drive trains).
- Perform on-site material hauling with trucks equipped with on-road engines (if determined to be less emissive than the off-road engines).
- Use a CARB approved low carbon fuel for construction equipment. (NO_X emissions from the use of low carbon fuel must be reviewed and increases mitigated.)
- Encourage and provide carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes.
- Use SmartWay certified trucks for deliveries and equipment transport.
- Develop a plan to efficiently use water for adequate dust control.

5.7 Transportation and Navigation

This section evaluates the construction-related effects of the alternatives on the transportation system and commercial navigation within the project area. This analysis considers short and long-term disruptions to traffic and shipping commerce.

5.7.1 Methodology and Basis of Significance

<u>Methodology</u>

This section evaluates the construction-related effects of the alternatives on roads and traffic in the study area.

<u>Basis of Significance</u>

Adverse effects on transportation were considered significant if implementation of an alternative plan would result in any of the following:

- Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system;
- Substantially increase hazards due to a design features or incompatible uses;
- Result in inadequate emergency access;

Adverse effects on navigation were considered significant if implementation of an alternative plan would result in any of the following:

- Disruptions to any deep water ship channel commerce activities;
- Increase or creation of safety hazards; and
- Disruption of the DWSC O&M activities.

5.7.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the transportation and navigation conditions would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the transportation and navigation conditions in the Delta, rendering uncertainty in the future condition of the Delta. No effects would occur from the restoration of intertidal marsh habitat at Big Break.

5.7.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

Transportation

Limited hauling would occur associated with the installation of the pipe on Jersey Island. Prior to installing the pipeline across the island, the contractor would place gravel to improve the roadway and provide access to the proposed staging area on the southern edge of Jersey Island adjacent to the restoration site. Access to the staging area would be via Jersey Island Road to the Jersey Island north levee road. Vehicles would then use a farm road to cross the island to the staging area. This route would be used for any worker vehicles and construction equipment necessary for pipe installation and vegetation planting. The work crew for this constructed is very small (no more than eight workers), and only a limited amount of off-road construction equipment is required (see Table 5-5 in Air Quality). Additionally, there are very few residents on Jersey Island and the roadways are very sparsely traveled. As a result, effects on transportation under this alternative would be less than significant.

Navigation

In order to create intertidal marsh habitat, material from O&M dredging would be pumped to the restoration site and placed to raise the submerged surface of portions of Big Break, as described in Section 3.9 and shown on Figure 3-14. On the northern edge of Jersey Island, a floating pump station would be installed on the edge of the Stockton DWSC to push the material across Jersey Island and to the Big Break restoration site. This location will also be where the dredging contractor would deliver the dredged material to the restoration project. The dredge pipe would be tied into the restoration pipeline on the edge of the DWSC at Jersey Island. The restoration pipeline would not encroach on the navigation corridor or the right-of-way of the Stockton DWSC.

A temporary, short term impact would occur during the annual two-week construction period due to the restoration pipeline floating across the Dutch Slough channel between Jersey Island and the Big Break remnant levee. Dutch Slough, in this location, is primarily used for recreational boating and is not a formal navigation channel. During the two-week construction period each year, boats would be detoured around the Big Break restoration area to the south, or to the east through Dutch Slough to Taylor Slough. Avoidance and minimization measures are discussed below that would reduce this impact to a less-than-significant level.

5.7.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to transportation and navigation under Alternative 3 would be consistent with those described for Alternative 2, except that the described effects would occur for 10 years instead of 5 years.

5.7.5 Avoidance and Minimization Measures

Transportation

Given that the proposed project would not impede on highways, streets, or official roadways of any kind, there would not be avoidance or minimization measures required for human transportation on land and a traffic control plan would not be required. Upon completion of construction, the restoration pipeline, the dredge pipe, and the floating pump station would be removed, restoring pre-construction conditions for the DWSC to the degree practicable. After construction is completed, all construction equipment would be removed and ecosystem restoration measures would be implemented as planned.

Navigation

All obstacles and hazards to recreational boaters would be clearly identified with U.S. Coast Guard approved markers and buoys. Coordination with the U.S. Coast Guard to ensure that boaters can safely pass along the rivers in the project area would occur prior to the start of any restoration activities. Any detours would be coordinated with the U.S. Coast Guard, the EBRPD, and any other required regulatory agencies in the area.

Prior to construction, additional coordination would occur with the EBRPD to:

- Inform boaters and anglers of project activities;
- Provide project safety information including maps of any restricted access areas; and
- Maps would be updated, as needed, to identify the new intertidal marsh restoration areas.

Coordination with recreational boaters, as described above, would ensure that impacts associated with construction of the project would be reduced to less than significant.

5.8 Recreation

5.8.1 Methodology and Basis of Significance

Methodology

This section evaluates the construction-related effects of the alternatives on recreation resources. This analysis considers short-term recreation effects within the project area at Big Break and discusses long-term beneficial effects to recreation. None of the alternatives would affect recreation associated with local marinas because access to these recreational facilities and opportunities would not be affected by implementation of any of the alternatives.

Basis of Significance

Adverse effects on recreation were considered significant if implementation of an alternative plan would:

- Substantially disrupt any institutionally recognized recreational facility or activity.
- Preclude existing recreational users from long-term use of existing recreation resources within and around Big Break.

5.8.2 Alternative 1 – No Action

Under the no action alternative, USACE would not participate in the construction of the proposed project and the recreation conditions would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the recreation conditions in the Delta, rendering uncertainty in the future condition of the Delta. No effects would occur from the restoration of intertidal marsh habitat at Big Break.

5.8.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

In order to create intertidal marsh habitat, material from O&M dredging would be pumped to the restoration site and placed to raise the submerged surface of portions of Big Break, as described in Section 3.9 and shown on Figure 3-9.

The restoration of intertidal marsh habitat at Big Break would not require the closure of any local recreation facilities such as harbors, parks, marinas, or resorts. Many people use the area around the project for multiple recreation activities, and would continue to use these areas during construction and once restoration has been completed. Therefore, impacts to recreation facilities are less than significant.

A temporary, short term impact would occur during the annual two-week construction period due to the restoration pipeline floating across the Dutch Slough channel between Jersey Island and the Big Break remnant levee. Dutch Slough, in this location, is primarily used for recreational boating. During the two-week construction period each year, boats would be detoured around the Big Break restoration area to the south, or to the east through Dutch Slough to Taylor Slough. Avoidance and minimization measures are discussed below that would reduce this impact to a less-than-significant level. After construction is completed, the new intertidal marsh habitat would provide a long-term beneficial impacts to recreational kayaking and canoeing. The mounds dispersed throughout the open water would provide new channel formations in approximately 112 acres of converted habitat.

The shallow waters of Big Break provide prime bass fishing habitat, like many areas throughout the Delta. The creation of intertidal marsh habitat could be controversial with bass fisherman due to the reduction of prime bass habitat in the project area. However, extensive bass habitat remains throughout adjacent shallow water areas, both in Big Break and elsewhere in the Delta, providing ample opportunities for anglers. Once the project is complete, a more diverse habitat would be created due to newly implemented intertidal marsh habitat and interconnected waterways between mounds. Therefore, with the coordination actions discussed in Section 5.8.5 below, effects to recreation would be less than significant.

5.8.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of dredged material, as described in Section 3.9.2. The material placement and planting would all be consistent with the description for Alternative 2, with the exception that project construction would occur over a 10 year period rather than a 5 year period and there would be an increase in acreage. Effects to recreation under Alternative 3 would be consistent with those described for Alternative 2, except that the described effects would occur for 10 years instead of 5 years.

5.8.5 Avoidance and Minimization Measures

All obstacles and hazards to recreational boaters would be clearly identified with U.S. Coast Guard approved markers and buoys. Coordination with the U.S. Coast Guard to ensure that boaters can safely pass along the rivers in the project area would occur prior to the start of any restoration activities. Any detours would be coordinated with the U.S. Coast Guard, the EBRPD, and any other required regulatory agencies in the area.

Prior to construction, additional coordination would occur with the EBRPD to:

- Inform boaters and anglers of project activities;
- Provide project safety information including maps of any restricted access areas; and
- Maps would be updated, as needed, to identify the new intertidal marsh restoration areas.

As an additional minimization measure, the USACE would ensure that kayaking opportunities are provided in the marsh restoration site. A “kayak trail” will be designed through the site as a part of the final design to reduce impacts to the EBRPD.

Coordination with recreational fisherman and boaters, as described above, and the proposed design refinements would ensure that impacts associated with construction of the project would be reduced to less than significant.

5.9 Cultural Resources

5.9.1 Methodology and Basis of Significance

Methodology

Analysis of the impacts was based on evaluation of the changes to the existing historic properties that would result from implementation of the project. The term "historic property" refers to any cultural resource that has been found eligible for listing, or is listed, in the NRHP. Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), outlines the process in which Federal agencies are required to determine the effects of their undertakings on historic properties. In making a determination of the effects to historic properties, consideration was given to:

- Specific changes in the characteristics of historic properties in the study area.
- The temporary or permanent nature of changes to historic properties and the visual study area around the historic properties.
- The existing integrity considerations of historic properties in the study area and how the integrity was related to the specific criterion that makes a historic property eligible for listing in the NRHP.

Basis of Significance

Any adverse effects on cultural resources that are listed or eligible for listing in the NRHP (i.e., historic properties) are considered to be significant. Effects are considered to be adverse if they:

- Alter, directly or indirectly, any of the characteristics of a cultural resource that qualify that resource for the NRHP so that the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association is diminished.

5.9.2 Alternative 1 –

Under the no action alternative, USACE would not participate in the construction of the proposed project and the cultural and historic conditions would remain unchanged. The no action alternative assumes that no action would be taken by USACE to restore intertidal marsh habitat at Big Break. It is assumed that restoration actions currently proposed under California EcoRestore and other projects would still be constructed, but not at Big Break. Additionally, other proposed actions such as the California WaterFix would likely still be constructed and could affect the cultural and historic conditions in the Delta, rendering uncertainty in the future condition of the Delta. No effects would occur from the restoration of intertidal marsh habitat at Big Break.

5.9.3 Alternative 2 – 160 Acres of Intertidal Marsh Restoration

In order to create intertidal marsh habitat, material from O&M dredging would be pumped to the restoration site and placed to raise the submerged surface of portions of Big Break, as described in Section 3.9 and shown on Figure 3-9. O&M dredging and the piping of material to the placement site is an ongoing USACE operation that is covered under the San Francisco Bay to Stockton (John F Baldwin and Stockton Ship Channels) Final Environmental Impact Statement from September 1980. As no historic properties have been identified within the APE, no effects to historic properties would occur. A small section of Jersey Island where a pipeline will be placed and a road will be improved requires pedestrian survey. We do not currently have access to this property, but 36 CFR 800.4 [b][2] allows for phased identification and evaluation if access to properties is not available. Therefore, the survey will be conducted prior to project implementation once rights of entry have been granted.

5.9.4 Alternative 3 – 340 Acres of Intertidal Marsh Restoration

Under the Preferred Alternative, Alternative 3, 340 acres of open water habitat would be converted to a combination of freshwater intertidal marsh habitat and shallow water habitat via the direct placement of O&M dredged material, as described in Section 3.9.2. Out of the 340 acres, approximately 90 acres would be planted with riparian and aquatic vegetation. The remaining 245 acres would be shallow water habitat for aquatic fauna species inhabiting Big Break. It is anticipated that sensitive vegetative habitat types located on the periphery of Big Break such as existing tidal marsh and riparian vegetation, would be avoided because placement of dredged material would be restricted to open water, outside these habitats. The O&M dredging, material placement, and planting would all be consistent with the description for Alternative 2 with the exception that project construction would occur over a 10 year period rather than a 5 year period with an increase in acreage. Therefore, impacts can be referenced in the section above for reference.

5.9.5 Avoidance and Minimization Measures

USACE has determined that no historic properties exist within the APE of the project. Therefore, none of the alternatives considered will result in an adverse effect to historic properties. If unanticipated discoveries are made USACE will follow 36 CFR §800.13.

5.10 Growth-Inducing Effects

NEPA regulations require an EIS to consider the potential indirect effects of a proposed action. These indirect effects occur later in time or farther away in distance, but are still reasonably foreseeable, and "may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate" (40 CFR Section 1508.8[b]). For this project, any growth-inducing effects would be related to: (1) the relative magnitude of temporary and permanent jobs created by the project; (2) the need for new workers in the project area; (3) the need for additional housing to accommodate new workers and families; and (4) the economic stimulus or growth due to an increase in population, recreational demand, and/or tourist-oriented land development.

However, based on the small size and type of project, the restoration work would be not expected to induce any growth in or near the project area. The regional work force would be adequate to provide sufficient workers for the relatively small number of temporary construction jobs created by the project. No new temporary or permanent jobs would be needed to maintain or monitor the restored habitat once construction is completed. As a result, no additional housing would be needed. Since the project would only restore wildlife habitat in a rural part of the Delta, no increase in population, recreational demand, and/or tourist-oriented land development is expected to result from the proposed restoration. Consequently indirect project effects for Alternative 2 or Alternative 3, if measurable at all, would be extremely minor and well below any reasonable threshold of significance. Therefore, growth-inducing effects would be less than significant and no avoidance or minimization measures are required.

5.11 Cumulative Impacts

The CEQ's regulations for implementing NEPA define a cumulative effect as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

This section discusses the potential cumulative effects of the Delta Study when added to other past, present, and reasonably foreseeable future actions. As presented in Section 5.1, eight resources (vegetation and wildlife, special status species, water quality, air quality, climate change, transportation and navigation, recreation, and cultural resources) are identified as potentially impacted by the project. These resources could experience a cumulative effect related to the project, and are therefore evaluated below. As described in Section 4.1, other resources (hazardous and toxic waste, hydrology and hydraulics, land use, socioeconomics, utilities and services, and geology) would not be affected, and are therefore not evaluated below.

5.11.1 Methodology and Geographic Scope of the Analysis

Methodology

The cumulative effects analysis determines the combined effect of the proposed project with other closely related, reasonably foreseeable projects. Cumulative effects were evaluated by identifying projects in and around the Delta region that could have significant adverse or beneficial effects. These potential effects are compared to the potential adverse or beneficial effects of the proposed alternatives to determine the type, length, and magnitude of potential combined cumulative effects of the proposed project, together with the other related reasonable foreseeable projects. Significance of cumulative effects is determined by meeting Federal and State mandates and specific criteria identified in this document for the affected resources.

Geographic Scope

The geographic area that could be affected by the project varies depending on the type of environmental resource being considered. Potentially affected air and water resources extend beyond the confines of the project footprint due to the dynamic nature of these resources. Table 5-8 presents the general geographic areas associated with the different resources addressed in this cumulative effects analysis.

Table 5-8. Geographic Areas that Would Be Affected by the Delta Study

Resource Area	Geographic Area
Vegetation and Wildlife	Big Break, Jersey Island, Dutch Slough, and San Joaquin River
Special Status Species	Big Break, Jersey Island, Dutch Slough, and San Joaquin River
Water Quality	Big Break, Jersey Island, Dutch Slough, and San Joaquin River
Air Quality	Bay Area Air Quality Management District
Climate Change	Global Environment
Navigation	Stockton DWSC/San Joaquin River
Recreation	Big Break and Dutch Slough
Cultural Resources	Immediate vicinity of construction activity

Temporal Scope

The period of analysis for this cumulative effects section includes past actions that continue to have an ongoing effect on the Delta region, such as recently completed development projects in the Oakley area and ongoing dredging operations. Present and reasonably foreseeable future projects were primarily focused on ongoing construction actions, or planning studies for future construction that have a released NEPA or CEQA document. If there is significant uncertainty about the future of an action, it was not considered, such as the Sacramento DWSC Deepening Project, which is currently inactive.

5.11.2 Past, Present, and Reasonably Foreseeable Future Projects

This section briefly describes other projects in the project area. The exact construction timing and sequencing of these projects are not yet determined or may depend on uncertain funding sources. All of these projects are required to evaluate the effects of the proposed project features on environmental resources in the area. In addition, avoidance and minimization measures must be developed to avoid or reduce any adverse effects to less than significant based on Federal and local agency criteria. Those effects that cannot be avoided or reduced to less than significant are more likely to contribute to significant cumulative effects in the area.

The Delta Islands and Levees Feasibility Study and Related Projects would be located in a rapidly growing area of eastern Contra Costa County. Relevant projects are projects that are related or similar projects that are reasonably foreseeable, and have the potential to affect the same resources and fall within the same geographic scope. A cumulative impact refers to two or more individual effects which, when considered together, are significant or compound or increase other environmental impacts. The individual effects may be changes resulting from a single project or a number of separate projects.

U.S Army Corps of Engineers Projects

Sacramento Deep Water Ship Channel Operations and Maintenance (Port of Sacramento)

USACE and the Port of Sacramento conduct annual maintenance dredging of the Sacramento DWSC in the summer or autumn. Fine sediments cause shoaling, which must be removed to maintain adequate depth for commercial shipping traffic using the navigation channels. Failure to perform maintenance dredging would result in unsafe conditions and a restriction to access to the Port of Sacramento from the San Francisco Bay. Failing to dredge the channel poses both a substantial risk to human safety, as well as an economic harm to the Port and the commercial activities that use the Port's facilities.

Dredged materials are removed by using a hydraulic cutter head suction dredge for dredging, and a dragline and clamshell crane are used for rock placement. The material is then deposited at previously authorized terrestrial dredged material placement (DMP) sites. Dredge slurry is routed to the DMP sites via pipelines. DMP sites are diked and dredge slurry is allowed to settle and consolidate at these sites. Decant water is then discharged back into the waterway, from some sites, as determined during annual coordination. Dredged spoils are allowed to dry and remain stockpiled at the sites for periodic use for levee repairs, livestock grazing, and other purposes.

Generally, impacts associated with the DWSC dredging include direct impacts due to fish entrainment, water quality, and some terrestrial impacts associated with use of the land-based dredged material placement sites, such as stormwater runoff containment, potential effects to giant garter snake, and presence of odors.

San Francisco Bay to Stockton Deep Water Ship Channel Operations and Maintenance (San Joaquin River)

USACE and the Port of Stockton, conduct annual maintenance dredging of the Stockton DWSC in the summer or autumn. Annual maintenance dredging is performed in the same general manner as described above for the Sacramento DWSC.

In addition, maintenance bank protection work is needed to maintain the integrity of existing bank protection placed to prevent erosion of the ship channel levees. Such bank erosion usually occurs due to wave action caused by ship traffic. Maintenance bank stabilization, in the form of rock replenishment, would stabilize the channel alignment and preserve the general uniformity of the bank lines. The levees protect ship channel traffic from adverse crosscurrents during the occurrence of flood flows in the Yolo Bypass and also protect adjacent lands from flooding during high flows. Implementation of the Delta Study is highly dependent upon the availability of dredged material from O&M operations within the Stockton DWSC. The availability of dredged material could affect the timing and completion of the Delta Study.

The effects associated with the Stockton DWSC operation is similar to those described for the Sacramento DWSC above.

<u>Department of Water Resources/State of California Projects</u>

Bay Delta Conservation Plan/California WaterFix/California EcoRestore

The BDCP was a part of California's overall water management portfolio. It was being developed as a 50-year habitat conservation plan with the goals of restoring the Sacramento-San Joaquin Delta (Delta) ecosystem and securing California water supplies. The BDCP would secure California's water supply by building new water delivery infrastructure and operating the system to improve the ecological health of the Delta. The BDCP also would restore or protect approximately 150,000 acres of habitat to address the Delta's environmental challenges.

On April 30, 2015, the State announced that they would separate the BDCP's conveyance facility and habitat restoration measures into two separate efforts: California WaterFix and California EcoRestore.

The California WaterFix focuses on the State Water Project water delivery system infrastructure in the Central Valley and is part of California's overall water management portfolio. The Governor's WaterFix planning effort is overseen by the California Natural Resources Agency and DWR. California EcoRestore, the habitat restoration program is overseen by the California Natural Resources Agency and implemented under the California Water Action Plan. California EcoRestore is a California Natural Resources Agency initiative implemented in coordination with State and Federal agencies to advance the restoration of at least 30,000 acres of Delta habitat by 2020. Concurrently, the CDFW is working with Federal, State and local agencies, and Delta stakeholders to develop a 25-year, high-level conservation framework for the Delta, Yolo Bypass and Suisun Marsh. The Delta Conservation Framework will serve as the long-term continuation of the California EcoRestore program focused on accelerating conservation actions by 2020. These efforts are a direct reflection of public comments and fulfill the requirement of the 2009 Delta Reform Act to meet the co-equal goals of water supply reliability and ecosystem restoration.

DWR and the USBR prepared a partially Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) that addresses the impacts of the California Water Fix. The RDEIR/SDEIS includes those portions of the DEIR/DEIS (for the BDCP) that were amended or supplemented based on comments received and changes in impact analysis warranting another public review prior to publication of final documents. On July 21, 2017 DWR certified the California WaterFix Final EIR/EIS, which was released on December 22, 2016, and on January 23, 2018 submitted a CEQA Addendum to the Final EIR/EIS. The California Water Fix preferred alternative includes the construction and operation of Delta intakes and tunnel conveyance facilities. It also provides responses to all substantive comments received on the 2013 Draft EIR/EIS and 2015 RDEIR/SDEIS.

Delta Research Station

The USFWS and DWR jointly propose to construct two research stations within the Delta to consolidate and support ongoing studies by the Interagency Ecological Program (IEP). The facilities are proposed for construction along the Sacramento River in Rio Vista and along the San Joaquin River in Stockton. The Delta Research Station – ERS and FTC Final EIR/EIS was certified in March 2017. The current construction schedule is unknown. Potential effects that could result from construction include soil disturbance and potential increases in turbidity since both of the proposed construction sites are adjacent to the waterways. Operation of the facilities could result in additional take for listed fish species for research purposes.

Delta Flood Emergency Facilities Improvement Project

Recovery from catastrophic failure of Delta levees will be undertaken by the State of California, if necessary, to manage salinity for the environment and human use, which will also protect the brackish Suisun Marsh. As described in DWR's Delta Flood Emergency Facilities Improvement Project, the State is working to ensure that it has the appropriate infrastructure and supplies in the Delta to respond to and recover quickly and effectively from, major flood or earthquake disasters in the Delta. Locations of storage and transfer sites for stockpiled flood fight materials are identified:

- Establish two new material storage and transfer facility sites in Stockton and at Brannan Island State Park.

- Modify an existing material storage 5.23.3 facility at Rio Vista.
- Establish new flood fight supply facilities at all three locations.
- Make site preparations to support Incident Command Posts at Stockton West, Weber Avenue and Brannan Island State Recreation Area.
- In addition to the 223,000 tons of quarry rock stockpiled by DWR at Rio Vista and within the Port of Stockton, DWR would also stockpile up to 40,000 tons of quarry rock material of variable gradations less than 24-inch-minus at Stockton West, Weber Avenue and Brannan Island and 20,000 tons of sand in Rio Vista for a total additional increment of 100,000 tons.

Effects associated with these actions primarily involve ground disturbance and increased turbidity, as the majority of these proposals involve stockpile areas and other related storage facilities near the Delta waterways.

The Delta Plan

The Delta Plan was developed by the Delta Stewardship Council (DSC) and adopted on May 16, 2013. It became effective, with legally-enforceable regulations, on September 1, 2013. It is a long-term, comprehensive management plan designed to meet the co-equal goals of providing a more reliable water supply for California and protecting, restoring and enhancing the Delta ecosystem. The Delta Plan generally covers five topic areas and goals: (1) increased water supply reliability; (2) restoration of the Delta ecosystem; (3) improved water quality; (4) reduced risks of flooding in the Delta; and (5) protection and enhancement of the Delta. The DSC does not propose constructing, owning or operating any facilities related to these topic areas. Rather, the Delta Plan sets forth regulatory policies and recommendations that seek to influence the actions, activities and projects of cities, counties, State, Federal, regional and local agencies toward meeting the goals in the 5 topic areas.

The Delta Plan could contribute to beneficial cumulative effects by setting forth regulatory policies and recommendations that influence projects in a manner that would improve water quality, water supply reliability, FRM and increase habitat for fish and wildlife.

Dutch Slough Tidal Marsh Restoration Project

The Dutch Slough Tidal Marsh Restoration Project, in an area formerly slated for urban development, will soon become 1,178 acres of critically needed habitat for fish and wildlife in the Delta. The project is a cooperative effort between State, Federal, and private agencies, including DWR, CDFW, State Coastal Conservancy, Reclamation Districts, Natural Heritage Institute, City of Oakley, Ironhouse Sanitary District, and private consultants. The project's location in the western Delta offers the opportunity, soil types, and lack of subsidence to create a large area of tidal marsh and complex intertidal channels favored by native Delta species. Shaded channels, native grasslands, and riparian forests will be restored in the upland portions of the site. The habitats to be restored are like those that historically dominated the Delta, and their restoration is considered a critical action to increase numbers of native sensitive species and improve general ecological health of the Delta. This project will not only provide critical habitat for native plants, fish, and wildlife that are in rapid decline in the Delta, but will also provide outdoor recreation and resources for the residents of the Delta and Bay Area. Construction of the habitat restoration is anticipated to begin in 2018.

Local Projects

The local development projects discussed below all involve residential improvements to the populated areas in the vicinity of Big Break, most notably in the city of Oakley and on Bethel Island. All of these projects would involve ground disturbance and the use of heavy construction equipment, which could result in air quality, water quality, and noise effects on the local community. Additionally, the development projects would result in an increased population, which could have increased socioeconomic benefits, but also increased traffic, noise, and air quality effects. These development projects are discussed below.

City of Oakley Community Park

The City of Oakley is proposing a Community Park and Public Access Conceptual Master Plan (City Community Park Project) for 55 acres adjacent to the Dutch Slough Restoration Project and four miles of levee trails on the perimeter of the project lands. The City Community Park will provide parking and trailheads for the public access components of the Dutch Slough Restoration Project. The project is currently under design.

Cypress Grove

The Cypress Grove EIR was certified by the City of Oakley in 2003. This development consisted of 637 new residential units on approximately 147 acres. The project is adjacent to and south of the Contra Costa Canal and adjacent to and east of Marsh Creek.

East Cypress Corridor Specific Plan and Summer Lake

The City of Oakley prepared a Supplemental EIR for the East Cypress Corridor Specific Plan which was finalized in February 2009. The specific plan proposed the development of up to 5,759 residential units on an approximately 2,500-acre site adjacent to 1.5 miles of the Contra Costa Canal, from the Rock Slough trash rack to Cypress Road. The specific plan area is within the City of Oakley's sphere of influence. The City of Oakley proposed to annex the entire specific plan area. Approximately 500 homes are in the East Cypress Corridor Specific Plan area. Most of the existing homes are along Sand Mound and Dutch Sloughs.

Dutch Slough Properties Development

The City of Oakley has approved plans to develop approximately 1,342 residential units on approximately 300 acres immediately south of the Dutch Slough Restoration Project site between the Contra Costa Canal and Cypress Road. The development area south of the Contra

Costa Canal consists of 140 acres of the Emerson property, which is estimated to have approximately 662 residential units. The City certified an EIR and approved a tentative map in November of 2007 for 506 residential units on 120 acres of the Gilbert property and 44 acres of the Burroughs property, which is anticipated to have approximately 174 residential units. The project was completed in 2012.

Delta Coves Development Project

The Delta Coves Development Project is a 310 acre waterfront marina community under development on Bethel Island. The community will feature 560 waterfront residences, 416 of which will have provide boat docks. The development has been planned since the 1970s, with construction beginning in the early 2000s, and halted in 2008. SunCal real estate development company purchased the project in 2012, and reinitiated the construction in 2015.

5.11.3 Cumulative Impacts Analysis

Vegetation and Wildlife

Implementation of the proposed alternatives would contribute to restoration of sensitive marsh habitat and would benefit aquatic and wildlife species in decline due to the steady loss of historical tidal marsh habitat in the Delta. Measures would be implemented during construction to minimize impacts to biological resources by preventing the spread of non-native plant species to the greatest extent practicable. As a result, the Delta Study would not contribute to a cumulative impact on vegetation and wildlife. The Delta Study, in combination with other restoration projects discussed in Section 5.11.2, such as the Dutch Slough Restoration Project, would contribute to the overall future health of the Delta and would improve overall habitat conditions. Any cumulative impacts associated with the Delta Study would be beneficial.

Special Status Species

By creating new intertidal marsh habitat, the Delta Study would bring significant ecosystem benefits to special status fish species, such as delta smelt, salmon, CCV steelhead, and sDPS green sturgeon. In conjunction with the restoration actions proposed by other projects, such as the Dutch Slough Restoration Project, the proposed restoration project will assist in recovery of listed species by creating new nearshore habitat for these species and improving the overall health of the Delta's ecosystem.

Other projects in the Big Break area could have potential impacts on Delta smelt and other listed fish species in the greater project vicinity. The new housing developments would increase the human population in the area, potentially leading to more recreation pressure at the site (boating, fishing, and litter). The increased volume of municipal sewage from the new developments would likely introduce more pollutants to the waters. In the context of these adverse development pressures on Delta ecosystems, implementation of the project, together with other regional marsh and wetlands restoration projects, would provide long-term net benefits to the Delta ecosystem that would assist with listed fish species recovery through the construction of primary productivity habitats.

The Delta Study is not likely to significantly impact other listed species in the region, including the giant garter snake and therefore would not contribute to a cumulative impact on these species.

Water Quality

Construction activities have the potential to temporarily degrade water quality through the direct release of dredged material into water bodies or the indirect release of contaminants into water bodies through placement activities. Related projects, including the San Joaquin River DWSC O&M, the Dutch Slough Tidal Marsh Restoration Project, and the Dutch Slough Properties Development could be under construction during the same timeframe as this project. If construction occurs during the same timeframe water quality could be diminished primarily due to increased turbidity.

Further urban development could increase runoff as the amount of impervious surfaces is increased. The new housing developments may cause more stormwater runoff laden with contaminants common in urban/suburban areas (i.e. pesticides, lawn fertilizers, hydrocarbons). The increased volume of municipal sewage from the new developments could also introduce more pollutants to Delta waters. The method by which treated wastewater is discharged would determine the severity of the impact to water quality from new and proposed residential subdivisions near the study area. All projects would be required to coordinate with the CVRWQCB and overall water quality will be required to meet the Basin Plan objectives. Degradation of water quality from the Delta Study would be short term and limited to the construction period. These short-term impacts would contribute to cumulative effects from the other related projects discussed above, however, the restoration would result in long-term benefits to water quality in the Big Break area partially due to the presence of vegetation and other related benefits from marsh habitat.

Air Quality

All of the related projects discussed above would cumulatively contribute to emissions of criteria pollutants throughout the region, particularly if projects are constructed concurrently, which could have a significant cumulative effect on air quality. It is anticipated that each of these projects would implement separate avoidance and minimization measures, as required by air quality control agencies, to reduce the emissions to below significance levels. Construction of the Delta Study is tentatively scheduled for 2020 through 2029, depending upon Congressional authorization and appropriation. Emissions from the Delta Study restoration would be below all local threshold levels, and additional BMPs would be applied to further reduce these levels. The annual two week construction window would not significantly contribute to the cumulative impact of all of the other long-term development projects occurring in the Oakley area and the Delta region.

Climate Change

It is unlikely that any single project by itself could have a significant impact on the environment with respect to GHGs. However, the cumulative effect of human activities has been linked to quantifiable changes in the composition of the atmosphere, which, in turn, have been shown to be the main cause of global climate change (IPCC 2007). Therefore, the analysis of the environmental effects of GHG emissions is inherently a cumulative impact issue. While the emissions of one single project will not cause global climate change, GHG emissions from multiple projects throughout the world have a cumulative effect on global climate change.

It is expected that the primary GHG impacts from present and planned Delta area projects would arise from their construction phases. On an individual basis, each of these projects, including the Delta Study, would be required by BAAQMD to implement BMPs to reduce GHG emissions to the maximum extent practicable. However, on a global scale, the emissions associated with these projects would not significantly contribute to global climate change, when added to the emissions associated with major stationary GHG emitters.

Transportation and Navigation

The Delta Study would not have a significant impact on local roadways in the study area. There is the potential for a cumulative impact due to worker vehicles and vehicles associated with the local development projects using similar access routes through the city of Oakley, however the vehicles associated with the local development projects would far outnumber the eight worker vehicles and one haul truck associated with the Delta Study. Additionally, any increase in traffic in the local area over the ten year construction period would likely be a result of the local development projects and not the Delta Study. While the Delta Study would contribute to traffic in the area, the impact would be insignificant compared to other actions going on in the area.

USACE does not anticipate any cumulative effects as a result of the dredging and placement activities of the Sacramento DWSC, the operations and maintenance activities on the Stockton DWSC along the San Joaquin River, and the Delta Study. The operations and maintenance activities on the Stockton DWSC are essential to the proposed alternatives. The Delta Study would not impact the Sacramento DWSC at all, and would not interfere with ship movement on the Stockton DWSC, since dredging and pumping equipment would remain on the edge of the channel adjacent to Jersey Island. Overall cumulative effects to navigation would not be significant.

Recreation

It is unlikely that any cumulative impacts would occur to recreation. Other local development projects could increase use of Big Break and the local marinas due to increased population. However, there is currently an expansion of passive recreation opportunities occurring through the various local Delta restoration projects, which would increase habitat for shore birds and provide opportunities for bird watching. There would be a reduction in bass fishing acreage at Big Break due to the project; however, other local projects would not contribute to this effect.

Cultural Resources

Cumulative impacts to cultural resources would be primarily related to other construction projects that could occur during the same timeframe as those considered for this study and within the same vicinity as this study. A cumulative impact to cultural resources is not likely as all accessible areas of the APE have been inventoried. The historic levee within the project footprint were found not eligible for inclusion in the National Register of Historic Places. Based on our previous research it is unlikely that the small, currently inaccessible section where a pipeline and road crossing on Jersey Island will be placed will impact cultural resources.

5.12 Unavoidable Significant Effects

The CEQ's NEPA Compliance Guide states that any significant adverse environmental effects that cannot be avoided if the project is implemented must be described. This description includes significant adverse effects that can be mitigated, but not reduced to a level of insignificance. No unavoidable significant effects were identified in the analysis that could not be mitigated to less than significant.

5.13 Relationship Between Short-Term Uses and Long-Term Productivity

In accordance with NEPA (40 CFR 1502.16), this section discusses the relationship between local short-term uses of the human environment and maintenance of long-term productivity for the project. Short-term effects on vegetation and wildlife, water quality, recreation, and air quality would be limited to the construction phase of the project. No short-term uses of the environment are expected after the project is placed in operation. In addition, the long-term productivity of the environment in the Delta would be increased by restoring aquatic, riparian, and adjacent terrestrial habitats for native plants and wildlife, including special status species.

5.14 Irreversible and Irretrievable Commitment of Resources

In accordance with NEPA (40 CFR 1502.16), this EIS discusses any irreversible and irretrievable commitment of resources that would be involved in the alternative plans. Significant irreversible environmental changes are defined as uses of nonrenewable resources during the initial and continued phases of the alternatives that cannot be undone.

The alternatives would result in the irreversible conversion open water habitat to intertidal marsh habitat. However, this conversion is restoring the environment to its historic condition and would be beneficial to the environment long-term.

In addition, the proposed alternatives would result in the irretrievable commitment of construction materials, fossil fuels, and other energy resources needed to construct the project. Operation and maintenance are not expected to increase the use of construction materials or fossil fuels.

CHAPTER 6. COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS

The status of the proposed action's compliance with applicable Federal environmental requirements is summarized below. Prior to initiation of construction, the work would be in compliance with all applicable Federal laws and Executive Orders.

The following typical laws and regulations are not applicable to these proposed alternatives:

- Federal Wild and Scenic Rivers Act: There are no designated wild and scenic rivers in the study area.
- Advisory Circular (AC) 150/5200-33A – Hazardous Wildlife Attractants on Near Airports: This AC establishes Federal Aviation Administration (FAA) buffer zones surrounding airports. The study area is outside of the designated buffer zones for the Byron Airport, which is approximately 20 miles away.
- Marine Mammal Protection Act of 1972: The study area is in a freshwater zone, therefore it is unlikely that marine mammals would be present.

6.1 Federal Laws

Clean Air Act, as amended, PL 91-604; 42 U.S.C. 1857h-7, *et seq.* *Full Compliance.* The USEPA is the Federal agency responsible for managing the Nation's air quality. USEPA establishes national ambient air quality standards, and oversees the air quality plans developed and implemented by the states. BAAQMD is responsible for developing local district air quality management plans and enforcing regulations pertaining to air emissions in the study area. As discussed in Section 5.2.5, the proposed action would not exceed national air quality standards based on modeled estimates of emission rates during construction of the project.

On November 30, 1993, the USEPA promulgated final general conformity regulations at 40 CFR 93B for Federal activities. These regulations apply to a Federal action in a non-attainment or maintenance area if the total emissions of the criteria pollutants and precursor pollutants caused by the action equal or exceed certain *de minimis* amounts, thus requiring the Federal agency to make a determination of general conformity. As discussed in Section 4.2.5, at least part of the Delta is in non-attainment for ozone, PM_{10}, and $PM_{2.5}$. As discussed in Section 5.5, the proposed action would not exceed *de minimis* thresholds based on modeled estimates of emission rates during construction of the project, and would be in full compliance with the CAA.

Clean Water Act, PL 92-500; 33 U.S.C. 1251, *et seq*. *Full Compliance.* The USEPA is the Federal agency responsible for managing the Nation's water quality. USEPA establishes national water quality standards and oversees the water quality plans developed and implemented by the states. The CVRWQCB is responsible for developing local district water quality management plans, issuing permits, and enforcing regulations pertaining to water quality in the Delta. In addition, USACE is responsible for issuing Section 404 permits for projects that involve discharge of fill material into Waters of the U.S.

The proposed action would involve discharge of fill material into Waters of the U.S. in the Delta. Although USACE does not issue permits for their own projects, USACE does comply with the guidelines and substantive requirements of Section 404, including Section 404(b)(1). As discussed in Section 5.2.4, a Section 404(b)(1) analysis was conducted on the TSP and is included in Appendix H. The analysis concluded that the project would not result in significant effects to water quality. The construction contractor would be required to implement the measures listed in the analysis to avoid or minimize adverse effects on the aquatic ecosystem.

The proposed action would also require a Construction General Permit since it would disturb one or more acres of land and involve possible storm water discharges to surface waters. Prior to initiation of construction, the contractor would be required to prepare a Storm Water Pollution Prevention Plan and then submit a NOI form to the CVRWQCB, requesting approval of the work. This storm water plan and an In-Water work plan would identify the measures to be implemented by the contractor to avoid or minimize any adverse effects of construction on surface waters.

Additional regulatory requirements of the Clean Water Act include Section 303 and Section 401. These Sections require coordination with the CVRWQCB prior to construction to ensure that the project is complying with established TMDLs and other required thresholds established in the Basin Plan. Feasibility level of design is not at a detailed enough level to initiate consultation with the CVRWQCB, therefore, under the Delta Study this coordination would occur prior to construction once designs have been refined to a 65% level during PED. With the receipt of the Section 401 Water Quality Certification from the CVRWQCB and all other required construction permits, the proposed restoration would be in full compliance with the Clean Water Act and could proceed with construction. For the purposes of the study phase, the documentation included in Appendix H provides USACE with full compliance for Congressional authorization purposes.

Coastal Zone Management Act of 1972, as amended, PL 93-612; 16 U.S.C. 1451-1464). *Full Compliance*. The regulated Coastal Zone for the San Francisco Bay and Delta extends only to the mouth of the Sacramento River, which is approximately 11 river miles downstream of Big Break. As a result, USACE is not required to consult under the Coastal Zone Management Act and the Delta Study is in full compliance with this Act.

Endangered Species Act of 1973, as amended, PL 93-205; 16 U.S.C. 1531, *et seq.* *Full Compliance.* USACE obtained a list of the Federally threatened, endangered, proposed, and candidate species that have the potential to occur in the Delta via the USFWS website in March 2018. Based on the locations of the proposed work, the listed species that could be affected by the proposed action include the Delta smelt and the giant garter snake under the jurisdiction of the USFWS and green sturgeon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and Sacramento River winter-run Chinook salmon under the jurisdiction of NMFS.

USACE has determined that the proposed alternatives may affect, but are not likely to adversely affect these species in the short-term due to construction-related effects associated with the placement of dredged material in-water, and the installation and removal of the pipeline across Jersey Island. Additionally, USACE has determined that the proposed intertidal marsh restoration would have long term beneficial impacts for listed species. Biological Assessments were prepared and submitted to USFWS and NMFS on October 12, 2017. USACE requested formal consultation with the USFWS on the Delta smelt, which resulted in a Biological Opinion issued to the Corps on Delta smelt and giant garter snake on June 14, 2018. USACE requested informal consultation with NMFS on May 17, 2018 and NMFS concurred with USACE's determination of may affect, not likely to adversely affect in a letter dated June 15, 2018. With this documentation included in Appendix G of the FR/EIS, the study is in full compliance with this Act.

Farmland Protection Policy Act, PL 97-98; 7 U.S.C. 4201, *et seq*. *Full Compliance.* The NRCS is the Federal agency responsible for administering this act, which requires Federal agencies to coordinate a Farmland Conversion Impact form with the NRCS whenever their projects or programs would affect land designated as prime or unique farmland. The proposed action would not remove or alter any land that is protected under this Act. As a result the project is in full compliance with this Act.

Fish and Wildlife Coordination Act of 1958, as amended, PL 85-624; 16 U.S.C. 661, *et seq.* *Full Compliance.* The USFWS is the Federal agency responsible for administering this Act, which requires Federal agencies to coordinate with USFWS and State wildlife agencies during the planning of projects that would result in the control or modification of a natural stream or body of water. The FWCA intends that wildlife conservation be given equal consideration with other features of these projects. Because of the sensitivity of the Delta, USACE initiated coordination with USFWS early in the planning process.

USFWS prepared a draft Coordination Act Report (CAR) in May 2014. This report details the vegetation, wildlife, and fisheries resources in the project area; evaluates the potential effects of the proposed action on those resources; determines required mitigation for adverse effects; and provides recommendations for consideration by USACE. Although adoption of the recommendations is not required by the Act, USACE usually adopts the recommendations unless there is an overriding consideration not to do so. On June 26, 2018, the USFWS provided USACE with a letter updating the project description and the recommendations from the 2014 draft CAR. This letter serves as the USFWS's Final CAR for the Delta Study. USACE is in agreement with the revised recommendations, as described in the 2018 Final CAR and will implement the recommendations, as appropriate. As a result, the Delta Study is in full compliance with the FWCA. Both the draft and final CARs are included with the FR/EIS as Appendix L.

Magnuson-Stevens Fishery Conservation and Management Act of 1996, as amended, PL 104-267; 16 U.S.C. 1801, *et seq*. *Full Compliance*. The Magnuson-Stevens Act (MSA) establishes a management system for national marine and estuarine fishery resources. This legislation requires that all Federal agencies consult with NMFS regarding all actions or proposed actions permitted, funded, or undertaken that may adversely affect EFH. Under the MSA, effects on habitat managed under the Pacific Salmon Fishery Management Plan must also be considered. In the June 15, 2018 ESA concurrence letter, NMFS identified that the proposed project would not adversely affect EFH, therefore the Delta Study is in full compliance with the MSA. The concurrence letter is included in Appendix G.

Migratory Bird Treaty Act of 1928, as amended; 16 U.S.C. 715, *et seq*. *Full Compliance.* USFWS is the Federal agency responsible for administering this Act, which implements a treaty between the U.S. and Great Britain (for Canada), Mexico, Japan, and the Soviet Union (now Russia) for the protection of migratory birds. Unless permitted by regulations, this law prohibits anyone to "pursue, hunt, take, capture, kill, attempt to take, capture or kill … any migratory bird …or any part, nest, or egg of any such bird" (16 U.S.C. 703). Areas in the Delta have foraging, resting, nesting, and breeding habitat for numerous migratory birds. To the extent possible, USACE would schedule construction outside periods of migration or nesting to avoid or minimize effects on migratory birds. In any case, prior to initiation of construction, surveys would be conducted by a USFWS-approved biologist to determine the presence of migratory birds and/or their nests in or around the Jersey Island pipeline route. If active nests are found, the USFWS would be contacted for advice and recommendations for how to avoid disturbance and whether a permit is necessary. With the implementation of these actions, the Delta Study would be in full compliance with this Act.

National Environmental Policy Act of 1969, as amended, PL 91-190; 42 U.S.C. 4321, *et seq*. *Partial Compliance.* The CEQ is responsible for ensuring that Federal agencies operate in accordance with NEPA, which requires full disclosure of the environmental effects, alternatives, potential mitigation, and environmental compliance procedures of most Federal management, regulation, or funding activities that affect the environment. NEPA requires the preparation of an environmental document to ensure that Federal agencies accomplish the law's purposes. This EIS is in partial compliance with NEPA. Full compliance will be achieved when the final EIS has been filed with the USEPA and the Record of Decision has been signed.

National Estuary Program. *Full Compliance.* The National Estuary Program was created by Congress in the 1987 amendments to the Clean Water Act. The Program consists of 28 local estuary programs, managed Federally by the USEPA, with a focus of improving the waters, habitats, and living resources of estuaries of national significance. The National Estuary Program is a non-regulatory program. The San Francisco Estuary, consisting of the San Francisco and Suisun Bays, the Suisun Marsh, and the Sacramento and San Joaquin River Delta, is one such estuary. The San Francisco Estuary program is managed by the USEPA, State of California, and locally by the San Francisco Estuary Partnership. Management of the estuary is guided by the San Francisco Estuary Project Comprehensive Conservation and Management Plan (CCMP). Since the purpose of the Delta Study is to restore historically lost tidal wetlands and reverse the effects of subsidence, which is included as one of the restoration goals of the CCMP, the Recommended Plan is in full compliance with the intent of this Program.

National Historic Preservation Act of 1966, as amended, PL 89-655; 16 U.S.C. 470a, *et seq.* *Full Compliance.* The SHPO in each state is responsible for ensuring that Federal agencies comply with Section 106 of this Act, which requires that they consider the effects of a proposed undertaking on properties that have been determined to be eligible for, or included in, the NRHP. The Section 106 review process consists of four steps: (1) identification and evaluation of historic properties; (2) assessments of the effects of the undertaking on historic properties; (3) consultation with the SHPO and appropriate agencies to develop a plan to address the treatment of historic properties; and (4) concurrence from the SHPO regarding the agreement or results of consultation.

As discussed in Section 4.2.12, both archeological and historic sites are found in the Delta. USACE has reviewed records for the Project areas, which includes all proposed work areas for this study. No cultural or historic sites were identified during document research or during a site inspection by water craft. Correspondence with interested Tribes regarding the study was initiated via letter dated April 2013. Based on this documentary research, previous consultation with local Indian Tribes, and field work, the project is in compliance with the National Historic Preservation Act of 1966. During PED, a small section of Jersey Island where a pipeline and road will cross will require pedestrian survey. The survey will be conducted prior to project implementation, following 36 CFR 800.4 [b][2]. Once the survey has been completed consultation will be updated with the SHPO and interested tribes. Based on our work to date, we do not anticipate any changes to our finding of *No Historic Properties Effected* (36 CFR 800.4 [d][1]) for this project..

6.2 Executive Orders

Executive Order 13112, Invasive Species, February 3, 1999. *Full Compliance.* This EO directs Federal agencies to prevent the introduction of invasive species, provide for their control, and minimize their economic, ecological, and human health effects. As discussed in Section 4.2.1, invasive species, including aquatics and weed species, are found throughout the Delta. Prior to construction, the construction contractor would be required to prepare an invasive species control plan to be approved by USACE and acceptable to appropriate Federal and State resource agencies. Existing invasive species in the project area would be treated and removed prior to construction, and native vegetation would be planted as part of project construction. The Monitoring and Adaptive Management Plan (Appendix M) includes measures designed for ensuring success of native vegetation. The Delta Study is in full compliance with this order.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994. *Full Compliance.* This EO directs Federal agencies not to exclude persons from participation in, deny persons the benefits of, or subject persons to discrimination under their programs, policies, and activities because of their race, color, or national origin. As discussed in Section 4.1.3, the proposed action would have no disproportionate effects on minority or low-income populations in the Delta, as there are no populations of this kind in the project area. Therefore, the Delta Study is in full compliance with this order.

Executive Order 11988, Floodplain Management, May 24, 1977. *Full Compliance.* This EO directs Federal agencies to avoid, to the extent possible, long- and short-term adverse effects associated with the occupancy or modification of the base flood plain (1% annual event), as well as to avoid direct and indirect support of development in the base flood plain, wherever there is a practicable alternative. As discussed in Section 4.1.1, the proposed action would have no measurable effect on the (FEMA's 100-year) floodplain in the Delta. In addition, because of the nature of the proposed work, the proposed action would not directly or indirectly support development in the floodplain. The Delta Study would be in full compliance with this order.

Executive Order 11990, Protection of Wetlands, May 24, 1977. *Full Compliance.* This EO directs Federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance their natural and beneficial values. As discussed in Section 5.2.4, the proposed action would have a net positive effect on Delta wetland by adding approximately 340 acres of new intertidal marsh to the aquatic ecosystem. Consequently the Delta Study would be in full compliance with this order.

CHAPTER 7 – PUBLIC AGENCY INVOLVEMENT AND REVIEW

This chapter describes the public involvement activities associated with the Delta Islands and Levees Feasibility Study. These activities included agency meetings and coordination; a community outreach program with public workshops, notices, and media; and distribution of the draft documents for public review and comment.

7.1 Agency Coordination

USACE has been coordinating with various agencies throughout the duration of the Delta Study to discuss the concerns and issues of these agencies regarding the project. The other agencies involved in the coordination include:

- U.S. Bureau of Reclamation;
- U.S. Fish and Wildlife Service;
- National Marine Fisheries Service;
- U.S. Environmental Protection Agency;
- California Department of Water Resources;
- California Department of Fish and Wildlife;
- Central Valley Regional Water Quality Control Board;
- Contra Costa County;
- East Bay Regional Park District;
- Delta Stewardship Council; and
- Delta Protection Commission.

7.2 Public Meetings and Workshops

On January 31 2013, USACE published a NOI in the *Federal Register* (Vol. 78, No. 921) to prepare an EIS. In February 2013, two scoping meetings were held for the project study. The meetings were held to educate the public about the study efforts and to garner input on the proposed scope, in accordance with NEPA. On February 19, 2013, the first meeting was conducted from 5:00 to 7:00 p.m. at the Old Sugar Mill in Clarksburg. The second meeting was conducted on February 19, 2013 from 2:00 to 4:00 p.m. at the Sheraton Grand Hotel in Sacramento.

The meeting locations were chosen because they are central to the region. The meeting times were chosen to accommodate both the workday schedules of public agency representatives and the general public, including residents and business owners.

The meetings were open-house style workshops in which attendees could read and view the information about the proposed alternatives and interact with project staff, including representatives of USACE and DWR. The views expressed in the scoping meeting are summarized in Section 7.4 below.

For more detail on comments received, information available at the meetings, and a summary of key issues that were raised, see Appendix A which contains a scoping report. A similar open-house format will be used for the public feasibility study draft report and EIS. USACE will ensure all agencies, organizations, and individuals who provide comments will be provided a copy of the final integrated report.

7.3 Comments on the NOI

Under NEPA, no time limit exists to receive written comments in response to the NOI. Appendix A contains the NOI and the comments received at the February 2013 scoping meetings. The views expressed in the scoping meeting are summarized as follows:

- Clarifications on data and history of the Delta;
- Concerns of siltation in Delta channels;
- Recommendation for coordination with other agencies and efforts in the Delta; and
- Recommendation to evaluate environmental effects of alternatives to water supply, water quality, and aquatic and terrestrial biology.

7.4 Public Review and Comments on the Draft Report

This draft Integrated Report was circulated for a 45 day review from April 18 to June 2, 2014 by Federal, State, and local agencies; organizations; and individuals who have an interest in the project. A notice of availability of the draft EIS was published in the *Federal Register* following distribution for public review. Public workshops were held during the public review period to provide additional opportunities for comments on the draft document. These meetings were held at the following times and places:

- Wednesday May 7, 2014, 5 p.m. to 7 p.m. at the Old Sugar Mill in Clarksburg, California.
- Friday May 9, 2014, 2 p.m. to 4 p.m. at the Sheraton Grand Hotel in Sacramento, California.

During public review of the draft report, a total of 7 comments were received from the public, including 2 Federal agencies, 3 State agencies and 2 local agencies and organizations. Comments received were primarily focused on: (1) consistency with Delta land use plans; (2) permitting requirements; (3) air quality considerations; and (4) salinity and water quality modeling. All comments received during the public review period were considered and incorporated into the final EIS, as appropriate.

7.5 Major Areas of Controversy

Based on the comments received, USACE did not identify any major areas of controversy; however, there were many comments expressing public concern about salinity and water quality, and associated potential impacts on drinking water.

7.6 Next Steps in the Environmental Review Process

Following the completion of Feasibility Level Design, USACE reviewed the revised FR/EIS to assess the need for an additional level of public review prior to finalizing the report. Typically, USACE recommends recirculation of a draft EIS if there is a significant change in the proposed action between the draft and final EIS, or if there is a change in significance determination for any resource. In the case of the Delta Study, there is a significant change in the size of the footprint for the proposed alternative; however, the action itself has not changed from what was analyzed under Alternative 2 in the draft FR/EIS. Additionally, while the footprint has increased, the majority of the effects described in the draft FR/EIS have reduced in significance. There are two major factors that led to this change: (1) the removal of excavation and pumping from dredged material placement sites; and (2) the determination that the dredged material would be primarily sand, which is expected to only have minor amounts of turbidity associated with its placement. Due these factors, USACE determined that it was reasonable to solicit comments on the final FR/EIS rather than recirculating a revised draft FR/EIS.

A Notice of Availability will be published in the Federal Register indicating that the FR/EIS will be available for a 30-day review period before USACE makes a final decision on the Recommended Plan. Additionally, the FR/EIS will be distributed to all individuals and agencies who commented on the draft document, and other members of the interested public. After considering any comments received, USACE will prepare a Record of Decision (ROD) for the project. The ROD is a written, public record explaining why USACE chose the course of action. The Recommended Plan and any applicable mitigation measures will be identified in the ROD. In addition, since the Recommended Plan has been revised, USACE will respond to any significant public comments in the ROD. The Recommended Plan cannot be initiated before the ROD is signed and Congressional Authorization and appropriations are obtained.

7.7 Document Recipients

The following Federal, State, and local agencies and organizations either received a copy of the draft EIS or a notification of the document's availability, and will receive a copy for the FR/EIS. Individuals who may be affected by the project or have expressed interest through the public involvement process were also be notified.

7.7.1 Elected Officials and Representatives

Governor of California
- Honorable Edmund G. Brown, Jr.

United States Senate
- Honorable Dianne Feinstein
- Honorable Kamala Harris

United States House of Representatives
- Honorable Ami Bera
- Honorable Mark DeSaulnier
- Honorable John Garamendi
- Honorable Doris Matsui
- Honorable Jerry McNerney

California State Senate
- Honorable Bill Dodd
- Honorable Cathleen Galgiani
- Honorable Richard Pan
- Honorable Steven Glazer

California State Assembly
- Honorable Jim Cooper
- Honorable Jim Frazier
- Honorable Timothy Grayson
- Honorable Kevin McCarty

Contra Costa County
- Supervisor John Gioia
- Supervisor Candace Andersen
- Supervisor Diane Burgis
- Supervisor Karent Mitchoff
- Supervisor Federal Glover

City of Oakley

Mayor Randy Pope
Vice Mayor Claire Alaura
Councilmember Doug Hardcastle
Councilmember Sue Higgins
Councilmember Kevin Romick

7.7.2 Government Departments and Agencies

Federal Government Agencies

- U.S. Environmental Protection Agency
- Council on Environmental Quality
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Federal Emergency Management Agency
- U.S. Geological Survey
- National Resources Conservation Service
- U.S. Bureau of Reclamation

State of California Government Agencies

- California Air Resources Board
- California Bay-Delta Authority
- Central Valley Flood Protection Board
- Central Valley Regional Water Quality Control Board
- California Department of Conservation
- California Department of Fish and Game
- California Department of Parks and Recreation
- California Department of Transportation
- California Department of Water Resources
- Native American Heritage Commission
- California State Office of Historic Preservation
- California State Clearinghouse

- California State Lands Commission
- California State Water Resources Control Board
- Governor’s Office of Emergency Services
- Delta Protection Commission
- Delta Stewardship Council

Regional, County, and City Agencies

- Contra Costa County
- Bay Area Air Quality Management District
- City of Oakley
- Bethel Island Municipal Improvement District
- Delta Counties Coalition
- Save the Delta
- The Delta Conservancy
- East Bay Regional Park District

Native American Tribes

- Cortina Band of Indians
- Ione Band of Miwok Indians
- Wilton Rancheria
- United Auburn Indian Community
- Yocha Dehe Wintun Nation
- North Valley Yokuts Tribe
- Nashville El Dorado Miwok

CHAPTER 8 – RECOMMENDED PLAN

This chapter describes the RP as well as procedures and cost sharing required for implementation if it is authorized and funded by Congress. A schedule and list of further studies are also included. Section 8.3 describes additional recommendations to be carried out under existing authorities and/or by others.

8.1 Recommended Plan

The plan identified as the RP is Alternative 3 (see Figures 8-1 and 8-2). The RP is described in detail below.

8.1.1 Features and Accomplishments

The principle feature of the RP is the placement of 1,000,000 cubic yards of fill material into Big Break from maintenance dredging of the Stockton DWSC to restore intertidal habitat elevations. A Monitoring and Adaptive Management Plan has been developed and included in the final report. Monitoring and Adaptive Management costs are included in first costs. The total first project cost of the RP is $25 million.

The RP provides a unique opportunity to restore 340 acres of intertidal marsh in the Delta, habitat which is now largely non-existent in this ecosystem of national significance. Prior to levee construction in the late 19th and early 20th centuries, the Delta was comprised almost solely of tidal marsh. As levees were constructed, floodplains were disconnected from the waterways and land began to subside and compact as it was farmed and developed for human use. Delta lands are now as much as 20 feet below sea level, much too low for intertidal marsh habitat without incorporation of subsidence reversal, which is typically cost prohibitive. For this reason, restoration of tidal marsh has been very limited throughout the central Delta in particular, where subsidence is most extensive and also where tidal marsh was historically most prevalent. The RP links the proposed ER actions to an ongoing USACE navigation project, providing a cost effective mechanism to implement otherwise costly subsidence reversal, resulting in restoration of habitat for multiple federally listed species, notably salmonids and Delta smelt. The restored habitat would also benefit the millions of migratory fowl on the Pacific Flyway as they travel through the Delta, part of the largest estuary on the West Coast. The RP would not conflict with any existing plans for dredged material reuse or restoration sites. The benefits of the RP are further described below in Section 8.1.2.

For an estimated period of ten years, material from Operations and Maintenance dredging in the Stockton DWSC will be directly placed via pipeline into a 340 acre area of Big Break adjacent to the north remnant levee. The area would be bound on the east and west by sacrificial hay bales to serve as a velocity dissipation measure and, if needed, turbidity curtains to contain the suspended material and minimize turbidity. A raised outflow manifold with baffle plate will be utilized to reduce the horizontal spreading of dredged material during placement so that mounds are constructed as symmetrically (and thus efficiently) as practicable. Material would be placed in the area until a target elevation of 3 ft (NAVD 88) is achieved, which would require approximately 1,000,000 cubic yards of material. Bulrush (*Schoenoplectus spp.*) will be planted over the area (10% coverage) to develop intertidal marsh habitat since it is slow to colonize but will spread over time. Additional native plants including cattails *(Typha spp.*) will naturally establish. It is expected that many of the initial channels between mounds will gradually accumulate sediment, organic material, and vegetation, while some channels will persist as a dendritic network of tidal marsh channels (Figure 8-2). Any potential impacts of the recommended plan on the overall conveyance area of delta outflows is extremely small and impacts to stage and flow are probably not measurable. The impacts to flow conveyance area would be less for larger floods because water depths are greater and the proposed sand mounds will become less of a percentage of the total conveyance area.

The restored marsh will include at least one permanent tidal channel that can incidentally be used as a kayak trail. The permanent channel will be formed by leaving additional unfilled space between dredged material mounds. The specific location of the channel/kayak trail will be determined in collaboration with the East Bay Regional Park District during detailed design.

The national significance of the Delta has been demonstrated many times through decades of Federal authorizations and partnerships. The CALFED Bay-Delta Program, which emerged from water crises of the 1990s, was a unique collaboration among 25 State and Federal agencies to improve California's water supply and the ecological health of the Bay-Delta. The San Francisco Estuary Partnership is a coalition of resource agencies, non-profits, citizens, and scientists working to protect, restore, and enhance water quality and fish and wildlife habitat in the Bay-Delta. Most recently, the 2009 California Bay-Delta Memorandum of Understanding Among Federal Agencies named the Bay-Delta *"among the most important estuary ecosystems in the Nation"* and committed the Federal agencies to work in partnership with the State and stakeholders to carry out the vision of "a healthy and sustainable Bay-Delta ecosystem that provides for a high-quality, reliable, and sustainable long-term water supply for California, and restores the environmental integrity and sustainability of the system." The RP recommends Federal action to restore 340 acres intertidal marsh, one of the most sought after habitat types in this unique, important estuary.

Specific features of the RP include:

The RP includes Big Break increments 1a and 1b using O&M dredging over a ten year period to create approximately 340 acres of intertidal marsh habitat. Of the 340 acres, approximately 95 acres would be planted with aquatic vegetation, and the remaining 245 acres would be shallow water habitat for aquatic fauna species. Dredged material would be acquired from O&M activities in the San Francisco Bay to Stockton DWSC between approximately station points 300+00 and 900+00 (see Appendix C). Big Break is owned and managed by the East Bay Regional Park District as part of Big Break Regional Shoreline. Dredged material would be directly pumped to the restoration site, rather than the usual land-based dredged material placement sites. A chemical and granular composition analysis of the materials would be conducted in advance of placement.

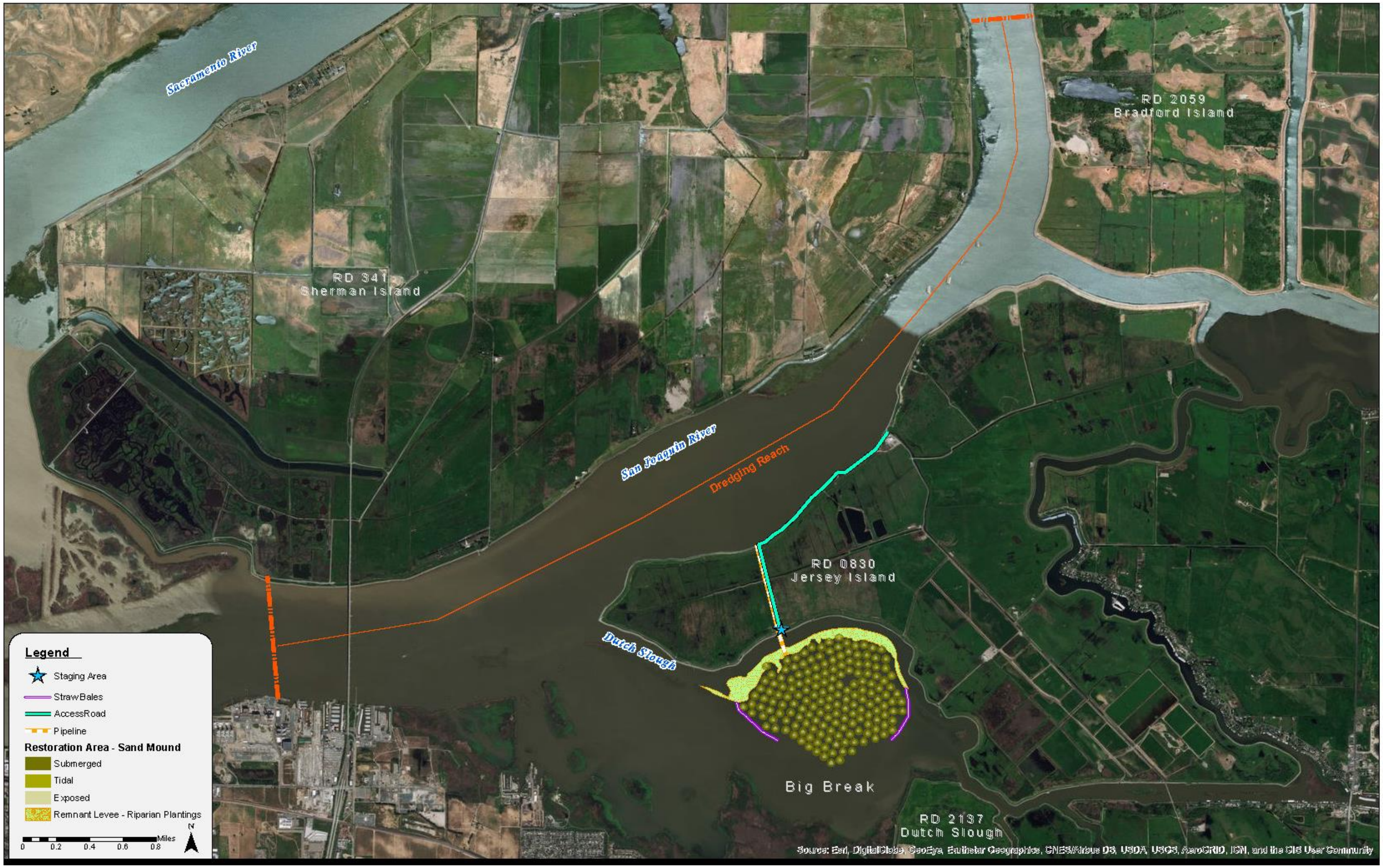

Figure 8-1. Recommended Plan

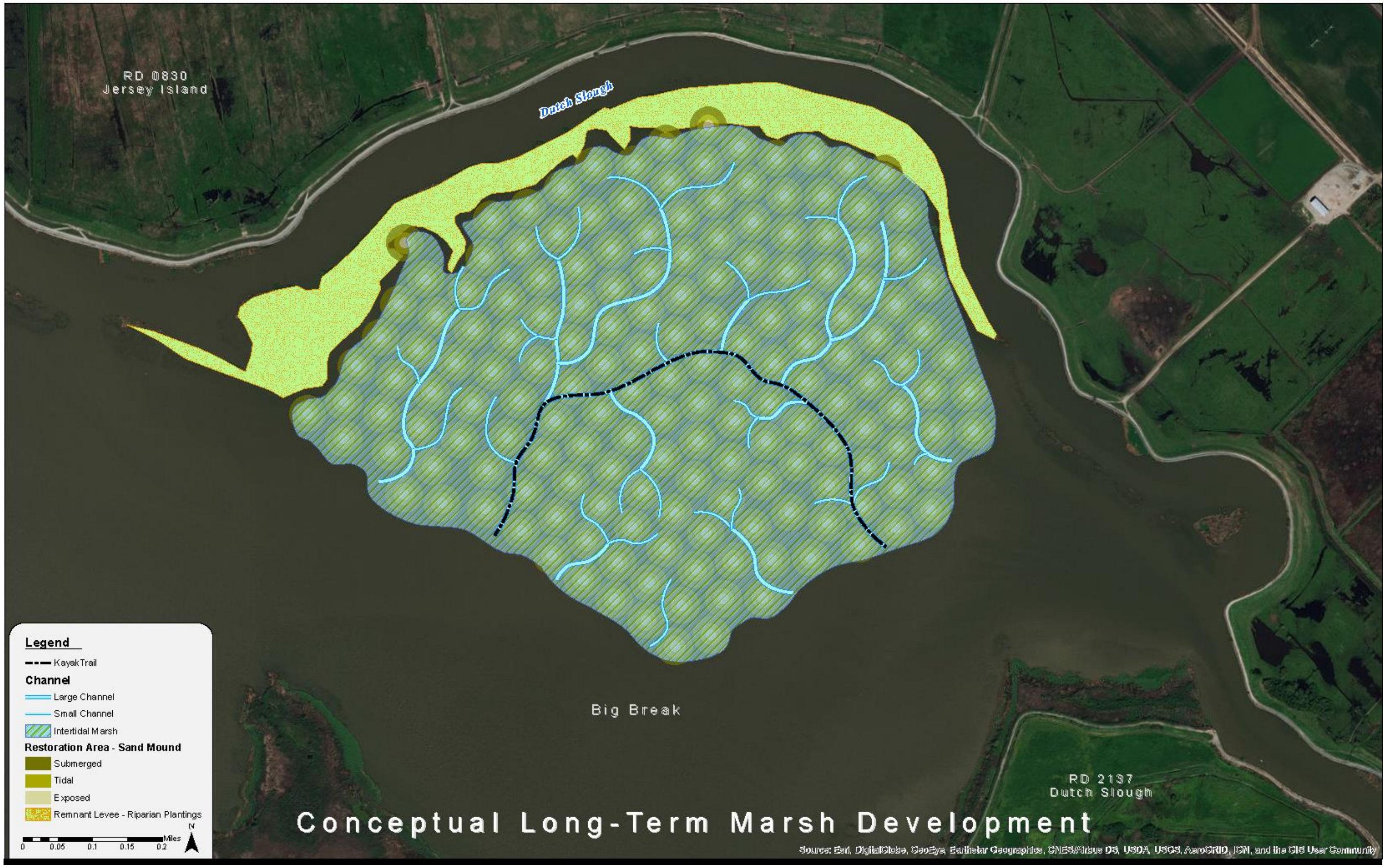

Figure 8-2. Conceptual View of Intertidal Marsh Restoration at Big Break

Direct Placement of O&M Dredged Material

A pipeline hydraulic suction dredge would be used to acquire material under the existing O&M Dredging Project. Dredging rates vary depending on the type of material being dredged, but production rates of 300 to 600 cubic yards per operational hour are typical. It is estimated that approximately 100,000 cubic yards of material would be available each year, for a total of approximately 1,000,000 cubic yards over the estimated 10 year construction period. If a different quantity of material is available in any given year, the overall construction schedule and footprint would be adjusted accordingly.

The dredging operations are expected to be conducted 24 hours per day, 7 days per week. Typically, approximately 18 hours per day are considered ‘operational,’ during which dredging occurs. Placement would occur over a five year period in the timeframe of August 1 to November 30, consistent with the current avoidance work windows for Delta smelt and salmonids established in the Biological Opinions for the O&M Dredging Project. Placement at Big Break is estimated to occur over approximately 15 days per work year.

Dredged material would be pumped from the dredging vessel directly to Big Break. Materials would be pumped to the proposed project areas through a floating 18 inch double wall high density plastic extrusion (HDPE) pipe (see Appendix C). The piping system would be placed along the shoreline of the Stockton DWSC in the San Joaquin River. The pipeline would be submerged and anchored to the bottom to avoid navigation hazards. A floating diesel repeater pump station would be positioned every 3 miles as necessary to aid slurry flow; pump(s) would be installed on a floating platform with stakes to secure its position. Work boats would install and maintain the floating pipeline. An additional work boat and crew would tender the position of the outfall slurry pipe during pumping operations to ensure correct placement of materials.

The pipeline would access Big Break from the DWSC via a land-based crossing at Jersey Island. There is one dirt farm road running north/south on Jersey Island; the pipeline would be placed adjacent to the road above ground. Prior to installation of the pipeline, the dirt road would be improved for vehicular access and hauling. Gravel would be placed on the road at a width of 25 feet. After the haul road is improved, the pipe would be installed by placing 60-foot segments of pipe and welding the segments together. The pipeline would take 1 day to install each construction season and 1 day to remove. The removal process would be the same as the installation process. A 12 person work crew could complete this task in a 12 hour work day.

The pipeline would cross one farm road running east/west, in addition to two levee roads on the north and south shore of the island. Above-ground, culvert-style crossings would be installed at these intersections in order to avoid impacts to the farm fields. The proposed crossing location is shown on Figure 3-14 above. The Jersey Island crossing is not anticipated to need a booster pump on the island; however, a floating booster pump station would likely be installed adjacent to the north shore of Jersey Island.

In addition, a 1-acre staging area would be used each year on Jersey Island. The staging area would be located on the south shore of Jersey Island at the end of the haul road and pipeline crossing. The staging area would be improved, as needed, by placing gravel for vehicular use.

Material Placement

The hydraulic slurry would be discharged at the restoration sites at an assumed average rate of 450 cubic yards per hour or 8,100 cubic yards per day. Placement of the material will occur using baffle plates to dispel the energy and direct the sediment downward to create quasi-symmetrical sand mounds. Analysis of over 10 years of grain size distribution data for the 400+00 to 850+00 dredging reaches shows the material to be virtually completely fine sand. Since this sand will be falling in a hydraulic slurry, the sand is assumed to settle to a 1 on 20 slope below the mean tide level (MTL, which is 2 feet higher than the mean lower low water [MLLW] level) and to a 1 on 10 slope above the MTL. This placement process is similar enough to sand depositing in the navigation channel that no bulking of the placed dredged material is assumed and no consolidation of the placed material is assumed (i.e. one cubic yard taken from the channel is equal in volume to one cubic yard of a placed sand mound).

Sand mounds would be placed so that the mound toes do not overlap, leaving channels of varying sizes between the mounds. The intent is to ensure that the channel centerlines are never shallower than the existing condition (-3 to -4 feet MLLW). The goal of this placement plan is to create a diverse habitat that provides value to both shallow water aquatic fauna that require varying depths of soft bottom habitat, as well as terrestrial marsh species such as shore birds. In addition, based on lessons learned from Donlon Island, this design is intended to provide sufficient flow through the site to maintain water quality. A larger channel will be identified through the restoration site in the preconstruction engineering and design phase to provide a kayak trail to minimize the loss of recreational opportunities in the restoration footprint.

The bed material at Big Break is former agricultural land that was prone to subsidence upon drying, thus the material is assumed to be highly compressible. Chapter 3 describes the assumptions that are thought to be reasonable but conservative for the compression of Big Break bed materials beneath hydraulically placed sand.

Sacrificial hay bales will be placed to provide barriers to the predominant flow paths to allow for sediment settling and sand mound stability. Hay bales are anticipated to persist 1 to 2 years, giving sufficient time for vegetative establishment, after which vegetation is assumed to provide adequate erosion resistance. Sacrificial hay bales would be used to aid in compliance with water quality requirements. Hay bale lines are not anticipated to be fully enclosing; however, should enclosure become a possibility, the top of the sacrificial hay bale line would be set at mean low tide level to allow fish an opportunity to escape the work area. If unanticipated quantities of fine-grained material are present in dredged sediments, turbidity curtains can be used in combination with sacrificial hay bales and would float slightly above the bottom allowing aquatic species to escape entrapment.

The bed level within the proposed footprint varies from -3 to -4 feet MLLW; mean tides within Big Break range from 0 feet MLLW to +4 feet MLLW. As a result, bed depths in the restoration area range from 3 feet during a mean lower low water tide to 8 feet during a mean higher high water tide. The proposed sand mounds would be constructed with a target elevation of +3 feet MLLW. Thus at high tide, sand mounds will be approximately 1 foot below the water surface level; and at low tide, the top of the vegetated sand mounds would be exposed.

Construction of the sand mounds would require approximately six workers. Approximately 12 employee trips per day of 20 miles each way would be typical for access to and from the site. Equipment anticipated for construction includes three generators/motors, one lift pump, and two work boats.

Plantings

Plantings would be installed during two separate periods: the aquatic vegetation would be installed in the spring and the terrestrial vegetation would be installed in the fall. Following planting is the initial establishment period, which starts when all the plants have been installed and accepted. The establishment period would be for three continuous years. Seed collection would occur in the spring or summer. The seeds would then be propagated in a nursery for approximately 1 year prior to installation. Chapter 3 identifies species generally conductive to the project region.

Riparian Planting

Prior to construction, the existing remnant levee would be treated to remove existing invasive vegetation. Invasive vegetation would be removed using a gas-powered hedger. The cuttings would be raked-up using pitchforks, and the cuttings would be chipped. The chips would be spread over the ground as mulch. The exposed residue rootstock would be treated with three treatments of herbicide, spaced one month apart. The herbicide would be approved for use near water bodies. This treatment is necessary to ensure the desirable planted grass and terrestrial vegetation would establish without competition. This would give the desirable vegetation a head start, and make it harder for the undesirable vegetation to return. Native grass would be seeded following initial invasive removal to provide both habitat and soil stabilization while the remnant levee is being monitored to ensure that the invasive treatment is successful. Invasive treatment of the remnant levee is anticipated to occur the summer before the first dredged placement occurs.

Terrestrial riparian species would be planted in the fall of the first construction season on the remnant levee at 235 plants per acre, protected and maintained for 3 years until their roots have established. Ground water is relatively close to the ground level, so survival is expected to be high and would easily achieve a goal of 141 plants per acre, or 60% of all installed plants. The ultimate goal is to promote root growth and enable the plants to achieve self-sufficiency by the end of the 3 year establishment period. The plantings are considered self-sufficient when a plant is developed and adapted sufficiently to its setting and is able to sustain itself in its current environment without artificial or human support.

Terrestrial riparian planting would be installed by a crew of up to eight workers for 12 hour work days. Equipment needs for riparian planting, establishment, and monitoring is estimated to include a boat, a truck, a hedger, a tractor, and a weed whacker.

Aquatic Planting

Following dredged material placement and the 10-month settlement period, vegetation would be installed on the sand mounds. Based on experience from the nearby Donlon Island restoration project, the plantable zone on the placed sand mounds is assumed to be from -2.5 to + 1 feet MTL (or, -0.5 to +3 MLLW). Desirable aquatic vegetation would be planted to pioneer a source for colonization before undesirable exotic vegetation could develop. The plant material may be nursery grown or collected from nearby sources and directly planted at the site. For the purposes of this analysis, it is assumed that the plant material would be nursery grown.

Bulrush (*Schoenoplectus* spp.) and cattail (*Typha* spp.) are two desirable prominent aquatic species that are expected to colonize the mounds. Other aquatic species to be planted are rushes, sedges and spike rushes. However, since cattail is a dominate colonizer and bulrush is slow to colonize, bulrush will be planted to give it a head start. Ten percent of the target area would be planted with bulrush spaced at 3 feet on center, which averages out to approximately 45 plants per acre, with natural recruitment assumed over time. Bulrush will be installed in the mid elevation of the aquatic planting elevation zone.

Aquatic plant installation would be conducted using a crew of approximately 4 workers. Equipment needs are estimated to require 2 boats and a truck for approximately 11 days of work (standard daylight work hours) each planting year.

<u>Monitoring & Adaptive Management</u>

Riparian Plant Monitoring & Adaptive Management

Maintenance activities as part of the riparian plant establishment process would begin after all installation is complete and would continue through the duration of the 3-year establishment period. Watering and weeding would ensure that individual plants are kept moist and free from competition. Mowing would ensure that the site and plants are accessible while minimizing undesirable seedhead development and potential fire danger. Spraying would reduce undesirable herbaceous competition, allowing the native grasses a greater opportunity to establish. Any herbicides used would be in compliance with water quality standards.

During the establishment period, all riparian plants would be surveyed in the fall before they lose their leaves. All dead terrestrial plants would be identified and replaced that same fall for the first two years of establishment. Based on historical data, it is expected that mortality would be below 20% for each of the first two years. Replacement plants would be with the same species that it is replacing, using the same size container as was originally planted, unless it is determined that another species would be more appropriate to the site. Where it becomes evident a particular species is not conducive to the site, a different species would be substituted to ensure success.

A riparian plant survival survey would be performed at the end of each establishment year and a report would be prepared. The report would include the monthly maintenance records, plant survey totals, and observations and recommendations of how to improve the site. As-builts would be prepared and kept current of what was planted, how much was planted, and where it was planted.

A monitoring and adaptive management plan is included as Appendix D. The monitoring plan establishes the methods and data that would be collected annually in order to determine restoration success. In addition, adaptive management measures are proposed to address challenges in meeting restoration success (i.e., lack of vegetative growth, increased turbidity, etc.) Monitoring reports and records would be required to document planting processes and progress. Since the purpose of the riparian restoration on the remnant levee is to reduce the potential for invasive species to overtake the marsh habitat, the riparian plantings would be monitored for the percent cover of invasive plant species versus native plant species. This process begins at the completion of the establishment period.

Aquatic Plant Monitoring and Adaptive Management

It is anticipated that the aquatic plantings would not require maintenance. Based on past experience on similar marsh restoration projects, the vegetation has established very quickly, typically within one year. During the 10 year construction period, the Corps would monitor the marsh habitat to ensure that it is performing as expected. If needed, adjustments would be made to the construction techniques on a year-to-year basis to apply lessons learned and adapt the plan to achieve maximum success.

The marsh habitat would be monitored following construction of each segment for 5 years to ensure success via percent cover of aquatic species. If needed, invasive plant species would be removed during the annual monitoring period. If the habitat is not meeting the success criteria in the timeframe anticipated, then contingency measures would be applied in order to ensure success. This could include the installation of more plantings, or an adjustment in the plant selection if the selected species are not conducive to the site.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. These reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). The reports would also document the results of the percent cover measurements, the proportional abundance of different habitat types, and the estimated natural recruitment versus planted habitats. Recommendations for additional adaptive management measures, as needed, would also be identified in the reports.

Operation and Maintenance

Following the establishment period, the project would be turned over to the non-Federal sponsor for long-term operation and maintenance. The restoration site would not require significant long-term maintenance beyond the establishment period. Soil accretion and vegetative recruitment have historically aided plantings on restored intertidal marsh habitats. Plantings typically survive and reach desired density within 2 years. Long term maintenance would primarily consist of replacement of any lost habitat due to damage; however, such a scenario is not considered to be highly likely, and it is anticipated that the habitat would be independently successful in perpetuity.

8.1.2 Regional Benefits

Although designed to stand alone, the RP complements other efforts underway in the California Bay-Delta. The State of California, U.S. Bureau of Reclamation, resource agencies, and other agencies are undertaking the California Water Fix and EcoRestore (formerly BDCP) to achieve the co-equal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The RP was formulated to not impede or be dependent upon the State's California WaterFix/EcoRestore initiatives; however, the RP does contribute to the goal of restoring the Delta ecosystem. Specifically, restoration of intertidal marsh is a high priority for the Delta as less than 5% of the historic tidal marsh remains throughout the Delta, due to agricultural and urban development. The only successful restoration of this lost habitat has been realized in relatively small areas. While it is difficult to fully restore connectivity through a small-projects approach, incremental improvements to connectivity can be made by selecting strategic locations for restoration. For example, Big Break is adjacent to Dutch Slough, an area currently being restored to tidal marsh habitat by the State of California. Additionally, across the San Joaquin River lies Donlon Island, an important reference site for this study, which USACE similarly restored to tidal marsh using dredged material in the early 1990's. As a result, restoring the proposed tidal marsh at Big Break would increase connectivity between these currently isolated habitat restoration actions.

The RP provides a variety of environmental and ecosystem benefits to the Delta Region. USACE has quantified ecological benefits of the intertidal marsh restoration using the marsh wren blue book model, with the marsh wren acting as an indicator species for assessing this habitat type. The modeled benefits for marsh wren resulted in 111.44 average annual habitat units (AAHUs) over the period of analysis (50 years). However, in addition to providing 90 acres of plantable intertidal marsh habitat, the RP also includes 250 acres of shallow water habitat. It should be noted that the reason for the per acre reduction in quantified Marsh Wren benefits is because the shallow water channels are not measured by the Marsh Wren model. However, the channels will provide additional habitat benefits to more valuable, Federally listed species, as well as contributing a more complex and successful restoration site based on lessons learned from other restoration actions. There was no Eco-PCX certified model available to quantify the benefits associated with the shallow water channels at the time that this analysis was completed, therefore the benefits must be described qualitatively.

Because the material is expected to be sandy, it will form into mounds when placed via hydraulic dredging, which will allow the design of the RP to incorporate varying topography and interwoven channels. This design would provide benefits for sensitive fish species of National importance in the Delta, including Delta smelt, juvenile salmonids, and sturgeon. The channels will provide foraging habitat for juvenile fish species, in addition to spawning habitat for Delta smelt. Aquatic vegetation would provide a food source for fish species, as well as nesting habitat for marsh wren and foraging habitat for other migratory birds. This project will result in more productive wetland and channel habitat that will enhance the food web and biodiversity in the vicinity, including food organisms used by Delta smelt and other pelagic fish species. These assumed benefits synergistically improve the overall ecosystem of the Delta region.

The RP presents opportunities for the beneficial use of dredged material to restore intertidal marsh. An opportunity exists to create a partnership between regional commercial deep water shipping maintenance activities and ER. Although 340 acres is relatively small given the expanse of the Delta, the created intertidal marsh would create primary productivity for listed and non-listed species and contribute to the migratory bird pathway. The project could serve as a pilot model for future intertidal marsh restoration throughout the Delta allowing other projects to follow the Delta Islands and Levees Feasibility Study.

8.1.3 Monitoring and Adaptive Management

After each construction season, the restoration site would be monitored until success criteria are met as specified in the Monitoring and Adaptive Management Plan (MAMP) and in the Terms and Conditions of the Biological Opinion (see Appendix D and Appendix G). The MAMP estimates 5 years of monitoring for each construction segment, which would be used to determine whether adaptive construction is necessary to apply lessons learned over the 10 year construction period. Additionally, monitoring would ensure that the success criteria for aquatic and riparian vegetation are met. Since construction is proposed for 10 years, with 5 years of monitoring for each segment, it is estimated that monitoring could occur for a maximum of 15 years, or less if success is achieved. Monitoring would be both quantitative and qualitative and would be conducted by a qualified ecologist, botanist, or biologist. The monitor would be objective and independent from the contractor responsible for maintenance of the site. Monitoring for endangered species would be performed in accordance with USFWS and NMFS guidelines. An annual report will document the monitoring results. Estimated monitoring costs are shown in Table 8-1 below.

If the monitoring results shows that the restoration site is not meeting its success criteria, as established in the MAMP, then adaptive management measures may be required. These measures are established and described in the MAMP, and include replanting of vegetation, adaptive construction of sand mounds, recontouring of previously constructed sand mounds, additional hay bale placement to adjust the flow regime, and removal of nonnative vegetation. Estimated adaptive management costs are shown in Table 8-1 below.

Table 8-1. Delta Study Monitoring and Adaptive Management Costs

	Costs
Monitoring Costs	$1,840,105
Adaptive Management Costs	$ 431,107
Total Monitoring and Adaptive Management	**$ 2,271,212**

8.1.4 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

Once construction of each functional portion of the project is complete, that functional portion would be turned over to the non-Federal sponsor. The non-Federal sponsor would then be responsible for the OMRR&R of the completed functional portions of the project in accordance with the interim or final OMRR&R manual.

Maintenance requirements will be discussed in detail in the OMRR&R manual. Based on the high rate of vegetative success at the nearby Donlon Island reference site, the restoration plantings are expected to be self-sufficient, therefore requiring no maintenance. A minimal amount of maintenance of signs, containment barriers, and other items that protect the restoration areas could be required. Also, periodic checklist type inspections on an annual or biannual basis would be required to monitor the site for severe adverse effects. A description of monitoring activities is included in the Monitoring and Adaptive Management Plan, which includes criteria for ecosystem restoration success, as well as the estimated cost and duration of the monitoring. Monitoring will continue until criteria for ER success have been met. Monitoring activities will be cost shared for a period of up to ten years; however, if monitoring is required beyond the ten year period, the cost of monitoring will be a non-Federal sponsor responsibility, per Section 2039 of WRDA 2007. The EBRPD will continue to manage public recreational use of Big Break consistent with their resource protection mandate.

OMRR&R costs are included in Table 8-3. During construction, draft and interim OMRR&R manuals would be prepared in coordination with the non-Federal sponsor and affected agencies. A final OMRR&R manual would be prepared after the completion of construction and provided to the non-Federal sponsor.

8.1.4 Real Estate

Acquisition of four property parcels will be required for the RP: two tracts of shallow open water and levee remnants owned in fee by the EBRPD (the restoration area), and two nearby parcels of marsh and fast lands on Jersey Island owned in fee by the Ironhouse Sanitary District, a sewage treatment and water purification agency serving Oakley and Bethel Island.

Because the non-federal sponsor, DWR, is not the primary landowner, USACE has coordinated the recommended plan with the EBRPD. The EBRPD has stated its willingness to become an additional project sponsor for the purpose of providing their lands and has provided a letter of support for the project.

Installation and operation of a submerged pipeline crossing the slough between the south bank of Jersey Island and levee remnant of Big Break will also require a lease from the California State Lands Commission, the authority governing all sovereign tidal lands. USACE and DWR are in discussions with the State Lands Commission to define the scope of such a lease and to prepare an application for issuance of an appropriate agreement.

On Jersey Island, DWR will need to obtain a 10-year right to run a temporary pipeline alongside an agricultural ditch, a 10-year right to create and use a one-acre temporary construction and laydown yard at the south end of this pipeline for storage of project equipment and materials during each annual dredging cycle (a period of about two months each year), and a 10-year right of vehicular use of existing unpaved private roads on Jersey Island for delivery of materials and construction equipment (also for about two months each year). Further details are located in Appendix K: Real Estate.

8.1.5 Plan Economics

The project first cost was estimated on the basis of October 2018 price levels and amounts to $25,041,000. This cost estimate includes all additional costs for placement of dredged material at the restoration site compared to the costs for routine disposal at existing land disposal sites. Table 8-2 shows this cost by primary project feature. Estimated average annual costs were based on a 2.75 percent interest rate, a period of analysis of 50 years, and physical construction ending in 2029. Table 8-3 shows the average annual costs and outputs.

Table 8-2. Estimated Costs of Recommended Plan

MCACES Account[2]	Description	Total First Cost[1] ($1,000s)
01	Lands and Damages	1,140
02	Relocations[3]	0
06	Fish and Wildlife	6,125
17	Marsh Development[4]	12,523
30	Planning, Engineering, and Design	3,621
31	Construction Management	1,632
	Total First Cost	25,041

[1]Based on October 2018 price levels; includes escalation of 2.1% for 01, 02, 06, and 17 Accounts, and 3.9% for 30 and 31 Accounts.
[2]Micro Computer-Aided Cost Engineering System.
[3]No relocations required in TSP.
[4]Dredged material placement at restoration site - calculated under Beach Replenishment account in MCACES cost estimating software.

Table 8-3. Economic Costs and Benefits of Recommended Plan

Item	Costs ($1,000s)	Benefits
Investment Cost		
First Cost[1]	25,041	
Interest During Construction (2.75% over 15 year construction period)	8,172	
Total	33,213	
Annual Cost		
Interest and Amortization (2.75% over 50 year period of analysis)	1,230	
OMRR&R[2]	5	
Subtotal	1,235	
Annual Benefits Non-monetary (Ecosystem)		111.44 AAHU's

[1] October 2018 price level.
[2] Operation, Maintenance, Repair, Replacement, and Rehabilitation

8.1.6 Cost Sharing

The apportionment of costs between the Federal Government and the sponsor is presented in Tables 8-4 and 8-5. Table 8-4 shows costs apportioned as either Federal or non-Federal costs based on October 2018 price levels. Cost apportionment based on the fully funded cost estimate is presented in Table 8-5 using the current project schedule and projected future rates of price escalation at the mid-point of construction.

Table 8-4. Summary of Cost-Sharing Responsibilities of the Recommended Plan (October 2018 Price Level)

Item	Federal	Non-Federal	Total First Costs ($1,000s) [1]
Fish & Wildlife Facilities	$6,125	$0	$6,125
Marsh Development[2]	$12,523	$0	$12,523
Lands and Damages	$107	$1,033	$1,140
Planning, Engineering, & Design	$3,621	$0	$3,621
Construction Management	$1,632	$0	$1,632
Subtotal	*$24,008*	*$1,033*	*$25,041*
Additional Cash Contribution	-$7,731	$7,731	
Subtotal	*$16,277*	*$8,764*	*$25,041*
Percentage	*65%*	*35%*	

[1]Based on October 2018 price levels.
[2]Dredged material placement at Big Break-calculated under Beach Replenishment account in MCACES cost estimating software.

Table 8-5. Summary of Projected Cost-Sharing Responsibilities of the Recommended Plan (Fully Funded)

Item	Federal	Non-Federal	Total First Costs ($1,000s) [1]
Fish & Wildlife Facilities	$6,976	$0	$6,976
Marsh Development	$14,291	$0	$14,291
Lands and Damages	$110	$1,064	$1,174
Planning, Engineering, & Design	$4,627	$0	$4,627
Construction Management	$2,175	$0	$2,175
Subtotal	*$28,180*	*$1,064*	*$29,244*
Additional Cash Contribution	-$9,171	$9,171	
Subtotal	*$19,009*	*$10,235*	*$29,244*
Percentage	*65%*	*35%*	

[1]Based upon Total Project Cost which incorporates the mid-point of construction escalations; see Total Project Cost in the Engineering Appendix (Appendix C).

8.1.7 Risk and Uncertainty

In general, the ability of the RP to provide the expected accomplishments depends on the validity of pertinent assumptions, base data, and analytical techniques used in this study; the successful completion of future studies, designs, and construction; and appropriate operation and maintenance after construction.

Other risks include constructability and resiliency to sea level rise. Subsidence reversal techniques have several factors that could affect constructability, such as estimated volumes of available material and containment of sediments in open water; however, successful implementation of similar projects (Donlon Island and Venice Cut) in the vicinity of Big Break indicate these risks are low. A study of marshes around the San Francisco Bay (Callaway 2015) showed mean accretion rates over the last 50 years to be between 3-4 mm/year, with nearby Browns Island having an accretion rate of 4.5 mm/year. This demonstrates that the marshes in the region are keeping up with sea level rise and are likely to continue being resilient to future changes. A sea level rise sensitivity analysis and inland hydrology analysis were done for a 100-year period in accordance with ER 1100-2-8162 and ECB 2018-3. The proposed project is expected to be self-correcting in relation to climate change over time, as accretion of sediment and organic material would exceed the impacts of sea level rise as a result of climate change. However, changing climate conditions and sea level rise could impact both the tide levels and the salinity conditions at Big Break. The project would be designed to accommodate both sea level rise and a variety of hydrological runoff and water management scenarios to address this risk. The sea level rise assessment for the proposed project is included as Appendix C.

The HEP, used to quantify ER benefits, provides a reasonable representation of the outputs of the project for plan comparison and selection. The use of the well documented, successful reference sites for the basis of the with-project assumptions for the HEP increases the certainty of expected benefits. A Monitoring and Adaptive Management Plan (Appendix D) has been developed to address and reduce implementation risks.

8.1.8 Environmental Operating Principles

The RP supports each of the seven USACE Environmental Operating Principles (EOPs). The EOPs are:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all USACE activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

The environmental operating principles are met in the following ways:

Environmental balance and sustainability (EOP 1, 2, 3, &4)

- Project avoids or minimizes environmental impacts while maximizing ecosystem restoration benefits.

Planning with the environment (EOP 1, 2, 4, and 5)

- Worked with local resource agencies during planning phase to minimize impacts to the environment.

Integrate scientific, economic, and social knowledge base (EOP 6)

- All pertinent, best available information was used during plan formulation and selection.

Seeks Public input and Comment (Win-win solutions) (EOP 7)

- Held stakeholder meetings and public workshops throughout the process.
- Worked with local groups to achieve a balance of project goals and public concerns.

8.1.9 USACE Campaign Plan

The mission of USACE is to provide vital public engineering services in peace and war to strengthen the Nation’s security, energize the economy and reduce risks from disasters. In order to meet this mission, the agency has developed the USACE Campaign Plan (FY13-18) as a component of the corporate strategic management process to establish priorities, focus on the transformation initiatives, measure and guide progress, and adapt to the needs of the future. The goals of the Campaign Plan are:

Goal 1 - Support National Security
Objective 1a – Support Combatant Commands and other U.S. government agencies
Objective 1b – Partner with Installation Management Communities
Objective 1c – Achieve National/Army energy security and sustainability goals
Objective 1d – Support the Engineer Regiment

Goal 2 - Transform Civil Works
Objective 2a – Modernize the Civil Works project planning program and process
Objective 2b – Enhance Civil Works budget development with a systems Watershed–Informed approach
Objective 2c – Deliver quality solutions and services
Objective 2d – Deliver reliable, resilient and sustainable infrastructure systems

Goal 3 - Prepare for Tomorrow
Objective 3a – Enhance interagency disaster response and risk reduction capabilities
Objective 3b - Enhance interagency disaster recovery capabilities
Objective 3c - Enhance interagency disaster mitigation capabilities
Objective 3d – Strengthen Domestic Interagency Support

Goal 4 - Reduce Disaster Risk
Objective 4a – Maintain and advance DoD and Army critical enabling technologies
Objective 4b – Build trust and understanding with strategic engagement, communication, and cyber-security
Objective 4c – Streamline USACE business, acquisition and governance processes
Objective 4d – Build ready and resilient people and teams through talent management / leader development

The RP is responsive to these goals and objectives by accomplishing the following:

Deliver reliable, resilient and sustainable infrastructure systems.

- Designing a project which avoids or minimizes environmental impacts while maximizing ecosystem restoration benefits.

Deliver quality solutions and services.

- Designing a project which provides quality future habitat for threatened and endangered species with minimal environmental impacts and the beneficial reuse of dredged material.

Build trust and understanding with strategic engagement, communication, and cyber-security.

- The Feasibility Study team organized and participated in stakeholder meetings and public workshops throughout the process and worked with local groups to achieve a balance of project goals and public concerns.

Build ready and resilient people and teams through talent management / leader development.

- The study successfully employed the use of District Quality Control, ATR, Risk Analysis, and IEPR to assist in the review of the development of a technically sound recommendation of Federal Interest.

8.2 Plan Implementation

This section describes the remaining steps to potential authorization of the project by Congress and implementation by USACE and the sponsor.

8.2.1 Report Completion

The draft FR/EIS was circulated for public and agency review from April 18, 2014 through June 2, 2014. Public meetings were held on May 7, 2014 and May 9, 2014 to obtain comments from the public, agencies, and other interested parties. Comments were considered and incorporated into the FR/EIS, as appropriate. Comments received during the public and agency review, as well as responses, are included as an appendix to the final report. The final FR/EIS will be provided to any public agency that provided comments on the draft report.

As required by NEPA, USACE will issue a notice of availability of the final report and file the report with the USEPA. The USEPA notice of availability published in the *Federal Register* starts a 30-day public review period. This final FR/EIS will be circulated to agencies, organizations, and individuals who have an interest in the proposed project. All comments received will be considered and incorporated into the final FR/EIS, as appropriate. USACE HQ will receive comments from Federal and State agencies and the public, and complete its policy review of the final report.

8.2.2 Report Approval

After USACE HQ review of the final FR/EIS, including consideration of public, state and agency comments, the Chief of Engineers makes a recommendation on project implementation and authorization by Congress through a Report of the Chief of Engineers. This report will be submitted to the Assistant Secretary of the Army for Civil Works [ASA(CW)], who will review and approve the NEPA Record of Decision (ROD). Following the ROD, the ASA(CW)'s office will coordinate with the Office of Management and Budget and submit the report to Congress.

8.2.3 Project Authorization and Construction

If the project is authorized by Congress, construction funds must be appropriated for the project by Congress before a Project Partnership Agreement (PPA) can be signed by USACE and the non-Federal sponsor and before project design and construction could begin.

8.2.4 Division of Responsibilities

Federal Responsibilities. USACE would conduct PED studies. After the PPA is signed and the non-Federal sponsor provides the required cash contribution, lands, easements, rights-of-way, relocations, and disposal areas, the Federal Government would construct the project.

Non-Federal Responsibilities. Under the PPA, the non-Federal sponsor would be responsible to USACE for all non-Federal costs and maintenance requirements.

Views of Non-Federal Sponsor. The non-Federal sponsor supports the RP.

Financial Capability of Sponsor. The non-Federal sponsor has indicated that it intends to fund the project, pending further development through the final report and supporting documents.

Project Cost-Sharing Agreements. After congressional approval, a Design Agreement must be executed between USACE and the non-Federal sponsor in order to cost share the development of detailed plans and specifications. Before construction is started, the Federal Government and the non-Federal sponsor would execute a PPA. The PPA defines the responsibilities of the parties throughout the project's design, construction and operational phases and specifies the non-Federal sponsor's required financial and real estate contributions.

8.2.5 Schedule

If the project is authorized in 2019 construction activities could start as early as 2020. The following is a schedule showing the approval and construction phases of the project, assuming optimal funding.

Chief of Engineers Report	**January 2019**
Potential Authorization	**October 2019**
USACE and Sponsor sign Design Agreement	**October 2019**
PED	**2019-2020**
Initiate Construction	**2020**
Complete Physical Construction	**2029**
Complete Plant Establishment Period	**2030**
Complete Monitoring	**2031**

8.2.6 Further Studies

During PED, some additional studies would be undertaken as part of developing detailed designs for the project. Upon initiation of PED, any new information that has been collected by others would be considered before undertaking these additional studies. These studies include:

- Hydraulic modeling as required for project design;
- Topographic surveys for project design; and
- Cultural resource surveys.

8.3 Additional Recommendations

In addition to the above, USACE recommends continued flood risk communication and flood warning and preparedness planning efforts, as described in Chapter 3. This can be accomplished through local and state efforts or through USACE programs such as Flood Plain Management Services and Silver Jackets Programs. Future action for implementing nonstructural flood risk management measures by other Federal, State, and local agencies will be important for managing flood risk in the Delta.

CHAPTER 9 – RECOMMENDATIONS

This chapter describes the Items of Cooperation for an Ecosystem Restoration (Single Purpose) Project that will be specifically authorized. I recommend that the Recommended Plan (RP) (Alternative 3) be authorized for implementation, as a Federal project, with such modifications thereof as in the discretion of the Commander, USACE, may be advisable. The estimated first cost (2018 price levels) of the RP is $25,041,000 with an estimated Federal cost of $16,277,000 and an estimated non-Federal cost of $8,764,000. The estimated annual OMRR&R cost is $5,000 (2018 price levels) Federal implementation of the RP would be subject to the non-Federal sponsor complying with applicable Federal laws and policies, including but not limited to:

a. Provide 35 percent of total project costs as further specified below:

    1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work;

    2. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction and O&M of the project;

    3. Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total project costs;

b. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

c. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

d. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

e. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

f. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations, and any specific directions prescribed by the Federal Government;

g. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

h. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

i. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;

j. Comply with all applicable Federal laws and regulations, including but not limited to: Title VI of the Civil Rights Act of 1964, Public Law 88-352, as amended (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and Army Regulation 600-7 issued pursuant thereto; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project.

However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

l. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

m. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213[j]), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

David G. Ray, P.E.
Colonel, U.S. Army
District Commander

CHAPTER 10 – LIST OF PREPARERS

This report was prepared by the USACE, Sacramento District, with participation from DWR. The following table identifies individuals who prepared technical analyses, wrote sections of the draft FR/EIS or provided technical or policy review of the draft final FR/EIS.

Table 10-1. List of Preparers

Name	Discipline	Credentials	Role in the Study
Anne Baker, Senior Environmental Manager	11 years USACE; Civil Works Planning and Environmental Compliance	B.A. English, UC Davis	Environmental Lead, Final Report NEPA analysis, Draft Report
Thomas Borrowman, Civil/Environmental Engineer	15 years USACE; Civil/Environmental Engineering	B.S. Civil Engineering M.S. Civil Engineering Post M.S. units in Coastal/Environmental Engineering	Engineering Technical Lead, Final Report
Mariah Brumbaugh, Senior Environmental Manager	8.5 Years USACE Environmental; 3 years Wetland Manager, Cosumnes River Preserve (BLM); 2.5 years NRCS.	M.S. CSU Chico B.S. Pacific University	Environmental District Quality Control; Vegetation Design, Final Report
Kim Carsell, Chief, Flood and Storm Risk Reduction Section	8 years USACE; Planning	Certified Floodplain Manager	Supervisory Planning Review, Final Report
Bill Casale	USACE; Real Estate		Real Estate Plan, Final Report
Dennis Clark, Project Manager	USACE; Project Management		Project Manager, Draft Report
David Colby, Senior Fisheries Biologist	5 years USACE; 10 years U.S. Fish and Wildlife Service	B.S. Freshwater Fisheries, Humboldt State University	Fisheries assessment, NEPA Analysis, and ESA Consultation, Final Report
Mike Dietl, Former Chief Flood and Storm Risk Reduction Section	15 years USACE; Military and Civil Works Projects; Planning, Environmental, and Engineering; U.S. and International	B.S. Fisheries Biology	District Quality Control, Draft Report

Margaret Engesser, Water Resources Planner	2 years USACE; Plan Formulation; 3 years U.S. Fish and Wildlife Service	MRP Regional Planning B.A. Environmental Studies Certified Floodplain Manager	Assistant Planner, plan formulation and evaluation, final report preparation
Matilda Evoy-Mount, Water Resources Planner	3 years USACE Plan Formulation		Assistant Planner, plan formulation and evaluation, draft report preparation
Jerry Fuentes, Regional Technical Specialist	29 years USACE; Plan Formulation	M.A., B.A. Social Studies, Certified Water Resources Planner	Policy Review, Final Report
Victoria Hermanson, Environmental Manager	5 years USACE Environmental	B.S. Biology, UC Santa Cruz	NEPA Analysis, Final Report
Steven Highland, Archaeologist	6 months USACE Cultural Resources; 3.5 years other Federal Cultural Resources; 8 years private sector.	PhD in Geography, Oregon State University MA in Anthropology, University of Wyoming BA in Anthropology, Boston University	Cultural Resources, Final Report
Patrick Howell, Project Manager	9 years USACE; Project Management; 3 years Private Sector Project Management	MBA B.S. Geology Project Management Professional certified	Project Manager, Final Report
Erik James, Sr. Geotechnical Engineer, Levee Safety Section	6 years USACE, 2 years private consulting, Civil/Geotechnical Engineering for Civil Works	B.S. Geology UC Davis B.S. Civil Engineering, Sacramento State	Lead Geotechnical Engineer, Draft Report
Brad Johnson, Environmental Manager	3 years USACE, Civil Works Projects, Environmental	B.S. Landscape Architecture, UC Davis	Environmental Lead, Draft Report
Sid Jones, Landscape Architect	30 years USACE; 3.5 years HLA Group, Inc.; 5 years Robert Trent Jones III Golf Course Architects	Licensed Landscape Architect (California), PLA 3137	Vegetation and Planting Design, Draft and Final Report
Daniel Killip, Cost Engineer	6 years USACE; Military and Civil Works Projects; Hydraulic Design; California & AED	B.S. Civil Engineering, Cal Poly SLO; EIT, LSIT	Lead Cost Engineer, Draft Report

Cory Koger, Toxicologist, Environmental Chemistry Section	12 years USACE; Military, Civil Works, Support for Others, FUDS, Dredging, HTRW and Environmental	PhD Pharmacology and Toxicology, UC Davis; M.S. Chemistry, UC Irvine; B.S. Chemistry, UC Irvine; B.S. Biology UC Irvine	HTRW and Dredging Engineering Technical Lead, Draft and Final Report
Kevin Lee, Hydraulic Analysis Section	6 years USACE; Civil Works Projects, Hydraulic Design/Analysis	B.S. Civil Engineering, UC Davis	Engineering Tech Lead, Draft Report
Brian Luke, Senior Environmental Manager/Biologist	7 years USACE; Military and Civil Works Projects; Planning and Environmental	B.S. Biological Conservation, CSUS	Habitat Evaluation and Incremental Cost Analysis, Draft Report
Rachael Marzion, GIS Specialist	3 years USACE; 10 years other	B.A. Math, History MLA Environmental Planning MA International and Area Studies	Sea Level Rise/Vulnerability Analysis, Final Report
Dean McLeod, Economist	15 years USACE Water Resource Economics	M.A. Economics, B.S. Finance	Lead Economist, Draft and Final Report
Scott Miner, Regional Technical Specialist	35 years USACE; Civil Works Projects; Planning and Environmental	M.S. Wildland Resource Science, UC Berkeley; B.A. Biology, San Francisco State University	Policy Review, Draft and Final Report
Laurie Parker, Realty Specialist	25 Years USACE; Hydrologic Technician; Planning; Real Estate	B.A. Geography	Real Estate Technical Lead, Draft and Final Report
Nikki Polson, Archaeologist	5 years USACE, 15 years archaeologist	M.A. Anthropology CSU Sacramento B.S. Anthropology Utah State University	Cultural Resources, Draft Report
Sarah Ross-Arrouzet, Water Resources Planner	8.5 years USACE; Environmental Planning and Plan Formulation; 5 years Sacramento Area Flood Control Agency	B.S. Wildlife, Fish, and Conservation Biology, UC Davis Masters, University of New South Wales, Australia	Plan Formulation District Quality Control, Final Report
Hope Schear, Archaeologist	2.5 years USACE; Cultural	B.A. Anthropology, Sacramento State	Cultural Resources, Final Report

Brooke Schlenker, Lead Planner	11 years USACE; Military and Civil Works Projects; Planning, Environmental, and Engineering; California and Georgia	M.S. Physical Science, Marshall University B.S. Integrated Science and Technology, Marshall University	Lead Planner; plan formulation and evaluation, Draft and Final report preparation, graphic preparation
Saba Siddiqui	17 years Hydraulics Experience	Licensed Civil Engineer (California) MS Civil Engineering, CSU Sacramento	Inland sea level rise analysis, Final Report
Dylan Van Dyne	3 years USACE; Regulatory, Civil Works; 7 years USEPA and NMFS	M.S. Biological Sciences, CSU Chico B.S. Biological Sciences, UC Davis	Project Management, Final Report

CHAPTER 11 – REFERENCES

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CHAPTER 12 – INDEX