DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SAN FRANCISCO BAY TO STOCKTON, CALIFORNIA NAVIGATION STUDY

APRIL 2019

This page is intentionally left blank.

DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SAN FRANCISCO BAY TO STOCKTON, CALIFORNIA, NAVIGATION IMPROVEMENT PROJECT

LEAD NEPA AGENCY: Department of Army, U.S. Army Corps of Engineers, Jacksonville District

NON-FEDERAL SPONSOR: Port of Stockton

ABSTRACT: The San Francisco Bay to Stockton Navigation Improvement Project was originally authorized by Congress in the Rivers and Harbors (R&H) Act of 1965. The originally authorized study was scoped for a 78-mile long navigation project to include the John F. Baldwin and Stockton channels, however, it was re-scoped in 2016 to include navigation improvements up to Avon. The study area for this draft integrated General Reevaluation Report and Environmental Impact Statement (GRR/EIS) is a 13.2 mile length of navigation channel which spans from Central San Francisco Bay to Avon (just east of the Benicia-Martinez Bridge) and includes the Pinole Shoal Channel and the Bulls Head Reach portion of the Suisun Bay Channel. The channels in the study area primarily serve crude oil imports and refined product exports to and from several oil refineries and two non-petroleum industries. Although the navigation channels in the study area are authorized to a depth of up to -45 feet mean lower low water (MLLW), the channels are currently maintained to only -35 feet MLLW. The Tentatively Selected Plan (TSP)/Proposed Project includes deepening the existing navigation channel to -38 feet MLLW (plus 2 feet of allowable overdepth), dredging a 2,600 foot sediment trap in Bulls Head Reach to -42 feet MLLW (plus 2 feet of allowable overdepth), leveling a rock outcrop within the Pinole Shoal channel, and using the dredged material at beneficial reuse sites to contribute to restoration within the Delta.

Send your comments by:
June 9th, 2019

For further information on this statement, please contact:
Stacie Auvenshine
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019
Telephone: 904-314-7614
E-mail: SFBaytoStockton@usace.army.mil

This page is intentionally left blank.

Using this Document

ꕥ⓪ꕤ **Report Reference Materials:** To ease navigation through the report, prompts are provided, alerting the reader to reference additional sections or graphics, or to explain the purpose of an ensuing discussion. In this report, these prompts can be identified by this blue box format.

Additionally, informational foldouts **Graphics Executive Summary 1 and 2** are provided in the Executive Summary to be used while reading the document as reference maps with key points and landmarks. In addition, an overall table of contents is provided, along with detailed tables of contents and an index at the end of the report.

Organization of this report follows Exhibit G-7 (Feasibility Report Content) provided in Appendix G of US Army Corps of Engineers Engineering Regulation (ER) 1105-2-100 (30 June 2004), documenting the iterative U.S. Army Corps of Engineers (USACE) Plan Formulation Process. The planning process consists of six major steps:

(1) Specification of problems and opportunities
(2) Inventory, forecast, and analysis of existing 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
(6) Selection of the recommended plan based upon the comparison of the alternative plans.

Steps may be repeated as problems become better understood and new information becomes available.

Steps 1 and 2 are discussed in Chapters 1-2, and provide the foundation for developing alternative plans and selection of a recommended plan outlined in Chapter 3.

Each chapter and summary graphic, as well as the Executive Summary, describe plan development as it progresses through the four integrated environments that shape a navigation project: **the built environment** (Federal project, port facilities, placement areas, transportation network, advance maintenance areas, etc.); **the natural environment** (physical and biological resources including species of concern); **the navigation environment** (navigation restrictions, etc.), and **the economic environment** (commodity movement, vessel fleet characteristics, and transportation costs). Concerns relative to plan formulation and National Environmental Policy Act (NEPA) review are summarized and encapsulated in the discussions of these four main environments. California Environmental Quality Act (CEQA) compliance is not addressed in this document.

The recommended format of an Environmental Impact Statement (EIS) is provided in 40 CFR 1502.10 and has been integrated into the General Reevaluation Report. The basic table of contents for the report outlines how the EIS format has been integrated into the planning process to develop a recommended plan that meets the requirements of both USACE Plan Formulation Policy and NEPA.

Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

TABLE OF CONTENTS

Executive Summary*……………………………..………………………..ES-1
EIS: Summary

1 Introduction*………………………………………………………..1-1
EIS: Purpose of and Need for Action

2 Existing and Future Without-Project Conditions*…………...……………..…………….……….2-1
EIS: Existing and Future Without-Project Conditions

3 Plan Formulation……………...………………………………………………....................................3-1
EIS: Alternatives Including Proposed Action

4 Comparison of Environmental Effects of Alternative Plans*………………….…...…………….….4-1
EIS: Information on the Proposed Action

5 The Tentatively Selected Plan ……………………………………………………………………..5-1
EIS: Alternatives Including Proposed Action

6 Environmental Compliance*……………………….………………………………….……………….6-1
EIS: Scoping, Public Involvement, Compliance with Environmental Regulations

7 Recommendations………………………………………………………………..………………..7-1

8 List of Preparers*…………………….……………………..………………………….……………….8-1
EIS: List of Preparers

9 References and Index*..……………………………………...……………………………………9-1

Appendices

APPENDIX A – CIVIL SITE
APPENDIX B – WATER RESOURCES
ATTACHMENT 1 – Salinity Modeling Report
APPENDIX C – COST ENGINEERING AND RISK ANALYSIS
APPENDIX D – ECONOMIC ANALYSIS
APPENDIX E – GEOTECHNICAL
APPENDIX F – REAL ESTATE PLAN
APPENDIX G – ENVIRONMENTAL
ATTACHMENT 1 – 404(b)(1) Evaluation
ATTACHMENT 2 – Coastal Zone Management Act Consistency Evaluation
ATTACHMENT 3 – Regulatory Setting
ATTACHMENT 4 – United States Fish and Wildlife and National Marine Fisheries Coordination
ATTACHMENT 5 – Air Quality Report
ATTACHMENT H – CULTURAL RESOURCES
APPENDIX I – PERTINENT CORRESPONDENCE
APPENDIX J – PLAN FOR MANAGEMENT OF PROJECT DREDGED MATERIALS

The Shoaling Analysis (Bulls Head Deposition HydroSurvey Tech Memo, April 2015) and Ship Simulation Study (*Vessel Simulation Navigation Study of the Proposed John F. Baldwin Ship Channel – Phase III Proposed Channel Improvements*, DTMA 91-88-C-80024, Final Report, August 1992) referenced in this report are available upon request.

1 INTRODUCTION* 1-1

1.1 FEDERAL PROJECT PURPOSE* 1-1

1.2 STUDY BACKGROUND AND LOCATION* 1-1

1.3 STUDY SPONSOR 1-1

1.4 STUDY PURPOSE, NEED AND SIGNIFICANCE 1-1

1.5 STUDY AUTHORITIES 1-3

1.6 RELATED DOCUMENTS* 1-4

1.7 FEDERAL PROJECTS & STUDIES NEAR THE STUDY AREA 1-5

1.8 OTHER CURRENT NON-FEDERAL STUDIES AND PROJECTS ADJACENT TO OR NEAR THE STUDY AREA 1-6

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS 2-1

2.1 GENERAL SETTING* 2-1

2.2 NATURAL ENVIRONMENT EXISTING CONDITIONS* 2-1
2.2.1 GEOLOGY AND SEISMICITY 2-1
2.2.2 SEDIMENT AND SEDIMENTATION 2-4
2.2.3 WATER QUALITY AND HYDROLOGY 2-7
2.2.4 AIR QUALITY 2-19
2.2.5 CLIMATE CHANGE 2-26
2.2.6 BIOLOGICAL RESOURCES 2-27
2.2.7 LAND USE AND PLANNING 2-42
2.2.8 MINERAL RESOURCES 2-43
2.2.9 AGRICULTURE 2-45
2.2.10 AESTHETICS 2-45
2.2.11 CULTURAL RESOURCES 2-45
2.2.12 ENVIRONMENTAL JUSTICE 2-49
2.2.13 NOISE 2-51
2.2.14 PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS 2-51
2.2.15 RECREATION RESOURCES 2-52
2.2.16 SOCIO-ECONOMICS 2-54
2.2.17 NATIVE AMERICANS 2-56

2.3 NAVIGATION ENVIRONMENT 2-56
2.3.1 VESSEL USE AND OPERATION 2-56
2.3.2 SEA LEVEL CHANGE 2-58
2.3.3 STORM SURGE 2-58

2.4 BUILT ENVIRONMENT 2-59

2.4.1 EXISTING FEDERAL PROJECT 2-59
2.4.2 OPERATIONS AND MAINTENANCE (INCLUDING HIGH SHOALING AREAS) 2-59
2.4.3 DREDGED MATERIAL PLACEMENT/BENEFICIAL REUSE 2-61
2.4.4 CHANNEL USERS 2-63
2.4.5 MARITIME INFRASTRUCTURE WITHIN THE STUDY AREA 2-65
2.4.6 BRIDGES 2-66
2.4.7 UTILITIES AND PUBLIC SERVICE 2-67

2.5 ECONOMIC ENVIRONMENT 2-71
2.5.1 COMMODITIES 2-71
2.5.2 FLEET 2-73

3 PLAN FORMULATION 3-1

3.1 PLAN FORMULATION RATIONALE 3-1

3.2 SCOPING* 3-2

3.3 PROBLEMS AND OPPORTUNITIES* 3-3
3.3.1 PROBLEMS 3-3
3.3.2 OPPORTUNITIES 3-4

3.4 CONSTRAINTS 3-4
3.4.1 PLANNING CONSTRAINTS 3-4
3.4.2 LOCAL CONSTRAINTS 3-5

3.5 OBJECTIVES 3-5
3.5.1 FEDERAL AND PROJECT SPECIFIC OBJECTIVES 3-5
3.5.2 STATE AND LOCAL OBJECTIVES 3-7

3.6 SUMMARY OF MANAGEMENT MEASURES 3-7
3.6.1 IDENTIFICATION OF MANAGEMENT MEASURES 3-7
3.6.2 PRELIMINARY SCREENING OF MEASURES 3-11

3.7 ALTERNATIVE FORMULATION STRATEGY 3-15

3.8 ALTERNATIVE COMPARISON AND EVALUATION OF THE FINAL ARRAY 3-15

3.9 ECONOMIC EVALUATION OF THE FINAL ARRAY 3-20

3.10 ADDITIONAL ANALSYIS FOR THE FINAL ARRAY 3-21

4 COMPARISON OF ENVIRONMENTAL EFFECTS OF ALTERNATIVE PLANS 4-1

4.1 NATURAL ENVIRONMENT 4-2
4.1.1 GEOLOGY AND SEISMICITY 4-9
4.1.2 SEDIMENT AND SEDIMENTATION 4-10
4.1.3 WATER QUALITY AND HYDROLOGY 4-11
4.1.4 AIR QUALITY 4-26
4.1.5 CLIMATE CHANGE 4-34
4.1.6 BIOLOGICAL RESOURCES 4-41

4.1.7 LAND USE AND PLANNING 4-56
4.1.8 MINERAL RESOURCES 4-56
4.1.9 AGRICULTURE 4-57
4.1.10 AESTHETICS 4-59
4.1.11 CULTURAL RESOURCES 4-61
4.1.12 ENVIRONMENTAL JUSTICE AND COMMUNITY EFFECTS 4-65
4.1.13 NAVIGATION, TRANSPORTATION, AND CIRCULATION 4-66
4.1.14 NOISE 4-68
4.1.15 PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS 4-69
4.1.16 RECREATION 4-71
4.1.17 SOCIO-ECONOMICS 4-72
4.1.18 UTILITIES AND PUBLIC SERVICE 4-73

4.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES 4-75

4.3 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS 4-75

4.4 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES 4-75

4.5 CONFLICTS AND CONTROVERSY 4-76

4.6 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS 4-76

4.7 CUMULATIVE EFFECTS 4-76

4.8 TENTATIVELY SELCTED PLAN 4-93

5 THE TENTATIVELY SELECTED PLAN 5-1

5.1 OVERVIEW OF THE TENTATIVELY SELECTED PLAN 5-1

5.2 MATERIAL QUANTITIES AND CLASSIFICATIONS 5-2

5.3 MITIGATION 5-2

5.4 CONSTRUCTION ASSUMPTIONS 5-3

5.5 OPERATION AND MAINTENANCE 5-4
5.5.1 SEDIMENT TRAP 5-5
5.5.2 DREDGED MATERIAL PLACEMENT SITES 5-5
5.5.3 MONTEZUMA WETLAND RESTORATION SITE (MWRP) 5-5
5.5.4 CULLINAN RANCH TIDAL RESTORATION SITE 5-6
5.5.5 SAN FRANCISCO DEEP OCEAN DISPOSAL SITE (SF-DODS) 5-6

5.6 BENEFITS OF THE TENTATIVELY SELECTED PLAN 5-6
5.6.1 ECONOMIC COSTS AND BENEFITS 5-6
5.6.2 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS 5-7
5.6.3 INCREMENTAL ANALYSIS OF THE SEDIMENT TRAP 5-8

5.7 FEDERAL IMPEMENTATION RESPONSIBILITIES 5-9

5.8 NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES 5-9

5.9 TENTATIVELY SELECTED PLAN COST 5-9

5.10 LANDS, EASEMENTS, RIGHT-OF-WAY & RELOCATION (LERR) SUMMARY 5-11

5.11 FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES 5-12

5.12 VIEWS OF THE NON-FEDERAL SPONSOR 5-13

5.13 RISK AND UNCERTAINTY 5-13
5.13.1 RESIDUAL RISK 5-14

6 ENVIRONMENTAL COMPLIANCE 6-1

6.1 SCOPING 6-1

6.2 LIST OF RECIPIENTS 6-1

6.3 COMMENTS RECEIVED AND RESPONSE 6-1

6.4 ENVIRONMENTAL COMMITMENTS 6-1

6.5 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS 6-2
6.5.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969 6-2
6.5.2 ENDANGERED SPECIES ACT OF 1973 6-2
6.5.3 FISH & WILDLIFE COORDINATION ACT OF 1958 6-2
6.5.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (*INTER ALIA*) 6-2
6.5.5 CLEAN WATER ACT OF 1972 6-3
6.5.6 CLEAN AIR ACT OF 1972 6-4
6.5.7 COASTAL ZONE MANAGEMENT ACT OF 1972 6-4
6.5.8 FARMLAND PROTECTION POLICY ACT OF 1981 6-4
6.5.9 WILD AND SCENIC RIVER ACT OF 1968 6-4
6.5.10 MARINE MAMMAL PROTECTION ACT OF 1972 6-4
6.5.11 ESTUARY PROTECTION ACT OF 1968 6-5
6.5.12 FEDERAL WATER PROJECT RECREATION ACT 6-6
6.5.13 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976 6-6
6.5.14 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990 6-6
6.5.15 RIVERS AND HARBORS ACT OF 1899 6-6
6.5.16 ANADROMOUS FISH CONSERVATION ACT 6-6
6.5.17 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT 6-6
6.5.18 MARINE PROTECTION AND SANCTUARIES ACT 6-6
6.5.19 EXECUTIVE ORDER (EO) 11990, PROTECTION OF WETLANDS 6-7
6.5.20 E.O 11988, FLOOD PLAIN MANAGEMENT 6-7
6.5.21 E.O. 12898 ENVIRONMENTAL JUSTICE 6-7
6.5.22 E.O. 13045, PROTECTION OF CHILDREN 6-7
6.5.23 E.O. 13089 CORAL REEF PROTECTION 6-7
6.5.24 E.O. 13112, INVASIVE SPECIES 6-8
6.5.25 ENVIRONMENTAL OPERATING PRINCIPLES 6-8

7 DRAFT RECOMMENDATIONS 7-1

7.1 DRAFT ITEMS OF LOCAL COOPERATION 7-1

8 LIST OF PREPARERS 8-1

8.1 PREPARERS 8-1

8.2 REVIEWERS 8-1

9 REFERENCES AND INDEX 9-1

9.1 REFERENCES 9-1

9.2 INDEX 9-2

DRAFT INTEGRATED GENERAL REEVALUATION REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
SAN FRANCISCO BAY TO STOCKTON, CALIFORNIA, NAVIGATION IMPROVEMENT PROJECT

Please refer to Graphic Executive Summary pages 1 and 2

EXECUTIVE SUMMARY

INTRODUCTION

The San Francisco Bay to Stockton Navigation Improvement Project was originally authorized by Congress in the Rivers and Harbors (R&H) Act of 1965. The authorization allowed for -45 foot channel depths, but the channels were only constructed to -35 feet mean lower low water (MLLW). This report is an interim response to the study authority.

The study was originally scoped for a 78-mile long navigation project to include the John F. Baldwin and Stockton channels, but was re-scoped in 2016 to only include improvements to Avon. The study area is a 13.2 mile length of navigation channel which spans from Central San Francisco Bay to Avon (just east of the Benicia-Martinez Bridge) and includes the Pinole Shoal Channel and the Bulls Head Reach portion of the Suisun Bay Channel. The channels in the study area primarily serve crude oil imports and refined product exports to and from several oil refineries and two non-petroleum industries. Although the navigation channels in the study area are authorized to a depth of up to -45 feet (MLLW), the channels are currently maintained to only -35 feet MLLW.

The U.S. Army Corps of Engineers (USACE) is responsible for preparing this integrated draft General Reevaluation Report (GRR)/Environmental Impact Statement (EIS) and is the lead Federal agency for National Environmental Policy Act (NEPA) compliance (42 USC Section 4321 et seq.; 40 CFR Section 1500.1). The Port of Stockton is the official non-Federal partner for the GRR/EIS.

Although this GRR was originally intended to be integrated with both NEPA and California Environmental Quality Act (CEQA) compliance requirements, this document may or may not be used as CEQA documentation; CEQA compliance will be determined by the non-Federal sponsor.

Although the non-federal sponsor (partner) for this project is the Port of Stockton, the navigation channel users benefitting from the proposed improvements are located within Contra Costa County. The County has been working to come to internal agreement to issue an updated Notice of Preparation (NOP) as CEQA lead for the project. However, at this time, Contra Costa County has determined they are unable to complete this process. On March 11, 2019, the Port of Stockton informed the Corps they were considering acting as CEQA lead for the proposed Tentatively Selected Plan (TSP) improvements included in this report through the issuance of a future NOP addressing project-level compliance for the Tentatively Selected Plan, and programmatic compliance for future deepening of the Stockton Deepwater Ship Channel (SDWSC). This intent has since been confirmed through a series of follow-on communications between the Port and Corps of Engineers' leadership in April 2019.

As stated in the current NOI issued on December 4, 2017 for this EIS and subsequent informal stakeholder discussions, the Corps of Engineers de-scoped the eastern portion of the original study area, which included the SDWSC, from consideration in this study. This current draft GRR/EIS only addresses the study area from the Golden Gate Bridge to Avon and the Army Corps is not preparing a feasibility study or NEPA document from Avon to the Port of Stockton. The sponsor has not yet provided a formal letter of their intention for a future study from Avon to the Port of Stockton, but in the spirit of full transparency and long history regarding this project, recent communications by the Port of Stockton regarding their future interests are documented in this report. As such, with the knowledge of Port's intention to potentially deepen the navigation channel from Avon to Stockton, that potential action is addressed in the Cumulative Effects section in Chapter 4, **Table 4-22**.

STUDY AREA, PURPOSE AND NEED

The navigation channels within the study area are regionally significant, providing navigation access to ports, harbors, refineries, and military terminals from San Francisco Bay through San Pablo and Suisun Bays and up the Sacramento-San Joaquin Delta and the San Joaquin River to the Port of Stockton.

The bays and delta through which the navigation channels cross are naturally shallow. Over time, channel deepening of the natural waterways and regular maintenance dredging has facilitated modern vessels to traverse the channels. The modern vessels crossing the channels can require up to 55 feet of draft when fully loaded. Given that these channels are maintained at -35 feet MLLW, most vessels must be “light-loaded”, or less than fully loaded with cargo, to navigate the channels with sufficient under-keel clearance. Light-loading increases the cost of transportation and, in turn, the cost of the shipped products because more trips must be made to carry the same volume of cargo. Within the study area, tankers carrying crude oil to California oil refineries and exporting petroleum are most impacted by light-loading practices.

According to the California Energy Commission, Californians consume nearly 44 million gallons of gasoline and 10 million gallons of diesel every day. California refineries produce these fuels and other products from crude oil and blending components. Transportation fuel production in California depends on the availability and quality of the crude oils used by refineries in the state. The supply of crude oil to California refineries has changed substantially in the last 10 years. Most notably, receipts of foreign crude oil have increased as production sources from California and Alaska have continued to decline. Each day approximately two million barrels (a barrel is equal to 42 U.S. gallons) of petroleum are processed into a variety of products, with gasoline representing about half of the total product volume. To comply with Federal and state regulations, California refiners invested approximately $5.8 billion to upgrade their facilities to produce cleaner fuels, including reformulated gasoline and low-sulfur diesel fuel.

According to data from the Waterborne Commerce Statistics Center, 20 million to 27 million tons of commodities moved through the Carquinez Straight annually between 2005 and 2013. In terms of both tonnage and value, the most important commodity that moves through the study is crude oil. Most of the crude oil moving through the channel is imported from foreign countries, although a small percentage of crude comes from domestic sources. This analysis focuses on the main oil refineries that import crude oil and export petroleum products. According to the Annual Energy Outlook (2015), the growth rate for crude oil imports is an annual rate of 0.3%, and petroleum and other liquid exports has an annual rate of 2.4%.

In order to maintain safety, the San Francisco Bar Pilots employ under-keel clearance of 3 feet for tankers and use of high tide when appropriate for vessels for fully loaded. It is a 5 hour transit from the entrance channel to refineries.

Given the constraints posed by existing channel depths, inefficient strategies that are currently employed to manage these constraints include:

- Vessels must light-load cargo
- Vessels must wait for favorable (high) tides which increases transportation costs
- High shoaling rates in Bulls Head Reach require dredging annually, incurring large mobilization and demobilization costs, and causing delays to vessels when dredging is postponed.

The Federal objective defining Federal interest in channel improvements is to reasonably maximize net benefits to the nation. Project specific objectives include:

1. Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020
2. Objective 2: Maximize beneficial reuse of dredged material while minimizing placement costs
3. Objective 3: Reduce frequency of operation and maintenance dredging in high shoaling areas

ALTERNATIVE PLANS AND THE TENTATIVELY SELECTED PLAN

MEASURES

In order to address the problems and meet objectives, a total of 16 measures were initially considered: 8 non-structural and 8 structural. Non-structural measures considered were: congestion fees, intermodal transportation systems, lightering, light-loading, use of favorable tides and daylight transit only, traffic management, pipeline, and relocation of port facilities. Structural measures considered were: channel deepening in depths from -37 to -45 feet (-37, -38, -40, -43, and -45), sediment traps, rock outcrop removal, and the beneficial use of material for dredged material placement.

The management measures were screened based on an assessment of how well they met the project objectives, the four planning and guidance accounts, and their ability to be complete, acceptable, efficient, and effective. The screening was performed to identify those measures appropriate for inclusion in developing alternative plans.

Non-structural and structural measures were compared and evaluated against a set of 12 different screening criteria to assess positive benefits and attributes which could be attained, worth a total of 2 points each, for a total maximum score of 24 points. Points were assigned as follows: Does Not Meet = 0;

Partially Meets = 1; Fully Meets = 2. Negative scores up to -2 points were assigned for areas where negative effects could occur. The total score of each measure was then determined and only measures which scored greater than 12 (over half of the total available points) were carried forward to be combined into alternatives.

Measures which were screened out include all non-structural alternatives and deepening alternatives at the -40 foot, -43 foot, and -45 foot depth. Measures carried forward include the no-action plan, deepening alternatives at the -37 foot and -38 foot MLLW depth, a sediment trap at the -42 foot depth plus 2 feet of overdepth (based on the shoaling analysis conducted in 2015 titled "Bulls Head Deposition HydroSurvey Tech Memo"), removal of the rock outcropping, and beneficial use of material.

ALTERNATIVE DEVELOPMENT

Remaining measures were then combined into alternatives. These alternatives include the no-action alternative and two deepening alternatives; to depths of -37 feet and -38 feet MLLW, with the dredged material being beneficially used at one or more of the existing permitted beneficial use sites, namely, Cullinan Ranch Restoration Project (Cullinan Ranch), Montezuma Wetlands Project (Montezuma Wetlands), as well as other sites including San Francisco Deep Ocean Disposal Site (SF-DODS), and in-bay placement. A sediment trap measure is also included at Bulls Head Reach in both of the action alternatives as a separable element, as well as a measure removing rock outcropping for increased navigability.

ALTERNATIVE COMPARISON

Per USACE guidance ER 1105-2-100, the final array of alternatives must be compared and evaluated against P&G criteria[1], and additionally, an economic evaluation must be completed to identify which plan in the final array maximizes NED benefits. An environmental analysis must also be conducted under the National Environmental Policy Act (NEPA) to compare and evaluate the final array for a set of environmental factors, prior to determination of the TSP.

Plan Formulation Comparison and Evaluation of the Final Array.

The initial array of alternatives were compared and evaluated against screening criteria, using an additional level of refinement in known information.

Comparison and evaluation of the initial array of alternatives (**Table 3-3**) resulted in identification of those alternatives to be carried forward into the final array. The final array consists of the no action alternative, a -37 foot deepening alternative, and a -38 foot deepening alterative, both including a sediment trap, rock removal, and beneficial use placement. An analysis of placement sites for each alternative determined that placement at Montezuma Wetlands and/or Cullinan Ranch were cost-effective options and, importantly, using these sites maximizes the planning objective to beneficially use material. In-bay placement does not contain adequate capacity for initial construction, additionally, although material placement within the bay at these sites would keep material in the local system, it would not constitute beneficial use. Placement of material at SF-DODS is not ideal since it takes material out of the natural system, while both Cullinan Ranch and Montezuma Wetlands both can beneficially use the material and are cost effective. While SF-DODS is not carried forward as a placement site, it is worth mentioning that

[1] The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

it is an available placement site if needed, if there are no other beneficial use sites with available capacity prior to construction.

Economic Comparison and Evaluation of the Final Array.
Preliminary screening level cost estimates were developed for the two proposed deepening alternatives and applied in the economic analysis. Costs shown in **Table 3-5** include Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) activities and Interest during Construction (IDC). Transportation costs and benefits were estimated using the USACE certified economic model *HarborSym* and estimated for a 50-year period of analysis for the years 2020 through 2069. The costs and benefits for each alternative were annualized at the FY16 price level and FY16 discount rate of 3.125% over 50 years.

The -38 foot deepening alternative provides higher net benefits than the -37 foot deepening alternative, and additionally meets planning criteria goals of being efficient, effective, acceptable, and implementable. The -38 foot deepening alternative also has a benefit to cost ratio greater than 1.

Environmental Comparison and Evaluation of the Effects of the Final Array.
The No Action Alternative is the NEPA benchmark or baseline for assessing environmental effects, including the cumulative impacts, of an action (e.g., project) alternative. The action alternatives are the -37 foot and -38 foot deepening alternatives. An alternative is considered to have a significant impact if it would cause a substantial adverse change in a resource compared to the NEPA baseline.

The effects of the alternatives on each resource category are described in Chapter 4. Effects of each of the action alternatives were found to be less than significant based upon the analyses. Impacts associated with hydrodynamic changes including salinity intrusion and water quality were addressed through extensive hydraulic modeling simulations (**Appendix B, Water Resources** - **Attachment 1, Salinity Model Report**). Modeling runs compared the hydrodynamic effects from the -37 foot, -38 foot, and the -38 foot with sediment trap and rock outcrop alternatives. The effects of the proposed project deepening on X2, the distance up the axis of the estuary to the daily-averaged 2 practical salinity units (psu) near-bed salinity, and on water quality at municipal and industrial water intake and export locations in the Sacramento-San Joaquin Delta were evaluated (further description of X2 discussed in **Section 2.2.3.3 Salinity and water supply**). The sediment trap and rock outcrop inclusion in modeling analyses were completed after the selection of the TSP, and were therefore only modeled in addition to the -38 foot depth. The change in X2 predicted in the model is insignificant with the -37 foot, -38 foot, and -38 foot plus sediment trap and rock outcrop alternatives, further explained in Chapter 4.

Effects on the endangered delta smelt are described fully in the Biological Assessment (**Appendix G**, **Environmental - Attachment 4**). The project is not expected to result in the loss of the shallow water habitat needed for smelt reproduction and the slight shift in X2 would not be expected to significantly alter habitat for smelt or other fish species. The dredged material will be placed on beneficial reuse sites that will benefit upland, wetland, and tidal wetland species, offsetting the less than significant project effects to threatened and endangered species in the study area.

THE TENTATIVELY SELECTED PLAN

The discussion above shows that the -**38 foot deepening alternative** met P&G criteria, as well as all other screening criteria, and was identified as the NED plan which maximizes net benefits, and was fully evaluated under NEPA for effects. No locally preferred plan (LPP) has been identified. Therefore, the TSP is the -38 foot deepening alternative. The TSP would deepen the existing maintained channel depth of the Pinole Shoal Channel and the Bulls Head Reach portion of the Suisun Bay Channel from -35 feet MLLW to -38 feet MLLW, with approximately 13.2 miles of new regulatory depths. Approximately 10.3 miles of the Pinole Shoal Channel (stations 0+00 to 548+00) and 2.9 miles of Bulls Head Reach to Avon (stations 0+00 62+00 and 88+00 to 159+00) would be dredged. A 2,600 foot-long sediment trap (width = 300 feet) is justified on its own as a separable element to reduce the frequency of operation and maintenance dredge events. It would be constructed at Bulls Head Reach (located between stations 62+00 and 88+00 of the Bulls Head Reach), with a depth of -42 feet MLLW, plus 2 feet of overdepth.

In summary, the TSP proposes the following:

- Deepen the existing maintained channel depth of the Pinole Shoal Channel and Bulls Head Reach (Suisun Bay) from -35 feet to -38 feet MLLW, with approximately 13.2 miles of new regulatory depths
- Dredge a 2,600 foot sediment trap at Bulls Head Reach with a depth of -42-feet MLLW, plus 2 feet of overdepth
- Level the rock outcropping located to the west of Pinole Shoal from a peak of -39.7-feet MLLW to -43-feet MLLW
- Use dredged material at permitted beneficial reuse sites

The TSP would result in approximately 1.6 million cubic yards of dredged material from an approximate 390-acre footprint. The breakout of volumes for each feature is shown as follows:

- Pinole Shoal deepening = 1,443,900 cy
- Bulls Head Reach deepening = 38,700 cy
- Bulls Sediment Trap = 120,600 cy
- Rock Outcropping (Suisun Bay Channel) = 40 cy of rock (950 sq. ft.)

All construction is expected to occur during the existing environmental work windows developed by the San Francisco Bay Long Term Management Strategy for the Placement of Dredged Material unless other windows are developed during consultation with the resource agencies. The environmental work window for the Pinole Shoal Channel is from June 1 through November 20 and the work window for the Bulls Head Reach portion of the Suisun Bay Channel is from August 1 through November 30.

It is assumed that the operation and maintenance (O&M) of the existing channels will be timed to be awarded prior to the new deepening project in Pinole Shoal and Suisan Bay Channel. For cost estimating purposes, it is assumed that a clamshell would be used and new deepening project O&M material would be placed at in-bay sites SF-10 and SF-16, according to the Federal standards.

Beneficial Reuse

The TSP includes placing new construction material from the Pinole Shoal channel at Cullinan Ranch and the new construction material from Bulls Head Reach at a suitable and permitted site, currently assumed to be Montezuma Wetlands. Preliminary coordination with project stakeholders concluded their support and preference for the beneficial use placement at Cullinan Ranch and Montezuma Wetlands, or other available beneficial reuse sites. The TSP was determined to have less than significant effects on all resources, as described further in Chapter 4 of this integrated document. The inclusion of beneficial reuse in the TSP would offset compensatory mitigation requirements by minimizing the already less than significant direct and indirect effects to environmental resources, specifically due to the slight shift in X2. The beneficial reuse sites contain their own monitoring programs (USACE and SCDEM 1998; USFWS and CDFW 2008 – these documents are available upon request). Therefore, this project does not propose any further mitigation or monitoring.

BENEFITS OF THE TENTATIVELY SELECTED PLAN

The TSP has estimated average annual net benefits of $10 Million (FY2019 price levels, FY2019 2.875% discount rate), with a benefit to cost ratio of 3.7 to 1.0.[2]

In addition to maximizing net benefits and identifying the plan with the best benefit to cost ratio, the four P&G accounts below: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) are always used as criteria in formulation and plan selection. These accounts are briefly summarized below.

National Economic Development (NED).

This project reasonably maximizes net benefits in the amount of $10 million average annual net benefits (FY2019, 2.875%), with a benefit to cost ratio of 3.7 to 1. The project allows tankers to utilize more of their existing capacity to transport all projected commodity volumes under existing and future conditions, reducing the amount of vessel transits in the future with-project compared to the future without-project scenario. By doing so, it provides transportation cost savings to the oil refineries, which are then passed on to the regional and national consumers who use the end product of the crude oil for gasoline, etc.

The sediment trap feature of the TSP provides direct benefit to channel users and vessel operations and is included as a separable element and incrementally justified feature of the TSP. It is sited in a portion of the channel that has traditionally required annual dredging at an estimated cost of $1 million each year; based on the historical use of clamshell dredges which are mobilized and demobilized each year, in addition to numerous interim emergency dredging events. The sediment trap would reduce maintenance dredging requirements from an annual cycle to 2 dredge events every 3 years, thus creating a savings based on a reduction in the frequency of mobilization and demobilization 1 out of every 3 years. This creates a total present value savings of $18 million for the O&M program, or an average annual equivalent savings of $680,000 per year over a 50 period of analysis at a discount rate of 2.875%.

Environmental Quality (EQ).

This project reduces the amount of vessel transits in the future with-project scenario. Reducing the number of vessels would also reduce potential disruptions to the environment as vessels transit, as well as the risk of oil spills. Beneficial use of material would create additional habitat for many species, including the federally endangered delta smelt.

Regional Economic Development (RED).

This project would likely temporarily stimulate the regional economy during construction.

[2] This study occurred over the span of several years. Therefore, price levels and discount rates were used as appropriate depending on what year the economic analysis occurred for varying levels of plan formulation. As such, this report cites FY price levels and discount rates used for each economic analysis throughout the study.

Other Social Effects (OSE).

Through beneficially placing material at permitted wetland sites, this project would also help provide resiliency and storm surge protection to infrastructure located around the perimeter of the channel and bay margins. One viable beneficial use placement option for the dredged material from this project is use as fill material to restore the wetlands due to subsidence and combat the further loss of wetlands by raising surrounding wetland and tidal marsh elevations to accelerate their development. Additionally, removing the rock outcropping in Pinole Shoal channel will greatly enhance the navigability of the channels for harbor pilots.

ENVIRONMENTAL CONSIDERATIONS

Over the past few decades, significant coordination has taken place between USACE, the Port of Stockton, and Federal, state, and local agencies, water managers, businesses, organizations, and the general public. The coordination has identified the following key areas of concern and are addressed in Chapter 4:

- Salinity intrusion in the delta, particularly related to impacts on drinking water and the designated critical habitat of the Federal and state listed endangered delta smelt.
- Impacts to threatened and endangered species including longfin smelt, green sturgeon, and salmonids.
- The potential to beneficially use dredged material in existing habitat restoration projects within the study area.

COST ESTIMATE AND IMPLEMENTATION

The cost estimate below reflects all project features as described earlier, including removal of the rock outcropping and sediment trap. There are no local facility costs associated with the project cost. Environmental windows factored heavily into construction windows and sequencing. The total project cost, including a risk-based contingency, is estimated at $59,400,000.

October 1, 2018 (FY2019) Price Levels[1]						
WBS Number	**General Navigation Features**	**Project Cost**	**Contingency**	**Total Project Cost**	**Federal Share 75%**	**Non-Federal Share 25%**
12	Mob, Demob, Dredging	$47,512,000	$9,526,000	$57,038,000	$42,779,000	$14,260,000
30	Pre-Construction, Engineering, and Design	$1,396,000	$279,000	$1,675,000	$1,256,000	$419,000
31	Construction Management (S&I)	$529,000	$106,000	$635,000	$476,000	$159,000
	Subtotal Construction of GNF[2]	**$49,437,000**	**$9,911,000**	**$59,348,000**	**$44,511,000**	**$14,838,000**
1	Lands, Easements, Right-of-Ways, Relocations (LERR)[3]	$49,000	$2,000	$51,000	$38,250	$12,750
	Total Project First Costs	**$49,486,000**	**$9,913,000**	**$59,400,000**	**$44,549,250**	**$14,850,750**
	Credit for Non-Federal LERR[4]	**$0**			**$0**	**-$12,750**
	10% GNF Non-Federal[5]	**$0**			**-$5,934,800**	**$5,934,800**
	Total Cost Apportionment	**$49,486,000**	**$9,913,000**	**$59,400,000**	**$38,614,450**	**$20,772,800**

1. Cost is based on Project First Cost (constant dollar basis) on Total Project Cost Summary Spreadsheet, which includes 0.5% escalation to program year 2019 at an effective price level 1 October 2018 (**Cost Appendix**)

2. 75% Federal/25% non-Federal including the cost of the sediment trap.

3. RE admin costs. There are no actual lands and damages but per USACE regulations, RE admin costs will be placed in the 01 account. Additional RE costs will be cost shared according to the GNF. Escalation from the TPCS accounts for some numerical differences.

4. Credit is given for the incidental costs borne by the non-Federal sponsor for lands, easements, rights of way and relocations (LERR) per Section 101 of WRDA 86, not to exceed 10% of the GNF

5. The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment except in the case of LERR for GNF.

COORDINATION WITH AGENCIES AND THE PUBLIC

A Notice of Intent (NOI) to Prepare an Environmental Impact Statement/Environmental Impact Report was published in the Federal Register on 4 December 2017. The current NOI announced the reduction in scope of this project (to include only the Pinole Shoal and the Bulls Head Reach portion of the Suisun Bay) from the NOI that was published on 4 March 2016. Scoping comments received in 2016 and 2018 are located in **Appendix I, Pertinent Correspondence**, along with a Comment Response Matrix to address the comments.

USACE participated in and gained valuable feedback at many meetings involving state and Federal agencies through various stages of this project. Most recently, informal working group meetings were held in December 2018, with attendees from the Environmental Protection Agency, National Marine Fisheries Service, United States Fish and Wildlife Service, Regional Water Quality Board, USACE, Contra Costa County, the Port of Stockton, Anchor QEA, California Department of Fish and Wildlife, Bay Area Air Quality Management District, Bay Area Conservation and Development District, Department of Water Resources, Delta Stewardship Council, Bureau of Reclamation, and State Water Contractors, among others. Discussions and feedback from these working group meetings provided valuable feedback that was considered in this report.

RESIDUAL RISK

SEA LEVEL RISE

Sea level rise is expected to be the same in both the future with-project and future without-project conditions. Numerical modeling has found that sea level rise is not anticipated to cause any significant changes to flow rates within San Francisco Bay and the Sacramento-San Joaquin Delta for both future without-project conditions and the TSP. The modeling has found that sea level rise may cause an increase in salinity intrusion into the delta in both future without-project conditions and the TSP if current reservoir operations are maintained. The potential impacts of rising sea level include increased salinity intrusion into the Sacramento-San Joaquin Delta, overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas.

STORM SURGE

Numerical modeling found that water elevations would be similar for future without-project conditions and the TSP. Therefore, there is no anticipated significant change in storm surge for future without-project conditions and the TSP.

SEDIMENT QUALITY

Sediment testing in 1998 to a depth of 49 feet showed chromium levels that would be higher than anticipated for wetland placement at the beneficial reuse sites. Recent sediment testing occurred in 2009 in Pinole Shoal from depths of -37 feet to -39 feet, similar to proposed TSP depths. The Pinole Shoal material to 39 feet was tested with no significant concerns. The sediment in Bulls Head Reach was not tested for chromium recently, but is assumed for the TSP depth to -38 feet plus 2 feet of overdepth that the sediment quality will likely be similar to that of Pinole Shoal's depth to 39 feet. However, the acreage of sediment from the sediment trap of -42 feet plus 2 feet of overdepth may only be compatible for foundation placement. Discussion on sediment is further described and evaluated in Sections 2.2.2 and 4.1.2. Overall, the sediment quality is assumed to be compatible with requirements for placement at the beneficial reuse sites, either as cover material or foundation placement. To confirm the suitability for marsh placement, sediment sampling of both Pinole Shoal and Suisun Bay will be redone during Preconstruction, Engineering, and Design (PED), based upon the project dredge template.

SAN FRANCISCO BAY TO STOCKTON NAVIGATION IMPROVEMENT

INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTRODUCTION

BACKGROUND

The San Francisco Bay to Stockton, California, Navigation Improvement Project was originally authorized by Congress in the Rivers and Harbors Act of 1965. The authorization allowed for 45 foot depths, but the channels were only constructed to 35 feet. The study was originally scoped for a 78-mile long navigation project to include the John F. Baldwin and Stockton channels, but has since been re-scoped to a total of 13.2 miles in the Pinole Shoal Channel and Suisun Bay Channel, to Avon. According to data from the Waterborne Commerce Statistics Center, 20 million to 27 million tons of commodities moved through the Carquinez Straight annually between 2005 and 2016. In terms of both tonnage and value, the most important commodity that moves through the study is crude oil. Most of the crude oil moving through the channel is imported from foreign countries, although a small percentage of crude comes from domestic sources. This analysis focuses on the main oil refineries that import crude oil and export petroleum products. In order to maintain safety, the San Francisco Bar Pilots employ under-keel clearance of 3 feet for tankers and use of high tide when appropriate for vessels for fully loaded. It is a 5 hour transit from the entrance channel to refineries. The tentatively selected plan (shown on the back) is to deepen from 35 feet to 38 feet in the Pinole Shoal Channel and Bulls Head reach portion of the Suisun Bay Channel. Additionally, the plan recommends a sediment trap at Bull's Head reach at cost savings of $680,000 per year, dredging of a navigational hazard (rock outcropping), and beneficial use of material, which provides average annual benefits of $13.5M with annual net savings of approximately $10M.

PROBLEMS - ECONOMIC INEFFICIENCIES

Existing channel depths (35 feet MLLW) require vessels to transit the harbor light loaded (less than fully loaded), which decreases economic efficiency and increases transportation costs which are passed on to the American consumer. Inefficient strategies that are currently employed include:

- Vessels must light-load cargo
- Vessels must wait for favorable (high) tides which increases transportation costs
- High shoaling rates in Bulls Head Reach often require emergency dredging outside of the regular scheduled dredging efforts, causing delays to vessels

PURPOSE OF STUDY

This is a single purpose navigation study to increase efficiency of existing tanker vessels. Due to the prior authorization, this study is a general reevaluation report to verify that the authorized project is still economically justified and in the Federal interest to cost share for construction. In concert with Federal law, this report also integrates an environmental impact statement (under the National Environmental Policy Act, or NEPA) and under California state law, an environmental impact report (under the California Environmental Quality Act, or CEQA).

PLAN FORMULATION

PROJECT OBJECTIVES

1) Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area
2) Maximize beneficial reuse of dredged material while minimizing placement costs
3) Reduce frequent of O&M dredging in high shoaling areas

PROJECT CONSTRAINTS

1) Avoid adverse impacts on species of special concern
2) Avoid impacts to water quality and water supply

NON-STRUCTURAL MEASURES

- Congestion Fees
- Intermodal Transportation systems
- Light loading
- Use of tides
- Traffic Management
- Pipeline
- Relocate Port Facilities

STRUCTURAL MEASURES

- Incremental depths of 36 to 43 feet MLLW
- Beneficial use of dredge material
- Sediment trap at Bulls Head Reach

Both non-structural and structural measures, as well as the no-action plan, were considered during plan formulation; however, the non-structural measures were all screened from further analysis since they are either already being done, do not meet project objectives, or are not supported by the non-federal sponsor. Analysis of depth alternatives were considered from 36 to 45 feet MLLW to arrive at the final array of alternatives, including beneficial use placement of dredge material and a sediment trap. Depths greater than 38 feet were ultimately screened out due to concerns about salinity intrusion. The final array included the 37 foot and 38-foot deepening alternatives, with sediment traps and beneficial use placement. The 38-foot deepening alternative, with associated features, had the highest net benefits and tentatively selected as the National Economic Development (NED) Plan (plan with reasonably maximizes benefits while protecting or minimizing impacts to the environment.

ECONOMICS

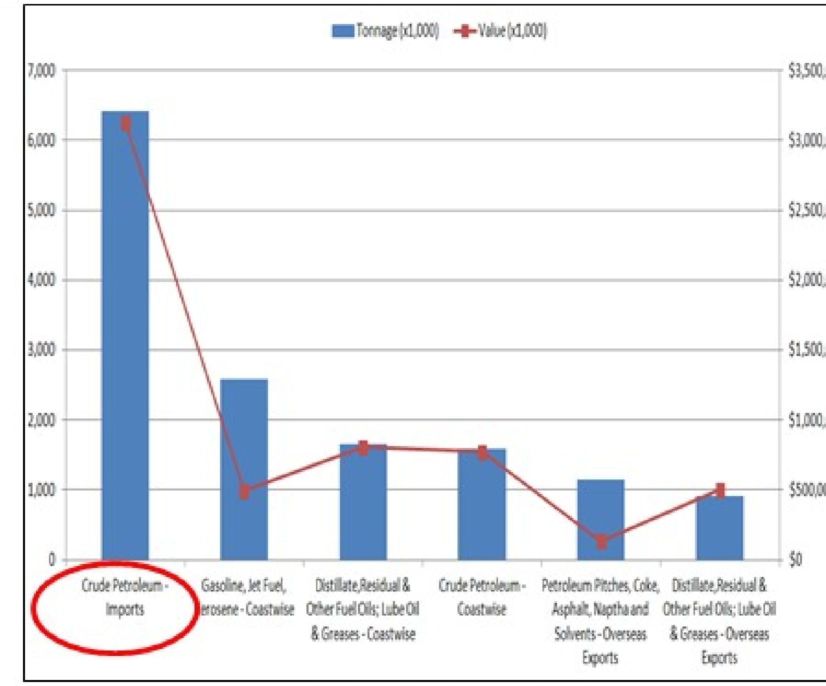
TRANSPORTATION COST SAVINGS

- Increased cargo vessel efficiency
  - Existing fleet of Panamax vessels will be able load more fully

BENEFITING VESSELS/DESIGN VESSEL

- DESIGN VESSEL - Panamax Tankers – 45 ft draft – represents more than 50% of vessels – benefits from project
- Aframax and Suezmax – 57 ft draft – visit other ports before visiting lightloaded – would not benefit

Benefiting vessels – 45 foot draft Panamax Tankers



Main commodity – Crude Oil

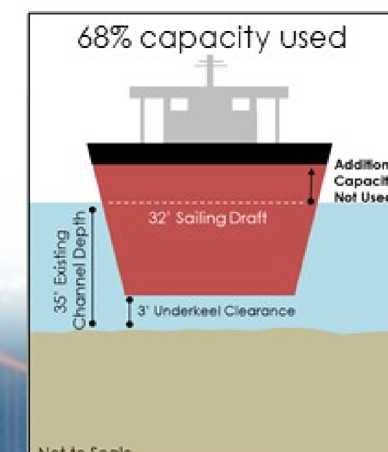
California residents ultimately use this product for motor oil, fuel for thermal power, and liquefied petroleum gas.

LIGHT-LOADING: Vessels can not use all available design cargo space, leading to more frequent trips, which translates to higher transportation costs.

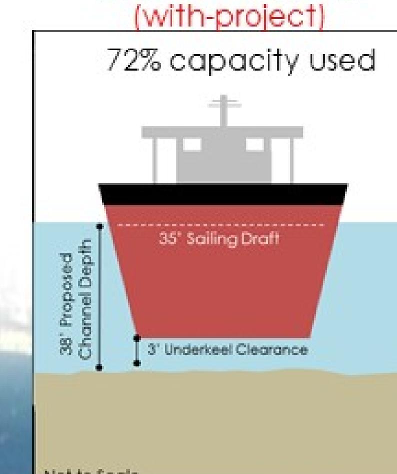
TSP BENEFITS

- More efficient use of vessels = savings of $10M annually
- Sediment trap to avoid frequent dredging of high shoaling area = stand alone savings of $680K annually
- This project will reduce the number of vessel transits by allowing current vessels to carry more goods per trip.
- Vessel fleet won't be changing as a result of this project - Same size vessels bringing in more goods at less cost.
- Benefit to Cost ratio = 3.7 to 1

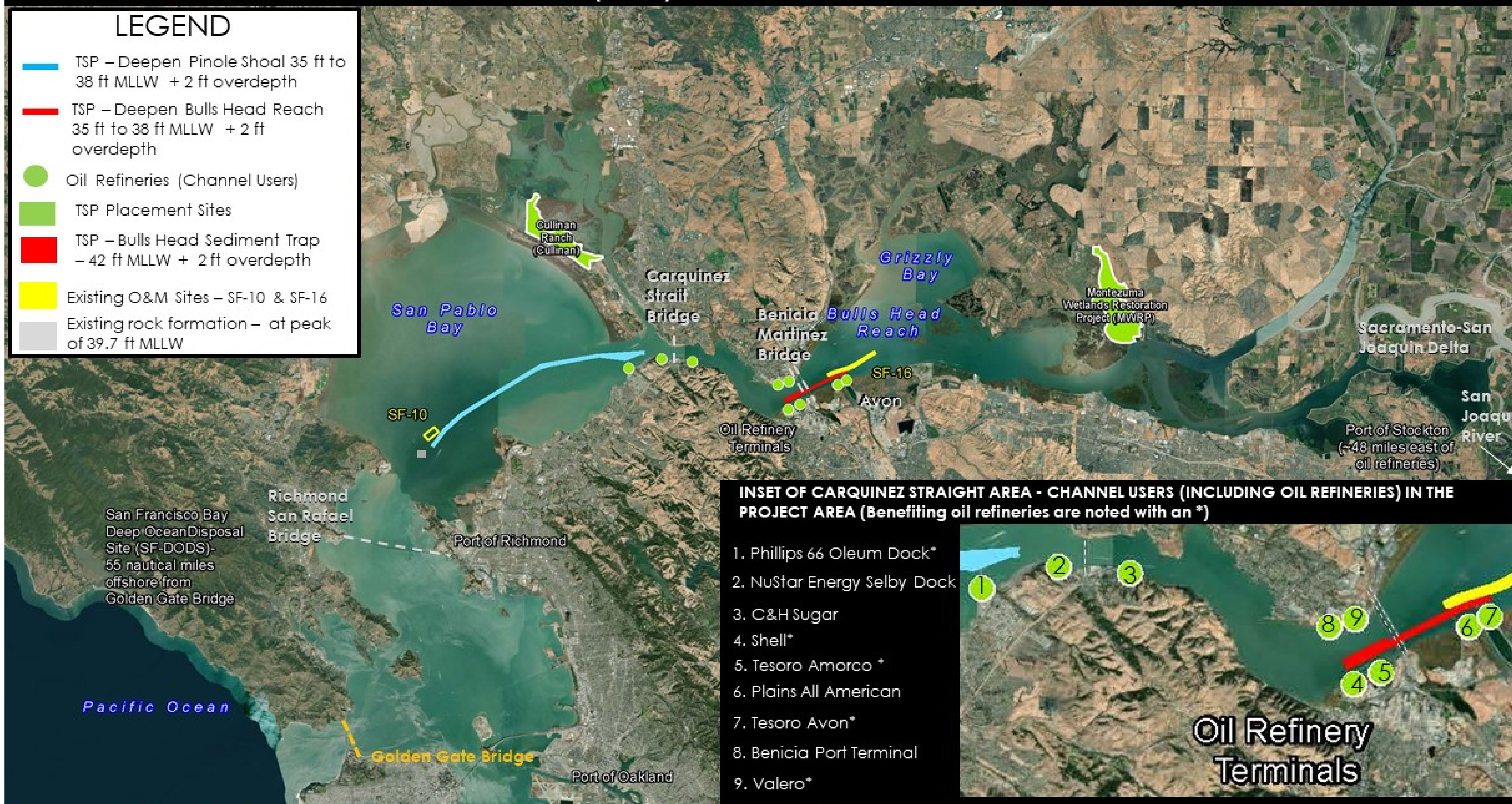
Existing Conditions



Future Conditions (with-project)



TENTATIVELY SELECTED PLAN (TSP) - SAN FRANCISCO BAY TO STOCKTON NAVIGATION IMPROVEMENT



TENTATIVELY SELECTED PLAN SUMMARY– 38-foot depth with sediment trap & rock outcropping removal

CHANNEL DEEPENING

- Deepen from 35 feet to 38 feet MLLW + 2 ft overdepth in two channels:
  - TOTAL PROJECT LENGTH = 13.2 miles
  - (PSC): 10.3 miles; STA 0+00 to 547+00, Width=600 feet
  - (BHR): 2.9 miles, STA 0+00 to 62+00 and 88+00 to 150+00

BULLS HEAD SEDIMENT TRAP

- Dredge trap to 42 feet MLLW+ 2 ft overdepth
- Length = 2,600 feet; STA 62+00 to 88+00
- Width = 300 feet

ROCK OUTCROPPING REMOVAL

- Dredge to 43 ft MLLW (via pneumatic jack-hammer)

VOLUMES AND CONSTRUCTION DURATION

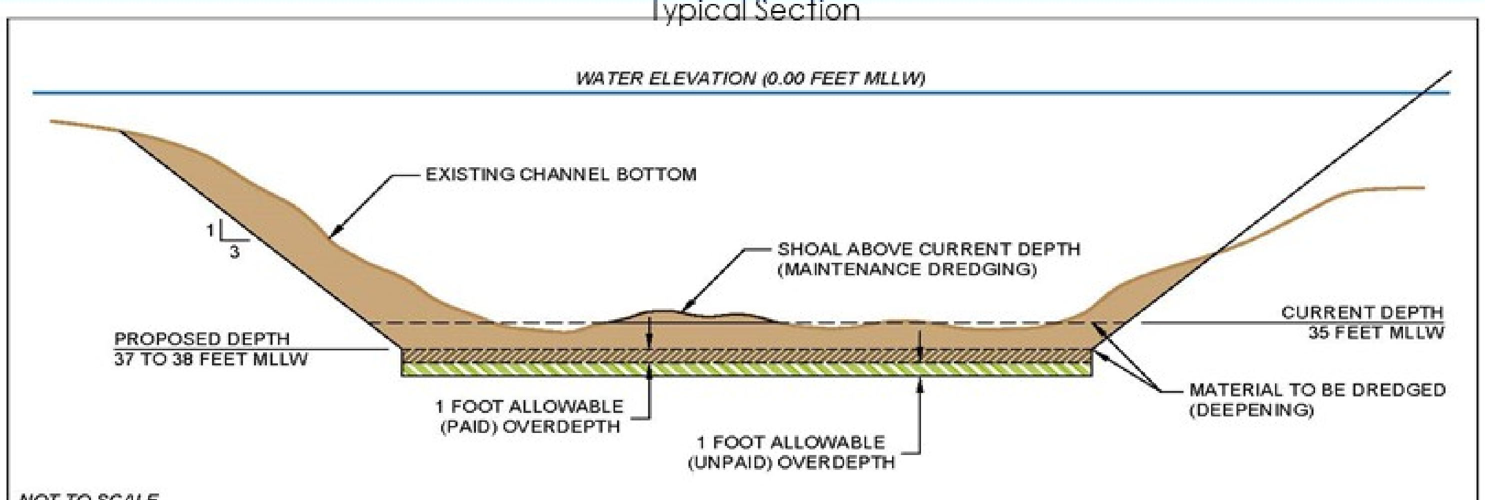
- TOTAL APPROX. PROJECT VOLUME = 1,603,200 cy
- Pinole Shoal = 1,443,900 cy
- Bulls Head Reach Channel = 38,700 cy
- Bulls Head Sediment Trap & Overdepth 2 ft = 120,600 cy
- Rock Outcropping = 40 cy rock(950 sq. ft)

PLACEMENT SITES & ASSUMPTIONS

- Pinole Shoal Channel – Cullinan Ranch
- Bulls Head Reach– Montezuma Wetland
- O&M – SF-10 and SF-16 (Federal standard)
- SF-DODS – not assumed for placement but a backup site if needed

Pinole Shoal Channel (PSC); Bulls Head Reach (BHR); Bulls Head Sediment Trap (BHST)

Typical Section



OPERATIONS & MAINTENANCE

EXISTING (historical)

- Pinole Shoal Channel = 255,000 cy/2 years (hopper)
- Bulls Head Reach Channel = 25,000 cy/year (clamshell)
- Bulls Head Reach Advance Maintenance Area= Annual dredging to 37 feet MLLW + 2 feet overdepth

FUTURE WITH PROJECT

- Pinole Shoal = 351,800 cy/2 years (hopper)
- Bulls Head Reach Channel= 47,500 cy/year (clamshell)
- Bulls Head Reach Sediment Trap = 8,900 cy/year (average) and would be dredged twice every three years

The sediment trap would save $1M for mob/demob costs once every 3 years, providing an average equivalent savings of $680,000 to the Federal O&M program per year over 50 years. The net present value of savings is $18 million. The initial investment will pay for itself 2 years after construction is complete.

BENEFICIAL USE OF MATERIAL:

- Beneficial use of material in permitted sites Montezuma and Cullinan will offset benthic foraging habitat and residual impacts

ENVIRONMENTAL WORK WINDOWS:

- PSC- June 1 to November 30.
- BHR -August 1 to November 30.

1 Introduction

1 INTRODUCTION*

ᢀ⓪ᢁ Please refer to Graphic Executive Summary Pages 1 and 2.

1.1 FEDERAL PROJECT PURPOSE*

The Federal interest in navigation is established by the Commerce Clause of the U.S. Constitution. The project purpose is to provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems to contribute to national economic development (NED), for movement of commerce, national security, and recreation.

1.2 STUDY BACKGROUND AND LOCATION*

The San Francisco Bay to Stockton Navigation Improvement Project was originally authorized by Congress in the Rivers and Harbors (R&H) Act of 1965. The authorization allowed for 45 foot channel depths, but the channels were only constructed and maintained to -35 feet MLLW. This report is an interim response to the study authority.

The study was originally scoped for a 78-mile long navigation project to include the John F. Baldwin and Stockton channels, but was re-scoped in 2016 to only include improvements to Avon. The re-scoped study area is a 13.2 mile length which spans from Central San Francisco Bay to Avon; just east of the Benicia-Martinez Bridge, and includes the Pinole Shoal Channel and the Bulls Head Reach portion of the Suisun Bay Channel. The channels in the study area primarily serve crude oil imports and refined product exports to and from several oil refineries and two non-petroleum industries.

1.3 STUDY SPONSOR

USACE is responsible for preparing the General Reevaluation Report (GRR) and is the lead Federal agency for NEPA compliance. The Port of Stockton is the official non-Federal partner for the GRR.

1.4 STUDY PURPOSE, NEED AND SIGNIFICANCE

The navigation channels within the study area are regionally significant, providing navigation access to ports, harbors, refineries, and military terminals from San Francisco Bay through San Pablo and Suisun bays and up the Sacramento-San Joaquin Delta and the San Joaquin River to the Port of Stockton.

The bays and delta through which the navigation channels cross are naturally shallow. Over time, channel deepening of the natural waterways and regular maintenance dredging has facilitated modern vessels to traverse the channels. The modern vessels crossing the channels can require up to 55 feet of draft when fully loaded. Given that these channels are maintained at -35 feet MLLW, most vessels must be "light-loaded", or less than fully loaded with cargo, to navigate the channels with sufficient under-keel clearance. Light-loading increases the cost of transportation and, in turn, the cost of the shipped products because more trips must be made to carry the same volume of cargo. Within the study area, tankers carrying crude oil to California oil refineries and those exporting petroleum are most impacted by light-loading practices.

According to the California Energy Commission, Californians consume nearly 44 million gallons of gasoline and 10 million gallons of diesel every day. California refineries produce these fuels and other products from crude oil and blending components. Transportation fuel production in California depends on the availability and quality of the crude oils used by refineries in the state. The supply of crude oil to California refineries has changed substantially in the last 10 years. Most notably, receipts of foreign crude oil have increased as production sources from California and Alaska have continued to decline. Each day approximately two million barrels (a barrel is equal to 42 U.S. gallons) of petroleum are processed into a variety of products, with gasoline representing about half of the total product volume. To comply with Federal and state regulations, California refiners invested approximately $5.8 billion to upgrade their facilities to produce cleaner fuels, including reformulated gasoline and low-sulfur diesel fuel.

According to data from the Waterborne Commerce Statistics Center, 20 million to 27 million tons of commodities moved through the Carquinez Strait annually between 2005 and 2013. In terms of both tonnage and value, the most important commodity moved through the strait is crude oil. Most of the crude oil moving through the channel is imported from foreign countries, although a small percentage of crude comes from domestic sources. This analysis focuses on the main oil refineries that import crude oil and export petroleum products. According to the Annual Energy Outlook (2015), the growth rate for crude oil imports is an annual rate of 0.3% and petroleum and other liquid exports have an annual rate of 2.4%.

In order to maintain safety, the San Francisco Bar Pilots employ under-keel clearance of 3 feet for tankers and use of high tide, when appropriate, for vessels fully loaded. It is a 5 hour transit from the entrance channel to refineries.

Given the constraints posed by existing channel depths, inefficient strategies that are currently employed to manage these constraints include:

- Vessels must light-load cargo
- Vessels must wait for favorable (high) tides which increases transportation costs
- High shoaling rates in Bulls Head Reach require dredging annually, incurring large mobilization and demobilization costs and causing delays to vessels when dredging is postponed.

The Federal objective defining Federal interest in channel improvements is to reasonably maximize net benefits to the nation. Project specific objectives include:

- Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020
- Objective 2: Maximize the beneficial reuse of dredged material while minimizing placement costs
- Objective 3: Reduce the frequency of operation and maintenance dredging in high shoaling areas

1.5 STUDY AUTHORITIES

- **1960 Rivers and Harbors Act, Pub.L. No. 86-845, Section 107, 84 State. 1818.** Authorizes the development and construction of small river and harbor improvement projects which will result in substantial benefits to navigation. This authorization facilitated the development and construction of a twenty-five (25) feet deep channel from Martinez to Avon.

- **1965 Rivers and Harbors Act, House Document 208, House Report 89-973 cited in Rivers and Harbors Act of 1965, Pub.L. No. 89-298, Section 301, 79 Stat. 1073.** Authorizes works of improvement of rivers and harbors and other waterways for navigation. This authority permits repair and restoration of works for wavewash protection within the limits of the modified San Joaquin River navigation project. This lead to the modification of five existing projects:
  - San Francisco Harbor, Bar Channel – deepen to 55' [*completed 1974]*
  - Richmond Harbor, Richmond Channel, and maneuvering area – construct new 45' deep, 600'wide channel; deepen maneuvering area (Richmond Long Wharf) to 45' [*completed 1986]*
  - San Pablo Bay, Mare Island Strait – deepen to 45' Pinole Shoal Channel and maneuvering area at Oleum
  - Suisun Bay – deepen to 45' up to Chipps Island, and to 35' beyond, widen to 600' upstream to Middle Point and to 400' beyond
  - San Joaquin River – deepen to 35' and realign the channel; place rock revetment on levees bordering Stockton Deep Water Channel; provide public recreation along improved channel [*deepening completed 1988]*
  - Vicinity of Antioch – provide a 35' channel access and turning basin to accommodate a potential harbor

- **Energy and Water Development Appropriations Act, 1998**. The Act appropriated funds to the Department of the Army, under the supervision of the Chief of Engineers, for authorized civil functions of the U.S. Army Corps of Engineers. Included in this authorization was the expenditure of funds necessary for the study and restudy of authorized projects and the "preservation, operation, maintenance and care of existing river and harbor, flood control, and related works," As such, USACE expended $100,000 to initiate a reconnaissance study on deepening the Stockton DWSC to -40-feet MLLW. USACE also expended $250,000 to complete the environmental review and continue preconstruction engineering and design for deepening the John F. Baldwin Ship Channel.

- **July 30, 2014, Resolution of the U.S. Senate Committee on Environment and Public Works.** The 2014 resolution provided authorization to study the San Francisco Bay to the Port of Stockton channels "in the interest of navigation, ecosystem restoration, flood risk reduction, recreation, and other water related resources purposes."

1.6 RELATED DOCUMENTS*

Numerous reports have been prepared in response to the Rivers and Harbors Act (RHA) of 1965 authorization:

- ***Final Environmental Impact Statement (EIS), Bank Protection, Filed with the Council on Environmental Quality on 11 October 1971.*** This document addressed impacts of the Venice Island to Stockton bank protection.

- ***San Francisco Bay to Stockton, California (Levee Setback***), ***Interim GDM (No. 3), U.S. Army Corps of Engineers*****, Sacramento District, June 1969 (approved 6 January 1970).** This document discussed the design and cost for construction of levees on a setback alignment at four locations between Venice Island and Stockton where channel excavation was within 50 feet of the toe of the existing levees.

- ***San Francisco Bay to Stockton, California (San Francisco Bar), Interim GDM (No. 4) and Final EIS, U.S. Army Corps of Engineers, San Francisco District, March 1971 (approved 17 August 1971).*** This document discussed the design, costs, construction methods, and environmental impacts of deepening the channel across the bar to -55 feet MLLW. Construction was completed in February 1974.

- ***San Francisco Bay to Stockton, California, (John F. Baldwin Ship Channel and Stockton DWSC) Avon to Stockton. Interim GDM and EIS (No. 1), U.S. Army Corps of Engineers, Sacramento District, September 1980.*** This project deepened the deep draft channels from Avon to the Port of Stockton to -35 feet MLLW. The project was completed in 1988.

- ***San Francisco Bay to Stockton, California, Project, FINAL Interim GDM (No. 5) and EIS (John F. Baldwin Ship Channel Phase II, Richmond Harbor Approach), U.S. Army Corps of Engineers, San Francisco District, May 1984.*** Construction of the West Richmond Channel and the maneuvering area near Richmond Long Wharf was addressed in the 1984 Interim Design Report and EIS. Deepening of the Richmond Long Wharf was completed in 1986. The West Richmond Channel has not been constructed to its authorized depth of -45 feet MLLW.

- ***SF Bay to Stockton Phase III (John F. Baldwin Ship Channel) Navigation Improvement Project Final EIR/EIS, U.S. Army Corps of Engineers, San Francisco District, September 1998.*** This document only analyzed improvement of the Western Reach channels and was prepared in tandem with the 1998 General Reevaluation Report (discussed below).

- ***SF Bay to Stockton, John F. Baldwin Ship Channel Phase III Contra Costa County, California Navigation Improvement Project General Reevaluation Report, U.S. Army Corps of Engineers, San Francisco District, 1998.*** The West Richmond Channel, Pinole Shoal Channel, Carquinez Strait, and the Bulls Head Reach portion of the Suisun Bay Channel were reevaluated in the 1990s. The resulting 1998 GRR recommended implementation of a crude oil pipeline alternative as a local plan in lieu of deepening because, at the time, the deepening plan was "...essentially non-implementable… because of the severe and unresolved issues associated with salinity intrusion into the Sacramento-San Joaquin River Delta area." This proposed oil pipeline project was never implemented since it was not supported by local non-Federal interests.

1.7 FEDERAL PROJECTS & STUDIES NEAR THE STUDY AREA

- ***Final Environmental Impact Statement/Environmental Impact Report for Montezuma Wetlands Restoration Project (July 1998)*** – The purpose of the project is to combine the commercial placement of dredged materials within the restoration of a tidal wetland ecosystem. Approved cover and non-cover dredged materials taken from the San Francisco Bay Area would be used to raise the subsided land to elevations suitable for the restoration of tidal marsh and other habitats, including some seasonal wetland features.

- ***Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (2001) –*** The project area is the San Francisco Bay in California. Policy objectives of the Long Term Management Strategy (LTMS) are to identify an acceptable array of dredge material placement sites, develop management, economic, and environmental plans for these sites, implement a decision making framework for site usage, streamline permit procedures, and establish long term site monitoring.

- ***Final Environmental Impact Statement/Environmental Impact Report for Cullinan Ranch Restoration Project, Solano and Napa Counties, CA. (April 2005)*** - The U.S. Fish and Wildlife Service (Service) and the California Department of Fish and Game are proposing a restoration plan for 1,500 acres of former hayfield farm land in the San Pablo Bay. This restoration project would combine tidal salt marsh habitat for endangered species, waterfowl, water birds, and fish, as well as public access features to increase accessibility to wildlife resource values in the San Pablo Bay, while minimizing project-induced flood impacts to Highway 37. The Cullinan Ranch is managed by the Service as part of the San Pablo Bay National Wildlife Refuge.

- ***Final Environmental Impact Statement/Environmental Impact Report for South San Francisco Bay Shoreline Project (Chief's Report December 2015)*** - This project will safeguard homes and businesses along the South Bay by restoring four miles of levees, as well as some 2,800 acres of tidal marsh, along with creating access for recreation. The region's flood risk has been compounded by threats of sea level rise which has become an increasingly urgent environmental issue for the Bay Area, including in San Francisco to the north.

- ***Final Environmental Assessment/Environmental Impact Report for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay, 2015-2024 (2015) –*** Sediment accumulation in these channels can impede navigability. Maintenance dredging removes this sediment and returns the channels to regulatory depths to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for the movement of commerce, national security needs, and recreation. Therefore, USACE's purpose in this project is to continue maintenance dredging of the Federal navigation channels in San Francisco Bay consistent with the goals and adopted plans of the LTMS, while adequately protecting the environment, including listed species.

- ***Delta Islands and Levees Feasibility Study Chief's Report (December 18, 2018)*** - recommends restoration of 340 acres of intertidal marsh at Big Break, located in Contra Costa County. The recommended plan would use approximately one million cubic yards of clean dredged material for annual maintenance of the Stockton Deep Water Ship Channel over an approximately 10 year period. The California Department of Water Resources is the non-Federal sponsor. The proposed restoration area is owned by the East Bay Regional Park District.

1.8 OTHER CURRENT NON-FEDERAL STUDIES AND PROJECTS ADJACENT TO OR NEAR THE STUDY AREA

Other non-Federal studies considered throughout this report, and cumulative effects, are located in **Table 4-22. Past, Present, and Reasonably Foreseeable Future Projects.**

- ***San Francisco Bay Living Shorelines Project –*** This project is managed by the State Coastal Conservancy and is a multiple objective habitat restoration pilot project. Per the project website, "This experimental restoration project allows us to learn more about the best locations and techniques for native oyster and eelgrass restoration, to gather information about fish, invertebrate, and bird use of the reefs, and to assess whether the reefs can provide physical benefits such as reducing wave action and protecting adjacent shorelines. Oyster and eelgrass reefs were constructed at two sites in San Francisco Bay in July and August 2012 (larger and small experiment at the San Rafael Shoreline, and small experiment at Hayward near the Eden Landing Ecological Reserve)."

- ***SF Bay Water Quality Improvement Fund (SFBWQIF) projects –*** Over 30 projects are part of an EPA grant program to improve San Francisco Bay water quality. These are focused on restoring impaired waters and enhancing aquatic resources.


2
Existing and Future Without
Project Conditions

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

Keeping in mind the initial problem statement in Chapter 1, this chapter describes the existing economic, navigation, built, and natural environment in which the oil refineries and their respective vessels operate, all of which are analyzed through the National Environmental Policy Act (NEPA) regulations. This chapter provides both the existing conditions (a baseline) as well as a forecast of the "future without-project" conditions, which will provide the basis for plan formulation in Chapter 3. The "future without-project" condition is also known as the no-action alternative for the NEPA analysis. The topics in this chapter mirror the topics in Chapter 4.0, *Comparison of Environmental Effects of Alternative Plans*, where the project alternative conditions are evaluated for the natural environment.

2.1 GENERAL SETTING*

Under the existing/no action/future condition, deepening the channel would not occur and all construction-related activities would be avoided. Ships would continue to employ inefficient strategies in managing channel depth constraints when transporting commodities to existing refineries. As no sediments would be dredged from channel deepening, there would be no placement of the proposed project sediments in the wetland creation sites in the San Francisco Bay area. However, maintenance dredging would continue and emergency or advanced maintenance dredging costs would be incurred on an as needed basis, with the Federal standard placement sites continuing to be used.

2.2 NATURAL ENVIRONMENT EXISTING CONDITIONS*

The affected environment for all natural environment resources includes the Bay Area and Sacramento-San Joaquin Delta encompassing the New York Slough, Pinole Shoal, and the Bulls Head Reach portion of Suisan Bay. These areas are located within the counties of Marin, Contra Costa, and Solano. The natural environment resources described in the following sections (Section 2.2.1 through 2.2.16) are not expected to change under the future without-project condition, therefore the resource descriptions below apply to both existing and future without-project conditions (the No Action Alternative discussed in Chapter 4), with the exception of sea level rise. The timing and ability to know what changes would occur from existing conditions to the 50 year project condition with sea level rise are difficult to predict, and therefore are described together in this section.

2.2.1 GEOLOGY AND SEISMICITY

Seismicity. Several Quaternary-active faults traverse the path of the navigation channels in the San Francisco Bay/Sacramento-San Joaquin Delta, including the Hayward fault zone, and the Franklin, Southampton, Green Valley, and Vaca faults. Quaternary-active faults are those that have slipped in Quaternary time (the last 1.8 million years). These are the most likely sources of future great earthquakes. The Hayward fault zone intersects the San Pablo Bay and the Pinole Shoal Channel; the Franklin and Southampton faults intersect the Carquinez Strait; the Green Valley fault zone and Concord fault intersect Suisun Bay at the Bulls Head Reach. The Vaca fault zone extends northwest to southeast immediately northwest of Sherman Island. There are no other Quaternary faults in the study area east of Sherman Island (USGS 2015).

The U.S. Geological Survey's (USGS 2010) 2009 Probable Seismic Hazard Analysis Program indicates that there is a 90 to 100 percent probability of a greater than 5.0 magnitude earthquake occurring within 50 years and 50 kilometers of the study area from the San Francisco Bay to McDonald Island. That probability drops to 80 to 90 percent east of McDonald Island. There is a 40 to 50 percent probability of a 7.0 or greater earthquake occurring within 50 years and 50 kilometers of San Francisco Bay. The probability steadily decreases eastward from the Carquinez Strait, dropping to 0 to 10 percent for the Stockton area (USGS 2010).

The Federal Emergency Management Agency's (FEMA) Seismic Design Category ratings define the potential effects of shaking in the study area as follows:

- **D_1, D_2**: Very strong shaking—Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures, and
- **E**: Strongest shaking—Damage considerable in specially designed structures; frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Shaking intense enough to completely destroy buildings.

For the study area, shaking intensity generally declines moving eastward from San Francisco Bay, with the highest shaking potential centered on the Hayward and Green Valley fault zones and the Concorde fault (FEMA 2015).

Alquist-Priolo fault zones are present within the study area counties including Contra Costa, Marin and Solano Counties and within the cities of Richmond and Benicia. Alquist-Priolo fault zones generally occur within approximately 200 to 500 feet of major fault lines or zones. In the study area, this includes areas adjacent to the Hayward and Green Hill fault zones and the Concord fault (California Department of Conservation 1982a, 1982b, 1993)[CDC]. Alquist�Priolo fault zones are limited to land areas; delta and bay waters 21are not considered within these zones.

Seismically Induced Liquefaction. Liquefaction is a process in which saturated, loosely packed, coarse-grained soils transform from a solid to a near-liquid state as a result of seismic ground shaking. Effects of liquefaction may include slope instability, lateral spreading, loss of foundation bearing capacity, and ground settlement. It is important to distinguish between susceptibility and hazard for liquefaction. Susceptibility involves the presence of saturated sandy-to-silty Quaternary material. Hazard involves both the presence of such soils and the likelihood that they would be displaced during a particular seismic event, which may trigger liquefaction.

The Association of Bay Area Governments (ABAG) maintains comprehensive liquefaction hazard maps for the San Francisco Bay Area, including the study area from the San Francisco Bay east to Webb Tract. Liquefaction susceptibility varies within the study area, with several shoreline and nearshore areas identified as being moderately to highly susceptible to liquefaction. Areas of very high susceptibility occur scattered along the shorelines of coastal cities within the study area including Richmond, San Pablo, Pinole, Hercules, and Vallejo. Hazard maps identify delta islands as having high liquefaction potential (ABAG 2015a). East of Webb Tract, delta islands and shorelines are also identified as susceptible to liquefaction (Sacramento County 2011; San Joaquin County 2005).

Slope Failure and Landslides. Shoreline areas containing wetlands, marsh fill areas, and steep or unstable slopes—including certain levees—may be susceptible to landslides, slumping, soil slips, or rockslides.

Inland dredged material placement sites containing steep slopes may also be susceptible to landslides. Although ABAG maintains landslide hazard maps for the San Francisco Bay Area, the shoreline and most inland areas adjacent to the study area have not been evaluated (ABAG 2015b). Slope or landslide hazard areas occur along the coast of the study area, as identified in General Plans for Tiburon (2005), Richmond (2012), Pinole (2010), Solano (2008), and Contra Costa counties (2005). Underwater slope failures are also possible within the study area, although susceptible areas have not been documented.

Other Upland Geologic Hazards. In addition to liquefaction and landslides, upland areas potentially used for placement of dredge material may be susceptible to lateral spreading, subsidence, settlement, and erosion which may be caused or exacerbated by seismic activity. Unlike for liquefaction and landslides, comprehensive maps for these hazards have not been developed for the study area. Site susceptibility to these hazards is dependent upon their specific location, which has not been determined at this time.

Shoreline Erosion. Waves breaking on shore can suspend sediment and erode the shoreline. Larger waves contain more energy and have greater capacity to mobilize sediment. Deep draft vessels also produce waves as a result of the bow wave and displace water as they move. Larger, more fully loaded vessels have the potential to create larger waves when compared to smaller, lighter vessels. Shoreline erosion from vessel-induced waves is not expected to be a problem from vessels traveling in the open waters of the bays.

Delta Levees. Approximately 1,100 miles of levees and berms protect 700,000 acres of reclaimed marshland and uplands within the delta (LTMS 1998). In addition, many dredged material placement sites along the San Joaquin River contain berms or use the existing flood control levees to contain the dredged material. Levees and berms are critical infrastructure that protect agricultural lands, water supplies, upland development, and roads and railways from flooding. Delta levees also play a critical role in preventing intrusion of salty water from San Francisco Bay into the delta channels. These channels serve an integral role in the state's water transfer system, which provides water to approximately two-thirds of California's population. Adjacent landowners built and maintain the vast majority of the 1,100 miles of levees (LTMS 1998). Due to great variations in levee construction and soil types, geology, and other factors, levee conditions and maintenance requirements differ throughout the delta region.

Bay Levees. Levee failure is identified as a seismic hazard for Martinez (2015), Contra Costa (2005), and Solano Counties (2008). While failure-prone levees are not explicitly identified, landslide hazard areas identified in the general plans for the study area appear to include potentially unstable levee areas.

Tsunamis and Seiches. Seismic activity can potentially result in tsunamis or seiches, which would present a hydrological hazard. Tsunamis (seismic sea waves) are long-period waves typically caused by underwater seismic disturbances, volcanic eruptions, or submerged landslides. Tsunamis can travel across oceanic basins and cause damage several thousand miles from their sources. Low-lying coastal areas, such as tidal flats, marshlands, and former bay margins that have been artificially filled, but are still at or near sea level, are generally the most susceptible to tsunami inundation.

A seiche is caused by oscillation of the surface of an enclosed water body, such as San Francisco Bay, resulting from an earthquake or large wind event. Seiches can result in long-period waves that cause run-up; i.e. uprush on the shoreline or structures above the still water level or overtopping of adjacent landmasses, similar to tsunami run-up. The primary tsunami threat along the central California coast is from distant earthquakes along subduction zones elsewhere in the Pacific basin, including Alaska (City and County of San Francisco 2011).

The shoreline and some nearshore areas adjacent to the study area in Marin and Contra Costa Counties are within tsunami inundation areas as delineated on the State's tsunami inundation maps (California Emergency Management Agency 2009a, 2009b). Based on a tsunami wave run-up of 20 feet entering the Golden Gate, the 2009 Contra Costa Countywide Comprehensive Transportation Plan indicates that tsunami attenuation in the San Francisco Bay would diminish the height of the wave to approximately 10 feet along the Richmond shoreline. East of Point Pinole, the wave height would diminish to approximately 2 feet (Contra Costa Transportation Agency 2009). Areas east of the Benicia Bridge are not included on State tsunami inundation maps. Tsunami effects are attenuated from their source, and tsunami effects extending east of the Benicia Bridge would be further attenuated by Suisun Bay and other upstream water bodies. The most recent local and significant tsunami event occurred in March 2011, when a tsunami originating in Japan caused a swell of two feet in the Bay (NOAA 2011). The NOAA operates the tsunami warning system serving the Pacific Northwest.

2.2.2 SEDIMENT AND SEDIMENTATION

2.2.2.1 SEDIMENTATION

The temporal fluctuation of maintenance dredging volumes depends primarily on the hydrologic conditions and the sediment supply from the Sacramento-San Joaquin Delta. Recent analyses of historical dredged material volumes and modeling results have indicated that sediment supply from tributaries to the Delta can vary by a factor of four or more between wet and dry years, and this can influence shoaling rates by a factor of two at some Federal navigation channels in Central Bay (Delta Modeling Associates 2015). However, the sediment supply to the Bay has decreased significantly in recent years (Schoellhamer 2011). Many factors contribute to the decreasing sediment yield; these factors may include depletion of erodible sediment from hydraulic mining, sediment impoundment by reservoirs, and riverbank protection.

2.2.2.2 SEDIMENT CHARACTERISTICS

The sediments within San Francisco Bay originate from erosion of surrounding hills or from later marine and riverine deposits. Generally, the upper several feet of the sediment profile in San Francisco Bay consists of more recently deposited marine and riverine sediments. The thickness of various underlying historic sediment formations varies throughout the San Francisco Bay/Delta Estuary and it can be several hundred feet thick. Large areas of San Francisco Bay, particularly in shallow areas, contain the marine clay-silt deposit termed "Bay Mud" several feet beneath softer, more recently deposited muds (USACE 2015b). In some areas of San Pablo Bay, Suisun Bay, and the Delta, natural peat deposits underlay more recent San Francisco Bay sediments. Estuary channels typically contain sandy bottoms, although regions where currents are strong, including the deep channels of San Francisco Bay and the central channels of the major rivers in the Delta, generally have coarser sediments (i.e., fine sand, sand or gravel) (LTMS 1998). San Francisco Bay surficial sediments have been deposited since industrialization began in California and, therefore, may have been exposed to anthropogenic sources of pollutants. Recent sand deposits, including riverine sand or sand bars in the San Francisco Bay, may also be exposed to anthropogenic sources of pollutants but typically do not accumulate significant pollutant concentrations. Data from monitoring sediment contaminants in the Bay indicate that overall, the peripheral industrialized areas have higher mean contaminant concentrations than Bay waters away from the shoreline (LTMS 1998).

Over the years, sediment proposed for maintenance or new work dredging in the study area has undergone a significant amount of sediment sampling and analysis, including physical, chemical, and biological testing. In addition, sediment proposed for maintenance dredging from each channel has undergone sediment testing according to the Master Sediment Sampling and Analysis Plan (Master SAP), for Pinole Shoal are located: http://www.dmmosfbay.org/site/alias__8959/171100/default.aspx and for Bulls Head Reach: http://www.dmmosfbay.org/site/alias__8958/171080/default.aspx. Sediment in the study area generally has low levels of contamination and does not contribute to significant environmental risks when dredged or disposed (LTMS 1998).

Sediment testing has been conducted to determine the suitability of dredged material for placement (e.g., either in ocean or in-Bay) or for beneficial reuse for the operations and maintenance dredging, and to evaluate potential contaminant releases during dredging. The data summaries presented in this section compare historic sediment quality results from the study area to regulatory criteria established by: the San Francisco Deep Ocean Disposal Site (SF-DODS) Ambient Concentrations of Toxic Chemicals Screening Levels (SFRWQCB 1998); Dredged Material Testing Thresholds for San Francisco Bay Area Sediments (SFEI 2014); Beneficial Reuse of Dredge Materials: Sediment Screening and Testing Guidelines (SFRWQCB 2000); and ambient or reference areas. This includes regulatory criteria for in-Bay placement, ocean, wetland cover material reuse, and wetland foundation material reuse.

Sediment from the Pinole Shoal Channel and Bulls Head Reach have been characterized and dredged. Overall, sediments in the Pinole Shoal Channel and Bulls Head Reach show little contamination and pose a low level of environmental risk (Lee 2000; Word and Kohn 1991). The following subsections discuss the sediment characterization studies and results in greater detail.

2.2.2.3 DEEPENING PROJECT CHARACTERIZATION OF THE JOHN F. BALDWIN SHIP CHANNEL

From 1989 to 1994, USACE conducted extensive testing under the guidelines in Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual (USEPA/USACE 1991) of the John F. Baldwin Ship Channel sediments for a potential deepening project to -45 feet MLLW plus 2 feet of overdepth (Kohn et al. 1991; Kohn et al. 1993; Kohn et al. 1994; Word and Kohn 1990). USACE conducted Tier III testing requirements for ocean placement, which are considered to be the most stringent and protective of the environment. Tier Ill testing requires conducting chemical, toxicity, and bioaccumulation testing to evaluate the risks associated with dredging and ocean placement of sediment. The results of these investigations are summarized in the following paragraphs.

Sediment core samples were collected to a depth of -47 feet MLLW (-45 feet MLLW plus 2 feet overdepth) from three reaches of the John F. Baldwin Ship Channel (West Richmond Reach, Pinole Shoal, and Carquinez Strait) in 1990. In the absence of a designated placement site at the time of the study, reference sediments representing two potential placement sites (one ocean site and one in-Bay site) were tested concurrently. While the study was in progress, the USEPA was in the process of designating SF-DODS, which was referred to as the Deep Off-Shelf reference site at that time. Therefore, the John F. Baldwin Ship Channel sediment data was compared to that reference data. Comparisons included biological responses of aquatic organisms to sediment exposure such as survival and contaminant bioaccumulation, as well as the sediment's physical, geological, and chemical characteristics.

All sediment samples were analyzed for conventional sediment measurements (grain size, total organic carbon, total volatile solids, percent solids, oil and grease, and total petroleum hydrocarbons), polycyclic aromatic hydrocarbons (PAHs), metals, and butyltins. Sediment composites and reference sediments for biological testing were also analyzed for chlorinated pesticides and polychlorinated biphenyls (PCBs). The bioaccumulation tissue samples were analyzed for PAHs, metals, and butyltins.

Water column tests showed there was no acute toxicity. The solid-phase tests of John F. Baldwin Ship Channel sediments showed no acute toxicity to *M. nasuta*, *N. caecoides*, or *R. abronius* relative to the Deep Off-Shelf reference site. However, sediment from Pinole Shoal Channel resulted in significant decrease in normal development of echinoderm larvae. The bioaccumulation testing results revealed that nine measured compounds for which action limits are established in tissues did not exceed Food and Drug Administration (FDA) action limits. However, significant bioaccumulation of the pesticide 4,4'-DDD was measured in organisms exposed to Pinole Shoal Channel sediment relative to the reference site. Four PAH compounds and tributyltin also significantly bioaccumulated in organisms exposed to Pinole Shoal Channel sediment relative to the reference site.

Based on the results of this study, proposed dredged material from John F. Baldwin Ship Channel met the deposited sediment toxicity (benthic bioassay) criteria for ocean placement, but some water column and bioaccumulation effects were observed.

Additional testing was conducted in 2000 on sediment to a depth of -47 feet MLLW from the West Richmond Channel and Pinole Shoal Channel to evaluate the suitability of dredged material for wetland beneficial reuse (Lee 2000). The test resulted in high levels of Chromium, however, the test results indicated that wetland creation using the tested sediment would create wetlands comparable to existing wetlands in the San Francisco Bay Area. Wetland plants and animals would contain contaminant levels similar to those of existing wetlands. Restrictions on the use of the tested sediment for wetland creation was not required at the time.

More recent material was tested from dredging the Pinole Shoal and Bulls Head Reach channels in 2009. The 2009 sampling at Suisun (Suisun Bay Channel New Your Slough SAR 2009 Jul.pdf) included some overdepth sampling at Bulls Head Shoal (-37 to -39 feet). The samples were not analyzed for total solids content of metals, instead they were tested for elutriate concentrations which are reported in ug/L instead of mg/Kg (dissolved metals in solution) for comparison with drinking water standards, leaching standards and RWQCB standards to determine suitability for in water placement and upland placement instead of wetland placement.

Based on the 2009 sampling results, it appears the material would be acceptable for in water placement and upland placement. There were no other non-maintenance event sampling reports available in USACE records. The 1990 samples in Suisun Bay showed chromium concentrations that exceed 250 mg/Kg, however, based other nearby sediment samples, dredge material from -38 to -40 feet may be suitable for wetland cover, while depths below that may exceed criteria for wetland cover but could possibly meet the criteria for use as foundation material in the wetland placement sites. The Bulls Head Reach sediment trap will be dredged deeper and this material may have higher concentrations of chromium. The sediment trap portion of new work material amounts to approximately 100,000 cubic yards. Testing of new work material will be done during the PED phase to determine its suitability for marsh placement (foundation or cover material) or alternative non-marsh placement.

The 2009 sediment testing data for Pinole Shoal from initial dredging for sample testing of -37 to -39 feet resulted in Chromium concentrations range from 51 to 61 mg/kg. The threshold criteria for wetland placement at surface is 112 mg/kg. Therefore, the material would be suitable for cover or wetland placement at the beneficial reuse sites. Confirmatory testing will be completed prior to placement at the reuse sites.

2.2.3 WATER QUALITY AND HYDROLOGY

The study area encompasses the waters of Central San Francisco Bay, San Pablo Bay, and Suisun Bay, and the lower Sacramento/San Joaquin Delta. **Figure 2-1**Figure 2-4. shows a map of the lower Sacramento and San Joaquin River basins which contribute freshwater flows that pass through Suisun Bay into San Francisco Bay.

Figure 2-1. Map of Sacramento and San Joaquin River Basins upstream of Suisun Bay (USGS, 2015). https://ca.water.usgs.gov/projects/2015-17.html)

Most of the precipitation in the study area falls as rain during winter and spring, which enters the Sacramento/San Joaquin Delta through surface water runoff and riverine flow. Precipitation varies significantly from year to year. Water years (WYs) are used to designate the differences in precipitation between years. Water years in California span the 12-month period between October 1 and September 30 (e.g., WY2014 spans from October 1, 2013 to September 30, 2014). This designation allows for all precipitation over the "wet season" (typically December through March) to be included in a single year. Water years are classified into five categories (e.g., critical (driest), dry, below normal, above normal, and wet (wettest)) based on inflows to the Delta. These are used to calculate Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices. The frequency of each WY type based on the Sacramento Valley Water Year Hydrologic Classification for the 109-year period of record between WY1906 and WY2014 is as follows:

- Critical (Driest) WY 13.8 percent occurrence over 109-year record
- Dry WY 21.1 percent occurrence over 109-year record
- Below Normal WY 18.3 percent occurrence over 109-year record
- Above Normal WY 13.8 percent occurrence over 109-year record
- Wet (Wettest)WY 33.0 percent occurrence over 109-year record

Delta inflows, exports and outflows can vary significantly between critical and wet water years. WY2014 was designated as a critical water year (California Department of Water Resources 2016) [CDWR], the driest classification category. Baseline conditions during and following a critical year were established for the 1-year period spanning January 1, 2014, through December 31, 2014. This period spans winter and spring period during a critical WY, followed by the fall period between October 1 and December 31 of the subsequent WY.

Figure 2-3. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2014 (Critical Year) Historic Conditions.

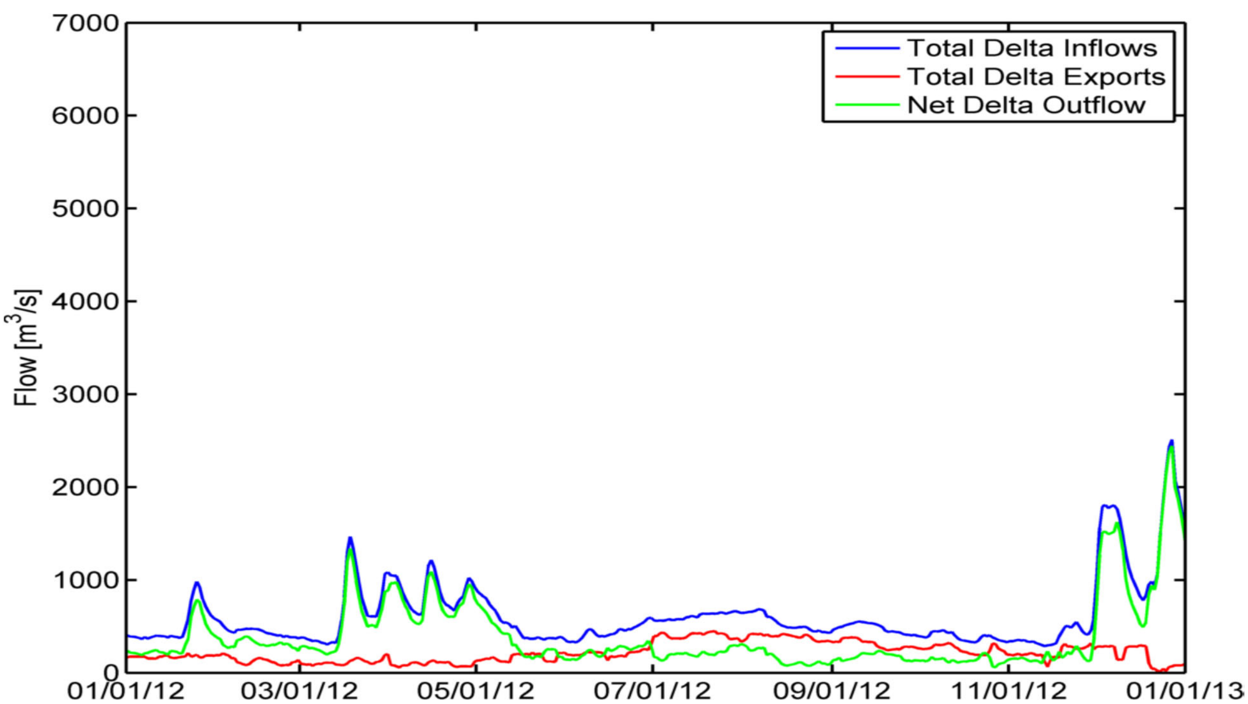


Figure 2-4: Shows the total delta exports (blue) and inflows (red), and the net delta outflow (green) during 2014. During this entire period, both Delta inflow and Delta outflow was extremely low.

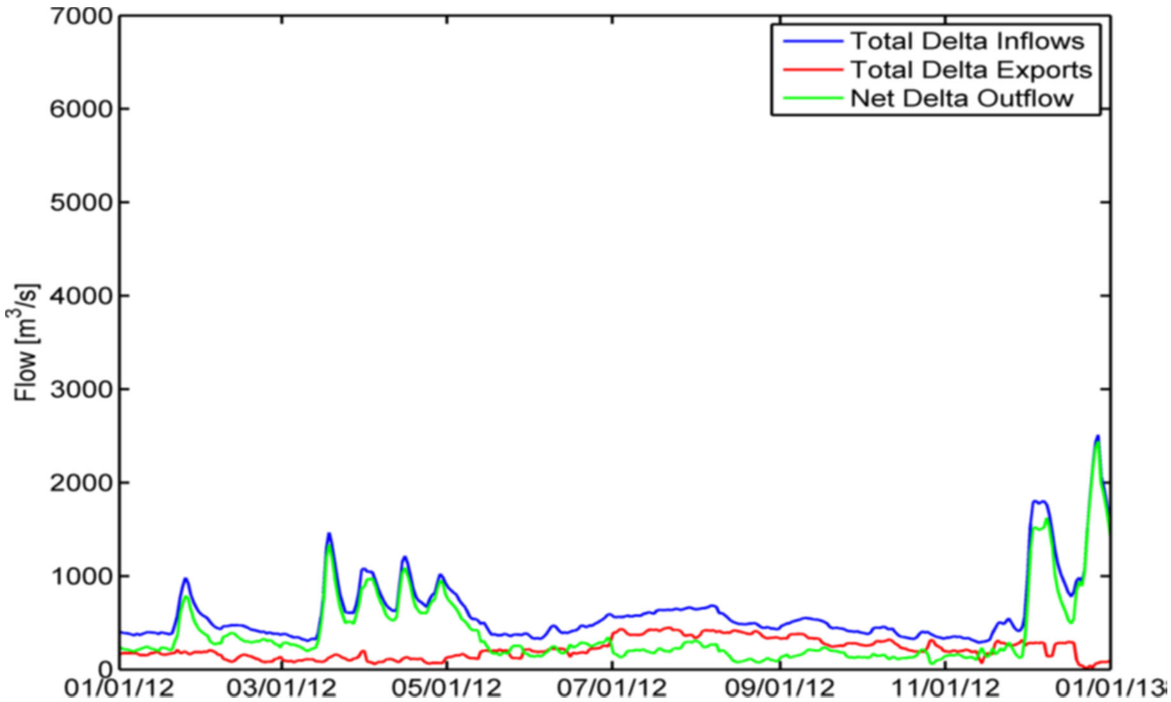


Figure 2-2. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2014 (Critical Year) Historic Conditions.

WY2012 was designated as a below normal year (CDWR 2016). The conditions during and following the below normal WY for the 1-year period spanning from January 1, 2012, through December 31, 2012, show that during this period monthly flows were below average for most of the water year. **Figure 2-4** shows the total delta exports (blue) and inflows (red), and the net delta outflow (green) during 2012.

In contrast, WY2011 was designated as a wet WY (CDWR 2016), the wettest classification category. The conditions during and following a wet WY for the 1-year period spanning from January 1, 2011, through December 31, 2011, show that during this entire period, both Delta inflow and Delta outflow were significantly higher throughout the wet WY (**Figure 2-5**) than during the below normal WY (**Figure 2-4**) or the critical WY (**Figure 2-3**).

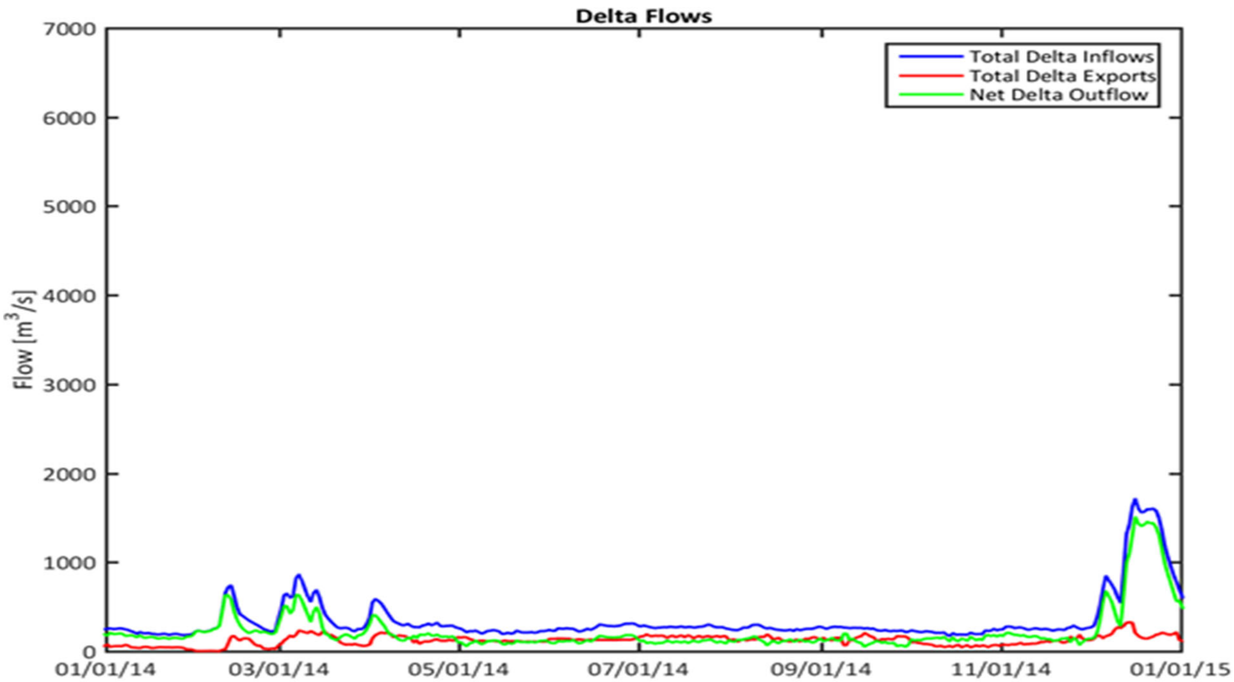


Figure 2-3. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2014 (Critical Year) Historic Conditions.

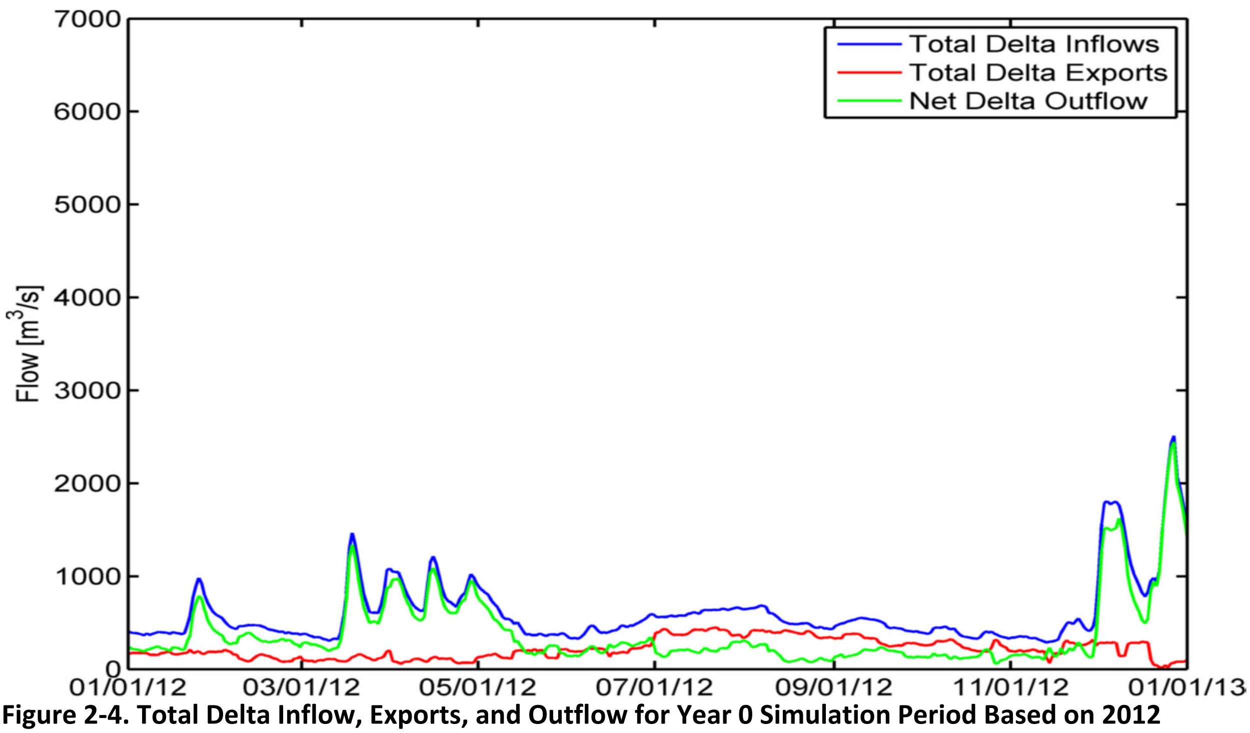


Figure 2-4. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2012 (Below Normal Year) Historic Conditions.

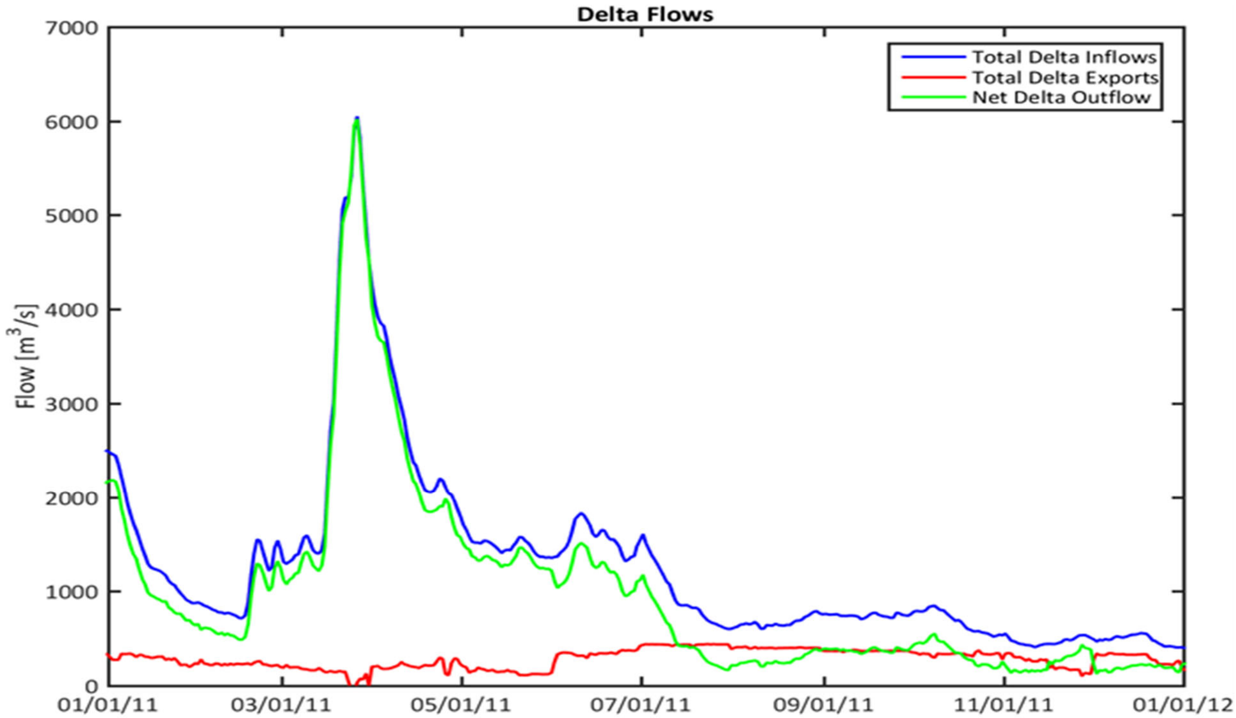


Figure 2-5. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2011 Historic Conditions Classified as a Wet (Wettest) Water Year.

2.2.3.1 REGIONAL HYDRODYNAMICS

The San Francisco Estuary is bathymetrically and hydrodynamically complex. Freshwater, sediment, nutrients, and pollutants are carried to the estuary by river flow. The largest sources of freshwater to the estuary are the Sacramento and the San Joaquin Rivers. Historically, the Delta was characterized by tidal wetlands and interweaving water channels. However, this original wetland landscape was diked, drained, and converted into islands surrounded by levees.

The mixing of this freshwater with the salt water from the Pacific Ocean results in an estuary-wide horizontal salinity gradient, with salinity varying from full marine conditions (more than 30 practical salinity units [psu]) near the Golden Gate Bridge to freshwater conditions (less than 0.1 psu) in the Sacramento River (The Bay Institute 1998; CALFED 2000a). However, there is a net westward water flow from the Delta through the San Francisco Bay resulting from the net freshwater outflow from the Delta. Inflows into the Delta are controlled by upstream dams and reservoirs, which restrain peak flows in the winter and spring for flood control and storage, and release water in the summer and fall to meet agricultural and municipal demands—both for exports to interaction of the semidiurnal tides with a complicated bathymetry (Cheng and Gartner 1984). During flood tides, the water flows into the San Francisco Bay and the Delta, and the water level increases and higher salinity travels upstream. During ebb tides, the river water flows out of the Delta and freshwater pushes saline water into the Bay.

As the precipitation-induced channel inflows increase in the winter months, flows in some Delta channels can become one-directional (i.e., downstream). During this period, the tidal influence is minimal and overshadowed by precipitation-induced channel inflows. During the summer months, the flow patterns more closely correspond with the flood/ebb tidal cycles because net inflows to the Delta and San Francisco Bay tend to be lower during the summer months.

Delta water users including the U.S. Bureau of Reclamation's Central Valley Project, the CDWRs' State Water Project, as well as other agricultural and municipal water users have adapted their water supply systems to the daily, seasonal, and inter-annual variations that occur in delta water availability. Designated beneficial uses of water for this area are presented in **Table 2-1**.

2.2.3.2 TIDAL HYDRAULICS

Astronomical tides in the study area are characterized as having a mixed semidiurnal tidal cycle, which means that the area experiences two high tides and two low tides of unequal height each lunar day. **Table 2-2** presents the mean and diurnal ranges at NOAA tidal gauge locations within the study area. The San Francisco, Richmond, and Martinez-Amorco Pier NOAA stations are located within the study area, while the Port Chicago station is outside of the study area (east). Tidal range increases from the San Francisco NOAA station into Central and South San Francisco Bays, and decreases moving west through San Pablo and Suisun Bays.

Table 2-1. Study Area Beneficial Uses Designation.

Water body	Designated Beneficial Reuse													
	AGR	MUN	IND	PROC	COMM	SHELL	FRESH	EST	MIGR	RARE	SPWN	WILD	REC-1	REC-2	NAV
Bulls Head Reach			E		E	E		E	E	E	E	E	E	E	E
West Richmond Channel			E	E	E	E		E	E	E	E	E	E	E	E
Pinole Shoal Channel			E	E	E			E	E	E	E	E	E	E	E

Notes:AGR - Agricultural Supply
COMM - Commercial and Sport Fishing
E - Existing Beneficial Use
EST - Estuarine Habitat
FRESH - Freshwater Habitat
IND - Industrial Service Supply
MIGR - Fish Migration
MUN - Municipal and Domestic Supply
NAV - Navigation
PROC - Industrial Process Supply
RARE - Preservation of Rare and Endangered Species
REC1 - Water Contact Recreation
REC2 - Noncontact Water Recreation
SHELL - Shellfish Harvesting
SPWN - Fish Spawning
WILD - Wildlife Habitat

Table 2-2. Tidal Ranges at NOAA Stations within the Study Area.

NOAA Station Location	NOAA Station Identification No.	Mean Tidal Range (feet)	Diurnal Range (feet)
San Francisco	9414290	4.09	5.84
Richmond	9414863	4.32	6.06
Martinez-Amorco Pier	9415012	3.93	5.31

Source: NOAA 2015.

2.2.3.3 SALINITY AND WATER SUPPLY

Salinity is a long-standing management concern in the Delta, since increased salt concentrations can adversely affect municipal, agricultural, and industrial water supplies, as well as aquatic habitat conditions. Salinity levels are influenced by tidal cycles, freshwater inflow, water intakes and exports, and agricultural diversions and return flows in the Delta. "Exports" divert water for use outside the legal boundary of the Delta. The two primary Delta exporters are the State Water Project and the Central Valley Project, which are located in the south Delta (see **Figure 2-6**). Delta water "intakes" divert water for use within the legal boundary of the Delta. Intakes in the study area include in-Delta diversions for agricultural use and Contra Costa Water District (CCWD) intakes at Rock Slough, Old River, and Middle River at Victoria Canal (see **Figure 2-6**). Consideration of salinity levels is critical for supporting municipal, agricultural, and industrial uses, as well as maintaining habitable conditions for fish and wildlife.

The abundance or survival of several estuarine biological populations in the San Francisco Estuary have historically been positively correlated with freshwater flow, as indexed by the position of the ***daily-averaged 2 psu isohaline near the bed***, (i.e., bottom) or **X2** (Jassby et al. 1995; Kimmerer et al. 2009; Kimmerer et al. 2013) as measured in kilometers from the Golden Gate Bridge as shown in **Figure 2-7**. In 1995, the State Water Resources Control Board (SWRCB) adopted X2 as a water quality standard to help restore the relationship between springtime precipitation and the geographic location and extent of estuarine habitat.

Water Rights Decision 1641 D-1641 (SWRCB 2000) requires that freshwater inflows to the Bay be sufficient to maintain X2 at specific locations for specific numbers of days each month during the spring (February through June). The objective of this "Spring X2" requirement is to help restore the relationship between springtime precipitation and the geographic location and extent of estuarine habitat. The Spring X2 requirement at Port Chicago (SWRCB 2000) applies only in months when the average electrical conductivity (EC) at Port Chicago (X2 = 64 km) during the 14 days just before the first day of the month is less than or equal to an EC measurement of 2.64 millimhos per centimeter (mmhos/cm). However, when X2 is less than 64, there are no current regulatory requirements that regulate the position of X2.

The Biological Opinion for delta smelt (*Hypomesus transpacificus*) calls for efforts to increase outflow to enlarge the area of habitat with suitable salinity (i.e., the low salinity zone) for this fish and has established X2 requirements during fall months following wet or above normal water years (USFWS 2008).

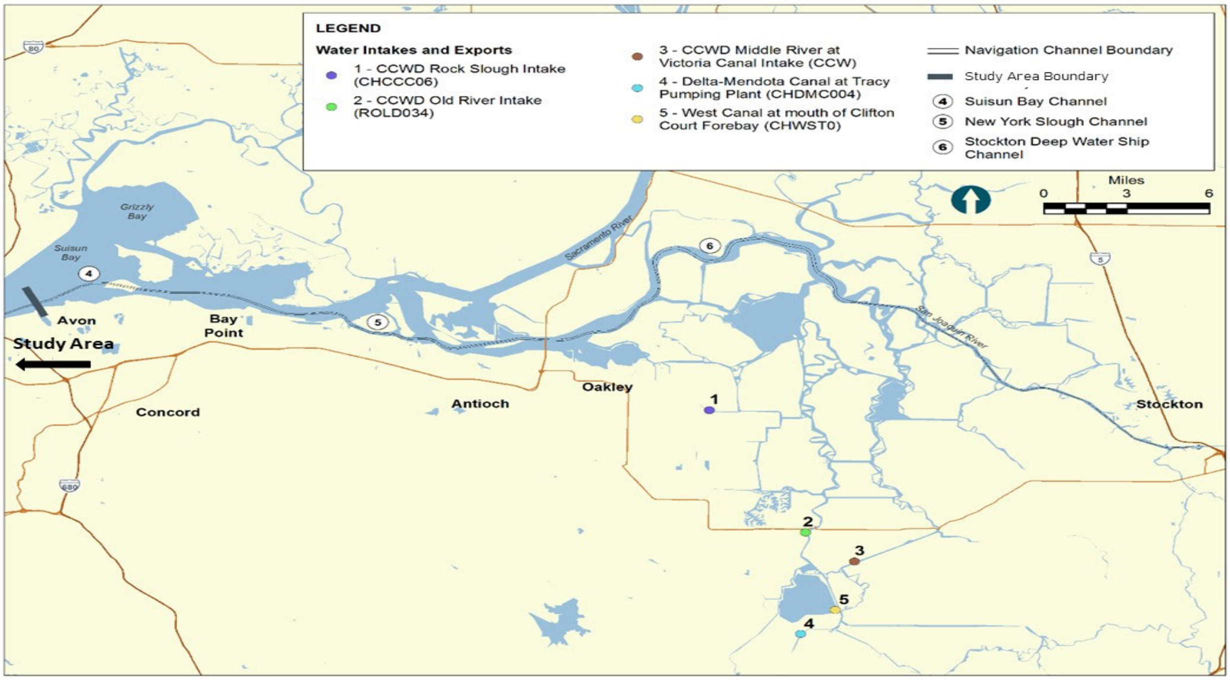


Figure 2-6. Locations of Water Intakes and Water Exports in the Delta.

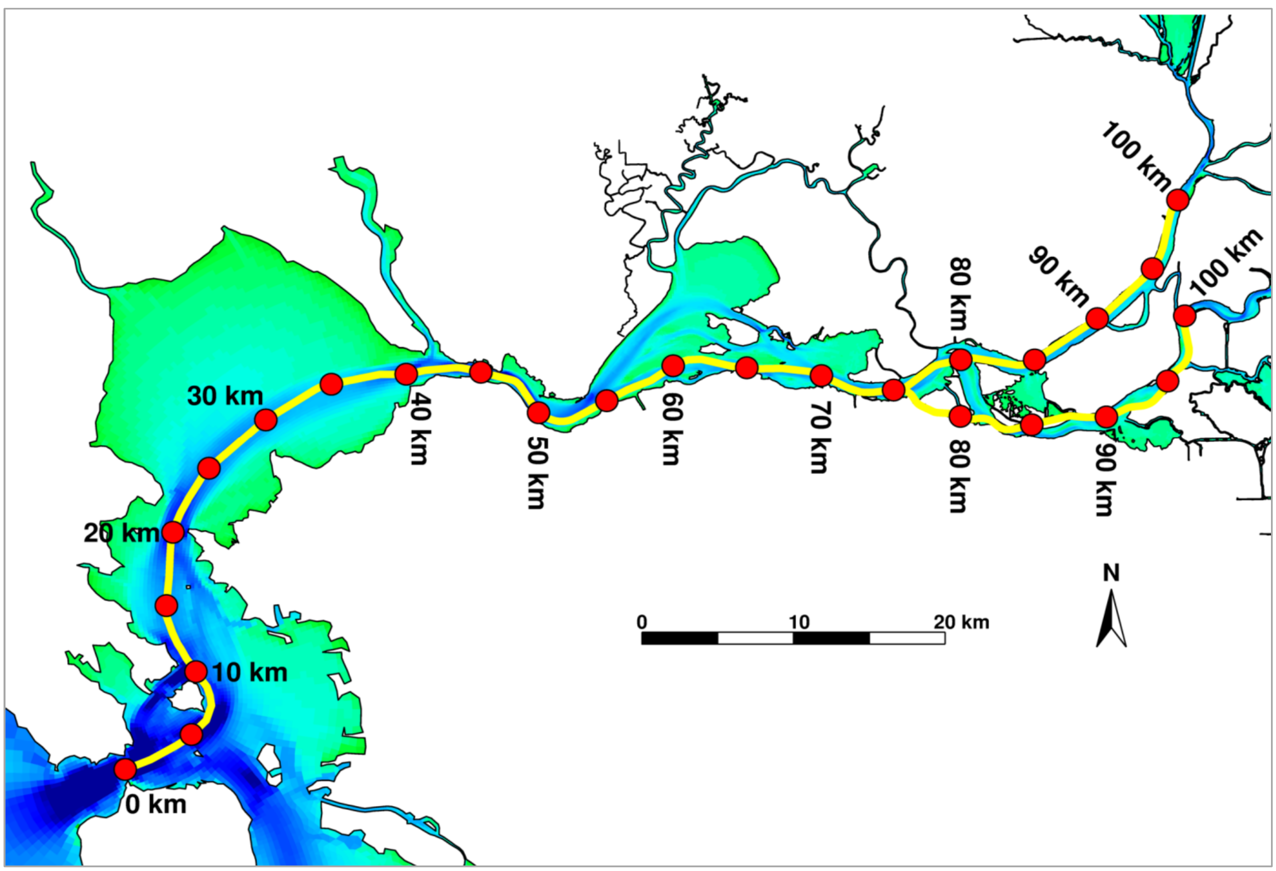


Figure 2-7. Transects Along Axis of Northern San Francisco Bay Used to Measure X2.

To meet the spring and fall X2 requirements, real-time operational changes are made to either increase the upper basin reservoir discharges or decrease Delta exports at the CVP and SWP pump stations or change both to increase the net delta outflow and push the 2 PSU isohaline downstream. While changing pumping rates and reservoir releases can be made with relative precision, the same cannot be said for the measurement of X2 or net Delta outflow. Delta outflow and X2 are utilized when assessing export pumping operations. The estimate for Delta outflow is prepared using a mass balance approach to sum all of the estimated inflows and outflows to compute a Net Delta Outflow Index (NDOI). Several of these flows such as net precipitation and agricultural consumptive use are inherently difficult to measure. The measurement errors from each of the components of the NDOI are additive and under low Delta outflow conditions can be substantial. Measurement of net Delta outflow using Doppler instrumentation is also imprecise, since filtering out tidal exchange volumes (which can be an order of magnitude greater than net outflow) requires accuracy that is beyond the ability of the current technology (particularly when net Delta outflow is below 10,000 cfs).

The measurement of X2 is similarly imprecise. For instance, while X2 is defined as the 2 PSU bottom salinity isohaline location, it is estimated using near surface salinity/electro conductivity measurements collected at four stations spaced approximately 10 kilometers apart. Since bottom salinity differs from surface salinity, an adjustment is applied to transform the interpolated average surface salinity 2 PSU location to the bottom 2 PSU isohaline location. Though the standard X2 estimate uses a single value for the surface to bottom salinity gradient adjustment, there have been several adjustment factors developed since X2 was originally conceived (Hericks et al, 2017). Mathematical estimation of the daily X2 location can also be done using autoregressive equations that consider the prior X2 location and current Delta outflow. The error in X2 location as estimated using autoregressive equations varies between 3.1 and 9.2 kilometer (Hericks et al 2017, MacWilliams et al, 2015).

The inability to accurately estimate X2 and net Delta outflow (NDOI) likely results in operational changes that at times results in either the targeted environmental conditions not being achieved because X2 is under estimated or the targeted environmental conditions are exceeded at the expense of thousands of acre-feet of project water released perhaps unnecessarily due to X2 being over-predicted (Hericks et al, 2017). Given the imprecision in measuring X2 and net Delta inflow, small changes to X2 positioning are generally not considered to be significant.

Impacts to X2 directly affect fish and wildlife through changes to the salinity distribution, and therefore, available low salinity zone habitat. Impacts also potentially affect water supply reliability during periods of the year when the position of X2 is managed by regulating (i.e., increasing) Delta outflow to push the X2 farther west. Within the study area/channel deepening, salinity varies significantly both geographically and seasonally. At the western end of the project area near the West Richmond Channel, salinity is typically around 30 psu, except during periods of very high Delta outflow. At the eastern end of the project area near Avon, salinity levels can be less than 1 psu during very high Delta outflows, but are generally more than 10 psu during periods of lower Delta outflow. Salinity gradients are also pushed seasonally westward into San Pablo Bay during typical periods of high Delta outflow in the winter and spring. In turn, salinity levels in Suisun Bay and the western Delta gradually increase in the summer and fall during periods of generally low Delta outflow. During critical WYs (
Figure 2-3. Total Delta Inflow, Exports, and Outflow for Year 0 Simulation Period Based on 2014 (Critical Year) Historic Conditions.

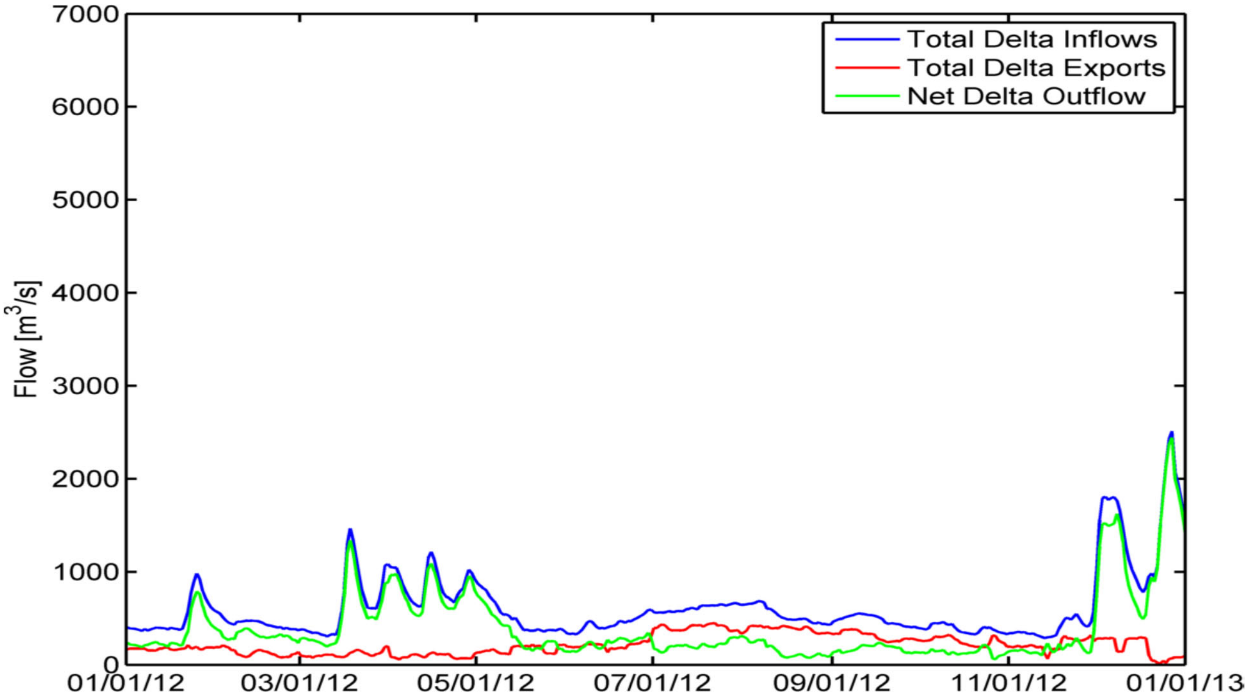


Figure 2-5: Delta outflows can remain low throughout the year, leading to higher salinity in Suisun Bay and the western Delta than during wet years when higher outflows through the winter and spring months push salinity gradients westward.

The D-1641 water quality objectives for municipal and industrial beneficial use stipulates a maximum allowable concentration of 250 milligrams per liter (mg/L) chloride at the municipal water intakes. It also stipulates a 150 mg/L chloride standard at either the intake to the Contra Costa Canal at Pumping Plant No. 1 or the City of Antioch's intake on the San Joaquin River. The 150 mg/L standard must be met for 155 to 240 days per year, depending on the type of WY. High bromide concentrations in raw water diverted from the Delta can also cause high concentrations of disinfection byproducts when water is treated for drinking water purposes. The disinfection byproducts are suspected carcinogens and are regulated by the USEPA. CCWD water plants include several treatment processes to minimize bromide/bromate and disinfection byproducts including coagulation, filtration, granulated activated carbon, chloramination, and ozone. The CCWD has a source water quality goal of 0.050 mg/L bromide concentrations. For the 1992 to 2004 period, the monthly average bromide concentration at the CCWD Rock Slough intake ranges between 0.10 mg/L in April to 0.44 mg/L in December (2010 USBR). In practice, the bromide goal is not typically met since 0.050 mg/L bromide equates to a concentration of 20 mg/L chloride which is well below the average chloride inflow concentration at any of the CCWD intake pump stations.

2.2.3.4 MERCURY AND METHYLMERCURY

Mercury and methylmercury contamination is another long-standing management concern in San Francisco Bay and the Delta. Methylmercury is an organometallic bioaccumulative environmental toxicant produced naturally by bacterial action on inorganic mercury (i.e., methylation). Once formed, methylmercury can also be converted back to inorganic mercury through demethylation.

The microbial mediated processes of methylation and demethylation are complex and often occur simultaneously (LTMS 2010). While the processes are not completely understood, methylmercury production appears to occur primarily in the absence or near-absence of oxygen. Therefore, methylation rates and the total abundance of methylmercury tend to be highest in shallow natural aquatic systems with fine, organic-rich sediments (such as wetlands). Methylmercury can be toxic to humans, fish, and wildlife and is of particular concern because it bioaccumulates and biomagnifies (i.e., becomes present in successively increasing quantities higher up in the food chain) and can cause sub-lethal effects.

The Central Valley RWQCB issued an amendment to the Central Valley Basin Plan that established a total maximum daily load (TMDL) for methylmercury, effective October 2011 (CVRWQCB 2011). The TMDL also requires that dredging activities and dredged material reuse projects in the Delta minimize increases in methylmercury and total mercury discharges to Delta waterways. The potential for methylmercury formation within wetland or upland dredged material placement sites has generated recent attention. Methylmercury can accumulate in wildlife directly from contact with water in the placement sites, or indirectly, after water from the dredged slurry is released back into the receiving water.

The San Francisco Bay RWQCB established a mercury TMDL in 2008 to protect both people who consume Bay fish and aquatic organisms and wildlife. The TMDL calls for Waste Discharge Requirements for dredging and placement operations and requires conducting studies to better understand how their operations affect mercury fate, transport, and biological uptake (USEPA 2015a).

A recent symposium on dredging operations and methylmercury convened by the San Francisco Bay LTMS summarized previous and ongoing pertinent research (LTMS 2010). Various studies conducted in the San Francisco Bay and Delta area have examined not only the relationship between mercury, methylmercury, and bioaccumulation, but also potential management practices for minimizing methylmercury generation in the placement sites. These studies suggest methylmercury production, transport, and bioaccumulation can vary widely across a range of spatial and temporal scales but it appears to be related to the availability (speciation) of inorganic mercury, organic matter, microbial activity (particularly sulfate-reducing and iron-reducing bacteria), and oxidation-reduction (redox) conditions in water and sediment, light level, and hydroperiod. The interim conclusion from the symposium was that although understanding of the relationship between specific environmental factors and mercury methylation is increasing, the current state of the science is not sufficiently advanced to promulgate best management practices (BMPs) for minimizing methylation.

USACE has undertaken studies in the Delta aimed at: (1) understanding the potential for placement sites to act as sources of methylmercury; and (2) identifying BMPs for mitigating methylmercury discharges. The results of these studies indicate that water column concentrations of methylmercury at dredged material placement sites generally increased and appeared to correlate with increases in water column total organic carbon. However, baseline data on both potential receiving water and natural occurrences (e.g., rainfall events) were not collected during this initial effort (Applied Marine Sciences 2010).

2.2.3.5 CHEMICAL POLLUTANTS

The overarching chemical water pollutant issues in the study area result from depleted freshwater flows, municipal and industrial wastewater discharges, agricultural drainage, and runoff. The chemical water pollutant issues for the study area are a result of municipal and industrial wastewater discharges and stormwater runoff. In urban areas, stormwater drainage systems may contain heavy metals and chemicals generated from vehicles and yard chemicals from residential and commercial areas. Because of pollutant loading, the Central Valley and San Francisco Bay Regional Water Quality Control Boards (RWQCBs) have developed and continue to develop programs in an effort to control pollutants from their sources, which include municipal, domestic, industrial, and agricultural wastewater and stormwater.

In San Francisco Bay, the San Francisco Estuary Institute (SFEI) administers a Regional Monitoring Program (RMP) for the San Francisco Bay RWQCB and major dischargers. SFEI conducts monitoring to assess spatial patterns and long-term trends in contamination throughout San Francisco Bay. To assess water quality, metals and organic (e.g., pesticides and polychlorinated biphenyls [PCBs]) contaminants are measured in water samples collected during the dry season. In 2011, results of the RMP showed significant improvements in basic water quality conditions due to investments in wastewater treatment (SFEI 2011). Contamination due to toxic chemicals has also generally declined since the 1950s.

2.2.3.6 NUTRIENTS

When discussing water quality, the term “nutrients” typically refers to nitrogen and phosphorus. Farmers apply fertilizer nutrients in the form of nitrogen, phosphorus, and potassium to prevent these elements from becoming limiting in the soil, and these nutrients eventually enter Delta waters as runoff. In addition, these elements become concentrated in wastewater discharges and can promote aquatic plant and algal growth to an excessive extent. Nitrogen in water can be used by aquatic plants in its inorganic form, either as nitrates or nitrites (combination of nitrogen and oxygen) or as ammonia (a combination of nitrogen and hydrogen). High levels of ammonia are believed to stimulate the growth of phytoplankton and be a threat to aquatic species. The sources of high ammonia contributions are likely wastewater treatment plants and, to a lesser extent, agricultural runoff from the use of nitrogenous fertilizers (CALFED 2009).

Excessive aquatic plant nutrients in the form of nitrogen and phosphorus compounds are causing and/or contributing to water quality issues in the Delta. These issues include:

- Excessive growth of algae causes severe taste and odor problems for domestic water utilities that use Delta water as a raw water source. This requires additional expenditures for water treatment. Harmful algal blooms may be caused by a combination of high nutrient concentrations and warm temperatures. Harmful algae compete with and may exclude diatoms and dinoflagellates, thus reducing primary production. Harmful algal blooms can produce powerful toxins that kill fish, shellfish, mammals, and birds, and may directly or indirectly cause illness in people. *Microcystis aeruginosa* (a common species of cyanobacteria) is an invasive alga that is common in the Delta during warmer months and may contribute to a reduction in copepod productivity (Lehman and Waller 2003).
- Excessive growths of water hyacinth (*Eichhornia crassipes*) and Brazilian elodea (*Egeria densa*), two highly invasive aquatic species, cause ecological impacts, impair recreational use of the Delta, and require herbicides to control, thus adding to water quality concerns. Further, after dying by herbicides, the decomposition of the dead plant materials can cause local declines in dissolved oxygen (DO) levels.
- Nutrient-rich waters may lead to increases in algal growth, which can also reduce DO levels through respiration and subsequent decomposition of the algal mats.
- San Francisco Bay has long been recognized as a nutrient-enriched estuary. However, DO concentrations in San Francisco Bay are much higher and phytoplankton biomass and productivity are substantially lower than would be expected from high nutrient enrichment. Studies suggests that phytoplankton growth and accumulation are largely controlled by a combination of factors,

such as strong tidal mixing, light limitation due to high turbidity, and grazing pressure by clams (Cloern and Jassaby 2012).

2.2.3.7 CLEAN WATER ACT (CWA) 303(D) LISTED IMPAIRED WATERS

Section 303(d) of the CWA requires the identification of water bodies that do not meet, or are not expected to meet, water quality standards (i.e., impaired water bodies). The affected water body, and associated pollutant or stressor, is then prioritized in the 303(d) List. The CWA further requires the development of a TMDL for each listing.

The study area channels are located within portions of San Francisco Bay that are listed as impaired for pesticides (e.g., chlordane, dichloro-diphenyl-trichloroethane (DDT), dieldrin, dioxin and furan compounds), mercury, invasive species, PCBs, selenium, and trash. In greater San Francisco Bay, Suisun Bay and San Pablo Bay are listed for these same parameters, except for trash (SFBRWQCB 2010). In the Delta, the California Department of Water Resources (CDWR) and the Interagency Ecological Program operate several water quality monitoring sites. Based on data collected at these monitoring sites, SWRCB and CVRWQCB have found Delta waters to contain sufficient concentrations of various pollutants that are in violation of water quality standards. As such, the standard of water quality for beneficial uses identified within the Delta is not being met. The Delta is listed as impaired for insecticides (i.e., diazinon, chlorpyrifos), pesticides, mercury, invasive species, PCBs, and selenium.

Dredging and dredged material placement can release sediment-associated metals and other pollutants by dispersion within the resulting sediment plume (Eggleton and Thomas 2004; Levine Fricke 2004) [LFR]. A number of studies have examined the release of contaminants into the water column (Bloom and Lasora 1999; Pieters et al. 2002; Vale et al. 1998), but general conclusions are difficult to draw because of the complex and specific nature of the physiochemical processes in each case. While the processes and mechanisms are well known, the exact results are dependent on numerous conditions that regulate them. Research to date has investigated the effect of dredging-induced sediment resuspension on many potentially toxic metals. However, despite the many comprehensive studies, there is very little consensus on the release of metals and their effects. Organic contaminants such as pesticides, PCBs, and PAHs (polycyclic aromatic hydrocarbons) are generally not very soluble in water and direct toxicity by exposure to dissolved concentrations in the water column is not very likely. Thus, the resulting short-term water quality impacts due to metal and organic contaminant releases from dredging activities do not appear to be a major issue.

Upstream of the study area, low DO is a concern in the interior Delta particularly upstream of Jersey Island. The causes of low DO include discharge of treated effluent loading from the City of Stockton, agricultural runoff, and reduced flushing of dead-end channels.

2.2.3.8 GROUNDWATER

Most groundwater wells used for potable water in the study area are hundreds of feet deep, due to the thickness of the overburden above the deep aquifer (Wu 2010).

2.2.4 AIR QUALITY

Air quality is affected by the rate, amount, and location of pollutant emissions and the meteorological conditions that influence pollutant movement and dispersal. Atmospheric conditions, including wind speed, wind direction, and air temperature, in combination with local surface topography (i.e., geographic features such as mountains, valleys, and large water bodies), determine the effect of air pollutant emissions on local air quality.

2.2.4.1 CRITERIA AIR POLLUTANTS

As required by the Federal Clean Air Act (CAA) passed in 1970, the U.S. Environmental Protection Agency (USEPA) has identified six criteria air pollutants that are pervasive in urban areas and for which state and national health-based ambient air quality standards have been established. The USEPA calls these pollutants "criteria air pollutants" because they are regulated by developing specific public health- and welfare-based criteria as the basis for setting permissible levels. Ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM), and lead are the six criteria air pollutants regulated by the USEPA. PM is measured in two size ranges: PM10 for particles less than 10 microns in diameter, and PM2.5 for particles less than 2.5 microns in diameter.
Table 2-3 lists the criteria pollutants and their major health effects.

2.2.4.2 TOXIC AIR CONTAMINANTS

Toxic air contaminants (TACs) are air pollutants that may lead to serious illness or increased mortality, even when present in relatively low concentrations. Potential human health effects of TACs include birth defects, neurological damage, cancer, and death. There are hundreds of different types of TACs with varying degrees of toxicity. Individual TACs vary greatly in the health risk they present. At a given level of exposure, one TAC may pose a hazard that is many times greater than another.

Table 2-3. Criteria Pollutants and Health Effects.

Pollutant	Description	Health Effect
Ozone	Ozone is a secondary air pollutant produced in the atmosphere through a complex series of photochemical reactions involving reactive organic gases (ROG, also sometimes referred to as volatile organic compounds or VOC by some regulating agencies) and nitrogen oxides (NO_x). The main sources of ROG and NO_x, often referred to as ozone precursors, are combustion processes (including motor vehicle engines) and the evaporation of solvents, paints and fuels. Ozone is referred to as a regional air pollutant because its precursors are transported and diffused by wind concurrently with ozone production through the photochemical reaction process.	Ozone causes eye irritation, airway constriction, and shortness of breath, and can aggravate existing respiratory diseases such as asthma, bronchitis, and emphysema.
Carbon Monoxide	CO is an odorless, colorless gas usually formed as the result of the incomplete combustion of fuels. The single largest source of CO is motor vehicles; the highest emissions occur during low travel speeds, stop-and-go driving, cold starts, and hard acceleration. CO concentrations have declined dramatically in California due to existing controls and	Exposure to high concentrations of CO reduces the oxygen-carrying capacity of the blood and can cause headaches, nausea, dizziness, and fatigue, impair central nervous system function, and induce angina (chest pain) in persons with serious heart disease. Very high levels of CO can be fatal.

Pollutant	Description	Health Effect
	programs and most areas of the state, including the study area, have no problem meeting the state and Federal CO standards.	
Particulate Matter (PM10 and PM2.5)	PM10 and PM2.5 are also termed respirable particulate matter and fine particulate matter, respectively, and are a class of air pollutants that consists of heterogeneous solid and liquid airborne particles from manmade and natural sources.	These particulates are small enough to be inhaled into the deepest parts of the human lung and can cause adverse health effects. Among the criteria pollutants that are regulated, particulates represent a serious ongoing health hazard.
Nitrogen Dioxide (NO_2)	NO_2 is a reddish brown gas that is a byproduct of combustion processes. Automobiles and industrial operations are the main sources of NO_2. NO_2 may be visible as a coloring component on high pollution days, especially in conjunction with high ozone levels.	Aside from its contribution to ozone formation, NO_2 can increase the risk of acute and chronic respiratory disease and reduce visibility.
Sulfur Dioxide (SO_2)	SO_2 is a colorless acidic gas with a strong odor. It is produced by the combustion of sulfur-containing fuels such as oil, coal and diesel.	SO_2 has the potential to damage materials and can cause health effects at high concentrations. It can irritate lung tissue and increase the risk of acute and chronic respiratory disease (BAAQMD 2012).
Lead	Leaded gasoline (phased out in the U.S. beginning in 1973), lead based paint (on older houses and cars), smelters (metal refineries), and manufacturing of lead storage batteries have been the primary sources of lead released into the atmosphere.	Lead has a range of adverse neurotoxic health effects, of which children are at special risk. Some lead-containing chemicals cause cancer in animals. Lead levels in the air have decreased substantially since leaded gasoline was eliminated. Ambient lead concentrations are only monitored on an as-warranted, site-specific basis in California.

2.2.4.3 ODORS

Odors are generally regarded as an annoyance rather than a health hazard. Manifestations of a person's reaction to odors can range from psychological (e.g., irritation, anger, or anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, and headache). The ability to detect odors varies considerably among the population and overall is quite subjective. People may have different reactions to the same odor. An odor that is offensive to one person may be perfectly acceptable to another. An unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. Known as odor fatigue, a person can become desensitized to almost any odor and recognition only occurs with an alteration in the intensity. The occurrence and severity of odor impacts depends on the nature, frequency, and intensity of the source; wind speed and direction; and the sensitivity of receptors. Odor impacts should be considered for any proposed new odor sources located near existing receptors, as well as any new sensitive receptors located near existing odor sources. Generally, increasing the distance between the receptor and the odor source will mitigate odor impacts.

2.2.4.4 SENSITIVE RECEPTORS

Air quality does not affect every individual in the population in the same way, and some groups are more sensitive to adverse health effects than others. Population subgroups sensitive to the health effects of air pollutants include the elderly and the young, those with higher rates of respiratory disease such as asthma and chronic obstructive pulmonary disease, and those with other environmental or occupational health exposures (e.g., indoor air quality) that affect cardiovascular or respiratory diseases.

Land uses such as schools, children's day care centers, hospitals, and nursing and convalescent homes are considered to be more sensitive than the general public to poor air quality because the population groups associated with these uses have increased susceptibility to respiratory distress. Parks and playgrounds are considered moderately sensitive to poor air quality because persons engaged in strenuous work or exercise also have increased sensitivity to poor air quality. However, exposure times are generally far shorter in parks and playgrounds than in residential locations and schools. Residential areas are considered more sensitive to air quality conditions compared to commercial and industrial areas because people generally spend longer periods of time at their residences, with associated greater exposure to ambient air quality conditions.[1]

Sensitive receptors include children, adults, and seniors occupying or residing in residential dwellings, schools, colleges and universities, daycares, hospitals, and senior-care facilities. Workers are not considered sensitive receptors because all employers must follow regulations set forth by the Occupation Safety and Health Administration to ensure the health and well-being of their employees.

2.2.4.5 REGIONAL SETTING

The geographic scope of the study area includes the waters within the North San Francisco Bay, San Pablo and Suisun Bays, covering the counties of Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, and San Francisco. The majority of the project area is located within the boundaries of the San Francisco Bay Area Air Basin (SFBAAB), though portions extend into the Sacramento Valley Air Basin (SVAB).

2.2.4.6 SAN FRANCISCO BAY AREA AIR BASIN

The SFBAAB encompasses a nine-county region, which includes all of Alameda, Contra Costa, Santa Clara, San Francisco, San Mateo, Marin and Napa counties, and the southern portions of Solano and Sonoma counties. The Bay Area Air Quality Management District (BAAQMD) has jurisdiction over air quality within the SFBAAB. The climate of the SFBAAB is determined largely by a high-pressure system that is almost always present over the eastern Pacific Ocean off the west coast of North America. During winter, the Pacific high-pressure system shifts southward, allowing more storms to pass through the region. During summer and early fall, when few storms pass through the region, emissions generated within the Bay Area can combine with abundant sunshine under the restraining influences of topography and subsidence inversions to create conditions that are conducive to the formation of photochemical pollutants such as ozone and secondary particulates such as nitrates and sulfates.

2.2.4.7 SACRAMENTO VALLEY AIR BASIN

The SVAB encompasses an eleven-county region, which includes all of Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba counties, and portions of Placer and Solano counties. The Yolo-

Solano Air Quality Management District (YSAQMD) is responsible for Yolo County and the eastern portion of Solano County. Other counties within the SVAB are outside of the study area. The climate in the SVAB is Mediterranean. Prevailing winds originate offshore of San Francisco Bay and flow through the Carquinez Strait, then north through the Sacramento Valley. Elevations of the broad valley floor range from 60 to 500 feet above mean sea level. The valley is bordered to the north by the Sierra Cascade Mountains, to the east by the Sierra Nevada, and to the west by the Coast Ranges. The topography and climate of the air basin create a high potential for air inversions. Inversions occur frequently during all seasons. The most stable of these inversions occurs in the late summer and early fall, when cool coastal air is trapped beneath a warm air mass. Photochemical smog (i.e., ozone) trapped in these inversions is often exacerbated when preceded by sunny days with relatively high temperatures. During late fall and winter, air inversions occurring at ground level often result in low-lying fog when valley air becomes trapped and does not mix with coastal air. It is during these periods that the air basin experiences the highest concentrations of CO, NO_x, and PM.

2.2.4.8 EXISTING AIR QUALITY

The BAAQMD, YSAQMD, and the ARB all monitor regional air quality through a network of monitoring stations, which record ambient concentrations of non-attainment criteria air pollutants. Probable future levels of air quality in the study area can generally be inferred from ambient air quality measurements conducted at the nearest monitoring stations by examining trends over time. The data gathered at these monitoring stations present the nearest available benchmark reference point as to what the pollutants of greatest concern are in the region and the degree to which the area is out of attainment with specific air quality standards.

The two closest monitoring stations to the study area in the SFBAAB are in Vallejo and San Pablo. **Table 2-4** shows a 3year (2015 through 2017) summary of monitoring data for ozone, PM10, and PM2.5 recorded at these stations. These stations recorded no violations of ozone or PM10 standards but identified violations of state and Federal 24-hour PM2.5 standards.

Table 2-5 shows a 3-year (2015 through 2017) summary of monitoring data for ozone, PM10, and PM2.5 recorded at the Vacaville and Davis air monitoring stations, which are the stations closest to the study area within the SVAB. These stations recorded violations of the ozone Federal standards, but no violations of the state or Federal PM2.5 standards. Neither station monitors PM10 concentrations.

The YSAQMD currently meets the USEPA's health standards for five pollutants. The YSAQMD is part of the SVAB regional non-attainment area for ground-level ozone and fine particulate pollution.

Table 2-4. Summary of Air Quality Monitoring Data within the SFBAAB (2015-2017).

Pollutant	**Applicable Standard**	**Number of Days Standards Were Exceeded and Maximum Concentrations Measured**[a]		
		2015	**2016**	**2017**
Ozone				
Vallejo – 304 Tuolumne Street				
Days 1hour State Std. Exceeded	>0.09 ppm[b]	0	**1**	**1**
Max. 1hour Conc. (ppm)	-	0.086	**0.097**	**0.105**
Days 8hour National Std. Exceeded	>0.070 ppm[c]	0	**1**	**2**
Days 8hour State Std. Exceeded	>0.07 ppm[b]	**1**	**1**	**1**
Max. 8hour Conc. (ppm)	-	**0.071**	**0.072**	**0.088**
San Pablo – Rumrill Blvd.				
Days 1hour State Std. Exceeded	>0.09 ppm[b]	0	0	**3**
Max. 1hour Conc. (ppm)	-	0.084	0.094	**0.104**
Days 8hour National Std. Exceeded	>0.070 ppm[c]	0	0	**2**
Days 8hour State Std. Exceeded	>0.07 ppm[b]	0	0	**2**
Max. 8hour Conc. (ppm)	-	0.062	0.061	**0.080**
Suspended Particulates (PM10)				
San Pablo – Rumrill Blvd.				
Days Over 24hour National Std.	>150 µg/m^3 [c]	0	0	0
Days Over 24hour State Std.	>50 µg/m^3 [b]	0	0	25.8
Max. 24hour Conc. (µg/m^3)	-	43	33	95.3
Annual Average (µg/m^3)	>20 µg/m^3 [b]	18.1	14.9	19.8
Suspended Particulates (PM2.5)				
Vallejo – 304 Tuolumne Street				
Days Over 24hour National Std.	>35 µg/m^3 [c]	**3**	0	**9**
Max. 24hour Conc. (µg/m^3)	-	**41.4**	23	**101.9**
Annual Average (µg/m^3)	>12 µg/m^3 [b]	9.6	7.3	11.5
San Pablo – Rumrill Blvd.				
Days Over 24hour National Std.	>35 µg/m^3 [c]	0	0	**9.3**
Max. 24hour Conc. (µg/m^3)	-	33.2	19.5	**71.2**
Annual Average (µg/m^3)	>12 µg/m^3 [b]	8.9	8.0	10.7
NOTES				
***Bold** values are in excess of applicable standard*				
conc. = concentration				
ppm = parts per million				
ppb = parts per billion				
µg/m^3 = micrograms per cubic meter				
N/A = not applicable				
[a] Number of days exceeded is for all days in a given year, except for particulate matter. PM10 and PM2.5 are monitored every six days.				
[b] state standard, not to be exceeded.				

Pollutant	Applicable Standard	Number of Days Standards Were Exceeded and Maximum Concentrations Measured[a]		
		2015	2016	2017
[c] Federal standard, not to be exceeded.				

Source: CARB 2016

Table 2-5. Summary of Air Quality Monitoring Data within the SVAB (2015-2017).

Pollutant	Applicable Standard	Number of Days Standards Were Exceeded and Maximum Concentrations Measured[a]		
		2015	2016	2017
Ozone				
Vacaville – Ulatis Drive				
Days 1hour State Std. Exceeded	>0.09 ppm[b]	0	0	0
Max. 1hour Conc. (ppm)	-	0.085	0.092	0.089
Days 8hour National Std. Exceeded	>0.070 ppm[c]	0	**1**	**2**
Days 8hour State Std. Exceeded	>0.07 ppm[b]	**1**	**1**	**2**
Max. 8hour Conc. (ppm)	-	0.070	**0.072**	**0.079**
Davis – UCD Campus				
Days 1hour State Std. Exceeded	>0.09 ppm[b]	0	0	0
Max. 1hour Conc. (ppm)	-	0.081	0.083	0.078
Days 8hour National Std. Exceeded	>0.070 ppm[c]	**1**	**1**	**1**
Days 8hour State Std. Exceeded	>0.070 ppm[b]	**1**	**1**	**1**
Max. 8hour Conc. (ppm)	-	**0.071**	**0.072**	**0.071**
Suspended Particulates ($PM_{2.5}$)				
Davis – UCD Campus				
Days Over 24hour National Std.	>150 µg/m^3 [c]	NA	NA	NA
Days Over 24hour State Std.	>50 µg/m^3 [b]	NA	N/A	N/A
Max. 24hour Conc. (µg/m^3)	-	36.3	30.5	**59.2**
Annual Average (µg/m^3)	>20 µg/m^3 [b]	10.1	NA	NA
NOTES				
***Bold** values are in excess of applicable standard*				
conc. = concentration				
ppm = parts per million				
ppb = parts per billion				
µg/m^3 = micrograms per cubic meter				
NA = not applicable				
[a] Number of days exceeded is for all days in a given year, except for particulate matter. PM10 and PM2.5 are monitored every six days.				

Pollutant	Applicable Standard	Number of Days Standards Were Exceeded and Maximum Concentrations Measured[a]		
		2015	2016	2017
[b] state standard, not to be exceeded.				
[c] Federal standard, not to be exceeded.				

Source: CARB 2016

2.2.5 CLIMATE CHANGE

Global warming is the increase in average global temperatures of the earth's surface and atmosphere. The natural balance of GHGs in the atmosphere regulates the earth's temperature. Without this natural greenhouse effect, the earth's surface would be approximately 60° F cooler (U.S. Global Change Research Program 2014) [USGCRP]. Various gases in the earth's atmosphere, classified as atmospheric GHGs, play a critical role in determining the earth's surface temperature though the greenhouse effect. Among the prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), ozone (O_3), water vapor, nitrous oxide (N_2O), and chlorofluorocarbons (CFCs). Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for enhancing the greenhouse effect, or climate change, which contributes to global warming.

Existing sources of GHGs in the study area are extensive and include vehicles, marine vessels, industry, and farms. However, the effect of GHGs differ from other pollutants in that they do not directly impact local or even regional settings and are not often the effect of individual large sources. Rather, excess GHG emissions from many different sources combine to increase mean global temperatures, which in turn have numerous direct and indirect effects on the environment and humans on regional and local scales.

In California, an assessment of climate change impacts predicts that temperatures will increase from 4.1° F to 8.6° F by 2100, based on low and high global GHG emission scenarios (CCCC 2012). In 2013, the California Office of Environmental Health Hazard Assessment report identified changes to California's climate because of GHG emissions (OEHHA 2013). Changes identified in the report include the following:

- Exacerbation of air quality problems,
- Reduction in municipal water supply from the Sierra snowpack,
- SLR that could displace coastal businesses and residences,
- Increase in wildfires,
- Damage to marine and terrestrial ecosystems, and
- Increase in the incidence of infection diseases, asthma, and other human health problems (CCCC 2012).

Observed environmental changes in California due to global warming include rising temperatures, rising sea levels, a lengthened growing season, and shifts in plant and animal ranges. At a local level, the navigation channel and surrounding area may be at greater risk of changing weather patterns, such as the current drought affecting water resources, the increasing intensity of rainfalls that can cause localized flooding, and the local effects from SLR. As discussed above, because the effects of climate change are regional in nature, the environmental setting in regards to climate change is the same throughout the study area.

2.2.6 BIOLOGICAL RESOURCES

The affected environment for biological resources was identified from existing information available for the San Francisco Bay Area and Sacramento San Joaquin Delta.

2.2.6.1 HABITAT TYPES

The study area provides habitat for a wide variety of aquatic species, including species associated with the benthos, such as annelids, mollusks, and crustaceans; phytoplankton and zooplankton; common fish species; special status fish species; invasive aquatic plants, fish, and invertebrates; and marine mammals. Aquatic habitats include tidal marsh and tidal mudflats; intertidal, shallow sub-tidal, and deep sub-tidal habitats; managed wetlands; rocky intertidal and subtidal; and open bay waters. Land adjacent to the San Joaquin River as it passes through the Delta is primarily used for agricultural purposes with pockets of residential, commercial, and industrial development. Much of the land adjacent to the Carquinez Strait, San Pablo Bay, and the San Francisco Bay is developed. Suisun Bay is adjacent to Suisun Marsh and other wetland areas, as well as some developed shorelines. Land adjacent to Suisun Bay, the Carquinez Strait, San Pablo Bay, and the San Francisco Bay is largely developed. The habitat types around the Bay and Delta often blend with one another and with nearby upland habitats in transition zones called ecotones. Species found in these areas often occur in more than one habitat type (USACE 2014a).

Tidal Marsh. Tidal marsh habitat is comprised of tidally inundated vegetated wetland that may be salt or brackish, depending on the extent of freshwater influence. The plant communities found in this marsh-type habitat are influenced by salinity, substrate, wave energy, marsh age, erosion, and accretion. Marshes provide important rearing and refuge habitat for juvenile salmon, steelhead, and longfin smelt, and a wide variety of birds use tidal marshes for nesting, foraging, and refuge.

Tidal marshes occur at scattered locations along the waterways of the Delta and Bay, at the margins of San Pablo Bay, and in Suisun Marsh. The Suisun Marsh is located north of San Pablo Bay and Grizzly Bay. Suisun Marsh includes 52,000 acres of managed wetlands; 27,700 acres of upland grasses; 6,300 acres of tidal wetlands; and 30,000 acres of bays and sloughs. The Marsh serves as the resting and feeding ground for thousands of waterfowl migrating on the Pacific Flyway. Suisun Marsh is designated EFH for Pacific salmonids and Pacific groundfish, as well as critical habitat for Chinook salmon, steelhead, delta smelt, and green sturgeon. Suisun Marsh supports the state's commercial salmon fishery by providing important tidal rearing areas for juvenile fish, which allows them to grow twice as fast as those reared in the upper watershed, which greatly enhances their survival (Interagency Ecological Program n.d.) [IEP].

Tidal Mudflats. Tidal mudflats occur from below mean lower low water (MLLW) to mean tide level. These flats are characterized by a fine-grained silt and clay substrate and usually include minimal vascular vegetation. They are generally associated with tidal freshwater or brackish emergent wetlands at their upper edge and the tidal perennial aquatic community at their lower edge. Tidal mudflats support ecologically important benthic communities that include aquatic worms (*Oligochaeta*), crustaceans, and mollusks and provide fertile feeding grounds for various shorebird species. When the tidal mudflat community is flooded at high tide, it serves as shallow open water habitat for pelagic fish species (including Sacramento splittail and salmonids) and benthic fish species (including sturgeon) (CDWR 2013).

Rocky Intertidal and Subtidal Habitat. Rocky intertidal and subtidal habitat occurs around the margins of the Central Bay and San Pablo Bay. A diversity of wildlife occurs in these areas, which provide encrusting habitat for invertebrates that in turn attract foraging fishes. Pacific herring spawn on rocky habitat and the algae attached to rocky substrates (State Coastal Commission 2010) [SCC]. Shorebirds also utilize these habitats, and harbor seals often come ashore (haul out) on rocky shores (USACE 2014a).

Open Bay. The open bay includes both deep waters (deeper than -18 feet MLLW) and shallow bay waters (shallower than -18 feet MLLW) which comprise a majority of the open bays. Deep bay areas are inhabited by free swimming invertebrates and fish and provide roosting habitat for waterbirds. A variety of fish species inhabit the shallow bay which provides Pacific herring spawning habitat and functions as nursery habitat for juvenile halibut and sanddabs (*Citharichthys stigmaeus*), shiner perch (*Cymatogaster aggregata*), herring, and other fishes. Eelgrass, the Bay's only rooted seagrass, is present in some shallow bay areas. Several species of fish frequent both the deep and shallow bay, as do marine mammals. Anadromous fish use both the deep and shallow bays as migratory pathways (USACE 2014a).

Managed Wetlands. Managed wetlands are intentionally flooded and managed to enhance habitat values for specific wildlife species. Managed wetlands are present in Suisun Marsh (CDWR 2013).

Terrestrial Habitats. The proposed dredged material placement sites are the only areas that include terrestrial habitat and are described within relevant environmental documents prepared for each site (USACE and SCDEM 1998; USFWS and CDFW 2008).

2.2.6.2 AQUATIC SPECIAL STATUS SPECIES

The discussion presented in this section is limited to protected aquatic resources, including Federal and/or state endangered or threatened species and their habitats; candidate Endangered Species Act (ESA) and California Endangered Species Act (CESA) species and their habitats; species of special concern and their habitats; and designated critical habitat for federally listed species. **Appendix G - Attachment 4** includes a list of aquatic special status species with recorded occurrences in the study area and identifies habitat types suitable for these species.

Special Status Fish Species and Critical Habitat. **Table 2-6** provides a summary of the habitat requirements; occurrence, life stage, and timing information; and designated critical habitat for special status fish species expected to occur in the study area.

Several species listed in **Table 2-6** have been identified as occurring in the study area during community monitoring surveys. These surveys include USACE entrainment and community monitoring for maintenance dredging of the Stockton and Sacramento DWSCs Reach (USACE 2015f) and the California Department of Fish and Wildlife's (CDFW's) Fall Midwater Trawl (FMWT) program (CDFW 2015a). General descriptions of these surveys and results are provided below.

USACE has conducted entrainment and community monitoring during annual Stockton and Sacramento DWSCs maintenance dredging since 2005 (USACE 2015f). Monitoring occurs at dredging locations throughout the Stockton and Sacramento DWSCs, which change annually, as well as in the dredge material placement sites. Monitoring methods include bottom trawling against the current, to monitor the fish community in the active dredge area of the DWSCs, and entrainment monitoring using a mobile entrainment monitoring screen at the end of the dredge pipe in the placement site. Monitoring requirements are focused on ESA and CESA listed threatened and endangered species, as well as CDFW species of special concern, although all fish encountered (with some exceptions) are counted and identified to the species level.

The CDFW's FMWT began in 1967 and has sampled every year except 1974 and 1979 (CDFW 2014; Feyrer et al. 2007; Stevens and Miller 1983). The FMWT samples at more than 100 stations from San Pablo Bay landward into the Sacramento-San Joaquin Delta. Each station is typically sampled once each month from September through December. The FMWT was designed to index the year-to-year relative abundance of juvenile (age-0) striped bass (*Morone saxatilis*) (Stevens and Miller 1983). However, all captured species are identified and measured and the FMWT has become a long-term indicator of population trajectories for several small, pelagic fish, including delta smelt (Moyle et al. 1992; Sommer et al. 2007). The FMWT sampling methods are less likely to encounter mature individuals of larger species such as green sturgeon, salmonids, and striped bass.

Table 2-6. Special Status Fish Species with Potential to Occur in the Study Area.

DPS/ESU	Legal Status	Habitat Association	Occurrence	Critical Habitat in Study Area
Southern DPS green sturgeon (*Acipenser medirostris*)	Federal threatened/ state species of special concern	Spawns in fast-moving, cool freshwater habitat in Sacramento, Klamath, and Trinity Rivers; juveniles rear in estuarine waters	Throughout Sacramento San Joaquin Delta and San Francisco Bay; spawn primarily in upper main stem of Sacramento River	Critical habitat present within the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays
Delta smelt (*Hypomesus transpacificus*)	Federal threatened/ state endangered	Inhabits open surface water; spawns primarily in sloughs and shallow edge-waters of channels in the upper Delta and Sacramento River	Known to occur in Sacramento-San Joaquin Delta and seasonally in Suisun Bay, Carquinez Strait, and San Pablo Bay	Critical habitat includes the Delta west to Carquinez Bridge
Sacramento River winter-run ESU Chinook salmon (*Oncorhynchus tshawytscha*)	Federal endangered /state endangered	Migrates through the northern and central portions of San Francisco Bay; spawns in the spring and summer, primarily in the Sacramento River	Commonly found migrating through the northern portion of San Francisco Bay; spawn primarily in the Sacramento River	Critical habitat present in all waters from Sacramento River at Chipp's Island to San Francisco Bay (north of the San Francisco/Oakland Bay Bridge)
Central Valley spring-run ESU Chinook salmon (*Oncorhynchus tshawytscha*)	Federal threatened/ state threatened	Spawns in freshwater; juveniles rear in fresh and estuarine water before migrating to ocean	Commonly found migrating through the northern portion of San Francisco Bay; spawn in the Sacramento River Basin	Critical habitat present within the San Francisco-San Pablo-Suisun Bay complex
Central Valley DPS steelhead (*Oncorhynchus mykiss irideus*)	Federal threatened	Spawns in freshwater; juveniles rear in fresh and estuarine water before migrating to ocean	Populations in the San Joaquin River and its tributaries	Critical habitat includes portions of the San Francisco-San Pablo-Suisun Bay estuarine complex

DPS/ESU	Legal Status	Habitat Association	Occurrence	Critical Habitat in Study Area
Central Coast DPS steelhead	Federal threatened/ state species of special concern	Spawns in freshwater; juveniles rear in fresh and estuarine water before migrating to ocean	Spawn in tributaries of San Francisco Bay, including in the San Joaquin watershed	Critical habitat includes portions of the San Francisco-San Pablo-Suisun Bay estuarine complex
Longfin smelt (*Spirinchus thaleichthys*)	state threatened, state species of special concern/ Federal candidate	Euryhaline, nektonic, and anadromous; found in open waters of estuaries, mostly in middle or bottom of water column	Spawn from Suisun Bay into upper area of estuary near Rio Vista; larval longfin smelt concentrated in Suisun and San Pablo bays	No critical habitat
Central Valley fall-run/late-fall-run ESU Chinook salmon (*Oncorhynchus tshawytscha*)	state species of special concern	Spawns in freshwater; juveniles rear in fresh and estuarine water before migrating to ocean	Commonly found migrating through the northern portion of San Francisco Bay; spawn in the Sacramento and San Joaquin River basins	No critical habitat
River lamprey and Pacific lamprey (*Entosphenus tridentatus; Lampetra ayresii*)	state species of special concern	Spawns in freshwater habitats in riffles; ammocoetes rear in freshwater benthos for 3 to 5 years before emerging and migrating to Ocean	Found in the San Francisco Bay, San Joaquin Delta, San Pablo Bay, and Suisun Bay watersheds	No critical habitat
Sacramento splittail (*Pogonichthys macrolepidotus*)	state species of special concern/ Federal candidate	Slow moving river sections, dead end sloughs; requires flooded vegetation for spawning and foraging for young	Range includes the lower part of the Delta and sloughs adjoining Suisun and San Pablo bays	No critical habitat
Sacramento perch (*Archoplites interruptus*)	state species of special concern	Historically found in the sloughs, slow-moving rivers, and lakes of the Central Valley	May be extirpated from native Delta (Crain et al. 2007)	No critical habitat

DPS = Distinct Population Segment *ESU = Evolutionarily Significant Unit* *NA = Not applicable*

Southern Distinct Population Segment Green Sturgeon (Acipenser medirostris) (Federal Threatened; State Species of Special Concern). The Southern Distinct Population Segment (DPS) of green sturgeon includes fish that inhabit the San Francisco Bay and Delta and spawn in the Sacramento River basin. Sub-adults and adults of this species inhabit nearshore oceanic waters, bays, and estuaries while also migrating to and from freshwater habitats. Freshwater occurrence of this species transpires during the early life-history stage (less than 4 years old), and later when adults return to freshwater to spawn (spawn age range of 10 to 15 years old). Spawning occurs in the spring and summer, as recorded in the upper Sacramento River and tributaries such as the Feather, Yuba, and American rivers. During the juvenile stage, green sturgeon can be found throughout the freshwater portions of their habitat the entire year. Juveniles of two apparent size groups (fork length range of 20 to 58 cm) have been collected in the Sacramento and San Joaquin rivers and Suisun Bay. However, there are substantial gaps regarding knowledge of this species' biology, ecology, and habitat within the study area (USACE 2015e).

Green sturgeon individuals were not collected during the 2014 USACE maintenance dredging surveys, although individuals have been collected in the Stockton DWSC during previous years (USACE 2015f). This includes a total of four green sturgeon individuals from 2005 through 2014, all of which were collected during community monitoring, with none having been entrained by dredging equipment.

A primary factor for the decline of the green sturgeon is the restriction of spawning habitat to a limited area below Keswick Dam. Also contributing to the decline are flows of sufficient velocity to initiate the upstream spawning migration (Kohlhorst et al. 1991 as cited in CDFG 2002; NOAA 2008). Reduced flows have been identified as a factor in weakened year class recruitment in the white sturgeon population and are believed to have the same effect on green sturgeon recruitment. In addition to the adverse effects of impassable barriers, numerous agricultural water diversions exist in the Delta along the migratory route of larval and juvenile sturgeon. Entrainment and impingement in water pumps and screens are serious threats to sturgeon during their downstream migration. Sturgeon are also susceptible to uptake of contaminants from contaminated sediments through both dermal contact and incidental ingestion of sediments while feeding. Bioaccumulation is also a concern due to their long life. All of the above threats were identified by the NMFS Biological Review Team as potentially affecting the continued existence of the southern DPS of green sturgeon (70 FR 17386).

Critical habitat for the green sturgeon was designated on October 9, 2009 (50 FR 226). In California, critical habitat for green sturgeon in the Delta includes all waterways up to the elevation of mean higher high water (MHHW) within the area defined in California Water Code 12220, although some waterways are specifically excluded. As shown in **Figure 2-8**, the entire San Francisco Bay below MHHW is also designated as critical habitat, which includes the portion of San Francisco Bay that overlaps with the study area (NOAA 2009).

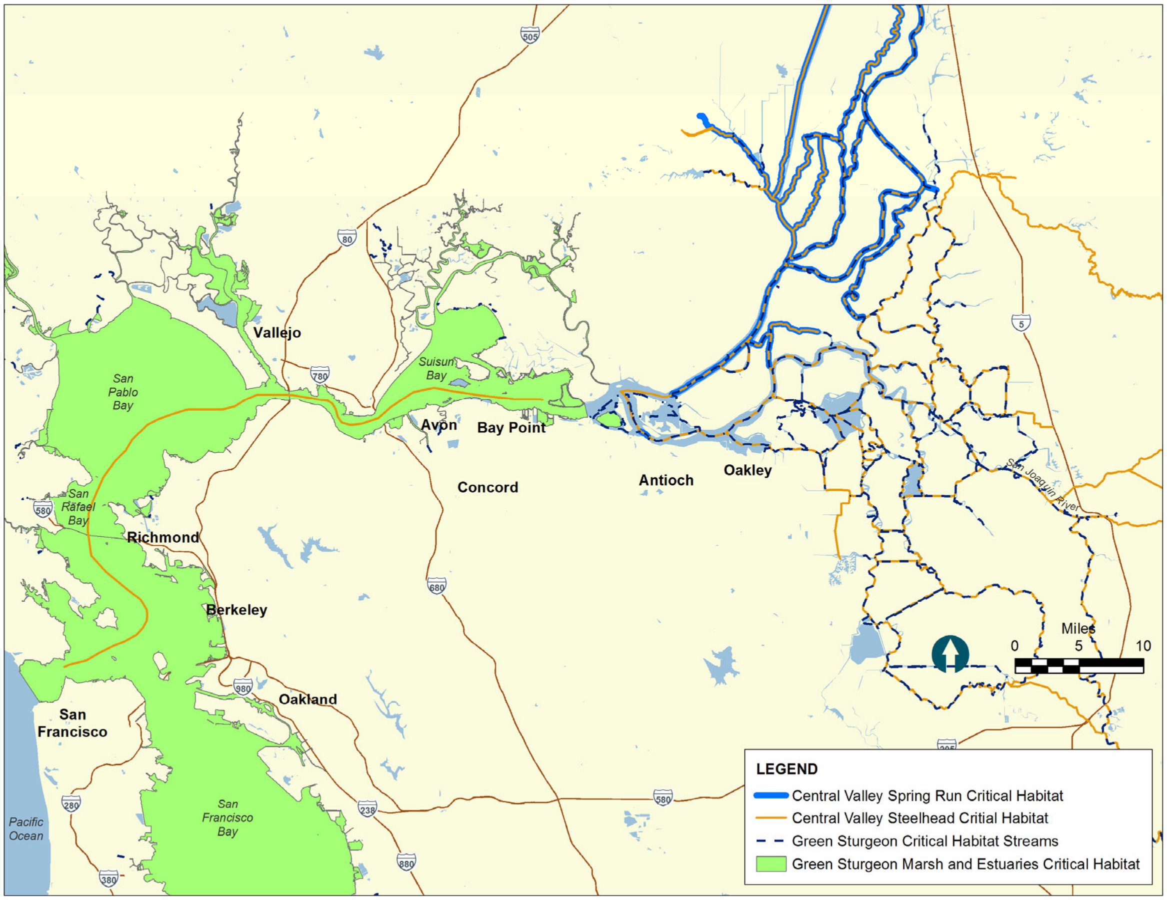


Figure 2-8. Designated Critical Habitat for Green Sturgeon and Central Valley Steelhead in the Northern San Francisco Bay System and Watershed.

Central Valley Distinct Population Segment Steelhead (Oncorhynchus mykiss) (Federal Threatened, State Threatened). The Central Valley DPS of steelhead includes all populations in the Sacramento and San Joaquin rivers and their tributaries. The current distribution ranges from Keswick Dam in the Upper Sacramento River to the Merced River in the San Joaquin River Basin, with distribution primarily limited by impassable dams.

Anadromous adults of the Central Valley steelhead Evolutionarily Significant Unit (ESU) make their upstream spawning migrations beginning in July (peaking in September and October) after residing in the ocean for 2 to 3 years. Spawning occurs from December through April. The study area is primarily used as a migration corridor. Spawning, incubation, and the majority of rearing occurs farther upstream than the study area. Juveniles reside in freshwater from 1 to 3 years, primarily occurring near the surface and in the water column above the benthos when over deeper waters. Juveniles feed on a diverse array of aquatic and terrestrial insects and other small invertebrates. Most juvenile Central Valley steelhead are found migrating through the study area during the spring, although outmigration occurs from December through August (USACE 2015e). No steelhead specimens have been encountered during USACE entrainment and community monitoring conducted during annual dredging from 2005 through 2014 (USACE 2015f). USACE maintenance dredging of the Stockton DWSC was accomplished in 2006 and 2007 during the June 1 through December 31 dredging windows, and from 2008 to the present during August 1 through November 30 dredging window.

Factors that limit productivity of steelhead populations include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps); loss of fish into unscreened agricultural diversions; predation by introduced species; and reduction in the quality and quantity of rearing habitat due to channelization, pollution, riprapping, and other factors (CACSST 1988; Dettman et al. 1987; Kondolf et al. 1996a, 1996b as cited in NOAA 2006).

Central Valley Spring-Run Evolutionarily Significant Unit Chinook Salmon (Oncorhynchus tshawytscha) (Federal Threatened, State Threatened). The Central Valley spring-run ESU of Chinook salmon is one of four distinct runs of salmon that spawn in the Sacramento-San Joaquin River system. The Chinook was historically the most abundant salmon species in the Central Valley. Populations remain in some tributaries of the Sacramento River, including Butte, Mill, Deer, Antelope, and Beegum creeks and the Yolo Bypass.

In general, spring-run Chinook salmon are found in the Suisun Marsh/North San Francisco Bay, Delta, Sacramento River, Feather River/Sutter Basin, Butte Basin, and North Sacramento Valley Ecological Zones (CDFG 1998). Spring-run Chinook adults typically migrate upstream to spawn from April to October, and spawn from August through October. Chinook alevins have been collected from Suisun Bay in January and February. Larger parr juveniles have been found from April to June. Juvenile life stages are commonly found inshore, in shallow water and throughout estuarine habitat. Some Chinook salmon delay their downstream migration until the early smolt stage. Juvenile outmigration peaks from May to June (USACE 2015e).

Similar to Central Valley steelhead, factors that limit productivity of salmonid populations include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps); loss of fish into unscreened agricultural diversions; predation by introduced species; and reduction in the quality and quantity of rearing habitat due to channelization, pollution, riprapping, and other factors (CACSST 1988; Dettman et al. 1987; Kondolf et al. 1996a, 1996b as cited in NOAA 2006).

Central Valley Fall-run/Late-fall-run Evolutionarily Significant Unit Chinook Salmon (Oncorhynchus tshawytscha) (State Species of Special Concern). The Central Valley fall-run and late-fall-run ESU of Chinook salmon are two of the four distinct runs of salmon that spawn in the Sacramento-San Joaquin River system. Late-fall-run Chinook are often larger than fish from other runs. They are most similar genetically to fall-run Chinook and are often combined into a single ESU, despite having distinctive life histories. The NMFS designated the Central Valley fall-run/late-fall-run Chinook salmon ESU as a candidate for listing on September 16, 1999, although the listing was later deemed unwarranted (50 CFR 223; NMFS 2009). The Central Valley fall-run/late-fall-run Chinook salmon ESU is a state species of special concern. The ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries, east of Carquinez Strait. Fall-run Chinook are the most abundant run in the Central Valley (Moyle 2002).

Fall-run Chinook spawn in upstream reaches of the Sacramento River from October through December, peaking in late October and November. Fall-run Chinook emerge between approximately December and March and out-migrate to the ocean between December and June. Late-fall-run adults enter the Sacramento River from October through April and spawn from January to April, peaking in February and

March. Late-fall-run Chinook fry typically emerge from April to June and rear year-round. Fall-run Chinook tend to mature in the ocean before returning to spawn, while late-fall-run Chinook may return to freshwater as immature adults (BCAG 2011).

Sacramento River Winter-run Evolutionarily Significant Unit Chinook Salmon (Oncorhynchus tshawytscha) (Federal Endangered, State Endangered). The Sacramento River winter-run ESU of Chinook salmon differs from other Chinook ESUs in that they have characteristics of both stream- and ocean-type races (Healey 1991). Study area waters are primarily used by winter-run Chinook for adult spawning migrations and juvenile out-migrations, with some usage overlap for juvenile rearing. Winter-run Chinook spawning occurs in accessible upper reaches of the Sacramento River basin from April through July, with adults migrating upstream from December to July. Chinook alevins have been collected from Suisun Bay in January and February. Larger parr juveniles have been found from April to June. Juvenile life stages are commonly found inshore, in shallow water and throughout estuarine habitat. Some Chinook salmon delay their downstream migration until the early smolt stage. Juvenile outmigration peaks from May to June (USACE 2015f).

Activities identified by the NMFS (NOAA 1994) that affect winter-run Chinook habitat include water management operations by the Central Valley Project (CVP) and the State Water Project (SWP), small and large water diversions by other private entities, bank restoration, dredging, and other construction-related activities in the Sacramento River and Delta.

Longfin Smelt (State Threatened, Federal Candidate). Longfin smelt is state-listed as threatened and is a Federal candidate species. Longfin smelt, a small sized euryhaline and anadromous fish, was historically among the most abundant fish in the San Francisco estuary and the Delta. Significant declines in longfin smelt abundance have occurred throughout its range during the past quarter century. Longfin smelt are distinguished by their long pectoral fins, which reach or nearly reach the base of their pelvic fins. They reach a maximum size of about 150 mm (total length), and reach maturity near the end of their second year. As they mature in the fall, adults found throughout San Francisco Bay migrate to brackish or freshwater in Suisun Bay, Montezuma Slough, and the lower reaches of the Sacramento and San Joaquin rivers. Spawning adults congregate at the upper end of Suisun Bay and in the lower and middle Delta, especially in the Sacramento River channel and adjacent sloughs (USACE 2015f). Spawning occurs primarily from January through March, after which most adults die (CDFG 2009a). In April and May, juveniles are believed to migrate downstream to San Pablo Bay. Juvenile longfin smelt are collected throughout the Bay during the late spring, summer, and fall and occasionally venture offshore as far as the Gulf of the Farallones. Juveniles typically inhabit the middle and lower portions of the water column (USACE 2015f).

Since 1967, CDFW has conducted monthly trawl surveys for longfin smelt during September through December at sampling sites throughout the Sacramento and Stockton DWSCs. The FMWT samples 122 stations each month from September to December and a subset of these data is used to calculate an annual abundance index. These 122 stations range from San Pablo Bay upstream to Stockton on the San Joaquin River, Hood on the Sacramento River, and the Sacramento Deep Water Ship Channel.Survey results from 8-year period 2010 through 2018 are presented in
Table 2-7. Longfin smelt populations have seen a significant decline since CDFW surveys began in 1967, when a total of 81,737 individuals were collected (CDFW 2015b).

Table 2-7. CDFW Fall Midwater Trawl Indices for Longfin Smelt.

Year	September	October	November	December	Total
2010	2	7	4	178	191
2011	68	16	92	301	477
2012	6	2	17	36	61
2013	8	28	21	107	164
2014	6	3	5	2	16
2015	0	0	0	4	4
2016	3	0	2	2	7
2017	6	23	25	87	141
2018	13	5	8	26	52

Source: CDFW 2015b, updated in 2019.

The annual abundance of longfin smelt is significantly and positively correlated with the amount of freshwater flow during spawning and larval periods (Baxter 1999; Hieb and Baxter 1993; Jassby et al. 1995; Stevens and Miller 1983). Three factors were identified as potentially responsible for this significant correlation: (1) a reduction in predation during high flows; (2) increased habitat availability that may improve survival by reducing intraspecies competition; and (3) an increase in nutrients stimulating the base of the food chain (Stevens and Miller 1983). However, the relationship changed to substantially lower longfin smelt abundance after the introduction of the invasive Amur River clam in the late 1980s. This corresponded with a decline in phytoplankton and zooplankton abundance due to grazing by the Amur River clam (Bennett et al. 2002). Other introduced species such as striped bass and inland silversides have had an impact on longfin smelt populations due to predation (CDFG 2009b).

In 2004, numbers of longfin smelt (along with other pelagic species including Delta smelt, striped bass, and threadfin shad) exhibited a sharp decline in abundance that has continued to the present time. The Pelagic Organism Decline (POD) phenomenon is currently under investigation to better understand how stock-recruitment effects, declines in habitat quality, increased mortality rates, and reduced food availability due to invasive species may be working separately or together to contribute to declining abundance of longfin smelt and other pelagic species.

Delta Smelt (Hypomesus transpacificus) (Federal Threatened, State Endangered). The delta smelt is a euryhaline fish with a habitat range extending from the lower reaches of the Sacramento and San Joaquin rivers, through the Delta, and into Suisun Bay. This Delta endemic species is currently found in very low abundance within the Sacramento and Stockton DWSCs.

Delta smelt was listed as a threatened species under the ESA on March 5, 1993 (58 FR 12854). The state status of delta smelt under CESA was elevated from threatened to endangered (March 4, 2009). On March 24, 2009, the USFWS initiated a 5 year status review of delta smelt. As of April 7, 2010, and again reconfirmed on December 5, 2014 (79 FR 72450), reclassification status of delta smelt to endangered was found warranted but precluded by other higher priority ESA listing actions (75 FR 17667).

Presence and abundance of delta smelt is closely associated with salinities between 0 and 7 practical salinity units (psu). The upper salinity tolerance for this species is 19 psu, with a strong preference for habitat near or upstream of the 2 psu isohaline. Delta smelt are not present in waters over 25°C and are rarely found in water temperatures above 22°C. Spawning habitat is present in dead-end sloughs, near inshore areas of the Delta, and shallow fresh water channels of the Delta and Suisun Bay. During the fall prior to spawning, delta smelt congregate in upper Suisun Bay and the lower reaches of the Delta. The spawning period is estimated to be from February to June. Delta smelt may prefer spawning over vegetation, if present, but often deposit their eggs over submerged tree branches and stems or in open water over sandy and rocky substrate, and they may even use the shallower areas of Delta levees. Eggs are demersal and adhesive. Newly hatched larvae float near the surface of the water, with movements following tides and discharge. Sommer and Meija (2013) state that delta smelt are more commonly associated with lower salinities and higher turbidities, moderate temperatures, and some tidal influence (USACE 2015f).

Larger juveniles and adults are most abundant during the spring and summer in Suisun Bay and the Delta, as evidenced from trawl and trap net catch data. Seasonal migrations occur within a short section of the upper estuary. Juvenile smelt move downstream to San Pablo Bay and Carquinez Strait before turning back to Suisun Bay or upstream sloughs for spawning. During average and high outflow years, delta smelt congregate from upper Suisun Bay to the Sacramento River near Decker Island. During low outflow and drought years, their pre-spawning congregations are centered in the channel of the Sacramento River and are rarely found further downstream in Suisun Bay (USACE 2015f).

Since 1967, CDFW has conducted monthly trawl surveys for delta smelt during September through December at sampling sites throughout the Sacramento and Stockton DWSCs. Survey results from the 8-year period 2010 through 2018 are presented in **Table 2-8** (CDFW 2015b).

Delta smelt are threatened by loss of estuarine habitat; entrainment during water diversion operations for the CVP, SWP, and the myriad of agricultural diversions; pulses of pesticides; food shortages; and predation by and competition from invasive species (Bennett 2005; CDFG 2009c; SWCA 2009). In 2004, scientific monitoring of aquatic organisms and water quality in the San Francisco estuary revealed a synchronous decline of several pelagic fish species (delta smelt, longfin smelt, striped bass, and threadfin shad) (Baxter et al. 2008). This POD is being investigated to better understand how stock-recruitment effects, declines in habitat quality, increased mortality rates, and reduced food availability due to invasive species, may be working separately or cumulatively to cause POD. Further information on the delta smelt is provided in the Biological Assessment (**Appendix G, Environmental - Attachment 4**).

Table 2-8. CDFW Fall Midwater Trawl Indices for Delta Smelt.

Year	September	October	November	December	Total
2010	6	12	0	11	29
2011	50	54	23	216	343
2012	0	23	12	7	42
2013	4	3	2	9	18
2014	4	4	0	1	9
2015	5	0	0	2	7
2016	0	0	8	0	8
2017	0	2	0	0	2
2018	0	0	0	0	0

Source: CDFW 2015b, updated in 2019.

Sacramento Splittail (Pogonichthys macrolepidotus) (State Species of Special Concern). The Sacramento splittail was federally-listed as threatened from 1999 to 2003 (68 FR 183) and is found exclusively in the Sacramento-San Joaquin Delta, Central Valley streams, and the Napa and Petaluma rivers. In 2003, the USFWS removed the splittail from the threatened species list, after litigation by water agencies challenged the listing. The listing was reconsidered following a 2009 suit by the Center for Biological Diversity, but it was determined the listing was not warranted. The species remains a state species of special concern.

The splittail is relatively long-lived (up to 9 years) and can grow up to 400 mm long. Historic populations occurred as far north as Redding in the Sacramento River, and as far south as Friant Dam near Fresno in the San Joaquin River. The splittail has adapted to living in estuarine systems and is tolerant of salinities from 10 to 18 parts per thousand. Young-of-year and yearling splittail abundance is highest in shallow water. Adults move slowly upstream during winter and spring to forage and spawn in flooded areas. The splittail's small, subterminal mouth with barbels and pharyngeal teeth, along with the large upper tail lobe, reflect their preference for feeding on bottom invertebrates in low to moderate current strength. Splittail reach adulthood in their second year at approximately 170 mm (USACE 2015f).

Since 1967, the CDFW has conducted monthly trawl surveys for Sacramento splittail during September through December at sampling sites throughout the Sacramento and Stockton DWSCs. Survey results from the 5-year period 2010 through 2014 are presented in **Table 2-9** (CDFW 2015b).

Populations of splittail have declined due to dams and other impassable barriers and modifications to flood basins that have reduced spawning habitat (Moyle 2002; UCCE 2010).

Table 2-9. CDFW Fall Midwater Trawl Indices for Sacramento Splittail.

Year	September	October	November	December	Total
2010	0	0	0	0	0
2011	15	0	0	0	15
2012	0	0	0	1	1
2013	0	0	0	1	1
2014	0	0	0	1	1
2015	0	0	0	0	0
2016	0	0	0	0	0
2017	0	0	0	1	1
2018	0	0	0	0	0

Source: CDFW 2015b, updated 2019

River Lamprey (Lampetra ayresii) (State Species of Special Concern) and Pacific Lamprey (L. [Entosphenus] tridentate) (State Species of Special Concern). Anadromous Pacific and river lamprey both occur in the project area. River lamprey in California have primarily been recorded within the Feather River and the lower Sacramento-San Joaquin River system, including both DWSCs. Less is known about the southern distribution of the river lamprey. Both species of lamprey have adult upstream migrations during the early spring and spawn from late spring to early summer in gravel substrates upstream of the Delta and lower Sacramento-San Joaquin river system (USACE 2015f).

During their upstream spawning migration, adult Pacific lamprey generally hibernate in freshwater for up to 1 year. They hibernate in substrates near their spawning area and do not feed prior to spawning the following year. River lamprey begin their transformation from ammocoete to adult form at about 120 mm total length, and Pacific lamprey at approximately 140 to 160 mm. River lamprey metamorphosis lasts from 9 to 10 months. During this time, both lamprey species congregate close to the saltwater-freshwater interface in estuaries. The lamprey's transformational stage between filter-feeding ammocoete and parasitic adult is known as macropthalmia. Adult teeth develop and grow during this period (USACE 2015f).

Migration of fully developed macropthalmia to the ocean likely occurs between late fall and spring, when outflows are high. However, some river lamprey may spend their entire life history in freshwater. River lamprey appear to be more parasitic in freshwater than Pacific lamprey. Adult river lampreys spend less time in the ocean or estuary migrating back to freshwater in the fall and winter. In general, adult Pacific lamprey migrate from stream to spawning areas in winter and spring (USACE 2015f).

During the 2014 USACE entrainment monitoring for Stockton and Sacramento DWSCs maintenance dredging, a total of 131 river lamprey were collected. During entrainment monitoring for maintenance dredging from 2005 through 2014, a total of 461 lampreys (211 river lamprey and 250 undetermined lamprey specimens) were collected (USACE 2015f).

<u>Sacramento Perch (Archoplites interruptus) (State Species of Special Concern)</u>. The Sacramento perch is a benthopelagic freshwater fish found in the Sacramento, San Joaquin, Pajaro, and Salinas River drainages (UCCE 2010). They prefer vegetated sloughs, pools in sluggish rivers, and lakes. Sacramento perch are most common in ponds and impoundments where they have been introduced throughout the state such as in Clear Lake and Alameda Creek (Crain et al. 2007). However, they may be mostly extirpated from their native Delta (FISHBIO 2010; Moyle 2002). These fish may be impacted by potential saltwater intrusion into freshwater habitat, though they are capable of surviving high temperatures, salinities of up to 17 parts per thousand, high turbidity, and low water clarity (UCCE 2010).

Sacramento perch are found along the bottom of inshore regions, feeding opportunistically throughout the day on small crustaceans within the sediment. Adult fish may feed on other fish, including juvenile perch. Sacramento perch reach sexual maturity in year 2 or 3 and generally spawn from March through early August when water temperatures range from -17.4 to -17.2°C. Prior to spawning, perch gather in shallow areas abundant with filamentous algae and macrophytes. Male perch create shallow nests, which are visited by a female. Upon release of eggs and milt, the female abandons the nest and the male remains to guard the nest and embryos for several days. Emergent larvae are planktonic for approximately 2 weeks.

Sacramento perch have not been collected during USACE community monitoring for Stockton and Sacramento DWSCs maintenance dredging (USACE 2015f).

<u>Striped Bass (Morone saxatilis) (Federally Protected Game Fish)</u>. Striped bass is a federally protected game fish (72 FR 205) introduced into the Delta in 1879 with the goal of introducing a commercial fishery. Within ten years of their introduction, the fishery had been established. Striped bass currently support one of California's largest commercial fisheries (CDWR 2013).

Striped bass move readily between saltwater and freshwater, spending most of their life cycle in estuaries. They are sensitive to temperatures above 25°C, but adults can also withstand the rapid changes in temperature that can be associated with changes in salinity. Striped bass need three very specific habitat features: (1) a large cool river for spawning, with enough flows sufficient to keep larvae suspended as they drift downstream to the estuary; (2) a large waterbody with plenty of fish to eat; and (3) a protective estuary for juveniles to grow by feeding on invertebrates. In California, the only area that satisfies these criteria is the San Francisco Bay estuary and its surrounding water bodies (UCCE 2010). Striped bass populations spend the majority of their time in bays but will move out into the ocean during El Niño years and winter in the Delta until the end of the spawning season.

Since 1967, the CDFW has conducted monthly trawl surveys for striped bass (age-0) during September through December at sampling sites throughout the Sacramento and Stockton DWSCs. Survey results from the last 5 years (2010 through 2014) are presented in **Table 2-10** (CDFW 2015b).

Table 2-10. CDFW Fall Midwater Trawl Indices for Striped Bass (age-0).

Year	September	October	November	December	Total
2010	16	5	11	11	43
2011	112	62	30	68	272
2012	20	16	14	75	125
2013	18	5	13	34	70
2014	8	2	4	45	59
2015	4	8	11	29	52
2016	43	4	5	72	124
2017	43	118	146	163	470
2018	4	16	9	13	42

Source: CDFW 2015b, updated 2019.

Marine Mammals. The most common marine mammals to inhabit the San Francisco Bay estuary are Pacific harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*). Other marine mammal species that occasionally inhabit the Bay and that could be considered transient visitors in the study area include the gray whale (*Eschrichtius robustus*), harbor porpoise (*Phocoena phocoena*), northern elephant seal (*Mirounga angustirostris*), Steller sea lion (*Eumetopias jubatus*), northern fur seal (*Callorhinus ursinus*), and, less frequently, the southern sea otter (*Enhydra lutris*) (URS 2003). On rare occasions, individual humpback whales (*Megaptera novaeangliae*) have entered the Bay. Marine mammals generally do not occur in Delta rivers, although in 2014 a wayward sea lion was found in the San Joaquin River (USFWS 2014).

Pacific harbor seals are non-migratory, have limited seasonal movements associated with foraging and breeding activities, and use the Bay year-round (Kopec and Harvey 1995). Harbor seals forage in shallow waters on a variety of fish and crustaceans and, therefore, can occasionally be found foraging in the study area. Harbor seals haul out in groups ranging in size from a few individuals to several hundred. Habitats used as haul out sites include tidal rocks, bayflats, sandbars, and sandy beaches (Zeiner et al. 1990). California sea lions breed in Southern California and along the Channel Islands. After the breeding season, males migrate up the Pacific Coast and enter into the Bay. During anchovy and herring runs, approximately 400 to 500 sea lions (mostly immature males) feed almost exclusively in the North and

Central Bay (USFWS 1992) and could occasionally forage in the study area. There are no haul-out sites for either the harbor seal or the California sea lion within the Federal navigation channels.

Essential Fish Habitat. The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) was enacted to maintain healthy populations of commercially important fish species. Under the Magnuson-Stevens Act, eight regional Fishery Management Councils are responsible for developing Fishery Management Plans (FMP) to manage the specified commercial species. The Sustainable Fisheries Act of 1996 amended the Magnuson-Stevens Act, requiring the protection of the habitats of species for which there is a fishery management plan. These habitats are designated as Essential Fish Habitat (EFH), being defined as "…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH can consist of both the water column and the underlying surface (e.g., seafloor) of a particular area, and it includes those habitats that support the different life stages of each managed species. A single species may use many different habitats throughout its life to support breeding, spawning, nursery, feeding, and protection functions. As shown in **Figure 2-9**, the study area is within the EFH for Pacific salmon, Pacific groundfish (fish that live on, in, or near the bottom of the water body they inhabit), and coastal pelagic species (fish that inhabit the water column, neither near the bottom nor shore of the water body they inhabit).

The Pacific salmon FMP includes Chinook and coho salmon (*Oncorhynchus kisutch*), and on occasion includes pink salmon (*Oncorhynchus gorbuscha*), sockeye (*Oncorhynchus nerka*), and chum (*Oncorhynchus keta*). The Pacific Groundfish FMP is designed to protect habitat for more than 90 species of fish, including rockfish, flatfish, some sharks and skates, and other species that associate with the underwater substrate, including both rocky and soft substrates. The coastal pelagic species EFH is defined as all marine and coastal waters from the shoreline offshore to the limits of the exclusive economic zone. The coastal pelagic FMP includes market squid (*Loligo opalescens*), Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel *(Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*).

Eelgrass Beds. Eelgrass requires specific environmental conditions to flourish, primarily salinity, light transmittance, and water depth. The proposed dredging areas within the study area include waters which are generally too deep, turbid, and fresh for eelgrass to survive. Thus, eelgrass is not expected to be present in the channel areas where dredging operations would take place.

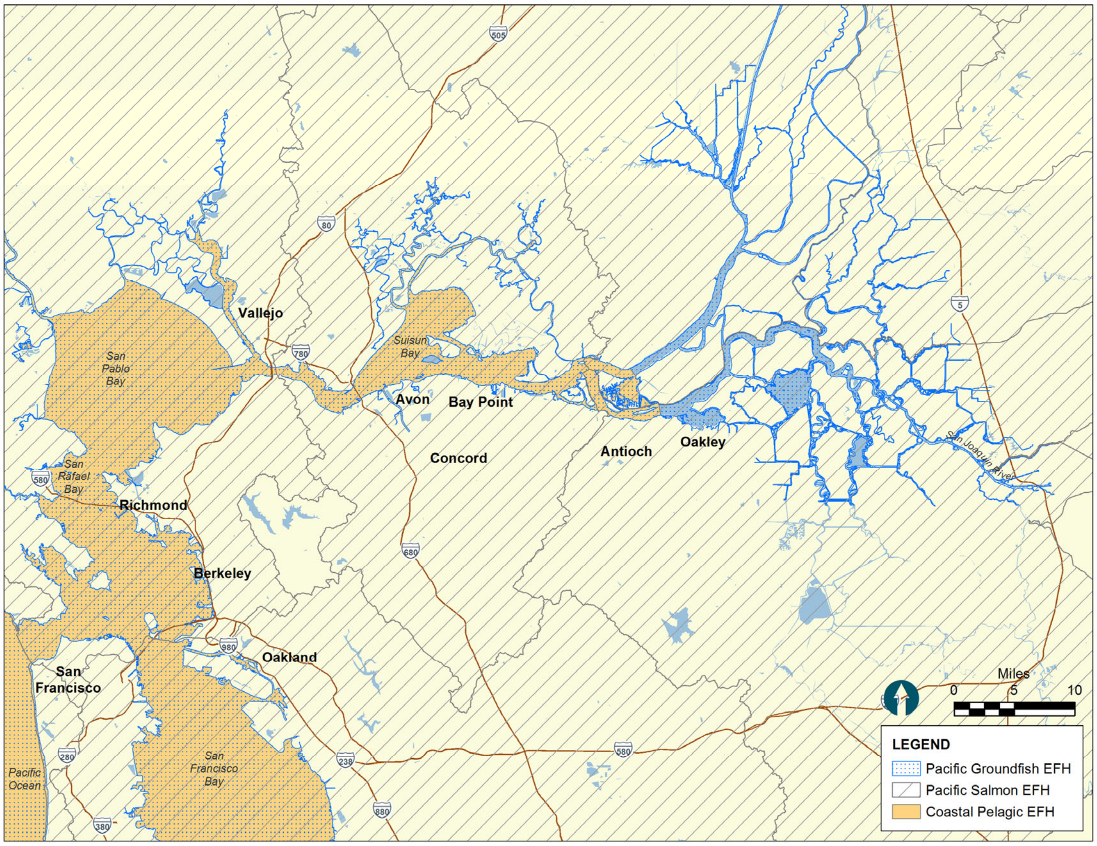


Figure 2-9. Essential Fish Habitat for Pacific Groundfish, Pacific Salmon, and Coastal Pelagic Fish in the Northern San Francisco Bay System.

Wildlife Management Areas. Figure 2-10 shows the wildlife management areas and national wildlife refuges in the study area that are managed by the CDFW, the USFWS, or similar entities. In these areas, lands are either enhanced for wildlife or permanently protected from development (USFWS 2010). The Federal Antioch Dunes National Wildlife Refuge (NWR) is located along the southern shore of the San Joaquin River south of West Island (USFWS 2010). It was the first NWR in the United States established to protect endangered plants and insects (USFWS 2010b). Established in 1980, the refuge provides protection for three endangered species: Lange's metalmark butterfly (*Apodemia mormo langei*), Antioch Dunes evening primrose (*Oenothera deltoides ssp. howellii*), and Contra Costa wallflower (*Erysimum capitatum*) (USFWS 2010b). The state-run Lower Sherman Island Wildlife Area is located at the confluence of the Sacramento and San Joaquin rivers (CDFG 2010). It includes approximately 3,100 acres of primarily marsh and open water habitat in the western Delta (CDFG 2010). The project area of San Pablo Bay and the Bulls Head Reach portion of Suisan Bay do not include any wildlife management areas.

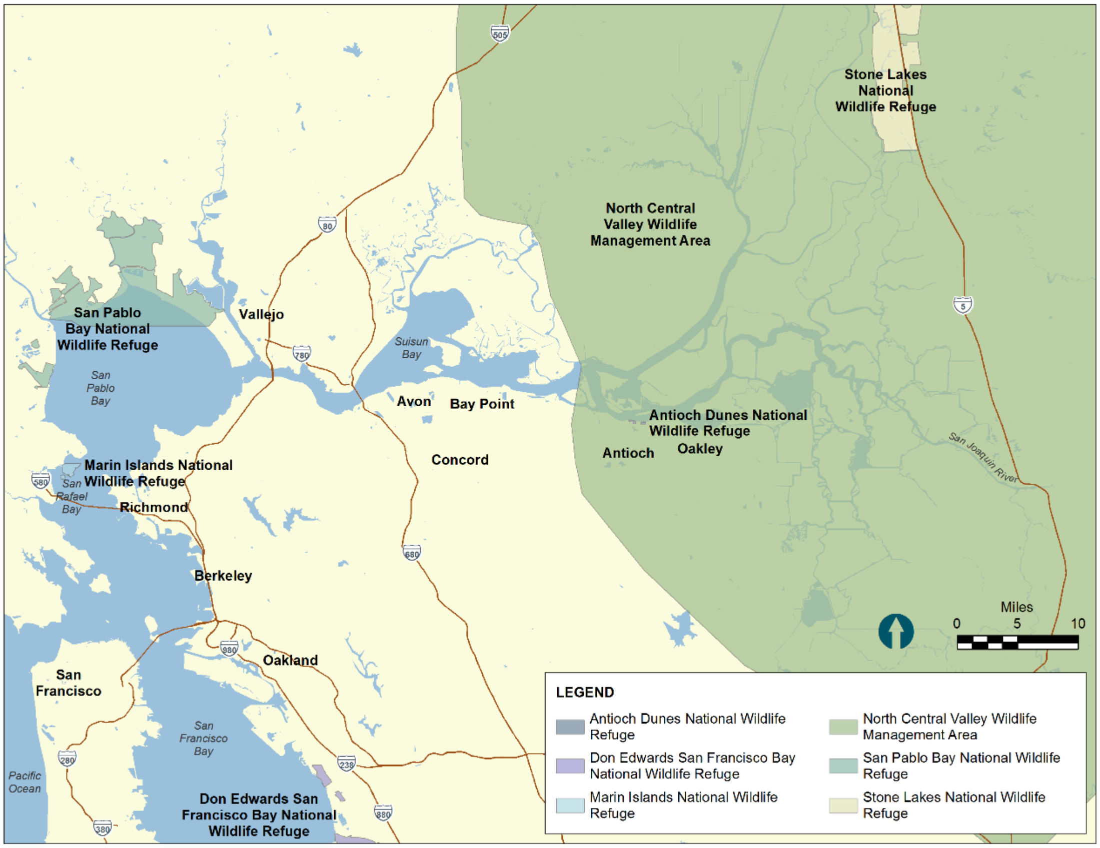


Figure 2-10. National Wildlife Refuges and Wildlife Management Areas in the Study Area.

2.2.7 LAND USE AND PLANNING

Marin County. The jurisdictions included within Marin County include the cities of Tiburon, San Rafael and Novato. There is moderate to low development in the Richardson Bay planning area, which contains watersheds that drain to Richardson Bay. The San Rafael Basin planning area is primarily within a city-centered corridor and is more highly developed. The Novato planning area is part of the city-centered/Baylands corridor, which generally contains watersheds that also drain to San Pablo Bay, and includes the unincorporated community of Bel Marin Keys and the Hamilton Wetlands Preserve (Marin County 2007).

Contra Costa County. As a whole, Contra Costa County is relatively undeveloped. Growth in the County is broken into the subareas of West County, Central County and East County. In the West and Central County areas, the suburban cities and towns are primarily residential, commercial, and industrial. In the East Central County and East County areas, land use is designated primarily for agriculture and general open space. The West County area consists of five cities, four of which (Richmond, Pinole, Rodeo and Hercules) are located in the study area. The city areas are developed with a wide variety of uses, but mostly contain a proportional mix of principal urban land uses. The Central County area includes the City of Martinez; the East County area includes Pittsburg, Oakley and Antioch. The affected uses within the Central and East County areas are predominantly residential, agricultural, recreational and open space. In these areas, development is concentrated in collections of small urban communities and mid-sized cities (Contra Costa County 2005).

The Contra Costa County Northern Waterfront is also located within the study area. The Northern Waterfront is approximately one-mile-wide and 55 miles long and contains 63.86 square miles. It includes six cities, several unincorporated communities, and a variety of unincorporated pockets of land (developed and undeveloped) located in the county. Within the Northern Waterfront there is a wide range of land uses from industrial, commercial, residential, marinas, public, and recreational uses, to natural habitat, open space, and wildlife refuges (Craft Consulting Group and Cambridge Systematics 2013) [CCG&CS]. The Northern Waterfront is located between the Port of Richmond on the west and the Ports of West Sacramento and Stockton on the east. Along this stretch of the John F. Baldwin Channel from the Carquinez Strait to Suisun Bay and the Delta there are a number of marine terminals and wharfs. These facilities are privately owned and primarily serve the adjacent manufacturing operations which include: C&H sugar refinery in Crockett; Tesoro and Shell at Martinez and Phillips 66 in Rodeo; the Mirant power plant, Dow chemical plant, and the USS-POSCO's steel-coil processing plant in Pittsburg (CCG&CS 2013).

Solano County. Solano County is divided into two topographic sections. The study area extends into the foothills of the coastal range and is characterized by steep slopes, which become more gently rolling in the east. The remainder of the County is part of the Sacramento Valley, which is characterized by level topography, with some isolated areas of low rolling hills. Approximately 14 percent of the total land area of the County is in cities. The remainder of the County (over 329,000 acres) is in agricultural use, 70 percent of which is unincorporated. The southern extent of the County (including the cities of Vallejo and Benicia), consists of waterfront area adjacent to San Pablo Bay and the John F. Baldwin Channel. Development in Vallejo and Benicia is a mixture of open space, residential, commercial, and waterfront. Agricultural land is concentrated in the eastern portion of the County and includes the watershed lands contiguous with the water bodies. A significant feature of the County is the Suisun Marsh, which has an area of more than 30 square miles (Solano County 2008).

2.2.8 MINERAL RESOURCES

Mineral resource deposits are described based on broad geologic classifications or resource zones. For purposes of addressing mineral resources, the affected environment discussion focuses on mineral resources within the counties adjacent to the navigation channels in the study area. Information was obtained directly from maps, interpretation of aerial photographs, and from plans and other documents associated with the various jurisdictions within which the study area coincides.

The mineral resources within the study area are shown in
Figure 2-11 and described in detail below.

Marin County

Of the eight mineral resource sites designated in Marin County, four are located in proximity to the study area and include:

- Ring Mountain (Tiburon Peninsula): A 190-acre site that is considered to be a Scientific Resource Zone rather than a production site due to the rare geologic formations found there. The site contains rare, colorful and enigmatic metamorphic rock as well as many species of rare plants. This preserve is the type location for the mineral Lawsonite.
- Section D-1 Novato Conglomerate (Black Point): Located adjacent to Bel Marin Key, this site is located within the city of Novato and is an alluvial resource, which contains a thick accumulation of well-

rounded pebbles, cobbles and boulders in a well-cemented sandy matrix. This material has been found to be suitable for use in Portland Concrete Cement.

- Sector D-2 Novato Conglomerate (Black Point): Located adjacent to Bel Marin Key, this site is located at the Renaissance Faire/Living History Centre and was once quarried for the conglomerate it contains. The material in this sector is a similar alluvial deposit as in Sector D-1 above.
- Sector I Franciscan Complex Sandstone (San Pedro Hill): This site is located at the tip of the San Pedro Peninsula just outside San Rafael City limits and has been mined since the beginning of the 20th century. The site has yielded crushed stone suitable for Portland Cement Concrete aggregate and rip rap. Shale deposits are also present and these materials have been developed by several quarries throughout the years to supply bricks, tile and lightweight aggregate (Marin County 2005b).

Figure 2-11. Mineral Resources.

Contra Costa County
The only mineral resource located near the study area in Contra Costa County is the shale deposit located on land near Port Costa. The Carquinez Strait Regional Shoreline Park surrounds the site. The mineral deposit is designated for protection in the County Conservation Plan (Contra Costa County 2005).

Solano County
The only regionally significant mineral resource near the study area in Solano County is the Sulphur Springs Mountain Deposit, which is a deposit of igneous rock from which aggregate is produced. The aggregate is used in the manufacture of asphaltic concrete, Portland Cement Concrete, rip-rap, drain rock and road base. An active quarry within the deposit exists along Lake Herman Road west of Lake Herman in the boundary hills between Benicia and Vallejo. Quarrying there has resulted in a cut face, which is visible from the Lake Herman area. Several abandoned mercury mines exist in the Sulphur Springs Mountain area. These mines have not been in production since the mid-1940s. This deposit is located on land and not in the navigation channel (Solano County 2008).

2.2.9 AGRICULTURE
There are no agricultural resources within the zone of impact (one-mile buffer) of the channel or the proposed beneficial reuse locations. Agricultural resources within the surrounding counties are too distant to potentially experience direct impacts by the alternatives considered, and no possible indirect effects can be identified.

2.2.10 AESTHETICS
The navigation channels within the portion of San Francisco Bay, San Pablo Bay and the small part of the Carquinez Strait included within the study area can be seen from parks, industrial areas, bridges, some roads, recreational boating, and residential areas. The area includes scenic views of water, hills, bridges, ships in the shipping channel, and recreational boats.

Sensitive visual receptors are locations or populations particularly exposed to visual impacts, or zones where visual impacts would be more apparent than elsewhere. They include residential areas and park users, such as those within the Point Pinole Regional Shoreline and Knox/Miller Regional Shoreline Parks in Richmond; China Camp State Park in Marin County; and the Martinez Regional Shoreline Park. Topography varies from beach areas adjacent to the waterways to higher elevations on natural hillsides. Lighting from urban uses exists in developed areas and on transportation infrastructure such as roads and bridges.

Most of the deep draft navigation channels in the study area are visible from open space; parks; agricultural, industrial, commercial, and residential land uses; bridges and some roads and recreational boating areas. The topography ranges from flat areas to hillsides. Existing users of the waterways are comprised of large ships, such as car carriers; other cargo ships; oil tankers; tug boats; barges; maintenance dredging equipment; and recreational users, such as small motor boats, sailboats and non-motorized craft, such as kayaks and paddle boards.

2.2.11 CULTURAL RESOURCES
This section summarizes existing cultural and historic resources that are located within the study area. For the purposes of this discussion the Area of Potential Effects (APE) is approximately ¼ mile around the project features where cultural resources could be impacted. The boundary of the APE will be further

refined during PED. Cultural resources include prehistoric and historic archaeological sites; architectural properties such as buildings, bridges, and infrastructure; and resources of importance to Native Americans (traditional cultural properties and sacred sites). "Artifacts" include any objects manufactured or altered by humans. The following are common terms used to discuss the regulatory requirements and treatment of cultural resources:

- ***Cultural resources*** describe several different types of properties: prehistoric and historical archaeological sites; architectural properties such as buildings, bridges, and infrastructure; and resources of importance to Native Americans or other groups of people.

- ***Historic properties*** are defined by the National Historic Preservation Act (NHPA) as any prehistoric or historic district, site, building, structure, shipwreck, or object included on, or eligible for inclusion on, the National Register of Historic Places (NRHP), including artifacts, records, and material remains related to such a property.

- ***Historical resources*** include buildings, sites, structures, objects, or districts, each of which may have historical, prehistoric, architectural, archaeological, cultural, or scientific importance, and is eligible for listing or is listed in the California Register of Historical Resources (CRHR) or a local register of historical resources. The CRHR also includes resources listed in or formally determined to be eligible for listing in the NRHP, as well as some California State Landmarks and Points of Historical Interest.

This section summarizes the cultural and historic settings of the general region within which the affected environment is located, and discusses in more detail the prehistoric and historic resources relevant to the study area.

Prehistoric Period. During the last major ice age, what is now San Francisco Bay was well above sea level, with today's underwater areas being an exposed valley of dry land. Within that valley, converging rivers drained through the Golden Gate and across the continental shelf toward the then Pacific coastline. Glacial melt began approximately 15,000 years ago, and meltwaters began filling San Francisco Bay around 10,000 to 11,000 years before present (B.P.). Around 8,000 B.P., marine waters rose to levels sufficient to enter San Francisco Bay. Sea levels rose rapidly until approximately 6,000 B.P., and have continued to rise more slowly since then (Moratto 1984).

San Francisco Bay, San Pablo Bay, the Carquinez Strait, Suisun Bay, the San Joaquin River and surrounding waterways, marshlands and uplands were used extensively by humans during prehistoric and historic times. Before circa A.D. 1770, around the time of the first major European contact, the San Francisco Bay and Delta regions were occupied by Miwok, Patwin, and Costanoan/Ohlone Native American people. The Costanoan/Ohlone population in 1770 has been estimated at 7,000. Archaeological remains related to the prehistoric occupation of the area are evidenced by hundreds of shellmounds and occupation sites that lined the shores of San Francisco, San Pablo, and Suisun Bays. Native people were also known to produce and use the naturally-occurring salt deposits that exist along San Francisco Bay. The locations of these shellmounds approximately follow the current shoreline, but also occur along major tributaries draining into the Bay (Moratto 1984).

Shellmounds are mounds or deposits containing shells, animal bones, and potentially human remains and other evidence of prehistoric settlement of an area. Many of the shellmounds known to be located around San Francisco Bay have been found in close relationship with marshy areas. A number of known shellmounds stand partially below current sea level, indicating that their accumulations began during lower water level occurrences in the past. Given the long duration for the bay water rise and human occupation of the shore zone, it is likely that earlier use and occupation sites, such as shellmounds, are present below current sea levels (Moratto 1984).

The configuration of the San Francisco Bay shoreline has also changed in the roughly last one hundred and fifty years due to deposition of gold mining sediments flowing downstream from hydraulic mining locations, agriculture, the narrowing of river channels through levee construction, construction of salt ponds, development of "man-made land," and more modern construction and fill near the shore. For example, it is estimated that 875 million cubic meters of sediment were deposited in the Bay between 1850 and 1914 as a result of mining in the Sierra Nevada foothills (Moratto 1984).

Spanish Time Period. Spanish explorers are said to have first visited the entrance to San Francisco Bay in 1769. Spanish explorers came into increasing contact with Native Americans in the first half of the 1770s as expeditions were led through the region. Travel from the sea into the Bay first occurred in 1775. Spanish exploration in the late 1700s and 1800s led to the establishment of permanent settlements along the coast of California, mostly in the form of missions (USACE and RWQCB 2015; USFW and CDFG 2008).

Mexican Time Period. In 1821 Mexico gained independence from Spain and California changed from Spanish to Mexican control. With this change in control came the relaxation of trade restrictions. Merchant ships, occasional whalers, and warships from the U.S. and Europe began freely entering the Bay. The change to Mexican independence brought new laws, administrators and a shift of power from missionaries to secular governors and ranching families. The decline of the missions allowed for the rise of extensive ranching along the California coast as well as in the Sacramento Valley area. What was then Native American land was divided into more than 500 land grants (i.e., Ranchos) distributed to prominent California families. Then followed a period of skirmishes and battles between the Mexican army and Native Americans. This and parceling of the land into Ranchos, along with epidemics of smallpox and malaria that spread through Native populations resulted in the further decimation of the Native population and culture (Paddison 2015; Sturtevant 1978; USACE and RWQCB 2015).

American Time Period. California became a part of the U.S. as a result of the Mexican-American War that ended in 1848. The Gold Rush (lasting from 1849 to approximately 1855) generated a large population increase of immigrants and gold seekers to California. The Gold Rush also resulted in a large increase in ships traveling into the Bay, with San Francisco becoming a major city and port. Various other cities also grew along the waterways within the Bay Area. Commercial whaling and salmon fishing began in the 1850s. Fishing and shrimping grew into major industries. Ferries became popular ways to travel throughout the Bay Area until the construction of train and car bridges, which caused people to switch modes of local travel (USACE and RWQCB 2015).

KEY RESOURCES OF THE STUDY AREA

Shipwrecks in San Francisco Bay. Since its exploration by Spanish navigators began in 1769, San Francisco Bay and its associated waterways have been the site of numerous shipwrecks. The California State Lands Commission (CSLC) has created a database of more than 1,500 shipwrecks off the coast of California and within its bays and waterways (CSLC 2015). The database includes the approximate latitude and longitude and other available information for each shipwreck. The data describes potential resource locations, since exact locations for many of the shipwrecks may not be known. In addition, NOAA's Automated Wreck and Obstruction Information Center includes over 13,000 listed shipwrecks and obstructions (NOAA 2013). Lastly, the U.S. National Parks Service (2015) maintains a list of shipwrecks that are on the National Register of Historic Places.

All three databases were searched for any known shipwrecks located in the areas that could be affected by the alternatives. No shipwreck locations listed on the NRHP were reportedly located in the area of potential effects (APE) of the alternatives considered. The CSLC database identifies 172 shipwrecks within the counties bounded by the study area which sank between 1595 and about 1979, and 24 within the project vicinity. Two of these shipwreck locations are reported within 0.25-miles of the proposed APE. Even though some shipwrecks have been salvaged through time, the CSLC database does not indicate if such salvaging has taken place for any of the shipwrecks contained on its list of wrecks.

In addition, to the reported shipwrecks, USACE contracted a submerged cultural resource survey of portions of the proposed APE which is documented in a report titled *Report on a Nautical Archaeological Survey of Four Areas in the John F. Baldwin Ship Channel* (Sullivan and Allan 1996). The survey identified eight acoustic targets in the vicinity of the Pinole Shoal Channel that are believed associated with the schooner *Sagamore*, which sank in 1864. The potential wreck was designated as the Baldwin Channel Wreck but was not assigned a trinomial archaeological site number. Instead, the site was designated by the state with two primary numbers (07-002760 and 07-0598) due to its location along the boundary of two counties.

It is possible that many of the shipwrecks identified within the CSLC and NOAA databases were salvaged or intentionally demolished to reduce risks to ship traffic. Dredging has taken place in the Federal shipping channels for a number of years. Dredging may have removed or disturbed evidence of shipwrecks that potentially present within the study area; however, portions of the channel are not in active shoaling areas and may still contain intact cultural resources. A submerged cultural resource target cluster consisting of eight acoustic targets were identified as part of the Baldwin Channel Wreck site within the Pinole Shoal Channel. The wreck was located in the vicinity of the rock outcropping just west of Pinole Shoal that is proposed for removal (07-002760 and 07-0598). These targets and the two other reported shipwreck locations may potentially be located on and/or within the bottoms affected by the alternatives are shown in **Table 2-11*.***

Table 2-11. A list of 24 historic shipwrecks reported within approximately 5-miles of the APE.

Project Features	Ship Name	Type	Year Sunk	Cause of Loss	County	Source
Pinole Shoals	*Ringleader*	Schooner	1869	Capsized	Contra Costa	CSLC 2011
San Pablo Bay	*Necanium*	Steam Schooner	1936	Foundered	Contra Costa	CSLC 2011
San Pablo Bay	*Fidelity*	Gas screw	1932	Burned	Contra Costa	CSLC 2011
Pinole Shoals*	*Sagamore*	Schooner	1864	Foundered	Contra Costa	CSLC 2011
Pinole Shoals	*Victor H. Kelly*	Tanker	1952	Burned	Contra Costa	CSLC 2011
Pinole Shoals*	*Harry*		1904	Storm	Contra Costa	CSLC 2011
Pinole Shoals	*Monarch*	Tug	1915	Collision	Contra Costa	CSLC 2011
Pinole Shoals	*Gold Hunter*	Steamship	1815	Collision	Contra Costa	CSLC 2011
Pinole Shoals	*Uncle Abe*	Schooner	1877	Stranded	Contra Costa	CSLC 2011
Pinole Shoals	*Stamboul*	Whaling Bark	1843		Contra Costa	CSLC 2011
Pinole Shoals	*Amelia*		1889	Burned	Contra Costa	CSLC 2011
Suisan Bay	*Sacramento*	Schooner	1866		Contra Costa	CSLC 2011
Suisan Bay	*J. Bragdon*		1853		Solono	CSLC 2011
Suisan Bay	*Fredrick Williams*	Schooner	1870	Stranded	Solono	CSLC 2011
Suisan Bay	*Tennessee*	Steamship	1851	Collision	Solono	CSLC 2011
Suisan Bay	*Montezuma*	Gas screw	1925	Burned	Solono	CSLC 2011
Suisan Bay	*Amelia*	Steamship	1874	Stranded	Solono	CSLC 2011
Suisan Bay	*Emma Adelia*	Schooner	1870	Burned	Solono	CSLC 2011
Suisan Bay	*Alden Anderson*	Steam Screw	1924	Burned	Contra Costa	CSLC 2011
Suisan Bay	*Comanche*	Steamboat	1853	Collision	Contra Costa	CSLC 2011
Cullinan Ranch WL	*Villa*	Sloop	1869	Capsized	Solano	CSLC 2011
Montezuma WL*	*Covina*	Gas screw	1926	Burned	Solano	CSLC 2011
Suisun Bay	*Forrester*	Schooner	1935	Stranded	Contra Costa	CSLC 2015
Suisun Bay	*Charles B. Kennedy*	Barge	1926	Wrecked	Contra Costa	CSLC 2015

** Denotes shipwrecks reported sunk within 0.25 miles of the APE.

2.2.12 ENVIRONMENTAL JUSTICE

The specific affected areas for Environmental Justice (EJ) impact analysis were determined in accordance with the Council of Environmental Quality's (CEQ) guidance for identifying the "affected community." This requires consideration of the nature of the likely project impacts and identification of an associated Area of Potential Effects (APE) within a corresponding unit of geographic analysis.

For the purpose of EJ analysis, the APE corresponds to the areas of effect associated with the specific environmental issues analyzed in this document. The APE includes communities (U.S. Census-designated places such as towns, cities, and neighborhoods) adjacent to the navigation channels: Tiburon, Corte Madera, Larkspur, San Rafael, Santa Venetia, Novato, Black Point – Green Point, Richmond, Bayview – Montalvin, Pinole, Hercules, Rodeo, Crockett, Vallejo, Benicia, Martinez, Bay Point, Pittsburg, Antioch, Oakley, Bethel Island, Country Club, and Stockton. The unincorporated community of Avon is heavily industrialized and does not have residents, so it is not a Census-designated community.

Census data describing residents of the communities in the APE are shown in Error! Reference source not found.. In the study area, the communities of Richmond, Hercules, Vallejo, and Rodeo have a greater percentage of minority residents than the APE as a whole. Richmond also has a higher percentage Hispanic or Latino residents than the APE as a whole. Therefore, impacts that disproportionately affect residents of these communities more than other communities in the APE could constitute an EJ impact.

Table 2-12. Characteristics of the Residents of the APE[1]

Towns and Cities Comprising the APE		Percent Minority (Non-White)[2]	Percent Hispanic or Latino	Percent in Poverty[3]	Percent Under Age 18
	Tiburon	12	5	5	25
	Corte Madera	16	8	4	27
	Larkspur	14	8	4	19
	San Rafael	29	30	12	22
	Santa Venetia	22	19	7	20
	Novato	24	21	7	25
	Black Point-Green Point	9	9	1	17
	Richmond	69	39	19	28
	Bayview-Montalvin	50	30	8	26
	Pinole	54	22	9	23
	Hercules	78	15	6	26
	Rodeo	56	25	9	27
	Crockett	20	16	11	15
	Vallejo	67	23	18	23

[1] APE = Area of Potential Effect (Consists of the communities of Tiburon, Corte Madera, Larkspur, San Rafael, Santa Venetia, Novato, Black Point – Green Point, Richmond, Bayview – Montalvin, Pinole, Hercules, Rodeo, Crockett, Vallejo, Benicia, Martinez, Bay Point, Pittsburg, Antioch, Oakley, Bethel Island, Country Club, and Stockton)

[2] Any person identifying as other than "one race, White"

[3] *Source: U.S. Census Bureau 2013.*

Table 2-13 compares data describing residents of the APE to data describing residents of the surrounding 7-county region within which the APE is located and to the State of California as a whole. Based on the data, the APE does not have a greater proportion of residents who are children (e.g., under the age of 18) or living in poverty (e.g., family of 4 with a household income of $23,550.00) compared to the surrounding 7-county region as a whole. The APE also does not contain a greater proportion of residents who are Hispanic or Latino, children, or living in poverty compared to California as a whole.

However, **Table 2-13** does show the APE has a greater proportion of residents who are Hispanic or Latino than the totality of the surrounding 7 counties. In addition, the APE has a greater percentage of residents who are minority compared to both the entire 7-county region and California as a whole. In summary, the APE is located in a part of the surrounding region that has a higher degree of minority and Hispanic or Latino residents.

Table 2-13. Comparison of Residents of the APE to Residents of the Region and State.[1]

Location	Percent Minority (Non-White)[2]	Percent Hispanic or Latino	Percent In Poverty	Percent Under Age 18
APE[3]	53	32	18	27
Surrounding Region[4]	44	26	16	26
California	42	38	17	25

[1] *Source: U.S. Census Bureau 2013.*
[2] Any person identifying as other than "one race, White"
[3] APE = Area of Potential Effects
[4] Surrounding Region = Marin, Sonoma, Napa, Contra Costa, Solano, Sacramento, and San Joaquin Counties

2.2.13 NOISE

The study area deep draft channels are flanked by shorelines characterized by parks and open space, residential areas, industrial zones, bridges and some roads. The distance from the channel to the shoreline ranges from as little as 0.2 mile (at station 72+00 of the Bulls Head Reach alignment) to as many as 7.76 miles (at station 113+00 of the Pinole Shoal Channel alignment).

Existing noise producers in the channels and waterways include large ships, such as car carriers, other cargo ships, oil tankers, tug boats, barges, maintenance dredging equipment and recreational users, such as motor boats. Along the Contra Costa shoreline, railroad noise contributes to the ambient noise, until the train tracks reach the railroad bridge across the Carquinez Strait between the Cities of Martinez and Benicia. Noise-sensitive receptors along the study area route include residential areas and park users, such as those within the Point Pinole Regional Shoreline and Knox/Miller Regional Shoreline parks in Richmond, China Camp State Park in Marin County, and the Martinez Regional Shoreline Park. Recreational boaters may also be noise receptors in the study area.

Ambient noise levels along shoreline areas of Contra Costa County adjacent to the study area range from 60 to 65 dB (L_{dn}) near roadways and trains, and 70 and 75 dB (L_{dn}) adjacent to the two bridges (Contra Costa County 2005).

2.2.14 PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS

Hazardous Materials Sites. Sites potentially containing hazardous materials were identified through database record searches for sites with known or potential hazardous waste and/or materials within the study area. This included a search of the California Department of Toxic Substances Control (CDTSC) EnviroStor database (CDTSC 2015), the State Water Resources Control Board (SWRCB 2015) GeoTracker database and the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration's "Where we Work" database (NOAA 2015). These databases list 83 sites with an active, open or unidentified status within 1,000 feet of the proposed deepening channel shoreline.

Hazardous Materials Transportation. Various products, including hazardous materials, are transported on shipping routes that cross the San Francisco Bay and the Sacramento-San Joaquin Delta. Transportation of hazardous materials involves some risk of spillage and subsequent contamination of soil, water or sediments. Hazardous materials shippers and transporters must comply with specific requirements of 49 CFR 171, including proper classification, labeling, packaging and handling.

Detailed information on commodities shipped and routes taken is not readily available due to security and proprietary reasons. However, entities that transport certain types and quantities of hazardous materials are required by the Hazardous Materials (HM)-232 final rule (49 CFR 172) to develop and implement security plans, as administered by the U.S. Department of Transportation's (DOT's) Research and Special Programs Administration. Security plans are considered "security sensitive information," available only on a "need to know" basis to those with relevant responsibilities or appropriate security clearance (Batelle and Total Security. US n.d.; 49 CFR 172, Section 172.802[c]). While non-disclosure of information concerning materials and routes is not a specific requirement of HM- 232, it is a common feature of security plans (Coleman personal communication as cited in ICF International 2013).

Information on specific types and quantities of hazardous materials transported through shipping channels in the study area is limited to publicly available information. Typical cargos at the Port of West Sacramento include cement, bulk and bagged fertilizer, pelletized Kaolin clay and anhydrous ammonia (ICF International 2013). Commodities brought through the Port of Stockton include bulk materials, such as aggregate, coal, petroleum coke, ores, clay, sulfur and anhydrous ammonia (Port of Stockton 2010).

Oil Production, Transport and Spills. Oil has been imported along the John F. Baldwin Ship Channel since at least the late nineteenth century. There are currently five refineries in Northern California, four of which are located in the study area. Shell, Tesoro, ConocoPhillips and Valero own four refineries. The fifth, Chevron, is located nearby at the Port of Richmond. There are also nine terminals that receive oil within the study area. Crude oil is the commodity imported to the terminals, while petroleum products are exported from the terminals.

A single oil spill has been recorded in study area waters. On February 10, 2015, the Shell refinery in Martinez reported a spill of crude oil from a line undergoing hydrostatic testing. The release occurred near the seaward end of the Shell pier, where a fixed containment boom is maintained. Response contractors were on the scene before sunset and applied additional containment boom and deployed skimmers (NOAA 2015). In addition to that occurrence, there is a single recorded instance of an oil spill attributable to a 2007 vessel collision in the San Francisco Bay (well out of the study area), when the *Cosco Busan* container ship struck a San Francisco-Oakland Bay Bridge tower, spilling 53,000 gallons of fuel oil (NOAA 2015).

2.2.15 RECREATION RESOURCES

The San Francisco Bay area and Delta combine to form a unique geographic region that provides exceptional recreational opportunities including boating, fishing, hunting, hiking, biking, camping and wildlife viewing. Across the Bay and Delta, opportunities for water and shoreline recreation are provided by wetlands, wildlife refuges, state parks, shoreline parks and waterfront areas, and landing/launching facilities (BCDC 2008). There are no national parks located in the study area.

Population is the most important driver of the demand for recreational opportunities in the San Francisco Bay region, including the demand for waterfront-oriented recreation. It is estimated that there is a pool of nearly 9.0 million persons considered to be potential recreationalists within a reasonable travel distance of the Delta and San Francisco Bay area (Delta Protection Commission 2005). Recreational users originate from both within and outside of these areas. The majority of the recreational activities within the Delta are focused on the navigable waterways which are publicly accessible. Boating use totals more than 6.4 million visitor days annually, and is composed of 2.13 million annual boat trips in the larger Delta-Suisun area (California Department of Water Resources 2007) [CDWR].

The existing supply of waterfront parks, beaches, 75 public fishing piers, regional trails, launching lanes and marinas in the San Francisco Bay area comprises a substantial part of the large, complex web of the region's recreational opportunities. The current waterfront park acreage in the region totals approximately 25,000 acres. The entire bay is relatively shallow, with narrow, deep channels near the Golden Gate Bridge and Carquinez Strait which tend to be maintained by tidal currents. Therefore, boating (including canoeing and sail boating), fishing, and windsurfing are common activities. There are 174 launching lanes (some ramps have multiple lanes) within the San Francisco Bay area, providing 18 percent of the State's boating facilities (BCDC 2006).

Most of the recreational facilities within the Delta are provided through private marinas and several thousand boat berths. Private facilities also provide launching facilities, recreational vehicle and tent camping, picnicking, restaurants, and bait and tackle shops.

Five fishing access/launching facilities owned by the California Department of Fish and Game and managed by Sacramento and Yolo Counties are located within the Delta. San Joaquin County provides land and water access at Westgate Park. Brannan Island State Recreation Area provides boat launching, camping, swimming, nature interpretation, and wind surfing. Hunting occurs mainly on private lands, although some hunting is allowed on state and federally owned lands and waterways (Delta Protection Commission 2015).

Marin County. Water-based recreational areas within Marin County include the San Pablo Bay National Wildlife Refuge, Marin Island National Wildlife Refuge, Hamilton Wetlands Preserve, and Corte Madera Marsh State Marine Park. Other recreational opportunities include camping, picnic areas, fishing access, trail access, and various preserves and state parks (e.g., Hamilton Wetlands Preserve, Tiburon Uplands Nature Preserve, China Camp State Park and Angel Island State Park). There are 17 public and private marinas within the study area channels that provide access to the Bay (CA Division of Boating and Waterways 2015).

Contra Costa County. Recreation areas within Contra Costa County include Browns Island (within the City of Pittsburg), Winter Island, Jersey Island, Bradford Island, Webb Tract, Holland Tract, Palm Tract, Orwood Tract, Knightsen area, and Coney Island, Bethel Island, Hotchkiss Tract and Veale Tract. Water areas include Big Break, partially owned by East Bay Regional Park District, Franks Tract and Clifton Court Forebay (Delta Protection Commission 2005). Access to these areas is provided by approximately 40 public and private marinas and launch facilities.

Other recreational opportunities include camping, picnic areas, fishing access (at a few marinas and at several sites created specifically for fishing), trail access, and three public parks (Antioch/Oakley Regional Shoreline, Barbara Price Marina Park and Riverview Park). In addition, Franks Tract State Recreation Area and Big Break allow public hunting access during waterfowl hunting season. The California Department of Fish and Game's Rhode Island Wildlife Area also allows fishing and hunting from boats only. In addition to these public opportunities, there are private hunting clubs operating on Winter Island and Veale Tract (Delta Protection Commission 2005).

Solano County. Solano County's recreational areas include Hastings Tract, Prospect Island, and Ryer Island. Waterways in the County include Barker Slough, Cache Slough, Hastings Cut, Hoss Slough, Lindsey Slough, the Sacramento River, and the Sacramento Deep Water Ship Channel. Solano County has four marinas (Arrowhead Harbor, Snug Harbor Resort, Hidden Harbor Marina and Delta Marina Yacht Harbor) and five launching facilities providing access to the Delta and nearby areas. All marinas and launching facilities are located along or near a confluence of the Sacramento River. Other recreational opportunities in Solano County include camping, fishing access, picnic areas, trail access, and one public park (Delta Protection Commission 2005).

2.2.16 SOCIO-ECONOMICS

The socio-economics of the surrounding community area are summarized in this section. The factors used to describe the demographic and socioeconomic environment include recent trends in population, as well as employment and income. More detailed information can be found in **Appendix D - Economic Analysis.**

2.2.16.1 POPULATION

California is ranked as the largest state in terms of resident population as of 2016, with 37.3 million residents. Between the years 1990 and 2010, California's population increased by 25.2%, from 29.8 million to 37.3 million people, which is higher than the national growth over the same historical period. All counties within the immediate economic regions of San Francisco Bay have seen a growth in population according to 2010 census data.

Census data from 2010 show increases in population across the bay area. Specifically, Contra Costa County (10.6 percent), Solano County (4.8 percent), and Marin County (2.1 percent). San Francisco is the largest city in the bay area, with a population of more than 800,000, followed by Stockton (291,707), Concord (122,067), and Vallejo (115,942).

Population projections (California Department of Transportation) forecast an increase of 8.12% from 2020 to 2030 and 6.52% from 2030 to 2040.

2.2.16.2 EMPLOYMENT AND INCOME

California private sector annual employment in 2014 totaled 13.5 million, with average annual wage of $69,880. Of the major industry sectors within the State, the Health Care and Social Assistance sector employs the most persons, with 2,000,372 employees. Retail Trade and Accommodation and Food Services follow closely behind in total employed persons, with 1,623,371 and 504,176 employees, respectively. County industry sectors yield employment distributions similar to the State level, with few exceptions.

Of the private sector industries, Mining, Quarrying, and Oil and Gas Extraction sector employees are paid the highest in average annual earnings, slightly over $138,000, followed by Information sector employees, earning on average $136,214. The average annual earnings of Mining, Quarrying, and Oil and Gas

Extraction sector employees nearly doubles the average annual wage earnings across all industry sectors. In December of 2014, the unemployment rate in California was 7 percent, higher than all but two other locations in the U.S. (Mississippi and Washington, D.C.). In October of 2015, California experienced the largest job growth in the country, adding nearly 41,200 new jobs and bumping its unemployment rate down to 5.8 percent.

2.2.16.3 SPECIFIC SOCIO-ECONOMICS IN THE STUDY AREA

According to the 2010 U.S. Census, the Bay Area and the State of California have higher percentages of minority populations relative to the total United States population. Within the Bay Area, approximately 55 percent of the population identified as White, 8.3% of the population identified as Black or African American, 18.5 percent of the population identified as Asian, and 11.1 percent of the population identified as Other. San Francisco County contained the highest percentage of minority populations relative to other area counties.

As a whole, the Bay Area in 2010 had a higher median age than the State of California and equaled the median age for the United States. Marin County and Contra Costa County all had median ages higher than or equal to the State and National median age. Solano County's median age was higher than the State level, but lower than the National level.

All counties had higher median household (2010 Census) incomes than the State of California.

Marin County had the highest median household income and per capita income. Marin County, Contra Costa County, and Solano County all had lower percentages of people living below poverty level compared to the State of California.

Marin County and Contra Costa County had higher percentages of people over the age of 25 that earned a Bachelor's Degree or higher when compared to the State of California and the United States. Solano County had lower percentages of people over the age of 25 that earned a Bachelor's Degree or higher, at 24.3 percent and 18.1 percent, respectively.

2.2.16.4 ECONOMIC SPENDING

Maritime infrastructure and recreation are the economic spending components included in this analysis due to their potential to be impacted.

Maritime Infrastructure. The major ports in San Francisco Bay include the ports of San Francisco, Oakland, Redwood City and Richmond. Contra Costa's Northern Waterfront includes ports and marine terminals on San Pablo Bay, Carquinez Strait, Suisun Bay and the Sacramento-San Joaquin River. The river ports include the Port of West Sacramento (79 nautical miles from the Golden Gate Bridge through the San Francisco Bay and the 30 foot deep Sacramento Ship Channel). The river ports are broadening their base away from their heavy dependence on construction materials by developing new export and import operations (Craft Consulting Group and Cambridge Systematics 2013) [CCG&CS].

The Bay Area ranks as the fourth largest exporting region in the U.S. in terms of tonnage. While the Port of Oakland handles 82 percent of the region's maritime trade, the Bay Area's ports at Richmond, Benicia, San Francisco and Redwood City, plus the inland port at Stockton, also handle significant maritime trade. The Port of Stockton is the primary Northern California port for bulk cargo, with the remainder handled at San Francisco and Redwood City. Richmond and Benicia handle mostly automobiles and trucks. Although it is a substantial maritime center, Northern California handles only 10.7 percent of West Coast tonnage, which primarily passes through the Port of Los Angeles (31.9 percent) and the Port of Long Beach (25.6 percent) (CCG&CS 2013).

Recreation. Recreational opportunities provide a large economic benefit to the region and to the State as a whole. Annual gross receipts in the Delta are over $247 million by boaters and over $186 million by anglers, as reported in the 1998 Delta Recreational User Survey report prepared by the U.S. Department of Agricultural and Resource Economics for the Delta Protection Commission and the Department of Boating and Waterways. These two recreation groups also impact spending on other industries (e.g., groceries, restaurants, gas stations and drugstores) in connection with their boating and fishing activities. When a multiplier was incorporated into the model to account for actual expenditures plus value-added dollars in the Delta, the annual estimated figures rose to over $444 million for boaters and over $336 million for anglers.

2.2.17 NATIVE AMERICANS

USACE has initiated consultations with Native American tribes with interests in the project area including Amah Mutsun Tribal Band of Mission San Juan Baptista, Cloverdale Rancheria of Pomo Indians, Coastanoan Rumsel Carmel Tribe, Cortina Rancheria Kletsel Dehe Band of Wintun Indians, Dry Creek Rancheria Band of Pomo Indians, Federated Indians of Graton Rancheria, Indian Canyon Mutsun Band of Costanoan, Kashia Band of Pomo Indians of the Stewarts Point Rancheria, Lytton Rancheria, Middletown Rancheria, Mishewal Wappo Tribe of Alexander Valley, Muwekma Ohlone Indian Tribe of the SF Bay Area, North Valley Yokuts Tribe, Ohlone Indian Tribe, United Auburn Indian Community of the Auburn Rancheria, Wilton Rancheria, and Yocha Dehe Wintun Nation. These tribes have a long history of living in the vicinity of the project area and maintain a strong connection to the region through continued use. In addition to the federally-recognized tribes, additional tribes who are not federally recognized have expressed a general interest in projects in the general vicinity of the study. The following tribes have provided responses to letters sent asking for input on the project on January 31, 2019 (see **Appendix H, Cultural Resources Correspondence**): the United Auburn Indian Community of the Auburn Rancheria, Wilton Rancheria, the Indian Canyon Band of the Costanoan, Lytton Rancheria, Northern Valley Yokut, Wilton Rancheria, and the Yocha Dehe Wintun Nation.

2.3 NAVIGATION ENVIRONMENT

2.3.1 VESSEL USE AND OPERATION

EXISTING CONDITIONS

Vessel traffic movement in the study area is managed by the San Francisco Bar Pilots, in coordination with the U.S. Coast Guard's Vessel Traffic Services (VTS). A bar pilot will board all deep draft vessels calling on ports and harbors, beginning at the offshore sea buoy, before vessels enter the San Francisco Bay through the -55 foot MLLW Main Ship Channel.

Once aboard, the pilot updates VTS with location and destination information, as well as any safety concerns, as necessary. In turn, VTS keeps pilots alert of other vessels, including other deep draft vessels, ferries, recreational vessels, tugs, and dredges navigating in the Bay. This close coordination between the bar pilots and VTS helps maintain safe navigation in the Bay Area. Early coordination between shipping companies and the bar pilots ensures that deep draft vessels arrive at the pilot station with an appropriate draft meeting under-keel regulations and at specific times such that vessels having deeper drafts can take advantage of prevailing tidal conditions to ”ride the tide” if necessary.

Astronomical tides in the San Francisco Bay area are mixed, semi-diurnal, with two highs and two lows of unequal height occurring each lunar day. The largest changes in water level typically occur as the tide falls from higher high to lower low water, an event generally requiring 7 to 8 hours. Tidal influence causes water in the San Joaquin River to flow out to sea during ebb tide, while reversing flow upstream towards Stockton during flood tide.

In the bay area, a 2 foot under-keel[3] clearance is required for non-hazardous material, and a 3 foot under-keel clearance is required for hazardous material (i.e., petroleum). This safety measure helps reduce the risk for a vessel to run aground while transiting the channel. Considering prevailing tidal conditions, the shallowest portion of the channel which the vessel must navigate determines the operating draft of each vessel.

Daylight restrictions, fog conditions, excessive shoaling, and other factors further restrict the maximum allowable draft of vessels over the course of the year. Maximum vessel drafts using the channels over the past 5 years have averaged about -33.5 feet for bulk and general carriers, and -29.5 feet for liquid tankers. These maximums take into account the required under-keel clearances for the different vessel types.

Often deep draft vessels will take advantage of tides higher than MLLW to allow for deeper drafts of ships transiting the channels. For example, an oil tanker with a required 3 foot under-keel travelling to an oil terminal in the vicinity of Carquinez Strait may arrive at the offshore pilot station with a draft of -37 feet MLLW, to navigate safely through the Pinole Shoal Channel, the tanker may traverse the channel on a high tide of at least 5 feet above the -35 foot MLLW channel depth (or limiting shoal) – this is referred to as “riding the tide”. If a vessel has to wait for a high tide to safely navigate a channel with the appropriate under-keel clearance, this is referred to as a “tidal delay.”

In general, the longest tidal delay for most vessels calling at the refineries near Carquinez Strait is approximately 12 hours, although there are reports of some vessels having to wait nearly 24 hours for the higher of the two daily high tides before moving through the channels. Typically, shippers try to reduce tidal delays by coordinating early and often with the bar pilots to ensure that they know what the anticipated operating depth is when they plan to arrive. The bar pilots will not only provide the anticipated operating depth of the day the vessel will arrive, but also the timeframe the respective vessel must be at the offshore pilot station to successfully use the tide to accommodate the vessel’s draft. Typically, the timeframe is only an hour. Outgoing vessels also take advantage of tides to move fully load vessels.

Lightering[4] of petroleum products is no longer allowed in San Francisco Bay. Light-loading refers to vessels carrying less cargo than their design allows in order to reduce their draft so that they can safely access a channel.

[3] Under-keel clearance is the vertical difference between the lowest protruding section of the hull and the minimum actual channel depth.

[4] Lightering is the process of transferring cargo between vessels of different sizes to reduce a vessel’s draft in order to enter port facilities.

The operational strategies described above (riding the tide and light loading) are used by the deep draft vessels that call at the oil refineries located throughout the study area. They are all economically inefficient, causing loss of time and money. More detailed information about navigation economics can be found in Section 2.5.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

These procedures for vessel operations, and inefficiencies, will continue to occur in the future without-project condition.

2.3.2 SEA LEVEL CHANGE

To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of Engineering Regulation, ER 1100-2-8162 and Engineering Technical Letter (ETL) 1100-2-1. Three scenarios are required by Engineering Regulation (ER) 1100-2-8612: a Baseline (or "Low") scenario, which is based on historic sea level rise and represents the minimum expected sea level change; an Intermediate scenario; and a High scenario representing the maximum expected sea level change.

EXISTING CONDITIONS

According to the Oceanic and Atmospheric Administration tide gauge (9414290) at San Francisco, California, the historic sea level rise rate was determined to be 0.00659 feet per year.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Following procedures outlined in EC 1165-2-212, baseline, intermediate, and high sea level rise values were estimated over the life of the project. In the future without-project conditions, sea level rise could be expected to increase by 0.36 feet (baseline), 0.85 feet (intermediate), and 2.38 feet (high) over the next 50 years. The potential impacts of rising sea level include increased salinity intrusion into the Sacramento-San Joaquin Delta, overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas.

2.3.3 STORM SURGE

EXISTING CONDITIONS

An excerpt from the USACE Deep Water Shipping Scenario Report (2011) predicted water stage at San Francisco Fort Point NOAA station (9414290) for the baseline scenario under 2007-2008 historic conditions. A tidally-averaged stageplot noted potential for existing storm surge within the study area of almost 1.64 feet (0.5 m), which was used under the baseline scenario.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Storm surge would be expected to remain approximately the same in the future without-project, but could increase with increased sea level rise.

2.4 BUILT ENVIRONMENT

2.4.1 EXISTING FEDERAL PROJECT

EXISTING CONDITIONS

The existing Federal navigation project within the study area is described in this section, and portions of the project proposed for deepening are detailed in **Table 2-14.** Other areas of the existing channel not presented below have naturally deep water at 39 feet MLLW or more. Pinole Shoal Channel is a length 10.3 miles, and the Bulls Head Reach portion of Suisun Bay is 2.9 miles long. The high shoaling area (referred to in this report as the advance maintenance area, and the area where the proposed sediment trap would be) in Bulls Head Reach is currently deepened to -37 feet MLLW + 2 feet of overdepth annually. Maintenance dredging events for these areas are described in the next section.

Table 2-14. Existing Federal Project Dimensions Within the Study Area.

Channel	Length (feet)	Existing	
		Depth (feet MLLW)	Width (feet)
Pinole Shoal Channel	54,800	-35	600
Bulls Head Reach (in Suisun Bay)	15,900	-35	300
Bulls Head Reach Advance Maintenance Area	2,600	-37	300

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future, these channels will continue to have the projects depths as stated above.

2.4.2 OPERATIONS AND MAINTENANCE (INCLUDING HIGH SHOALING AREAS)

EXISTING CONDITIONS

USACE maintains the navigability of Federal navigation channels to either the authorized depth or a lesser regulatory depth. The regulatory depth is the depth to which environmental compliance has been completed. Accumulated sediments settling in the channels can impede navigability in the study area channels. Maintenance dredging removes this sediment and returns the channels to regulatory depths to provide safe, reliable, and efficient waterborne transportation systems.

Table 2-15. Median Annual Maintenance Dredging Volumes in Study Area for Fiscal Years 2005 to 2014.

Channel	Dredge Type	Typical Dredging Frequency (years)	Median Volume Dredged Annually (CY)	Federal Placement Site
Pinole Shoal Channel	Hopper	2	255,000	SF-10 (San Pablo Bay)
Bulls Head Reach	Clamshell	1	25,000	SF-16 (Suisun Bay)
Bulls Head Reach Advance Maintenance Area	Clamshell	1		SF-16 (Suisun Bay)

HIGH SHOALING AREA IN BULLS HEAD REACH

The Bulls Head Reach advance maintenance area portion of the Suisun Bay Channel begins approximately 1 mile south of the Interstate 680 Benicia-Martinez Bridge and extends east approximately 3 miles to the Avon Wharf.

USACE typically elects to perform advance maintenance every year in this area because it shoals faster than the annual dredging cycle, and it is essential for USACE to maintain the utility of the channel as long as possible before needing to address any shoaling issues outside of the work windows established by the Long Term Management Strategy (LTMS) Plan within which USACE may conduct maintenance dredging activities so as to minimize impacts to listed species and species of concern. Within the study area, maintenance dredging is constrained for environmental reasons to the period between June and November in the West Richmond and Pinole Shoal channels, and to the period between August and November in the Bulls Head Reach.

Since 2000, emergency dredging actions have been performed in Bulls Head Reach outside of the regular maintenance window with an average frequency of approximately 3 years. Beginning in 2012, the high shoaling area within Bulls Head reach was deepened for advance maintenance to -37 ft MLLW plus 2 ft of overdepth and since then, emergency dredging outside of the scheduled O&M dredging has not been required – however, annual dredging of this advance maintenance area still occurs, and is performed as described below.

For the immediate future, hopper dredges will no longer be permitted to dredge in the Suisun Bay Channel, including Bulls Head Reach, because of the presence of delta smelt, which is a listed endangered species. Therefore, annual advance maintenance dredging actions will be performed using clamshell dredge plants. Currently, each annual advance maintenance effort must be consulted and coordinated with the environmental resource agencies and the Major Subordinate Command (South Pacific Division) for authorization and approval. This effort can take two to three months to complete at an annual cost of approximately $75,000 in labor for all involved, and at a cost of $1,000,000 for mobilization and demobilization (not including the cost of the removal of the material itself).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Maintenance dredging of the channels would continue to occur at the same frequency and would generate the same volumes of dredged material as under the existing conditions, with additional time and cost spent for each event as described above. Maintenance dredging will continue to occur annually at Bulls Head Reach and every two years at Pinole Shoal to maintain the current depth of -35 feet MLLW + 2 feet of overdepth. Maintenance dredging should continue to produce annual volumes of dredged sediments similar to those shown in **Table 2-15**, with the dredged sediments continuing to be disposed in a similar fashion as is presently done.

For the high shoaling area in Bulls Head Reach, advance maintenance dredging actions will be performed annually using clamshell dredge plants (to -37 feet MLLW + 2 feet of overdepth), with emergency maintenance events outside of planned maintenance dredging if needed.

2.4.3 DREDGED MATERIAL PLACEMENT/BENEFICIAL REUSE

EXISTING CONDITIONS

USACE is a partner in the Dredged Material Management Office (DMMO) along with the San Francisco Bay Regional Water Quality Control Board (Water Board), San Francisco Bay Conservation and Development Commission (BCDC), State Lands Commission, and the U.S. Environmental Protection Agency (USEPA). The DMMO was created as a recommendation of the 2001 LTMS to coordinate dredging and dredged sediment placement and placement within San Francisco Bay. The LTMS was approved in 2001 and set goals for beneficial reuse and in-Bay open water placement of dredged material.

In April 2015, USACE and the Water Board completed an Environmental Assessment and Environmental Impact Report for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay, Fiscal Years 2015-2024 (Maintenance Dredging EA/EIR). That document is intended to fulfill NEPA and CEQA requirements for maintenance dredging of the Federal navigation channels in San Francisco Bay for the Federal fiscal years 2015 through 2024.

POTENTIAL BENEFICIAL USE SITES

In addition to using dredged sediment to restore ecosystems in the Delta, a combination of existing and newly permitted beneficial reuse sites as well as existing and new upland dredged material placement sites used by USACE and the Port of Stockton for annual maintenance dredging events can be considered. The proposed project envisions the dredged material placement sites to be Cullinan Ranch and Montezuma Wetlands, however additional opportunities could be identified as viable sites in the future such as the Delta Islands project, partner restoration projects or programs, or a newly permitted site not identified yet. Should other placement options become available during preliminary project design, additional coordination with the resource agencies and public will be completed as appropriate.

Beneficial reuse of dredged material at the Cullinan Ranch and Montezuma Wetlands restoration sites is being proposed to proactively minimize environmental effects associated with project construction or the effects of slight movement in salinity. Accordingly, the proposed project does not result in significant adverse impacts, as described in Chapter 4 of this integrated document. These beneficial reuse sites have their own NEPA documents and monitoring programs and this EIS adopts and incorporates those NEPA analysis by reference (USACE and SCDEM 1998 and USFWS and SDFW 2008). Therefore, this project does not propose any further compensatory mitigation or monitoring of the beneficial reuse sites.

CULLINAN RANCH TIDAL RESTORATION SITE. Cullinan Ranch is a beneficial use site owned by the USFWS. Once restored, the site will become part of the larger San Pablo Bay Wildlife Refuge. The site is fully permitted and has been accepting dredged material from Federal and non-Federal maintenance dredging projects since 2013. Cullinan Ranch currently has capacity of approximately 2.8 million cubic yards of dredged material, but, it is in the process of amending the permit to increase the capacity to 9 million cubic yards. The Cullinan Ranch Tidal Restoration Site is located immediately adjacent to State Highway 37. The southern off-loader location is within 200 feet of the Highway 37 Mare Island Bridge over the Napa River, with the northern off-loader location being approximately 750 feet north of the Mare Island Bridge.

Details on the purpose and need, design, construction requirements, and environmental impacts are provided in the Cullinan Ranch Wetland Restoration Site's EIS/EIR (USFWS and CDFW 2008; CSLC 2012). This GRR/Draft EIS incorporates the beneficial reuse site NEPA documents by reference and therefore does not provide further details regarding the construction activities associated with restoration construction or off-loading dredged material.

MONTEZUMA WETLANDS RESTORATION PROJECT. Montezuma Wetlands restoration site is an approximate 2,400-acre privately-owned upland beneficial use site that has been receiving dredged material from Federal and non-Federal dredging Projects since 2001. It is located on the eastern edge of Suisun Marsh, west of Collinsville, in Solano County. The purpose of the site is to restore approximately 1,800 acres of tidal wetlands, seasonal wetlands, intertidal ponds, vernal pools, and upland buffer zones. Montezuma is a fully permitted ecosystem restoration and beneficial use site. Ground elevations have subsided by up to 10 feet and dredged material is used to raise site elevation such that restoration can occur. The site has a current capacity for approximately 12 million cubic yards of dredged material and can accept both cover and non-cover material.

Dredged material scows having a capacity of 4,000 to 5,000 cubic yards would be transported anywhere from 16 to 32 miles from the area of deepening to the off-loader anchored at the mouth of Montezuma Slough adjacent to the site. Implementation of the project could deliver sediment to the Montezuma off-loader. The off-loader is located approximately 100 feet offshore of the southeastern levee of the Montezuma site, approximately 0.5 mile east of the mouth of Montezuma Slough and 0.2 mile north of Chain Island. The hamlet of Collinsville, which contains several residences, is located approximately 1,900 feet east of the off-loader location. Recreational boaters are likely to pass by this site, and the Department of Water Resources Collinsville Day-Use area is about 2 miles northwest of the off-loader location. In the area of the Montezuma Wetlands, ambient noise, consisting of nearby roadway noise, is estimated to be less than 60 dB. (Solano County 2015).The off-loader would pump the slurry from the scows into the designated cells within the Montezuma site. The water used to make up the slurry would be pumped from Montezuma Slough. The Montezuma site is permitted to draw water from Montezuma Slough and discharge any water used during the process of off-loading dredged material back into the bay water via Montezuma Slough, provided it meets the site's waste discharge requirements. Once dredged material is off-loaded to the site, it would be placed in cells where it would be available for onsite ecosystem restoration.

The Montezuma Wetlands Restoration Site is responsible for all environmental impacts associated with off-loading, placing, and managing the dredged sediment. Details on the purpose and need, design, construction requirements, and environmental impacts are provided in the Montezuma Wetland Restoration Site's EIS/EIR (USACE and SCDEM, 1998). This GRR/Draft EIS incorporates the NEPA analysis of the beneficial reuse sites by reference and therefore does not provide further details regarding the construction activities associated with restoration construction or off-loading of dredged material; the reader is referred to the Montezuma EIS/EIR for that information.

DELTA ISLANDS RESTORATION SITE. 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. The Delta Islands converted into farmland until a levee break in 1928 inundated the island. Since then, Big Break has remained unvegetated open water.

The Final EIS can be found here:
https://www.spk.usace.army.mil/Portals/12/documents/civil_works/Delta/DeltaStudy/FinalEIS/Delta_Islands_Final_Feasibility_Report-EIS_Sep2018.pdf?ver=2018-09-14-162532-197. The Recommended Plan in the Delta Islands study 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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project would not contribute sediment to the beneficial reuse sites. The sites would continue to accept material from other dredging projects throughout the area.

2.4.4 CHANNEL USERS

EXISTING CONDITIONS

The channels in the study area serve crude oil imports and refined product exports to and from facilities located on the shoreline of Carquinez Strait. Channel users include seven petroleum related facilities (oil refineries and tank farms), one marine terminal, and a sugar factory. The nine channel users are described below:

- **Phillips 66, Oleum Dock, Rodeo**: Phillips 66 Oleum operates three docks located in the waters off Rodeo, California, at the eastern end of the Pinole Shoal Channel. Crude oil is received by pipelines from California oil fields and also from tankers. The facility has a total capacity of 1 million barrels of crude oil and 2.9 million barrels of petroleum products. The dock has three berthing areas totaling about 2,500 feet. The berths can accommodate vessels up to 1,000 feet long with depths up to -38 feet MLLW. Crude oil pipelines extend from the dock areas to 45 steel storage tanks.
- **NuStar Energy, Selby Dock, Rodeo**: NuStar Energy is a privately owned trans-shipper of petroleum products located in Crockett, California. NuStar Energy does not own products shipped through the facility. Rather, it warehouses products for its customers. The facility has 24 storage tanks with a capacity of 3.04 million barrels per day. Crude oil is delivered to refineries through the Kinder Morgan pipeline system and by sea. It operates one dock for off-loading petroleum products to storage tanks. The dock has one berth with a draft of -45 feet MLLW and can accommodate vessels up to 831 feet long and 100,000 dead weight tons. NuStar Energy is also serviced by trucks and rail.
- **C&H Sugar, Port of Crockett**: C&H Sugar is located east of the Carquinez Bridge on the southern shore of Carquinez Strait, in Crockett, California. The port contains five berths that can accommodate vessels up to 750 feet long with depths up to -36 feet MLLW. It receives

unrefined sugar and ships packaged refined sugar. The current capacity is approximately 112 thousand tons of sugar. The facility is also serviced by the Union Pacific Railroad.

- **Shell Oil Refinery, Martinez**: Shell Oil Refinery is located on approximately 1,100 acres along the southern shore of Carquinez Strait in Martinez, California. The refinery has a tanker and barge petroleum loading and unloading facility that imports and refines crude and exports refined petroleum products. It converts approximately 165,000 barrels of crude oil per day into gasoline, jet fuel, diesel, petroleum coke, industrial fuel oil, liquefied petroleum gas, asphalt, and sulfur. The docking facilities provide four berthing areas. Berths 1 and 2 are on the channel side and are currently in operation. The berths can accommodate vessels up to 1,000 feet long that draw up to -39 feet MLLW. Berths 3 and 4 are on the south side of the dock (inland side) and not currently maintained.
- **Tesoro Amorco Marine Oil Terminal, Martinez:** Amorco Marine Oil Terminal is owned and operated by Tesoro Refining and Marketing Company. The terminal is a tanker and barge petroleum unloading facility (i.e., import only) used by Golden Eagle Refinery, located in Martinez, Contra Costa County, California. The terminal imports crude oil to Tesoro's Amorco Tank Farm immediately upland where it later is transferred to Tesoro's Golden Eagle Refinery for refining. The single berth dock is approximately 1,130 feet long by 150 feet wide with a depth of up to -40 feet MLLW. The terminal can accommodate up to 190,000 dead-weight ton (DWT) vessels with displacements up to 200,000 DWT. Annual ship and barge traffic averages about 69 vessels per year. The current throughput of the terminal is 16.9 million barrels.
- **Plains All American Terminal, Martinez**: The Plains All American Oil Terminal is a 225-acre site located on the south shore of Carquinez Strait, in Martinez, California. The oil terminal owns and operates the Shore Terminal docks in Martinez. The dock is a single-vessel berth with associated pumps and pipelines to transport crude to upland storage tanks and refinery. The dock is approximately 100 feet long, 40 feet wide, with a -38 foot MLLW berthing area that operates as a barge and tanker loading and unloading facility. The dock can currently handle vessels up to 950 feet long and 150,000 deadweight tonnage (DWT) displacements.
- **Tesoro Avon Marine Terminal**: Tesoro Avon Marine Terminal is owned and operated by Tesoro Refining and Marketing Company (Tesoro). The terminal is a tanker and barge petroleum export facility associated with the Golden Eagle Refinery, located in Contra Costa County, California. The facility exports refined petroleum products, including premium fuel oil, gas oil, diesel, and cutter stock, from the refinery to tanker vessels for export. Although the Avon terminal is a multi-berth terminal facility consisting of two berths (Berth 1 and Berth), the terminal currently supports only Berth 1. The docking facility is approximately 1,520 feet long and ranges from 20 to 80 feet wide, with a depth of -40 feet MLLW. The terminal can accommodate vessels up to 113,635 DWT with displacements of up to 102,600 long tons. Annual ship and barge traffic averages 124 vessels per year (between 2004 and 2013) and the throughput ranges from about 5.1 to 12.8 million barrels per year.
- **Benicia Port Terminal Company AmPorts:** The Port of Benicia is located in the Benicia Industrial Park, immediately west of the Martinez Bridge. It is a small port (640 acres) owned and operated by AMPORTS, one of North America's largest auto processors, processing more than 1 million vehicles each year. The port also provides break bulk service. The port is

located near rail service. It can handle up to three -38 foot deep MLLW draft vessels along its 2,400 foot long wharf.

- **Valero Benicia Refinery**: Valero Refinery is located on the northeastern shore of Carquinez Strait, in Benicia, Solano County, California. The facility currently processes crude oil received by pipeline and marine tanker and barge vessels. It also has significant asphalt production capabilities, producing 25 percent of the asphalt supply in northern California. Currently, Valero refines domestic crude from the San Joaquin Valley (delivered by pipeline) and Alaska North Slope (delivered by tanker or barge), as well as foreign sour crude. The refinery has a throughput capacity of 170,000 barrels per day. The dock has a berthing length of 1,100 feet and a depth of -32 feet MLLW

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

These channel users will continue to use the channels in the future without-project conditions.

2.4.5 MARITIME INFRASTRUCTURE WITHIN THE STUDY AREA

EXISTING CONDITIONS

Major ports located within the study area include the Ports of Richmond and Benicia and the Contra Costa County Northern Waterfront. The Port of Stockton is also a major port whose customers utilize these navigation channels, although port facilities are located at the terminus of the Stockton Deep Water Ship Channel, outside the area of proposed improvements.

Port of Richmond. The Port of Richmond is located approximately nine miles northeast of the Golden Gate Bridge on the eastern shore of San Francisco Bay. The Port encompasses five city-owned terminals and ten privately owned terminals for handling bulk liquids, dry bulk materials, metals, vehicles and break bulk cargoes. In 2008, the Port handled 19 million short tons of cargo, primarily in the form of liquid petroleum. In recent years, the Port has expanded its dry bulk, break bulk and containerized cargo handling capabilities and has increased its automobile processing facilities. It ranks number one for ports in San Francisco Bay in vehicles and liquid bulk. In addition to these general commodities, the Port can also handle dry-bulk, break bulk and containers. The Port is connected to a sophisticated rail network served by four major rail companies (CCG&CS 2013).

Port of Benicia. The Port of Benicia is a privately owned and operated port located in Solano County. The Port specializes in handling bulk goods such as agricultural products and motor vehicles. There is direct port access to I-680 and I-780 interstate freeways; UP Rail service; a dockside water depth of -38 feet and a 2,400 foot long deep water pier. The Port also has an oil terminal for the Valero oil refinery at Benicia (CCG&CS 2013).

Contra Costa County Northern Waterfront. The Northern Waterfront is located between the Port of Richmond on the west and the ports of West Sacramento and Stockton on the east. Along this stretch of the channel from the Carquinez Strait to Suisun Bay and the Delta there are a number of marine terminals and wharfs. These facilities are privately owned and primarily serve the adjacent manufacturing operations including: C&H sugar refinery in Crockett; Tesoro and Shell at Martinez and Phillips 66 in Rodeo; and Mirant power plant, Dow chemical plant, and the USS-POSCO’s steel-coil processing plant in Pittsburg (CCG&CS 2013).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

These ports will continue to use the channels in the future without-project conditions.

2.4.6 BRIDGES

EXISTING CONDITIONS

Vehicle traffic in the study area is limited to five bridges that cross the Central San Francisco Bay, the Carquinez Strait and the San Joaquin River (**Table 2-16**). The vehicle bridges are all of fixed height, ranging between 135 to 148 feet vertical clearance as measured from the water surface at high tide. Therefore, the movement of vehicle traffic on Interstate 80, Interstate 580, Interstate 680, and State Route 160 is not affected by vessel traffic.

Table 2-16. Bridges in the Study Area.

Official Name	Common Name	Number of Spans	Vertical Clearance[1]	Waterbody	Purpose
Golden Gate Bridge	Golden Gate Bridge	2	220 feet	Central San Francisco	Vehicle Traffic on the National Highway System
N/A	Richmond-San Rafael Bridge	2	135 feet	Central San Francisco/San Pablo Bays	Vehicle traffic on Interstate 580
Alfred Zampa Memorial Bridge	Carquinez Bridge	Two	148 feet	Carquinez Strait	Vehicle traffic on Interstate 80
George Miller, Jr. Bridge	Benicia-Martinez Bridge	Two	138 feet	Carquinez Strait	Vehicle traffic on Interstate 680
Union Pacific Rail Bridge	Part of the Benicia-Martinez Bridge	One lift-span	Closed 70 feet Open 135 feet	Carquinez Strait	Union Pacific, Burlington Northern Santa Fe, and Amtrak trains

[1] Vertical clearance at high tide

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The brides will continue to be built and function as described above.

2.4.7 UTILITIES AND PUBLIC SERVICE

The Utility Investigation Report for the San Francisco to Stockton Deep Water Ship Channel (USACE 2011) was the primary source of information considered for known utility channel crossings. The most recent NOAA Nautical Charts covering the study area were also consulted to identify locations where the deep draft shipping channels intersect with overhead transmission lines or buried cables and pipelines.

Known utilities in the study area include the buried Trans Bay Cable and other transmission lines, buried pipelines, and overhead transmission lines as discussed in the following sections. The region is served by an extensive network of natural gas pipelines and a number of these pipelines cross the study area navigation channels. In addition, there are a number of petroleum refineries in the region and some petroleum product pipelines originating at the refineries cross the study area navigation channels. Other underwater cables crossing the shipping channels within the study area include both telephone and fiber optic lines.

2.4.7.1 BURIED/UNDERWATER CABLES (UWC)

The 53-mile long Trans Bay Cable runs between the converter stations in Pittsburg, Contra Costa County, and the City of San Francisco (**see Figure 2-12**). This power transmission cable, carrying 400 megawatts (high voltage) of direct current, generally runs east-west along the same route as the shipping channels, close to the West Richmond Channel, the Pinole Shoal Channel, through the Carquinez Straight and close to the Bulls Head Reach. Plan and profile drawings of the cable were included in the Utility Investigation Report (USACE 2011). Design documents indicate that the cable was to be buried at a depth of 3 to 6 feet below the bottom sediments. Based on available information, the Trans Bay Cable crosses the dredged channels at two locations (UWC-3 and UWC-4). Although the crossing designated UWC-1 is included for completeness, it is located in the West Richmond Channel which, currently, is not dredged.

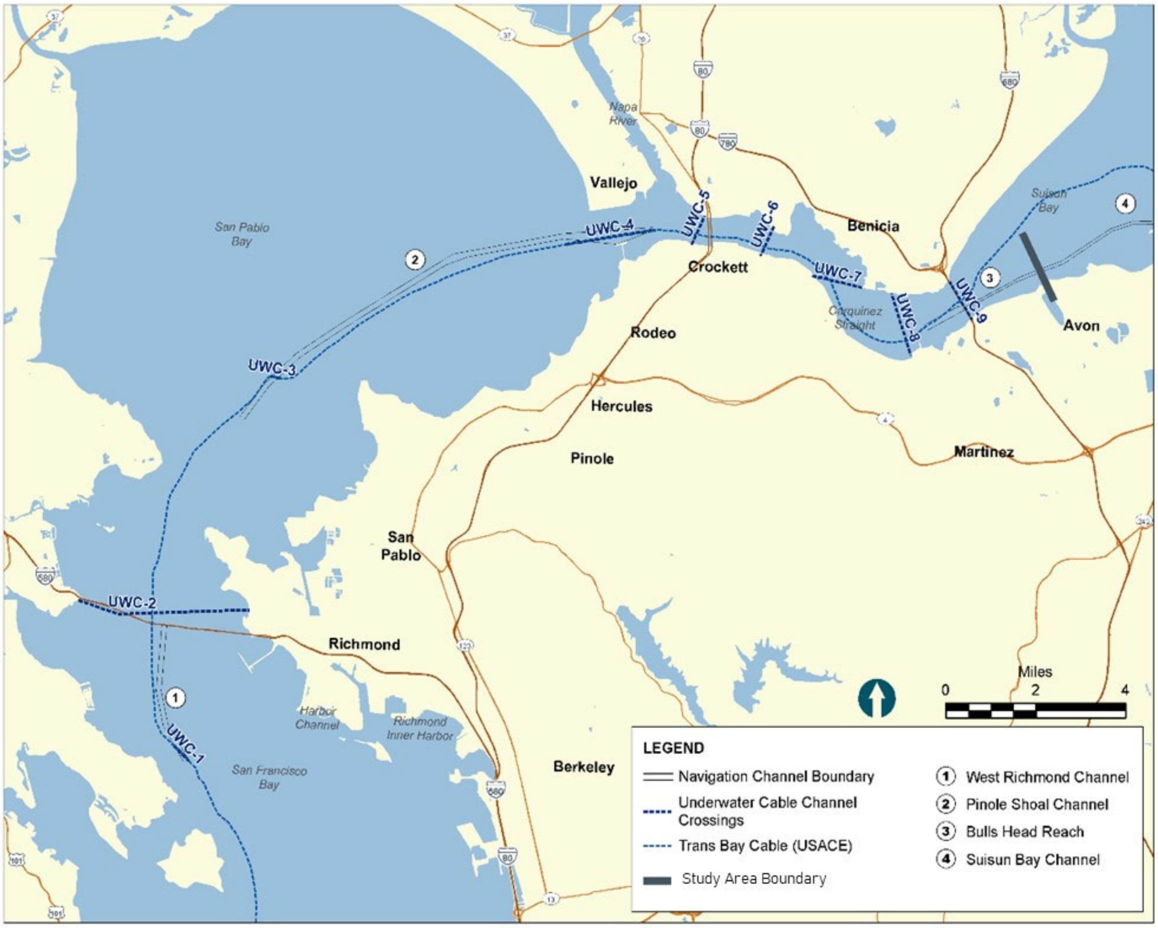


Figure 2-12. Buried/Underwater Cables.

Other buried cables found in the study area cross the ship channel at the Richmond-San Rafael Bridge, in the Carquinez Strait, and at the Benicia-Martinez Bridge. The Level 3 Communications fiber optic cable at the Benicia-Martinez Bridge, designated as UWC-9, is the only other cable that crosses a dredged portion of the navigation channel.

Table 2-17. Known Buried/Underwater Cable Crossings.

Designator on Figure 4-20	Near or in Channel	Location Description	Depth Below Channel Bottom	Description of Crossing
UWC-1	West Richmond Channel	Southern extremity of the West Richmond Channel	3-6 feet	Trans Bay Cable
UWC-2	West Richmond Channel	Richmond - San Rafael Bridge	Unknown	Two Pacific Telephone and Telegraph lines

Designator on Figure 4-20	Near or in Channel	Location Description	Depth Below Channel Bottom	Description of Crossing
UWC-3	Pinole Shoal Channel	Western extremity of Pinole Shoal Channel	3-6 feet	Trans Bay Cable
UWC-4	Pinole Shoal Channel	Eastern extremity of the Pinole Shoal Channel	3-6 feet	Trans Bay Cable runs in parallel and within with the shipping channel
UWC-5	Carquinez Strait	Western extremity of Carquinez Strait, west of Carquinez Bridge, Vallejo	Unknown	A 12-inch fiber optics conduit owned by Level 3 Communications
UWC-6	Carquinez Strait	Within Carquinez Strait, east of Carquinez Bridge	Unknown	Two Pacific Telephone and Telegraph lines
UWC-7	Carquinez Strait	Within Carquinez Strait, east of Carquinez Bridge	Unknown	Unknown
UWC-8	Carquinez Strait	Within Carquinez Strait, west of Benicia-Martinez Bridge	20 feet	A 3-inch steel pipe with fiber optic cable owned by AT&T
UWC-9	Bulls Head Reach	At the Benicia-Martinez Bridge	Unknown	A fiber optics line owned by Level 3 Communications

Sources: eCoastal 2015; NOAA 2015; USACE 2011.

2.4.7.2 BURIED/UNDERWATER PIPELINES (PLC)

Available information indicates that there are at least seven buried pipelines crossing the navigation channel. There is a natural gas pipeline crossing at the Carquinez Bridge (PLC-1) and there are six pipelines that cross at the Benicia-Martinez Bridge (PLC-2) (**see Figure 2-13*)***

The existing 35 foot channel is not currently dredged at the Carquinez Bridge and as a result of prevailing natural depths it is not proposed for deepening. The existing 35 foot depth of the Bulls Head Reach at the Benicia-Martinez Bridge is maintained by annual dredging, or on an as needed basis. The locations of the pipeline crossings are shown in **Figure 2-13** with details provided in **Table 2-18.**[5]

[5] Sources: California Natural Gas Pipelines (California Energy Commission 2015) [CEC]; Final Environmental Impact Report for the Proposed Trans Bay Cable Project (URS 2006); Utility Investigation Report San Francisco to Stockton Deep Water Ship Channel (USACE 2011); and NOAA Nautical Charts (NOAA 2015).

Table 2-18. Buried/Underwater Pipeline Crossings

Designator on Figure 4-21	Near or in Channel	Location	Depth Below Channel Bottom	Description
PLC-1	Carquinez Strait	At the Carquinez Bridge, Valejo	Unknown	A Pacific Gas and Electric (PG&E) natural gas pipeline
PLC-2	Bulls Head Reach	At the Benicia-Martinez Bridge	Unknown	Six pipelines cross below the surveyed channel bottom. Three are owned and operated by Valero Benicia Refinery and three are owned and operated by Kinder Morgan.

Sources: CEC 2015; NOAA 2015; URS 2016; USACE 2011.

Figure 2-13. Buried/Underwater Pipelines.

2.4.7.3 OVERHEAD POWER TRANSMISSION LINES (OHC)

There are two overhead transmission line crossings in the Carquinez Strait (OHC-1 and OHC-2), as shown in **Figure 2-14**. The height of power lines crossing over the channels does not limit the safe clearance and passage of vessels traveling in the channels because some bridges in the study area are lower.

Figure 2-14. Overhead Cables.

2.5 ECONOMIC ENVIRONMENT

The section differs from the previous socio-economics section in that it discusses the economics of the navigation environment. The base year for this economic analysis is 2020.[6]

2.5.1 COMMODITIES

EXISTING CONDITIONS

Between 2005 and 2010, 20 to 26 million tons of commodities moved through Carquinez Straight annually, with the largest commodity in terms of weight being crude oil shown in **Figure 2-15.** Crude oil represented the majority of the total tonnage of import commodities that moved through the study area to port

[6] Environmental analyses in the following sections use 2023 as the base year. The 3 year difference is negligible for the overall assumptions in the analyses.

facilities in the study area. Most of the crude oil moving through the channel is imported from foreign countries, although a small percentage of crude comes from domestic sources such as Alaska.

All of the crude oil shipments arrive at the various oil industry ports in the vicinity of Avon. Crude oil is imported, while petroleum products are exported. Historical imports and export moving through the oil terminals from 2011 to 2013 are provided in **Table 2-19.**

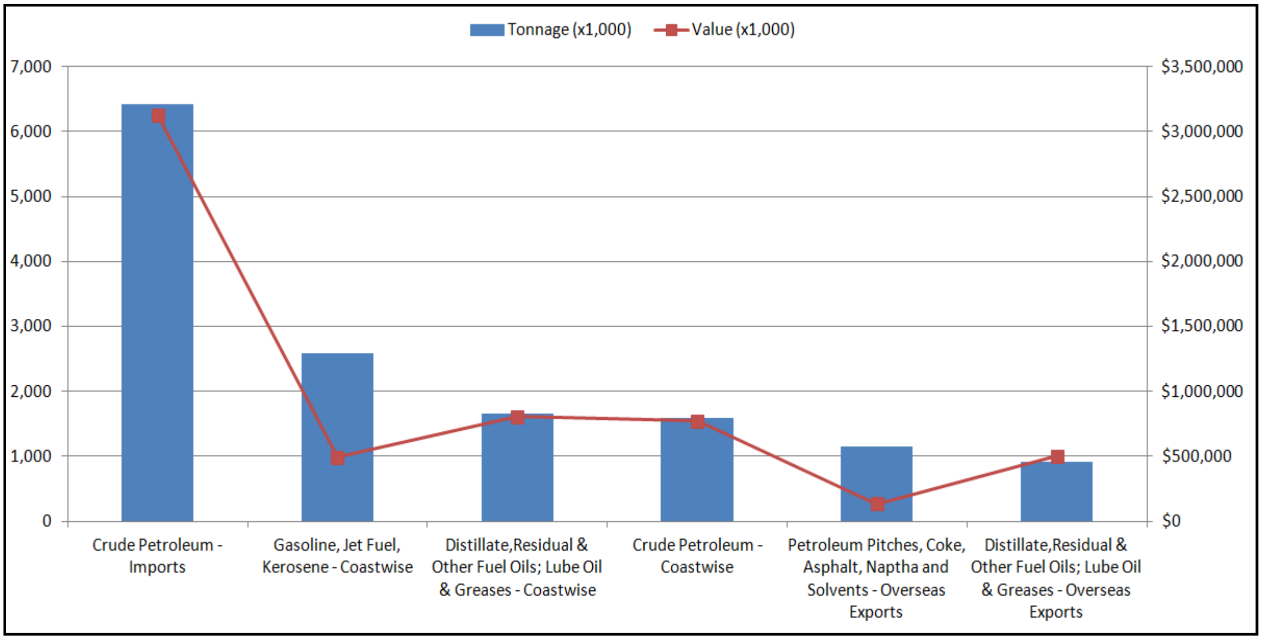


Figure 2-15. Tonnage and Value of Top Commodities Moving Through the Study Area.

Table 2-19. Historical Imports and Exports.

Petroleum Product Movements	2011	2012	2013	3-year Average
Total Crude Imports	7,864,034	7,729,726	7,292,532	**7,628,764**
Total Petroleum Exports	1,813,297	1,949,962	2,109,409	**1,957,556**

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Estimates of growth for the oil refineries that import crude oil and export petroleum products are described in the **Appendix D, Economic Analysis**. Crude oil imports are projected to grow at an annual rate of 0.3%. Petroleum and other liquid exports are projected to grow at an annual rate of 2.4%. **Table 2-20** shows the commodity forecast for years 2020, 2030, and 2040. Even though port and terminal capacity would not be reached, for the purposes of this report's analysis, it is assumed that tonnage would be held constant after year 2040[7].

[7] Per ER 1105-2-100, "specific commodity studies are of limited value for projections beyond approximately 20 years". This is a general guideline for deep draft navigation studies due to uncertainty in forecasts.

Table 2-20. Commodity Forecast 2020-2040 (metric tons).

Commodity	2020	2030	2040
Total Crude Imports	7,790,000	8,027,000	8,271,000
Total Petroleum and Other Liquid Exports	2,311,000	2,930,000	3,714,000

2.5.2 FLEET

EXISTING CONDITIONS

Vessels in the study area are primarily tankers with maximum design drafts ranging from -40 to -55 feet MLLW as shown in **Table 2-21**. Crude oil vessels can generally be classified into two groups:

- **Group 1:** Aframax and Suezmax tankers with DWTs typically between 80,000 and 150,000 dead weight tons (DWT). These vessels have design drafts of as much as -55 feet, and arrive in Northern California only after having lightered elsewhere, typically Southern California. These vessels arrive less than half full and will often, but not always need to use the tides to deliver their remaining load.

- **Group 2:** Panamax tankers. Because of the draft restrictions in the channels, the tankers will arrive between 70 percent and 80 percent loaded and will use the available tide to arrive drafting between -35 feet and -37 feet.

Tankers from both groups typically deliver approximately 50,000 metric tons of commodities. **Table 2-21** shows vessel fleet data for foreign deep draft vessels calling the refineries. **Table 2-22** shows the 2010 distribution of oil tankers calling at ports in the study area by weight. More than 50 percent of the vessels are 50,000 or 70,000 DWT.
Table 2-23 **s**hows the annual transits in both directions (i.e., inbound and outbound) and sailing drafts for 2011, 2012, and 2013 in the study reach channels.

Table 2-21. Vessel Types and Attributes.

Vessel Type	Capacity (DWT)	Maximum Design Draft	Maximum Beam	Maximum Length Overall	Tons Per Inch (TPI)
Panamax Medium	16,000-40,000	40	101	700	100
Panamax	35,000-77,000	45	106	760	154
Aframax	77,001-120,000	50	160	920	238
Suezmax	120,001-195,000	55	165	960	299

Table 2-22. Tankers by Class - Year 2000.

DWT	20k	25k	35k	50k	60k	70k	80k	90k	110k	150k	165k
Vessel Calls	28	79	102	44	34	15	7	15	14	14	35
Percentage of Calls	7%	20%	26%	11%	9%	4%	2%	4%	4%	4%	9%

Table 2-23. Tankers by Class - Year 2015.

DWT	20k	25k	35k	50k	60k	70k	80k	90k	110k	150k	165k
Vessel Calls	1	1	59	27	34	72	0	34	75	34	0
Percentage of Calls	0%	0%	18%	8%	10%	21%	0%	10%	22%	10%	0%

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Figure 2-16 shows the forecast of vessels calling on the terminals within the study area if there is no action taken, where vessel transits could increase from 127 in 2020 to 179 in 2040. Panamax vessels will continue to transit the most frequently and experience the most inefficiencies.

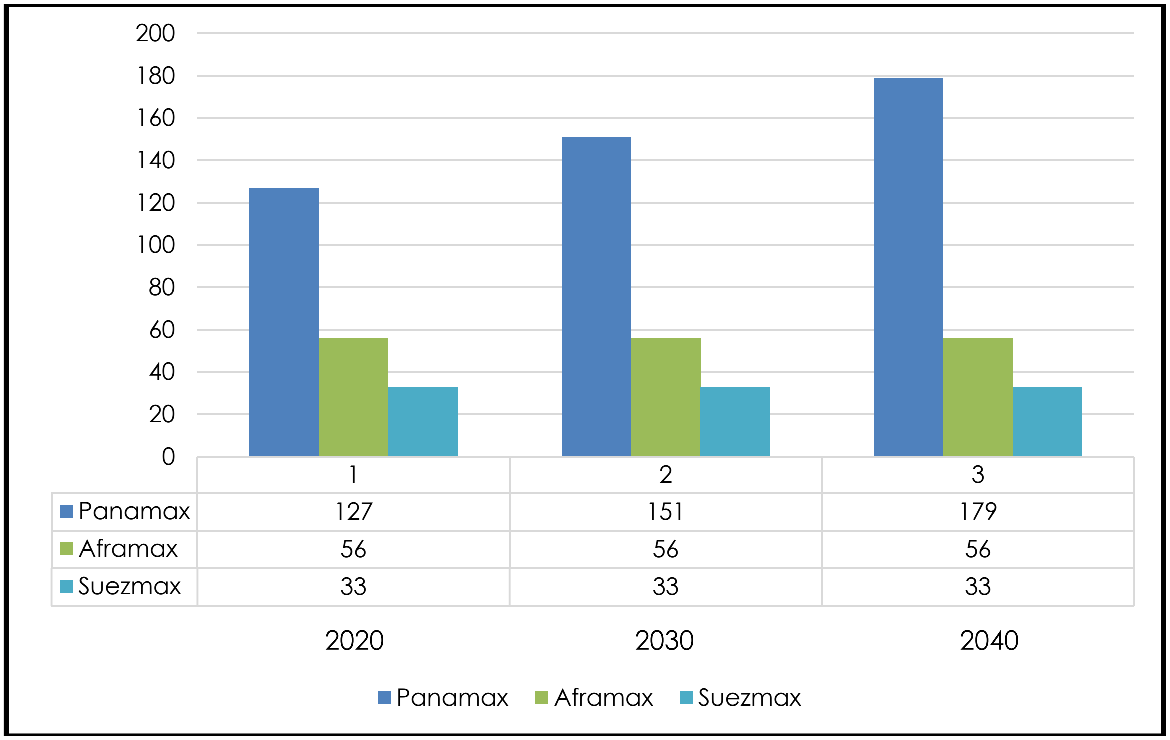


Figure 2-16. Forecast of Vessels calling at terminals within the study area.


3
Plan Formulation

3 PLAN FORMULATION

3.1 PLAN FORMULATION RATIONALE

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

Plan formulation is the process of developing alternative plans to address a given problem and established objectives. The first step in plan formulation involves identifying all potential management measures for the given problems. A management measure is a structural or nonstructural action that can be implemented at a specific geographic site to address one or more planning objectives.

An alternative plan includes one or more management measures to address the problem. Alternative plans can differ by types of measures, or how measures are combined or defined, including dimensions, quantities, materials, locations or implementation time frames.

Four accounts (P&G 1983) facilitate the evaluation of management measures and display the effects of alternative plans.

- National Economic Development (NED) account: Includes consideration of a measure's potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and consider project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gage the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure's adaptability to such change were considered under the National Economic Development (NED) account.

- Environmental Quality (EQ) account: Considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA).

- Other Social Effects (OSE) account: Includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and, the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the planning objectives to maintain recreation and maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements.

- Regional Economic Development (RED) account: Considers the potential impacts on the local economy, and sales volume.

The P&G require the NED plan to be selected as the recommended plan, unless an exception is granted. The NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these four criteria.

Preliminary plans were formulated by combining management measures. Each plan was formulated in consideration of the following four criteria described in the Principles and Guidelines (P&G):

1. **Completeness:** Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
2. **Effectiveness:** Extent to which the plan contributes to achieving the planning objectives
3. **Efficiency:** Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
4. **Acceptability:** Workability and viability of the alternative plan with respect to acceptance by Federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies

3.2 SCOPING*

DETERMINATION OF STUDY AREA AND SCOPE

A Ship Simulation Study (*Vessel Simulation Navigation Study of the Proposed John F. Baldwin Ship Channel – Phase III Proposed Channel Improvements*, DTMA 91-88-C-80024, Final Report) was completed in August 1992 for USACE by Marine Safety International. The study used a USACE-approved numerical model that met the acceptance criteria identified in EM 1110-2-1613, and was conducted with input from the San Francisco Bay Harbor Pilots. The design vessel for the study was the Exxon Benicia[8]. In addition to proposed deepening alternatives (which were being explored at that time), the preliminary design included some minor channel realignments but did not include any widening. The Pilots made recommendations for relocation of navigation aids and channel realignment details that would increase navigation safety and satisfy their concerns. The final study report confirmed that if the recommendations were incorporated into the proposed channel design, there would be no need for any widening. Since the ship simulation was performed, all of the pilot's recommendations have been incorporated into the existing channel configurations, with the exception of the actual deepening. The pilots also requested that USACE consider another measure, such as a sediment trap to control excessive shoaling that occurs in the Suisun Bay Channel in the Bulls Head reach north of the Martinez Bridge.

The study area was originally scoped in 2008 to include the entire 78-mile long navigation project to include the John F. Baldwin and Stockton channels, however, it was re-scoped in 2016 to include navigation improvements up to Avon. The re-scoped study area described in this report is more

[8] Dimensions of the Exxon Benecia were as follows: LOA = 906 feet; Beam =173 feet; Draft = 43 feet. Current dimensions of the Panamax design vessel is: LOA = 750 feet; Beam = 105 feet; Draft = 45 feet.

appropriate for the immediate problems facing existing vessels and the study fits into the three year timeframe required for USACE feasibility studies. The study area now encompasses the area which spans from Central San Francisco Bay to Avon (just east of the Benicia-Martinez Bridge). All other existing channels within this area are already naturally deep, and therefore Pinole Shoal Channel, and the Bulls Head Reach portion of the Suisun Bay Channel are the focused areas carried forward for the study area.

PUBLIC AND AGENCY INPUT

On March 12, 2008, USACE and the Port of Stockton published the original Notice of Intent/Notice of Preparation (NOI/NOP) for an EIS/EIR. Two public scoping meetings were held on March 26 and April 2, 2008. Comments and questions were solicited for consideration in evaluating potential impacts, environmental issues, and alternatives for the proposed channel deepening between San Francisco Bay and the Port of Stockton.

Because of the amount of time that has passed since the original NOI/NOP were published, USACE and the Port of Stockton published a supplemental NOI and supplemental NOP on March 4, 2016, to notify the public of the preparation of this EIS/EIR, provide an update on the study description, and re-open the public scoping process. Because the 2016 NOI/NOP was a supplement to the original, no additional public meetings were held. The public scoping period ended on April 4, 2016.

An additional NOI was published in the Federal Register on December 4, 2017. The current NOI announced the reduction in scope of this project (to include only Pinole Shoal and the Bulls Head Reach portion of the Suisan Bay) from the NOI that was published on March 4, 2016. Scoping comments received in 2016 and 2017/2018 are located in **Appendix I, Pertinent Correspondence**, along with a comment response matrix to address the comments.

3.3 PROBLEMS AND OPPORTUNITIES*

3.3.1 PROBLEMS

The study area as described earlier is the existing navigation channel from the Golden Gate Bridge to Avon (approximately 44 miles), with a specific focus on the Pinole Shoal and Bulls Head Reach portion of the Suisun Bay Channel.

Pinole Shoal Channel and Bulls Head reach are maintained at -35 feet MLLW. However, even the smallest class of vessels, the panamax class, has the capacity to draft at -45 feet MLLW. Therefore, vessels must be "light-loaded", or less than fully loaded with cargo, to navigate the channels with sufficient under-keel clearance (for liquid tankers, under-keel clearance is 3 feet). Light-loading increases the cost of transportation and, in turn, the cost of the shipped products because more trips must be made to carry the same volume of cargo.

Channel depths in ship channel are inadequate for fully loaded modern deep-draft vessels, which increases transportation costs and decrease economic efficiency. Inefficient strategies that are currently employed include:

- Insufficient Depth, leading to inefficient use of capacity and inefficient transit schedules:

  - All vessels must light-load cargo to safely transit the -35 foot channel depth.
  - Panamax tankers are the smallest class and most easily affected, lightloading to -32 feet and unable to use their full draft capacity of -45 feet
  - Vessels will often wait for favorable (high) tides of up to 6 feet in a two hour window (up to 12 hours of delay) to in order to gain additional draft efficiencies.

- Additional time and cost to project:
  - High shoaling rates in Bulls Head Reach often require additional dredging outside of the regular scheduled dredging efforts. The U.S. Coast Guard considers any shoaling above the currently maintained depth of -35 feet MLLW in Bulls Head Reach to be a hazard to navigation.

3.3.2 OPPORTUNITIES

- **Increase efficiency of vessels (both in capacity used and in transit schedules)**
- **Reduce transportation costs**
- **Reduce frequency of operation and maintenance dredging intervals in high shoaling areas**
- **Opportunity to beneficially use dredged material.** Several opportunities to beneficially use dredged material for habitat restoration exist at a number of wetland restoration sites within the San Francisco Bay Area. These opportunities would be enhanced by deepening the ship channel since new work material is superior to maintenance material to accomplish the habitat restoration objectives at these sites. For implementation and permitting, an important consideration in any navigation improvement project is ensuring maximum beneficial use of dredged material, also echoed in the San Francisco Bay Long Term Management Strategy (LTMS) for dredged material.

3.4 CONSTRAINTS

3.4.1 PLANNING CONSTRAINTS

A constraint is a restriction that limits the extent of the planning process; it is a statement of effects that alternative plans should avoid. Constraints are designed to avoid undesirable changes between without and with-project future conditions. The planning constraint for this study area is to avoid conflict with Federal regulations, as stated in Federal law, USACE regulations, and executive orders, and specifically to:

1. Avoid adverse impacts on species of special concern:

   <u>Avoid Salt Water Intrusion:</u> Deepening beyond certain depths in the channel could potentially allow saltwater to flow upstream into freshwater habitat, which has the potential to adversely impact several state and federally-listed threatened and endangered species, such as salmonids, green sturgeon, and delta and longfin smelt, as well as aquatic habitats in the Delta.

   <u>Dredge Within Environmental Windows:</u> To minimize effects to special status species from in-water work, several environmental work windows have been established in San Francisco Bay and

the Delta. Environmental work windows limit the timeframe when in-water work can occur, which would affect any construction schedule developed to implement a project. In addition, some of the listed species are present all year long, thereby further complicating construction activities. The work windows to protect special status species vary from 4 months to 6 months during the year, with actual months in which dredging is prohibited depending on the specific channel location. Permission to dredge outside of the established work windows would require extensive coordination with the resource agencies.

<u>Type of Dredge:</u> To minimize effects to listed species due to entrainment, a mechanical clamshell dredge will be considered for any channel deepening. Much data exists on entrainment based on several years of monitoring from maintenance dredging.

The Biological Opinions for the maintenance dredging require construction to occur within special status work windows and mechanical clamshell dredges in the Bulls Head Reach area.

2. Avoid significant impacts to water quality and water supply: A measure considered to improve navigation efficiency in the project study area must not significantly impact California water supply and quality without acceptable mitigation. Water quality and water supply in the Sacramento-San Joaquin Delta is a very contentious issue in California, particularly considering drought years. Water that flows through the Delta provides drinking water to more than 25 million Californians, irrigation waters to approximately 1 million acres of farmland, and water to more than 3 million acres of wildlife refuges. Affected water supply stakeholders include, but are not limited to:
    - Contra Costa Water District
    - Metropolitan Water District of Southern California (a consortium of 26 cities and water districts that provides drinking water to nearly 19 million people in parts of Los Angeles Orange, San Diego, Riverside, San Bernardino and Ventura counties)
    - California Department of Water Resources
    - U.S. Bureau of Reclamation
    - Westlands Water District

3.4.2 LOCAL CONSTRAINTS

Local and state laws, such as California State statutes, do not constrain NED formulation. However, they may be considered in the selection of a Locally Preferred Plan (LPP).

3.5 OBJECTIVES

3.5.1 FEDERAL AND PROJECT SPECIFIC OBJECTIVES

The Federal objective, as stated in the P&G, is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, 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. Contributions to NED are the direct net economic benefits that accrue in the study area and the rest of the nation.

The Federal objective is to reasonably maximize net benefits to the nation, and as such, it does not seek to identify specific targets within objectives.

4. Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020
5. Objective 2: Maximize beneficial reuse of dredged material while minimizing placement costs
6. Objective 3: Reduce frequency of operation and maintenance dredging in high shoaling areas

3.5.1.1 FEDERAL ENVIRONMENTAL OBJECTIVES

USACE strives to balance the environmental and development needs of the nation in full compliance with the National Environmental Policy Act and other authorities provided by Congress and the Executive Branch. Public participation is encouraged early in the planning process to help define problems and environmental concerns relative to the study. Therefore, significant environmental resources and values that would likely be impacted, favorably as well as adversely, by an alternative under consideration are identified early in the planning process. All plans are formulated to avoid to the fullest extent on significant resources. Significant adverse impacts that cannot be avoided are mitigated as required by Section 906(d) of WRDA 1986.

This report is an integrated General Reevaluation study and Environmental Impact Statement, which discusses and documents the environmental effects of the recommended plan and summarizes compliance with Federal statutes and regulations.

3.5.1.2 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities. Section 6.6.27 includes a discussion of USACE Environmental Operating Principles and how the study addresses them.

3.5.1.3 CAMPAIGN PLAN OF THE U.S. ARMY CORPS OF ENGINEERS (USACE)

USACE Campaign Plan goals and objectives are derived, in part, from the Commander's intent, the Army Campaign Plan, and the Office of Management and Budget. The four campaign plan goals and their associated objectives also build on prior strategic planning efforts. Each campaign plan goal and objective is led by a USACE senior leader who manages and oversees actions to reach the goal and objectives.

The successful achievement of the campaign plan goals and objectives are dependent on actions implemented by the entire USACE team. The implementing actions supporting each goal and objective are contained in the headquarters staff and Major Subordinate Command (MSC) implementation guidance for the Campaign Plan. The four goals of the Campaign Plan are:

Goal 1: Deliver innovative, resilient, and sustainable solutions to the Department of Defense (DoD) and the nation.

Goal 2: Deliver enduring and essential water resource solutions, utilizing effective transformation strategies.

Goal 3: Deliver support that responds to, recovers from, and mitigates disaster impacts to the nation.

Goal 4: Build resilient People, Teams, Systems and Processes to sustain a diverse culture of collaboration, innovation and participation to shape and deliver strategic solutions.

These Campaign Plan goals and associated objectives will be addressed through the course of this feasibility study.

3.5.2 STATE AND LOCAL OBJECTIVES

State and local objectives in this case are consistent with the Federal and project objectives.

3.6 SUMMARY OF MANAGEMENT MEASURES

Assessment and avoidance of measures that would result in significant changes in salinity was a large factor in the consideration, comparison and evaluation of measures during this study. As noted in the existing conditions chapter of this report, salinity variations within the channel are a high priority concern for the communities and ecological resources (delta smelt being the most sensitive species to salinity changes in the area) in the immediate study area. As such, this was a heavily weighted factor under the environmental quality P&G account, which resulted in the screening of several deeper channel depths of -40 feet, -43 feet and -45 feet from further consideration.

3.6.1 IDENTIFICATION OF MANAGEMENT MEASURES

The following non-structural and structural management measures were considered and screened for possible inclusion in alternative plans. A short description of each measure is listed below.

NON-STRUCTURAL (AN ACTIVITY) MEASURES

1. ***Congestion fees.*** Congestion fees are charged when high traffic results in delays unloading cargo. This measure was screened out because congestion in the channels is not a problem and not projected to be a problem in the future. Therefore, fees would be ineffective at meeting the planning objectives.

2. ***Intermodal Transportation Systems***. Since commercial enterprises and industries utilizing shipping channels are profit-maximizing entities, a reasonable assumption is that movement of goods and commodities already employ the most effective and efficient intermodal means of transportation, given current channel depth constraints in conjunction with other operational considerations. If modification or improvements utilizing one of the other modes to reduce transportation costs were

more effective and efficient, the commercial enterprises and industries would likely pursue that that approach in lieu of channel deepening. Diverting shipped cargo to overland transportation networks may also incur adverse impacts associated with increased traffic congestion and air pollution in the region. Because navigation is the most efficient way of transporting goods to the port facilities in the study area with the least emissions, this measure was considered ineffective at meeting planning objectives and was screened out.

3. ***Lightering***. This measure was screened out because Petroleum lightering is prohibited in San Francisco Bay and it is assumed that this will still be prohibited in the future without-project condition.

4. ***Light Loading***. This measure refers to vessels not loading to their full capacity, in order to safely transit existing channel depths. This measure is already being employed, and it is assumed to be a part of the future without-project condition; therefore it was screened from further analysis.

5. ***Use of Favorable Tides and Daylight Transit Only.*** Use of favorable tides refers to vessels entering a channel at high tide so that they can come in at a deeper draft than they would be able to at low tide. This measure (i.e., "riding the tide") was screened out because it is already being implemented to the maximum extent possible and is also considered a component of the future without-project condition.

6. ***Traffic Management.*** Traffic management of commercial vessels is not a problem in the study area. Therefore, the traffic management measure were screened out because it would be ineffective in meeting the planning objectives.

7. ***Pipeline.*** The pipeline measure was selected in the 1998 GRR as the locally preferred plan. The pipeline was conceptually designed to utilize an existing pipeline owned by PG&E and to construct portions of a new pipeline between Avon and Richmond. This alternative also proposed to construct a -45 foot MLLW deep-draft berth near Richmond where oil tankers could unload petroleum products. After the 1998 GRR was finalized, it was determined that USACE does not have the authority to construct an oil pipeline. Subsequently, the oil industry determined that it was not in their interest to proceed with the pipeline because it was not cost effective. Today, the non-Federal sponsor does not support this management measure as an alternative, and it is no longer within the re-scoped study area.

8. ***Relocate Port Facilities.*** Relocating port facilities to deeper water and/or docking boats in the bay was screened out due to the extensive landside development investment associated with the existing refinery sites and due to safety concerns.

STRUCTURAL (CONSTRUCTION/ASSEMBLY ON-SITE) MEASURES

Channel Deepening. Various intermediate depths beyond the existing -35 foot MLLW maintained depth were considered up to the authorized project depth of -45 foot MLLW depth, as described as follows for Pinole Shoal and Bulls Head reach portion of Suisun Bay to Avon. Depths were considered at increments that would be most likely to address the problems and objectives.

1. **Deepen to -37 Feet MLLW.** Deepening to -37 feet MLLW would result in approximately 0.8 million cubic yards of material being dredged from the ship channel. This measure meets the overall goal of reducing the transportation costs and increasing the efficiencies of transporting commodities to and from facilities, and improves travel schedules for vessels arriving at and departing from San Francisco Bay. Based on draft salinity intrusion significance thresholds used for the EIS analyses (as defined in CCWD 2010), salinity modeling results indicate that potential impacts from deepening to -37 feet MLLW would likely not result in salinity intrusion that would require mitigation.

2. **Deepen to -38 Feet MLLW.** Deepening to -38 feet MLLW would result in approximately 1.4 million cubic yards of material being dredged from the ship channel. This measure meets the overall goal of reducing the costs and increasing the efficiencies of transporting commodities to and from facilities, and improves travel schedules for vessels arriving at and departing from San Francisco Bay. Based on draft salinity intrusion significance thresholds developed for the EIS analyses (as defined in CCWD 2010), salinity modeling results indicate that potential impacts from deepening to -38 feet MLLW would also likely not result in salinity intrusion that would require mitigation.

3. **Deepen to -40 Feet MLLW.** Deepening to -40 feet MLLW would result in approximately 3.8 million cubic yards of material being dredged from the ship channel. This measure meets the overall goal of reducing the costs and increasing the efficiencies of transporting commodities to and from facilities, and improves travel schedules for vessels arriving at and departing from San Francisco Bay. However, salinity modeling results performed to date indicate that deepening to -40 feet MLLW or a greater depth would potentially result in salinity impacts that could require mitigation. Therefore, a -40 foot MLLW channel is more likely than shallower depths to require mitigation and there is significant risk, uncertainty and a high likelihood of required mitigation costs. This management measure was screened out of further analysis based on the risk, uncertainty, and likely high costs associated with mitigating for the impacts to water supply.

4. **Deepen to -43 Feet MLLW**. Deepening to -43 feet MLLW would result in approximately 7.0 million cubic yards of material being dredged from the ship channel. This measure meets the overall goal of reducing the costs and increasing the efficiencies of transporting commodities to and from facilities, and improves travel schedules for vessels arriving at and departing from the San Francisco Bay. This depth could allow a shift in the vessel class size calling on the San Francisco to Stockton ports. However, salinity modeling results performed to date indicate that deepening to -40 feet MLLW or a greater depth would potentially result in salinity impacts that could require mitigation. Therefore, there is more certainty that -43 foot channel is more likely than shallower depths to require mitigation. This management measure was screened out of further analysis based on the risk, uncertainty, and likely high costs associated with mitigating for the impacts to water supply.

5. **Deepen to -45 Feet MLLW.** This measure would attain the Congressionally-authorized depth for the channels specified in the Rivers and Harbors Act of 1965. Deepening to -45 feet MLLW would result in approximately 9.5 million cubic yards of material being dredged from the ship channel. This

measure meets the overall goal of reducing the costs and increasing the efficiencies of transporting commodities to and from facilities, and improves travel schedules for vessels arriving at and departing from the San Francisco Bay. The increased efficiencies and improvement in vessel schedules for a -45 foot channel depth would be the highest of any of the channel depths considered. However, salinity modeling results performed to date indicate that deepening to -40 feet MLLW or a greater depth would potentially result in salinity impacts that could require mitigation. Therefore, based on draft salinity intrusion significance thresholds, there is a high probability that a -45 foot MLLW channel is more likely to require significant mitigation for salinity intrusion. This management measure was screened out of further analysis based on the risk, uncertainty, and likely high costs associated with mitigating for the impacts to water supply.

6. ***Sediment Trap.*** A sediment trap was considered to address the consistent high rate of shoaling in the advanced maintenance area within this reach, as requested by the San Francisco Bar Pilots. Existing conditions require advance maintenance during regular maintenance dredging episodes or emergency dredging to retain the dredged depth throughout the year. To reduce the likelihood and frequency of dredging for the Bulls Head Reach, a shoal analysis was performed which showed a sediment trap of an additional 4 foot depth could be dredged to ensure that the Bulls Head Reach is maintained reliably and is consistent with the prevailing maintained depth of the connecting Federal channels. The estimated increase in dredging volume associated with deepening the sediment trap is considered negligible when compared to the total volume of material that would dredged with any of the alternative channel depths considered in this study; therefore, volume estimates for a sediment trap have been included with the total estimated volume of material that would be dredged for each channel depth discussed above.

7. ***Rock outcrop removal*****.** This measure refers to a small natural rock outcropping of approximately 950 square feet just south of Pinole Shoal Channel, which is a navigation hazard to vessels. This measure would propose to level the rock using a pneumatic jackhammer from -39.7 feet MLLW to -43 feet MLLW, which is estimated to be 40 cubic yards. The debris would be sidecast and allowed to fall to the Bay floor.

8. ***Dredged Material Placement Sites.*** This is a required measure associated with channel dredging measures, regarding the identification and use of a site(s) to place the material removed from the channel. Several placement site options were considered, including the San Francisco Bay Deep Ocean Disposal Site (SF-DODS), using existing beneficial use sites, constructing new beneficial-use sites, and partnering with other projects and programs in the region that could benefit from the availability of project-generated material. It was determined that owing to unknowns related to the completion of design and receipt of construction funding for this project relative to other regional efforts, those opportunities would be reevaluated during the design phase of work. The existing sediment chemistry, physical characteristics, and bioassay data for the material proposed for dredging were evaluated and that data was compared to the requirements of each available placement site. In addition, the available capacity of each placement site was compared against the volume of material estimated to be dredged, as well as if the site would be available to accept dredged material when the channels in the study area would be deepened. The analysis also included other proposed deepening projects within San Francisco Bay (e.g., Redwood City Harbor) and maintenance dredging

projects that could also use the placement sites. The analysis resulted in three sites chosen to be carried forward for consideration as the most likely sites given current assumptions, and are briefly discussed below:

1. ***Cullinan Ranch.*** Cullinan Ranch, a 1,575-acre parcel in the San Pablo Bay National Wildlife Refuge, was originally purchased by the USFWS for the purpose of increasing habitat for salt marsh harvest mouse (*Reithrodontomys raviventris*) and California clapper rail (*Rallus longirostris obsoletus*). Located in Solano County, the southern property boundary of the parcel is a naturally formed levee that is the base for State Highway 37. The western property boundary of the parcel comprises Dutchman Slough and South Slough, both of which flow into the nearby Napa River. Cullinan Ranch is a tidal restoration project with the goal of restoring diked baylands to historic tidal marsh conditions. Cullinan Ranch is permitted to receive up to 9 million cubic yards of dredged material and currently has the capacity to accept up to 2.4 million cubic yards of dredged material. The Redwood City Harbor deepening project and other maintenance dredging projects are also considering using this site. Placing material at Cullinan meets the planning objective of maximizing beneficial use of dredged material.
2. ***Montezuma Wetlands*.** The approximately 1,800-acre Montezuma Wetlands Restoration Project is a privately owned and operated wetland restoration project located adjacent to Montezuma Slough in northern Honker Bay. The site can take dredged material with elevated concentrations of constituents of concern, as long as this sediment is buried under 3 feet of clean cover material. The Montezuma site currently has the capacity to accept up to 12 million cubic yards of dredged material. However, the Redwood City Harbor deepening project is also considering using this site for dredged material. Placing material at Montezuma Wetlands meets the planning objective of maximizing beneficial use of dredged material.
3. ***San Francisco Bay – Deep Ocean Disposal Site (SF-DODS).*** The SF-DODS is located in the Pacific Ocean, approximately 55 nautical miles west of the Golden Gate Bridge. The site is the deepest and farthest-offshore ocean placement site in the nation. The regulatory site capacity of SF-DODS is 4.8 million cubic yards per year. Sediment placed at SF-DODS can have higher concentrations of constituents of concern compared to many beneficial-use sites.

3.6.2 PRELIMINARY SCREENING OF MEASURES

The management measures presented above were screened based on an assessment to meet project objectives, avoid constraints, ability to meet the four P&G accounts, and ability to meet with 4 P&G criteria. The screening was performed to identify those measures that are appropriate for inclusion in developing alternative plans. **Table 3-1 and Table 3-2** provides an overview of the screening results for the measures identified for the project study area.

Non-structural and structural measures were compared and evaluated against a set of 12 different screening criteria to assess positive benefits and attributes which could be attained, worth a total of 2 points each, for a total maximum score of 24 points. Points were assigned as follows: Does Not Meet = 0;

Partially Meets = 1; Fully Meets = 2. Negative scores up to -2 points were assigned for areas where negative effects could occur. The total score of each measure was then determined, and only measures which scored greater than 12 (over half of the total available points) were carried forward to be combined into alternatives.

Table 3-1.Preliminary Structural Measures Screening Matrix.

San Francisco Bay to Stockton - Structural Management Measures							
1. Measures							
2. Impact Assessment (4 P&G Accounts)	**Deepen to -37 feet MLLW**	**Deepen to -38 feet MLLW**	**Deepen to -40 feet MLLW**	**Deepen to -43 feet MLLW**	**Deepen to -45 feet MLLW**	**Sediment Trap**	**Rock Outcropping**
A. National Economic Development (NED)	F -Acheives NED benefits.	F -Acheives NED benefits.	P - Likely to achieve NED benefits but costs may be larger than benefits	P - Likely to achieve NED benefits.	P - Likely to achieve NED benefits.	P - Likely to achieve NED benefits.	P - Likely to contriibute to NED benefits when combined.
	2	2	1	1	1	1	1
B. Environmental Quality (EQ)	P - May have some environmental affects but not likely to have salinity intrusion which would require mitigation.	P - May have some environmental affects but not likely to have salinity intrusion which would require mitigation.	O - Expected to have salinity impacts that would require signifcant mitigation and community opposition.	O - Expected to have salinity impacts that would require signifcant mitigation and community opposition.	O - Expected to have salinity impacts that would require signifcant mitigation and community opposition.	P - May have some environmental affects but not likely to have salinity intrusion which would require mitigation.	P - Unlikely to have environmental affects.
	1	1	-2	-2	-2	1	1
C. Regional Economic Development (RED)	P - Could have some RED during construction.	P - Could have some RED during construction.	P - Could have some RED during construction.	P - Could have some RED during construction.	P - Could have some RED during construction.	P - Could have some RED during construction.	P - Contributes toward RED when combined
	1	1	1	1	1	1	1
D. Other Social Effects (OSE)	P - Community may be affected in the short term during construction but overall would benefit.	P - Community may be affected in the short term during construction but overall would benefit.	O- Community may be affected in the short term during construction. Community would likely be against environmental aspects of this plan.	O- Community may be affected in the short term during construction. Community would likely be against environmental aspects of this plan.	O - Community may be affected in the short term during construction. Community would likely be against environmental aspects of this plan.	P - Community may be affected in the short term during construction but overall would benefit.	F - Improves navigability for vessels.
	1	1	0	0	0	1	2
3. Plan Evaluation							
A. Contribution to Planning Objectives							
Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020	F - Would likely reduce transportation costs and increase efficiency.	F - Would likely reduce transportation costs and increase efficiency.	F - Would likely reduce transportation costs and increase efficiency.	F - Would likely reduce transportation costs and increase efficiency.	F - Would likely reduce transportation costs and increase efficiency.	F - Would likely reduce transportation costs and increase efficiency.	P - Will contribute to this objective when combined.
	2	2	2	2	2	2	1
Objective 2: Maximize beneficial reuse of dredged material while minimizing placement costs	F - Would likely be able to have an opportunity to place material at beneficial use site.	F - Would likely be able to have an opportunity to place material at beneficial use site.	F - Would likely be able to have an opportunity to place material at beneficial use site.	F - Would likely be able to have an opportunity to place material at beneficial use site.	F - Would likely be able to have an opportunity to place material at beneficial use site.	F - Would likely be able to have an opportunity to place material at beneficial use site.	P - Possibility of beneficial resuse
	2	2	2	2	2	2	1
Objective 3: Reduce frequency of operation and maintenance dredging in high shoaling areas	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	F - Would liklely be able to reduce operation and maintenance in shoaled areas.	O - Does not contribute.
	2	2	2	2	2	2	0
B. Response to Planning Constraints							
(1) Avoid conflict with state and Federal regulations, as stated in Federal law, USACE regulations and Executive Orders.	F - Fully meets	F - Fully meets	F - Fully meets	F - Fully meets	F - Fully meets	F - Fully meets	F - Fully meets
	2	2	2	2	2	2	2
C. Response to Evaluation Criteria							
(1) Completeness	F - Complete	F - Complete	F - Complete	F - Complete	F - Complete	F - Complete	P -Must be combined with deepening to be complete.
	2	2	2	2	2	2	1
(2) Effectiveness	F - Meets all objectives.	F - Meets all objectives.	F - Meets all objectives.	F - Meets all objectives.	F - Meets all objectives.	F - Meets all objectives.	P - Meets some objejctoves when combined.
	2	2	2	2	2	2	1
(3) Efficiency	F - Is cost-effective	F - Is cost-effective	P- cost effectiveness is unknown with mitigation concerns	P- cost effectiveness is unknown with mitigation concerns	P- cost effectiveness is unknown with mitigation concerns	F - Is cost-effective	F - Is cost-effective when combined.
	2	2	1	1	1	2	2
(4) Acceptability	P - Would be generally acceptable.	P - Would be generally acceptable.	O - Would likely not be acceptable to community and environmental agencies.	O - Would likely not be acceptable to community and environmental agencies.	O - Would likely not be acceptable to community and environmental agencies.	P - Would be generally acceptable.	P - Would be generally acceptable.
	1	1	-2	-2	-2	1	1
SCORE	20	20	11	11	11	19	14
CARRIED FORWARD	Yes	Yes	No	No	No	Yes	Yes
O = Does not meet; P - Partially meets; F = Fully meets							

Table 3-2. Preliminary Non-Structural Measures Screening Matrix.

San Francisco Bay to Stockton – Non-Structural Management Measures								
1. Measures								
2. Impact Assessment (4 P&G Accounts)	**No-Action**	**Congestion Fees**	**systems**	**Lightering/Light Loading**	**Tides and Daylight Transit Only**	**Traffic Management**	**Relocate Port Facilities**	**Pipeline**
A. National Economic Development (NED)	O - Does not improve NED.	O - Congestion is not an issue; Would not create benefits and would likely have no benefits to offset the costs.	O - Would not be more cost effective than vessel transportation.	P - Possibly could be cost efficient and have reasonable benefits.	O - This measure is already being done and is not providing needed benefits in the existing conditions.	O - Traffic Management is not an issue; Would not create benefits and would likely have no benefits to offset the costs.	O - This measure could have NED benefits but the large landside cost investment could outweigh the benefits.	P - This measure could have NED benefits but the large lcost investment could outweigh the benefits.
	0	0	0	1	0	0	0	1
B. Environmental Quality (EQ)	P - Environmental effects will continue with current trends.	O - Would not affect the environment in postive or negative ways.	O - Would not be more advantageous than vessel transportation.	O - There are potential negative environmental impacts associated with lightering	O - Would not affect the environment in postive or negative ways.	O - Would not affect the environment in postive or negative ways.	O - This measure could have impacts with moving the existing oil refinery to a new location.	P- There are potential negative environmental impacts associated oonstruction of a pipeline.
	1	0	0	0	0	0	0	1
C. Regional Economic Development (RED)	O - Does not improve RED.	P - Could provide slight increase in regional economy through fees.	P - Could provide some regional economic development through other transporation modes.	P - Could provide some regional economic benefit development associted with private companies performing lightering operations	O - This measure is already being done and would not provide additional regional economic development benefits.	O - Would not provide regional economic benefits.	P - Could provide some regional economic development during relocation and new construction.	P - Could provide some regional economic development during pipeline construction.
	0	1	1	1	0	0	1	1
D. Other Social Effects (OSE)	P - Community would not be affected beyond future without project trends.	O - Would not affect public in positive or negative ways.	P - Could create positive or negative effects (is negative: More trucks on the road = more congestion for community)	O - There are potential negative environmental impacts associated with lightering, which affect the community's environmental and well-being	P - This measure is likely not affecting the community in a negative way.	O - Would not affect public in positive or negative ways.	O - Relocation may not be acceptable to the community in terms of noise, construction activity, potential environmental impacts and saftey concerns.	P - Pipliline may not be acceptable to the community in terms of noise, construction activity, and potential environmental impacts.
	1	0	1	0	1	0	0	1
3. Plan Evaluation								
A. Contribution to Planning Objectives								
Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020	O - Would not reduce transportation costs	O - Congestion in the channels is not a problem; therefore this measure would meet the objective.	O - Would not reduce transportation costs as shipping is generally the least cost of all modes.	P - Could potentially reduce transportation cost.	O - This measure is already being done and is not providing needed benefits in the existing conditions.	O - Congestion in the channels is not a problem; therefore this measure would meet the objective.	P - Relocation to deeper water could meet this objective.	P - Could potentially reduce transportation cost.
	0	0	0	1	0	0	1	1
Objective 2: Maximize beneficial reuse of dredged material while minimizing placement costs	P - Beneficial use could occur independent of a project.	O - Would not meet.	O - Would not apply to this objective.	O - Would not apply to this objective.	O - Would not apply to this objective.	O - Would not meet.	P- This could potentially be met.	P- This could potentially be met.
	1	0	0	0	0	0	1	1
Objective 3: Reduce frequency of operation and maintenance dredging in high shoaling areas	O - Reduction of operation and maintence would not occur.	O - Would not meet.	O - This objective would not be met.	O - This objective would not be met.	O - This objective would not be met.	O - Would not meet.	P - Depending on the new location, shoaling could potentially decrease or increase.	O - This would not be met
	0	0	0	0	0	0	1	0
B. Response to Planning Constraints								
(1) Avoid conflict with state and Federal regulations, as stated in Federal law, USACE regulations and Executive Orders.	F - Fully meets	F - Fully meets	F - Fully meets	O - Petroleum lightering in not allowed in San Francisco Bay.	F - Fully meets	F - Fully meets	P - Fully meets; uncertain if this could feasibily be done within regulations.	P -Decision by vertical team post 1998 GRR that Corps is not authorized to construct this measure. Non-Federal sponsor could construct but does not support, nor do the oil refineries.
	2	2	2	0	2	2	1	1
C. Response to Evaluation Criteria								
(1) Completeness	F- Complete.	P - Could potentially be combined for completeness.	P - Could potentially be combined for completeness.	P - Could potentially be combined for completeness.	O - This measure is not complete.	O - This measure is not complete.	P - This measure would likely be complete.	O - This measure is not complete.
	2	1	1	1	0	0	1	0
(2) Effectiveness	O - Not effective in meeting objectives.	O - Not effective in meeting objectives.	O - Not effective in meeting objectives.	O - Not effective in meeting objectives.	O - Not effective in meeting objectives.	O - Not effective in meeting objectives.	P - Would meet objectives.	O - Not effective in meeting objectives.
	0	0	0	0	0	0	1	0
(3) Efficiency	O - Would not provide needed benefits - therefore not cost effective.	O - Would not provide needed benefits - therefore not cost effective.	O - Would not provide needed benefits - therefore not cost effective.	P - Could possibly achieve some benefits.	O - Would not provide needed benefits - therefore not cost effective.	O - Would not provide needed benefits - therefore not cost effective.	O - Benefits would likely not outweigh costs	O - Would not provide needed benefits - therefore not cost effective.
	0	0	0	1	0	0	0	0
(4) Acceptability	P - Would be generally acceptable but not to Port.	P - Would be generally acceptable.	P - May or may not be acceptable to the public and agencies.	O - Would not be acceptable.	P - Would be generally acceptable.	P - Would be generally acceptable.	O -W ould likely be unacceptable to Port due to high cost and coordination, and community.	O - This is not acceptable to Port or Oil Refineries.
	1	1	1	0	1	1	0	0
SCORE	5	5	6	5	4	3	7	7
CARRIED FORWARD	Yes- carried for comparison.	No	No	No	No	No	No	No
O = Does not meet; P - Partially meets; F = Fully meets								

3.7 ALTERNATIVE FORMULATION STRATEGY

Error! Reference source not found.**Table 3-1** and **Table 3-2** list management measures that met the evaluation and screening criteria, along with additional pertinent information.

As mentioned earlier, comparison and evaluation of effects of measures to potential salinity changes, and its subsequent effects towards communities and species (in particular, delta smelt) as a result of deepening was a major factor in the screening process.

Another key consideration during this process was to set an objective to integrate the dredged material beneficially into the environment for each alternative. This approach would offset several (already minimal) environmental effects that could potentially occur, avoiding the need for compensatory mitigation by minimizing the effects through the project. The contribution of dredged material to the beneficial reuse sites would contribute to additional wetland and benthic habitat, and benefit several sensitive species, including delta smelt habitat beyond what is currently in the area.

Measures which were screened out include all non-structural alternatives, as they are already being implemented or did not compete well relative to other measures, and deepening alternatives at the 40 foot, 43 foot and 45 foot depths, as the risk of potential salinity change and associated effects was too significant at these depths.

Measures carried forward as feasible ways to alleviate problems, meet objectives, show benefits under the P&G accounts, meet P&G screening criteria, and have low risk in terms of adverse environmental effects include the no-action plan, deepening alternatives at the -37 foot and -38 foot MLLW depth, sediment trap at the -42 foot depth plus 2 feet of overdepth (based on the shoaling analysis titled Bulls Head Deposition HydroSurvey Tech Memo- 2015), and removal of the rock outcropping in Pinole Shoal channel.

These remaining measures were then combined into alternatives. These alternatives include the no-action alternative and two deepening alternatives (to depths of -37 feet and -38 feet MLLW), with the dredged material being beneficially used at one or more of the existing permitted beneficial use sites, namely, Cullinan Ranch, Montezuma Wetlands, or other sites such as SF-DODS, and in-Bay placement. A sediment trap measure is also included at Bulls Head Reach in both of the action alternatives, as well as the measure addressing removal of the rock outcropping for increased navigability.

3.8 ALTERNATIVE COMPARISON AND EVALUATION OF THE FINAL ARRAY

Table 3-3 displays the initial array of alternatives, which were then compared and evaluated against screening criteria, using an additional level of refinement with known information. A description of each alternative is below.

No-Action: The no-action alternative is defined as the continuation of present-day policies and actions to maintain the existing Federal project channel dimensions within the study area, assuming no new Federal actions re: channel improvements over the next 50 years. The purpose of the no-action alternative and subsequent alternative analyses is to provide a comparison of the magnitude of environmental effects of the action alternatives against a benchmark of no-action. This comparison also demonstrates the degree to which the need for channel improvement is real and that it was thoroughly considered and appropriately and adequately answered.

The shipping channel in the study area would continue to remain in place and function at the existing constructed depths. Maintenance dredging of the channel would continue to occur at the same frequency and would generate the same volumes under current conditions, and would occur annually at both the Pinole Shoal Channel and at Bulls Head Reach to maintain the current depth of -35 feet MLLW. Maintenance dredging would continue to be managed and environmental review of maintenance dredging would continue to be performed by USACE.

-37 foot MLLW Alternative: The -37 foot MLLW alternative would deepen Pinole Shoal channel and the Bulls Head Reach portion of Suisun Bay channel within the shipping channels to a depth of -37 feet MLLW. The existing advance maintenance area within Bulls Head Reach Channel would be further deepened from -37 feet MLLW (plus 2 feet of overdepth) to -42 feet MLLW (plus 2 feet of overdepth) to function as a sediment trap.

The total dredging volume for the -37 foot MLLW Alternative would be approximately 860,000 million cubic yards from over approximately 200 acres of channel bottom. An estimated 438,500 cubic yards of sediment would be dredged to reach -37 feet MLLW and an additional 422,800 cubic yards of sediment would be dredged if the allowable overdepth (2 feet) was fully dredged.

To reduce the risk of entrainment of special status fish, dredging would be conducted during approved seasonal environmental work windows and by using a mechanical clamshell dredge. Dredged material would be placed in scows and, once full, transported by tugs to one of the sites where it would be off-loaded to the respective beneficial use site. Deepening under this alternative would take approximately 3 months and would be completed in 1 year during the existing environmental work windows for Pinole Shoal and Bulls Head Reach. The environmental work windows for these channels are June 1 through November 30 and August 1 through November 30, respectively.

Environmental resources that have the potential to be affected include special status fish, native and commercially important fish, benthic resources, water quality, and air quality. Dredging within the existing work windows with a clamshell dredge would ensure that impacts to special status fish are avoided or minimized. Impacts to water quality could result from increases in suspended sediment concentrations and minor salinity intrusion. Impacts resulting from increased suspended sediment and turbidity would be temporary and localized around the vicinity of dredging. Impacts to air quality would result from emissions during dredging and dredged material transport to the beneficial-use sites. As this alternative would use existing sites with all environmental permits to accept dredged material, analysis of the impacts of off-loading the dredged material and any habitat construction activities once the material is off-loaded is not required in this report.

-38 foot MLLW Alternative: The -38 foot MLLW Alternative would deepen Pinole Shoal channel and the Bulls Head Reach portion of Suisun Bay channel to a depth of -38 feet MLLW of the advance maintenance area within Bulls Head Reach Channel would be further deepened from -38 feet MLLW (plus 2 feet of overdepth) to -42 feet MLLW (plus 2 feet of overdepth) to function as a sediment trap.

The total dredging volume for the -38 foot MLLW Alternative would be approximately 1.5 million cubic yards from over approximately 390 acres of channel bottom. An estimated 861,300 cubic yards of sediment would be dredged to reach -38 feet MLLW and an additional 646,200 cubic yards of sediment would be dredged if the allowable overdepth (2 feet) was fully dredged.

To reduce the risk of entrainment of special status fish, dredging would be conducted during approved seasonal environmental work windows and by using a mechanical clamshell dredge. Similar to the -37 foot MLLW Alternative, dredged material would be transported by tugs to one of the sites where it would be off-loaded. Deepening under this alternative would take approximately 4.5 months and would be completed in 1 year during the existing environmental work windows for Pinole Shoal and Bulls Head Reach.

Environmental resources that have the potential to be affected are similar to those discussed in for the -37 foot MLLW Alternative.

Removal of Rock Outcrop

The rock formation in Pinole Shoal channel was surveyed at approximately -39.7 feet MLLW. Even though this rock feature is not within the boundaries of the Federal channel, it is located in the shipping lane and will need to be addressed as part of this project to provide safe navigation. The rock formation will be lowered so that there is a minimum of 3 feet of additional clearance below the 2 feet of overdepth tolerance, lowering the rock formation to approximately -43 feet MLLW for the -3 foot depth. Although the rock formation has not been specifically sampled, it is assumed that because of its predicted hardness, the removal will likely require using a pneumatic jack-hammer attachment that would be mounted to an excavator mounted on a work barge. The jack-hammer would chisel the rock down to the desired elevation and the material would be sidecast to the bottom of the Bay floor. The estimated quantity of rock to be removed is approximately 40 cubic yards (CY) to achieve a safe navigation depth of 43-feet MLLW for the -38 foot TSP depth, within an area of approximately 950 square feet.

Table 3-3. Initial Array of Alternatives Criteria and Screening

1. Alternatives	**No Action (Future Without-Project)**	**SF-DODS**		**Cullinan Ranch**		**Montezuma Wetlands**		**In bay Disposal (SF-10 and SF-16)**	
2. Impact Assessment (4 P&G Accounts)		**37 feet**	**38 feet**	**37 feet**	**38 feet**	**37 feet**	**38 feet**	**37 feet**	**38 feet**
A. National Economic Development (NED)	O - Vessels (Tankers) will continue to load ineffieciently, passing additional costs on to the customer; would not produce any additional benefits to the nation	P - Some NED savings will be achieved at approx. $5,800,000	F - Higher NED savings will be achieved at approx. $7,680,000	P - Some NED savings will be achieved at approx. $5,710,000	F - Higher NED savings will be achieved at approx. $7,720,000	P - Some NED savings will be achieved at approx $5,750,000	F - Higher NED savings will be achieved at approx. $7,580,000	P - Some NED savings will be achieved	F - Higher NED savings will be achieved
	0	1	2	1	2	1	2	1	2
B. Environmental Quality (EQ)	F- Environmental quality will remain as it currently is.	O - material placed in this site would be taken out of the natural system.	O - material placed in this site would be taken out of the natural system.	F- placement here can offset mitigation anticipated for loss of benthic foraging habitat and residual impacts to special status species	F- placement here can offset mitigation anticipated for loss of benthic foraging habitat and residual impacts to special status species	F- placement here can offset mitigation anticipated for loss of benthic foraging habitat and residual impacts to special status species	F- placement here can offset mitigation anticipated for loss of benthic foraging habitat and residual impacts to special status species	P- placement here will keep material in the natural system	P- placement here will keep material in the natural system
	2	0	0	2	2	2	2	1	1
C. Regional Economic Development (RED)	P - Regional development will continue on a similar trend as it has in the past	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved	P - Some regional economic development could be achieved
	1	1	1	1	1	1	1	1	1
D. Other Social Effects (OSE)	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are	P - Other social effects will remain as they currently are
	1	1	1	1	1	1	1	1	1
3. Plan Evaluation									
A. Contribution to Planning Objectives									
Objective 1: Reduce transportation costs and increase deep draft navigation efficiency for the shipment of commodities to and from all facilities within the study area beginning in 2020	O - This objective will not be met.	P - Annual Net Benefits (Transportation Cost Savings) =$5,800,000	F - Most fully meets with Annual Net Benefits (Transportation Cost Savings) =$7,680,000	P - Annual Net Benefits (Transportation Cost Savings) =$5,710,000	F- Most fully meets with Annual Net Benefits (Transportation Cost Savings) =$7,720,000	P - Annual Net Benefits (Transportation Cost Savings) =$5,750,000	F - Most fully meets with Annual Net Benefits (Transportation Cost Savings) =$7,580,000	P - Annual Net Benefits (Transportation Cost Savings)	F - Most fully meets with Annual Net Benefits (Transportation Cost Savings)
	0	1	2	1	2	1	2	1	2
Objective 2: Maximize beneficial reuse of dredged material while minimizing placement costs	O - This objective will not be met.	O - material placed in this site would be taken out of the natural system.	O - material placed in this site would be taken out of the natural system.	F - Material would be beneficially used in this site.	F - Material would be beneficially used in this site.	F - Material would be beneficially used in this site.	F - Material would be beneficially used in this site.	P- placement here will keep material in the natural system but would not be considered as beneficial use	P- placement here will keep material in the natural system but would not be considered as beneficial use
	0	0	0	2	2	2	2	1	1
Objective 3: Reduce frequency of operation and maintenance dredging in high shoaling areas	O - This objective will not be met.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.	F - A sediment trap is proposed with all alternatives and would reduce frequency of emergency O&M events and provides a total cost savings (present value) of $8.6M to the nation over 50 years.
	0	2	2	2	2	2	2	2	2
B. Response to Planning Constraints									
(1) Avoid conflict with state and Federal regulations, as stated in Federal law, USACE regulations and Executive Orders.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	F - Will remain in compliance with all regulations, etc.	O- Disposal at this site would not be permitted as the State and Federal Program "Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (LTMS) Program" cannot exceed 700,000 cy per year. Initial construction would exceed this.	O- Disposal at this site would not be permitted as the State and Federal Program "Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (LTMS) Program" cannot exceed 700,000 cy per year. Initial construction would exceed this.
	2	2	2	2	2	2	2	-2	-2
C. Response to Evaluation Criteria									
(1) Completeness	O - Not considered to be complete because it does not provide investments or actions to ensure realization to meet the planning objectives.	F- Complete	F- Complete	F- Complete	F- Complete	F- Complete	F- Complete	P- Partially complete; Full capacity not available.	P- Partially complete; Full capacity not available.
	0	2	2	2	2	2	2	1	1
(2) Effectiveness	O - Not effective in meeting the planning objectives	P - Partially effective with Annual Benefits = $7,630,000	F- More fully effective with Annual Benefits =$11,310,000	P - Partially effective with Annual Benefits =$7,630,000	F- More fully effective with Annual Benefits =$11,310,000	P - Partially effective with Annual Benefits =$7,630,000	F- More fully effective with Annual Benefits =$11,310,000	P - would not meet the beneficial use objective	P - would not meet the beneficial use objective
	0	1	2	1	2	1	2	1	1
(3) Efficiency	P - Cost effectiveness - does not incur a cost but also does not obtain benefits	P - Partially efficient with Annual Net Benefits =$5,800,000	F- More fully efficient with Annual Net Benefits =$7,680,000	P - Partially efficient with Annual Net Benefits =$5,710,000	F- More fully efficient with Annual Net Benefits =$7,720,000	P - Partially efficient with Annual Net Benefits =$5,750,000	F- More fully efficient with Annual Net Benefits =$7,580,000	P - Partially efficient with Annual Net Benefits	F- More fully efficient with Annual Net Benefits
	1	1	2	1	2	1	2	1	2
(4) Acceptability	P - Currently accepted as the status quo and is compatible with existing laws, regulations, and public policies; however, it does not achieve full acceptability since there are problems which can be improved.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	P- This plan would likely be sufficiently acceptable to public communities and agencies.	O - Would not be acceptable to State and Federal entities.	O - Would not be acceptable to State and Federal entities.
	1	1	1	1	1	1	1	-2	-2
O = Does not meet; P - Partially meets; F = Fully meets	8	13	17	17	21	17	21	7	10

Table 3-4. Final Array of Alternatives.

Alternative	Description of Alternative	Screening Outcome
No Action	No action would be taken to reduce the cost of transportation and increase economic efficiencies.	**Retained**
Deepen: -37 feet MLLW Placement Site: Existing permitted beneficial use sites	• Deepen to -37 feet MLLW with 2 feet of overdepth. • Includes sediment trap at Bulls Head Reach. • Beneficially use approximately 860,000 cubic yards of dredged sediment at Montezuma Wetlands or Cullinan Ranch. • Rock outcrop removal.	**Retained**
Deepen: -38 feet MLLW Placement Site: Existing permitted beneficial use sites	• Deepen to-38 feet MLLW with 2 feet of overdepth. • Includes sediment trap at Bulls Head Reach. • Beneficially use approximately 1.6 million cubic yards of dredged sediment at Montezuma Wetlands or Cullinan Ranch. • Rock outcrop removal.	**Retained**

Comparison and evaluation of the initial array of alternatives shown in **Table 3-3** resulted in a reduced array of alternatives moving forward to the final array of alternatives that will be addressed in this report, shown in **Table 3-4**. An analysis of placement sites for each alternative determined that placement at Montezuma Wetlands and/or Cullinan Ranch were cost-effective options and importantly, using these sites maximizes the planning objective to beneficially use material. Inland bay placement does not contain adequate capacity for initial construction, and would not be permitted or acceptable by agencies; additionally, although material placement within the bay at these sites would keep material in the local system, it would not constitute beneficial use. Placement of material at SF-DODS is not ideal since it takes material out of the natural system, while both Cullinan Ranch and Montezuma Wetlands both can beneficially use the material and are cost effective. While SF-DODS is not carried forward as a placement site, it is worth mentioning that it is an available placement site if needed, if there are no other beneficial use sites with available capacity prior to construction.

3.9 ECONOMIC EVALUATION OF THE FINAL ARRAY

Preliminary screening level cost estimates were used for the two proposed deepening alternatives for use in the economic analysis. Costs shown in **Table 3-5** include Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) activities and Interest during Construction (IDC). Transportation costs and benefits were estimated using the USACE certified economic model, HarborSym, and estimated for a 50-year period of analysis for the years 2020 through 2069. For this comparison, the costs and benefits were annualized at the FY16 discount rate of 3.125% over 50 years.

The -38 foot alternative provides higher net benefits than the -37 foot alternative, and additionally meets planning criteria goals of being complete, efficient, effective, and acceptable. The -38 foot alternative also shows a positive benefit to cost ratio of 3.1 to 1.

Table 3-5. Final Array - NED Determination.

	ALTERNATIVES		
	No-Action (35')	**37'**	**38'**
AAEQ Transportation Cost	$209,846,000	$202,221,000	$198,534,000
AAEQ Transportation Cost Reduction (Benefit)	0	$7,625,000	$11,312,000
Project Cost	0	$33,400,000	$54,600,000
Construction Duration (months)	0	5	5
Interest During Construction (IDC)	0	$172,000	$635,000
Sub-total Cost Including IDC	0	$33,572,000	$55,235,000
Annualized Construction Cost & IDC	0	$1,917,000	$2,198,000
OMRR&R	0	$581,300	$1,397,000
TOTAL Average Annual Costs	0	$1,917,000	$3,596,000
Average Annual Benefits	0	$7,625,000	$11,312,000
Average Annual Costs	0	$1,917,000	$3,596,000
Net Benefits	0	$5,708,000	$7,716,000
BCR	0	3.9	3.1

3.10 ADDITIONAL ANALSYIS FOR THE FINAL ARRAY

The final array of alternatives must be compared and evaluated against P&G criteria, as displayed throughout this chapter. Additionally, an economic evaluation must be made to identify which plan in the final array maximizes NED benefits, discussed above. An environmental analysis must also be conducted under NEPA to compare and evaluate the final array for a set of environmental factors (Chapter 4), prior to determination of the Tentatively Selected Plan (TSP).


4
Comparison of
Environmental Effects of
Alternative Plans

4 COMPARISON OF ENVIRONMENTAL EFFECTS OF ALTERNATIVE PLANS

This section describes the potential environmental effects (direct, indirect, and cumulative) anticipated to result from the alternatives as compared to the NEPA baselines, and the methods used to conduct the evaluation. The environmental effects are evaluated against "significance impact thresholds" identified for each resource. Significance thresholds specify the level of impact beyond which an alternative is considered to have a significant impact.

This EIS classifies effects as follows:

- A ***beneficial effect*** would generally be regarded as an improvement or substantial positive change in the resource
- A ***negligible effect*** /***no impact*** would cause a slight adverse, beneficial or negative change in the resource, but one that generally would not be either noticeable or unacceptable
- A ***less-than-significant impact/adverse but not significant effect*** would cause an adverse change in the resource that would likely be noticeable, but would not cross the specified significance threshold
- A ***significant effect*** would cause adverse effects greater than the specified significance threshold; the alternative would cause a substantial adverse change in the resource that would significantly affect its condition; the severity of the impact could be reduced by pursuing specific mitigation measures
- A ***significant and unavoidable adverse effect*** would result in adverse effects that exceed the specified significance impact threshold, and the use of mitigation measures would not reduce this impact to less than significant levels
- ***An adverse effect*** is found when an undertaking alters, directly or indirectly, any of the characteristics of a historic property that qualify the property for listing in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.
- If there is insufficient information to evaluate the effect of an alternative, a result of ***no determination*** may be made.

The environmental consequences analyses also distinguish between the effects that would be associated with the construction and subsequent operational phases.

As previously described, construction of the alternatives will include the dredging and associated activities required to deepen the channels for each depth considered in the final array of alternatives. The analyses consider all activities and consequences resulting from construction up to and including transport of dredged material to the off-loaders at the beneficial reuse sites proposed for material placement. However, the analysis does not address the subsequent activities undertaken at the placement sites using the dredged material because those activities have already been covered in relevant environmental documents prepared for each site (USACE and Solano County Department of Environmental Management [SCDEM] 1998; USFWS and CDFW 2008).

The operations phase includes the long-term activities, including periodically performing maintenance dredging, disposing of the resulting dredged material, and maritime activities in the study area over the

50-year evaluation period. A 50-year period was selected to analyze environmental effects because USACE policy specifies that the economic life of deep draft navigation projects is 50 years (see **Appendix D, Economic Analysis)**. For the -37 foot and -38 foot MLLW Alternatives, the 50-year period covers the years 2020 to 2069.

When a significant effect to a resource is anticipated for an alternative, mitigation measures are identified to avoid, minimize, reduce, rectify, or compensate for the anticipated impact. Where possible, the effect analyses also predict the residual impacts that would still exist after all available mitigation measures are implemented. Compensatory mitigation is not expected to occur for this project because this project has used minimization measures to proactively reduce risk and offset environmental effects to the extent practicable. These minimization measures include working within existing and USFWS-approved environmental work windows, use of clamshell dredges, and utilizing the dredged material to contribute to wetland restoration at beneficial reuse sites.

4.1 NATURAL ENVIRONMENT

A summary of the environmental effects impact rating is presented first in this chapter. Each section will describe the effects of the alternatives in further detail. As described in Chapter 3, the alternatives include No Action, deepening the navigation channel to -37 foot MLLW or -38 foot MLLW. Preliminary modeling of the final array of alternatives (-37 foot MLLW and -38 foot MLLW) did not include the sediment trap or rock outcrop. The analysis in each resource section describes the effects of the -37 and -38 foot alternatives without a sediment trap and rock outcrop. If effects on each resource are similar for -37 foot MLLW, -38 foot MLLW, and 38 foot MLLW plus the sediment trap and rock outcrop, the effects are described within the same paragraph. The TSP (-38 foot MLLW plus sediment trap and rock outcrop removal) was further modeled to show any incremental effects of adding the sediment trap to the 38 foot depth. The 38 foot MLLW plus sediment trap at Bulls Head Reach plus the rock outcrop result in different effects from the -37 and -38 foot deepening only alternatives for the water quality, biological resources, and cultural resources. The results of the effects analysis for these resources are described with a subheading of -38 foot + Sediment Trap and Rock Outcrop.

Table 4-1 provides a summary of the environmental effects and benefits that would occur for each of the alternatives. The level of adverse impact for a given resource is defined as: (0) negligible/no impact; (-1) adverse but not significant impact/less than significant; (-2) significant but mitigatable adverse impact; (-3) significant and unavoidable adverse impact that cannot be mitigated. Beneficial impacts are indicated in the table by “B”.

Table 4-1. Summary of Environmental Effects with Impact Ratings

Significance Impact Threshold ID	Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)	Impact Rating[1] (Primary/Cumulative)			Mitigation Measures[1]		
		No Action	-37 Foot	-38 Foot	Measure Number	Mitigation Measure Description	Residual Impact
Geology and Seismicity							
GSS-01	Increase potential risks related to rupture of a known earthquake fault; seismic shaking; tsunami or seiche; or seismic related ground failure, including liquefaction or landsides.	0/0	0/0	0/0	NM	NM	NA
GSS-02	Cause geologic units or soils to become unstable and potentially result in on-site or off-site landslide, lateral spreading, subsidence, liquefaction, collapse, or erosion.	0/0	-1/-1	-1/-1	NM	NM	NA
Sediment and Sedimentation							
SS-01	Substantially degrade sediment quality due to dredging and placement of dredged materials.	0/0	-1/0	-1/0	NM	NM	NA
SS-02	Cause substantial modification of sedimentation or sediment transport processes that results in significant effects on downstream areas.	0/0	-1/0	-1/0	NM	NM	NA
Water Quality and Hydrology							
WQ-01	Substantially degrade water quality through alteration of temperature, salinity, pH, and dissolved oxygen; increased turbidity, or nutrient loading.	0/0	-1/0	-1/0	NM	NM	NA
WQ-02	Violate quality standards because of mobilization of contaminated sediments or release of hazardous materials.	0/0	-1/0	-1/0	NM	NM	NA
WQ-03	Negatively impact groundwater or surface water quality from leaching of contaminants or surface water runoff from placement sites.	0/0	-1/0	-1/0	NM	NM	NA

Significance Impact Threshold ID	Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)	Impact Rating[1] (Primary/Cumulative)			Mitigation Measures[1]		
		No Action	-37 Foot	-38 Foot	Measure Number	Mitigation Measure Description	Residual Impact
WQ-04	Cause substantial modification of tidal hydraulics, tidal currents, and circulation that would result in significant effects on water levels or tidal flows within either San Francisco Bay or the Sacramento-San Joaquin Delta.	0/0	-1/0	-1/0	NM	NM	NA
WQ-05	Substantially impair water quality for municipal and industrial beneficial uses.	0/0	-1/-1	-1/-1	NM	NM	NA
WQ-06	Substantially affect water exports and operations due to shifts in X2.	0/0	-1/-1	-1/-1	NM	NM	NA
Air Quality							
AQ-01	Violate any air quality standard, or contribute substantially to an existing or projected air quality violation.	0/0	-1/0	-1/0	NM	NM	0
AQ-02	Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable Federal or state ambient air quality standard, including releasing emissions that exceed quantitative thresholds for ozone precursors.	0/0	-1/0	-1/0	NM	NM	0
AQ-03	Expose sensitive receptors to substantial pollutant concentrations.	0/0	0/0	0/0	NM	NM	0
AQ-04	Create objectionable odors affecting a substantial number of people.	0/0	0/0	0/0	NM	NM	0
AQ-05	Conflict with, or obstruct implementation of the applicable air quality plan.	0/0	0/0	0/0	NM	NM	0
Climate Change							
CC-01	Directly or indirectly exceed applicable Federal or state GHG standards.	0/0	0/0	0/0	NM	NM	0

Significance Impact Threshold ID	**Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)**	**Impact Rating[1] (Primary/Cumulative)**			**Mitigation Measures[1]**		
		No Action	**-37 Foot**	**-38 Foot**	**Measure Number**	**Mitigation Measure Description**	**Residual Impact**
CC-02	Conflict with an applicable plan, policy, or regulation adopted to reduce GHG emissions and climate change impacts.	-1/0	-1/-1	-1/-1	NM	NM	--1
Biological Resources							
BR-01	Cause increased turbidity that adversely affects special-status species and critical habitat.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-02	Cause benthic habitat disturbance that adversely affects special-status species, critical habitat, or habitat for commercially valuable marine species.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-03	Cause underwater noise that adversely affects special-status fish and marine mammals.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-04	Adversely affect special-status or commercially or recreationally important marine species through entrainment.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-05	Result in the disturbance of EFH and "Special Aquatic Sites," including eelgrass beds and mudflats.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-06	Interfere with the movement of resident or migratory fish or wildlife species.	0/0	-1/-1	-1/-1	NM	NM	NA
BR-07	Adversely affect special-status fish species, including their critical habitat, as a result of X2 shifts.	0/0	-1/-1	-1/-1	NM	NM	NA
Land Use and Planning							
LU-01	Introduce land uses or activities incompatible with existing or adjacent land uses.	0/0	-1/0	-1/0	NM	NM	NA
Mineral Resources							

Significance Impact Threshold ID	Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)	Impact Rating[1] (Primary/Cumulative)			Mitigation Measures[1]		
		No Action	-37 Foot	-38 Foot	Measure Number	Mitigation Measure Description	Residual Impact
MIN-01	Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated in a county General Plan, specific plan, or other land use plan.	0/0	0/0	0/0	NM	NM	NA
Agricultural Resources							
AG-01	Degrade the quality, or agricultural productivity, of Important Farmland or farm resources (including irrigation water systems, levees, drainage systems), or directly or indirectly cause lands presently in agricultural production (including Important Farmland) to convert to non-agricultural uses.	0/0	0/0	0/0	NM	NM	NA
Aesthetics							
AE-01	Have a substantial adverse effect on a scenic vista or substantially degrade the existing visual character or quality of the site and its surroundings.	0/0	0/0	0/0	NM	NM	NA
AE-02	Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.	0/0	0/0	0/0	NM	NM	NA
Cultural Resources and Native American Trust Assets							
CR-01	Cause an adverse effect to a historic property (including shipwrecks and shellmounds).	0/0	0/0	0/0	NM	NM	NA
					NM	Archaeologist oversight	
CR-02	Disturb any human remains, including those interred outside of formal cemeteries.	0/0	0/0	0/0	NM	NM	NA
Environmental Justice and Community Effects							
EJ-01	Disproportionately affect environment of communities within the APE when compared to surrounding areas.	0/0	0/0	0/0	NM	NM	NA

Significance Impact Threshold ID	Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)	Impact Rating[1] (Primary/Cumulative)			Mitigation Measures[1]		
		No Action	-37 Foot	-38 Foot	Measure Number	Mitigation Measure Description	Residual Impact
Navigation, Transportation and Circulation							
NT-01	Change vessel traffic patterns, resulting in unplanned or regularly occurring delays, adverse change in freedom of movement, increase safety risks, or introduction of safety hazards.	0/0	-1/0	-1/0	NM	NM	NA
Noise							
NOI-01	Result in a 90 dBA equivalent continuous sound level over a 1-hour period in a residential or public park area, or a 100 dBA equivalent continuous sound level over a 1-hour period in an industrial area.	-1/-1	-1/-1	-1/-1	NM	NM	NA
Public Health and Environmental Hazards							
PH-01	Operations occur on a site that is included on a list of hazardous material sites and, as a result, create a significant hazard to the public or the environment.	0/0	0/0	0/0	NM	NM	NA
PH-02	Create a significant hazard to the public or the environment by disrupting the routine transport, use, or placement or storage of hazardous materials or wastes.	0/0	0/0	0/0	NM	NM	NA
PH-03	Impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan.	0/0	0/0	0/0	NM	NM	NA
Recreation							
RE-01	Substantially reduce or restrict the availability or quality of existing recreation opportunities in the Project area.	-1/0	-1/0	-1/0	NM NM	NM NM	NA
Socioeconomics, Population and Housing							
SOC-01	Result in a rapid or sizeable shift in population trends or would notably affect regional employment, spending and earning patterns, or community resources in a manner that could not be easily absorbed or accommodated by the economy as a whole.	0/-1	0/-1	0/-1	NM	NM	NA

Significance Impact Threshold ID	Significance Impact Threshold Description (An alternative is considered to have a significant impact if it would)	Impact Rating[1] (Primary/Cumulative)			Mitigation Measures[1]		
		No Action	-37 Foot	-38 Foot	Measure Number	Mitigation Measure Description	Residual Impact
Utilities and Public Services							
UTIL-01	Interfere with operations of, cause damage to, or otherwise disrupt the use of any buried underwater cable, buried underwater pipeline, or overhead power transmission lines.	0/0	0/0	0/0	NM	NM	NA

[1]Impact Rating - First number denotes primary impact. Second number (after the slash) denotes cumulative impact, following these rating definitions:

-3 = significant and unavoidable adverse impact
-2 = significant but mitigable adverse impact
-1 = adverse but not significant impact/less than significant impact
0 = negligible or no impact
B = beneficial
MM = Mitigation measure (see text for description of measure)
NM = No mitigation required
NA = No residual impacts
ND = No impact determination can be made at this time

4.1.1 GEOLOGY AND SEISMICITY

Impacts on or associated with geology were qualitatively evaluated based on the potential to temporarily or permanently alter geologic or seismic conditions of the study area. In addition, because geological hazards such as earthquakes happen independently of the project, the potential for increased risk of injury due to geologic and seismic hazards were qualitatively evaluated.

Under NEPA, an alternative would be considered to have a significant impact on or associated with geology and seismicity if it would:

> Impact GSS-01: Increase potential risks related to rupture of a known earthquake fault; seismic shaking; tsunami or seiche; or seismic-related ground failure, including liquefaction or landsides; or
>
> Impact GSS-02: Cause geologic units or soils to become unstable and potentially result in onsite or offsite landslide, lateral spreading, subsidence, liquefaction, collapse, or erosion.

NO ACTION ALTERNATIVE

It is anticipated that the current hazard resulting from fault rupture or seismic-induced hazards will persist over the 50-year analysis addressed in this report. This would continue to present a risk of very strong to strongest ground shaking throughout the study area. The risk of seismically induced liquefaction or slope failure in areas prone to instability would remain, including coastal areas with wetlands, marsh fill, steep or unstable slopes, and within certain levees in Contra Costa and Solano counties. It is also anticipated that the current hazard resulting from tsunami and seismically induced seiche on the San Francisco Bay and Delta would continue. The hazard of a substantial tsunami affecting the Delta and the Suisun Marsh appears to be minor because of their distance from the Pacific Ocean and the attenuating effect of San Francisco and Suisun Bay waters. Therefore, the No Action Alternative, which involves continued maintenance dredging and use of the existing deep draft navigation channels, would have no impact related to the rupture of a known earthquake fault; seismic shaking; tsunami or seiche; or seismic-related ground failure, including liquefaction; or landsides. The No Action Alternative would also have no impact related to geologic units or soils becoming unstable.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVE

Evaluation of Impact GSS-01: Increase potential risks related to rupture of a known earthquake fault; seismic shaking; tsunami or seiche; or seismic-related ground failure, including liquefaction or landsides: The -37 foot and -38 foot MLLW Alternative would be constructed and maintained within the same footprint as the existing -35 foot MLLW channel and context of the same potential geologic hazards described above for the No Action Alternative. Thus, it is anticipated that the current hazards resulting from fault rupture or seismic-induced hazards would persist. Channel deepening would not result in an increased risk of fault rupture or ground shaking and would not result in construction of any structures that would be susceptible to seismic hazards. While dredging would occur in waters adjacent to potentially unstable coastlines, the dredge prism would be designed to avoid underwater sloughing that could potentially undermine levee or shoreline stability. All construction would occur in compliance with Title 23, Division 1, Article 8, Sections 111137 of the CCR and other applicable regulations. Tsunami and seiche hazards in the study area would be unaffected by this alternative and would remain minimal. This alternative would not interfere with any tsunami warning systems or response plans. Neither Alternative would, therefore, have no impact related to rupture of a known earthquake fault; seismic shaking; tsunami or seiche; or seismic-related ground failure, including liquefaction; or landsides.

Evaluation of Impact GSS-02: Cause geologic units or soils to become unstable and potentially result in onsite or offsite landslide, lateral spreading, subsidence, liquefaction, collapse, or erosion: Geologic hazards potentially resulting from upland placement of dredge material were addressed during the evaluation and construction of existing placement sites, and would be analyzed separately for any new placement sites that are separately permitted and used for both alternatives. Dredging and deepening would not create unstable geologic units within the navigation channel, as existing side slopes ratios would be maintained. Although this alternative may result in minimal erosion of the channel sides from sloughing after dredging due to the disturbance of sediments, historic patterns of erosion and sediment accumulation would not be expected to change.

Certain shoreline areas adjacent to the Alternatives dredging footprint may be susceptible to geologic hazards, however, the dredge prism would be designed to avoid underwater sloughing that could potentially undermine levee or shoreline stability. All construction would occur in compliance with Title 23, Division 1, Article 8, and Sections 111137 of the CCR, the USACE Coastal Engineering Manual, and other applicable regulations.

The deeper channel would be able to accommodate more fully loaded vessels, potentially creating larger waves and increased shoreline erosion. However, the number of shipping vessels under both alternatives is projected to decrease slightly compared to the No Action Alternative. Any potential increase in shoreline erosion from more fully loaded vessels would, therefore, be nominal when considered in the context of potential reduction in shipping vessels and broader vessel activity in the Bay and Delta. Therefore, the both alternatives would have less than significant impacts related to geologic units or soils becoming unstable.

4.1.2 SEDIMENT AND SEDIMENTATION

Impacts on or associated with sediment and sedimentation were qualitatively evaluated based on the potential for the alternatives to temporarily or permanently alter sediment quality or transport conditions in the project area. Under NEPA, an alternative could have an impact from sediment if it would cause the following:

> Impact SS-01: Substantially degrade sediment quality due to dredging and placement of dredged materials; or
>
> Impact SS-02: Cause substantial modification of sedimentation or sediment transport processes that results in significant effects on downstream areas.

For each of the thresholds established previously, the effect of the project was evaluated using available information and data.

NO ACTION ALTERNATIVE

Under the No Action Alternative, maintenance dredging would continue to occur where and when needed. Historic sediment testing data show low levels of contamination throughout the study area. Sediments from the area are typically suitable for placement in the ocean, in-Bay, and for beneficial reuse. USACE would continue to conduct sediment testing for maintenance dredging activities in accordance with appropriate Federal and regional guidelines and continue to obtain all necessary permits and approvals as described above. Therefore, the No Action Alternative would continue to not degrade sediment quality as a result of regular dredging and placement of dredged materials in the study area.

Under the No Action Alternative, existing sedimentation patterns would continue to occur and periodic maintenance dredging would also continue to be performed in the present manner such that the channels in the study area are maintained at the existing -35 foot regulated depths. Thus, there would be no change in sedimentation or sediment transport processes.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Evaluation of Impact SS-01: Substantially degrade sediment quality due to dredging and placement of dredged materials: Based on historic sediment testing data, sediment from the dredge prism for the -37 foot and -38 foot MLLW Alternatives show low levels of contamination and it was determined suitable for placement in-Bay or for wetland or upland beneficial reuse. USACE will conduct all necessary testing and coordination required with the DMMO and obtain all necessary approvals for dredging and placement of dredged material prior to construction. Conformance with guidelines and agency review would ensure that dredging and dredged material placement activities would not substantially degrade sediment quality either in the channels, or at placement sites or placement sites. For these reasons, the -37 foot and -38 foot MLLW Alternative would result in less than significant impacts on sediment quality.

Evaluation of Impact SS-02: Cause substantial modification of sedimentation or sediment transport processes that results in significant effects on downstream areas: The effects of deepening the navigation channels were evaluated by estimating the increase in channel sedimentation resulting from the deepening. USACE estimated an increase in channel sedimentation (for combined Pinole Shoal Channel, Bulls Head Reach and the sediment trap) of 185,200 cubic yards as a result of deepening to -37 feet MLLW (**Appendix A - Civil Site*)*** and 230,500 cubic yards as a result of deepening to -38 feet MLLW. The increase in dredging volumes required to maintain the depth of -37 feet MLLW is estimated to be only 0.5 percent of the average annual sediment flux to San Francisco Bay, and 1.2 percent for -38 feet, based on sediment flux estimates by McKee et al. (2013). As breakouts of the total volumes described above, the estimated increase in channel sedimentation for deepening the sediment trap under the -37 foot alternative is 5,700 cy and under the -39 foot alternative is 8,900 cubic yards (**Appendix A - Civil Site)**. The increase in dredging volumes required to maintain the navigation channel to a depth of -38 feet MLLW plus the sediment trap is estimated to be only 1.2 percent of the average annual sediment flux to San Francisco Bay, based on sediment flux estimates by McKee et al. (2013).

As a result, the effect of both alternatives is expected to result in a less than significant impact on sedimentation and sediment transport processes in areas downstream of the study area.

4.1.3 WATER QUALITY AND HYDROLOGY

Water quality variables that are potentially affected by dredging operations include turbidity, dissolved oxygen, nutrients, salinity, temperature, pH, and concentrations of trace metals and organic contaminants if they are present in the sediments.

The analysis considered whether the alternatives would:

- Substantially degrade water quality through alteration of temperature, salinity, pH, and dissolved oxygen; increased turbidity; or nutrient loading

- Violate any water quality standards (**Table 4-2**), or substantially degrade water quality because of mobilization of contaminated sediments or release of hazardous materials during dredging and placement activities.

The analysis also describes Best Management Practices (BMPs) and other measures to avoid, minimize, or mitigate potential adverse impacts on water quality, including measures mandated under existing regulations and programs, as applicable.

Under NEPA, an alternative would be considered to have a significant impact on water quality, water supply, and/or hydrology and hydraulics if it would:

Impact WQ-01: Substantially degrade water quality through alteration of temperature, salinity, pH, and dissolved oxygen; increased turbidity, or nutrient loading; or
Impact WQ-02: Violate quality standards because of mobilization of contaminated sediments or release of hazardous materials; or
Impact WQ-03: Negatively impact groundwater or surface water quality from leaching of contaminants or surface water runoff from placement sites; or
Impact WQ-04: Cause substantial modification of tidal hydraulics, tidal currents, and circulation that would result in significant effects on water levels or tidal flows within either San Francisco Bay or the Sacramento-San Joaquin Delta; or
Impact WQ-05: Substantially impair water quality for municipal and industrial beneficial uses; or
Impact WQ-06: Substantially affect water exports and operations due to shifts in X2.

In an effort to easily compare the effect analysis of each alternative, this water quality and hydrology section is arranged per impact rather than by alternatives in the previous sections.

Table 4-2. Water Quality Objectives (Standards).

Chemical	Pinole Shoal and Bulls Head Reach (Marine)[a]			East of Bulls Head Reach (Freshwater)		
	WQO 1-Hour Average	WQO 24-Hour Average (µg/L)	WQO 4 day Average (µg/L)	WQO Maximum (µg/L)[b]	WQO 1-Hour Average (µg/L)[a]	WQO 4 day Average (µg/L)[a]
Metals (µg/L)						
Arsenic	69	--	36	10	340	150
Boron	--	--	--	200[e]	--	--
Barium	--	--	--	100	--	--
Cadmium	42	--	9.3	50[e]	3.9[f]	1.1[f]
Chromium	1,100	--	50	5[e]	16[f]	11[f]
Copper	9.4[c]	--	6.0[c]	10	13[f]	9[f]
Lead	210	--	8.1	15[e]	65[f]	2.5[f]
Mercury	2.1	--	--	2[e]	2.4	0.025
Nickel	74	--	8.2	200[e]	470[f]	52[f]
Selenium	20	--	5	5[e]	20	5
Silver	1.9	--	--	10	3.4[f]	--
Zinc	90	--	81	100	120[f]	120[f]
PAHs (µg/L)	--	15	--	--	--	--
Pesticides (µg/L)						
Chlorpyrifos	--	--	--	--	0.025	0.015
Diazinon	--	--	--	--	0.16	0.1
Dissolved Oxygen (mg/L)	5/7[d]	--	--	6	--	--
Cyanide (µg/L)	9.4	--	2.9	--	22	5.2

Notes:

WQOs for metals are based on the dissolved fraction unless noted otherwise.

a. As defined in the SF Bay Basin Plan
b. As defined in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
c. Applicable to the portion of the delta located in the San Francisco Bay Region, Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, and the portion of Lower San Francisco Bay north of the line representing the Hayward Shoals
d. Downstream of Carquinez Bridge = 5.0 mg/L minimum; Upstream of Carquinez Bridge= 7.0 mg/L minimum
e. Based on the total fraction
f. Based on hardness; value shown assume hardness of 100 mg/L

— = No guidance value
µg/L = micrograms per liter
mg/L = milligrams per liter
PAH = polycyclic aromatic hydrocarbon
WQO = Water Quality Objectives

EVALUATION OF IMPACT OF WQ-01: SUBSTANTIALLY DEGRADE WATER QUALITY THROUGH ALTERATION OF TEMPERATURE, SALINITY, PH, AND DISSOLVED OXYGEN; INCREASED TURBIDITY, OR NUTRIENT LOADING

NO-ACTION ALTERNATIVE

The No Action Alternative would continue ongoing maintenance dredging, placement of dredged material in approved open water placement sites, and use of the channel. There would be no long-term changes in water quality from baseline conditions. Sediment sampling and analysis would be required for ongoing maintenance dredging efforts to avoid potential sediment and water quality impacts. Therefore, temperature, salinity, pH, and dissolved oxygen, increased turbidity, or nutrient loading would remain unchanged from baseline conditions.

FUTURE WITH -37 FOOT ALTERNATIVE

Background concentrations of suspended particulates and resulting turbidity measurements, as well as other water quality parameters, already vary as a result of numerous natural and anthropogenic factors including ship traffic, erosion, storms, and seasonal high freshwater inflows into the Delta during the winter and spring. Dredging for the -37 foot MLLW Alternative would temporarily re-suspend sediments in the water column, thereby increasing turbidity, and affecting other water quality parameters.

Mechanical dredging is proposed for the -37 foot MLLW Alternative. Operating from a crane or derrick on a barge, the clamshell bucket is lowered, filled with sediment, raised through the water column, and positioned above the dump barge for temporary containment prior to placement. Clamshell dredging generates turbidity from the impact of the bucket with the channel bottom and from spillage and leakage of material from hoisting the bucket through the water column and swinging it over the barge. Key factors that influence turbidity in the water column are the cycle time of the dredging, the bucket type, the amount of bottom sweeping/smoothing, and the number of passes at a specific location (Collins 1995). Clamshell dredging activities typically result in localized water column concentrations of re-suspended sediment of several hundred mg/L near the dredging operation. The extent of sediment resuspension is a byproduct of several factors, including physical properties of the sediment, site conditions, nature and extent of debris and obstructions, and operational considerations of the dredge equipment and operator. Levels of suspended sediment are expected to be highest closest to the dredging operations. Concentrations typically become reduced to near background levels within several hundred feet of the dredge (Palermo et al. 1990; Bridges et al. 2008). Suspended sediment plumes generated in the immediate vicinity of the dredge are transported by currents to nearby areas until they settle out of the water column (Anchor 2003).

Increased suspended sediments can affect aquatic organisms both directly and indirectly. The level of impact to individual organisms depends on the amount of time an individual organism is exposed to suspended sediments, the concentration of suspended sediment in the water column, and the composition of the sediments (fine-grained versus coarse-grained and chemical associations). An extensive literature review on the subject of dredging-induced turbidity and potential effects on aquatic organisms concluded that it is very unlikely that total suspended solids (TSS) levels would reach harmful concentrations as a result of dredging (Anchor 2003). The length of time it takes the suspended material to settle, combined with the current direction and velocity, would determine the size and duration of the turbidity plume. It is expected that the mixing zone would rapidly return to background or preconstruction conditions upon completion of the construction activities. Furthermore, settling rates are largely determined by the grain size of the suspended material.

Potential impacts from dredging also include short-term decreases in DO and increases in nutrients, or changes in temperature or pH, due to resuspension of sediment and sediment-bound organic material. These impacts would be temporary, generally being confined to the dredging area, and would return relatively quickly to background levels following construction (Jones and Lee 1978; LaSalle 1990; Lee et al. 1978; Simenstad 1988). USACE research has shown that there are techniques (e.g., slowing the dredge cycle, use of silt curtains, dredge bucket design) that can be employed to dredge sediment and cause a limited amount of sediment to be re-suspended (USACE 1986).

Under the -37 foot MLLW Alternative, impacts from changes in temperature, salinity, pH, and DO; increased turbidity; or nutrient loading would be short-term. Measurements of these water quality parameters would rapidly return to baseline conditions once construction in a given area concludes. Additionally, the alternative does not propose to dredge farther than Port Chicago, which is at least 25 miles downstream of Jersey Island and the area where DO is currently low. Thus, impacts to water quality from construction are expected to be less than significant as a result of the -37 foot MLLW Alternative as compared to the baseline.

FUTURE WITH 38 FOOT ALTERNATIVE

Potential water quality impacts of the -38 foot MLLW Alternative due to construction would be the same as those of the -37 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material. However, the impacts to water quality due to construction are expected to be less than significant as a result of the -38 foot MLLW Alternative as compared to the baseline.

FUTURE WITH 38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP (TSP)

Potential water quality impacts of the TSP Alternative due to construction would be the similar to those of the -38 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material from the sediment trap and rock removal. The impacts to water quality due to construction of this alternative are expected to be less than significant as a result of the TSP Alternative as compared to the baseline.

EVALUATION OF IMPACT OF WQ-02: VIOLATIONS OF WATER QUALITY STANDARDS BECAUSE OF MOBILIZATION OF CONTAMINATED SEDIMENTS OR RELEASE OF HAZARDOUS MATERIALS

Dredging of sediments has the potential to release contaminants into the water column if they are present in the material at high concentrations. The suspension of sediment can mobilize sediment-bound contaminants into the water column, where they have the potential to dissolve into the water. However, most contaminants are tightly bound to finer sediment, such as silt, clay, and organic matter and are not readily water soluble or easily released during short-term resuspension of sediments, as would be the case during dredging operations and from the passage of ships (LTMS 1998).

NO ACTION ALTERNATIVE

The No Action Alternative would continue ongoing maintenance dredging, placement of dredged material in approved open water placement and upland placement sites, and use of the channel. As a result, there would be no changes from the present strategy for evaluating the potential of mobilizing contaminated sediments or release of hazardous materials above baseline conditions. As discussed in **Section 2-4**, there have been no contaminated sediment issues with ongoing maintenance dredging efforts. Therefore, there would be no new impact related to violations of water quality standards, and water quality would be unchanged from baseline conditions.

FUTURE WITH -37 FOOT ALTERNATIVE

Prior to dredging the -37 foot MLLW Alternative, sediment chemistry testing would be done to ensure that the new work material does not contain contaminants at concentrations that might result in elevated levels in the water column during dredging. Prior testing has been done in some reaches of the channel to this depth and the results indicated that mobilization into the water column is not likely to result in water quality violations.

Sediment within the study area is expected to be suitable for beneficial reuse or unconfined placement as is noted in ***Section 2-4*** (Sediment and Sedimentation). Past characterizations have not determined the presence of any contaminated materials. Prior to dredging, sediment within the dredge footprint for the -37 foot MLLW Alternative would be sampled and analyzed as described in ***Section 2.2.2 and 4.1.2***. This process would also identify contaminated sediments (e.g., sediments unsuitable for beneficial reuse or placement at approved sites) or any hazardous waste. If any such sediments were identified, appropriate dredging and placement methods would be implemented as a condition of the project approvals.

Additionally, USACE would implement BMPs and comply with water quality protection measures included as conditions to the WDRs and WQCs issued by RWQCB and the letter of concurrence issued by the BCDC for USACE's consistency determination. Adherence to these measures and BMPs would minimize the potential for water quality degradation.

Vessels would be operated in compliance with all applicable regulations related to the prevention of water pollution by fuel, harmful substances, and garbage, as well as from accidental discharges. During transport, the dredged material would be secured, with precautions in place to minimize any risk of spills. As such, the potential for the release of hazardous substances from vessel operations during dredging, transport, and placement activities would be minimal.

Therefore, dredging and placement activities are not expected to increase contaminant concentrations in the water column above background conditions, or result in violation of a water quality standard. Impacts of dredging to water quality standards under the -37 foot MLLW Alternative would be less than significant as compared to the baseline.

FUTURE WITH 38 FOOT ALTERNATIVE

Potential water quality impacts of the -38 foot MLLW Alternative are likely to be the same as those of the -37 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material. Dredging and placement activities are not expected to increase contaminant concentrations in the water column above background conditions, or result in violations of water quality standards. Thus, short-term, less than significant impacts to water quality are expected under the -38 foot MLLW Alternative as compared to the baseline.

FUTURE WITH 38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP

Potential water quality impacts of the TSP Alternative are likely to be the same as those of the -38 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material. Dredging and placement activities are not expected to increase contaminant concentrations in the water column above background conditions, or result in violations of water quality standards. Thus, short-term, less than significant impacts to water quality are expected under this Alternative as compared to the baseline.

EVALUATION OF IMPACT OF WQ-03: NEGATIVE IMPACT TO GROUNDWATER OR SURFACE WATER QUALITY FROM LEACHING OF CONTAMINANTS OR SURFACE WATER RUNOFF FROM PLACEMENT SITES

NO ACTION ALTERNATIVE

The No Action Alternative would continue ongoing maintenance dredging of the existing 35 foot channels and placement of dredged material in designated open water placement areas. This alternative would not result in new sources of contaminant leaching compared to baseline conditions. Therefore, there would be no negative impact to groundwater or surface water quality at the placement sites compared to baseline conditions.

FUTURE WITH -37 FOOT ALTERNATIVE

Based on historic sediment testing conducted for the study area (see ***Section 2.2.2***), dredged material is expected to meet both upland and wetland beneficial reuse placement criteria. However, if dredged material were placed at an upland or beneficial reuse site, additional tests to estimate leachate concentrations from sediments would need to be conducted. Wetland or upland placement of dredge material must comply with Subchapter 15 of the Porter-Cologne Water Quality Control Act, which regulates the upland placement of spoil material and subsequent diffuse discharge of water that may affect groundwater quality. The RWQCB is responsible for regulating discharges of waste that could affect the quality of waters of the State. These regulations consider the groundwater-surface water interface within the basin, and are designed to reduce potential groundwater quality impacts from dredged material placement to a less than significant level. The -37 foot MLLW Alternative does not involve excavation to depths that would affect aquifer systems or groundwater movement, and would not involve the construction of substantial new impervious surfaces that would impede groundwater recharge. Thus, less than significant impacts to groundwater or surface water quality are expected under the -37 foot MLLW Alternative as compared to the NEPA baseline.

FUTURE WITH 38 FOOT ALTERNATIVE

Potential water quality impacts of the -38 foot MLLW Alternative would be the same as those of the -37 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material. Thus, less than significant impacts to groundwater or surface water quality are also expected under the -38 foot MLLW Alternative as compared to the NEPA baseline.

FUTURE WITH 38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP

Potential water quality impacts of this Alternative would be the same as those of the -38 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material. Thus, less than significant impacts to groundwater or surface water quality are also expected under this Alternative as compared to the NEPA baseline.

EVALUATION OF IMPACT OF WQ-04: CAUSE SUBSTANTIAL MODIFICATION OF TIDAL HYDRAULICS, TIDAL CURRENTS, AND CIRCULATION THAT WOULD RESULT IN SIGNIFICANT EFFECTS ON WATER LEVELS OR TIDAL FLOWS WITHIN EITHER SAN FRANCISCO BAY OR THE SACRAMENTO-SAN JOAQUIN DELTA

NO ACTION ALTERNATIVE

Under the No Action Alternative, sedimentation and periodic maintenance dredging would continue to occur as the study area channels have traditionally been maintained at their existing -35 foot MLLW depths. As a result, there would be no changes to the existing geometry of the study area and, therefore, there would be no impact on existing water levels or tidal flows.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP (TSP) ALTERNATIVES

A detailed analysis of the effect of deepening the navigation channels to the maximum depths under evaluation on water levels, tidal velocities, and tidal flows throughout San Francisco Bay and the Delta is presented in **Appendix B, Water Resources.** Impacts were shown to be less than significant.

EVALUATION OF IMPACT OF WQ-05: SUBSTANTIALLY IMPAIR WATER QUALITY FOR MUNICIPAL AND INDUSTRIAL BENEFICIAL USES

The D-1641 salinity requirements pertaining to the study area, as well as high bromide concentration concerns for drinking water, are discussed in ***Section 2.2.3***. The significance threshold for the project is defined as a violation of D-1641 water quality criteria, or a detectable, measurable adverse impact to drinking water quality due to changes in chloride or bromide concentration. Evaluation of project impacts against published water quality compliance criteria is normally straightforward. However, there is no single widely accepted criterion for what constitutes a detectable, measurable adverse impact to drinking water quality when criteria are met. Previous studies in the Delta have applied thresholds based on monthly-average salinity differences between conditions with and without a project corresponding to a chloride concentration increase of more than 5 percent or 5 mg/L whichever is greater (e.g., CCWD 2010). Other studies have evaluated water quality impacts based on how or whether the timing of exports would be shifted to maintain water quality conditions equivalent to those under the No Action Alternative (USBR 2015).

The change in X2 position and change in water quality (chloride) were assessed at CCWD, SWP, and CWP pump stations for the -37 ft and -38 ft alternative under Critical Year (2014) and Wet Year (2011) Conditions. For the TSP alternative (-38 ft alternative with outcrop removal and sediment trap), additional evaluation was done including simulation of a Below Normal Year (2012), a period of record evaluation of X2 changes, additional chloride compliance evaluation at Antioch, and evaluation of changes at the Emmaton, and Jersey Point electroconductivity compliance locations. The results of the modeling predictions are presented in detail in the Salinity Modeling Report that is included as **Appendix B, Water Resources- Attachment 1**. For measurable changes to water quality, the significance level for chloride is no increase levels that exceed 5 mg/L and 5 percent of the baseline concentration. For bromide, the significance level is 5 percent increase in estimated concentration. The significance of changes to bromide levels is evaluated using the percent change in chloride concentration. This is done using the relationship between bromide and chloride concentrations at Delta intakes developed by Denton (2005).

Since the exact weather, hydrology, and operations conditions for the base year cannot be accurately predicted, this analysis considered the effects on salinity during a wet WY, below normal WY, and a critical

WY representative of the range of possible Year 0 conditions. The evaluation of effects on salinity during both the wettest, below normal, and driest conditions provides an assessment of the full range of effects on salinity that are likely to result from the alternatives.

NO ACTION ALTERNATIVE

The No Action Alternative would continue ongoing use of the channel and maintenance dredging at the -35 foot MLLW depth and placement of dredged material in approved open water placement areas. Continuation of existing conditions in the study area would not result in impairment of municipal or industrial beneficial uses. Therefore, there would be no negative impact to municipal or industrial uses.

FUTURE WITH -37 FOOT ALTERNATIVE

A three-dimensional hydrodynamic model was used to evaluate the -37 foot MLLW Alternative's impacts on water quality at municipal and industrial water intake and export locations in the Delta (see **Figure 2-6** and **Appendix B, Water Resources*).*** The -37 foot MLLW Alternative was predicted to result in a maximum monthly-average change in chloride concentration of between 0.3 mg/L at the CCWD Middle River at Victoria Canal Intake to 0.7 mg/L at the CCWD Rock Slough Intake during a critical WY (**Table 4-2, Appendix B** - **Attachment 1)**. During the wet WY evaluated, the predicted maximum monthly-average change in chloride concentration ranged from 0.0 mg/L at the CCWD Middle River at Victoria Canal Intake and the West Canal at the mouth of Clifton Court Forebay to 0.2 mg/L at the CCWD Rock Slough (**Table 4-6, Appendix B - Attachment 1**).

The D-1641 water quality objectives for municipal and industrial beneficial use stipulate a maximum allowable concentration of 250 mg/L Cl at the municipal water intakes. The critical year and wet year simulations show that at the CCWD, SWP, and CWP intakes there were no occurrences of chloride above 250 mg/L (**Figures 4.1-2 through Figure 4.1-6 and Figures 4.2-2 through Figure 4.2-6, Appendix B - Attachment 1**). The maximum monthly-average change in chloride concentration predicted to result from the -37 foot MLLW Alternative during the critical and wet years evaluated was less than 0.3 percent of the allowable chloride concentration. This 0.3 percent maximum monthly-average change in chloride concentration occurred during the critical WY, which has historically occurred in 13.8 percent of the years between 1906 and 2014. During the wet WY, which has historically occurred in 33 percent of the years between 1906 and 2014 (see **Section 2.2.3** and **Appendix B, Water Resources – Attachment 1**), the maximum monthly-average change in chloride concentration was less than 0.1 percent of the allowable chloride concentration (250 mg/L).

Since these predicted maximum monthly average changes in chloride concentration (occurring during both wet and critical WY) are significantly less than either 5 percent or 5 mg/L, the long-term impact to water quality at the Delta intake and export locations would be less than significant as a result of the 37 foot MLLW Alternative as compared to the NEPA baseline.

The D-1641 criteria includes an evaluation of the number of days chloride must be below 150 mg/L which varies from 155 day/year for a critical year to 240 days for a wet year. A review of the chloride histograms for the FWO and -37 ft alternatives shows no difference in the number of days with chloride below 150 mg/L (**Figures 4.1-2 through Figure 4.1-6 and Figures 4.2-1 through Figure 4.2-6, Appendix B - Attachment 1**). Given no change in the number of days < 150 mg/L for the wet and critical year simulations, the impact of the -37 ft alternative on meeting this D1641 criteria is less than significant.

FUTURE WITH 38 FOOT ALTERNATIVE

The three-dimensional hydrodynamic model was also used to evaluate the 38 foot MLLW Alternative's impacts on water quality at municipal and industrial water intake and export locations in the Delta (see **Appendix B, Water Resources – Attachment 1**). For the 38 foot MLLW Alternative, the predicted maximum monthly-average change in chloride concentration ranged from 1.2 mg/L at the CCWD Middle River at Victoria Canal Intake and the Delta-Mendota Canal at Tracy Pumping Plant to 2.4 mg/L at the CCWD Rock Slough Intake during a critical WY (2014) (**Table 4-3, Appendix B - Attachment 1)**. During the wet WY (2011) evaluated, the predicted maximum monthly-average change in chloride concentration ranged from 0.1 mg/L at the CCWD Middle River at Victoria Canal Intake to 0.8 mg/L at the CCWD Rock Slough Intake Slough (**Table 4-7, Appendix B - Attachment 1**).

The D-1641 water quality objectives for municipal and industrial beneficial use stipulate a maximum allowable concentration of 250 mg/L Cl at the municipal water intakes. The critical year and wet year simulations show that at the CCWD, SWP, and CWP intakes there were no occurrences of chloride above 250 mg/L (Figures 4.1-8 through Figure 4.1-12 and Figures 4.2-8 through Figure 4.2-12, Attachment 1, Appendix B). The maximum monthly-average change in chloride concentration predicted to result from the 38 foot MLLW Alternative during the 2 years evaluated was less than 1.0 percent of the allowable chloride concentration. This 1 percent maximum monthly-average change in chloride concentration occurred during a critical WY (2014), which has historically occurred in 13.8 percent of the years between 1906 and 2014. During a wet WY (2011), which has historically occurred in 33 percent of the years between 1906 and 2014, the maximum monthly-average change in chloride concentration was 0.3 percent of the allowable chloride concentration (see **Section 2.2.3** and **Appendix B, Water Resources – Attachment 1**). Since these predicted maximum monthly average changes in chloride concentration (occurring during both wet and critical WYs) are significantly less than either 5 percent or 5 mg/L, the long-term impact to water quality at the Delta intake and export locations would be less than significant as a result of the 38 foot MLLW Alternative as compared to the NEPA baseline.

The D-1641 criteria includes an evaluation of the number of days chloride must be below 150 mg/L which varies from 155 day/year for a critical year to 240 days for a wet year. A review of the chloride histograms for the FWO and 38 ft alternatives shows no difference in the number of days with chloride below 150 mg/L (**Figures 4.1-8 through Figure 4.1-12 and Figures 4.2-8 through Figure 4.2-12, Appendix B - Attachment 1**). Given no change in the number of days < 150 mg/L for the wet and critical year simulations, the impact of the 38 ft alternative on meeting this D1641 criteria is less than significant.

FUTURE WITH 38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP

The three-dimensional hydrodynamic model was also used to evaluate the TSP Alternative's impacts on water quality at municipal and industrial water intake and export locations in the Delta (see **Appendix B, Water Resources – Attachment 1**). For the TSP Alternative, the predicted maximum monthly-average change in chloride concentration ranged from 1.8 mg/L at the CCWD Middle River at Victoria Canal Intake and the Delta-Mendota Canal at Tracy Pumping Plant to 3.6 mg/L at the CCWD Rock Slough Intake during a critical WY (**Table 5-2, Appendix B - Attachment 1**). During the below normal WY evaluated, the predicted maximum monthly-average change in chloride concentration ranged from 1.1 mg/L at the CCWD Middle River at Victoria Canal Intake to 3.1 mg/L at the CCWD Rock Slough Intake (**Table 5-5, Appendix B-Attachment 1**). During the wet WY evaluated, the predicted maximum monthly-average change in chloride concentration ranged from 0.1 mg/L at the CCWD Middle River at Victoria Canal Intake to 1.1 mg/L at the CCWD Rock Slough Intake (**Table 5-8, Appendix B, Water Resources – Attachment 1**).

The D-1641 water quality objectives for municipal and industrial beneficial use stipulate a maximum allowable concentration of 250 mg/L Cl at the municipal water intakes. The critical year (2014), below normal year (2012) and wet year (2011) simulations show that at the CCWD, SWP, and CWP intakes there were no occurrences of chloride above 250 mg/L (**Figures 5.2-2 through 5.2-6, 5.3-2 through 5.3-6, and 5.4-2 through 5.4-6, Appendix B – Attachment 1**). The maximum monthly-average change in chloride concentration predicted to result from the TSP Alternative during the three years evaluated was 3.6 mg/L which is less than 1.5 percent of the allowable chloride concentration (**Table 5-1, Appendix B – Attachment 1**). This 1.5 percent maximum monthly-average change in chloride concentration occurred during a critical WY (2014), which has historically occurred in 13.8 percent of the years between 1906 and 2014. For the 2012WY, which is classified as a below normal year (historically occurred about 20 percent of the years between 1906 and 2014), the maximum monthly change in chloride concentration was 3.1 mg/L which is 1.2 percent of the allowable chloride concentration (Table 5-6, Attachment 1, Appendix B). During the wet WY (2011), which has historically occurred in 33 percent of the years between 1906 and 2014, the maximum monthly-average change in chloride concentration was less than 0.5 percent of the allowable chloride concentration (**Table 5-7, Appendix B - Attachment 1**).

Compliance with the D-1641 criteria regarding minimum number of days of chloride less than 150 mg/L was assessed at the CCWD Rock Slough pump stations (CHCCC06) and the Antioch intake (RSAN007) in **Figures 5.2-7, 5.3-7, and 5.4-7 of Appendix B – Attachment 1**. To meet the Critical, Below Normal, and Wet water year water quality objectives, the number of days with daily concentration of Cl- is less than 150 mg/l should exceed 155 days, 175 days, and 240 days respectively at either CHCCC06 or RSAN007. For the critical year, the number of days below 150 mg/L meets the 155 day minimum at CHCCC06 for both the TSP and No Action Alternative though the TSP has 8 fewer days below 150 mg/L. The critical year results at RSAN007 do not meet the criteria for either the TSP or No Action Alternatives though there is no change in the number of days below 150 mg/L. Because this standard stipulates that daily mean chloride concentration must be less than 150 mg/l for at least 155 days during a critical water year at either at Contra Costa Canal at Pumping Plant #1 or at the Antioch Water Works intake, this standard is met for the Year 0 TSP scenario. For the below normal year, the number of days below 150 mg/L meets the 175 day minimum at CHCCC06 for both the TSP and No Action Alternative with no change in number of days meeting criteria. The below normal year results at RSAN007 do not meet the criteria for either the TSP or No Action Alternatives and the TSP has 4 fewer days with Cl below 150 mg/L. Because one of the two stations is in compliance, this standard is met for the below normal Year 0 TSP scenario. For the wet year, the number of days below 150 mg/L meets the 240 day minimum at both CHCCC06 and RSAN007 for both the TSP and No Action Alternative with no change in number of days meeting criteria. Because both of the stations are in compliance, this standard is met for the wet Year 0 TSP scenario.

Compliance with the D-1641 conductivity criteria at Emmaton were assessed in **Figures 5.2-8, 5.3-8, 5.4-8, of Appendix B - Attachment 1.** The Emmaton conductivity water quality objectives for agricultural beneficial use apply from April 1 through August 15. **Figure 5.2-8** shows the predicted 14-day running average electrical conductivity on the Sacramento River at Emmaton for the Critical Year No Action Alternative and the Critical Year TSP scenario. The bar chart shows both the TSP and No Action Alternative result in exceedance of the conductivity criteria. The TSP results in one additional day of exceedance relative to the No Action Alternative. However, in 2014 the State Water Resources Control Board (SWRCB) issued an Order that Approved a Temporary Urgency Change in License and Permit Terms that allowed exceedance of this criteria without violation. **Figure 5.3-8** shows the predicted 14-day running average electrical conductivity on the Sacramento River at Emmaton for the Below Normal Year No Action Alternative and the Below Normal Year TSP scenario. There were no conductivity exceedances for the TSP or the No Action Alternative for the below normal year. Figure 5.4-8 shows the predicted 14-day running average electrical conductivity on the Sacramento River at Emmaton for the Wet Year No Action Alternative and the Wet Year TSP scenario. There were no conductivity exceedances for the TSP or the No Action Alternative for the Wet year.

Compliance with the D-1641 conductivity criteria at Jersey Point were assessed in **Figures 5.2-9, 5.3-9, 5.4-9, of Appendix B - Attachment 1**. These figures show that there were no conductivity exceedances for the TSP or the No Action Alternative under any of the tested water supply scenarios (Critical, Below Normal, Wet).

The change in bromide concentration was evaluated using the predicted Chloride concentrations for the TSP (**Tables 5-2, 5-5, and 5-8, Appendix B - Attachment 1**) and a regression equation to predict bromide concentration using chloride (Denton, 2015). For the critical year, the expected percent change in bromide concentration is similar to that predicted for chloride. For the Rock Slough intake, a maximum monthly increase of 0.013 mg/L and average annual increase of 0.008 mg/L. At the Old River intake, the bromide increase for the critical year would be a maximum monthly increase of 0.006 mg/L and average annual increase of 0.003 mg/L. For the below normal year, the expected change in bromide concentration is similar for the Rock Slough intake is a maximum monthly increase of 0.011 mg/L and average annual increase of 0.004 mg/L. At the Old River intake, the bromide increase for the below normal year would be a maximum monthly increase of 0.009 mg/L and average annual increase of 0.003 mg/L. For The wet year, bromide at Rock Slough Intake increased by a maximum of 0.004 mg/L and 0.002 mg/L at Old River intakes though the average annual increased bromide at these stations was 0.0 at both stations. For the three simulation years, all of the projected monthly bromide increases at all five stations (Clifton Court, Tracy, Rock Slough, Old River, and Middle River) were lower than the 5 percent change significance threshold and are similar in magnitude to the Minimum Detection Limit for bromide using the standard EPA 300.1 laboratory method.

Since these predicted maximum monthly average changes in chloride concentration (occurring during wet, below normal, and critical WYs) are significantly less than either 5 percent or 5 mg/L, and less than 5 percent for bromide, and there is no significant change in D-1641 compliance conditions at any of the relevant stations (CCWD, SWP, and CWP), the long-term impact to water quality at the Delta intake and export locations would be less than significant as a result of the TSP Alternative as compared to the NEPA baseline.

EVALUATION OF IMPACT OF WQ-06: SUBSTANTIALLY IMPAIR WATER EXPORTS AND OPERATIONS DUE TO SHIFTS IN X2

The following discussion focuses on the effects of the alternatives on a shift in the position of X2 (see discussion above) as it relates to an impact on water quality that would require a significant change in water exports or operations. The effect of a shift of X2 on biological resources and sensitive species is evaluated separately in the Biological Resources section.

Changes to channel dimensions can affect salinity intrusion, which can result in impacts to water quality. Gravitational circulation is a primary mechanism that results in saltwater intrusion into the Delta.

Freshwater is less dense than seawater and as a result, freshwater flows on top of salty water resulting in salinity stratification. This stratification and the resulting exchange of flows causes a mixing action that enhances salt intrusion. Because the strength of gravitational circulation, which is one of the primary mechanisms responsible for salinity intrusion, generally increases with water depth, incremental deepening of the channels from the existing -35 feet MLLW to -37 or -38 feet MLLW could potentially lead to increased salinity intrusion, resulting in an increase in X2 (i.e., a retreat farther upstream in the estuary of the location at which the daily-averaged 2 psu isohaline occurs near the bed (see ***Section 2.2.3*** and **Appendix B, Water Resources - Attachment 1**).

Since water management operations are regulated during specific conditions in the spring and fall of some WYs, an increase in X2 may impact water operations if the changes in X2 were sufficient to affect exports or require changes to water operations to meet the X2 requirements mandated by either D-1641 or the Biological Opinion (BO) for delta smelt. The 2010/2017 Los Vaqueros Expansion EIS/EIR used a significance threshold for X2 location of a change of more than 1.0 km (CCWD 2010, 2017). The 2015 Long-Term Water Transfers EIS/EIR used a 10 percent change in the location of X2 as its significance threshold; however, this project was projected to improve X2 positioning so its adverse impacts to Delta Smelt habitat would likely be minimal. For this project, the significance threshold for a change in X2 is identical to the one used by the CCWD and USBR for the Los Vaqueros Expansion project. A significance threshold for change in X2 of greater than 1 km, is reasonable in light of the accuracy of measuring X2 using surface salinity data and the inherent uncertainty in the estimate of net Delta Outflow which is a component of the operations decision tree used for the export pump stations and the upstream control structures.

Since the exact weather, hydrology, and operation conditions for the base year when the proposed project is constructed cannot be accurately predicted, the effects on X2 during both a wet WY, a below normal WY, and a critical WY are representative of the range of possible Year 0 conditions. To understand how the project will impact future conditions, Year 50 conditions are assessed for the TSP. The evaluation of effects on X2 during a recent 10 year period (2008-2017) as well as for the period of record (1906-2017) have also been evaluated for the TSP using a X2 regression equation that was validated using results from the UnTrim Bay Delta model. The evaluation of the changes in acreage of the Low Salinity Zone (LSZ) was prepared primarily for the biological impact assessment; however, it can be applied to the WQ-6 analysis to reinforce the low significance of changes in X2 (i.e., the location at which the daily-averaged 2 psu isohaline occurs near the bed) that result from the project. Each of these analyses are detailed in **Chapters 6, 7, and 8 of the Hydrodynamic and Salinity Intrusion Modeling Report (Appendix B - Attachment 1**).

NO ACTION ALTERNATIVE

The No Action Alternative would continue ongoing use of the channel and maintenance dredging and placement of dredged material in approved open water placement areas, including continued use of the deep draft channels. The No Action Alternative would have no influence on any impairments of water exports and operations that may occur in the study area since this is the baseline condition for comparison. Such impairments, if they occur, would continue to be caused by larger exterior forces such as prolonged natural drought events similar to those that have occurred during critical WYs (see **Appendix B, Water Resources - Attachment 1**). Therefore, there would be no negative impact to water exports or operations due to a shift in X2 resulting from the No Action Alternative.

A discussion of the maintenance dredging effects on the position of X2 is warranted here because of differences between modeling assumptions and actual conditions. Maintenance of the existing 35 foot channel has limited influence on the position of X2. Maintenance of the navigation channel, particularly in the Bulls head reach of Suisun Bay is done on an annual basis in the fall to restore the authorized depth plus some advanced maintenance incremental depth. The position of X2 is influenced by the changing status of the channel bathymetry. While the actual bathymetry of the channel is constantly changing in portions that are subject to high rates of shoaling and annual fall dredging events, the hydrodynamic model uses a single bathymetric dataset that represents the maximum allowable depth for each alternative since it includes the authorized channel depth and two full feet of overdepth. Just after a maintenance dredging event, the authorized channel depth with overdepth provides the least resistance to upstream transport of saline bay water. Just before a maintenance event, resistance to upstream transport of saline water is at its greatest, since shoaling has reduced the overall depth of the channel. The position of X2 is influenced by the changing status of the channel bathymetry. For this alternative, the No Action Alternative model bathymetry assumed an authorized depth of -35 ft channel plus 2 ft of over-depth for all of the channel. Since 2009, USACE has been dredging a 2,600 ft section of Bulls head reach to a depth of approximately -38 ft MLLW. In general, if the channel is shoaling over the winter, spring, and summer, the X2 position estimates provided by the model output for the No Action Alternative are likely somewhat higher than would be experienced in reality given a slightly shallower depth during the critical summer and early fall X2 periods. Additionally, since the actual dredging practice is to dredge Bulls Head Reach to -38 ft MLLW instead of the model assumption of -37 ft MLLW including overdepth, comparisons of change relative to the No Action Alternative are somewhat conservative since the depths in the Bulls Head Reach in the No Action Alternative are greater than -37 ft following advanced maintenance dredging.

FUTURE WITH -37 FOOT ALTERNATIVE

The three-dimensional hydrodynamic model was also used to conduct a detailed evaluation of the effect of the -37 Foot MLLW Alternative on X2 under both wet and critically dry conditions. Based on this analysis, the average annual predicted shift in X2 for the -37 Foot MLLW Alternative was 0.03 km downstream during a critical WY and 0.08 km downstream during a wet WY (**See Tables 4-1 and 4-5, Figures 4.1-1 and 4.2-1**). When only the portions of the year when X2 was greater than 64 km were considered (since there are no regulatory requirements that govern the position of X2 when X2 is west of Port Chicago and less than 64 km), the average predicted shift in X2 for the -37 Foot MLLW Alternative was 0.03 km during a critical WY and 0.05 km during a wet WY.

Since these predicted shifts in X2 are much smaller than the accuracy to which X2 can be measured operationally, it is not expected that deepening the existing channel an additional 2 feet (plus overdepth) would result in a significant shift in the timing or magnitude of water exports in order to maintain water quality conditions equivalent to those under baseline conditions. Based on this evaluation of the change in X2, the impact of the -37 foot MLLW Alternative on water exports or operations would be less than significant as compared to the NEPA baseline.

FUTURE WITH -38 FOOT ALTERNATIVE

The three-dimensional hydrodynamic model was also used to conduct a detailed evaluation of the effect of the -38 foot MLLW Alternative under both wet and critically dry conditions **(See Tables 4-1 and 4-5, and Figures 4.1-7 and 4.2-7 in Appendix B – Attachment 1)**. Based on this analysis, the average annual predicted shift in X2 for the -38 foot MLLW Alternative was 0.11 km during a critical WY and 0.20 km during a wet WY. When only the portions of the year when X2 was greater than 64 km were considered (since there are no regulatory requirements that govern the position of X2 when X2 is west of Port Chicago and less than 64 km), the average predicted shift in X2 for the -38 foot MLLW Alternative was 0.11 km during a critical WY and 0.15 km during a wet WY.

Since these predicted shifts in X2 are on the same order of magnitude as the accuracy to which X2 can be measured operationally, it is not expected that deepening the existing channel three additional feet (plus overdepth) would result in a significant shift in the timing or magnitude of exports in order to maintain water quality conditions equivalent to those under the No Action Alternative. Based on this evaluation of the change in X2, the impact of the 38 foot MLLW Alternative on water exports or operations would be less than significant as compared to the NEPA baseline.

FUTURE WITH -38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP

The three-dimensional hydrodynamic model was also used to conduct a detailed evaluation of the effect of the 38 Foot MLLW Alternative plus the sediment trap and rock outcrop under critically dry, below normal, and wet conditions for Year 0 and the critically dry condition for Year 50. Based on this analysis, the average annual predicted shift in X2 for the TSP Alternative was 0.17 km during a critical WY, 0.21 km during a below normal WY, and 0.27 km during a wet WY (Year 0 conditions). When only the portions of the year when X2 was greater than 64 km were considered (since there are no regulatory requirements that govern the position of X2 when X2 is west of Port Chicago and less than 64 km), the average predicted shift in X2 for the TSP Alternative was 0.17 km during a critical WY, 0.21 km during a below normal WY, and 0.23 km during a wet WY (Year 0 conditions). For Year 50 conditions, the average predicted shift in X2 for the TSP Alternative was 0.17 km for all the year and for that portion of the year with X2 > 64 km; the difference between the Year 0 and Year 50 dry year model runs show the relative position of X2 moves down 4 km in the upstream area if there are no changes made to upstream releases and downstream pumping to account for climate and sea level change.

As discussed in the X2 assessment for the No Action Alternative, the predictions of change for the TSP are expected to be somewhat conservative because the No Action Alternative model bathymetry assumption of -37 ft MLLW depth (-35 feet + 2 foot of overdepth) for the 2,600 ft. Bullshead segment was used rather than the actual -38 ft MLLW depth the channel has been deepened to as part of the advanced maintenance dredging episodes in this segment since 2009 (similarly the X2 change predictions for the -37 ft and -38 ft alternatives are also likely somewhat conservative.)

In addition to the three simulated years, X2 was predicted for the 10 year period from 2008 to 2017 using a calibrated and validated X2 empirical function as detailed in Chapter 8 of the Hydrodynamic and Salinity Intrusion Model (**Appendix B - Attachment 1**). The results shown in Table 8-1 of the Salinity Model Report show that the annual average change in X2 for the TSP for these 10 years ranges from 0.18 to 0.22 km. This is an indication that the TSP change to X2 varies little (roughly 0.2 km) regardless of hydrologic loading. That the empirical equation predictions compare very favorably to the three years of UnTRIM simulation results provides the authors additional confidence in the overall analysis.

Chapter 7 of the Hydrodynamic and Salinity Intrusion Modeling Report includes an assessment of the change in the Low Salinity Zone (LSZ) of Suisun Bay. This analysis shows that the predicted change in X2 location due to the TSP for all three simulated years' results in average monthly changes that range from an additional 446 acres to a loss of 597 acres. The average monthly change in acreage across all 36 simulated months was a reduction of 45 acres out of a monthly average of 20,375 acres. If only months with losses are averaged, the loss in acreage due to the TSP is less than 1.1 percent of the average monthly acreage. These insignificant changes in LSZ acreage due to the TSP are another indication that the change in X2 position from the TSP is not significant.

Since these predicted shifts in X2 are on the same order of magnitude as the accuracy to which X2 can be measured operationally and the change in LSZ acreage is not significant as discussed in **Chapter 7 of the Hydrodynamic and Salinity Intrusion Modeling Report (Appendix B - Attachment 1**), it is not expected that deepening the existing channel by three feet will result in a significant shift in the timing or magnitude of exports in order to maintain water quality conditions equivalent to those under the No Action Alternative. Based on this evaluation of the change in X2, the impact of the TSP Alternative on water exports or operations would be less than significant as compared to the NEPA baseline.

4.1.4 AIR QUALITY

Using the assumptions and models discussed in ***Sections 2.2.4***, air pollutant emissions from the proposed construction and operational activities were calculated using the most current emission factors and methods, then compared to the criteria identified in ***Section 2.2.4*** to determine their significance. For impacts that exceeded a significance criterion, measures were evaluated for their ability to mitigate the impacts to insignificance. No sensitive land uses are located in the study area—it primarily contains the existing ship channel and placement sites. No sensitive land uses are located within 1,000 feet of the proposed dredging footprints or within 1,000 feet of the docking locations for ships.

An alternative would be considered to have a significant impact on air quality if it would cause the following:

Impact AQ-01: Violate any air quality standard, or contribute substantially to an existing or projected air quality violation

Impact AQ-02: Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable Federal or state ambient air quality standard, including releasing emissions that exceed quantitative thresholds for ozone precursors

Impact AQ-03: Expose sensitive receptors to substantial pollutant concentrations

Impact AQ-04: Create objectionable odors affecting a substantial number of people

Impact AQ-05: Conflict with, or obstruct implementation of the applicable air quality plan

4.1.4.1 THRESHOLDS

The purpose of the general conformity program is to ensure that actions taken by the Federal government do not undermine state or local efforts to achieve and maintain NAAQS. Before a Federal action is taken, it must be evaluated for conformity with the State Implementation Plan (SIP). All reasonably foreseeable emissions, both direct and indirect, predicted to result from the action are taken into consideration and must be identified with respect to location and quantity. Direct emissions occur at the same time and place as the action. Indirect emissions are reasonably foreseeable emissions that may occur later in time and/or farther removed from the action. The emissions are subject to conformity if the Federal agency can practicably control them and maintain control through a continuing program responsibility. If it is found that the action would create emissions above de minimis threshold levels specified in USEPA regulations, the action cannot proceed unless mitigation measures are specified that would bring the project into conformance.

General conformity applies in both Federal non-attainment and maintenance areas. In these areas, it applies to any Federal action not specifically exempted by the CAA or USEPA regulations. General conformity does not apply to projects or actions that are covered by the transportation conformity rule. If a Federal action falls under the general conformity rule, the Federal agency responsible for the action is responsible for making the conformity determination. In some instances, a state will make the conformity determination under delegation from a Federal agency.

The significance criteria used to evaluate NEPA air quality effects are based on the Federal general conformity thresholds. Currently, the SFAAB is classified as moderate nonattainment for the Federal 8-hour ozone standard, nonattainment for the 24-hour $PM_{2.5}$ standard, and maintenance for the Federal CO standards. Because sulfur dioxide is considered a precursor to $PM_{2.5}$, the conformity threshold for SO_2 also applies. The portion of the SVAB under jurisdiction of YSAQMD is currently classified as severe non-attainment for the Federal 8-hour ozone standard, non-attainment for the 24-hour $PM_{2.5}$ standard, and maintenance for the Federal CO standards. **Table 4-3** shows the applicable general conformity thresholds that apply to the TSP in both air basins.

Table 4-3. General Conformity de minimis Thresholds for Projects in the SFBAAB and SVAB

Pollutant	SFBAAB Threshold (tpy)	SVAB Threshold (tpy)
CO	100	100
NO_X	100	25
ROG	50	25
$PM_{2.5}$	100	100
PM_{10}	--	100
SO_2	100	100

Source: USEPA 2016

NO ACTION ALTERNATIVE

AQ-01: Would the alternative conflict with or Obstruct Implementation of the Applicable Air Quality Plan? The No Action Alternative would continue maintenance dredging of the 35 foot deep navigation channel and existing shipping patterns. This alternative does not include construction, does not increase ship calls as compared to the 50-year NEPA baseline, and would not incrementally increase emissions within the study area. Therefore, the No Action Alternative would not violate any air quality standard or contribute to any violations.

Impact AQ-02: Would the alterantive result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard? The No Action Alternative would continue maintenance dredging of the 35 foot deep navigation channel and existing shipping patterns. This alternative does not include construction, does not increase ship calls as compared to the 50-year NEPA baseline, and would not incrementally increase emissions within the study area. Therefore, the No Action Alternative would not result in a net increase of any criteria pollutant for which the project region is in a nonattainment status or release emissions that exceed ozone precursor emissions.

Impact AQ-03: Would the alternative expose sensitive receptors to substantial pollutant concentrations? The No Action Alternative does not include construction and does not increase ship calls as compared to the NEPA baseline. There would be no incremental emissions because of the No Action Alternative. Therefore, the No Action Alternative would not expose sensitive receptors to substantial pollutant concentrations under NEPA.

Impact AQ-04: Would the alternative result in other emissions (such as those leading odors) adversely affecting a substantial number of people? The No Action Alternative would continue maintenance dredging of the 35 foot deep navigation channel and existing shipping patterns. This alternative does not include construction, does not increase ship calls as compared to the 50-year NEPA baseline, and would not incrementally increase emissions within the study area. Therefore, the No Action Alternative would create no objectionable odors affecting a substantial number of people under NEPA.

Impact AQ-05: Would the Alternative Conflict With, Or Obstruct Implementation of The Applicable Air Quality Plan? The No Action Alternative would continue maintenance dredging of the 35 foot deep navigation channel and existing shipping patterns. This alternative does not include construction, does not increase ship calls as compared to the 50-year NEPA baseline, and would not incrementally increase emissions within the study area. Therefore, the No Action Alternative would not conflict with any applicable plans, policies, or regulations adopted to reduce emissions and there would be no impact as compared to the NEPA baseline.

FUTURE WITH -37 FOOT ALTERNATIVE

AQ-01: Would the alternative conflict with or Obstruct Implementation of the Applicable Air Quality Plan
Table 4-4 shows the annual construction emissions for the -37 Foot MLLW Alternative. The data show that construction emissions would not exceed the applicable general conformity thresholds for any of the applicable criteria pollutants in either the SFBAAB or SVAB, where construction activities would take place for the -37 foot MLLW Alternative.

Table 4-4. Annual Construction Emissions for the -37 Foot MLLW Alternative as Compared to the De Minimis Thresholds

Operational Activities	Air Pollutant					
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2
Within SFBAAB						
Dredging (tpy)	1.6	24.7	10.3	24.7	24.7	0.1
Worker Transport (tpy)	0	0.2	0.4	0	0	0
Sediment Transport (tpy)	2.4	19.6	32.6	0.5	0.5	0
Total Emissions (tpy)	**3.9**	**44.4**	**43.2**	**25.2**	**25.2**	**0.1**
SFBAAB de minimis Threshold (tpy)	50	100	100	--	100	100
Exceed?	No	No	No	No	No	No
Within SVAB						
Sediment Transport (tpy)	0.2	1.5	2.5	0.04	0.04	0.001
SVAB de minimis Threshold (tpy)	25	25	100	100	100	100
Exceed?	No	No	No	No	No	No

Table 4-5 shows the annual operational emissions for the -37 Foot MLLW Alternative as compared to the No Action Alternative (NEPA baseline). As shown, for the years 2023, 2030, or 2040, as compared to the NEPA baseline, emissions would decrease under the -37 Foot MLLW Alternative. Therefore, emissions would not exceed the applicable general conformity thresholds for any of the applicable criteria pollutants in the SFBAAB. This comparison uses SFBAAB thresholds because: 1) most of the impacts would occur in this air basin; and 2) the SFBAAB has more stringent thresholds than the SVAB.

Because emissions would not exceed applicable NEPA thresholds, the -37 Foot MLLW Alternative would result in less-than-significant impacts.

Table 4-5. Annual Operational Emissions under the -37 Foot MLLW Alternative Compared to the No Action Alternative (NEPA)

Operational Activities	Air Pollutant			
	ROG	NO_X	PM_{10}	$PM_{2.5}$
2023				
Vessels (tpy)	-0.33	-7.92	-0.19	-0.18
Tugs (tpy)	-0.18	-0.89	-0.03	-0.03
Total Emissions (tpy)	-0.51	-8.81	-0.23	-0.21
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No
2030				
Vessels (tpy)	-0.3	-7.2	-0.18	-0.16
Tugs (tpy)	-0.13	-0.81	-0.03	-0.03
Total Emissions (tpy)	-0.43	-8.01	-0.21	-0.19
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No
2040				
Vessels (tpy)	-0.3	-7.2	-0.18	-0.16
Tugs (tpy)	-0.13	-1.14	-0.03	-0.03
Total Emissions (tpy)	-0.43	-8.34	-0.21	-0.19
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No

Impact AQ-02: Would the alterantive result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicatble federal or state ambient air quality standard? As shown in **Table 4-4** and **Table 4-5**, construction and operations under the -37 Foot MLLW Alternative would not result in substantial emission increases. Consequently, the -37 Foot MLLW Alternative would not cause or contribute significant increases in air quality criteria pollutants as compared to the NEPA baseline.

Impact AQ-03: Would the alternative expose sensitive receptors to substantial pollutant concentrations? Construction activities would produce Diesel Particulate Matter (DPM) and $PM_{2.5}$ emissions from a variety of equipment, including dredging, boat operation, and pumps. These emissions could result in elevated concentrations of DPM and $PM_{2.5}$ at sensitive receptors. A health risk assessment was not conducted because the distance between the emission sources and sensitive receptors exceeds the 1,000 feet screening threshold established by the BAAQMD (BAAQMD 2012).

Construction activities would produce DPM and $PM_{2.5}$ emissions due to diesel combustion equipment such as dredging equipment, marine vessels, and sediment unloading equipment. These emissions could result in elevated concentrations of DPM and $PM_{2.5}$.

BAAQMD uses the 1,000-foot screening threshold to determine whether a project's emissions of TACs during construction and operation merit a health risk assessment. YSAQMD does not require a health risk assessment for projects that consist primarily of mobile source emissions. Construction emissions generated by the -37 foot MLLW Alternative would occur in water-based locations located substantially farther than 1,000 feet from sensitive receptors. Consequently, a quantitative health risk assessment was not performed for this alternative. The -37 foot MLLW Alternative would not expose sensitive receptors to substantial quantities of TACs or $PM_{2.5}$, and impacts would be less than significant as compared to the NEPA baselines.

Impact AQ-04: Would the alternative result in other emissions (such as those leading odors) adversely affecting a substantial number of people? The -37 foot MLLW Alternative would include construction and a decrease in ship calls as compared to the No Action Alternative (NEPA baseline). Both activities would generate odors from diesel fuel combustion. However, construction dredging would occur in the ship channel, which is located at substantial distances from sensitive receptors. The placement sites are also located at considerable distances from sensitive receptors. Operationally, fewer ships would travel in the ship channel than under the No Action Alternative, and these ships would dock at industrial locations, distant from sensitive receptors. Therefore, there would be no incremental odor impacts as a result of the -37 foot MLLW Alternative.

Impact AQ-05: Would the Alternative Conflict With, Or Obstruct Implementation of The Applicable Air Quality Plan? The -37 foot MLLW Alternative includes construction and changes in operational emissions associated with ship calls. USEPA has established general conformity requirements that establish de minimis emission thresholds. Projects that exceed de minimis thresholds are required to prepare an in-depth conformity analysis that demonstrates that the project would not worsen existing violations or contribute to new violations of the NAAQS. As shown in **Table 4-4** and **Table 4-5**. The -37 foot MLLW Alternative does not exceed any de-minimis thresholds.

SIPs are the primary planning tool for areas that are nonattainment for one or more of the NAAQS. SIPs are also required for areas that were previously nonattainment but that have been reclassified as attainment-maintenance. The -37 foot MLLW Alternative would not conflict with BAAQMD's existing SIPs because marine transportation is typically not covered by SIPs and the alternative would not result in emissions that exceed the Federal conformity thresholds. Consequently, there would be no impact to existing federally required air quality plans.

FUTURE WITH 38 FOOT AND 38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

AQ-01: Would the alternative conflict with or Obstruct Implementation of the Applicable Air Quality Plan
The applicable Federal air quality plan is the general conformity program, which is to ensure that actions taken by the Federal government do not undermine state or local efforts to achieve and maintain NAAQS. Before a Federal action is taken, it must be evaluated for conformity with the SIP. Error! Reference source not found. shows the annual construction emissions for the TSP. As shown, construction emissions would not exceed the applicable general conformity thresholds for any of the applicable criteria pollutants in the SFBAAB or SVAB under the TSP.

Table 4-6. Annual Construction Emissions for the TSP as Compared to Conformity Thresholds

Construction Activities	Air Pollutant					
	ROG	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2
Year 2023 Within BAAQMD						
Dredging (tpy)	0.89	6.29	14.37	0.35	0.34	0.04
Worker Transport (tpy)	0.06	0.35	0.29	0.01	0.01	0.00
Sediment Transport (tpy)	1.46	29.43	9.64	0.21	0.2	0.05
Total Emissions (tpy)	**2.41**	**36.07**	**24.3**	**0.57**	**0.54**	**0.09**
SFBAAB de minimis Threshold (tpy)	50	100	100	--	100	100
Exceed?	No	No	No	No	No	No
Year 2023 Within YSAQMD						
Dredging (tpy)	0.0	0.0	0.0	0.0	0.0	0.0
Worker Transport (tpy)	0.0	0.0	0.0	0.0	0.0	0.0
Sediment Transport (tpy)	0.0	0.3	0.1	0.0	0.0	0.0
Total Emissions (tpy)	**0.0**	**0.3**	**0.1**	**0.0**	**0.0**	**0.0**
SVAB de minimis Threshold (tpy)	25	25	100	--	100	100
Exceed?	No	No	No	No	No	No

Table 4-7 shows the No Action Alternative (NEPA Baseline) and TSP emissions and **Table 4-8** shows the annual operational emissions for the TSP as compared to the No Action Alternative (NEPA baseline). As shown, for the years 2023, 2030, or 2040, emissions would not exceed the applicable thresholds for any of the applicable criteria pollutants in the SFBAAB. This comparison uses BAAQMD thresholds because: 1) most of the impacts would occur in the SFBAAB; and 2) BAAQMD has more stringent thresholds than YSAQMD.

Table 4-7. Annual Operational Emissions for the No Action Alternative (NEPA Baseline) and TSP.

Operational Activities	Air Pollutant			
	ROG	NO_X	PM_{10}	$PM_{2.5}$
No Action Alternative				
2023				
Vessels (tpy)	3.85	91.42	2.24	2.07
Tugs (tpy)	1.63	7.99	0.39	0.27
Total Emissions (tpy)	5.48	99.41	2.63	2.34
2030				
Vessels (tpy)	4.58	108.69	2.67	2.46
Tugs (tpy)	1.94	11.46	0.47	0.4
Total Emissions (tpy)	6.52	120.15	3.14	2.86
2040				
Vessels (tpy)	5.43	128.85	3.16	2.91
Tugs (tpy)	2.3	14.55	0.55	0.5
Total Emissions (tpy)	7.73	143.4	3.71	3.41
TSP				
2023				
Vessels (tpy)	3.43	81.34	0.88	0.82
Tugs (tpy)	1.45	6.85	0.35	0.23
Total Emissions (tpy)	4.87	88.19	1.23	1.05
2030				
Vessels (tpy)	4.12	49.53	2.4	2.22
Tugs (tpy)	1.75	10.24	0.42	0.35
Total Emissions (tpy)	5.87	59.77	2.83	2.57
2040				
Vessels (tpy)	5.01	118.77	2.91	2.68
Tugs (tpy)	2.12	13.41	0.51	0.46
Total Emissions (tpy)	7.12	132.18	3.42	3.14

Table 4-8. Annual Operational Emissions for the TSP Compared to the No Action Alternative (NEPA Baseline).

Operational Activities	Air Pollutant			
	ROG	NO_X	PM_{10}	$PM_{2.5}$
2023				
Vessels (tpy)	-0.42	-10.08	-1.36	-1.25
Tugs (tpy)	-0.18	-1.14	-0.04	-0.04
Total Emissions (tpy)	**-0.61**	**-11.22**	**-1.4**	**-1.29**
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No
2030				
Vessels (tpy)	-0.46	-59.16	-0.27	-0.24
Tugs (tpy)	-0.19	-1.22	-0.05	-0.05
Total Emissions (tpy)	**-0.65**	**-60.38**	**-0.31**	**-0.29**
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No
2040				
Vessels (tpy)	-0.42	-10.08	-0.25	-0.23
Tugs (tpy)	-0.18	-1.14	-0.04	-0.04
Total Emissions (tpy)	**-0.61**	**-11.22**	**-0.29**	**-0.27**
BAAQMD Thresholds (tpy)	50	100	100	100
Exceed?	No	No	No	No

Because emissions would not exceed applicable thresholds, the TSP would result in less-than-significant impacts.

Impact AQ-02: Would the alternative result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable Federal or state ambient air quality standard? Construction and operations under the TSP would not result in substantial emission increases. Consequently, the TSP would not cause or contribute to significant increases in air quality criteria pollutants as compared to the NEPA baseline.

Impact AQ-03: Would the alternative expose sensitive receptors to substantial pollutant concentrations? The TSP would include construction and a decrease in ship calls as compared to the No Action Alternative (NEPA baseline). However, emissions associated with construction are not expected to expose sensitive receptors to substantial pollutant concentrations because emissions would occur in the existing ship channel, more than 1,000 feet from sensitive receptors. This impact is considered less than significant.

Impact AQ-04: Would the alternative result in other emissions (such as those leading odors) adversely affecting a substantial number of people? The TSP would include construction and a decrease in ship calls as compared to the No Action Alternative (NEPA baseline). Both activities would generate odors from diesel fuel combustion. However, construction dredging would occur in the ship channel, which is located at substantial distances from sensitive receptors. Similarly, the placement sites are also located at considerable distances from sensitive receptors. Operationally, fewer ships would travel in the ship channel than under the No Action Alternative, and these ships would dock at industrial locations, distant from sensitive receptors. Therefore, there would be no incremental odor impacts as a result of the TSP.

Impact AQ-05: Would the Alternative Conflict With, Or Obstruct Implementation of The Applicable Air Quality Plan? The TSP includes construction and changes in operational emissions associated with ship calls. USEPA has established general conformity requirements that establish de minimis emission thresholds. Projects that exceed de minimis thresholds are required to prepare an in-depth conformity analysis that demonstrates that the project would not worsen existing violations or contribute to new violations of the NAAQS. As shown in Table 4-7 and Table 4-8, the TSP does not exceed any de minimis thresholds.

State Implementation Plans (SIPs) are the primary planning tool for areas that are nonattainment for one or more of the NAAQS. SIPs are also required for areas that were previously nonattainment but that have been reclassified as attainment-maintenance. The TSP would not conflict with BAAQMD's existing SIPs because marine transportation is typically not covered by SIPs and the alternative would not result in emissions that exceed the Federal conformity thresholds. Consequently, there would be no impact to existing federally required air quality plans.

4.1.5 CLIMATE CHANGE

The project specific analysis examines the environmental effects from construction associated with deepening the study area channels to either -37 or -38 feet MLLW + the sediment trap and rock outcrop. The analysis also evaluates changes in shipping operations directly attributable to the alternatives. GHG emissions from the proposed construction and operational activities were calculated using the most current emission factors and methods, and then compared to the applicable criteria to determine their significance. For GHG emission impacts that exceeded a significance criterion, measures were evaluated for their ability to mitigate these impacts to insignificance.

4.1.5.1 OPERATIONAL ASSUMPTIONS

Appendix D, Economic Analysis projects that the volume of petroleum products (which are the dominant cargo in the project area) will grow at the same rate. The vessel mix, however, is projected to change if deepening is implemented. The predicted increase in petroleum product volumes is expected to be shipped primarily in vessels of the Panamax medium class. The deeper channel depth would allow those vessels to avoid some of the costly operational strategies currently in use, making them a more efficient option than the larger vessels. Therefore, the climate change analysis focuses on the change of Panamax vessels over time among alternatives as shown in **Table 4-9**, with the year 2023 as the construction start year, similar to the economic analysis.

Table 4-9. Projected Annual Number of Panamax Ship Calls Over Time.

Year	Total Panamax Ship Calls/Year		
	NEPA Baseline/No Action Alternative (35-Foot)	-37 foot MLLW Alternative	-38 foot MLLW Alternative
2023	127	116	113
2030	151	141	136
2040	179	169	165

The following assumptions were used to assess GHG emissions from operations:

- Annual ship calls are based on 2014 data, which represented the available full year of ship data in the USACE Waterborne Commerce Statistics Center (USACE 2016) at the time the analysis was conducted.
- The maximum tugboat engine size is assumed to be 3,600 hp for main engines and 235 hp for auxiliary engines, based on the maximum values in CARB's OFFROAD2014 model. A load factor of 50 percent for main engines and 31 percent for tugboats is assumed based on OFFROAD2014.
- Two tugboats would accompany each Panamax vessel (Port of Los Angeles 2008b).
- Marine vessel emissions are based on the CARB's Emission Estimation Methodology for Ocean-Going Vessels (2011). CARB's estimation procedure uses separate calculations for main and auxiliary engines.
- Average vessel characteristics for tankers assumes main engine power of 13,034 kilowatts and auxiliary power of 2,339 kilowatts (CARB 2011). Estimates assume a load factor of 83 percent for main engines and 26 percent for auxiliary engines (CARB 2011). Emission factors for main engines and auxiliary engines are based on medium marine distillate (0.1 percent sulphur) (CARB 2011). Main engines are assumed to operate for 2 hours per ship call and auxiliary engines for 34 hours per ship call.
- Annual ship calls are based on 2014 data, which represents the most recently available full year of ship data in the USACE Waterborne Commerce Statistics Center (USACE 2016).

Maintenance dredging of the channels to their maintained depths would continue to occur annually during the dredging window.

An alternative could have an impact on climate change if it would cause the following:
<u>Impact CC-1</u>: Directly or indirectly exceed applicable Federal or state GHG standards:

- NEPA: GHG emissions are compared to the CEQ reference point of 25,000 metric tons per year of CO_2 equivalent.

<u>Impact CC-2</u>: Conflict with an applicable plan, policy, or regulation adopted to reduce GHG emissions and climate change impacts

NO ACTION ALTERNATIVE

Table 4-10. Operational GHG Emissions for the No Action Alternative (Metric Tons per Year).

Activities/yr.	CH_4	N_2O	CO_2	CO_2 equivalent
2023				
Vessels	0.07	-	538	540
Tugs	0.002	0.005	187	189
O&M[1]	0.0	0.0	0.0	0.0
Total GHG Emissions	0.07	0.00	726	**729**
GHG Emissions Threshold				10,000
Exceed Threshold?				**No**
2030				
Vessels	0.15	-	1,184	1,188
Tugs	0.004	0.01	412	415
O&M[1]	0.0	0.0	0.0	0.0
Total GHG Emissions	0.15	0.01	1,596	**1,603**
GHG Emissions Threshold				10,000
Exceed Threshold?				**No**
2040				
Vessels	0.24	-	1,938	1,943
Tugs	0.01	0.02	674	680
O&M[1]	0.0	0.0	0.0	0.0
Total GHG Emissions	0.25	0.02	2,612	**2,623**
GHG Emissions Threshold				10,000
Exceed Threshold?				**No**

Impact CC-1: Directly or indirectly exceed applicable Federal or state GHG standards: Because the No Action Alternative does not include construction and does not increase ship calls as compared to the NEPA baseline, it would not result in additional GHG emissions. Therefore, the No Action Alternative would not conflict with any applicable plans, policies, or regulations adopted to reduce GHG emissions and there would be no impact as compared to the NEPA baseline.

Impact CC-2: Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing GHG emissions and climate change impact: Under the No Action Alternative, there would be no construction-related GHG emissions and ship calls would be the same as compared to the NEPA baseline. This impact is considered less than significant because the level of increased ship activity would not conflict with applicable plans, policies, or regulations designed to reduce GHG emissions and climate change impacts.

FUTURE WITH -37 FOOT ALTERNATIVE

Impact CC-1: Directly or indirectly exceed applicable Federal or state GHG standards: The -37 foot MLLW Alternative would generate GHG emissions during construction and operation. Construction emissions would occur in 2021 and would include dredging emissions, worker transport on land and by boat to the dredging operation, and boat transport of dredged sediment to placement sites (**Table 4-11**). CO_2

equivalent emissions of 11,778 metric tons per year are less than the CEQ reference point of 25,000 metric tons per year.

As compared to the No Action Alternative, the -37 foot MLLW Alternative would have fewer ship calls in 2023, 2030, and 2040 (Table CC-1), reducing GHG emissions from vessels and tugs (**Table 4-12**). Even though operation and maintenance emissions would increase to maintain the deeper ship channel, total GHG emissions would be substantially below the Federal threshold of 25,000 metric tons of CO2 equivalent per year for all three future years considered in this analysis.

USACE has not adopted a significance threshold and has established the position that there are no science-based GHG significance thresholds. In the absence of an adopted or science-based GHG standard, in compliance with the CEQ and USACE NEPA implementing regulations, a significance determination regarding the -37 foot MLLW Alternative's GHG emissions is not made under NEPA.

Table 4-11. Construction GHG Emissions for the -37 foot MLLW Alternative (Metric Tons per Year).

Activities	**CH_4**	**N_2O**	**CO_2**	**$CO_{2\ equivalent}$**
Dredging	0.75	0.24	9,472	9,565
Worker Transport	0.004	0.01	130	133
Sediment Transport	0.12	0.05	2,061	2,080
Total GHG Emissions	0.87	0.3	11,663	**11,778**
CEQ GHG Reference Point				25,000
Exceed Threshold?				**No**

Table 4-12. Operational GHG Emissions for the -37 foot MLLW Alternative Minus the No Action Alternative (Metric Tons per Year).

Activities/yr.	CH_4	N_2O	CO_2	$CO_{2\ equivalent}$
2023				
Vessels	-0.04	-	-296	-297
Tugs	-0.001	-0.003	-103	-104
O&M[1]	0.149	0.054	2,087	2,107
Total GHG Emissions	0.16	0.04	1,696	**1,713**
GHG Emissions Threshold				25,000
Exceed Threshold?				**No**
2030				
Vessels	-0.034	-	-269	-270
Tugs	-0.001	-0.002	-94	-94
O&M[1]	0.159	0.058	2,226	2,248
Total GHG Emissions	0.149	0.054	2,087	**1,883**
GHG Emissions Threshold				25,000
Exceed Threshold?				**No**
2040				
Vessels	-0.034	-	-269	-270
Tugs	-0.001	-0.002	-94	-94
O&M[1]	0.149	0.054	2,087	2,107
Total GHG Emissions	0.11	0.05	1,724	**1,743**
GHG Emissions Threshold				25,000
Exceed Threshold?				**No**

Table 4-13. Operational GHG Emissions for the -37 foot MLLW Alternative Minus Existing Conditions (Metric Tons per Year).

Activities/yr.	CH_4	N_2O	CO_2	$CO_{2\ equivalent}$
2014 Baseline				
Vessels	0.36	0.00	2,880	2,887
Tugs	0.011	0.026	1,002	1,010
O&M[1]	NA	NA	NA	NA
Total GHG Emissions	0.37	0.03	3,882	**3,898**
Exceed Threshold?				**No**
2023				
Vessels	0.03	-	242	243
Tugs	0.001	0.002	84	85
O&M[1]	0.15	0.05	2,087	2,107
Total GHG Emissions	0.18	0.06	2,414	**2,435**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**
2030				
Vessels	0.11	-	915	918
Tugs	0.003	0.008	318	321
O&M[1]	0.15	0.05	2,087	2,107
Total GHG Emissions	0.27	0.06	3,321	**3,346**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**
2040				
Vessels	0.21		1,669	1,673
Tugs	0.01	0.01	581	585
O&M[1]	0.149	0.054	2,087	2,107
Total GHG Emissions	0.36	0.07	4,336	**4,366**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**

Impact CC-2: Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing GHG emissions and climate change impact: GHG emissions generated by construction and operation of the -37 foot MLLW Alternative would not exceed the Federal GHG emission level of 25,000 metric tonnes of CO_2 equivalent per year. As a result, the -37 foot MLLW Alternative would not conflict with adopted plans aimed at reducing GHG emissions, and impacts would be considered less than significant.

FUTURE WITH 38 FOOT AND 38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact CC-1: Directly or indirectly exceed applicable Federal or state GHG standards: The 38 foot MLLW Alternative would generate GHG emissions during construction and operation. The construction emissions would occur in 2021 and 2023 and include dredging emissions, worker transport on land and by boat to the dredging operation, and boat transport of dredged sediment to various placement sites (**Table 4-14. Construction GHG Emissions for the -38 foot MLLW Alternative (Metric Tons per Year)**). Although the 38 foot MLLW Alternative's emissions of 17,841 metric tons of CO_2 equivalent per year would be higher than that associated with construction of the -37 foot MLLW Alternative (see **Table 4-11. Construction GHG Emissions for the -37 foot MLLW Alternative (Metric Tons per Year)**, it would still be less than the Federal threshold of 25,000 metric tons per year.

Table 4-14. Construction GHG Emissions for the -38 foot MLLW Alternative (Metric Tons per Year).

Activities	CH_4	N_2O	CO_2	$CO_{2\ equivalent}$
Dredging	1.22	0.4	15,365.07	15,517.34
Worker Transport	0.01	0.01	239.01	243.65
Sediment Transport	0.12	0.05	2,061.23	2,080.17
Total GHG Emissions	1.34	0.46	17,665.31	**17,841.16**
GHG Emissions Threshold				25,000
Exceed Threshold?				**No**

As compared to the No Action Alternative, the -38 foot MLLW Alternative would have fewer ship calls in 2023, 2030, and 2040, thereby reducing GHG emissions from vessels and tugs (**Table 4-13 and Table 4-14)**. Even though operation and maintenance emissions would increase to maintain the deeper ship channel, total GHG emissions would be substantially below the Federal threshold of 25,000 metric tons of CO2 equivalent per year.

USACE has not adopted a significance threshold and has established the position that there are no science-based GHG significance thresholds. In the absence of an adopted or science-based GHG standard, in compliance with the CEQ and USACE NEPA implementing regulations, a significance determination regarding the -38 foot MLLW Alternative's GHG emissions is not made under NEPA.

Table 4-15. Operational GHG Emissions for the 38 foot MLLW Alternative Minus Existing Conditions (Metric Tons per Year).

Activities/yr.	CH_4	N_2O	CO_2	$CO_{2\ equivalent}$
2023				
Vessels	0.02	-	161	162
Tugs	0.001	0.001	56	57
O&M[1]	0.159	0.058	2,226	2,248
Total GHG Emissions	0.18	0.06	2,444	**2,466**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**
2030				
Vessels	0.1	-	780	783
Tugs	0.003	0.007	272	274
O&M[1]	0.159	0.058	2,226	2,248
Total GHG Emissions	0.26	0.07	3,278	**3,304**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**
2040				
Vessels	0.2	-	1,561	1,565
Tugs	0.006	0.01	543	548
O&M[1]	0.159	0.058	2,226	2,248
Total GHG Emissions	0.36	0.07	4,330	**4,361**
BAAQMD Emissions Threshold				10,000
Exceed Threshold?				**No**

Impact CC-2: Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing GHG emissions and climate change impact: GHG emissions generated by construction and operation of this alternative would not exceed the Federal GHG emission level of 25,000 metric tons of CO_2 equivalent per year. As a result, the 38 foot MLLW Alternative would not conflict with adopted plans aimed at reducing GHG emissions.

4.1.6 BIOLOGICAL RESOURCES

Impacts on biological resources, including special status species, critical habitat, EFH, and other sensitive resources, were qualitatively evaluated based on the habitat preferences for various species known or suspected to occur in the study area, as well as the quantity and quality of existing habitat. Potential impacts were analyzed using recent CDFW, California Native Plant Society, NMFS, and USFWS data for special status species and habitats, fish surveys, literature reviews, and professional expertise and judgment in evaluating how the alternatives could interact with and impact aquatic biological resources.

Under NEPA, an alternative would be considered to have a significant impact on biological resources if it would:

- <u>Impact BR-01</u>: Cause increased turbidity that adversely affects special status species and critical habitat; or

- Impact BR-02: Cause benthic habitat disturbance that adversely affects special status species, critical habitat, or habitat for commercially valuable marine species; or
- Impact BR-03: Cause underwater noise that adversely affects special status fish and marine mammals; or
- Impact BR-04: Adversely affect special status or commercially or recreationally important marine species through entrainment; or
- Impact BR-05: Result in the disturbance of EFH and "Special Aquatic Sites," including eelgrass beds and mudflats; or
- Impact BR-06: Interfere with the movement of resident or migratory fish or wildlife species; or
- Impact BR-07: Adversely affect special status fish species, including their critical habitat, as a result of X2 shifts.

NO ACTION ALTERNATIVE

Impact BR-01: Cause increased turbidity that adversely affects special status species or critical habitat: The No Action Alternative would continue ongoing maintenance dredging and use of the channel, and would not result in turbidity changes above baseline conditions. Therefore, special status species or critical habitat would not be affected by turbidity above baseline conditions.

Impact BR-02: Cause benthic habitat disturbance that adversely affects special status species, critical habitat, or commercially valuable marine species: The No Action Alternative would continue ongoing maintenance dredging and use of the channel, and would not result in changes to benthic habitat above baseline conditions. USACE would continue to implement standard practices intended to minimize the impacts of dredging and placement on the marine environment, and the potential effects of benthic habitat disturbance would be short term and localized. Therefore, there would be no additional impacts to special status species, critical habitat, or commercially valuable marine species above baseline conditions.

Impact BR-03: Cause underwater noise that adversely affects special status fish or marine mammals: The No Action Alternative would continue ongoing maintenance dredging and use of the channel. The existing baseline underwater noise levels associated with periodic dredging of the channels and regular ship traffic movements within the channels would not change. Therefore, there would be no additional noise related impacts to special status fish or marine mammals above baseline conditions. It is likely that most animals occurring within and near the channels have become adapted to the existing underwater navigation related noises that regularly occur throughout the year.

Impact BR-04: Adversely affect special status or commercially or recreationally important marine species through entrainment: The No Action Alternative would continue ongoing maintenance dredging and use of the channel, and would not result in additional entrainment impacts. Therefore, there would be no impacts to special status or commercially or recreationally important marine species above baseline conditions.

Impact BR-05: Result in the disturbance of EFH and "Special Aquatic Sites," including eelgrass beds and mudflats: The No Action Alternative would continue ongoing maintenance dredging operations and shipping use of the channel, and would not result in additional disturbance of EFH or Special Aquatic Sites. Therefore, there would be no new impacts to EFH and Special Aquatic Sites above baseline conditions.

Impact BR-06: Interfere with the movement of resident or migratory fish or wildlife species: The No Action Alternative would continue ongoing maintenance dredging operations and shipping use of the channel, and would not result in additional changes that would interfere with the movement of resident migratory fish or wildlife species. Therefore, there would be no impacts to the movement of resident migratory fish or wildlife species.

Impact BR-07: Adversely affect special status fish species, including their habitat, as a result of X2 shifts: The No Action Alternative would continue ongoing maintenance dredging operations and shipping use of the channel. Continuation of those activities would not result in a shift in the X2. Therefore, compared to the NEPA baseline, there would be no additional impacts to special status fish species due to a shift in X2 under the No Action Alternative.

FUTURE WITH -37 FOOT ALTERNATIVE

Impact BR-01: Cause increased turbidity that adversely affects special status species or critical habitat: Background turbidity in the estuary is naturally high, with total suspended solids (TSS) levels varying from 10 mg/L to more than 100 mg/L (Robinson and Greenfield 2011). Turbidity plumes from dredging that could limit plankton productivity would be of short duration, as well as being localized and small in the area affected compared to surrounding areas of similar habitat. In San Francisco Bay, turbidity plumes would be quickly diluted to near or within background particulate concentrations. Any increases in turbidity associated with construction of the -37 foot MLLW Alternative would represent a negligible change from turbidity effects that now result from maintenance dredging under the No Action Alternative. Increased turbidity from dredging is therefore expected to have a negligible effect on plankton productivity.

The turbidity resulting from dredging to deepen the channels may affect some marine and estuarine organisms and aquatic wildlife during various life stages by affecting respiration (clogging gills), reducing visibility and the ability to forage or avoid predators, and altering movement patterns (due to avoidance of turbid waters). Suspended sediments have been shown to affect fish behavior, including avoidance responses, territoriality, feeding, and homing behavior.

Wilber and Clarke (2001) found that suspended sediments result in cough reflexes, changes in swimming activity, and gill flaring. Suspended sediments can have other impacts, including abrasion to the body and gill clogging. Generally, bottom-dwelling fish species are the most tolerant of suspended solids, and filter feeders are the most sensitive. The effect of dredging on fish can vary with life stage; early life stages tend to be more sensitive than adults. For example, pelagic eggs and larvae of fishes and shellfishes depend on local hydrodynamic conditions for transport into and out of dredging activity areas and have limited avoidance capabilities. Demersal eggs (eggs sinking to the bottom) and sessile, or non-motile life history stages, are perceived to be particularly susceptible because of their longer exposure to elevated suspended sediments or due to smothering by increased sedimentation. Motile organisms can generally avoid unsuitable conditions.

The USACE Waterways Experiment Station Technical Report DS785 Effects of Dredging on Aquatic Organisms (Hirsch et al. 1978), states that:

> "…most organisms tested are very resistant to the effects of sediment suspensions in the water, and aside from natural systems requiring clear water such as coral reefs and some aquatic plant beds, dredging induced turbidity is not a major ecological concern."

Pacific herring, a commercially important species, spawn in San Francisco Bay from November through March and so could be affected if spawning occurred in the area just before the end of the work window for maintenance dredging activities (i.e., November). Exposure of Pacific herring eggs to suspended San Francisco Bay dredged sediments at ecologically relevant concentrations of 250 or 500 milligrams per liter (mg/L) within their first 2 hours of contact with water has been documented to result in higher percentages of abnormal larvae, as well as an increase in larval mortality (Griffin et al. 2009). However, the suspended sediment from dredging in the shipping channel would need to travel into the shallow spawning areas for adverse effects to occur.

It should be noted that the eggs or larval life stages of steelhead, Chinook salmon, or green sturgeon are not expected to be present in any of the Federal navigation channels since those areas are not used as spawning habitat. In addition, large adult and juvenile fish (including steelhead, Chinook salmon, and green sturgeon) as well as marine mammals are motile enough to avoid areas of high turbidity plumes caused by dredging.

Increased turbidity and activity during dredging may disturb marine mammal foraging activities by temporarily decreasing visibility or causing the relocation of mobile prey from the area affected by the sediment plume. Marine mammals would not be substantially affected by dredging operations because they forage over large areas of San Francisco Bay and the ocean and can avoid areas of temporarily increased turbidity and dredging disturbance.

Standard practices intended to minimize increases in turbidity would be implemented, and work would be limited to applicable windows unless otherwise approved. Therefore, compared to the NEPA baseline, impacts on special status species and critical habitat from localized and temporary increases in turbidity would be less than significant, and similar to the impacts resulting from maintenance dredging and ongoing use of the channel under the No Action Alternative.

Impact BR-02: Cause benthic habitat disturbance that adversely affects special status species, critical habitat, or commercially valuable marine species: Construction dredging would directly impact benthic communities through physical disruption and direct removal of benthic organisms, resulting in the potential loss of most, if not all, organisms in the dredged area. Benthic habitat within the existing Federal channels is highly disturbed because of regular maintenance dredging and the propeller wash of ship traffic. Organisms immediately adjacent to the dredged channels may also be lost during deepening because of smothering or burial from sediments re-suspended in the water column as a result of the dredging.

Critical habitat for steelhead, Chinook salmon, delta smelt, and green sturgeon overlaps with some or all of the estuarine/marine portions of the project area. Benthic habitat can be an important part of critical habitat for some species by providing foraging areas, especially for green sturgeon. The loss of benthic invertebrates during dredging activities may decrease the forage value of critical habitat at the dredge location. No state-listed or federally-listed benthic epifauna and infauna are likely to occur in the study area. Because delta smelt feed in the water column, benthic habitat provides less of a function for that species than for species that forage in the benthos.

The -37 foot MLLW Alternative may impact two primary constituent elements[1] of delta smelt critical habitat: rearing habitat and adult migration. Rearing habitat includes shallow water river and tributary habitat extending eastward from Carquinez Strait, including Suisun Bay. Additional rearing habitat outside of the dredge footprint is present at Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break. Protection of this habitat is most important from February through summer. The entire study area is within the rearing habitat primary constituent element. With the exception of August, the work window for Bulls Head Reach (August 1 through November 30), which is a part of the Suisun Bay Channel is mostly protective of the delta smelt rearing life stage. However, rearing delta smelt may still be affected by the -37 foot MLLW Alternative to a minor degree.

With respect to adult migration, adults must be provided unrestricted access to suitable spawning habitat from December through July. Spawning areas include areas of the Sacramento and San Joaquin rivers and tributaries, Cache Slough, Montezuma Slough, and tributaries. Although spawning habitat is not found in the project area, adult delta smelt begin migrating from the study area to spawning grounds in September and October. Dredging activities may affect adults migrating through the study area to spawning grounds during this timeframe, since dredging would occur during the existing work windows of June 1 through November 30 in the Richmond and Pinole Shoal channels and August 1 through November 30 in the Bulls Head Reach (part of the Suisun Bay Channel). However, the affected area would be limited to the immediate dredging or placement zone and would not substantially limit the available habitat or movement of fish. Effects would be similar to those of ongoing maintenance dredging. As evidenced by Bay Study and the FMWT data (**see Table 4-16 *and* Table 4-17**), little or no delta smelt are expected to occur within the dredge footprint within the Pinole Shoal Channel (e.g., less than 1 percent of delta smelt have been collected in almost 50 years of trawling). Therefore, there is no potential for impact on delta smelt or delta smelt critical habitat from benthic disturbance.

Table 4-16. Percent of Delta Smelt Caught in Pinole Shoal Channel Dredge Area During Fall Midwater Trawl and Bay Study 2000-2013 (June 1 to November 3).

Station Number	Total Delta Smelt Catch	Total Catch at All Stations*	Percent of Total Catch
Fall Midwater Trawl Stations			
306	0	799	0
309	0	799	0
310	0	799	0
321	0	799	0
325	0	799	0
337	0	799	0
338	0	799	0
Bay Study Stations			
325	0	173	0
346	0	173	0

[1]A physical or biological feature essential to the conservation of a species for which its designated or proposed critical habitat is based on, such as space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution.

Table 4-17. Percent of Delta Smelt Caught in Suisun Bay Dredge Area During Fall Midwater Trawl and Bay Study 2000-2013 (August 1 to November 30).

Station Number	Total Delta Smelt Catch	Total Catch at All Stations*	Percent of Total Catch
Fall Midwater Trawl Stations			
407	2	911	0.22
408	1	911	0.11
409	0	911	0
410	0	911	0
Bay Study Stations			
432	2	125	1.6

Following sediment-disturbing activities such as dredging, disturbed areas are usually recolonized quickly by benthic organisms (Newell et al. 1998). The species that recolonize first are usually characterized by rapid growth and reproduction rates. Marine benthic invertebrates often colonize disturbed sedimentary habitats via pelagic larvae that settle from the water column. Crustaceans, such as amphipods that are abundant in San Francisco Bay, brood young to much more advanced stages than pelagic larvae, releasing what are essentially miniature adults into the sediment. These can rapidly colonize adjacent disturbed areas.

Since recovery may be slower in deep water channels, there is potential for some loss of habitat and forage to organisms that use the channels. This potential is minimal, because the Federal deep-draft navigation channels are in a constant state of disturbance by deep draft vessels that travel through the channels at a maximum of 15 knots under their own power. At a minimum, oil tankers can be as close as 3 feet to the channel bottom and other vessels as close as 2 feet. Annually, approximately 3,800 vessel trips occur in the Oakland Harbor Channel; 2,300 vessel trips occur in the Richmond Harbor Channel; 2,300 to 4,000 vessel trips occur in the Pinole Shoal Chanel; 800 vessel trips occur in the Suisun Bay and New York Slough channels; and 250 vessel trips occur on Redwood City Harbor Channels (**Appendix D, Economic Analysis**). Under these conditions, the benthos of these highly used channels, which are also dredged annually, is in a constant state of disruption. The potential for habitat loss in channels that are dredged less frequently would be slightly greater, but still small due to disruption of benthos from frequent vessel traffic.

Studies have indicated that even relatively large areas disturbed by dredging activities are usually recolonized by benthic invertebrates within 1 month to 1 year, with original levels of biomass and abundance developing within a few months to between 1 and 3 years (Newell et al. 1998). Following dredging, disturbed areas are recolonized, beginning with mobile and opportunistic species (Lenihan and Oliver 1995; Oliver et al. 1977). These species, characterized by rapid growth and reproduction, may or may not be the same species that were present in the area prior to the disturbance.

San Francisco Bay harbors more nonindigenous benthic invertebrate species than any other aquatic ecosystem in North America (Cohen and Carlton 1995). The introduced species range from approximately 20 to 80 percent of all species present (Lee et al. 1999). Therefore, depending on the area of San Francisco Bay, recolonization would likely include nonindigenous species already present in the area.

Under the -37 foot MLLW Alternative, USACE would continue maintenance dredging the project area. The frequency of dredging and volumes dredged may increase slightly in the future to account for the incrementally deeper channel.

USACE would continue to implement standard practices intended to minimize the impacts of dredging and placement on the marine environment. As described previously, the potential effects of benthic habitat disturbance would be short term and localized. Therefore, compared to the NEPA baseline, impacts on special status species, critical habitat, or commercially valuable marine species from localized and temporary disturbances of benthic habitat from the -37 foot MLLW Alternative and future maintenance dredging would be less than significant.

Impact BR-03: Cause underwater noise that adversely affects special status fish or marine mammals: Mechanical and hydraulic dredges produce a complex combination of repetitive sounds that may be intense enough to cause adverse effects on fish and marine mammals. In addition, the intensity, periodicity, and spectra of emitted sounds differ among dredge types and the substrate being dredged. Clamshell dredges have a repetitive sequence of sounds generated by winches, bucket impact with the substrate, closing and opening the bucket, and sounds associated with dumping the dredged material into the barge. The most intense sound impacts are produced during the bucket's impact with the substrate, with peak Sound Pressure Levels (SPLs) of 124 dB being measured 150 meters from the bucket strike location (Dickerson et al. 2001; Reine et al. 2002).

The scientific knowledge of the effects of dredge-generated noise and sound waves on fishes is limited and varies depending on the species. Effects may include behavioral changes, neurological stress, and temporary shifts in hearing thresholds. Studies on the effects of noise on anadromous Pacific coast fishes are primarily related to pile-driving activities. The interagency Fisheries Hydraulic Working Group has established interim criteria for noise impacts from pile driving on fishes. A peak SPL of 206 dB is considered injurious to fishes. Accumulated SPLs of 187 dB for fishes that are greater than 2 grams, and 183 dB for fishes below that weight, are considered to cause temporary shifts in hearing, resulting in temporarily decreased fitness (i.e., reduced foraging success and reduced ability to detect and avoid predators). The NMFS uses 150 dB as the threshold for adverse behavioral effects.

Injury to fish from peak noise (e.g., rupture of swim bladder) is not expected to occur, but behavioral effects (e.g., changes in feeding behavior, fleeing, and startle responses) could occur. All fish, listed or otherwise, would experience the same effects. For reference, commercial shipping vessels present under baseline conditions can produce continuous noise in the range of 180 to 189 dB which exceeds the NFMS thresholds for adverse behavioral effects to fish and marine mammals (Reine and Dickerson 2014).

For marine mammals, the NMFS criteria define exposure to underwater noises from impulse sounds at or above 160 dB Root Mean Square (RMS)[1] and continuous sounds at or above 120 dB as constituting harassment to marine mammals. The NMFS has also determined that noises with SPLs above 180 dB RMS can cause injury to cetaceans (whales, dolphins, and porpoises), and SPLs above 190 dB RMS can cause injury to pinnipeds (seals and sea lions). Marine mammals are highly motile and would likely avoid areas of noise and disturbance from dredging operations.

The construction noise related impacts of the -37 foot MLLW Alternative would generate noise levels and produce behavioral reactions and effects to fish and marine mammals that would be similar to the existing conditions under the No Action Alternative. The -37 foot MLLW Alternative would take place in the Federal

[1] Root-mean-square measures the average noise energy measured over a 35-millisecond period. Note that this is a different type of measurement than the peak sound or sound exposure level used to measure impacts to fish (NOAA 2012).

navigation channels, which already receive regular boat traffic, and have annual maintenance dredging occurring with clamshell dredges, and therefore have high background levels of underwater noise. Therefore, based on the analysis presented above, compared to the NEPA baseline, temporary adverse effects to special status fish or marine mammals from underwater noise would be less than significant during -37 foot MLLW Alternative construction and future maintenance dredging of slightly incrementally deeper channels.

Impact BR-04: Adversely affect special status or commercially or recreationally important marine species through entrainment: All forms of dredging have the potential to incidentally remove organisms from the environment along with the dredged material, a process referred to as entrainment. Mechanical dredging, as would occur under the -37 foot MLLW Alternative, is generally accepted to entrain far fewer fish than hydraulic dredging because little water is removed along with the sediment and it does not involve any suction. However, even a clamshell dredge may remove demersal fish and crustaceans that live in or on the sediment. Entrained fish are likely to suffer mechanical injury or suffocation during dredging, resulting in mortality. Organisms that can survive entrainment, such as small crustaceans, would be transported and released with the dredged material. Such organisms would be lost if the dredged material is disposed of in an upland location or in habitat unsuitable for the species.

The existing work windows include seasonal avoidance of Dungeness crab, Pacific herring, delta smelt, steelhead, coho salmon, and Chinook salmon for dredging conducted in various portions of San Francisco Bay. The work windows have been established to avoid sensitive periods for these species (i.e., migration periods and spawning periods). In the past, dredging schedules have occasionally slipped for logistical or financial reasons, and dredging occurred outside of the existing work window for one or more species. In the event that this should occur in any year covered by this EIS, USACE would initiate an additional consultation process with the appropriate agencies to obtain written authorization to work outside these windows.

Dredging would be conducted in accordance with standard practices including measures to reduce the potential for entrainment. USACE would also implement appropriate measures to minimize impacts to EFH, as detailed in the Agreement on Programmatic EFH Conservation Measures for Maintenance Dredging Conducted Under the LTMS Program (2011).

The following paragraphs address the potential for entrainment-related impacts to occur from the -37 foot MLLW Alternative on special status or commercially or recreationally important marine species potentially present as compared to the NEPA baseline:

Dungeness crab (*Cancer magister*) and Pacific herring. The commercially important Dungeness crab and Pacific herring may occur in the project area and could be entrained during dredging, if work was improperly managed. By complying with the existing work windows and other standard practices intended to reduce the potential for entrainment, effects to Dungeness crab and Pacific herring would be less than significant.

Steelhead and salmon. Steelhead and salmon may occur in the project area. By using mechanical dredges and complying with the existing work windows and other standard practices intended to reduce the potential for entrainment, effects to steelhead and salmon would be less than significant.

Sacramento splittail. Sacramento splittail have been collected during the CDFW FMWT (1 encountered in 2017). By using mechanical dredging and complying with the existing work windows and other standard practices intended to reduce the potential for entrainment, effects to Sacramento splittail would be less than significant.

Pacific and river lamprey. Pacific and river lamprey are anadromous and may occur in the dredge footprint. There currently is no work window approved for Pacific and river lamprey. Although Pacific and river lamprey are likely to occur in the project area, due to their relative abundance and the limited potential for entrainment impacts to occur by using a mechanical dredge, there would be less than significant impacts on these species.

Striped bass. Striped bass individuals are regularly collected during the CDFW FMWT (560 age-0 bass encountered since 2010). Although striped bass are likely to occur in the project area, due to their relative abundance and the limited potential for entrainment impacts to occur by using a mechanical dredge, there would be less than significant impacts on striped bass.

Sacramento perch. Sacramento perch may be extirpated from its native Delta habitat. Since this species is not known to occur in the project area, individuals of this species should not be impacted.

Demersal fish species. Demersal fish species (e.g., Pacific staghorn sculpin and Pacific sanddab [*Citharichthys sordidus*]) which live and feed on and near the bottom, have a higher potential to be entrained with the sediment. Although some of these fish may be entrained, these are not special status species. The minimal mortality anticipated from these bottom species, if any, would have no significant effect on their population numbers or species survival. Therefore, there would be a less than significant impact of these species.

Green sturgeon. There is currently no work window approved for green sturgeon. This species is presumed to be present year round throughout the estuary. Green sturgeon spawn in the Sacramento River which is outside the project area. Although juvenile and adult green sturgeon are expected to be present in the estuary during dredging, it is generally believed they would be motile enough to avoid entrainment. The LTMS agencies are in the process of updating the LTMS Programmatic ESA consultation with the NMFS to include green sturgeon. The updated consultation would satisfy ESA compliance for green sturgeon for USACE's future maintenance dredging under the LTMS program. Therefore, there would be less than significant impacts on green sturgeon.

Delta smelt. Delta smelt have the potential to occur in the portions of the estuary that include the Napa River Channel, San Pablo Bay/Mare Island Straight, and Suisun Bay Channel dredge areas during certain seasons. Delta smelt occur in San Pablo Bay in lower numbers than in the Napa River or Suisun Bay. However, they may be present in San Pablo Bay in increased numbers during high water outflow years. Delta smelt are not expected to occur in the other Federal channels.

Due to their small size and fragile nature, any entrained individuals would likely be killed either through physical injury during entrainment or suffocation in the collected dredged material. Because delta smelt typically occur in the upper portion of the water column, entrainment is more likely when dredging in shallow waters (Sweetnam and Stevens 1993). To reduce delta smelt entrainment, the LTMS uses a depth of 10 feet to distinguish between "shallow" and deeper waters when implementing work windows for delta smelt. Furthermore, the agreed-upon LTMS work windows include seasonal avoidance of delta smelt for dredging conducted in various portions of San Francisco Bay. As evidenced by Bay Study and the FMWT data mentioned above, few or no delta smelt are expected to occur within the dredge footprint within the Pinole Shoal and Suisun Bay channels. As discussed, since less than 1 percent of delta smelt have been collected in the dredge footprint in almost 50 years of trawling, there is limited potential for entrainment to occur. Furthermore, the use of mechanical dredging will greatly reduce the likelihood of entrainment. Therefore, there is almost no potential for delta smelt to be entrained in this channel segment, and no impact is anticipated.

Longfin smelt. Longfin smelt have the potential to occur throughout much of the San Francisco Bay estuary, and populations are seasonally concentrated in certain portions of the estuary. The densities of longfin smelt in the estuary are lowest in the fall, when spawning adults have moved upstream and before larval smelt have moved down into the estuary. During the winter and spring months, larval longfin smelt are concentrated in Suisun and San Pablo bays, but are also present in the Central and South bays in lower densities. While juveniles and adults are present throughout the estuary at all times of year, the majority of the population is concentrated in the Suisun, San Pablo, and Central bays, as well as nearshore waters during the summer months.

As evidenced by Bay Study and FMWT data (see **Table 4-18 and Table 4-19**), longfin smelt are likely to occur within the proposed dredge footprints in the Pinole Shoal and Bulls Head Reach channels. Across all years of the Bay Study and FMWT data, as discussed above, over 11 percent of the total longfin smelt were collected in the dredge area. Although longfin smelt are likely to occur in the project area, because of their relative abundance and the limited potential for entrainment impacts by using a mechanical dredge, there would be less than significant impacts on longfin smelt.

Table 4-18. Percent of Longfin Smelt Caught in the Proposed Dredge Footprint in Pinole Shoal During Fall Midwater Trawl and Bay Study 2000-2013 (June 1 to November 3).

Station Number	Total Longfin Smelt Catch	Total Catch at All Stations*	Percent of Total Catch
Fall Midwater Trawl Stations			
306	132	2089	6.32
309	9	2089	0.43
310	181	2089	8.66
321	196	2089	9.38
325	21	2089	1.01
337	4	2089	0.19
338	23	2089	1.1
Bay Study Stations			
325	89	834	10.67
346	145	834	17.39

Source: CDFW 2015a, 2015b.

*Includes all the stations in San Pablo and Suisun bays

Table 4-19. Percent of Longfin Smelt Caught in the Proposed Dredge Footprint in the Suisun Bay Channel During Fall Midwater Trawl and Bay Study 2000-2013 (August 1 to November 30).

Station Number	Total Longfin Smelt Catch	Total Catch at All Stations*	Percent of Total Catch
Fall Midwater Trawl Stations			
407	20	3205	0.62
408	19	3205	0.59
409	87	3205	2.71
410	33	3205	1.03
Bay Study Stations			
432	8	885	2.94

Source: CDFW 2015a, 2015b.

*Includes all the stations in San Pablo and Suisun bays

Impact BR-05: Result in the disturbance of EFH and "Special Aquatic Sites," including eelgrass beds and mudflats: All of the waterbodies in the project area are designated as EFH under one or more FMPs. The programmatic EFH agreement completed in 2011 includes a number of conservation measures that enhance the environmental protectiveness of the LTMS program.

Eelgrass beds and mudflats are considered special aquatic sites and are subject to jurisdiction under Section 404 of the CWA and San Francisco Bay Conservation and Development Commission jurisdiction under Section 66605 of the McAteer-Petris Act. Additionally, eelgrass beds and estuarine areas such as San Francisco Bay are considered special aquatic sites under EFH.

Eelgrass in San Francisco Bay provides spawning habitat for herring and serves as a nursery ground and shelter for juvenile fish, among other functions. Eelgrass has been identified as EFH for various life stages of fish species managed by FMPs. Although eelgrass does exist near the Richmond Inner Harbor Channel and Oakland Inner Harbor, there is no known eelgrass within any of the channel boundaries. Examination of surveys done over the last 15 years indicates that eelgrass has persisted in essentially the same locations and densities around Richmond Harbor (USACE 2012b). Pre- and post-surveys of eelgrass conducted at Oakland Harbor in 2010 and 2011 found an increase in eelgrass habitat area and in the density of existing beds, in comparison with several reference sites (Merkel & Associates 2011, 2012). These results indicate that there does not appear to be any adverse effect to, or decline in, eelgrass habitat resulting from annual maintenance dredging activities at Richmond Harbor and Oakland Harbor. Furthermore, mapping of eelgrass in San Pablo Bay indicates that it occurs almost entirely downbay of Point Pinole (i.e., at the far western end of the proposed project area) and at depths shallower than 6 feet (see Boyer and Wyllie-Echeverria 2010 for a discussion), and so would be unlikely to be affected by project activities.

Mudflats serve as important foraging areas for shorebirds species and provide shallow water habitat for juvenile fish. No loss of mudflat acreage would occur as a result of dredging activities under this alternative. Sensitive habitats (such as marshes and mud flats) that occur in the vicinity of some of the Federal navigation channels (e.g., the Napa River) would not be disturbed.

Dredging to -37 feet would result in a loss of benthic habitat considered EFH for Pacific Groundfish. This would occur due to the removal of sediment and benthic organisms with a clamshell dredge, which is unavoidable. Although essentially all of the effects of the proposed project may be considered temporary, the recolonization of disturbed areas by benthic invertebrates is thought to require several months at a minimum, and may take longer. Other effects such as the creation of noise or turbidity plumes would cease immediately or within minutes or hours of when active dredging stops, and may be avoided or minimized by fish (including prey fishes) exhibiting avoidance behavior.

The disturbance of the soft-bottom habitat and removal of sediment containing benthic invertebrates from dredging may be partially offset through the beneficial reuse of the dredged sediment, which is expected to be used to create 160 acres of wetland habitat and would increase food production in adjacent Bay waters.

Based on the analysis presented above, compared to the NEPA baseline, the -37 Foot MLLW Alternative would result in no impacts tomudflats or eelgrass, but may result in an impact to EFH.

Impact BR-06: Interfere with the movement of resident or migratory fish or wildlife species: Since the -37 Foot MLLW Alternative only involves deepening the existing channel by 2 feet, it would not permanently interfere with the movement of resident or migratory fish or other wildlife species. The extent to which dredging activities could impede migration because of entrainment is discussed in the analyses for ***Impact Criteria BR-04 through BR-06***. The noise and in-water disturbance associated with dredging could cause fish and wildlife species to temporarily avoid the immediate dredging or placement area while work is being conducted. However, these impacts would be short term and localized. Therefore, compared to the NEPA baseline, the -37 foot MLLW Alternative would have less than significant impacts related to movement of resident or migratory fish or wildlife species. There would be no new impacts to non-aquatic species potentially associated with placement sites, as placement sites have been pre-authorized.

Impact BR-07: Adversely affect special status fish species, including their habitat, as a result of X2 shifts: Previous analyses pertaining to effects of X2 shifts on special status fish species and their critical habitat (CCWD 2010) used a significance criterion based on the shift in X2 for the purposes of evaluating changes in habitat quantity and quality for estuarine species. In their analysis, an upstream change in X2 location within 1 km of baseline conditions was considered to be less than significant for estuarine species. The 1 km X2 criterion used in CCWD's analysis was derived from the criterion applied to the environmental analysis of the Environmental Water Account (U.S. Bureau of Reclamation et al. 2003). For purposes of this analysis, the established quantitative threshold as previously applied was considered, as well as other factors.

Because salinity intrusion generally increases with water depth, incrementally deepening the existing channel 2 additional feet below the -37 foot MLLW Alternative could potentially lead to increased salt intrusion which would result in an increase in X2. Since an increase in X2 may impact special status fish species, the distribution of which is influenced by salinity levels, a detailed evaluation of the effect of the - 3 7 foot MLLW Alternative was conducted under both wet and critically dry conditions (see **Appendix B, Water Resources-Attachment 1, Salinity Model Report**). The average annual predicted shift in X2 was0.03 km upstream during a critical dry water year and 0.08 km upstream during a wet water year. Estimating X2 from field observations has a measurement uncertainty of at least 0.05 km (see **Appendix B, Water Resources- Attachment 1, Salinity Model Report, page 38**). Since these predicted shifts in X2 are much smaller than the 1 km shift considered to be less than significant, as compared to the NEPA baseline, the shift in X2 resulting from the -37 foot MLLW Alternative would result in less than significant impact to special status fish species through X2 shifts.

FUTURE WITH 38 FOOT ALTERNATIVE

Impact BR-01: Cause increased turbidity that adversely affects special status species or critical habitat: The incrementally greater deepening proposed under the 38 Foot MLLW Alternative would have no additional significant effect on turbidity or turbidity impacts compared to the -37 foot MLLW Alternative. Standard practices intended to minimize increases in turbidity would be implemented, and work would be limited to applicable work windows unless otherwise approved. Therefore, compared to the baseline, impacts on special status species and critical habitat from localized and temporary increases in turbidity would be less than significant.

Impact BR-02: Cause benthic habitat disturbance that adversely affects special status species, critical habitat, or commercially valuable marine species: The incrementally deeper -38 foot MLLW Alternative would have no significant additional disturbance on benthic habitat compared to the -37 foot MLLW Alternative. Although both the -38 foot MLLW Alternative and the -37 foot MLLW Alternative would remove and affect a greater amount of benthic organisms compared to the No Action Alternative, the potential effects of benthic habitat disturbance would remain short term and localized, and standard practices to minimize impacts would be implemented. Therefore, compared to the baseline, impacts on special status species, critical habitat, or commercially valuable marine species from localized and temporary disturbances of benthic habitat would be less than significant.

Impact BR-03: Cause underwater noise that adversely affects special status fish or marine mammals: The incrementally greater deepening proposed under the -38 foot MLLW Alternative may result in a commensurate increase in the duration of construction and associated underwater noise impacts. However, noise levels would be unchanged and behavioral effects of aquatic organisms, if any, would be similar to those effects associated with the -37 foot MLLW Alternative and would be less than significant.

Impact BR-04: Adversely affect special status or commercially or recreationally important marine species through entrainment: The incrementally deeper channel under the -38 foot MLLW Alternative would have no significant incremental entrainment effects compared to the -37 foot MLLW Alternative. Dredging would continue to occur during established construction windows designed to protect special status fish species, unless otherwise approved. Mechanical dredging would be the type of dredge machinery for this project. Similar to the -37 foot MLLW alternative, few or no delta smelt are expected to occur within the -38 foot MLLW Alternative dredge footprint during the proposed construction windows. Therefore, compared to the baseline, the -38 foot MLLW Alternative would result in less than significant impacts to special status and commercially important species resulting from entrainment, and no significant impacts to smelt and demersal species are expected.

Impact BR-05: Result in the disturbance of EFH and “Special Aquatic Sites,” including eelgrass beds and mudflats: The slightly greater deepening proposed under the -38 foot MLLW Alternative compared to the -37 foot MLLW Alternative would have no additional significant effects on mudflats or eelgrass compared to the No Action Alternative. Dredging would continue to occur in accordance with the provisions established through the formal programmatic Federal EFH consultations for the LTMS, and no new areas potentially containing mudflats or eelgrass would be dredged or used to contain dredged material. Therefore, the -38 foot MLLW Alternative would result in no impacts to mudflats or eelgrass.

The bottom ground that would be dredged to -38 feet would result in a loss of 318 acres of benthic habitat that would potentially affect EFH. Those are listed below and described in more detail in the Biological Assessment (**Appendix G – Attachment 4**).

Pacific Groundfish EFH: *Adverse effect* under the Magnuson-Stevens Act "means any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH" (50 CFR § 600.810). The proposed action is *likely to adversely affect EFH for Pacific Groundfish*. This would occur due to the removal of sediment and benthic organisms with a clamshell dredge, which is unavoidable. Although essentially all of the effects of the proposed project may be considered temporary, the recolonization of disturbed areas by benthic invertebrates is thought to require several months at a minimum, and may take years. Other effects such as the creation of noise or turbidity plumes would cease immediately or within minutes or hours of when active dredging stops, and may be avoided or minimized by fish (including prey fishes) exhibiting avoidance behavior.

The disturbance of 318 acres soft-bottom habitat and removal of sediment containing benthic invertebrates from dredging may be partially offset through the beneficial reuse of the dredged sediment, which is expected to be used to create 160 acres of wetland habitat and would increase food production in adjacent Bay waters.

Pacific Salmonid EFH: Potential effects to pacific salmonid EFH are expected to be similar to those discussed under the ESA impacts to listed salmonid habitat and critical habitat (Sections **Error! Reference source not found.** and **Error! Reference source not found.**). As discussed in those sections, the proposed action would temporarily affect estuarine habitat and water quality during dredging. Additionally, salinity intrusion may slightly increase the salt content of water near the eastern portion of the salinity wedge; however, this is not likely to be perceptible to migrating and rearing salmonids transitioning between freshwater and saltwater. Therefore, the proposed action is *not likely to adversely affect Pacific Salmonid EFH*.

Coastal Pelagic EFH: Northern anchovy is one of the most abundant fishes in the San Francisco Bay and an important commercial fish and prey resource other commercial fisheries. During construction, the proposed action has the potential to temporarily increase noise and suspended sediment in the surrounding water column. However, these impacts would be localized and not permanently affect coastal pelagic EFH. Restoration of wetland habitat resulting from beneficial reuse of dredged material would ultimately benefit coastal pelagic EFH by improving the quality and quantity of food resources. Because of the localized and temporary impacts, it is expected that the proposed action is *not likely to adversely affect Coastal Pelagic EFH*.

Impact BR-06: Interfere with the movement of resident or migratory fish or wildlife species: The slightly greater deepening under the -38 foot MLLW Alternative would have no additional significant effects on fish or wildlife migration compared to the -37 foot MLLW Alternative. Entrainment impacts and, by extension migration impacts, would remain minimal as described in the preceding discussions. Behavioral impacts from noise and in-water disturbance associated with dredging would remain short term and localized. No new structures that might impede fish or wildlife movement would be constructed. Therefore, the -38 foot MLLW Alternative would result in less than significant impacts related to movement of resident or migratory fish or wildlife species as compared to the baseline.

Impact BR-07: Adversely affect special status fish species, including their habitat, as a result of X2 shifts: The -38 foot MLLW Alternative represents a slight incremental increase over the previous -37 foot MLLW Alternative and a 3 foot incremental increase over the No Action Alternative of a -35 foot MLLW channel depth. The analysis contained in **Appendix B- Attachment 1** and discussed in Water Quality and Hydrology**,** also evaluated the effect of the -38 foot MLLW Alternative under both wet and critically dry conditions. Based on this analysis, the average annual predicted shift in X2 for the -38 foot MLLW Alternative was 0.11 km upstream during a critical water year and 0.2 km upstream during a wet water year. Since these predicted shifts in X2 are much smaller than the 1 km shift considered to be less than significant, the shift in X2 resulting from the -38 Foot MLLW Alternative would result in less than significant impacts to special status fish species with distributions determined by salinity levels.

FUTURE WITH -38 FOOT ALTERNATIVE + SEDIMENT TRAP AND ROCK OUTCROP

The addition of the sediment trap and removal of the rock outcrop to the -38 foot MLLW alternative would have the potential to further impact X2 and increase noise impacts, respectively. Therefore, BR-03 and BR-07 are further discussed within this section. Impacts to BR-01, BR-02, BR-04, BR-05, and BR-06 result in similar effects to the -38 foot Alternative.

Impact BR-03: Cause underwater noise that adversely affects special status fish or marine mammals: Noise effects on fish from the removal of the rock outcrop are discussed in detail in the BA, and are not likely to adversely affect special status species (**Appendix G- Attachment 4).** No effects to fish habitat are anticipated because the rock outcrop currently does not protrude above the bottom substrate.

Noise effects from removal of the rock outcrop on marine mammals may include complex changes in behavior or hearing loss which may easily be linked to reduced fitness. Specific impacts may include changes in breeding, feeding, or predator-avoidance behaviors; changes in migration routes, dive times, or swimming speeds; changes in mating call frequency or duration; habitat avoidance; etc. (Erbe 2012; Johnson and Tyack 2003; NMFS 2018; Wursig et al. 1998). Impacts may be species specific (NMFS 2018).

Two pinniped marine mammal species may occur in the project area, California sea lion (*Zalophus californianus*) and harbor seal (*Phoca vitulina*). The SPL of 132 dB produced by removal of the rock outcrop and discussed in the BA (**Appendix G- Attachment 4**) is well under NMFS's threshold of 190 dB rms for assessing auditory impacts to pinnipeds (NMFS 2018).

NMFS (2018) provides new guidance for assessing noise impacts to marine mammals. The associated new methodology focuses on identifying temporary threshold shifts (TTS) and permanent threshold shifts (PTS) that may be induced by anthropogenic noise. Also, marine mammals are categorized according to their hearing abilities to account for species-specific differences. The California sea lion and harbor seal fall into different categories based on their taxonomic families (i.e., *Otariidae* and *Phocidae*, respectively). Specifically, harbor seals are expected to have an extended range of hearing compared to California sea lions, and also are better adapted to underwater hearing and presumably more vulnerable to noise impacts.

The new TTS and PTS thresholds are based on measurements of peak sound pressure level (PK) and cumulative sound exposure level (SEL cum). Using NMFS's companion spreadsheet tool (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance), the noise impacts of the project (i.e., PTS SEL cum isopleth to threshold [meters]; NMFS 2018) were determined to be 0 and hence well under the more conservative threshold of 185 meters for phocid pinnipeds. The second measurement of noise impacts (i.e., PTS PK isopleth to threshold (meters); NMFS 2018) generated an "NA" result compared to the 218 meter PK threshold for phocid pinnipeds. Results were the same whether dB rms values were used for noise 50 feet or 400 feet from the source. In summary, noise impacts from the proposed removal of the rock outcrop are not likely to adversely affect California sea lion or harbor seal.

The rock outcrop is located just outside of the Federal navigation channels, but within the shipping channel of Pinole Shoal, which already experience regular boat traffic producing high background levels of underwater noise. Therefore, compared to the baseline, temporary adverse effects to special status fish and marine mammals from underwater noise would be less than significant.

Impact BR-07: Adversely affect special status fish species, including their habitat, as a result of X2 shifts: With the inclusion of the sediment trap, the average annual predicted shift in X2 was 0.17 km upstream during a critical dry water year and 0.27 km upstream during a wet water year (see **Appendix B, Water Resources- Attachment 1, Salinity Model Report**). Since these predicted shifts in X2 are much smaller than the 1 km shift considered to be less than significant, as compared to the baseline, the shift in X2 resulting from the -38 Foot MLLW Alternative + Sediment Trap and Rock Outcrop would result in a less than significant impact to special status fish species through X2 shifts.

4.1.7 LAND USE AND PLANNING

Project components were evaluated with regard to consistency with Federal, state, and local plans, policies, and regulations pertaining to land use. Land use was also evaluated for compatibility of the alternatives with county General Plans and physical division of existing communities.

An alternative would be considered to have a significant impact if it would cause the following:
Impact LU-01: Introduce land uses or activities incompatible with existing or adjacent land uses.

NO ACTION ALTERNATIVE

LU-01: Introduce land uses or activities incompatible with existing or adjacent land uses: Under the No Action Alternative land uses would remain the same as they currently exist at both the dredging and placement sites. There would be no introduction of new land uses or activities incompatible with existing or adjacent land uses. Therefore, no land use impacts would occur under the No Action Alternative.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

LU-01: Introduce land uses or activities incompatible with existing or adjacent land uses: Under this alternative there would be no introduction of new land uses. Expected dredging activities and use of placement sites would be consistent with designated land uses. Dredging equipment would be temporarily present in areas used for commercial navigation and recreational boating. This may result in an ongoing and/or temporary condition, but considered as an insignificant impact since there would be no new land uses or activities introduced. Consequently, impacts to land use would be less than significant.

4.1.8 MINERAL RESOURCES

The analysis of potential impacts to mineral resources included review and evaluation of maps, reports and other relevant data for mineral resources in the study area. Known deposits of mineral resources that may be impacted were evaluated for their relative importance in a regional as well as national context. To ascertain the compatibility of the alternatives with county General Plans, the proposed alternatives were compared to the mineral conservation goals and policies identified in the General Plans.

An alternative would be considered to have a significant impact if it would cause the following:

Impact MIN-01: Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State, or a locally important mineral resource recovery site delineated in a county General Plan, specific plan, or other land use plan.

NO ACTION ALTERNATIVE

Impact MIN-1: Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated in a county General Plan, specific plan, or other land use plan: Under the No Action Alternative, activities associated with the proposed channel deepening would not occur. There would be no change in the existing maintenance dredging and placement of dredged material practices and no change in use of the proposed placement sites. Therefore, no impacts to mineral resources would occur.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact MIN-1: Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated in a county General Plan, specific plan, or other land use plan: Under these alternatives, dredging activities would occur entirely within the existing alignment of the channel and dredged material placement during construction would occur at established beneficial use sites. Subsequent maintenance of the deepened channel would follow current practices used for the existing channel. The areas identified for channel dredging would not overlap with areas identified for in-water mining of sand in the bays or in the Delta. There would also be no change to land uses as a result of this alternative and there would be no change in availability or access to mineral resources in the area. As such, no impacts to mineral resources would occur under this alternative.

4.1.9 AGRICULTURE

The California Agricultural Land Evaluation and Site Assessment Model (CDC 1997) provides an accepted methodology to assess the effects of proposed projects on agricultural resources. The Model determines a proposed activity's projected impact on the adequacy of soils for agriculture. However, the Model does not readily apply in the case of navigation channels. If the Model were used, the maximum impact score would be far below the threshold score required for a determination of significant impact. Rather than use the Model, for this analysis, the impacts to agricultural resources are evaluated based on a qualitative assessment of potential effects of construction, operation and maintenance activities conducted for the alternatives considered. This evaluation considers possible effects to soils and irrigation systems, changes in vulnerability to drought, and induced land use changes.

Any alternative would be considered to have a significant impact on the agricultural resources in the affected area if the alternative would:

Impact AG-01: Degrade the quality, or agricultural productivity, of Important Farmland or farm resources (including irrigation water systems, levees, drainage systems), or directly or indirectly cause lands presently in agricultural production (including Important Farmland) to convert to non-agricultural uses.

NO ACTION ALTERNATIVE

Impact AG-01: Degrade the quality, or agricultural productivity, of Important Farmland or farm resources (including irrigation water systems, levees, drainage systems), or directly or indirectly cause lands

presently in agricultural production (including Important Farmland) to convert to non-agricultural uses: Under the No Action Alternative, activities associated with proposed deepening of the existing channel would not occur. There would be no change in the existing maintenance dredging and placement of dredged material practices, and no change in use of the proposed placement sites. Therefore, no impacts to agricultural resources would occur under the No Action Alternative.

However, even in the absence of Federal action to deepen the shipping channels, agricultural lands in the study area and region are impacted by a variety of factors, many of which threaten the viability of farmlands in the future. Among the threats is increasing urbanization and other developmental pressures over the next 50 years that could result in the conversion of some marginal farmlands to more intensive land uses. Aside from the potential of direct farmland conversion, other future threats to agriculture in the study area include drought, salinity intrusion, soil subsidence, and sea level rise, none of which are influenced by the continued maintenance of the existing -35 feet navigation channel.

Future extended droughts are likely to continue to periodically occur, affecting the study area and a large portion of California. Such droughts will reduce the availability of irrigation water. The more extreme drought events may also allow higher salinity waters from the San Francisco Bay system to extend farther upstream into the Delta, creating temporary problems for irrigation users in the most downstream reaches of the lower Delta. Salinity intrusion is already a water supply management issue affecting the use and management of Delta agricultural lands. A variety of existing factors interact to influence salinity levels in the Delta waterways and groundwater. Major factors include:

- Flows from the San Joaquin and Sacramento Rivers
- Tidal fluctuations and exchanges from San Francisco Bay
- Levees originally built to reclaim tidal wetlands for agricultural uses
- Sub-surface agricultural irrigation and drainage systems
- Subsidence due to oxidation of peat soils behind levees
- Operation by the Central Valley Project and the State Water Project of large water supply intakes in the south Delta
- Releases of freshwater from the Delta Cross Channel, New Melones Dam and other similar facilities, and
- Temporary salinity barriers

These factors, which are unrelated to maintenance of the existing -35 feet channel, are anticipated to continue contributing, in varying degrees, to the existing salinity intrusion problems in the Delta.

Projected sea level rise will likely contribute to the existing salinity intrusion problem in the future, which would adversely affect agricultural activities and production within the Delta. Sea level rise would make Delta waters too saline for irrigation use, groundwater could become too saline, or the water table could become elevated. The result would be that lands currently in agricultural production may become unusable for current crops and could be converted to other land uses.

Soil subsidence has the potential to undermine the structural integrity of the levees that protect farmlands in areas influenced by seasonal flooding, in addition to reducing the subsurface distance between the root zone and the ambient water table.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact AG-01: Degrade the quality, or agricultural productivity, of Important Farmland or farm resources (including irrigation water systems, levees, drainage systems), or directly or indirectly cause lands presently in agricultural production (including Important Farmland) to convert to non-agricultural uses: The -37 foot and -38 foot MLLW Alternatives would have no significant adverse impacts on agricultural resources because they would not directly or indirectly contribute to the conversion of farmland to non-agricultural uses and would not contribute to increased salinity intrusion into the Delta (see ***Section 4.1.3 Water Quality and Hydrology***).

The environmental effects, both in the short-term and the long-term, are very similar to the impacts projected for the No Action Alternative. The principal difference between these two alternatives is that new work dredged material removed during to provide the -37 and -38 feet MLLW channel would be placed in established beneficial use sites, none of which contain farmland. All future maintenance dredged materials would continue to be placed in existing approved open-water sites. As a result, neither Alternative would have no significant adverse impact on agricultural resources.

4.1.10 AESTHETICS

The visual character of a project site is typically evaluated with respect to its physical components and an analysis of its compatibility with the land uses of the immediate surrounding areas. Visual impacts are also analyzed through an examination of views and/or viewsheds. Viewshed impacts are typically characterized by the loss and/or obstruction of existing scenic vistas or other major views in the area available to the general public.

The analysis of impacts on aesthetics for the study area included a general comparison of existing conditions to conditions that would result from implementation of the alternatives. Aerial photography, other photographs, land use maps, and topographical data were reviewed to collect data to determine the impacts to the affected environment. Impacts to aesthetic resources were qualitatively evaluated based on the potential for the various alternatives to temporarily or permanently alter or result in the loss of aesthetic resources in the study area. In addition, general construction impacts were assessed within the immediate area of the navigation channels to be dredged. Light and glare impacts were also analyzed by considering the qualitative aesthetic characteristics of the existing nighttime lighting and daytime glare environments on the site and any modifications the proposed alternatives would make to those environments.

An alternative would be considered to have a significant impact if it would cause the following:

> Impact AE-01: Have a substantial adverse effect on a scenic vista or substantially degrade the existing visual character or quality of the site and its surroundings; or
>
> Impact AE-02: Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.

NO ACTION ALTERANTIVE

Impact AE-01: Have a substantial adverse effect on a scenic vista or substantially degrade the existing visual character or quality of the site and its surroundings: The No Action Alternative would result in no additional construction dredging equipment in the various waterways. Annual operations and maintenance dredging would continue to occur within the established work windows for the respective channels. No impacts to scenic vistas would result.

Impact AE-02: Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area: The No Action Alternative results in no additional construction dredging equipment for this project throughout the various waterways. Therefore, no light or glare impacts would result.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact AE-01: Have a substantial adverse effect on a scenic vista or substantially degrade the existing visual character or quality of the site and its surroundings: Construction dredging equipment would be visible to various visual receptors along the project route during the construction phase. As described more fully in the project description, the dredging equipment that would be seen from varying distances would likely include a 26-cubic yard clamshell dredge working in tandem with up to four 2,000 to 5,000 cubic yard capacity scows (depending on the beneficial use site used) and two or three tug boats. It is likely that there would be one scow at the dredge plant and at least one scow in transit to or from the off-loading facility, while one scow would be at the off-loading facility to be unloaded.

During construction, viewers would see a mechanical clamshell dredge and the above identified auxiliary vessels involved in construction activities. Construction would occur throughout the day and night. At night, lighting would be required for the work areas and for navigational aids. It is expected that low-intensity industrial lighting would be used in the work areas.

The views of construction equipment would be from a distance. They would vary depending on the location of the viewing point, and the construction-related aesthetic impacts would be temporary. Viewers of the shipping channel commonly see various shipping operations, including the transport of dredging, industrial and commercial equipment. With the exception of differences in the type of equipment used, construction activities viewed would be similar to those seen in historical and current routine maintenance dredging of the navigation channels within the study area.

The operational phase would result in a similar number of ships traveling along the waterway as occurs during existing conditions. There would likely be fewer oil tankers and other types of ships passing by viewers. This is because a deeper channel would result in fewer tankers filled to a higher capacity, reducing the number of trips required to transport the same tonnage of commodities. In addition, following construction, the type and duration of future channel maintenance dredging activities would continue essentially unchanged from existing operations. Therefore, no adverse impacts to vistas and scenic character are expected to occur during the construction or operation phase.

Impact AE-02: Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area: Construction would occur both day and night, with night lighting being required to illuminate the work areas and be used as navigational aids. These are expected to consist of low-intensity, industrial lighting, which would focus upon the work areas. The views would be temporary and would not result in nighttime glare or permanent changes in the viewshed. No new lights are expected at any of the ports, as existing facilities would continue to serve the shipping needs. No significant impacts to day or nighttime views as a result of additional glare or light would occur.

4.1.11 CULTURAL RESOURCES

The analysis of impacts of the -37 foot, -38 foot, and -38 foot with sediment trap and rock outcrop removal (TSP) on cultural resources and historic properties for the study area was completed through a review of existing databases, reports, and other information sources to determine if any cultural resources exist in the area. A review of CEQA/NEPA documents that previously evaluated impacts of channel dredging and placement practices on cultural resources was also completed, including the EA/EIR addressing maintenance dredging of the Federal navigation channels in San Francisco Bay for the period 2015 through 2024 (USACE and RWQCB 2015). A separate analysis of the impacts on cultural resources for the beneficial use areas at Montezuma Wetlands Project and Cullinan Ranch included the EIR/EIS for Montezuma Wetlands and is ongoing (USACE 1998; USFWS and CDFW 2008).

Pursuant to Section 106 of the National Historic Preservation Act (NHPA) (36 CFR § 800.8), USACE is employing a phased process to identify and evaluate historic properties and assess effects. Once the project has been authorized by Congress and the appropriate funding obligated, ongoing consultation and consideration of effects will occur during PED as the area of potential effects (APE) may be subject to change based on final designs or modifications of project features. Cultural resources assessments will be conducted in areas that have not been previously surveyed with a high potential for containing historic properties. During PED and prior to construction, these surveys and a final determination of effects for any historic properties within the APE will be coordinated with the California State Historic Preservation Officer (SHPO), Native American Tribes, and other consulting parties. Due to the timing of the San Francisco to Stockton Navigation Improvement project, USACE is currently unable to identify and evaluate cultural resources and determine effects of the alternatives on historic properties prior to completion of the EIS. Therefore; pursuant to 54 U.S.C. 306108 and § 800.4(b)(2), UACE is deferring the final identification and evaluation of historic properties until after project approval, additional funding becomes available, and prior to construction by executing a Programmatic Agreement with the California State Historic Preservation Office and the Advisory Council of Historic Preservation, if inclined to participate.

USACE's Dredging Guidance Letter No. 89-01 (USACE 1989) directs USACE to make a reasonable and good faith effort to identify submerged cultural resources that may be affected by project implementation. The review of project documents, the California Historical Resources Information System (CHRIS) database, and historical records has determined that there is a high potential for submerged cultural resources to be present within the APE.

The project does not propose demolition of existing structures or the introduction of features that would be incompatible with the historic setting of the built environment. The placement of dredge material within the Montezuma Wetlands and Cullinan Ranch will assist in the restoration of the landscape to its historical elevations prior to the twentieth-century construction of levees. The effects on the landward side of levees is considered as part of USACE's compliance with Section 106 of the National Historic Preservation Act (NHPA); however, this NEPA analysis only considers the effects of the project on the submerged archaeological resources because previous NEPA studies have been completed on these placement areas. The three shipwreck databases were searched for any known shipwrecks located in the areas that might be affected by the alternatives. The significance of effects was determined based on the presence of a historical resource potentially affected and the type of anticipated impacts.

For the purposes of NEPA, to determine whether cultural resources could be adversely affected, the historical significance and integrity of the resource itself must first be evaluated.

NO ACTION ALTERNATIVE

Impact of CR-01: Cause a substantial adverse effect to a historic property. Under the No Action Alternative, all activities associated with proposed deepening of the existing channel would not occur. There would be no change in the existing maintenance dredging and placement of dredged material practices and no change in use of the proposed placement sites. Therefore, no impacts to historic properties would occur under the No Action Alternative. Since no individual impacts would occur from the No Action Alternative; that alternative would not contribute to any cumulative impacts from other past, present, and reasonably foreseeable future activities that could have substantial adverse impacts on historic properties in the study area.

Evaluation of Impact CR-02: Disturb any human remains, including those interred outside of formal cemeteries. Under the No Action Alternative, activities associated with proposed deepening of the existing channel would not occur. There would be no change in the existing maintenance dredging and placement of dredged material practices and no change in use of the proposed placement sites. Since there would be no additional construction dredging to deepen the existing navigation channel, no human remains, including those interred outside of formal cemeteries should be encountered or disturbed. Therefore, no impacts would occur to human remains. Because the No Action Alternative would not disturb any human remains, including those interred outside of formal cemeteries, continued maintenance and use of the navigation channels would not incrementally contribute to the cumulative effects of other unrelated past, present, and reasonably foreseeable actions within the study area having the potential to adversely affect human remains.

FUTURE WITH -37 FOOT ALTERNATIVE

Impact of CR-01: Cause an adverse effect to a historic property. Under the Future with -37 Foot Alternative, activities associated with proposed deepening of the existing channel have the potential to cause an adverse effect to historic properties, if present. Analysis of CHRIS data shows a previously recorded shipwreck, which is identified as the Baldwin Channel Wreck (P7-002760 and 21-000598), within 500 feet of the Pinole Shoal Channel APE; however, there is some question as to the location of the wreck. The wreck was identified during a USACE sponsored submerged cultural resource survey of portions of proposed Baldwin Channel Navigation improvements (Sullivan and Allan 1996). Sullivan and Allan (1996) tentatively identified the wreck and indicated that portions of the wreck were located within the existing Pinole Shoal Federal Navigation Channel. The wreck site was tentatively identified as the *Sagamore*, a schooner which foundered in 1864. Although this wreck was reported in the vicinity, it could also be one of several other ships that were reported sunk in the area (USACE and RWQCB 2013). The California State Lands Commission (CSLC) database identified 24 shipwrecks that sank near the channel dredging and placement areas, three of which are reported within the APE. The *Harry*, which sank in 1904, and the *Alden Anderson*, a steam screw which sank in 1924, were reportedly lost within what is now the navigation channel. The gas screw *Cavina*, which was reported lost in 1926, was located within 0.25 miles of MWRS (see **Table 2-11*).***

Globally, sea levels began rising at the end of the Late Glacial Maximum (LGM). The present configuration of San Francisco Bay began forming between 15,000 to 18,000 BP, with the inundation of the Sacramento and San Joaquin river valleys (Masters and Aiello 2007). By the end of the Holocene (8000 BP) sea levels were approximately 20 meters below the present-day levels. Locally, these levels may have varied considerably due to tectonic instability in the San Francisco Bay region. In general, this rise resulted in the submergence of prehistoric sites throughout the Bay area. No prehistoric archaeological sites are recorded in the immediate vicinity of the existing navigation channel. However, an early twentieth century map showing the locations of shell mounds sites in the San Francisco Bay region show multiple shell mounds located along the north and south shores of the Carquinez Strait (Nelson 1909). While these sites are located outside the APE, they do indicate that the area was a nexus for prehistoric settlements in the late prehistoric period. Earlier sites can be expected to have been situated on former ridges and hills which were located adjacent to the Pleistocene and Holocene paleochannels. Preliminary analysis of bathymetry data within the APE indicates the possible presence of inundated ridges and islands directly adjacent to the Suisun Bay navigation channel. Some of these areas can be considered to have a moderate to high probability of containing inundated prehistoric sites.

At those locations along the channels where prevailing bottom depths are 35 feet or less MLLW, dredging the channel to -37 feet could disturb a narrow width of existing bottoms paralleling both sides of the existing navigation channel to accommodate a deepened dredging prism. In some instances over-depth dredging may disturb a larger footprint than anticipated. Additionally, sloughing of the channel side slopes may occur over time as the overall channel cross section adjust to the altered sediment conditions. This unavoidable process has a potential to adversely impact any shipwreck or inundated prehistoric site that may be located near the edge of the existing navigation channels. Based on the proximity of 24 known wrecks in the project vicinity, the presence of the Baldwin Channel wreck within the APE, and the presence of several landforms which appear to have a moderate to high probability of containing prehistoric resources it is possible that dredging may cause an adverse change effect to historic properties, if present. Any submerged archaeological site or submerged historic resource that has remained in California State waters for more than 50 years will require evaluation for eligibility for listing on the National Register of Historic Places (NRHP).

Although no previously identified historic properties are located within the APE, the locations of historic shipwrecks that are listed in the CSLC database are imprecise and in some instances inaccurate. Therefore, it is possible that additional unknown shipwrecks and submerged archaeological sites occur within the project APE. Deepening the existing maintained -35 foot MLLW channel segments to -37 feet, has the potential to have adverse impacts to historic properties. Additional archaeological resource investigations will be required as a component of future detailed design studies of this alternative to either confirm the absence of shipwrecks or submerged prehistoric sites within the APE.

Evaluation of Impact CR-02: Disturb any human remains, including those interred outside of formal cemeteries. Under the Future with -37 Foot Alternative there is no evidence of the presence of human remains within the study area. However, activities associated with the proposed deepening of the existing channel have the potential inadvertently disturb human remains with implementation of this alternative. Therefore, the potential to disturb unidentified human remains would be a significant adverse impact. If human remains of Native American origin are discovered during dredging, it would be necessary to comply with state laws relating to the disposition of Native American burials, which fall under the jurisdiction of the Native American Heritage Commission (PRC Section 5097). In addition, pursuant to State law (CEQA Guidelines Section 15064.5, PRC 5097.87, and the Health and Safety Code Section 7050.5) mitigation measure, MM-CR-02 would be implemented if any human remains are discovered.

Globally, sea levels began rising at the end of the Late Glacial Maximum (LGM). The present configuration of San Francisco Bay began forming between 15,000 to 18,000 BP, with the inundation of the Sacramento and San Joaquin river valleys (Masters and Aiello 2007). By the end of the Holocene (8000 BP) sea levels were approximately 20 meters below the present-day levels. Locally, these levels may have varied considerably due to tectonic instability in the San Francisco Bay region. In general, this rise resulted in the submergence of prehistoric sites throughout the Bay area. No prehistoric archaeological sites are recorded in the immediate vicinity of the existing navigation channel. However, an early twentieth century map showing the locations of shell mounds sites in the San Francisco Bay region show multiple shell mounds located along the north and south shores of the Carquinez Strait (Nils 1906). Shell mounds can contain Native American burials. While the mounds identified on the Nils (1906) map are located outside the APE, they do indicate that the area was a nexus for prehistoric settlements in the late prehistoric period. Earlier sites can be expected to have been situated on former ridges and hills which were located adjacent to the Pleistocene and Holocene Paleochannels. Preliminary analysis of bathymetry data within the APE indicates the possible presence of inundated ridges and islands directly adjacent to the Suisun Bay navigation channel. Some of these areas can be considered to have a moderate to high probability of containing inundated prehistoric sites.

At those locations along the channels where prevailing bottom depths are -35 feet or less MLLW, dredging the channel to -37 feet could disturb a narrow width of existing bottoms paralleling both sides of the existing navigation channel to accommodate a deepened dredging prism. In some instances over-depth dredging may disturb a larger footprint than anticipated. Additionally, sloughing of the channel side slopes may occur over time as the overall channel cross section adjust to the altered sediment conditions. This unavoidable process has a potential to adversely impact inundated prehistoric sites or burials that may be located near the edge of the existing navigation channels. Potential impacts to cultural resources from anchoring or spudding during dredging and off-loading operations are possible beyond the limits of the dredging. Any submerged archaeological site or submerged historic resource within the APE more than 50 years will require evaluation for eligibility for listing on the NRHP.

Although no human remains have been identified within the APE submerged terrestrial archaeological sites may occur within the project APE. Deepening the existing maintained -35 foot MLLW channel segments to -37 feet, has the potential to have impact human remains. Additional archaeological resource investigations will be required as a component of future detailed design studies of this alternative to either confirm the absence of submerged prehistoric sites within the APE.

Cultural resources assessments will be conducted in areas that have not been previously surveyed with a high potential for containing historic properties. During PED and prior to construction, these surveys and a final determination of effects for any historic properties within the APE will be coordinated with the California SHPO, Native American Tribes and other consulting parties. Discovery of historic properties may also lead to the development of avoidance, minimization, and/or mitigation plans in consultation with the SHPO. Due to the timing of the San Francisco Navigation Improvement project planning, USACE is currently unable to identify and evaluate cultural resources and determine effects of deepening the channel to -37 feet on historic properties prior to completion of the EIS.

FUTURE WITH -38 FOOT ALTERNATIVE

Under the Future with -38 Foot Alternative, activities associated with proposed deepening of the existing channel have the same potential as those of the -37 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material.

FUTURE WITH -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP

Under the Future with -38 foot MLLW Alternative, sediment trap, and removal of rock outcrop activities associated with proposed alternative have the same potential as those of the -37 foot MLLW Alternative, although they would occur on proportionally larger scales due to the larger volume of dredged material from the inclusion of the sediment trap and rock outcrop removal. In addition, the analysis of CHRIS) data shows that a previously recorded shipwreck, which is identified as the Baldwin Channel Wreck (P7-002760 and 21-000598), is located within the rock outcrop APE; however, there is some question as to the location of the wreck. A submerged cultural resource survey of this site will be required to provide an accurate location of this resource. If this site is identified within the APE a diver identification and evaluation survey will be required to assist USACE determine the eligibility of the site for listing on the NRHP.

If an archaeological resource cannot be avoided, the Project archaeologist shall consult with the appropriate agencies and tribes as described within the Programmatic Agreement to resolve adverse effects to a potential historic property. USACE shall evaluate the potential of the resource to meet the criterion for eligibility for listing on the NRHP and CRHR. USACE shall complete a determination of effects Report, which shall be submitted to USACE for review upon completion.

4.1.12 ENVIRONMENTAL JUSTICE AND COMMUNITY EFFECTS

The methodology for conducting the environmental justice (EJ) impact analysis included review of the impact conclusions presented in Chapter 4 of this report for each of the environmental resource categories considered. An EJ analysis was accomplished to determine if minority populations or low-income populations could experience disproportionately high and adverse effects where the following effect scenarios were identified: (1) significant impacts would occur to a specific environmental resource; (2) could contribute to a cumulatively significant impact on a study area resource when considered in combination with other projects; and/or (3) impacts are judged to be high and adverse, even if not significant.

Potential EJ impacts were analyzed through the following ordered process:

1. Identify types of impacts that may occur,
2. Describe the portion of the study area in which impacts may occur,
3. Identify potentially affected populations, and
4. Determine whether environmental impacts are disproportionate to low-income or minority populations.
5. To determine whether impacts are disproportionate, the APE was compared to surrounding geographic entities to determine if it contains disproportionately low-income or minority populations. The results were compared to the impact analyses from other resource categories to determine the likelihood of disproportionate impacts to low-income or minority populations.

An alternative would be considered to have a significant EJ impact if it would cause the following:
Impact EJ-01: Disproportionate environmental effects to communities within the APE when compared to surrounding areas.

NO ACTION ALTERNATIVE

Impact EJ-01: Disproportionately disrupt economic vitality or community cohesion: No significant impacts compared to the No Action Alternative would result from increased ship calls in the future. Any operational air quality impact would be equally borne by all populations. Therefore, there would be no disproportionate impacts to the communities within the APE compared to surrounding areas under the No Action Alternative.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact EJ-01: Disproportionately disrupt economic vitality or community cohesion: No significant impacts compared to the No Action Alternative would result from increased ship calls in the future. Any operational air quality impact would be equally borne by all populations. Therefore, there would be no disproportionate impacts to the communities within the APE compared to surrounding areas under the No Action Alternative.

4.1.13 NAVIGATION, TRANSPORTATION, AND CIRCULATION

Impacts on navigation, transportation and circulation were assessed by determining the net increase in vessel traffic resulting from both phases of the study compared to vessel safety, as well as the potential to increase risks to vessel traffic during both construction and operation. This analysis also examined the potential changes in maintenance dredging requirements as a result of channel deepening. As discussed previously, deepening will primarily affect crude oil tankers.

An alternative would be considered to have a significant impact if it would cause the following:

> Impact NT-01: Change vessel traffic patterns, resulting in unplanned or regularly occurring delays, adverse change in freedom of movement, increase safety risks, or introduction of safety hazards

Based on the environmental setting of the study area and the characteristics of the alternatives under evaluation, there would be no adverse impacts to the navigation, transportation, and circulation topics described below; therefore, they are not discussed further in this section:

- **Increase land-based traffic on roadways, railways, and recreational pathways**. The alternatives would not affect roadways, railways, and recreational pathways on land.
- **Increase roadway and rail traffic due to changes in bridge operations.** Roadway traffic in the study area is not affected by vessel traffic because existing roadway bridges are all of fixed height. Rail traffic is not expected to be affected because vessel traffic would be reduced under the alternatives.

NO ACTION ALTERNATIVE

Impact NT-1: Change vessel traffic patterns, resulting in unplanned or regularly occurring delays, adverse change in freedom of movement, increase in safety risks, or introduction of a safety hazards: The No Action Alternative represents the current and future conditions assuming channel deepening does not take place. No construction would occur, so there would be no temporary impacts to vessel traffic patterns as a result of construction activities under the No Action Alternative.

Because the primary impacts to marine navigation are expected to be borne by tankers carrying petroleum products, projections about changes in petroleum shipping and the effect on the vessel fleet mix are used to determine the vessel traffic and commodity movements with the No Action Alternative. Both imports and exports of petroleum products are expected to increase modestly based on global economic conditions with or without channel deepening. **Table 4-20** shows projected changes in commodity imports and exports under the No Action Alternative (see **Appendix D, Economic Analysis**).

Table 4-20. Commodity Forecast for No Action Alternative (Metric Tons).

Commodity	Forecast		
	2020	2030	2040
Total Crude Imports	7,736,000	7,892,000	8,052,000
Total Petroleum Exports	2,311,074	2,930,000	3,714,000

The commodities identified in **Table 4-20** would move through the project area in a mix of vessels. Under the No Action Alternative, the number of larger Aframax and Suezmax vessels is forecasted to remain the same through 2040 (approximately 50 and 30, respectively). The number of Panamax vessels are projected to increase modestly from approximately 125 in 2020 to 175 in 2040.

Recreational vessel traffic would continue throughout the study area under the No Action Alternative. No forecasts are available for recreational traffic, but it would be expected to change proportionally with population in the Bay Area. According to the Plan Bay Area 2040, a joint planning document, the population of the nine-county San Francisco Bay area is projected to increase by 29 percent by 2040 (ABAG and MTC 2013). Therefore, a corresponding increase in recreational vessel traffic could be expected. However, recreational traffic is separated from commercial traffic under the governing international and inland rules of navigation, so changes affecting large commercial vessels would not be expected to affect recreational traffic.

Under the No Action Alternative, the existing maintenance dredging program would continue as it has historically occurred throughout the study area. The manner in which the existing 35 foot MLLW channel is maintained has been determined to have negligible effect on marine navigation (USACE 2014a).
Based on the above analysis, the No Action Alternative would have no impact on the vessel traffic patterns, safety risks, safety hazards, freedom of movement or safety issues for either commercial or recreational vessels.

FUTURE WITH -37 FOOT ALTERNATIVE

Impact NT-1: Change vessel traffic patterns, resulting in unplanned or regularly occurring delays, adverse change in freedom of movement, increase in safety risks, or introduction of a safety hazards: Appendix D, Economic Analysis projects that the volume of petroleum products (which are the dominant cargo in the project area) will grow at the same rate whether the proposed project is implemented or not. However, the vessel mix is projected to change if deepening is implemented. Specifically, additional cargo volume would be accommodated by vessels under 35,000 DWT, the main class of vessels that would benefit from the deepening. However, there would not necessarily be an increase in the number of vessels because they could travel more fully loaded in a deeper channel. The predicted increase in petroleum product volumes is expected to ship primarily in vessels of the Panamax medium class. The deeper channel depth would allow those vessels to avoid some of the costly operational strategies currently in use, making them a more efficient option than the larger vessels.

Table 4-21 shows the predicted maximum traffic volumes of bulk tankers in the project area (see **Appendix D, Economic Analysis**). Compared to the No Action Alternative, the number of vessels transiting this area may actually decrease under the -37 foot MLLW alternative. Because no increases in traffic are expected and traffic will continue to be controlled by Vessel Traffic Services implementing Federal and state rules of navigation, no adverse impacts are likely to commercial shipping, freedom of movement, and/or safety associated with operations with the -37 foot MLLW Alternative compared to the baseline.

Table 4-21. Bulk Vessel Fleet Volume Forecast.

Vessel Type	**No Action Alternative**			**-37 Foot MLLW Alternative**			**-38 Foot MLLW Alternative**		
	2020	**2030**	**2040**	**2020**	**2030**	**2040**	**2020**	**2030**	**2040**
Panamax	125	150	175	116	141	169	113	136	165
Aframax	50	50	50	56	56	56	56	56	56
Suezmax	30	30	30	33	33	33	33	33	33
Total	**205**	**230**	**255**	**205**	**230**	**258**	**202**	**225**	**254**

Recreational traffic is separated from commercial traffic under governing international and inland rules of navigation, so changes affecting large commercial vessels are not expected to affect recreational traffic.

Dredged material from construction deepening would be placed at existing beneficial reuse sites which have all permits. Use of these sites would result in short-term increases in tug and barge movement. These effects would be limited to the year that it could take to deepen the channel if work is performed during only the established work window that spans June 1 to November 30 in San Pablo Bay and August 1 through November 30 in Bulls Head Reach. After construction is complete, regular maintenance dredging would continue to be conducted on an annual basis in the project area. Maintenance dredging would essentially resemble that now performed with the existing 35 foot channel and would continue to have a negligible impact on marine navigation. All dredging equipment would be required to comply with local safety requirements including publication of construction announcements in the USCG Local Notice to Mariners. Thus, impacts would be temporary and less than significant.

FUTURE WITH 38 FOOT AND 38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact NT-1: Change vessel traffic patterns, resulting in unplanned or regularly occurring delays, adverse change in freedom of movement, increase in safety risks, or introduction of a safety hazards: According to **Appendix D, Economic Analysis**, the -38 foot MLLW Alternative would result in a slight decrease in commercial vessel traffic compared to the -37 foot MLLW Alterative and the No Action Alternative. This reduction is forecast because vessels under 35,000 DWT (e.g., Panamax medium class vessels) would be able to travel the channel more fully loaded, avoiding some currently used operational strategies such as lightering and tidal delay. Because of this projected reduction in the number of vessels, no adverse impacts are expected to commercial shipping or recreational vessel traffic.

Impacts under the -38 foot MLLW Alternative would be similar in nature to those that would occur under the -37 foot MLLW Alternative. The removal of the rock outcrop would reduce the safety risk to vessels traversing the shipping channel. Therefore, impacts would be temporary and less than significant.

4.1.14 NOISE

The analysis of noise includes a general comparison of existing noise conditions to potential noise levels during the construction. The U.S. Federal Transit Administration guidelines for assessment of noise impacts for construction activities provide commonly accepted thresholds for construction noise impacts to residential and industrial areas. These thresholds were adopted as significance thresholds for this analysis.

Impact NOI-01: Result in a 90 dBA equivalent continuous sound level over a 1-hour period in a residential or public park area or a 100 dBA equivalent continuous sound level over a 1-hour period in an industrial area.

NO ACTION ALTERNATIVE

Impact NOI-01: Result in a 90 dBA equivalent continuous sound level over a 1-hour period in a residential or public park area or a 100 dBA equivalent continuous sound level over a 1-hour period in an industrial area: The No Action Alternative would not result in any construction dredging activities to deepen the various channel segments and would not result in the off-loading of dredged soils. Annual operations and maintenance dredging would continue to occur within the established work windows for the respective channels. Noise impacts from annual maintenance dredging were analyzed for the period 2015-2024 in the San Francisco Bay Federal Channels Maintenance and Operations EA/EIR (USACE and RWQCB 2015) and found to be less than significant.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact NOI-01: Result in a 90 dBA equivalent continuous sound level over a 1-hour period in a residential or public park area or a 100 dBA equivalent continuous sound level over a 1-hour period in an industrial area: The effects of the -37 foot MLLW Alternative on noise would be similar to the No Action Alternative, although the timeframe within which higher noise levels would be generated would be extended because of the larger quantities of sediments that would be dredged during initial construction. However, subsequent noise generated during routine maintenance would be essentially the same as that associated with the No Action Alternative. Thus, noise impacts that would be produced by this alternative along the open water route of the navigation channels would be less than significant.

At the placement sites, sensitive receptors could include recreational users and non-motorized boaters. While the noise level in the immediate vicinity of the tug (within approximately 400 feet) may periodically exceed the applicable noise threshold, the presence of tugs at the off-loader would be episodic, and of limited duration. In addition, there is extensive availability of alternative recreation locations and recreational users and non-motorized boat users have ample opportunities for recreational activities in areas away from the off-loading location. Therefore, impacts to sensitive receptors at the placement sites would be less than significant. The potential impacts to wildlife from the proposed project due to noise is discussed in Biological Resources as well as **Appendix G- Attachment 4, Biological Assessment**.

4.1.15 PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS

Potential impacts to the study area from hazardous releases or storage of such materials were analyzed using a qualitative approach based on information compiled from known hazardous materials sites and current operations within the study area. This analysis considered changes or impacts to these conditions that may occur as a result of implementing navigation improvements. Potential impacts were analyzed using professional expertise and judgment in evaluating how construction and operational activities could impact known hazardous material sites and existing operations and potentially cause hazardous releases or exposure of individuals to hazards.

Alternatives are considered to have a significant impact if implementation or operations activities would:

- Impact PH-01: Occur on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a significant hazard to the public or the environment; or
- Impact PH-02: Create a significant hazard to the public or the environment by disrupting the routine transport, use, or placement or storage of hazardous materials or wastes; or
- Impact PH-03: Impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan.

NO ACTION ALTERNATIVE

Impact PH-01: Occur on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a significant hazard to the public or the environment: Although two existing hazardous sites may overlap with the No Action Alternative maintenance dredging footprint, impacts to those hazardous sites would be avoided by coordinating ongoing maintenance dredging and placement operations with any active cleanup activities. This includes existing or future cleanup efforts at the U.S. Army MOTCO MRS 8 and MRS 10 sites or at hazardous materials sites in the shoreline or nearshore areas. There is no pathway for existing dredging or placement practices to impact other listed hazardous sites. Therefore, the No Action Alternative would have no impact related to hazardous material sites.

PH-02: Create a significant hazard to the public or the environment by disrupting the routine transport, use, disposal, or storage of hazardous materials or wastes: Operation and maintenance activities would remain unchanged under the No Action Alternative, and new hazardous material exposure pathways would not be introduced. Therefore, the No Action Alternative would have no impacts to the routine transport, use, disposal or storage of hazardous materials or wastes.

Impact PH-03: Impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan: The No Action Alternative would not impair implementation or interfere with any emergency response or evacuation plans. In the event of an emergency, dredge equipment would be removed from the channel or positioned in such a manner as to not impede the navigation of emergency response or evacuation vessels. Maintenance of the existing 35 feet MLLW channel depth would have a long-term beneficial impact by removing shoaled sediment and maintaining the navigability of the Federal channels for use by vessels during emergency response operations. Therefore, the No Action Alternative would have no adverse impacts on emergency plans.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact PH-01: Occur on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a significant hazard to the public or the environment: There are no existing hazardous sites, and existing cleanup or hazardous material enforcement actions at the shoreline or nearshore area would be unaffected by this alternative. The Alternatives would introduce no new uses that would increase exposure to hazardous material sites. Therefore, the Alternatives would have no impacts related to hazardous material sites.

PH-02: Create a significant hazard to the public or the environment by disrupting the routine transport, use, disposal, or storage of hazardous materials or wastes: Under all Alternatives, the channel would be able to accommodate vessels with deeper drafts, allowing vessels to carry heavier loads. This could potentially include increased volumes of hazardous material cargo compared to baseline conditions. This could result in increased hazardous material discharges in the event of a spill or vessel collision. Although the amount of hazardous material cargo may increase in individual vessels, the overall amount of hazardous cargo is not projected to increase (see **Appendix D, Economic Analysis**). Therefore, hazardous cargo shipping demands could potentially be accommodated with fewer vessels carrying greater cargo loads. The economic analyses completed for this alternative predict that the overall number of shipping vessels is projected to remain nearly the same or even decrease slightly compared to the No Action Alternative, and the risk for vessel accidents would not increase. Furthermore, vessel accidents in the project area are rare, as supported by NOAA records. Transport of hazardous materials would continue to occur in compliance with all Federal, state, and local regulations. Hazardous material use associated with vessel operation (e.g., fuels, oils and solvents) would be unchanged from existing conditions and would continue to occur according to established best management practices and in compliance with applicable regulations, as discussed in Water Quality and Hydrology.

In addition, all sediment to be dredged as part of the Alternatives would undergo extensive testing in advance of dredging to ensure that it meets the requirements for beneficial reuse. Based on the analysis presented above, the Alternatives would have no impacts to the routine transport, use or disposal of hazardous materials or wastes and/or hazardous sites.

Impact PH-03: Impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan: Same as No Action Alternative.

4.1.16 RECREATION

Environmental effects on recreational resources were assessed by evaluating the potential for direct interference with recreational activities (e.g., blocking access to a marina entrance) and reduced access to recreational facilities and areas (e.g., through the presence of construction equipment in the waterways). Information was obtained for each county from the Delta Protection Commission's Inventory of Recreational Facilities, County General Plans, and other publically available information on local recreation.

An alternative would be considered to have a significant impact if it would cause the following:

- Impact RE-01: Substantially reduce or restrict the availability or quality of existing recreation opportunities; or
- Impact RE-02: Conflict with Federal, state, and/or local agency regulations and policies regarding recreational resources.

The following recreation topic will not be discussed because there would be no adverse impacts.

RE-02: Conflict with Federal, state, and/or local agency regulations and policies regarding recreational resources. Activities proposed would comply with current Federal, state, and local agency regulations and policies. While it is possible that the cities and counties in the study area could amend regulations specific to recreational resources in their General Plans, it is unlikely that the regulations pertaining to recreational resources would be modified to prohibit dredging or dredged material placement activities in the identified placement sites. Thus, as compared to the baseline conditions, proposed activities should conform with Federal, state, and local agency regulations and policies regarding recreational resources. In addition, the alternatives would not be anticipated to contribute incrementally to any cumulative adverse effects on such regulations and policies when considered in combination with other activities within the study area.

NO ACTION ALTERNATIVE

Impact RE-01: Substantially reduce or restrict the availability or quality of existing recreation opportunities: Under the No Action Alternative recreation features would continue to function as they do currently. Any short-term impacts associated with the dredging activities would be inconsequential. Therefore, based on a worst case analysis, existing recreation resources and activities could experience occasional, less than significant, adverse impacts during dredging events. Over time, an increase in ship traffic could also have less than significant effects on recreational boat use. Overall, impacts of the No Action Alternative on recreation would be less than significant.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact RE-01: Substantially reduce or restrict the availability or quality of existing recreation opportunities: The proposed dredging and placement activities under this alternative would not create a demand for new recreational facilities and would not result in increased use or deterioration of existing recreational facilities. Dredging would create a long-term beneficial impact for watercraft by ensuring safe navigation. However, these benefits would be less than significant.

Construction activities under this alternative may occasionally delay or temporarily impede recreational watercraft during dredging and placement activities. However, in most locations, there would be sufficient room for recreational vessels to maneuver around the dredge equipment, and therefore, impacts from dredging activities are expected to be negligible. Compared to the baseline conditions, there would be short-term impacts to the use, quality, and availability of recreational opportunities due to the presence of construction equipment. However, these types of activities are typical and impacts would be less than significant.

4.1.17 SOCIO-ECONOMICS

NEPA does not provide specific thresholds of significance for socioeconomic impact assessment. Significance is understood to vary depending on the setting of the proposed action (40 CFR 1508.27[a]).

For the purposes of this analysis, the effects of the alternatives on socioeconomic factors are considered to be significant if an alternative would result in any of the following socioeconomic impacts:

- Impact SOC-01: Result in a rapid or sizeable shift in population trends or would notably affect regional employment, spending and earning patterns, or community resources in a manner that could not be easily absorbed or accommodated by the economy as a whole.

Measurable and/or prolonged change in local job supply or change in revenue from leading industries. Navigation improvements would provide access to oil terminals and industry in Pittsburg and the Port of Stockton. Dredging of the navigation channels would provide a beneficial socioeconomic impact by maintaining navigability of the channels and access to local ports and harbors critical to maritime commerce and the regional economy.

Dredging and associated construction activities are expected to result in economic benefits related to a small, local increase in jobs. The majority of these jobs would likely be associated with the dredging activities, while a few temporary jobs would also be created at the sediment delivery location if a beneficial reuse site is used. Subsequent shipping operations and maintenance of the channels are not expected to result in a large increase in local employment placing added demands on housing and/or public services.

NO ACTION ALTERNATIVE

Impact SOC-01: Result in a rapid or sizeable shift in population trends or would notably affect regional employment, spending and earning patterns, or community resources in a manner that could not be easily absorbed or accommodated by the economy as a whole: There would be no new dredging activities or new use of the placement sites under the No Action Alternative. The existing deep draft channel dimensions would continue to be maintained, existing activities at facilities called on by commercial vessels would continue, and the number of vessels would increase slightly into the future. Existing beneficial effects of navigation transportation would continue to be enjoyed by local ports and the industries that transport commodities through the ports as well as by the port and industrial workers that depend upon the availability of the existing navigation channels. Thus, there would be no effect on population in the study area as a result of routine maintenance of the existing navigation channels.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact SOC-01: Result in a rapid or sizeable shift in population trends or would notably affect regional employment, spending and earning patterns, or community resources in a manner that could not be easily absorbed or accommodated by the economy as a whole: This alternative would create a small, local, temporary increase in jobs. However, it is expected that all jobs would largely be filled by local workers and there would be no impact on regional employment. Any spending and earning in the local area from the temporary increase in jobs would not have the ability to impact regional spending or earning patterns. Similarly, there would be no additional demand on community resources that could not be accommodated by the economy as a whole. Dredging of the navigation channel would provide a beneficial socioeconomic impact by maintaining navigability of the channels and access to local ports and harbors critical to maritime commerce and the regional economy. There is likely to be increased efficiency in use of the channels from the deepening of the channel for importing and exporting of materials. However, no noticeable change in maritime infrastructure or regional economy associated with this alternative is expected.

4.1.18 UTILITIES AND PUBLIC SERVICE

The significance threshold used in this analysis focuses on impacts that navigation channel deepening could have on buried utility cables, buried pipelines, and/or overhead power transmission lines. Implementation of an alternative would be considered to have a significant impact on the utilities considered if the alternative would:

- UTIL-01: Interfere with operations of, cause damage to, or otherwise disrupt the use of any buried/underwater cable or pipeline, or overhead power transmission line.

NO ACTION ALTERNATIVE

Impact UTIL-01: Interfere with operations of, cause damage to, or otherwise disrupt the use of any buried/underwater cable or pipeline, or overhead power transmission line: In the absence of Federal action to deepen the existing -35 feet MLLW navigation channels, continuation of regular maintenance dredging would have no adverse impacts to buried underwater cables and pipelines, water supply infrastructure, or overhead power transmission lines. Commercial ships would continue to navigate the marked ship channels using the same precautions as at present.

FUTURE WITH -37 FOOT, -38 FOOT, AND -38 FOOT + SEDIMENT TRAP AND ROCK OUTCROP ALTERNATIVES

Impact UTIL-01: Interfere with operations of, cause damage to, or otherwise disrupt the use of any buried/underwater cable or pipeline, or overhead power transmission line: For the alternatives, the utilities that have the potential to be impacted by channel deepening are: (1) the Trans Bay Cable and 2) the Rodeo Sanitary District sewer outfall. The height clearance of the two overhead power transmission lines that cross the channels exceeds the low clearance of some bridges in the study area. That means the transmission lines would not be affected by implementation of either channel deepening alternatives.

The Rodeo sanitary sewer outfall is located in the Carquinez Straight at the edge of the naturally deep channel in between where the Pinole Shoal ends and the Bulls Head Reach begins, and will not be investigated further. Therefore, the only utility that was analyzed to determine effects from the alternatives is the trans-bay cable utility owned by Trans Bay Cable.

The utility survey that was conducted in 2011 provided As-Built drawings from Trans Bay Cable for their 10 inch diameter direct current (DC) transmission line that was constructed in 2010. The As-Built drawings were reviewed and compared with the USACE hydrographic condition survey that was performed at approximately the same period that the trans-bay cable was installed. The drawings indicate that the trans-bay cable crosses the Pinole Shoal in two locations: STA 62+00 and from STA 468+00 to STA 547+11. In both locations, the channel is naturally deeper than the alternative depths. The As-Built drawings indicate the trans-bay cable was buried to a depth that is approximately -32 feet MLLW for both crossing locations. The cable utility does not intersect the other Federal channels in the remainder of the project footprint. Therefore, it has been determined that the trans-bay cable utility will not be impacted by the alternatives.

Figure 4-1 shows that the extent of the area to be dredged does not coincide with the Benicia-Martinez Bridge pipeline and cable crossing area. Similarly, it shows that the alignment of the trans-bay cable does not enter the area to be dredged in the Pinole Shoal Channel.

During design of the channels, consultations will be initiated with all owners and operators of the known buried/underwater cables and pipelines under or near the navigation channels to obtain depth of crossing information and other relevant as-built data.

Implementation of these actions would not impact any utilities.

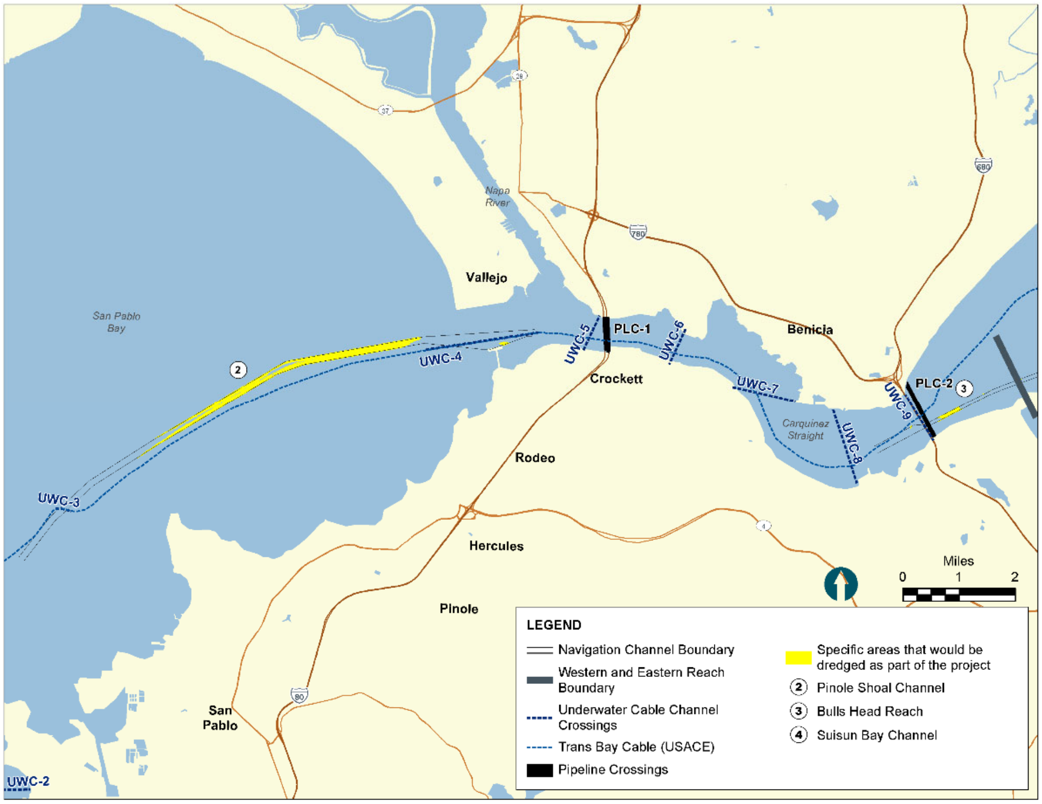


Figure 4-1. Dredged Area and Utility Crossings

4.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The resource commitments needed for the -38 foot MLLW + sediment trap and rock outcrop (TSP) are neither irreversible nor irretrievable, with most impacts being short-term and temporary. The only expected irretrievable resource commitment from is the consumptive use of non-renewable fossil fuels for the operation of dredge, tugs, and related support equipment during construction and future maintenance dredging. There is no other expected commitment of irretrievable resources.

4.3 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The alternatives would not result in any significant and unavoidable adverse environmental impacts. The salinity would shift due to the proposed project, however, it is considered a less than significant effect supported by hydrodynamic modeling (see discussion in **Appendix B, Water Resources - Attachment 1 Salinity Modeling Report and Section 4.1.2 and 4.1.3 of the main report**).

4.4 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

As described in above, the TSP is compatible with Federal, state, and local objectives. The alternatives do not conflict with any stated plans or policies. By facilitating wetland creation through beneficial reuse of dredged sediment, both the -37 foot MLLW and -38 foot MLLW Alternatives are furthering Long-term Management Strategy objectives for managing dredging in the San Francisco Bay Area. Therefore, the alternatives would maintain consistency of future vessel operational emissions in the Bay Area with applicable plans and objectives.

4.5 CONFLICTS AND CONTROVERSY

Extensive coordination undertaken by USACE and the Port of Stockton with Federal, state, and local agencies, water managers, businesses, organizations, and the general public prior to preparation of this report identified the following key issues of known concern and expected controversy:

- Salinity intrusion in the Delta, particularly related to impacts on drinking water and designated critical habitat of the Federal and state listed endangered delta smelt.
- Impacts to threatened and endangered species including longfin smelt, green sturgeon, and salmonids.
- The potential to beneficially use dredged material in existing habitat restoration projects within the study area.
- Effects of sea level rise within the study area.

4.6 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

The TSP is not unique or unusual, and understanding of the resources in the area is thorough. The effects of dredging activities are well understood; USACE has extensive experience evaluating the environmental effects associated with dredging projects. The environmental analysis did not identify any highly uncertain, unique, or unknown risk effects on the human environment which would result from implementing the project.

4.7 CUMULATIVE EFFECTS

EPA requires the consideration of cumulative effects of the proposed action combined with those of other projects. NEPA defines a cumulative effect as an environmental effect that results from the incremental effect of an action when combined with other past, present and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7).

Cumulative effects can result from individually less than significant, but collectively significant, actions taking place over a period of time. Cumulative effects can result in unintended adverse environmental effects despite efforts to mitigate for an individual action’s specific direct and indirect impacts. The purpose of a cumulative impacts analysis is to identify the potential for incremental increased environmental effects caused by a series of actions.

An inherent part of the cumulative effects analysis is the uncertainty surrounding actions that have not yet been fully developed. The CEQ (1997) regulations provide for the inclusion of uncertainties in the EIS analysis, and state that “(w)hen an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking” (40 CFR Part 1502.22). The CEQ regulations do not say that the analysis cannot be performed if the information is lacking. Consequently, the analysis contained in this section includes what could be reasonably anticipated to occur given the uncertainty created by the lack of detailed investigations to support all cause and effect linkages that may be associated with the Proposed Action/TSP.

The cumulative effect analyses include considerations of the past, present, and reasonably foreseeable future actions listed in **Table 4-22**. Potential cumulative effects were evaluated by comparing the effects of the alternatives with those of the actions identified in **Table 4-22**. The analyses do not specifically address each action listed unless the impacts of the alternative under evaluation, combined with those of a specifically identified action could result in a cumulative effect.

Table 4-22 summarizes cumulative effects on the geographic scope by identifying the past, present, and reasonably foreseeable future projects. Resources listed in the table (

Table 4-23) are only the resources that would be expected to potentially have effects in relation to cumulative effects. Resources discussed in Chapter 4, but not listed in the cumulative effects table includes Geology and Seismicity, Air Quality, Mineral Resources, and Agriculture.

Table 4-22. Past, Present, and Reasonably Foreseeable Future Projects.

Project Name	Location	Lead Agency	Summary
Bay-Delta Water Quality Control Plan Update	Sacramento-San Joaquin Delta	State Water Resources Control Board (SWRCB)	SWRCB is updating the plan to modify water quality objectives for the Lower San Joaquin, Stanislaus, Tuolumne, and Merced Rivers, evaluate and potentially amend existing water quality objectives that protect beneficial uses and the program of implementation to achieve those objectives, require changes to water rights and other measures to implement changes from the first two phases, and evaluate and potentially establish water quality criteria and flow objectives that protect beneficial uses on tributaries to the Sacramento River.
Cache Slough Area Restoration	Cache Slough	California Department of Water Resources (CDWR)	Evaluation of restoring areas within the Cache Slough Complex as part of the CDWR and California Department of Fish and Wildlife (CDFW) Fish Restoration Program. The 53,000-acre Cache Slough Complex is located in the northwest corner of the Delta at the downstream end of the Yolo Bypass.
CALFED Bay-Delta Program (CALFED) Levee Stability Program	Sacramento-San Joaquin Delta	USACE	Management of levees to protect agricultural and other resources. Implementation is ongoing.
CALFED Levee System Integrity Program	Sacramento-San Joaquin Delta	CDWR, CDFW, and USACE	Provides for long-term protection of natural resources through maintenance and improvement of the Delta levee system. Goals are to protect life, infrastructure, and properties, and to reduce the risk to land use and associated economic activities, water supply, infrastructure, and ecosystem from catastrophic breaching of Delta levees. Implementation is ongoing.
Calhoun Cut/Lindsey Slough Tidal Habitat Restoration	Cache Slough (Delta)	CDFW	Excavation and placement of fill over 927 acres at the historic Lindsey Slough in the Calhoun Cut Ecological Reserve to reestablish tidal connection to the historic marsh and channel system and enhance existing marsh habitat and associated vernal pools and grassland. Completed in November 2014.

Project Name	Location	Lead Agency	Summary
California EcoRestore	Sacramento-San Joaquin Delta	California National Resources Agency (CNRA)	Initiative to help coordinate and advance at least 30,000 acres of critical habitat restoration in the Sacramento-San Joaquin Delta. Includes implementation of existing mandates for habitat restoration. Planned to occur through 2020.
California Water Action Plan	State-wide	CDWR	Presents the status and trends of California's water-dependent natural resources; water supplies; and agricultural, urban, and environmental water demands for a range of plausible future scenarios. Evaluates different combinations of regional and statewide resource management strategies to reduce water demand, increase water supply, reduce flood risk, improve water quality, and enhance environmental and resource stewardship. Existing plan was initiated in January 2014; plans are revised every 5 years.
California Water Fix	Sacramento / San Joaquin River Basins	CDWR, BOR, CNRA	Project diverts Sacramento River water at Cortland and Clarksburg into twin tunnels that discharge at Clinton Court Bay 40 miles south. Goal is to make more reliable water deliveries to the State Water Project and the Central Valley Project and better meet the environmental flow requirements in the lower San Joaquin Delta. Project EIS has been released for public review in 2017. Expect implementation to begin in 2025 and 10 years to construct.
Chipps Island Tidal Marsh Restoration	Suisun Marsh	Fishery Foundation of California	Returning 750 acres of island to tidal marsh habitat that can be used by estuarine fish for spawning and rearing.
Cullinan Ranch Restoration Project	Solano County	Ducks Unlimited and U.S. Fish and Wildlife Service (USFWS)	Restoration of diked baylands to tidal marsh. Would serve as a beneficial reuse placement site for millions of cubic yards of dredged material. Construction ongoing since 2011.
Decker Island Tidal Habitat Restoration	East Decker Island	CDWR	Acquisition and restoration of approximately 140 acres of tidal wetlands on Decker Island. Includes breaching the island's perimeter levee to restore tidal hydrology to the site. Construction anticipated for completion in 2020.

Project Name	Location	Lead Agency	Summary
Delta Islands and Levees Feasibility Study	Sacramento-San Joaquin Delta	USACE	Restoration of approximately 89.5 acres of lost or degraded tidal marsh habitat in the west/central Delta. Involves transporting and placing dredged material (from annual dredging of the Stockton Deep Water Ship Channel [DWSC] and previously stockpiled dredged material from existing dredged material placement sites) into open water. Draft Feasibility Study and EIS released in April 2014.
Delta Long Term Management Strategy	Sacramento-San Joaquin Delta	USACE	Interagency program focused on the development of a comprehensive, long-term management plan for dredged material management in the Delta to maximize beneficial reuse of dredged sediment and streamline permitting.
Delta Wetlands Projects	Sacramento-San Joaquin Delta	Semitropic Water Storage District	Transformation of two low-lying islands to reservoirs to store 215,000 acre-feet of water, and two other islands into 9,000 acres of protected wetlands and wildlife habitat. Reservoir islands will store available water in winter months for beneficial use during summer months. Final EIR released in 2011.
Dutch Slough Tidal Marsh Restoration	West Delta	CDWR	Seasonal wetland and tidal marsh restoration of 1,166 acres in the western Delta. Final EIR was released in September 2014.
Franks Tract Project	Sacramento-San Joaquin Delta	CDFW and BOR	Evaluation of installing operable gates to reduce seawater intrusion and positively influence movement of fish species to areas that provide favorable habitat conditions in the Delta. Gates would be operated seasonally and during certain hours of the day, depending on fisheries and tidal conditions. Currently on hold.
Hamilton/Bel Marin Keys Wetlands Restoration - Phase III	Marin County	State Coastal Conservancy and USACE	Placement of dredged material to raise elevations, develop wetlands, and to construct additional levees to protect neighboring communities. Implementation of tidal connectivity via levee breaching. Wetlands restoration has already occurred at the Hamilton Airfield.
Hill Slough Tidal Habitat Restoration	Suisun Marsh	CDFW and private partners	Restoration of tidal marsh and enhancement of upland managed wildlife habitat over 1,750 acres. Design consists of breaching levees, lowering levee segments, and other improvements. Road improvements and

Project Name	Location	Lead Agency	Summary
			interior site work will begin in 2018, with all inwater construction work taking place in 2019.
In-Delta Storage Project	Sacramento-San Joaquin Delta	CDWR and BOR	Would provide capacity to store approximately 217,000 acre-feet of water in the south Delta for water supply, water quality, and ecosystem benefits. Project includes two storage islands and two habitat islands. Design is similar to the Delta Wetlands proposal from a decade prior, but would also include new embankment design, consolidated inlet and outlet structures, new project operations, and revised Habitat Management Plans. Suspended since July 2006 due to funding issues.
Liberty Island Conservation Bank	Liberty Island	Wildlands, Inc.	Restoration of 186 acres to mitigate permitted impacts to tidal fisheries habitat throughout the Delta, with a permanent conservation easement and a non-wasting long-term endowment to manage the property in perpetuity. Bank is currently active.
Long Term Water Transfers	State-wide, San Luis and Sacramento-San Joaquin Delta	Mendota Water Authority and BOR	Would facilitate transfer of up to 600,000 acre-feet of water per year from willing sellers north of the Delta to buyers south of the Delta or in the Bay Area over a 10-year period. Transfer methods could include groundwater substitution, reservoir release, cropland idling, crop shifting, and conservation. Final EIS/EIR released in March 2015.
Los Vaqueros Reservoir Expansion Project	Los Vaqueros Reservoir	Contra Costa Water District and BOR	Increased the storage capacity of Los Vaqueros Reservoir and diverted additional water from the Delta intake near Rock Slough for additional storage volume. Originally constructed in 1998 and expanded in 2012 to 160,000 AF. CCWD and BOR currently in process of planned expansion to 275,000 AF (2017 Supplemental EIS, BOR).
Lower San Joaquin Feasibility Study	Sacramento-San Joaquin Delta	USACE	Evaluation of whether there is a Federal interest in providing flood risk management and ecosystem restoration improvements along the Lower San Joaquin River.
Lower Yolo Restoration Project	Cache Slough	Westlands Water District	Restoration of approximately 1,670 acres on a site that has historically been used for pasture/cattle grazing. Currently on hold pending ownership issues; expected completion by the end of 2017.

Project Name	Location	Lead Agency	Summary
Meins Landing Tidal Habitat Restoration	Suisun Marsh	CDWR	Restoration of 666 acres of seasonally managed (non-tidal) marsh in Suisun Marsh, Solano County, to provide a diversity of habitats. Identified as part of the Delta Ecosystem Enhancement Program.
Navigation Improvement from Avon to Stockton	Avon to Stockton – Stockton Deep Water Ship Channel	Port of Stockton	The Port of Stockton may propose to deepen the Stockton Deep Water Ship Channel from Avon to the Port of Stockton in the reasonably foreseeable future. The Port would have to address alternatives and their environmental effects through a separate NEPA and CEQA analysis and obtain approvals and permits from the appropriate resource agencies. The project would be responsible for avoidance, minimization, and mitigation requirements determined to be necessary based on the outcome of the NEPA/CEQA analysis completed for the project. At this time, the project is undefined as to the proposal for navigational depth improvements, as well as timing of proposal.
North Bay Aqueduct Alternative Intake	Sacramento River	CDWR	Construction and operation of an alternate intake that will draw water from the Sacramento River and connect it to the existing North Bay Aqueduct system to provide reliable delivery of water to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. Would operate in conjunction with the existing North Bay Aqueduct intake at Barker Slough. Final EIR anticipated for release in summer 2016.
Ongoing Maintenance Dredging of Port of Stockton Docks	Stockton	Port of Stockton	Annual maintenance dredging is conducted at the Port of Stockton's 19 docks. Authorized depths are -35 feet MLLW at 17 docks and -40 feet MLLW at Docks 12 and 13 to accommodate a sediment trap. Dredged material is typically placed at upland placement sites on Roberts and Rough and Ready islands.
Ongoing Operations and Maintenance Dredging of Federal Navigation Channels	Stockton, Sacramento, and John F. Baldwin DWSCs	USACE	Annual maintenance dredging is conducted throughout the Stockton, Sacramento, and John F. Baldwin DWSCs to maintain existing depths, which range from -30 to -35 feet MLLW. Depending on the channel, dredged material is either placed in-Bay, at the San Francisco Deep Ocean

Project Name	Location	Lead Agency	Summary
			Disposal Site, at separately permitted beneficial reuse sites, or at upland placement sites.
Prospect Island Tidal Habitat Restoration	Cache Slough	CDWR	Restoration of 1,316 acres to freshwater tidal wetland and open water (subtidal) habitats to benefit native fish and improve aquatic ecosystem functions. Includes interior grading, vegetation management, possible clean fill import for subsidence reversal, possible weir installation, and breaching of exterior levees. Draft EIR was released in August 2016.
Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes	Sacramento-San Joaquin Delta	USFWS	Addressing recovery needs for several fish species in the Delta. Recovery actions involve increasing freshwater flows; reducing entrainment losses to water diversions; reducing the effects of dredging, contaminants, and harvesting; developing additional shallow-water habitat, riparian vegetation zones, and tidal marsh; reducing effects of toxic substances from urban non-point sources; reducing the effects of introduced species; and conducting research and monitoring. Released in 1996.
Rush Ranch Tidal Habitat Restoration	Suisun Marsh	Solano Land Trust	Restoration, management, and monitoring of wetlands and other shoreline habitat, including the mouth of Spring Branch Creek. Installation and management of public trails over a 2,070-acre area. Initial Study/Mitigated Negative Declaration was released in 2015.
Sacramento River DWSC Deepening	Sacramento River	USACE and Port of Sacramento	Evaluation of deepening and widening the Sacramento River DWSC to improve transportation efficiencies. Draft EIS/EIR released in 2011. Currently on hold.
San Joaquin River Restoration Program: Salmon Conservation and Research Facility	San Joaquin River	CDFW	Program involves construction and operation of the salmon conservation and research facility, reintroducing and managing Chinook salmon in the restoration area, conducting fisheries research and monitoring in the restoration area, and managing and supporting recreation within the restoration area. Draft Environmental Assessment released in January 2016.

Project Name	Location	Lead Agency	Summary
San Joaquin River Restoration Program	San Joaquin River	San Joaquin River Restoration Program	Comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts. First water releases from Friant Dam began in 2009. Restoration flows began in 2014.
Suisun Marsh Habitat Management, Preservation, and Restoration Plan	Suisun Marsh	CDFW, USFWS, BOR, and Suisun Marsh Charter Group	Completed in 2014, plan balances goals of Bay-Delta Program, Suisun Marsh Preservation Agreement, and Federal and state endangered species programs within the Suisun Marsh. Would provide for simultaneous protection and enhancement of: (1) existing wildlife values in managed wetlands; (2) endangered species; (3) tidal marshes and other ecosystems; and (4) water quality (including maintenance and improvement of levees). Implementation occurring over 30 years.
Tule Red Restoration	Suisun Marsh	Westervelt Ecological Services, Inc.	Will restore over 400 acres of tidal wetlands in the Suisun Marsh. Construction was completed in the fall of 2018.
Upgrade of Facilities to Restore Delta Smelt and Other Native Aquatic Species	Rio Vista	USFWS, BOR, CDWR, and CDFW	Development of a permanent fish restoration facility in Rio Vista as part of the 2009 Interim Federal Action Plan for the Delta and upgrades to the existing facility to serve as an interim restoration propagation facility until the Rio Vista facility is operational.
Upper San Joaquin River Basin Storage Investigation	San Joaquin River	BOR	Investigation considered alternatives for storage of water from the upper San Joaquin River watershed. Goals are improving water supply reliability and operational flexibility in the Central Valley, San Joaquin Valley, and other regions of California, and enhancing water temperature and flow conditions in the San Joaquin River. Draft EIS released in August 2014.

Table 4-23. Cumulative Effects.

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
Sediment and Sedimentation	Continued dredge maintenance and use of the navigation channels will continue but would not incrementally contribute to any cumulative effects on sediment quality within the study area.	Sediment testing has shown low levels of contamination and was determined suitable for in-Bay, wetland, or upland beneficial reuse. All required testing and coordination will be completed prior to construction of the project.	Projects in **Table 4-22** may affect sediment quality within the study area. Any such projects would be required to undergo separate environmental review and to implement avoidance and minimization measures as needed to address such impacts. Therefore, it is therefore anticipated that any present or foreseeable projects would result in less than significant impacts to these water quality parameters.
Water quality and Hydrology	Present conditions would not degrade water quality through alteration of temperature, salinity, pH, and dissolved oxygen/ increased turbidity, or nutrient loading; continued maintenance and use of the navigation channels would not incrementally contribute to any cumulative adverse effects.	The TSP -related shift of X2 of between 0.17 and 0.27 km would not be individually significant and should not contribute to cumulatively significant impacts when considered in combination with other known past, present, or future activities within the study area. This small change in X2 position is likely to intermittently result in relatively small reductions in Delta Export pumping when other export constraints are not controlling. However, these reductions are expected to not be significant and may be partially or wholly mitigated by small increases in export pumping during periods when X2 and other constraints are not limiting.	The less than significant change in X2 position from the TSP is likely to be relatively unaffected in the future due SWP/CVP responses to climate change. The Year 50 analysis shows that due primarily to projected sea level rise, the X2 isohaline will move upstream by a distance of 4 km unless significant changes are made to water management operations. However, despite this large change in X2 due to sea level rise under future baseline conditions the predicted effect of the TSP under these conditions was predicted to be similar to the effect under existing conditions. This suggests that the TSP effects are likely to be relatively unaffected by cumulative changes resulting from other projects in the Delta. The change in X2 is more than 10 times greater than the

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
			predicted change in X2 associated with implementation of this project. This is an indication that the current water management operations and facilities will have to undergo significant change under any scenario if environmental and water quality/supply targets are to be met in the future. The California Water Fix project currently planned for implementation by 2035, is an example of the kind of large-scale infrastructure project needed to ensure delivery of SWP/CVP water and protect the Delta ecosystem. If the Waterfix project or a similar project is implemented, a large fraction of SWP/CVP water will be diverted from Sacramento River water will bypass the Delta. In this case, the less than significant impact of this project on water supply operations could be diminished since Delta export pumping will be less influenced by the X2 position criteria. The depth, timing, and complete project description associated with a navigational deepening project from Avon to the Port of Stockton is currently unknown. In 2016, prior to the reduction in scope for the current TSP, a salinity analysis considering depths ranging from -37 feet to -38 feet was developed. The modeling scenarios to deepen the channel to

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
			-37 and -38 feet showed slightly greater impacts than the TSP. Additional modeling would need to be completed by the project to assess and understand the Avon to Port of Stockton deepening project's impacts and how those impacts would contribute to cumulative effects on water quality and salinity intrusion in conjunction with projects throughout the area. Depending on the proposed project depth (and other project description variables), the potential Avon to Port of Stockton deepening project may result in significant cumulative effects to water quality. Further study is needed. The project would be responsible for environmental documentation and, if necessary, implementing avoidance, minimization, and/or mitigation measures to offset or reduce environmental impacts that would result from channel deepening.
Climate change	Because the existing conditions does not include construction and does not increase ship calls as compared to the NEPA baseline, it would not result in additional GHG emissions. Therefore, the No Action Alternative would not conflict with any applicable plans, policies, or regulations adopted to reduce GHG	GHG emissions are inherently cumulative and any incremental amount of emissions contributes to global warming. No specific cumulative quantitative level of GHG emissions from related projects in the region or state-wide has been identified which no impacts would occur. Therefore, it is conservatively assumed that any additional emissions related to	Current and future projects would incorporate a variety of GHG reduction measures in response to a variety of rules and measures. However, because GHG emissions are inherently cumulative and any incremental amount of emissions contributes to global warming, no specific cumulative quantitative level of GHG emissions from related projects in the region or statewide has been identified

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
	emissions and there would be no impact as compared to the NEPA baseline.	the proposed project would represent a short term cumulative impact.	to which no impacts would occur. Therefore, it is conservatively assumed that the any additional emissions represent a significant cumulative impact.
Biological Resources	Current maintenance dredging would continue to alter the bottom habitat without the proposed project. The maintenance dredging of the current navigation channel for Pinole Shoal is a two year cycle and for Bulls Head Reach a one year cycle.	The proposed project would deepen the existing channel by 3 feet, with maintenance dredging every 2 years. Effects would be similar to the current maintenance dredging operations. The additional 3 feet in Pinole Shoal and 4-5 feet of dredging in Bulls Head Reach would affect delta and longfin smelt habitat (see BA in the Environmental Appendix) by removing some existing habitat along the bottom of Suisan Bay and the side slopes in Pinole Shoal. These impacts are expected to be offset by the use of dredged material at Cullinan Ranch and Montezuma Wetlands, which have both been shown to benefit smelt and other listed species.	The proposed project may result in a cumulative effect in concert with reasonably foreseeable future projects, specifically channel deepening from Avon to the Port of Stockton. Based on the existing 2019 salinity modeling for the TSP and modeling conducted in 2016, effects of deepening from Avon to the Port of Stockton would be greater than the current TSP, depending on the channel depth proposed. Depending on the effect of the deepening the channel to the Port of Stockton on the change in X2, the EIS/ EIR for the Avon to the Port of Stockton project would be responsible for addressing any environmental or biological effects. If the Port of Stockton pursues a deepening from Avon, additional analysis on the X2 position would likely be performed. The Port of Stockton would address any environmental impacts related to their proposed alternatives under a separate NEPA and CEQA analysis and consultation with the appropriate resource agencies.
Land Use and Planning	The No Action would be unchanged from present conditions and does not introduce land uses or activities	Dredging to 38 feet and subsequent maintenance and use of the deepened channel would be very similar to the No	No significant cumulative effects are expected to land use due to implementation of the

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
	that are incompatible with existing land uses within the study area, continued maintenance of the navigation channels would not add incremental impacts to any cumulative land use conflicts that may occur when considered in combination with other actions within the study area.	Action Alternative. The potential for incompatible land use conflicts to occur would be less than significant. As a result, this alternative is not expected to contribute incrementally to land use conflicts that may occur within the study area when considered in combination with other unrelated activities.	proposed action or future actions within the existing navigation channel.
Aesthetics	The No Action Alternative would be unchanged from present conditions and does not impact existing scenic vistas, continued maintenance of the navigation channels would not add any incremental aesthetic issues.	The views of construction equipment would be from a distance, depending on the location of the viewing point, and these views would be temporary. Views of various maritime activities are typical along the route. The proposed project would not result in individual or cumulative impacts to existing scenic vistas and/or visual character when considered in combination with other unrelated activities within the study area.	The proposed project would not result in individual or cumulative impacts to existing scenic vistas and/or visual character when considered in combination with other activities within the study area.
Cultural Resources	Existing conditions would not change due to the maintenance dredging of the existing navigation channels.	The proposed project is not expected to result in significant cumulative impacts to cultural resources.	The proposed project is not expected to result in significant cumulative impacts to cultural resources when considered in combination of other past, present, and reasonably foreseeable impacts in the future.

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
Environmental Justice	The No Action Alternative would not disproportionately affect communities within the APE, continued maintenance and shipping use of the navigation channel would remain the same.	The proposed project would not disproportionately affect communities within the APE. The proposed project is within a current Federal navigation channel that is routinely dredged on a yearly basis.	The proposed project would not result in cumulatively considerable impacts when considered in combination with other past, present, and reasonably foreseeable future activities within the APE, the study area as a whole, and the surrounding 7-county region.
Navigation, Transportation, and Circulation	The No Action Alternative would be unchanged from present and anticipated future conditions, it would not contribute to any cumulative effects related to changes in vessel traffic patterns, unplanned or regularly occurring delays, freedom of movement, increased safety risks, or safety hazards.	Vessel traffic would not increase under the proposed project and traffic would continue to be controlled by Vessel Traffic Services implementing Federal and state rules of navigation.	Numerous types of vessel use occur in the Bay, and increases in these uses over time are expected. Construction or operation of other projects described in Table 4-22 could contribute to a short- or long-term increase in vessel traffic in the Bay. The TSP could contribute to changes in vessel traffic patterns if the SDWSC were deepened by others subsequent to construction. However, unplanned or regularly occurring delays or freedom of movement should not be affected. In addition, the TSP should decrease navigational safety risks/hazards when considered in combination with other past, present, and reasonably foreseeable future activities within the study area.
Noise	Continued maintenance dredging would continue to occur within the navigation channel.	Noise generated by construction activities would have a slightly longer duration in any given area along the path of the navigation channels compared to routine existing maintenance dredging operations. The rock outcrop would be	The proposed project would not result in significant individual or cumulative noise impacts within the study area when considered in combination with other noise generating activities.

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
		removed using a jackhammer, producing underwater noise that is discussed in the Biological Resources section and the Biological Assessment.	
Public Health and Environmental Hazards	Continued maintenance and use of the navigation channels would not affect public health.	The proposed project is not expected to affect any hazardous material sites.	It is unlikely that the present or foreseeable future projects listed in **Table 4-22** would be located on hazardous material sites, or would affect management of any such sites. The proposed project should not incrementally contribute to any significant cumulative hazards to the public or the environment when considered in combination with other past, present, and/or reasonably foreseeable actions within the study area.
Recreation	Continued maintenance of the navigation channels would not contribute incrementally to any cumulative adverse effects on recreation when considered in combination with other activities within the study area.	The proposed project would comply with current Federal, state, and local agency regulations and policies regarding recreation and would not contribute incrementally to any cumulative adverse effects on recreation when considered in combination with other activities within the study area.	Activities associated with implementation of this alternative would comply with current Federal, state, and local agency regulations and policies regarding recreation and would not contribute incrementally to any cumulative adverse effects on recreation when considered in combination with other activities within the study area.
Socioeconomics	Continued maintenance of the navigation channels would have no influence on population trends, regional employment, spending patterns, or community resource needs.	The proposed project would not affect regional employment, spending and earning patterns, or community resources. Other projects in the area would have a greater cumulative influence on these socioeconomic variables.	Due to the size and stability of the regional economy, the cumulative effects of this alternative in combination with all other reasonably foreseeable activities would remain less than significant.

Resource	Past and Present (Existing Condition)	Proposed Action (TSP)	Cumulative Effects (with consideration of future projects)
Utilities and Public Service	The existing conditions would not affect buried underwater cables and pipelines or overhead transmission lines Continued maintenance and use of the navigation channels would not incrementally contribute to any cumulative effects that other unrelated actions within the study area may have on these utility resources.	The proposed project is not expected to adversely affect the utilities that cross the navigation channels.	The channel deepening activities would not add to any cumulative impacts on utilities within the study area when considered in combination with the effects of other past, existing, and/or future projects and activities in the area regardless of their origin.

4.8 TENTATIVELY SELCTED PLAN

Under the definition of the National Economic Development (NED), the -38 foot deepening alternative with the sediment trap and removal of the Pinole Shoal channel rock outcrop reasonably maximizes net benefits, and is therefore identified to be the NED plan. Since there is not a locally preferred plan, this is also the tentatively selected plan.

The environmental evaluation shows minimal changes between the -37 foot, -38 foot, and -38 foot with sediment trap and removal of rock outcrop alternatives, with the exception of the shift in X2. The sediment trap produces a slightly greater shift in the X2 from the -38 foot alternative, however, the addition of the sediment trap removes the need for interim emergency dredging operations in the Bulls Head Reach area. The beneficial reuse of material in each alternative minimizes effects to species in the area, as it would contribute to habitat needed for several species throughout the Delta, including the endangered delta smelt. Because the alternatives include using the dredged material beneficially, no compensatory mitigation is expected to be required due to the TSP.


5
The Tentatively Selected Plan

5 THE TENTATIVELY SELECTED PLAN

This chapter discusses the details of the tentatively selected plan (TSP) and environmental analysis of effects in Chapter 4. The details of the TSP discussed in this chapter include material quantities and classifications, operations and maintenance, dredged material placement, cost, risk and uncertainty.

5.1 OVERVIEW OF THE TENTATIVELY SELECTED PLAN

Refer to the Executive Summary foldout as a reference map and consolidated graphic.

No locally preferred plan (LPP) has been identified. Therefore, the TSP is the **-38 foot deepening** alternative with the sediment trap and removal of rock outcrop. The TSP proposes to deepen the existing maintained channel depth of the Pinole Shoal Channel and the Bulls Head Reach portion of the Suisun Bay Channel from -35 feet MLLW to -38 feet MLLW, with approximately 13.2 miles of new regulatory depths. Approximately 10.3 miles of the Pinole Shoal Channel (stations 0+00 to 548+00) and all 2.9 miles of the Bulls Head Reach to Avon (stations 0+00 62+00 and 88+00 to 159+00) would be dredged. A 2,600 foot-long sediment trap (width = 300 feet) would be constructed at Bulls Head Reach (located between stations 62+00 and 88+00 of the Bulls Head Reach in the area currently subject to annual advance maintenance dredging to a depth of -38 feet), with a depth of -42 feet MLLW, plus 2 feet of overdepth. The sediment trap would be maintained at -42 feet MLLW during future maintenance dredging to reduce rapid shoaling in the channel and emergency maintenance.

The TSP proposes the following:

- Deepen the existing maintained channel depth of the Pinole Shoal Channel and Bulls Head Reach (Suisun Bay) from -35 feet to -38 feet MLLW, with approximately 13.2 miles of new regulatory depths
- Dredge a 2,600 foot sediment trap at Bulls Head Reach with a depth of -42 feet MLLW, plus 2 feet of overdepth.
- Level the rock outcropping located to the west of Pinole Shoal from a peak of 39.7 ft. MLLW to 43 feet MLLW
- Beneficially reuse the dredged material

If the entire overdepth prism were dredged, the TSP would result in approximately 1.6 million cubic yards of dredged material from an approximate 390-acre footprint. The breakout of volumes for each feature is shown as follows:

- Pinole Shoal Channel deepening = 1,443,900 cy
- Bulls Head Reach deepening = 38,700 cy
- Bulls Sediment Trap & Overdepth 2 feet = 120,600 cy
- Rock Outcropping (Pinole Shoal Channel) = 40 cy of rock (950 sq. ft.).

All construction is expected to occur during the existing environmental work windows developed by the San Francisco Bay Long Term Management Strategy for the Placement of Dredged Material unless other work windows are developed during consultation with the resource agencies. The environmental work window for the Pinole Shoal Channel is from June 1 through November 20 and the work window for the

Bulls Head Reach portion of the Suisun Bay Channel is from August 1 through November 30.

It is assumed that the operation and maintenance (O&M) of the existing channels will be timed to be awarded under the same contract as the new deepening project in Pinole Shoal and Suisan Bay Channel. For cost estimating purposes, it is assumed that a clamshell/mechanical dredge would be used for both the O&M dredging cycle and new construction deepening project, with O&M dredging and new construction dredging occurring in series within the environmental work window in the same year; dredging of both would occur simultaneously. O&M material would be placed at in-bay sites SF-10 and SF-16, according to the Federal standard. New construction material from deepening Pinole Shoal channel would be placed at Cullinan Ranch; new construction material from deepening Bulls Head Reach would be beneficially used at a suitable and permitted site, currently assumed to be Montezuma Wetlands. The beneficial use placement at Cullinan Ranch and Montezuma Wetlands is currently assumed to minimize effects to special status species and essential fish habitat, offsetting the minimal effects of the change in salinity. The TSP has estimated average annual net benefits of $8.2 Million (fiscal year 2019 price levels, 2.875% discount rate).

5.2 MATERIAL QUANTITIES AND CLASSIFICATIONS

The TSP proposes dredging and placement of a total of approximately 1.6million cubic yards (cy) of material. Of that total amount, approximately 1,443,900 cy material would be placed in the Cullinan Ranch Site and roughly 159,300 cy of material would be used in Montezuma Wetlands Restoration Site, as shown in **Table 5-1**.

Table 5-1. Project Features and Associated Dredging Volumes.

CHANNEL	QUANTITY (CY)	PROPOSED PLACEMENT	CLASSIFICATION
Pinole Shoal Channel (STA 0+00 to STA 547+00)	1,443,900	Cullinan Ranch	Silty Sand/Clayey Sand
Suisun Bay Channel (STA 0+00 to STA 62+00)	38,700	Montezuma Wetland	Silty Sand/Clayey Sand
Bulls Head Reach Sediment Trap (STA 62+00 to 88+00)	120,600	Montezuma Wetland	Silty Sand/Clayey Sand
Dredge Rock Formation	40 cy	Sidecast	Rock
TOTAL ESTIMATED DREDGING QUANTITIES	**1,603,200**		

5.3 MITIGATION

Compensatory mitigation is not required for this project as the TSP includes measures to minimize environmental effects that include use of a mechanical clamshell dredge, working within USFWS-approved environmental work windows, and beneficial use of dredged material. After preliminary coordination with project stakeholders, the stakeholders found these measures and the proposed beneficial use placement of dredged material at the permitted Cullinan Ranch and Montezuma Wetlands restoration sites favorable because they would reduce project effects to special status species to below significance thresholds. Accordingly, compensatory mitigation is not proposed.

5.4 CONSTRUCTION ASSUMPTIONS

INITIAL DEEPENING WORK/DREDGING

The following construction assumptions were used for cost estimating purposes for the channel deepening elements of the TSP:

- Two dredge plants will be used with 21-CY clamshell buckets in the Pinole Shoal Channel
- Four 2,000 CY scows and two 1,800 HP tug boats will be used for dredged material placement at Cullinan Ranch from Pinole Shoal Channel
- One 21-CY clamshell dredge plant will be used in the Bulls Head Reach Channel
- Two 4,000 CY scows and one 1,800 HP tug boat for placement at Montezuma Wetlands Restoration Project From the Bulls Head Reach Channel

The dredged material will be hauled by scow from the Pinole Shoal channel to the Cullinan Ranch beneficial use placement site, and dredged material from the Bulls Head Reach channel will be hauled to the Montezuma Wetlands Restoration Project site where off-loaders will be stationed to unload scows and pump the dredged material into both sites. The Napa River that leads to the Cullinan Ranch site is too shallow for fully loaded 4,000 CY scows, so it is assumed that the scows will be loaded to only 65 percent of their capacity, or less, in order to transit to the off-loader location. It is also possible that the contractor may use 2,000 CY scows that can be fully loaded.

Utilizing two dredge plants for dredging in Pinole Shoal Channel and placement of dredged material at the Cullinan Ranch site, and one dredge plant in Bulls Head Reach channel with dredged material placement at the Montezuma wetlands site, the total construction duration for the dredging component of the TSP is estimated at 4.6 months.

Although the method described above is assumed for cost estimating purposes, other methods could be used during construction and are described in the **Appendix A, Civil Site.**

All dredging is assumed to begin at the western end of the Pinole Shoal Channel, where the previously discussed rock formation is located, and progress easterly to the end of the project boundary at the Avon terminal in the Bulls Head Reach channel.

It is assumed that the timing of the channel deepening will occur immediately after completion of the O&M dredge cycle within each reach. The O&M dredging event in Pinole Shoal Channel will remove the material above 35-ft MLLW plus 1-ft of paid overdepth, to be disposed at the "Federal standard" placement site in San Pablo Bay, SF-10. The environmental work window for O&M dredging is the same as the work window for the deepening project, which begins 1 June. O&M dredging in Pinole Shoal Channel can be completed within approximately 10 to 20 days, depending on the volume of material to be dredged. The deepening work within the Pinole Shoal channel would begin in late June, with an estimated construction duration of 3.5 months.

A separate O&M dredging contract for the Bulls Head Reach channel will be awarded and dredging will begin on 1 August, with an estimated completion timeframe of mid-September. The O&M material from

Bulls Head Reach will be disposed at the "Federal standard" in-bay placement site near Suisun Bay, SF-16. The deepening work for the Bulls Head Reach channel would begin in mid to late-September after the O&M dredging is completed.

ROCK OUTCROPPING

A rock formation posing a potential navigation hazard outside the Pinole Shoal Federal navigation project in the shipping lane was recently surveyed and the peak is found to be at approximately 39.7-ft MLLW. Even though this rock formation is not in the Federal channel, it is located in the shipping lane and will need to be addressed as part of this project to provide safe navigation at the minimum TSP depth of 38-ft MLLW. The rock formation will be lowered so that there is a minimum of 3-ft of additional clearance below the 2-ft of overdepth tolerance, lowering the rock formation to approximately 43-ft MLLW for the 38-ft depth. Although the rock formation has not been specifically sampled, it is assumed that because of its predicted hardness, the removal will likely require using a pneumatic jack-hammer attachment that would be mounted to an excavator mounted on a work barge. The jack-hammer would chisel the rock down to the desired elevation and the material would likely fall to the bay floor where it is naturally deep. The estimated quantity of rock to be removed is approximately 40 cubic yards (CY) to achieve a safe navigation depth of 43-ft MLLW for the 38-ft TSP depth, within an area of approximately 950 square feet.

5.5 OPERATION AND MAINTENANCE

Existing O&M dredging requirements would increase by the amounts as shown in **Table 5-2**. O&M material from Pinole Shoal and Suisun Bay will continue to be placed in the in-bay placement sites SF-10 and SF-16, respectively. The combined capacity for these sites for both Federal and non-Federal projects is 700,000 cy. It is estimated the existing placement sites are adequate and no new placement sites will be needed as a result of the new 230,000 CY O&M volume. See **Appendix J, Plan for Management of Dredged Materials**, for additional detail. This information will be incorporated into the next San Francisco Bay Dredged Material Management Plan (DMMP) update.

Table 5-2. Estimated Future O&M Volumes.

Channel	Dredge Type	Typical Dredging Frequency (years)	Median Volume Dredged Annually (CY)	Estimated Annual Increase (cy)	Future Estimated Annual O&M Total (cy)	Federal Placement Site
Pinole Shoal Channel (STA 0+00 to STA 547+00)	Hopper	2	127,500	48,400	175,900	SF-10 (San Pablo Bay)
Bulls Head Reach (STA 0+00 to STA 62+00)	Clamshell	1	25,000	20,700	45,700	SF-16 (Suisun Bay)
Bulls Head Reach (Advance Maintenance Area) Sediment Trap(STA 62+00 to 88+00)	Clamshell	1	0	8,900	8,900	SF-16 (Suisun Bay)
TOTAL DREDGING QUANTITIES			**152,500**	**78,000**	**230,500**	
***Sediment trap currently does not exist, but material is removed annually from the advance maintenance area.**						

5.5.1 SEDIMENT TRAP

The shoal rate for the Bulls Head Reach was determined independently based on the shoal analysis in **Appendix B, Water Resources**. The analysis determined that if a sediment trap was excavated to a depth 4-ft deeper than the rest of the Bulls Head Reach channel, the sediment trap would provide sufficient capacity for the annual channel shoaling that has been typically encountered. This will allow the entire Suisun Bay Channel to be maintained with dredge events only 2 out of every three years (ie: annual dredging for two years sequentially and able to forego the consecutive dredging event each third year), and without the need for interim emergency dredging.

5.5.2 DREDGED MATERIAL PLACEMENT SITES

During initial construction, the TSP must use placement sites that are cost effective and can also accept the dredged material from these channels. The following sections outline where material will be placed during initial construction and assumptions to date.

For the purposes of cost estimating, it is assumed that material will be beneficially used at Montezuma Wetlands and Cullinan Ranch. Confirmatory sediment testing of the dredged material will take place during PED, and based upon testing results, these sites could require reevaluation at that time. Other beneficial use sites (i.e. Delta Islands) may be more appropriate and will be re-assessed during PED.

5.5.3 MONTEZUMA WETLAND RESTORATION SITE (MWRP)

Placement at Montezuma Wetlands Restoration Project (MWRP) meets one of the project objectives to beneficially use material. The approximately 1,800-acre Montezuma Wetlands Restoration Project is a privately owned and operated wetland restoration project located adjacent to Montezuma Slough in northern Honker Bay. It is located on the eastern edge of Suisun Marsh, west of Collinsville, in Solano County. The site can take both clean cover material and material with elevated concentrations of constituents of concern, as long as this sediment is buried under 3 feet of clean cover material. Montezuma Wetlands has approximately 12 million cy of capacity. All site preparation, monitoring, and reporting is handled by the MWRP, which charges a tipping fee for accepting dredged sediment. The tipping fee includes the use of the off-loader 'Liberty'. All of the tasks associated with removing sediment from the scows, drawing water from Montezuma Slough to slurry material in the scows, managing the sediment on-site including decanting water and water quality monitoring are separately permitted under the Montezuma Wetland water quality certification. The average haul distance from the Suisun Bay Channel area to the MWRP off-loader is 13 miles.

5.5.4 CULLINAN RANCH TIDAL RESTORATION SITE

Placement at Cullinan Ranch Wetland Tidal Restoration Site meets one of the project objectives to beneficially use material. Cullinan Ranch Wetland Restoration Site is a 1,575 acre parcel in the San Pablo Bay National Wildlife Refuge. It was originally purchased by the USFWS for the purpose of increasing habitat for salt marsh harvest mouse and California clapper rail. Located in Solano County near the city of Vallejo, the southern property boundary of the parcel is a naturally formed levee that is the base for State Highway 37. The western property boundary of the parcel comprises Dutchman Slough and South Slough, both of which flow into nearby Napa River. Cullinan Ranch is a tidal restoration project with the goal of restoring diked baylands to historic tidal marsh conditions. There is currently capacity for up to 2.4 million cubic yards of dredged material. The sediment from the project will be used to raise up to 290 acres of the site to marsh plain elevation. The site has two permitted locations for an off-loader to moor, both located in Napa River, north and south of the mouth of Dutchman Slough, respectively. The average haul distance from the Pinole Shoal Channel area to the Cullinan off-loader is 10 miles.

5.5.5 SAN FRANCISCO DEEP OCEAN DISPOSAL SITE (SF-DODS)

It is not anticipated that this site will be used – however, should the above sites not be available at the time of construction, and should other beneficial use sites not be available, this site does have adequate capacity and would be used as a last option. The SF-DODS is located in the Pacific Ocean, approximately 55 nautical miles west of the Golden Gate Bridge. The site is approximately 70 nautical miles from the beginning of the Pinole Shoal Channel and approximately 88 miles from the beginning of the Suisun Bay Channel. The site was established in 1994 by the Long Term Management Strategy agencies, and is managed by the EPA Region 9.

5.6 BENEFITS OF THE TENTATIVELY SELECTED PLAN

5.6.1 ECONOMIC COSTS AND BENEFITS

Table 5-3 below, shows the economic cost as a summary for the TSP. The economic cost shown varies slightly from the total project cost shown earlier in Chapter 3for a few reasons. First, the sediment trap costs as well as the sediment trap savings benefits were included in the below final analysis (and were not included in the Chapter 3 final array analysis). Second, this summary includes Interest During Construction (IDC), described in the section below, as well as OMRR&R. Finally, this table shows a refinement in project first cost, to include a risk-based contingency which is periodically updated as new information becomes available. The benefit to cost ratio is justified (over 1.0) at 3.7 to 1. More details on this analysis can be found in the **Appendix D, Economics Analysis**.

Table 5-3. Summary of Economic Costs - TSP Net Benefits and BCR.[11]

Project (Depth)	38 foot deepening
Project First Cost	$ 59,400,000
Interest During Construction (IDC)	$ 497,000
Total Economic Costs with IDC	$ 59,897,000
Annualized Economic Cost & IDC	$ 2,273,000
OMRR&R Cost	$ 1,397,000
TOTAL ECONOMIC AVERAGE ANNUAL COST	$ 3,567,000
Annualized Transportation Cost Savings (Benefits)	$ 12,859,000
Annualized Sediment Trap Cost Savings (Benefits)	$ 682,000
TOTAL AVERAGE ANNUAL BENEFITS (Deepening + Sediment Trap)	$ 13,541,000
AA Net NED Benefits	$ 9,974,000
BCR (x:1)	3.7

INTEREST DURING CONSTRUCTION

Interest during construction (IDC) accounts for the opportunity cost of expended funds before the benefits of the project are available and is included among the economic costs that comprise the recommended plan project costs. The amount of the pre-base year cost equivalent adjustments depends on the interest rate; the construction schedule, which determines the point in time at which costs occur; and the magnitude of the costs to be adjusted. Pre-construction, Engineering, and Design (PED) costs are included in the IDC as well as construction costs and durations. The IDC calculation includes 5 months for construction activities.

5.6.2 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS

As mentioned earlier in the Plan Formulation Rationale, the four accounts NED, RED, EQ and OSE are always used as criteria in formulation and selection of a plan, in addition determining the plan with the highest net benefits and a justified benefit to cost ratio. These points are listed and briefly summarized below.

[11] The summary reflects the FY19, 2.875% discount rate, annualized over 50 years.

NATIONAL ECONOMIC DEVELOPMENT (NED)

This project reasonably maximizes net benefits in the amount of $10 million average annual net benefits. The project allows tankers to utilize more of their existing capacity, reducing the amount of vessel transits in the future with-project compared to the future without-project scenario. By doing so, it provides transportation cost savings to the oil refineries, which is then passed on to the regional and national consumers who use the end product of the crude oil for gasoline, etc.

ENVIRONMENTAL QUALITY (EQ)

This project reduces the amount of vessel transits in the future with-project scenario, and by reducing the number of vessels could also reduce any disruptions to the environment as vessels transit, as well as further reducing the risk of oil spills. Beneficial use of material would not only offset any immediate effects but would contribute to the creation of additional habitat for delta smelt.

REGIONAL ECONOMIC DEVELOPMENT (RED)

This project would likely temporarily stimulate the regional economy during construction.

OTHER SOCIAL EFFECTS (OSE)

Through beneficially using material to wetland sites, this project would also help provide resiliency and storm surge protection of the established infrastructure in the developed areas that surround the general bay area. One viable beneficial use for the dredged material from this project is as fill material to raise grades in the wetlands and tidal marsh areas adjacent to the bays in order to accelerate their development. Additionally, benefits of removing the rock outcropping will greatly add to the navigability of the channels for harbor pilots.

5.6.3 INCREMENTAL ANALYSIS OF THE SEDIMENT TRAP

A shoal analysis was performed on this area of the channel in 2015, entitled Bulls Head Deposition HydroSurvey Tech Memo, April 2015. The analysis recommends continuing advance maintenance (currently at -37 feet MLLW + 2 feet of overdepth in the advance maintenance area), or construct a permanent sediment trap between STA 62+00 and STA 88+00 to a depth of -42 feet MLLW for the -38 feet MLLW TSP depth. The proposed sediment trap in Bull Head Reach channel will be excavated to a depth that will be 4ft below the selected alternative depth and will also have 2 ft of allowable overdepth, and side slopes that are cut at a 3H: 1V horizontal to vertical ratio. The location of the proposed sediment trap is based on historical hydrographic survey data from the previous 17 years. The historical survey data indicates that this area of the Bulls Head Reach channel shoals in at a much higher rate than the rest of the Suisun Bay Channel.

The sediment trap is an added benefit for channel users and is included as a feature of the alternative plans as a separable element with stand-alone benefits and savings. It is proposed in an area that typically needs to be dredged annually, at an estimated cost of $1 million each year (based on historical use of a clamshell dredge). The sediment trap would reduce the maintenance requirements to 2 dredging cycles every 3 years, resulting in a cost savings associated with a reduction in the frequency of maintenance dredging. This creates a net present value savings of $18 million, with an average annual equivalent savings of $680,000 per year over a 50 period of analysis at a discount rate of 2.875%.

A more detailed incremental analysis of the costs and benefits associated with the proposed sediment trap are included in **Appendix D, Economic Analysis,** while additional information on the historical and annual dredging activities can be found in **Appendix A, Civil Site.**

5.7 FEDERAL IMPEMENTATION RESPONSIBILITIES

Under the Water Resources Development Act (WRDA) 1986, as amended by Section 201 of WRDA 1996, Federal participation in navigation projects is limited to sharing costs for design and construction of the general navigation features (GNF) consisting of breakwaters and jetties, entrance and primary access channels, widened channels, turning basins, anchorage areas, locks, and dredged material placement areas with retaining dikes.

5.8 NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES

Non-Federal interests are responsible for and bear all costs for acquisition of necessary lands, easements, rights-of-way and relocations; terminal facilities; and dredging berthing areas and interior access channels to those berthing areas.

5.9 TENTATIVELY SELECTED PLAN COST

The cost was estimated using MII[12].
Table 5-4 addresses USACE cost sharing guidelines while **Table 5-5** displays the total project cost. The estimate used for the cost sharing table shown in is based on the "constant dollar basis" (second column) on the Total Project Cost Summary (TPCS) spreadsheet (**Appendix C, Cost Engineering and Risk Analysis**), which includes 0.5% escalation to program year 2019 at effective price level 1 Oct 18. The Total Project Cost represents the most refined level of cost detail, with added contingency, which was determined through the Cost and Schedule Risk Analysis (CSRA). More details on the cost estimate can be found in **Appendix C, Cost Engineering and Risk Analysis**, as can details of cost assumptions, and risks that factored into the contingency.

The cost estimate below reflects all TSP project features, including removal of the rock outcropping and sediment trap. There are no local facility costs associated with the project cost. Environmental windows factored heavily into construction windows and construction sequencing.

The total project cost, with added contingency, is estimated at $59,400,000.

---

[12] MII is the second generation of the Micro-Computer Aided Cost Estimating System (MCACES). It is a detailed cost estimating software application that was developed in conjunction with Project Time & Cost, Inc. (PT&C). MII is one of several modules of an integrated suite of cost engineering tools called Tri-Service Automated Cost Engineering Systems (TRACES). It interfaces with other PC based support modules and databases used by the Tri-Service Cost Engineering community. MII provides an integrated cost estimating system (software and databases) that meets the U.S. Army Corps of Engineers (USACE) requirements for preparing cost estimates.

Table 5-4. Cost Share Guidelines.

Feature	**Federal Cost %[1]**	**Non-Federal Cost % [1]**
General Nav. Features (GNF)	· 90% from 0’ to 20’	· 10% from 0’ to 20’
	· 75% from 20’ to 45’	· 25% from 20’ to 45’
	· 50% from 46’and deeper	· 50% from 46’ and deeper
Mitigation (if needed)	· 75%	· 25%
GNF’s costs for this project include: mobilization, all dredging costs, and all placement area construction costs.		
Navigation Aids	· 100%	· 0%
Operation and Maintenance		
GNF	· 100% except cost share 50% costs for maintenance > 45 feet	· 0% except cost share 50% for maintenance > 45 feet
(1) The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF over a period of 30 years, at an interest rate determined pursuant to Section 106 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment.		

Table 5-5. Project Cost and Cost Sharing, -38 foot deepening project (TSP).

October 1, 2018 (FY19) Price Levels[1]						
WBS Number	**General Navigation Features**	**Project Cost**	**Contingency**	**Total Project Cost**	**Federal Share 75%**	**Non-Federal Share 25%**
12	Mob, Demob, Dredging	$47,512,000	$9,526,000	$57,038,000	$42,779,000	$14,260,000
30	Pre-Construction, Engineering, and Design	$1,396,000	$279,000	$1,675,000	$1,256,000	$419,000
31	Construction Management (S&I)	$529,000	$106,000	$635,000	$476,000	$159,000
	Subtotal Construction of GNF[2]	**$49,437,000**	**$9,911,000**	**$59,348,000**	**$44,511,000**	**$14,838,000**
1	Lands, Easements, Right-of-Ways, Relocations (LERR)[3]	$49,000	$2,000	$51,000	$38,250	$12,750
	Total Project First Costs	**$49,486,000**	**$9,913,000**	**$59,400,000**	**$44,549,250**	**$14,850,750**
	Credit for Non-Federal LERR[4]	**$0**			**$0**	**-$12,750**
	10% GNF Non-Federal[5]	**$0**			**-$5,934,800**	**$5,934,800**
	Total Cost Apportionment	**$49,486,000**	**$9,913,000**	**$59,400,000**	**$38,614,450**	**$20,772,800**

1. Cost is based on Project First Cost (constant dollar basis) on Total Project Cost Summary Spreadsheet, which includes 0.5% escalation to program year 2019 at an effective price level 1 Oct 2018 (Cost Appendix)

2. 75% Federal/25% non-Federal including the cost of the sediment trap.

3. RE admin costs. There are no actual lands and damages but per USACE regulations, RE admin costs will be placed in the 01 account. Additional RE costs will be cost shared according to the GNF. Escalation from the TPCS accounts for some numerical differences.

4. Credit is given for the incidental costs borne by the non-Federal sponsor for lands, easements, rights of way and relocations (LERR) per Section 101 of WRDA 86, not to exceed 10% of the GNF

5. The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment except in the case of LERR for GNF.

5.10 LANDS, EASEMENTS, RIGHT-OF-WAY & RELOCATION (LERR) SUMMARY

This section serves as a summary of **Appendix F, Real Estate Plan,** which can be referenced for more detailed information. Navigation Servitude will be applied to this project as it meets the dominant right of the Government under the Commerce Clause of the U.S. Constitution (U.S. CONST. art. I, §, cl.3) to use, control and regulate the navigable waters of the United States and the submerged lands thereunder for various commerce related purposes including navigation and flood control provided in paragraph 12-7 of ER 405-1-12. This project serves a purpose to improve navigation by deepening of the Pinole Shoal

Channel and Bulls Head Reach Channel, which are located below the mean or ordinary high water mark of a navigable watercourse.

Under navigation servitude, the sponsor is not required to acquire any lands for the project. In accordance with ER 405-1-12, paragraph 12-29 states, "the non-Federal sponsor should not be instructed to acquire and "provide" such land if it is otherwise available for project purposes through exercise of the navigation servitude rights by the Government."

All material dredged from the project would be beneficially used at one or more existing permitted Dredged Material Beneficial Use Disposal sites – either at Cullinan Ranch or Montezuma Wetlands Restoration Site.

In addition, the non-Federal sponsor will not be eligible for credit for placement sites as it is a designated permitted site. Any costs associated with placement have been captured under construction costs and not a LERR.

Credit will only be applied to LERRs owned and/or held by the sponsors that fall within the "project footprint," namely the LERRs required for the Project. Lands outside of the project requirements and that may be acquired for the sponsor's own purposes which do not support the minimum interests necessary to construct, operate and maintain the Project would not be creditable LERRs. Only land deemed necessary to construct, operate and maintain the plan would be creditable.

Currently, additional real estate is not required for the project; however the non-Federal sponsor will be required to acquire the minimum interest in real estate that will support the construction and subsequent operation and maintenance of the proposed USACE project should additional real estate be required.

There are no real estate acquisitions costs associated with the project as all activities will occur within the channel where navigational servitude will be exerted. Therefore there will be no credit issued to the non-Federal sponsor for project lands unless additional acquisition is identified.

An estimated $25K for Federal and $25K non-Federal administrative fees is for real estate certification.

There are no Public Law 91-646 Relocations required in connection with the project.

5.11 FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES

A financial analysis is required for any plan being considered for USACE implementation that involves non-Federal cost sharing. The ultimate purpose of the financial analysis is to ensure that the non-Federal sponsor understands the financial commitment involved and has reasonable plans for meeting that commitment. By memorandum dated April 24, 2007, the Assistant Secretary of the Army (Civil Works), granted approval of the self-certification of non-Federal sponsors for their ability to pay the non-Federal share of projects. The self-certification is required prior to submission of the Project Partnership Agreement, typically during the PED phase of the project. Included with the self-certification, the financial analysis shall include the non-Federal sponsor's statement of financial capability, the non-Federal sponsor's financing plan, and an assessment of the sponsor's financial capability.

5.12 VIEWS OF THE NON-FEDERAL SPONSOR

The Port of Stockton, the non-Federal sponsor, greatly supports this project both financially through cost sharing and legislatively through project authorization.

5.13 RISK AND UNCERTAINTY

Engineering Regulation 1105-2-100 directs planners to identify areas of risk and uncertainty in their analysis and describe them clearly, so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. During the beginning of the feasibility phase, a risk register was developed and each aspect of the project was evaluated for risk, and a rating was given of high, medium or low. Throughout the study, risk ratings were upgraded or downgraded depending on new information, and new items were added as needed. The areas of study risk that still remain important are as follows.

Economics. For the economics portion of the study, risk and uncertainty is always present in the future projections. No growth rate projection will ever be 100% accurate, and the true ups and downs of business cycles cannot be accurately forecast through a linear or exponential growth rate. Linear or steady compound growth rates (exponential growth) are meant only to be representative of projected tonnage that is expected to transit through the port over longer periods. Using smoother curves as estimates for actual tonnage acts to normalize peaks and valleys in future business cycles. In reality, future tonnage will likely exceed the forecast in some years, and fall short of the forecast in others. A "most-likely" steady growth rate will account for both of these occurrences over the long run because the positive and negative differences from the estimated to actual tonnage will eventually cancel each other out. Risk and uncertainty is also present in the fluctuation of the Federal interest rate, in changes in vessel operating costs, and in unforeseen changes and paradigm shifts. A sensitivity analyses was done for each of the major commodity forecasts to show alternative scenarios for crude oil imports and petroleum exports, and confirm Federal Interest with a positive BCR in each scenario. All topics described above can be found in more detail in the **Appendix D, Economic Analysis**.

Engineering. A potential area of risk is sediment testing of the dredge material. One source (USFSW 1998) indicates material at a 49 foot depth may have elevated levels of Chromium. However, this sediment was sampled at a deeper depth than what the project depth will be. Additionally, risk to using information from this report alone is inherent due to different sampling methods than which are currently used. Another source (ERDC 2000) indicates suitability of dredged material from Pinole Shoal and Bulls Head Reach as follows "Overall, the wetland mesocosms tests indicated that creating wetlands with Pinole Shoal Channel sediments will produce plants or animals with tissue metal concentrations in the range of those found in existing San Francisco Bay area wetlands; PAH concentrations were negligible; PCBs and butyltins were not detected in mesocosms organisms. Use of Pinole Shoal sediments for wetland creation would produce wetlands comparable to existing wetlands in the Bay area." Therefore, this is considered to be a medium risk at this time. Sediment testing will take place during PED. If testing shows levels of chromium are not acceptable for cover material at one or both sites, other combinations of placement/disposal are available (ex: combination of non-cover at Montezuma and SF-DODS, all SF-DODS, or other beneficial use sites willing to take the material). This has been modeled in the Cost and Schedule Risk Assessment and would be covered by the project contingency if needed.

Environmental. Risks during construction to threatened and endangered species have been minimized within the proposed plan (using beneficial use to offset effects) and cost estimate by avoiding seasons of peak activity, using a clamshell dredge, and incorporating other management methods such as observers. Risks as a result of salinity changes were incorporated early in the plan formulation process and were avoided by considering depths which would not incur large scale salinity effects. Remaining salinity risks have been addressed through modeling to verify assumptions along with coordination with water user groups and resource agencies.

Cost. Each of the above factors, as well as a thorough analysis of each project element, were incorporated into the Cost and Schedule Risk Assessment (CSRA) process, where the purpose of the CSRA is to develop a more statistically based project contingency. Therefore, areas of specific risk to cost and schedule were translated into higher contingencies which were then applied to the total project cost. Some of the risk and uncertainty will continue to decrease in the plans and specifications phase, as more information is developed, thus lowering project contingency. More detail on the CSRA can be found in **Appendix C, Cost Engineering and Risk Analysis**.

5.13.1 RESIDUAL RISK

Residual risks are risks that remain after all risk reduction actions have been completed. In this case, it applies to risks which would happen without the implementation of the TSP in the future without-project condition, but would also be the same with implementation of the TSP.

SEA LEVEL RISE

Following procedures outlined in EC 1165-2-212, baseline, intermediate, and high sea level rise values were estimated over the life of the project. In the future without-project conditions, sea level rise could be expected to increase by 0.36 feet (baseline), 0.85 feet (intermediate), and 2.38 feet (high) over the next 50 years.

Sea level rise is expected to be the same in both the future with-project and future without-project conditions. Numerical modeling has found that sea level rise is not anticipated to cause any significant changes to flow rates within San Francisco Bay and the Sacramento-San Joaquin Delta for both future without-project conditions and the TSP. The modeling has found that sea level rise may cause an increase in salinity intrusion into the Delta for both future without-project conditions and TSP if current reservoir operations are maintained in the Delta. The potential impacts of rising sea level include increased salinity intrusion into the Sacramento-San Joaquin Delta, overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas.

STORM SURGE

The USACE Deep Water Shipping Scenario Report (2011) predicted water stage at San Francisco Fort Point NOAA station (9414290) for the baseline scenario under 2007-2008 historic conditions. A tidally-averaged stageplot noted a storm surge of almost 1.64 feet (0.5 m), which was used under the baseline scenario for existing and future without-project conditions.

Relative to the baseline (existing) surge at Fort Point, no significant change in stage was predicted for deepening of -45 feet plus 2 feet of overdepth, which is what the above cited report assumed at the time. The TSP in this report proposes to deepen the channel to -38 feet MLLW + 2 feet of overdepth, which is less than what was modeled in the above mentioned report. Therefore, it can be assumed that no significant change would be expected with the implementation of the TSP. However, in the both the future without-project condition and TSP, storm surge could increase additionally with increased sea level rise.


6
Environmental Compliance

6 ENVIRONMENTAL COMPLIANCE

This chapter discusses the status of coordination and compliance of the Tentatively Selected Plan (TSP) with environmental requirements. Additionally, it shows how the TSP meets USACE environmental operating principles.

6.1 SCOPING

Scoping included publication in the Federal Register of a Notice of Intent to prepare an Environmental Impact Statement/Environmental Impact Report on March 4, 2016. At that time, the project included deepening the navigation channel to Stockton. Based upon salinity modeling results and public controversy, the scope of the project was reduced to deepen the navigation channel only to Avon. Salinity modeling was revisited to include deepening only to Avon, while also including a sediment trap at Bulls Head Reach. The results are presented in **Appendix B, Water Resources- Attachment 1**, as well as in Chapter 4. An additional Notice of Intent to prepare an Environmental Impact Statement/Environmental Impact Report was published December 4, 2017 to announce the reduction in scope on this navigation project. All agency and public scoping comments from 2016 and 2017, with a comment response matrix, are included in **Appendix I, Pertinent Correspondence**. Because this study has been ongoing since prior to 2016, the baseline conditions were not updated to include the most recent data for economics, greenhouse gases, socio-economics, or air quality. In efforts to minimize expenditure of funds to repeat extensive analyses, a qualitative assessment was completed to compare the most up to date data with what was previously used in analysis and found to be similar enough not to change the results significantly.

6.2 LIST OF RECIPIENTS

The draft EIS was made available to appropriate stakeholders and agencies by letter with the location of the document on the internet (https://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/). From the link provided, go to "Other Locations", then SF Bay to Stockton. Hard copies of the document were made available to the public at the following libraries. A list of stakeholders who received notification is available upon request.

Libraries where a hard copy is available to view:
Cesar Chavez Central Library 605 N El Dorado St, Stockton, CA 95202
Contra Costa County Library – Martinez Branch 740 Court St, Martinez, CA 94553

6.3 COMMENTS RECEIVED AND RESPONSE

Comments received on the draft EIS or from the public scoping meeting are located in the **Appendix I Pertinent Correspondence**, along with a comment/response matrix.

6.4 ENVIRONMENTAL COMMITMENTS

The proposed project minimizes risk to environmental resources, and threatened and endangered species by:

- Working with the approved USFWS environmental work window for delta smelt

- Using a clamshell dredge to avoid entrainment of species
- Placing all dredged material from deepening onto beneficial reuse sites to create/enhance wetland habitats and conditions for species within the delta, including delta and longfin smelt
- Commitments in the Programmatic Agreement for Cultural Resources

Other environmental commitments related to threatened and endangered species will be discussed in the Biological Opinion (BO) that will be received from the USFWS. Any terms and conditions provided in the BO will be followed.

6.5 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

The status of the proposed action's compliance with applicable Federal environmental requirements is summarized below. Prior to initiation of construction, the project will be in compliance with all applicable Federal laws and Executive Orders.

6.5.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969

Environmental information on the project has been compiled and this EIS/EIR has been prepared. The draft EIS was circulated for review by NOA in the Federal Register in Spring 2019. All correspondence has been included as **Appendix I, Pertinent Correspondence**. The project is in compliance with the National Environmental Policy Act (NEPA).

6.5.2 ENDANGERED SPECIES ACT OF 1973

USACE obtained a list of the federally threatened and endangered species and critical habitat that have potential to occur within the project area on November 27, 2017 (**Appendix G - Attachment 4**). USACE submitted the Biological Assessment to the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) (**Appendix G-Attachment 3 and 4**) at the time of release of this draft report. The proposed project is therefore in compliance with the Act.

6.5.3 FISH & WILDLIFE COORDINATION ACT OF 1958

Coordination with the USFWS under the FWCA is ongoing. A Draft Coordination Act Report is included as part of the coordination with USWFS under ESA, and is located in **Appendix G-Attachment 4**. USACE will continue to coordinate future actions with the USFWS, and is expected to receive a Final CAR prior to release of the Final Report. The project is in compliance with the Act.

6.5.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (*INTER ALIA*)

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, Native American Indian Tribes, 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.

Pursuant to Section 106 of the NHPA (36 CFR § 800.8), USACE is employing a phased process to identify and evaluate historic properties and assess effects. Once the project has been authorized by Congress and the appropriate funding obligated, ongoing consultation and consideration of effects will occur during

Planning, Engineering and Design (PED) as the APE may be subject to change based on final designs or modifications of project features. Therefore; pursuant to 54 U.S.C. 306108 and § 800.4(b)(2), USACE is deferring final identification and evaluation of historic properties until after project approval, additional funding becomes available, and prior to construction by executing a Programmatic Agreement (PA) with the California State Historic Preservation Office and the Advisory Council of Historic Preservation, if inclined to participate.

USACE shall avoid, minimize, and mitigate adverse effects to historic properties that could be affected by activities associated with the implementation of the project, including dredging and pipeline placement. During the PED phase of the project, the specific location of the proposed work (e.g., alignment, width, and depth) shall be developed in consultation with the California SHPO, and Native American Tribes. USACE shall make reasonable attempts to identify cultural resources through remote sensing surveys to determine whether the dredging activities would adversely archaeological resources or historic properties. If a potential site is identified near or within the channel or project feature, after consultation with the SHPO, additional investigations will be undertaken to evaluate the site for eligibility for listing on the NRHP. Should the site be determined to be historically significant, the project design would be modified to either avoid or mitigate the site. If necessary, additional NHPA documentation would be prepared at that time to disclose the adverse effects that would result from the undertaking. If the activities are proposed to take place in an area that would affect the site(s), USACE shall not complete that part of the proposed action until the site is evaluated for NRHP eligibility, the appropriate environmental review is completed, and a follow-on course of action is agreed upon through consultation with all appropriate entities and outlined in the PA.

The potential always exists that during construction, a previously unknown archaeological sites could be discovered even after cultural resource surveys have been completed. In such a situation, the following measures would be incorporated into the dredging contract(s) to mitigate any potential impacts during construction to shipwrecks, Native American, and/or historical archaeological resources

As discussed in ***Section 4.2.12 Cultural Resources***, both archeological and historic sites are found in the vicinity of the project. USACE has reviewed records for the Project areas, which includes all proposed work areas for this study. Correspondence with interested Tribes regarding the study was initiated via letter dated January 31, 2019. Based on this documentary research, consultation with local Indian Tribes, and field work, the project is currently in compliance with the National Historic Preservation Act of 1966. A programmatic agreement describing the phased approach of USACE compliance with, following 36 CFR 800.4 [b][2] is currently in development. During PED, any necessary surveys and evaluations will be conducted and completed prior to project construction, following 36 CFR 800.4 [b][2]. Once surveys and evaluations have been completed consultation will be updated with the SHPO and interested tribes.

6.5.5 CLEAN WATER ACT OF 1972

The Federal CWA (33 U.S.C. § 1257 et seq.) requires states to set standards to protect water quality. The objective of the Federal CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Specific sections of the CWA control discharge of pollutants and wastes into marine and aquatic environments, as further discussed in Section 3.4.1. USACE has initiated Section 401 Water Quality Certification with the Regional Water Board. It is expected that this certification would be obtained during the PED phase of the project, prior to construction. USACE is in compliance with this Act.

6.5.6 CLEAN AIR ACT OF 1972

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 nonattainment 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, PM10, and PM2.5. 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.

6.5.7 COASTAL ZONE MANAGEMENT ACT OF 1972

The CZMA, established in 1972 and administered by the NOAA's Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources through a state and Federal partnership. Under the Federal consistency provisions of the CZMA, Federal projects need to be consistent with the state's coastal zone management program and policies to the maximum extent practicable (16 U.S.C. § 1456); this determination is made by the lead Federal agency, and concurrence is requested from the state or local agency responsible for implementing the CZMA. For San Francisco Bay, the Bay Area Coastal Development Conservation District (BCDC) is the state's coastal zone management agency responsible for issuing concurrence with consistency determinations under the CZMA. The San Francisco Bay Plan is BCDC's policy document specifying goals, objectives, and policies for BCDC jurisdictional areas. For portions of the study area outside of San Francisco Bay, concurrence with consistency determinations is issued by the California Coastal Commission. USACE has prepared a CZMA Evaluation within this Draft EIS, located in **Appendix G, Attachment 2**, and requests a consistency determination concurrence from the BCDC or California Coastal Commission prior to commencing dredging activities. It is expected that BCDC's consistency determination concurrence would be obtained during PED, prior to construction.

6.5.8 FARMLAND PROTECTION POLICY ACT OF 1981

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 proposed project is in full compliance with this Act.

6.5.9 WILD AND SCENIC RIVER ACT OF 1968

No wild or scenic river reaches would be affected by the proposed project related activities. This Act is not applicable.

6.5.10 MARINE MAMMAL PROTECTION ACT OF 1972

The Marine Mammal Protection Act (MMPA) prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.)

directs the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issue or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings are set forth. NMFS has defined "negligible impact in 50 CFR 216.103 as: "an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance which has the potential to: (i) injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). An Incidental Harassment Authorization (IHA) may be issued, except for activities that have the potential to result in serious injury or mortality (i.e., it may only authorize Level A and B harassment), for a period of no more than one year, following a 30-day public review period. Alternatively, regulations may be granted for a period of five years and may include takes by serious injury and mortality. Upon rulemaking (i.e., defining regulations), Letters of Authorization (LOAs) will be issued to the authorization holder. The rulemaking and associated LOAs cannot be valid for a period of more than five consecutive years. For both an IHA and regulations, authorization shall be granted if the Secretary finds that the taking will have a negligible impact on a species or stock, and that the IHA or regulations are prescribed setting forth the permissible methods of taking, the means of effecting the least practicable adverse impact, and requirements pertaining to monitoring and reporting.

In order to minimize effects below threshold requiring an IHA, protective measures for marine mammals such as sea lions and dolphins would be implemented during construction activities. Additional information can be found in Chapter 4 and Section 6.4 of this report. Coordination with the USFWS and NMFS under the MMPA is ongoing.

6.5.11 ESTUARY PROTECTION ACT OF 1968

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 proposed project is in full compliance with the intent of this Program.

6.5.12 FEDERAL WATER PROJECT RECREATION ACT

Recreation opportunities and potential impacts to current recreation were considered during the planning processes for this study. Although the study area provides recreational benefits, the principles of this Act (Public Law 89-72) as amended, are not applicable to this project.

6.5.13 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) establishes a management system for national marine and estuarine fishery resources. This legislation mandates the identification, conservation, and enhancement of EFH, which is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," for all managed species.

Federal agencies consult with NMFS on proposed actions that may adversely affect EFH. The main purpose of the EFH provisions of the act is to avoid loss of fisheries due to disturbance and degradation of the fisheries habitat. USACE EFH assessment is incorporated into Section 4.1.6 of this report and is included in the Biological Assessment (**Appendix G-Attachment 4**). Coordination with NMFS will occur concurrently with release of the draft report. The proposed project is in compliance with this Act.

6.5.14 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

There are no designated coastal barrier resources in the project area that will be affected by this project. These Acts are not applicable.

6.5.15 RIVERS AND HARBORS ACT OF 1899

Rivers and Harbors Act refers to a conglomeration of many pieces of legislation and appropriations passed by Congress since the first such legislation in 1824. The Rivers and Harbors Act of 1899 was the first Federal water pollution act in the United States. It focuses on protecting navigation, protecting waters from pollution, and acted as a precursor to the CWA of 1972. Section 10 of the Rivers and Harbors Act of 1899 regulates alteration of and prohibits unauthorized obstruction of navigable waters of the United States.

6.5.16 ANADROMOUS FISH CONSERVATION ACT

The project is not expected to have a significant impact and is discussed in Section 4.1.6. The project is in coordination with NMFS and is in compliance with the Act.

6.5.17 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

No migratory birds will be affected by project activities. The USACE standard MBPP will be used to minimize potential impacts to migratory birds. The project is in compliance with these Acts.

6.5.18 MARINE PROTECTION AND SANCTUARIES ACT

The Marine Protection and Sanctuaries Act (MPRSA) is the United States' implementation of an international treaty, the Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter (also known as the "London Convention"). Section 102 of the MPRSA authorizes USEPA to establish criteria for evaluating all dredged material proposed for ocean dumping. These criteria are published separately in the Ocean Dumping Regulations at 40 C.F.R. pt. 220-228. Section 102 also authorizes the USEPA to designate permanent ocean-dredged material placement sites in accordance with specific site selection criteria designed to minimize the adverse effects of ocean placement of dredged material. Section 103 of the MPRSA authorizes USACE to issue permits, subject to USEPA concurrence or waiver, for dumping dredged materials into the ocean waters. It requires public notice, opportunity for public hearings, compliance with criteria developed by the USEPA (unless a waiver is granted), and the use of designated sites whenever feasible. Although USACE does not issue itself permits, USACE and USEPA apply these standards to USACE projects as well. This EIS does not evaluate the impacts of the ocean placement of dredged material from USACE-maintained Federal navigation channels in San Francisco Bay, because the project proposes to only place the dredged material on beneficial reuse sites.

6.5.19 EXECUTIVE ORDER (EO) 11990, PROTECTION OF WETLANDS

No wetlands would be negatively affected by project activities. Cullinan Ranch and Montezuma Wetlands would benefit from this project, by placing the dredged material onto the restoration sites. The proposed project is in compliance with the goals of this Executive Order (E.O.).

6.5.20 E.O 11988, FLOOD PLAIN MANAGEMENT

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. The proposed action would have no measurable effect on the (FEMA's 100-year) floodplain in the Bay Area. In addition, because of the nature of the proposed work, the proposed action would not directly or indirectly support development in the floodplain. The proposed project would be in full compliance with this order.

6.5.21 E.O. 12898 ENVIRONMENTAL JUSTICE

The purpose of the proposed action is to provide increased safety, efficiency, and lower costs for navigation while protecting the environment. The proposed activity would not (a) exclude persons from participation in, (b) deny persons the benefits of, or (c) subject persons to discrimination because of their race, color or national origin, nor would the proposed action adversely impact "subsistence consumption of fish and wildlife." The proposed project would benefit shipping and the general economy including minority and low income populations. Furthermore, construction activities and any additional trucking/commerce that would be associated with project improvements is not anticipated to disproportionately affect economically disadvantaged residential areas or persons belonging to minority groups. Construction traffic and logistic traffic use commercial traffic routes immediately adjacent to the Port, including U.S. Highways and Interstate highways. Construction activities and any additional trucking/commerce that would be due to the project are not expected to disproportionately affect economically disadvantaged residential areas of persons belonging to minority groups. The proposed project is in compliance with the goals of this E.O.

6.5.22 E.O. 13045, PROTECTION OF CHILDREN

This E.O. requires each Federal agency to "identify and assess environmental risks and safety risks [that] may disproportionately affect children" and ensure that its "policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks." This project has no environmental or safety risks that may disproportionately affect children and is in compliance.

6.5.23 E.O. 13089 CORAL REEF PROTECTION

This project would not impact those species, habitats, and other natural resources associated with coral reefs as defined in the E.O. The deepening would occur within the already authorized and regularly maintained navigation channel. The proposed project is in compliance with the goals of this E.O.

6.5.24 E.O. 13112, INVASIVE SPECIES

This project would not introduce or affect the status of any invasive species and is therefore in compliance with the goals of this E.O.

6.5.25 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with NEPA, USACE has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose on environmental issues and ensure that environmental conservation, preservation, and restoration are considered in all USACE activities.

USACE Environmental Operating Principles are:

1. Foster sustainability as a way of life throughout the organization.
   Throughout the planning process, the team strived for minimization of impacts to the surrounding environment, with a key focus on salinity effects.
2. Proactively consider environmental consequences of all USACE activities and act accordingly.
   Throughout the planning process, the interdependence of the built environment, navigation environment, economics environment, and living environment remained evident and each project measure was carefully considered for all elements.
3. Create mutually supporting economic and environmentally sustainable solutions.
   Beneficial use of material will offset any effects during construction and could expand habitat for the delta smelt.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments.
   Each element of human health, welfare, and viability of natural systems was thoroughly assessed throughout this report in a responsible manner.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
   Cumulative impacts to the environmental were thoroughly assessed in this report and any effects have been thoroughly evaluated.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
   USACE collected a great deal of information throughout the preparation of this study which has been thoughtfully prepared and organized in a manner so as to facilitate a greater knowledge base about the area, its challenges, and the opportunities which can be achieved.
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activites.
   USACE worked with many agencies, individuals, and groups throughout this study, sharing scientific, economic and social information and exchanging ideas for the betterment of a design that will find solutions to the problem while maintaining the level of quality within the surrounding environment.


7
Recommendations

7 DRAFT RECOMMENDATIONS

I have given consideration to all significant aspects in the overall public interest including engineering feasibility, economic, social, cost and risk analysis, and environmental effects. The Tentatively Selected Plan (TSP) described in this draft report provides the optimum solution for National Economic Development (NED) benefits within the study area that can be developed with the framework of the formulation concepts. Implementation of the TSP described in this the San Francisco Bay to Stockton Navigation Study is recommended at this time, with such modification as in the discretion of the Commander, Headquarters, U.S. Army Corps of Engineers (HQUSACE), may be advisable.

7.1 DRAFT ITEMS OF LOCAL COOPERATION

The Tentatively Selected Plan conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements of Federal law and policy for navigation projects including WRDA 1986, as amended; and would be implemented with such modifications, as the Chief of Engineers deems advisable within his discretionary authority. Federal implementation is contingent upon the non-Federal sponsor agreeing to comply with applicable Federal laws and policies. Prior to implementation, the non-Federal sponsor shall agree to:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

(1) 25 percent of the cost of design and construction of the general navigation features (GNFs).

b. Provide all lands, easements, rights-of-way, relocations, and placement areas (LERRDs), including those necessary for the borrowing of material and the placement of dredged or excavated material, and perform or assure the performance of all relocations, including utility relocations, all as determined by the Federal government to be necessary for the construction or operation and maintenance of the GNFs.

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of the GNFs less the amount of credit afforded by the Government for the value of the LERRD is provided by the sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LERRD, and relocations, including utility relocations, provided by the sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LERRD and relocations, including utility relocations, in excess of 10 percent of the total cost of construction of the GNFs.

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities 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.

e. Provide 100 percent of the excess cost of operation and maintenance of the project over that cost which the Federal government determines would be incurred for operation and maintenance of a depth in excess of the NED plan.

f. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

g. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the Sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs.

h. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors.

i. Keep, and maintain books, records, documents, and 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, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, 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. 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), 42 USC 9601–9675, that may exist in, on, or under LERRD that the Federal government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the Federal government provides the sponsor with prior specific written direction, in which case the sponsor shall perform such investigations in accordance with such written direction.

k. Assume complete financial responsibility, as between the Federal government and the sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LERRD that the Federal government determines to be necessary for the construction or operation and maintenance of the project.

l. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the local service facilities for the purpose of CERCLA liability.

m. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

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 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

o. Comply with the 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 necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the placement of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

p. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; 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 substantive 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)).

q. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project.

r. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the sponsor's obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the Port of Stockton (the non-Federal sponsor), interested Federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

Robert J. Clark
Colonel, U.S. Army
District Commander


8
List of Preparers

8 LIST OF PREPARERS

8.1 PREPARERS

This GRR/EIS was prepared by the following U.S. Army Corps of Engineers:

Stacie Auvenshine	Environmental, NEPA Compliance
Stacey Roth	Plan Formulation
Beth Campbell	ESA, Biologist
David Doak	Civil Design
Patrick Sing	Coastal Hydraulics
Pam Castens	Project Manager
Caitlin Bryant	Economics
Tu Nguyen	Geotechnical
Sherman Fong	Cost Engineering
Bonievee Delapaz	Real Estate
Jason Moser	Cultural Resources
Mark Shafer	Water Quality

8.2 REVIEWERS

This report was reviewed by the following personnel:

Paul DeMarco	Environmental, NEPA Compliance
Eldon Gatwood	Plan Formulation
Cynthia Fowler/Paul DeMarco	ESA, Biologist
Joseph Ryan	Civil Design/Cost Engineering
Philip Sylvester	Coastal Hydraulics
Jay Kinberger	Project Manager
Daniel Abecassis	Economics
Jennifer Coor	Geotechnical
William Casale	Real Estate
S. Joe Griffin	Cultural Resources
Paul DeMarco	Water Quality


9
References

9 REFERENCES AND INDEX

9.1 REFERENCES

[Anchor] Anchor Environmental, L.P. 2003. Literature Review of Effects of Resuspended Sediments Due to Dredging Operations. Prepared for Los Angeles Contaminated Sediments Task Force, Los Angeles. Jun.

[ABAG] Association of Bay Area Governments. 2015a. Interactive Liquefaction Susceptibility Map. Available at: http://gis.abag.ca.gov/website/Hazards/?hlyr=liqSusceptibility. (Accessed 2015 Oct 26)

[ABAG] Association of Bay Area Governments. 2015b. Interactive Landslide Zone Map. Available at: http://gis.abag.ca.gov/website/Hazards/?hlyr=cgsLndsldZones. (Accessed 2015 Oct 28)

[ABAG] Association of Bay Area Governments. 2015c. About ABAG. Available at: http://www.abag.ca.gov/about_abag/. (Accessed 2015 Oct)

Baxter R. 1999. Osmeridae. Edited by Orsi JJ. Report on the 1980–1995 Fish, Shrimp, and Crab Sampling in the San Francisco Estuary, California. The Interagency Ecological Program for the Sacramento-San Joaquin Estuary: 179–216.

[BCAG] Butte County Association of Governments. 2011. Butte Regional Conservation Plan. Available at: http://www.buttehcp.com/. (Accessed 2012 Feb 16)

[BCDC] San Francisco Bay Conservation and Development Commission 2006. Recreation and San Francisco Bay. Staff Report. Jul.

[BCDC] San Francisco Bay Conservation and Development Commission. 2008. San Francisco Bay Plan. Jan. Available at: http://www.bcdc.ca.gov/pdf/bayplan/bayplan.pdf. (Accessed 2016 Mar).

The Bay Institute. 1998. From the Sierra to the Sea: The Ecological History of the San Francisco Bay–Delta Watershed. Jul. Available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/cmnt081712/sldmwa/thebayinstitutefromthesierratotheseatheecologica.pdf. (Accessed: 30 Dec 2015)

Bennett WA, Kimmerer WJ, and Burau JR. 2002. Plasticity in Vertical Migration by Native and Exotic Estuarine Fishes in a Dynamic Low-Salinity Zone. Limnology and Oceanography 47(5): 1496–1507.

Bloom NS, Lasora BK. 1999. Changes in Mercury Speciation and the Release of Methyl Mercury as a Result of Marine Sediment Dredging Activities. The Science of the Total Environment 237-238:379-385.

Bridges TS, Ells S, Hayes D, Mount D, Nadeau SC, Palermo MR, Patmont C, Schroeder P. 2008. The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk. Prepared for USACE Dredging Operations and Environmental Research Program. Jan.

[CACSST] California Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance: 1988 Annual Report. Prepared for the California Department of Fish and Game [CALFED] CALFED Bay-Delta Program. 2000a. Final Programmatic Environmental Impact Statement and Environmental Impact Report. Including portions of the Ecosystem Restoration Program Plan Including the Multi-Species Conservation Strategy, Technical Appendix. Sacramento. Jul.

[CALFED] CALFED Bay-Delta Program. 2009. Background/Summary of Ammonia Investigations in the Sacramento-San Joaquin Delta and Suisun Bay. [Updated March 02, 2009] Available at: http://www.science.calwater.ca.gov/pdf/workshops/workshop_ammonia_bckgrnd_paper_nh4-nh3_030209.pdf.

[CARB] California Air Resources Board. 2008. Climate Change Scoping Plan. Dec. Available at: http://www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm.

[CARB] California Air Resources Board. 2009a. California Almanac of Emissions and Air Quality – 2009 Edition, Table 5-44 and Figure 5-12. Available at: http://www.arb.ca.gov/aqd/almanac/almanac09/chap509.htm.

[CARB] California Air Resources Board. 2011. Emissions Estimation Methodology for Ocean-Going Vessels. California Air Resources Board Planning and Technical Support Division. May. Available at: http://www.arb.ca.gov/regact/2011/ogv11/ogv11appd.pdf.

[CCCC] California Climate Change Center. 2012. The Third Climate Change Assessment. Jul.

[CDC] California Department of Conservation. 1982a. State of California Special Studies Zones Mare Island Revised Official Map. Jan 01.

[CDC] California Department of Conservation. 1982b. State of California Special Studies Zones Richmond Revised Official Map. Jan 01.

[CDC] California Department of Conservation. 1993. State of California Special Studies Zones Vine Hill Quadrangle Revised Official Map. Jul 01.

[CDC] California Department of Conservation. 1997. California Agricultural Land Evaluation and Site Assessment Model, Instruction Manual. Office of Land Conservation. Sacramento. Available at: http://www.conservation.ca.gov/dlrp/lesa/Documents/lesamodl.pdf.

[CDFG] California Department of Fish and Game. 1998. Report to the Fish and Game Commission: A status review of the spring-run Chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River Drainage.

[CDFG] California Department of Fish and Game. 2009a. Longfin Smelt Fact Sheet. Available at: https://www.dfg.ca.gov/delta/data/longfinsmelt/documents/LongfinsmeltFactSheet_July09.pdf. (Accessed 2016 Jan 11)

[CDFG] California Department of Fish and Game. 2009b. Report to the Fish and Game Commission: A Status Review of the Longfin Smelt in California.

[CDFG] California Department of Fish and Game. 2010. Lower Sherman Island Wildlife Area. Available at: https://www.wildlife.ca.gov/Lands/Places-to-Visit/Lower-Sherman-Island-WA. (Accessed 2015 Nov 12)

[CDFW] California Department of Fish and Wildlife. 2015a. San Francisco Bay Study. Available at: https://www.wildlife.ca.gov/Conservation/Delta/Bay-Study. (Accessed 2015 Dec 18) [CDFW] California Department of Fish and Wildlife. 2015b. Fall Midwater Trawl Monthly Abundance Indices. Available at: http://www.dfg.ca.gov/delta/data/fmwt/indices.asp. (Accessed 2015 Nov 17, updated March 2019)

CDFW 2019. http://www.dfg.ca.gov/delta/data/fmwt/indices.asp

[CDTSC] California Department of Toxic Substances Control. 2015. EnviroStor. Available at: http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=80001733. (Accessed 2015 Jun 04)

[CDWR] California Department of Water Resources. 2007. Status and Trends of Delta-Suisun Service. May. Available at: http://deltavision.ca.gov/DeltaVisionStatusTrends.shtml.

[CDWR] California Department of Water Resources. 2013. Public Draft Bay Delta Conservation Plan. Sacramento. Nov.

[CDWR] California Department of Water Resources. 2013. Bay Delta Conservation Plan. [Revised Administrative Draft] (ICF 00343.12.) Prepared 18 by ICF International, Sacramento. Nov.

[CDWR] California Department of Water Resources. 2016. Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices. Available at: http://cdec.water.ca.gov/cgi-progs/iodir/wsihist.

California Division of Boating and Waterways. 2015. Marin County Facility Index. Available at: http://dbw.parks.ca.gov/maps/facilityindex.asp. (Accessed 2015 Oct)

California Emergency Management Agency. 2009a. Tsunami Inundation Map for Emergency Planning, San Francisco. California Geological Survey, University of Southern California. Available at:

http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/SanFrancisco/Documents/Tsunami_Inundation_SF_Overview_SanFrancisco.pdf. (Accessed 2013 Mar 18)

California Emergency Management Agency. 2009b. Tsunami Inundation Map for Emergency Planning, San Francisco North Quadrangle. California Geological Survey, University of Southern California. Available at: http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Marin/Documents/Tsunami_Inundation_SanFranciscoNorth_Quad_Marin.pdf. (Accessed 2013 Mar 18)

[CSLC] California State Lands Commission. 2012. Addendum to the Final Environmental Impact Report for the Cullinan Ranch Restoration Project, Solano and Napa Counties.

[CSLC] California State Lands Commission. 2015. SLC Shipwreck Database. Available at: http://shipwrecks.slc.ca.gov/ShipwrecksDatabase/Shipwrecks_Database.asp. (Accessed 2015 Dec 02)

Cheng RT, Gartner JW. 1984. Tides, Tidal and Residual currents in San Francisco Bay, California – Results of Measurements, 1979-1980. U.S. Geological Survey, Water Resources Investigations Report 84-4339.

Cloern JE, Jassby AD. 2012. Drivers of Change in Estuarine-Coastal Ecosystems: Discoveries from Four Decades of Study in San Francisco Bay. Rev. Geophys., 50, RG4001, doi:10.1029/2012RG000397.

Cohen AN and Carlton JT. 1995. Nonindigenous Aquatic Species in a United States Estuary: A 16 Case Study of the Biological Invasions of the San Francisco Bay and Delta. U.S. Fish and Wildlife 17 Service, Washington, D.Collins MA. 1995. Dredging Induced Bear-Field Resuspended Sediment Concentrations and Source Strengths. U.S. Army Corps of Engineers Dredging Operations Technical Support Program. Aug.

Contra Costa County. 2005. Contra Costa County General Plan 2005-2020. Contra Costa County Department of Conservation and Development. Jan 18. Available at: http://ca-contracostacounty2.civicplus.com/DocumentCenter/View/30922.

Contra Costa Transportation Agency. 2009. Draft Environmental Impact Report, 2009 Countywide 11 Comprehensive Transportation Plan. State Clearinghouse No. 2008052073. Feb 18.

[CCWD] Contra Costa Water District. 2010. Los Vaqueros Reservoir Expansion Project, Environmental Impact Statement, Environmental Impact Report, State Clearinghouse No. 2006012037. Prepared for United States Department of the Interior, Bureau of Reclamation, Mid-Pacific Region, Contra Costa Water District, Western Area Power Administration. Mar.

[CEQ] Council on Environmental Quality. 2014. Revised Draft Guidance on the Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews. Dec. Available at: https://www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance_searchable.pdf.

[CCG&CS] Craft Consulting Group and Cambridge Systematics. 2013. Technical Memorandum #1. Contra Costa County Northern Waterfront Initiative Market Assessment. To: Rich Seithel, Chief, Annexations and Economic Stimulus Programs, From: Gary Craft, Kevin Stichter, Michael Fischer, Monica Isbell, and Chiranjivi Bhamidipati. Aug 19. Available at: http://www.cccounty.us/DocumentCenter/View/30555.

Crain PK, Woodley CM, Schwartz RS, and Moyle PB. 2007. Restoration of the Sacramento Perch to the San Francisco Estuary. Final Report ERP-02-P34. May.

Delta Modeling Associates. 2015. Analysis of the Effect of Project Depth, Water Year Type and Advanced Maintenance Dredging on Shoaling Rates in the Oakland Harbor Navigation Channel, Central San Francisco Bay 3-D Sediment Transport Modeling, Final Report. Prepared for U.S. Army Corps of Engineers, San Francisco District. Mar 05.

Delta Protection Commission. 2005. Inventory of Recreation Facilities. Feb.

Delta Protection Commission. 2015. Land Use and Resource Management Plan. Available at: http://www.delta.ca.gov/plan.htm. (Accessed 2015 Oct)

Denton, Richard A., 2005, Delta Salinity Constituent Analysis, Prepared for the State Water Project Contractors Authority, Richard Denton & Associates, Oakland, CA., https://www.baydeltalive.com/assets/588ee18bdb51ef1619ac6fd28b97f694/application/pdf/Denton_2015_Delta_Salinity_Constituents_Report.pdf (Accessed, January 2019)

Department of Boating and Waterways (DBW). n.d. Safe Boating Hints for the San Francisco Bay. Available at: http://www.dbw.ca.gov/Pubs/SFBay/SFBay.pdf. (Accessed 2015 Oct)

Dettman DH, Kelley DW, and Mitchell WT. 1987. The influence of flow on Central Valley salmon. Prepared for the California Department of Water Resources. Jul.

Dickerson C, Reine KJ, and Clarke DG. 2001. Characterization of underwater sounds produced by bucket dredging operations. DOER

Technical Notes Collection (ERDC TN DOER-E14). U.S. Army Engineer Research and Development Center, Vicksburg. Available at: http://el.erdc.usace.army.mil/elpubs/pdf/doere14.pdf. (Accessed 2016 Apr 05)

Eggleton J, Thomas KV. 2004. A Review of Factors Affecting the Release and Bioavailability of Contaminants during Sediment Disturbance Events. Environment International 30:973-980.

Feyrer F, Nobringa M, and Sommer T. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, U.S.A. Canadian Journal of Fish and Aquatic Science 136: 1393–1405. Available at: http://dx.doi.org/10.1139/F07-048.

FISHBIO. Who's Who… February 2010. Available at: http://fishbio.com/environmental-consulting-and-environmental-research-field-notes/2010/02/18/whos-who/. (Accessed 2015 Dec 30)

Griffin FJ, Smith EH, Vines CA, and Cherr GN. 2009. Impacts of Suspended Sediments on Fertilization, Embryonic Development, and Early Larval Life Stages of the Pacific Herring, Clupea pallasi. Biol. Bull. 216: 175–187.

Healey MC. 1991. Edited by Groot C and Morgolis L. Life History of Chinook Salmon (Oncorhynchus tshawytscha). Pacific Salmon Life Histories. Vancouver, B.C. UBC Press: 313–396.

Hericks, David B., Sujoy B. Roy, Jon Burau, and Erin Foresman, (2017) Advancement of Salinity and Flow Monitoring in the San Francisco Bay Delta, San Franscisco Bay Delta Action Plan Implementation Support, Final Report, Contract No. EP099BOA001. https://www.epa.gov/sites/production/files/2017-02/documents/epa_bay_action_plan_salinity_and_flow_monitoring_020117.pdf (Accessed Jan 2019).

Hieb K and Baxter R. 1993. Edited by Herrgesell PL. Delta Outflow/San Francisco Bay. 1991 Annual Report. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary: 101–116.

Hirsch ND, DiSalvo LH, and Peddicord R. 1978. Effects of dredging and disposal on aquatic organisms. Technical Report DS-78 55. U.S. Army Engineer Waterways Experiment Station, Vicksburg. NTIS No. AD A058 989.

ICF International. 2013. Bay Conservation and Development Plan Draft EIR/EIS. Nov. Available at: http://baydeltaconservationplan.com/EnvironmentalReview/EnvironmentalReview/2013-2014PublicReview/2013PublicReviewDraftEIR-EIS.aspx. (Accessed 2015 Oct 20)

Jassby AD, Kimmerer WJ, Monismith SG, Armor C, Cloern JE, Powell TM, Schubel JR, and Vendlinski TJ. 1995. Isohaline Position as a Habitat Indicator for Estuarine Populations. Ecological Applications 5:272–289.

Jones RA, Lee GF. 1978. Evaluation of the Elutriate Test as a Method of Predicting Contaminant Release during Open Water Disposal of Dredged Sediment and Environmental Impact of Open Water Dredged Material Disposal, Vol. I: Discussion. Technical Report D-78-45. U.S. Army Corps of Engineers WES, Vicksburg.

Kimmerer WJ, Gross ES, and MacWilliams ML. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? Estuaries and Coasts 32:375–389.

Kimmerer WJ, MacWilliams ML, and Gross ES. 2013. Variation of fish habitat and extent of the low-salinity zone with freshwater flow in the San Francisco Estuary. San Francisco Estuary and Watershed Science 11(4). Available at: https://escholarship.org/uc/item/3pz7x1x8.

Kohn NP, Lefkovitz LF, Barton KO, and Word JQ. 1991. Chemical evaluations of the John F. Baldwin Ship Channel Sediment Phase II. PNL-7700. San Francisco: U.S. Army Corps of Engineers, San Francisco District.

Kohn NP, Karle LM, Pinza MR, Mayhew HL, White PJ, Gruendell BD, and Word JQ. 1993. Ecological Evaluation of Proposed Dredged Material from the John F. Baldwin Ship Channel (Phase III-Biological Test). PNL-8828.

Kohn NP, White PJ, Gardiner WW, and Word JQ. 1994. Ecological evaluation of proposed dredged material from Bulls Head Channel (lower Suisun Bay). Battelle/Pacific Northwest Laboratory. San Francisco: U.S. Army Corps of Engineers, San Francisco District.

Kopec D and Harvey J. 1995. Toxic Pollutants, Health Indices, and Pollution Dynamics of Harbor Seals in San Francisco Bay, 1989–91: Final Report. Moss Landing Marine Labs, Moss Landing.

LaSalle MW. 1990. Edited by Simenstad CA. Physical and Chemical Alterations Associated with Dredging: An Overview. In Effects of Dredging on Anadromous Pacific Coast Fishes. University of Washington, Seattle. pp 1-12.

Lee GF, Jones R, Saleh F, Mariani G, Homer D, Butler J, and Bandyopadhyay P. 1978. Evaluation of the Elutriate Test as a Method of Predicting Contaminant Release during Open Water Disposal of Dredged Sediment and Environmental Impact of Open Water Dredged Material Disposal, Vol. II: Data Report. Technical Report D-78-45. U.S. Army Corps of Engineers WES, Vicksburg.

Lee CR. 2000. Evaluation of wetland creation with John F. Baldwin Ship Channel sediment. U.S. Army Corps of Engineers, Engineer Research and Development Center.

Lee H, Thompson B, and Lowe S. 1999. Impacts of Nonindigenous Species on Subtidal Benthic Assemblages in the San Francisco Estuary. Prepared for U.S. Environmental Protection Agency Region IX.

Lenihan HS and Oliver JS. 1995. Anthropogenic and natural disturbances to marine benthic communities in Antarctica. Ecological Applications 5:311 326.

[LFR] Levine Fricke. 2004. Framework for Assessment of Potential Effects of Dredging on Sensitive Fish Species in San Francisco Bay. Aug.

[LTMS] Long-Term Management Strategy Agencies. 1998. Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region, Final Policy Environmental Impact Statement/Environmental Impact Report. Vol I.

MacWilliams, M.L., Bever, A.J., Gross, E.S., Ketefian, G.S., and Kimmerer, W.J., 2015. Three-dimensional modeling of hydrodynamics and salinity in the San Francisco Estuary: An evaluation of model accuracy, X2, and the low salinity zone, San Francisco Estuary and Watershed Science, Available from: http://escholarship.org/uc/item/7x65r0tf

MacWilliams, M.L., A.J Bever, et al, 2015, Three-Dimensional Modeling of Hydrodynamics and Salinity in the San Francisco Estuary: An Evaluation of Model Accuracy, X2, and the Low-Salinity Zone, San Francisco Estuary & Watershed, Vol 13, Issue 1, April 2015.

Marin County. 2005a. Marin Countywide Plan Noise Technical Background Report. Oct. Available at: http://www.marincounty.org/~/media/files/departments/cd/planning/currentplanning/publications/county-wide-plan/background-reports/noisebr.pdf.

Marin County. 2005b. Geology, Mineral Resources and Hazardous Materials Technical Background Report. The Marin County Community Development Agency, Planning Division. Nov.

Marin County. 2007. Marin Countywide Plan. The Marin County Community Development Agency. Nov 5.

Martinez, City of. 2015. Draft General Plan 2035.

McKee LJ, Lewicki M, Schoellhamer DH, and Ganju NK. 2013. Comparison of sediment supply to San Francisco Bay from watersheds draining the Bay Area and the Central Valley of California. Marine

Geology 345:47-62. DOI: 10.1016/j.margeo.2013.03.003.

Masters, PM and IW Aiello. 2007. "Postglacial Evolution of Coastal Environments" in California Prehistory: Colonization, Culture and Complexity. TL Jones and KA Klar (eds). AltMira Press, Lanham, MD.

Merkel and Associates. 2011. 2010–2011 Richmond Harbor Maintenance Dredging Post Dredging Eelgrass Impact Analysis. Prepared for U.S. Army Corps of Engineers San Francisco District. Jun.

Merkel and Associates. 2012. Richmond Harbor 2010–2011 Maintenance Dredging Year Two Post-Dredging Eelgrass Impact Analysis. Prepared for U.S. Army Corps of Engineers San Francisco District. May.

Moratto MJ. 1984. California Archaeology. San Diego: Academic Press, Inc.

Moyle PB. 2002. Inland Fishes of California. Berkeley: University of California Press.

Moyle PB, Herbold B, Stevens DE, and Miller LW. 1992. Life history and status of Delta Smelt in the Sacramento—San Joaquin Estuary, California. Transactions of the American Fisheries Society 121: 67–77. Available at: http://dx.doi.org/10.1577/1548-8659(1992)121<0067:LHASOD>2.3.CO;2.

National Cancer Institute. 2012. Lifetime Risk (Percent) of Being Diagnosed with Cancer by Site and Race/Ethnicity, Both Sexes: 18 SEER Areas, 2007-2009 (Table 1.14). Available at: http://seer.cancer.gov/csr/1975_2009_pops09/results_merged/topic_lifetime_risk_diagnosis.pdf. (Accessed 2013 Jun 27)

[NMFS] National Marine Fisheries Service. 2009. Species of Concern NOAA National Marine Fisheries Service Chinook salmon Oncorhynchus tshawytscha Central Valley Fall, Late fall run ESU. Available at: http://www.nmfs.noaa.gov/pr/pdfs/species/chinooksalmon_detailed.pdf. (Accessed 2015 Jan 01)

[NOAA] National Oceanic and Atmospheric Administration. 1994. Endangered and threatened species: Status of Sacramento River winter-run Chinook salmon. 59 FR Section 440–450. Jan.

[NOAA] National Oceanic and Atmospheric Administration. 2008. Designation of Critical Habitat for the threatened Southern Distinct Population Segment of North American Green Sturgeon Final Biological Report. October 2009. Available at: http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/green_sturgeon/g_s_critical_habitat/gschd_finalbiologicalrpt.pdf. (Accessed 2015 Dec 30)

[NOAA] National Oceanic and Atmospheric Administration. 2009. Endangered and Threatened Wildlife and Plants: Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon; Final Rule. 50 CFR Part 226. Federal Register 74(195): 52300–52351. National Marine Fisheries Service. October 9, 2009. Available at: http://www.epa.gov/fedrgstr/EPASPECIES/2009/October/Day-09/e24067.htm.

[NOAA] National Oceanic and Atmospheric Administration. 2011. NOAA/West Coast and Alaska Tsunami Warning Center, Observations and Forecasts for the U.S. West Coast, British Columbia, and Alaska. Mar 11, 2011 entry, Japan Tsunami. Available at: http://wcatwc.arh.noaa.gov/previous.events/03-09-11/03-09-11.htm. (Accessed 2015 Nov 18)

[NOAA] National Oceanic and Atmospheric Administration. 2015. Center for Operational Oceanographic Products and Services, Tides and Currents. Available at: http://tidesandcurrents.noaa.gov/stations.html?type=Water+Levels. (Accessed 29 Jan 2016.

Nelson, NC. 1909. Shell Mounds in San Francisco Bay Area. M. Booker and A. Roberts. Spatial History Lab, Stanford University. http://web.stanford.edu/group/spatialhistory/media/visualizations/Shell%20Mounds%20in%20SF%20Bay.jpg (Accessed 5 April 2019).

Newell RC, Seiderer LJ, and Hitchcock DR. 1998. The impacts of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanogr. and Mar. Biol. Ann. Rev. 36:127 178.

Oliver JS, Slattery PN, Hulberg LW, and Nybakken JW. 1977. Patterns of succession in benthic infaunal communities following dredging and dredge spoil disposal in Monterey Bay, California. Technical Report D-77 27. Dredge Material Research Program. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg.

Paddison J. 2015. 1821-1847: Missions, Ranchos, and the Mexican War for Independence. University of California, Calisphere. Available at: http://www.calisphere.universityofcalifornia.edu/calcultures/eras/era3.html. (Accessed 2015 Jan 28)

Palermo MR, Teeter AM, Homziak J. 1990. Evaluation of Clamshell Dredging and Barge Overflow, Military Ocean Terminal, Sunny Point, North Carolina. Technical Report D 90 6, U.S. Army Engineer Waterways Experiment Station, Vicksburg.

Pieters A, Van Parys M, Dumon G, Speleers L. 2002. Chemical Monitoring of Maintenance Dredging Operations at Zeebrugge. Terra et Aqua 86:3-10.

Port of Los Angeles. 2008a. Pacific LA Marine Terminal LLC, Pier 400, Berth 408 Final EIR. Nov 14. Available at: https://www.portoflosangeles.org/EIR/PacificLAMarine/FEIR/feir_pacificLA_marine.asp.

Port of Los Angeles. 2008b. Pacific L.A. Marine Terminal LLC Crude Oil Terminal Final SEIS/SEIR.

Port of Stockton. 2010. Available at: http://www.portofstockton.com. Accessed: October 2015.

Reine KJ, Clarke DG, and Dickerson C. 2002. Acoustic characterization of suspended sediment plumes resulting from barge overflow. DOER Technical Notes Collection (ERDC TN-DOER-E15). U.S. Army Engineer Research and Development Center, Vicksburg. Available at: http://el.erdc.usace.army.mil/elpubs/pdf/doere15.pdf. Reine, KJ, Clarke DG, and Dickerson C. 2012. Characterization of Underwater Sounds Produced by a Backhoe Dredge Excavating Rock and Gravel (ERDC TN-DOER-E36). Dec. Available at http://www.nan.usace.army.mil/Portals/37/docs/harbor/Biological%20and%20Physical%20Monitoring/Acoustic%20Monitoring/ERDC%20TN-DOER-E36.pdf.

Reine KJ and Dickerson C. 2014. Characterization of Underwater Sounds Produced by a Hydraulic Cutterhead Dredge during Maintenance Dredging in the Stockton Deepwater Shipping Channel, California. DOER E38. U.S. Army Engineer Research and Development Center, Vicksburg. Available at: http://el.erdc.usace.army.mil/elpubs/pdf/doere38.pdf.

Robinson A and Greenfield BK. 2011. LTMS Longfin Smelt Literature Review and Study Plan. SFEI Contribution. San Francisco Estuary Institute, Oakland.

Sacramento County. 2011. Sacramento County General Plan of 2005-2030. [Amended 2011 Nov 09]

[SFRWQCB] San Francisco Bay Regional Water Quality Control Board. 1998. Staff Report: Ambient Concentrations of Toxic Chemicals in San Francisco Bay Sediments. May.

[SFRWQCB] San Francisco Bay Regional Water Quality Control Board. 2000. Regional Water Board, Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines, Draft Staff Report. May.

[SFEI] San Francisco Estuary Institute. 2011. The Pulse of the Estuary: Pollutant Effects on Aquatic Life. SFEI Contribution 660. San Francisco Estuary Institute, Oakland.

[SFEI] San Francisco Estuary Institute. 2014. Dredged Material Testing Thresholds for San Francisco Bay Area Sediments. Available at: http://www.sfei.org/content/dmmo-ambient-sediment-conditions. (Accessed 2016 Apr 05)

San Joaquin County. 2005. San Joaquin Countywide General Plan. Feb.

Schoellhamer DH. 2011. Sudden Clearing of Estuarine Waters upon Crossing the Threshold from Transport to Supply Regulation of Sediment Transport as an Erodible Sediment Pool is Depleted: San Francisco Bay, 1999. Estuaries and Coasts 34(5):885-899.

Simenstad CA. 1988. Effects of dredging on anadromous Pacific Coast fishes. Workshop Proceedings September 8 to 9, 1988. University of Washington, Seattle.

Solano County. 2008. Solano County General Plan, Planning for a Sustainable Solano County. Nov.

Sommer T, Armor C, Baxter R, Bruer R, Brown L, ChotkowskI M, Culberson S, Feyrer F, Gingras M, Herbold B, Kimmerer W, Mueller-Solger A, Nobringa M, and Souza K. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32(6): 270–277. Available at: http://dx.doi.org/10.1577/1548-8446(2007)32[270:TCOPFI]2.0.CO;2.

[SCC] State Coastal Commission. 2010. San Francisco Bay Subtidal Habitat Goals Project. Available at: http://www.sfbaysubtidal.org.

[SWCA] SWCA Environmental Consultants. 2009. Stockton and Sacramento Deepwater Ship Channel Maintenance Dredging Project 2008 Fish Community and Entrainment Monitoring Report. Prepared for U.S. Army Corps of Engineers Sacramento District. Prepared by SWCA Environmental Consultants, Portland, Oregon. Apr.

[SWRCB] State Water Resources Control Board. 2000. Revised Water Right Decision 1641, In the Matter of: Implementation of Water Quality Objectives for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; A Petition to Change Points of Diversion of the Central Valley Project and the State Water Project in the Southern Delta; and A Petition to Change places of Use of the Central Valley Project. Published December 1999. [Revised in Accordance with Order WR 2000-02] Mar. Available at: http://www.swrcb.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1641_1999dec29.pdf.

[SWRCB] State Water Resources Control Board. 2015. GeoTracker. Available at: http://geotracker.waterboards.ca.gov/map/?CMD=runreport&myaddress=richmond%2C+ca. (Accessed 2015 Jun 04)

Stevens DE and Miller LW. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin River System. North American Journal of Fisheries Management 3:425–437. Available at: http://dx.doi.org/10.1577/1548-8659(1983)3<425:EORFOA>2.0.CO;2.

Sturtevant WC, editor. 1978. Handbook of North American Indians. 20 vols. Smithsonian Institution, Washington, D.C. Available at: https://books.google.com/books?id=I6b6EEE1YlIC&pg=PA299&lpg=PA299&dq=malaria+epidemic+california+1822&source=bl&ots=EVWoKYVPu7&sig=GmAk2nVhNfMCB3AOz4E5SYuh0Lw&hl=en&sa=X&ei=CYDBVNaHAYGlNqrPgLgK&ved=0CB4Q6AEwAA#v=onepage&q=malaria%20epidemic%20california%201822&f=false. Accessed December 2015.

Sullivan, S. and J. Allan. 1996. Report on a Nautical Archaeological Survey of Four Areas in the John F. Baldwin Ship Channel. Report prepared for US Army Corps of Engineers San Francisco District. Contract No. DACW07-95-D-008.

[UCCE] University of California Cooperative Extension. 2010. California Fish Website. Available at: http://calfish.ucdavis.edu/index.cfm. (Accessed 2010 Apr)

[URS] URS Corporation. 2003. Final Program Environmental Impact Report Expansion of Ferry Transit Service in the San Francisco Bay Area. Prepared for Water Transit Authority. Jun.

[URS] URS Corporation. 2006. Final Environmental Impact Report for the Proposed Trans Bay Cable Project. Pittsburg, CA. Oct.

[USACE] U.S. Army Corps of Engineers. 1986. Environmental Effects of Dredging Technical Notes: Guide to Selecting a Dredge for Minimizing Resuspensions of Sediment. EEDP-09-01. U.S. Army Corps of Engineers Environmental Laboratory. Dec.

[USACE] U.S. Army Corps of Engineers. 2011. Utility Investigation Report San Francisco to Stockton Deep Water Ship Channel. San Francisco District, San Francisco. May.

[USACE] U.S. Army Corps of Engineers. 2012a. Environmental Assessment for Pinole Shoal Channel Maintenance Dredging for Calendar Year 2012. Sept.

[USACE] U.S. Army Corps of Engineers. 2012b. Environmental Assessment for Richmond Harbor Channels Maintenance Dredging for Calendar Year 2012. Sept.

[USACE] U.S. Army Corps of Engineers. 2014a. Draft Environmental Assessment/Environmental Impact Report Maintenance Dredging of the Federal

Navigation Channels in San Francisco Bay Fiscal Years 2015–2024. Dec.

[USACE] U.S. Army Corps of Engineers. 2015a. Coastal Engineering Manual No. 1110-2-1100. [updated Sept 30, 2015]

[USACE] U.S. Army Corps of Engineers. 2015b. Environmental Assessment/Environmental Impact Report: Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015 – 2024. Prepared for U.S. Army Corps of Engineers San Francisco District and Regional Water Quality Control Board San Francisco Bay Region. Prepared by URS Group, Inc. Apr.

[USACE] U.S. Army Corps of Engineers. 2015c. Personal communication with Tim Rimpo. Dec.

[USACE] U.S. Army Corps of Engineers. 2015e. Fish and Water Quality Monitoring Report for the 2014 Port of Stockton Dredging Projects at Berths 14–15 and Berths 18–20. Jun.

[USACE] U.S. Army Corps of Engineers. 2015f. Stockton and Sacramento Deep Water Ship Channel Maintenance Dredging and Dredge Material Placement Projects 2014 Fish Community, Entrainment and Water Quality Monitoring Report. May.

[USACE] U.S. Army Corps of Engineers. 2016. Waterborne Commerce Statistics Center. Available at: http://www.iwr.usace.army.mil/About/TechnicalCenters/WCSCWaterborneCommerceStatisticsCenter.aspx. (Accessed 2016 Mar 24)

[USACE and SCDEM] U.S. Army Corps of Engineers and Solano County Department of Environmental Management. 1998. Montezuma Wetlands Project Final Environmental Impact Report / Environmental Impact Statement. Jul.

[USACE and RWQCB] United States Army Corps of Engineers and Regional Water Quality Control Board San Francisco Bay Region. 2015. Final EA/EIR, Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay, Fiscal Years 2015-2024. Apr. Available at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/dredging/Fed%20Nav%20Channels_FEAEIR_April%202015.pdf.

[USBR] U.S. Bureau of Reclamation. 2015. Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report, Final. U.S. Department of the Interior Bureau of Reclamation Mid-Pacific Region, San Luis & Delta-Mendota Water Authority. Mar. Available at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=18361. (Accessed 2016 Jan 27)

[USEPA] U.S. Environmental Protection Agency. 2015a. Water Quality Progress Report: San Francisco Bay – Mercury. Jun. Available at: https://www.epa.gov/sites/production/files/2015-07/documents/12-sf-bay-mercury-tmdl-implementation-report-2015-06-15.pdf.

[USFWS] U.S. Fish and Wildlife Service. 1992. Status and trends report on wildlife of the San Francisco Estuary. Prepared under USEPA cooperative agreement CE-009519 0. Sacramento, California. Jan.

[USFWS] U.S. Fish and Wildlife Survey. 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP). Available at: http://www.fws.gov/sfbaydelta/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf.

[USFWS] U.S. Fish and Wildlife Service. 2010a. National Wildlife Refuge System: Habitat. Available at: http://www.fws.gov/refuges/whm/habitat.html. (Accessed 2015 Nov 12)

[USFWS] U.S. Fish and Wildlife Service. 2010b. Antioch Dunes. Available at: http://www.fws.gov/refuge/antioch_dunes/. (Accessed 2015 Nov 12)

[USFWS] U.S. Fish and Wildlife Service. 2014. Field Notes Entry SAN JOAQUIN RIVER NWR: Wayward Sea Lion Returns to the Pacific Ocean. May 20.

[USFWS and CDFW] U.S. Fish and Wildlife Service and California Department of Fish and Wildlife. 2008. Cullinan Ranch Restoration Project, Solano and Napa Counties, California. April. DEIS/EIR.

[USGCRP] U.S. Global Change Research Program. 2014. Global Climate Change Impacts in the United States. Oct.

Vale C, Ferreira AM, Micaelo C, Caetano M, Pereira E, Madureira MJ, Ramalhosa E. 1998. Mobility of Contaminants in Relation to Dredging Operations in a Mesotidal Estuary (Tagus estuary, Portugal). Water Science and Technology 37:25-31.

Wilber DH and Clarke DG. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21(4):855 875.

Word JQ and Kohn NP. 1990. Chemical evaluations of John F. Baldwin Ship Channel Sediment. Prepared by Pacific Northwest Laboratory. Prepared for the U.S. Army Corps of Engineers under a Related Services Agreement with the U.S. Department of Energy.

Wu F. 2010. Regarding: FW: Submittal of the Preliminary 60 Percent Draft SRDWSC SEIS/SEIR. Email to: K. Chamberlin, Anchor QEA. Nov 19 4:08 p.m.

Zeiner DC, Laudenslayer WF, Mayer KE, and White M. 1990. California's Wildlife. Volume II: Birds and Volume III: Mammals. California Statewide Wildlife Habitat Relationships System. California Department of Fish and Game, Sacramento, California. Available at: http://www.co.monterey.ca.us/planning/gpu/2007_GPU_DEIR_Sept_2008/Text/References/Zeiner1990a.pdf. (Accessed 2013 Oct 28)

9.2 INDEX

A

Alternatives · 3-6

C

cost · 8, 5-6, 5-7, 5-9, 5-10

E

Economics · 2-1, 3-6, 5-6, 5-7, 6-7
Economy · 3-1
Employment · 3-1
Environmental Justice · 6-7
Executive Orders
  E.O. 12898, Environmental Justice · 6-7
  E.O. 13089, Coral Reef Protection · 6-7

F

Federal · 3-6
Federal Water Project Recreation Act · 6-5

I

Income · 3-1
Introduction · 2

M

Migratory Bird Treaty Act and Migratory Bird Conservation Act · 6-6
Mitigate · 3-6
Mitigation · 5-2

N

National Environmental Policy Act · 2-1, 3-1, 3-6
No Action Alternative · 2-1, 2-28, 2-29, 2-31, 2-33, 2-35, 2-36, 2-37, 2-42, 2-44

O

ODMDS · 5-2

P

Plan Formulation · 2

R

Recommendations · 2
Recommended Plan · 2-1, 5-1, 5-6, 5-7
References · 2
Resources · 3-6
risk · 5-1, 5-13, 5-14, 6-7

S

Scoping · 2
Screening
  Alternatives · 3-1, 3-13, 3-14
System · 5-9

V

Vegetation · 4-11, 4-13, 4-26, 4-29, 4-36, 4-47, 4-48, 4-49, 4-50, 4-53, 4-56, 4-58, 4-59, 4-61, 4-62, 4-64