Draft Supplemental
Environmental Impact Report

Dutch Slough Tidal Marsh Restoration Project

SCH# 2006042009

January 2014

Prepared for the
California Department of Water Resources
and the California State Coastal Conservancy

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT: DUTCH SLOUGH TIDAL MARSH RESTORATION PROJECT

January 2014

SCH # 2006042009

Prepared for:

State of California
Department of Water Resources
FloodSAFE Environmental Stewardship and Statewide Resources Office
901 P Street, Fourth Floor
P.O. Box 942836
Sacramento, CA 94236-0001

and

California State Coastal Conservancy
1330 Broadway, 13th Floor
Oakland, CA 94612-2530

Prepared by:

Grassetti Environmental Consulting
7008 Bristol Drive
Berkeley, CA 94705
(510) 849-2354

TABLE OF CONTENTS

List of Figures

List of Tables

1. INTRODUCTION

1.1 PURPOSE OF THE SUPPLEMENTAL EIR

This supplement to the Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report [1](2010 EIR), certified by the California Department of Water Resources (DWR) on March 17, 2010, addresses the potential environmental impacts of proposed changes to the tidal wetlands restoration project in the Dutch Slough area at the mouth of Marsh Creek in Eastern Contra Costa County. This Supplemental EIR is intended to inform DWR decision-makers, other responsible and trustee agencies, and the general public of the proposed changes to the Project and their potential environmental consequences. DWR is the Lead Agency for the environmental review of the proposed Project. Unless otherwise noted, references to "the Project" in this document refer to the Project as modified by the proposed changes discussed in this document.

This Supplemental EIR has been prepared because the currently proposed Project includes a number of substantive changes to the restoration proposal described in the 2010 EIR, and these changes have the potential to result in new significant environmental effects beyond those identified in the previous EIR. The key purpose of this review is to determine whether the environmental effects of the Project as currently proposed would result in new, significant environmental effects or a substantial increase in the severity of previously identified environmental effects pursuant to Section 15163 of the California Environmental Quality Act (CEQA) Guidelines. This section of the CEQA Guidelines is discussed in more detail below.

1.2 REPORT ORGANIZATION

This Supplemental EIR is organized into the following chapters:

Chapter 1 – Introduction: Discusses the overall purpose of the Supplemental EIR; summarizes the organization of the document; discusses the function of a Supplemental EIR as described in the CEQA Guidelines.

Chapter 2 – Summary: summarizes the original and revised Project, and any changes in impacts that would result from implementation of the revised Project.

Chapter 3 – Project Description: Provides background information about the Project, including the Project's environmental review history; existing conditions at the Project site; the objectives and physical characteristics of the Project; and changes to the entitlements that would be required as part of the Project.

Chapter 4 – Supplemental Environmental Setting, Impacts, and Mitigation Measures: This chapter, which constitutes the updated environmental analysis of the proposed Project, describes existing conditions, and evaluates the potential effects of the Project as they relate to biological resources, hydrology and water quality, and cultural resources. It also provides summaries of other issues addressed in the 2010 EIR, and explains why the proposed revisions to the Project have either

[1] California Department of Water Resources, Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report, March, 2010, accessible at http://www.water.ca.gov/floodsafe/fessro/environmental/dee/dutch.cfm.

not changed, or would not have the potential to significantly adversely affect those resources.

Chapter 5 – Report Preparation: Identifies preparers of the Supplemental EIR, references used in the analysis, and organizations/individuals that were contacted.

1.3 PROPOSED MODIFICATIONS TO THE PROJECT

The Dutch Slough Tidal Marsh Restoration Project proposes wetland and upland restoration and public access to the 1,178-acre Dutch Slough property owned by DWR. The Project seeks to restore habitat for native fishes and other aquatic and wetland species, improve the understanding of restoration science in tidal marsh wetland ecosystems in the region, and provide public access to the restored area.

Since the certification of the 2010 EIR, a number of changes have been made to the Project design and proposed construction methodologies that may affect the analysis of impacts provided in that document. The following summarizes the Project changes DWR will consider in this Supplemental EIR.

- DWR is proposing to construct a new flood protection levee along the southern boundary of the restoration area to maintain or improve the existing level of flood protection for properties to the south. The southern flood protection levee, which would generally follow the southern boundary of the Project site, would require crossing Little Dutch Slough and would include installation of a new drainage culvert and flap gate in Little Dutch Slough at the levee crossing.
- DWR is proposing to shift the alignment of the eastern flood protection levee from the eastern Project boundary to an alignment on higher ground, and in a location that reduces cost and fill volumes. The new levee alignment would follow Jersey Island Road on the southern portion of the Burroughs parcel, bisect the parcel between the enhanced irrigated pasture and the restored marsh area, and connect with the existing flood protection levee on the east side of Little Dutch Slough.
- DWR is proposing to remove and replace portions of the existing outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough for public safety, stability, and flood protection purposes. Some in-water work would be required to replace armoring located below the mean tide line.
- DWR has refined the proposed management strategy on the northern portion of the Gilbert parcel to reflect management of non-tidal freshwater marsh, which would provide enhanced habitat for California black rail and giant garter snake.
- DWR has refined the proposed management strategy on the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat, which would be connected to adjacent tidal channels by breaching the Gilbert perimeter levee in two locations.

- DWR has refined the proposed management strategy on the northern portion of the Burroughs parcel to select preservation and enhancement of foraging and nesting habitat for Swainson's hawk and other avian species.
- DWR has identified a preferred alignment for relocation of the Marsh Creek delta on the Emerson parcel. The existing Marsh Creek levee would be breached at the southwest corner of the parcel and a new channel network would be constructed through the Emerson parcel to discharge into Dutch Slough. The existing tidally influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is.
- DWR is considering modifying the loop trail around the Emerson parcel to create two separate destination trails extending around the perimeter of the parcel which would end on either side of the Marsh Creek outlet breach (i.e., there would be no bridge over the outlet breach).
- DWR has revised the proposed in-water construction methodology for several Project components, including the temporary crossing of Marsh Creek and the enlargement of Little Dutch Slough. The revised construction methods would require installation of cofferdams and temporary dewatering of portions of Marsh Creek and Little Dutch Slough.
- The 2010 EIR included a mitigation measure (Mitigation 3.1.1-5) that stated breaching of the Dutch Slough Project levees would not commence until encasement of the Contra Costa Canal had been completed. The Project now proposes to potentially breach the levees prior to en-casement of the Contra Costa Canal.
- New cultural resources studies of the site identified additional resources that may be affected by Project construction.

These changes are described in detail in Chapter 2, Project Description. The entire Project, including the components that are unchanged, are also summarized in that chapter.

The 2010 EIR also addressed two related projects, the City of Oakley's Community Park and the Ironhouse Sanitary District's proposed restoration of creek and wetlands habitat on an adjacent site. No changes are proposed for those projects at this time, and they are not addressed in this Supplemental EIR given the environmental impacts for those projects (direct, indirect, and cumulative), as described in the 2010 EIR, would not change as a result of the proposed changes considered in this document.

1.4 CEQA REQUIREMENTS FOR A SUPPLEMENTAL EIR

This Supplemental EIR has been prepared in compliance with CEQA and the CEQA Guidelines, as amended. A Supplemental EIR, as defined in CEQA Guidelines Section 15163, is intended to evaluate changes to a project analyzed in a certified EIR, when those project changes could result in new or more substantial impacts – or require new or altered mitigation measures or project alternatives – beyond those already identified in the certified EIR. CEQA Guidelines Section 15162, referenced in Section 15163, lists the conditions requiring preparation of a Subsequent or Supplemental EIR:

- Substantial changes are proposed in the project which will require major revisions of the previous EIR or negative declaration due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects;

- Substantial changes occur with respect to the circumstances under which the project is undertaken which will require major revisions of the previous EIR or negative declaration due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects; or
- New information of substantial importance, which was not known and could not have been known with the exercise of reasonable diligence at the time the previous EIR was certified as complete or the negative declaration was adopted, shows any of the following:

  (A) The project will have one or more significant effects not discussed in the previous EIR or negative declarations;

  (B) Significant effects previously examined will be substantially more severe than shown in the previous EIR;

  (C) Mitigation measures or alternatives previously found not to be feasible would in fact be feasible and would substantially reduce one or more significant effects of the project, but the project proponents decline to adopt the mitigation measure or alternative; or

  (D) Mitigation measures or alternatives which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the project proponents decline to adopt the mitigation measure or alternative.

CEQA Guidelines Section 15163 states:

(a) The lead or responsible agency may choose to prepare a supplement to an EIR rather than a subsequent EIR if:

(1) Any of the conditions described in Section 15162 would require the preparation of a subsequent EIR, and

(2) Only minor additions or changes would be necessary to make the previous EIR adequately apply to the project in the changed situation.

(b) The supplement to the EIR need contain only the information necessary to make the previous EIR adequate for the project as revised.

(c) A supplement to an EIR shall be given the same kind of notice and public review as is given to a draft EIR under Section 15087.

(d) A supplement to an EIR may be circulated by itself without recirculating the previous draft or final EIR.

(e) When the agency decides whether to approve the project, the decision-making body shall consider the previous EIR as revised by the supplemental EIR. A finding under Section 15091 shall be made for each significant effect shown in the previous EIR as revised.

A Supplemental EIR is being prepared for the Project because, per CEQA Guidelines Section 15162, the proposed changes to the Project summarized in Section 1.3 above would represent changes to the development proposed for the site as anticipated in the 2010 EIR, and these changes would require revisions to the 2010 EIR due to potential new significant environmental impacts. In particular, the changes to the Project could result in additional or changed impacts to biological resources, hydrology and water quality, and cultural resources beyond those identified in the 2010 EIR.

This document includes revised sections addressing those topics only. These changed impacts are discussed in detail in Sections 4.1 through 4.3. All other topics are summarized in Section 4.4, Effects Found Not to be Significant. This additional analysis constitutes minor additions and changes to the previous EIR because of the following:

- no new significant impacts are identified beyond those identified in the 2010 EIR,
- impacts would not be substantially more severe than those described in the 2010 EIR,
- all revised impacts can be mitigated to a less-than-significant level with implementation of identified measures, and
- only 4 out of the 15 topics addressed in the 2010 EIR would be affected by the proposed changes.

Therefore, DWR determined that a Supplemental EIR is the appropriate document to analyze the proposed Project.

1.5. SCOPE OF THIS SUPPLEMENTAL EIR

On December 14, 2012, DWR circulated a Notice of Preparation (NOP) to help identify the types of impacts that could result from changes to the proposed Project, as well as potential areas of controversy. The NOP was mailed to public agencies (including the State Clearinghouse), organizations, and individuals considered likely to be interested in the proposed Project and its potential impacts. The public comment period ended on January 15, 2013. Based on preliminary research into the potential environmental effects of the Project and scoping, DWR determined that potential new significant effects of the proposed Project would be limited to the topics of biological resources, hydrology and water quality, and cultural resources. The NOP and written comments received during the scoping period are included in Appendix A.

1.6. USES OF THIS SUPPLEMENTAL EIR

This document is a project-level Supplemental EIR for the Dutch Slough Restoration Project. Its primary use is to provide CEQA compliant review of any changes to impacts identified in the 2010 EIR that may result from modifications to the proposed Project and changes to background conditions that have been identified since certification of the 2010 EIR.

Under CEQA, a responsible agency is an agency other than the lead agency that has a legal responsibility for carrying out or approving a project or elements of a project (Public Resource Code [PRC] Section 21069). Responsible agencies are encouraged to actively participate in the CEQA process of the lead agency, review the CEQA documents of the lead agencies, and use the documents when making decisions on the project. Possible CEQA responsible agencies for components of this project that are proposed to change include:

- California State Coastal Conservancy
- California Department of Fish and Wildlife (CDFW), Bay-Delta Region
- Central Valley Regional Water Quality Control Board (RWQCB)(Region 5)
- State Water Resources Control Board (SWRCB)

- City of Oakley
- Contra Costa Flood Control and Water Conservation District (CCFCWCD)
- Reclamation Districts (RD) 799 and 2137

Specifically, the following State permits would be required to construct the proposed Project:

- DFW: Incidental Take Permit for California Endangered Species Act (CESA) consultation for potential effects on state-listed species; Lake or Streambed Alteration Agreement, in accordance with California Fish and Game Code Section 1600 et. seq., for alteration of the bed, bank and/or channel of streams in the Project area.
- SWRCB: National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit) for land disturbance greater than 1-acre during construction.
- RWQCB: Water Quality Certification (WQC) in accordance with Section 401 of the Clean Water Act (CWA) and Waste Discharge Requirements.

In addition, local permits would be required from Contra Costa Water District CCWD and the Reclamation Districts for levee encroachment/construction. CCFCWCD will also issue permits for work in Marsh Creek channel.

Federal agencies and their regulatory authority for the project include:

- U.S. Army Corps of Engineers (USACE): CWA Section 404 permit for discharge of dredge or fill material to waters of the United States.
- National Marine Fisheries Service (NMFS): Federal Endangered Species Act (ESA) compliance for potential effects on anadromous fish species federally-listed as threatened or endangered.
- U.S. Fish and Wildlife Service (USFWS): ESA compliance for potential effects on resident fish and terrestrial species federally-listed as threatened or endangered.
- SHPO: In compliance with Section 106 of the National Historic Preservation Act (NHPA), as codified in 36 Code of Federal Regulations 800.4, federal agencies, such as USACE, are required to consult the State Historic Preservation Officer (SHPO) if the Project would affect resources that are eligible for listing as a historic resource on the National Register of Historic Places (NRHP).
- US Environmental Protection Agency: Oversight responsibility for federal CWA permits.

A trustee agency is a state agency having jurisdiction by law over natural resources affected by a project, which are held in trust for the people of the State of California (PRC Section 21070). Other agencies may have a non-permitting interest in proposed revisions to the project, including:

- Reclamation Districts 799 and 2137
- CALFED Bay Delta Program
- Contra Costa Water District
- East Bay Regional Park District
- Contra Costa County Flood Control and Water Conservation District

- Delta Protection Commission
- State Historic Preservation Officer
- California Department of Toxic Substances Control
- State Lands Commission

2. EXECUTIVE SUMMARY

2.1 OVERVIEW OF THE PROJECT AND SUPPLEMENTAL EIR

The Draft Environmental Impact Report (Draft EIR) for the Dutch Slough Tidal Marsh Restoration Project (hereinafter called Dutch Slough Restoration Project or Project) near Oakley in Eastern Contra Costa County (See Figures 3-1 and 3-2) addresses the potential environmental impacts of the Project. The Project entails wetland and upland restoration and public access to the 1,178-acre Dutch Slough property owned by the California Department of Water Resources (DWR). The property is comprised of three parcels separated by narrow man-made sloughs. Currently each parcel is leased for grazing.

Tidal marsh restoration is seen by most Delta planning efforts (Delta Vision, Bay Delta Conservation Plan, CALFED Ecosystem Restoration Plan) as a critical component of improving the Delta ecosystem, and the primary goal of the Dutch Slough Restoration Project is to provide ecosystem benefits, including habitat for sensitive aquatic species. The Project has been designed and will be implemented to maximize opportunities to assess the development of those habitats and measure ecosystem responses so that future Delta restoration projects will be more successful.

This supplement to the Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report [1](2010 EIR), certified by the California Department of Water Resources (DWR) on March 17, 2010, addresses the potential environmental impacts of proposed changes to the tidal wetlands restoration project in the Dutch Slough area at the mouth of Marsh Creek in Eastern Contra Costa County. This Supplemental EIR is intended to inform DWR decision-makers, other responsible and trustee agencies, and the general public of the proposed changes to the Project and their potential environmental consequences. DWR is the Lead Agency for the environmental review of the proposed Project. Unless otherwise noted, references to "the Project" in this document refer to the Project as modified by the proposed changes discussed in this document.

This Supplemental EIR has been prepared because the currently proposed Project includes a number of substantive changes to the restoration proposal described in the 2010 EIR, and these changes have the potential to result in new significant environmental effects beyond those identified in the previous EIR. The key purpose of this Supplemental EIR is to determine whether the environmental effects of the Project as currently proposed would result in new, significant environmental effects or a substantial increase in the severity of previously identified environmental effects pursuant to Section 15163 of the California Environmental Quality Act (CEQA) Guidelines, and to provide this information to the public and decision makers.

[1] California Department of Water Resources, Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report, March 2010, accessible at http://www.water.ca.gov/floodsafe/fessro/environmental/dee/dutch.cfm.

2.2 PROJECT PURPOSE AND NEED

2.2.1 The Dutch Slough Restoration Project

The proposed Dutch Slough Restoration Project would provide restored habitat for native fishes and other aquatic and wetland species. It also would provide a significant opportunity to improve understanding of restoration science in tidal marsh wetland ecosystems in the region.

The Dutch Slough Restoration Project has the following overarching goals:

1. Benefit native species by re-establishing natural ecological processes and habitats;
2. Contribute to scientific understanding of ecological restoration by implementing the Project under an adaptive management framework; and,
3. Provide shoreline access, educational, and recreational opportunities.

2.3 PROPOSED MODIFICATIONS TO THE PROJECT

Since the certification of the 2010 EIR, a number of changes have been made to the Project design and proposed construction methodologies that may affect the analysis of impacts provided in that document. The following summarizes the Project changes DWR will consider in this Supplemental EIR.

- DWR is proposing to construct a new flood protection levee along the southern boundary of the restoration area to maintain or improve the existing level of flood protection for properties to the south. The southern flood protection levee, which would generally follow the southern boundary of the Project site, would require crossing Little Dutch Slough and would include installation of a new drainage culvert and flap gate in Little Dutch Slough at the levee crossing
- DWR is proposing to shift the alignment of the eastern flood protection levee from the eastern Project boundary to an alignment on higher ground, and in a location that reduces cost and fill volumes. The new levee alignment would follow Jersey Island Road on the southern portion of the Burroughs parcel, bisect the parcel between the enhanced irrigated pasture and the restored marsh area, and connect with the existing flood protection levee on the east side of Little Dutch Slough.
- DWR is proposing to remove and replace portions of the existing outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough for public safety, stability, and flood protection purposes. Some in-water work would be required to replace armoring located below the mean tide line.

- DWR has refined the proposed management strategy on the northern portion of the Gilbert parcel to reflect management of non-tidal freshwater marsh, which would provide enhanced habitat for California black rail and giant garter snake.
- DWR has refined the proposed management strategy on the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat, which would be connected to adjacent tidal channels by breaching the Gilbert perimeter levee in two locations.
- DWR has refined the proposed management strategy on the northern portion of the Burroughs parcel to select preservation and enhancement of foraging and nesting habitat for Swainson's hawk and other avian species.
- DWR has identified a preferred alignment for relocation of the Marsh Creek delta on the Emerson parcel. The existing Marsh Creek levee would be breached at the southwest corner of the parcel and a new channel network would be constructed through the Emerson parcel to discharge into Dutch Slough. The existing tidally influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is.
- DWR has revised the proposed in-water construction methodology for several Project components, including the temporary crossing of Marsh Creek and the enlargement of Little Dutch Slough. The revised construction methods would require installation of cofferdams and temporary dewatering of portions of Marsh Creek and Little Dutch Slough.
- The 2010 EIR included a mitigation measure (Mitigation 3.1.1-5) that stated breaching of the Dutch Slough Project levees would not commence until encasement of the Contra Costa Canal had been completed. The Project now proposes to potentially breach the levees prior to encasement of the Contra Costa Canal.
- New cultural resources studies of the site identified additional resources that may be affected by Project construction.

2.4 PURPOSE AND USE OF THIS SUPPLEMENTAL EIR

This Supplemental EIR has been prepared in compliance with CEQA and the CEQA Guidelines, as amended. A Supplemental EIR is being prepared for the Project because, per CEQA Guidelines Section 15162, the proposed changes to the Project summarized above would represent a change to the development proposed for the site as anticipated in the 2010 EIR, and this change would require changes to the 2010 EIR due to potential new significant environmental impacts. In addition, some impacts identified in the 2010 EIR have been eliminated due to design changes to the selected project.

Based on a comparison of the proposed changes to the Project with the potential environmental effects identified in the 2010 EIR, as well as scoping for this EIR, DWR determined that potential new significant effects of the proposed Project would be limited to the topics of biological resources, hydrology and water quality, and cultural resources. These changed impacts are discussed in detail in Chapter 4, Supplemental Environmental Setting, Impacts, and Mitigation Measures. This additional analysis would not constitute a major change to the previous EIR because of the limited potential for new or substantially revised impacts and the limited number of resource areas that may experience revised impacts. Therefore, DWR determined that a Supplemental EIR is the appropriate document to analyze the revised Project.

2.5 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The environmental impacts and mitigation measures of the Dutch Slough Restoration Project for hydrology/water quality, biological resources, and cultural resources are summarized on Table 2-1 and are briefly described by topic below. Table 2-2 provides a cross-reference showing how impacts and mitigation measures changed for these topics between the 2010 EIR and Supplemental Draft EIR. Impacts and mitigation measures for other resource areas (described in Chapter 4, Effects Found Not to Be Significant) have not changed and remain as summarized in the 2010 Final EIR.

Hydrology and Geomorphology

As described in the 2010 EIR, the Project would have potential impacts on erosion in terminal sloughs due to increased tidal prisms, possible decreased flood flow conveyance of Marsh Creek, possible changes in groundwater levels due to groundwater seepage, potential levee overtopping into the Contra Costa Canal, and sedimentation issues. Groundwater seepage into the Contra Costa Canal is re-evaluated in this Supplement EIR in light of a new seepage study and the Project's likely construction prior to canal encasement. This impact is addressed in the hydrology and water quality section of this document and was determined to be mitigated to a less-than-significant level. Most geomorphic and hydrologic impacts would be less than significant or would be mitigated to less than significant levels by implementation of mitigation measures identified in the 2010 EIR. The Project would be designed such that planned levees and deposition of plant materials and sediments would partially reduce/offset the effects of anticipated sea-level rise, however this impact may still be significant as further discussed in Chapter VI-1.

Water Quality

As described in the 2010 EIR, the Project would have potential short-term impacts of degradation of water quality due to potential release of contaminants and sediment from construction activities, degradation of water quality due to increased mercury and dissolved organic carbon in Delta waters, increased erosion and turbidity, possible increased salinity in the

Contra Costa Canal, and possible degradation of water quality from other pollutant sources associated with fill materials and Marsh Creek flows. Water quality impacts would be mitigated to less than significant levels by implementation of mitigation measures identified in this Supplemental EIR. The primary change from impacts described in the 2010 EIR is that the Contra Costa Canal would not necessarily be encased prior to project construction, resulting in the need for new mitigation measures. Other impacts and mitigation measures have been revised compared to the 2010 EIR because changes in the project have eliminated the impacts/need for mitigation measures, or new information has resulted in refinement of the measures.

Geology and Soils

As described in the 2010 EIR, the Project would have potential impacts of exposing people or structures to potential substantial adverse effects (including liquefaction and levee failure) resulting from strong seismic ground shaking, erosion of soil, and seepage-induced levee failure. All short-term geological and soils impacts would be less than significant or would be mitigated to less than significant levels by implementation of mitigation measures identified in the 2010 EIR. In addition, through construction or reconstruction of levees surrounding the site to increase their resistance to seismic shaking and liquefaction, the Project would provide additional flood control benefits to the surrounding lands.

Biological Resources

As described in the 2010 EIR, the Project would provide significant habitat benefits by creating tidal marsh and other habitats; however the Project would also have potentially significant impacts to wildlife by disturbing or eliminating existing freshwater marsh and seasonal wetland habitats and terrestrial habitats, including riparian woodland/scrub, as well as short-term impacts to a number of individual sensitive species. Impacts to terrestrial biological resources would be less than significant or would be mitigated to less than significant levels by implementation of mitigation measures identified in this Supplemental EIR, as summarized in Table 2-1, below.

Similarly, the Project would have long-term beneficial effects on aquatic resources both within the project site and in surrounding waters, although decreased water quality, creation of habitat for non-native fishes, entrainment of fish, and levee repair activities as a result of Project construction may have limited adverse impacts to some aquatic species. Most Project impacts would be less than significant or would be mitigated to less than significant levels by implementation of mitigation measures identified in this Supplemental EIR. There may be significant unavoidable impacts to aquatic resources related to the potential introduction of non-native fish, as summarized in Table 2-1 below.

Air Quality

As described in the 2010 EIR, the Project would have potential short-term impacts from construction emissions, which would be mitigated to less than significant levels by implementation of mitigation measures identified in the 2010 EIR. Vehicular emissions of all alternatives would be less than significant. In the long-term, the Project would reduce dust emissions associated with agricultural uses of the site.

Noise

As described in the 2010 EIR, the Project would have potential short-term construction noise impacts that would be less than significant.

Aesthetics

As described in the 2010 EIR, the Project would not affect light and glare. Other aesthetic issues would be less than significant or cause no impact.

Land Use

As described in the 2010 EIR, the Project is not expected to conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the Project. It would not affect other land use issues, such as physically dividing an established community.

Agricultural Resources

As described in the 2010 EIR, the Project would not conflict with a Williamson Act (agricultural land preservation) contract. There would be a less-than significant conversion related to agricultural resources, based on compliance with agricultural policies contained in the City of Oakley General Plan.

Recreation

As described in the 2010 EIR, the creation of a loop trail around the perimeter of the Emerson parcel would provide improved shoreline access, education, and recreational opportunities, consistent with the City of Oakley's General Plan. Although the Project could generate conflicts between non-motorized watercraft and motorized watercraft, recreational impacts would be less than significant or would be mitigated to less-than-significant levels by implementation of mitigation measures identified in this 2010 EIR.

Cultural Resources

New cultural resources studies since certification of the 2010 EIR found an additional archaeological site on the Project site. Old vineyards on a portion of the site also have historic values. Impacts associated with this resource would be mitigated to a less than significant level. The project's significant unavoidable impacts to rural historic landscapes would remain as identified in the 2010 EIR.

Transportation/Traffic

As described in the 2010 EIR, the Project would have the potential to generate construction-related, operational, and other traffic issues, which would be less than significant.

Public Services, Utilities, and Service Systems

As described in the 2010 EIR, the Project's potential impact to police protection, fire protection, water supply, wastewater, storm drainage, and electrical and gas transmission would be less than significant or mitigated to less than significant levels.

Hazards and Hazardous Materials

As described in the 2010 EIR, the potential effects of soils contamination and building demolition would be mitigated to less than significant levels by implementation of mitigation measures identified in the 2010 EIR.

Cumulative Impacts

As described in the 2010 EIR, the proposed Project and other proposed or approved projects in the area could result in short- or long-term cumulative impacts to hydrology and geomorphology, water quality, geology and soils, air quality, noise, aesthetics, land use, recreation, transportation/traffic, public services, utilities and service systems, and hazardous materials. However, all of these cumulative impacts would be less than significant or less than significant after mitigation.

The Project and other proposed or approved projects in the area would contribute to significant cumulative impacts on terrestrial and wetland biological resources, and on the Dutch Slough Rural Historic Landscape. Mitigation would reduce the Project's contribution to these impacts, however they would still be significant. The Projects also would result in cumulative benefits associated with provision of habitat for aquatic resources as well as recreation.

2.6 SIGNIFICANT UNAVOIDABLE IMPACTS

The Project's significant unavoidable impacts would be the same as described in the 2010 EIR except that it would no longer have the potential to result in a significant unavoidable impact to burrowing owls in the Project area. Significant unavoidable impacts of the project as currently proposed would be:

- Creation of habitat that benefits non-native fish species
- Demolition of historic buildings/rural historic landscape features.
- Cumulative loss of rural historic landscapes

TABLE 2-1. SUMMARY OF SUPPLEMENTAL IMPACTS AND MITIGATIONS

Supplemental EIR Impact		Proposed Mitigation		Impact Significance
Number	Impact	Number	Mitigation Measure	
Hydrology and Water Quality				
4.1-1	Erosion in terminal sloughs due to increased tidal prisms	4.1-1	Erosion monitoring and adaptive management of Emerson Slough	SM
4.1-2	Point bar formation in Marsh Creek	4.1-2	Marsh Creek channel monitoring	SM
4.1-3	Sedimentation in tidal portion of relocated Marsh Creek	4.1-2	Marsh Creek channel monitoring	SM
4.1-4	Peak fluvial-tidal deposition	4.1-2	Marsh Creek channel monitoring	SM
4.1-5	Possible water quality degradation in Contra Costa Canal due to groundwater seepage	4.1-3	Phase I, Emerson Parcel, breach after encasement	SM
		4.1-4	Manage and monitor during tule cultivation on Gilbert and Burroughs Parcels	
		4.1-5	Reduce or eliminate seepage effects	
4.1-6	Groundwater intrusion onto adjacent parcels	4.1-6	Groundwater intrusion protection-east of site	SM
		4.1-7	Groundwater monitoring	
4.1-7	Wind-wave driven levee overtopping into Contra Costa Canal	N/A	No impact	NI
4.1-8	Insufficient sedimentation in new tidal wetlands	N/A	None identified	N/A
4.1-9	Limited persistence of shallow tidal marsh channels	N/A	Less than significant. No mitigation identified	LS
4.1-10	Degradation of water quality due to release of contaminants and sediment from construction activities	4.1-8	Develop a Storm Water Pollution Prevention Plan	SM
		4.1-9	Dewatering restriction	
		4.1-10	Contractor training for protection of water quality	
		4.1-11	Minimize potential pollution caused by inundation of site	

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR
LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

4.1-11	Degradation of water quality due to increased dissolved organic carbon in Delta waters	4.1-12	Marsh Creek water quality testing and evaluate feasibility of Marsh Creek relocation based on water quality considerations	SM
4.1-12	Operational degradation of water quality due to increase erosion and turbidity	4.1-1	Erosion monitoring and adaptive management of Emerson Slough	SM
4.1-13	Potential degradation of water quality due to increased mercury methylation	N/A	Less than significant. No mitigation required.	LS
4.1-14	Degradation of drinking water quality due to alteration to salinity levels in Delta waters	N/A	Less than significant. No mitigation required.	LS
4.1-15	Degradation of water quality due to increased salinity concentrations in Contra Costa Canal	4.1-3	Phase I, Emerson Parcel, breach after encasement	SM
		4.1-4	Manage and monitor during tule cultivation on Gilbert and Burroughs Parcels	
		4.1-5	Reduce or eliminate seepage effects	
4.1-16	Degradation of water quality due to elevated metals, endocrine disrupting chemicals, or other pollutants	4.1-12	Marsh Creek water quality testing and evaluate feasibility of Marsh Creek relocation based on water quality considerations	SM
4.1-17	Cumulative Impacts	NA	Mitigations 4.1-1 through 4.1-12, above apply to Project contribution to cumulative impacts	SM
Biological Resources - Terrestrial				
4.2-1	Potential impacts to irrigated pasture (including jurisdictional seasonal wetlands) and associated wildlife species	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
4.2-2	Recreation-related wildlife disturbance	N/A	Less than significant. No mitigation required.	LS

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

4.2-3	Impacts of Enlarging Little Dutch Slough (Tidal Marsh Erosion)	N/A	Less than significant. No mitigation required.	LS
4.2-4	Wildlife disturbance associated with maintenance of exterior levee	4.2-2	Minimize disturbance associated with maintenance of exterior levee	SM
		4.2-3	Rock slope protection placement and backfill and riparian planting	
4.2-5	Potential impacts to tidal freshwater marsh habitats and associated wildlife species	N/A	Less than significant. No mitigation required.	LS
4.2-6	Potential impacts to non-tidal freshwater marsh and riparian woodland/scrub and associated wildlife species	N/A	Less than significant. No mitigation required.	LS
4.2-7	Potential impacts to alkali meadow and seasonal wetland flats and associated wildlife species	N/A	Less than significant. No mitigation required.	LS
4.2-8	Fill of Little Dutch Slough to accommodate southern levee	N/A	Less than significant. No mitigation required.	LS
4.2-9	Potential impacts to special-status plants	4.2-4	Mitigation for potential impacts to special-status plants	SM
4.2-10	Potential impacts to special-status bat species	4.2-5	Minimization and compensation for potential impacts to special-status bat species	SM
4.2-11	Potential impacts to Cooper's hawk	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-6	Mitigation for potential impacts to Cooper's hawk	

KEY:

SU = Significant and not mitigable impact   SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact   NI = No impact   B = Beneficial impact   ? = unknown/speculative impact

4.2-12	Impacts to Swainson's hawk	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-7	Conduct Swainson's hawk nest surveys and establish buffers around active nests	
		4.2-8	Plant replacement trees	
4.2-13	Potential impacts to burrowing owls	4.2-9	Mitigation for potential impacts to burrowing owl	SM
4.2-14	Potential impacts to white-tailed kite and northern harrier	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-10	Mitigation for potential impacts to nesting birds	
4.2-15	Potential impacts to nesting birds	4.2-10	Mitigation for potential impacts to nesting birds	SM
4.2-16	Potential impacts to tri-colored blackbird	N/A	Less than significant. No mitigation required.	LS
4.2-17	Potential impacts to California horned lark	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-10	Mitigation for potential impacts to nesting birds	
4.2-18	Potential impacts to loggerhead shrike	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-10	Mitigation for potential impacts to nesting birds	
4.2-19	Potential impacts to yellow-breasted chats and other songbirds of marsh and riparian habitats	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	SM
		4.2-11	Mitigation for potential impacts to yellow-breasted chats and other songbirds of marsh and riparian habitats	
4.2-20	Potential impacts to special-status wading birds	N/A	Less than significant. No mitigation required.	LS

KEY:

SU = Significant and not mitigable impact

SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact

NI = No impact

B = Beneficial impact

? = unknown/speculative impact

4.2-21	Potential impacts to California black rail	4.2-2	Minimize disturbance associated with maintenance of exterior levee	SM
		4.2-3	Rock slope protection placement and backfill and riparian planting	
		4.2-12	Mitigation for potential impacts to California black rail	
4.2-22	Potential Impacts to California tiger salamander	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	SM
4.2-23	Potential Impacts to California red-legged frog	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	SM
4.2-24	Potential Impacts to northwestern pond turtle	4.2-2	Minimize disturbance associated with maintenance of exterior levee	SM
		4.2-3	Rock slope protection placement and backfill and riparian planting	
		4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	
4.2-25	Potential impacts to giant garter snake	4.2-2	Minimize disturbance associated with maintenance of exterior levee	SM
		4.2-3	Rock slope protection placement and backfill and riparian planting	
		4.2-14	Mitigation for potential impacts to giant garter snake	
4.2-26	Potential impacts to silvery legless lizard	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	SM
4.2-27	Potential impacts to vernal pool invertebrates	N/A	No impact	NI
4.2-28	Potential impacts to valley elderberry longhorn beetle	N/A	No impact	NI

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

4.2-29	Potential impacts to heritage or other trees protected by local ordinance	4.2-15	Mitigation for potential impacts to protected trees	SM
4.2-30	Cumulative Impacts (Terrestrial Resources)	N/A	Less than significant. No mitigation required	LS
Biological Resources - Aquatic				
4.2-31	Decreased water quality due to construction / dredging activities	4.2-16	Develop a Storm Water Pollution Prevention Plan	SM
		4.2-17	In-water construction windows	
4.2-32	Stranding or entrainment of fish in cofferdams	4.2-18	Implement fish rescue plan inside cofferdams	SM
4.2-33	Pile driving effects on fish species	4.2-19	Pile driving underwater sound pressure measures	SM
4.2-34	Release of low quality water from Project during revegetation period	4.2-20	Release on-site water gradually	SM
		4.2-21	Limit operation during migration periods of sensitive species	
		4.2-22	Maintain short residence time	
4.2-35	Entrainment of fish into areas disconnected from the delta	4.2-23	Install fish screens on pumps and culverts	SM
4.2-36	Mercury methylation could case bioaccumulation and toxicity to fish	N/A	Less than significant. No mitigation required.	LS
4.2-37	Disturbance of benthic habitats	N/A	Less than significant. No mitigation required.	LS
4.2-38	Creation of habitat that benefits non-native fish species	4.2-34	Enhance tidal exchange	SU
4.2-39	Endocrine disrupting chemicals and other contaminants entering the site from Marsh Creek or from fill soils could harm fish	4.2-25	Water quality monitoring	SM
4.2-40	Impacts to riparian woodland cover	N/A	Less than significant. No mitigation required.	LS
4.2-41	Cumulative Impacts (Aquatic Resources)	N/A	Less than significant. No mitigation required.	LS

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR
LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

Cultural Resources				
4.3-1	Potential disturbance of the Native American archaeological site on the Gilbert Parcel (CCO-820/H)	4.3-1	Implement treatment plan	SM
4.3-2	Potential disturbance of the Prehistoric habitation site in the Jose Vineyard	4.3-2	Implement treatment plan	SM
4.3-3	Loss of unknown archaeological resources	4.3-3	Implement a Cultural Resources Monitoring and Inadvertent Discoveries Plan	SM
		4.3-4	Worker awareness training	
4.3-4	Demolition of historic structures / landscape features that contribute to the rural historic landscape	4.3-5	Historic documentation	SU
4.3-5	Disturbance of the Jose Vineyard	4.3-6	Implement treatment plan	SU
4.3-6	Cumulative impacts to cultural resources	N/A	No mitigation prescribed	SU

KEY:

SU = Significant and not mitigable impact

SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact

NI = No impact

B = Beneficial impact

? = unknown/speculative impact

TABLE 2-2. IMPACT AND MITIGATION MEASURE CROSS-REFERENCE: SUPPLEMENTAL EIR AND 2010 FINAL EIR

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
Hydrology and Water Quality					
4.1-1	Erosion in terminal sloughs due to in-creased tidal prisms	4.1-1	Erosion monitoring and adaptive management of Emerson Slough	Same as Impact 3.1.2-1	Replaces Mitigation 3.1.2-1.2; Mitigation 3.1.2-1.1 is no longer applicable.
4.1-2	Point bar formation in Marsh Creek	4.1-2	Marsh Creek channel monitoring	Replaces Impact 3.1.2-3	Replaces (and combines) Mitigations 3.1.2-3 and 3.1.2-4.1
4.1-3	Sedimentation in tidal portion of relocated Marsh Creek	4.1-2	Marsh Creek channel monitoring	Same as Impact 3.1.2-4	Replaces (and combines) Mitigations 3.1.2-3 and 3.1.2-4.1
4.1-4	Peak fluvial-tidal deposition	4.1-2	Marsh Creek channel monitoring	Replaces Impact 3.1.2-5	Replaces (and combines) Mitigations 3.1.2-3 and 3.1.2-4.1
4.1-5	Possible water quality degradation in Contra Costa Canal due to groundwater seepage	4.1-3	Phase I, Emerson Parcel, breach after encasement	Replaces Impact 3.1.2-7	Replaces Mitigation3.1.2-7
		4.1-4	Manage and monitor water during tule cultivation on Gilbert and Bur-roughs Parcels		
		4.1-5	Reduce or eliminate seepage effects		
4.1-6	Groundwater intrusion onto adjacent parcels	4.1-6	Groundwater intrusion protection-east of site	Replaces Impact 3.1.2-8	Same as Mitigation 3.1.1-6.2; Mitigation 3.1.1-6.3 no longer necessary
		4.1-7	Groundwater monitoring		Replaces Mitigations 3.1.1-6.1 and 3.1.1-6.2

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
4.1-7	Wind-wave driven levee overtopping into Contra Costa Canal	N/A	No impact	Same as Impact 3.1.2-9	Mitigation 3.1.2-9 is no longer applicable
4.1-8	Insufficient sedimentation in new tidal wetlands	N/A	None identified	Same as Impact 3.1.2-10	None identified
4.1-9	Limited persistence of shallow tidal marsh channels	N/A	Less than significant. No mitigation required.	Same as Impact 3.1.2-11	Mitigation 3.1.2-11 is no longer necessary
4.1-10	Degradation of water quality due to re-lease of contaminants and sediment from construction activities	4.1-8	Develop a Storm Water Pollution Prevention Plan	Replaces Impact 3.2.2-1	Replaces Mitigation 3.2.1-1.1
		4.1-9	Dewatering restriction		Same as Mitigation 3.2.1-1.2
		4.1-10	Contractor training for protection of water quality		Same as Mitigation 3.2.1-1.3
		4.1-11	Minimize potential pollution caused by inundation of site		Same as Mitigation 3.2.1-1.4
4.1-11	Degradation of water quality due to in-creased dissolved organic carbon in Delta waters	4.1-12	Marsh Creek water quality testing and evaluate feasibility of Marsh Creek relocation based on water quality considerations	Replaces Impact 3.2.2-2	Replaces Mitigation 3.2.1-2.1 and 3.2.1-7; Mitigation 3.2.1-2.2 has already been accomplished
4.1-12	Operational degradation of water quality due to increased erosion and turbidity	4.1-1	Erosion monitoring and adaptive management of Emerson Slough	Replaces Impact 3.2.2-3	Mitigation 3.2.1-3 no longer applicable
4.1-13	Potential degradation of water quality due to increased mercury methylation	N/A	Less than significant. No mitigation required.	Same as Impact 3.2.2-4	Mitigation 3.2.1-4 is no longer applicable.
4.1-14	Degradation of drinking water quality due to alteration to salinity levels in Delta waters	N/A	Less than significant. No mitigation required.	Replaces Impact 3.2.2-5	No mitigation identified
4.1-15	Degradation of water quality due to in-creased salinity concentrations in Contra	4.1-3	Phase I, Emerson Parcel, breach after encasement	Replaces Impact 3.2.2-6	Replaces Mitigation 3.1.2-7

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR
LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
4.1-15	Costa Canal (from elevated groundwater)	4.1-3	Phase I, Emerson Parcel, breach after encasement	Replaces Impact 3.2.2-6	
		4.1-4	Manage and monitor water during tule cultivation on Gilbert and Bur-roughs Parcels		
		4.1-5	Reduce or eliminate seepage effects		
4.1-16	Degradation of water quality due to ele-vated metals, endocrine disrupting chemi-cals, or other pollutants	4.1-12	Marsh Creek water quality testing and evaluate feasibility of Marsh Creek relocation based on water quality considerations	Replaces Impact 3.2-7	Replaces Mitigation 3.2.1-2.1 and 3.2.1-7;
4.1-17	Cumulative Impacts	N/A	Mitigations 4.1-1 through 4.1-12, above apply to Project contribution to cumulative impacts	Same as Impact 3.2.2-8	None identified
Biological Resources - Terrestrial					
4.2-1	Potential impacts to irrigated pasture (including jurisdictional seasonal wet-lands) and associated wildlife species	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Revises Impact 3.4.2-1.1	Same as Mitigation 3.4.2-1.1
4.2-2	Recreation-related wildlife disturbance	N/A	Less than significant. No mitigation required.	Replaces Impacts 3.4.2-1.2 and 3.4.2-2.2	Mitigations 3.4.2-1.2 and 3.4.2-2.2 no longer appli-cable
4.2-3	Impacts of Enlarging Little Dutch Slough (Tidal Marsh Erosion)	N/A	Less than significant. No mitigation required.	Revises Impact 3.4.1-2.1	Mitigations 3.4.1-2.1A and 3.4.1-2.1B no longer appli-cable
4.2-4	Wildlife disturbance associated with main-tenance of exterior levee	4.2-2	Minimize disturbance associated with maintenance of exterior levee	Revises Impact 3.4.1-2.3	Same as Mitigation 3.4.1-2.3
		4.2-3	Rock slope protection placement and backfill and riparian planting		New mitigation

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR
LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
4.2-5	Potential impacts to tidal freshwater marsh habitats and associated wildlife species	N/A	Less than significant. No mitigation required.	Same as Impact 3.4.2-2.1	No mitigation required
4.2-6	Potential impacts to non-tidal freshwater marsh and riparian woodland/scrub and associated wildlife species	N/A	Less than significant. No mitigation required.	Revises Impact 3.4.2-3	Mitigation 3.4.2-3 no longer applicable
4.2-7	Potential impacts to alkali meadow and seasonal wetland flats and associated wildlife species	N/A	Less than significant. No mitigation required.	Revises Impact 3.4.2-4	Mitigation 3.4.2-4 no longer applicable
4.2-8	Fill of Little Dutch Slough to accommodate southern levee	N/A	Less than significant. No mitigation required.	New impact	N/A
4.2-9	Potential impacts to special-status plants	4.2-4	Mitigation for potential impacts to special-status plants	Same as Impact 3.4.2-5	Same as Mitigation 3.4.2-5
4.2-10	Potential impacts to special-status bat species	4.2-5	Minimization and compensation for potential impacts to special-status bat species	Same as Impact 3.4.2-6	Replaces Mitigation 3.4.2-6
4.2-11	Potential impacts to Cooper's hawk	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Same as Impact 3.4.2-7	Same as Mitigation 3.4.2-1.1
		4.2-6	Mitigation for potential impacts to Cooper's hawk		Same as Mitigation 3.4.2-7
4.2-12	Impacts to Swainson's hawk	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Revises Impact 3.4.2-8	Same as Mitigation 3.4.2-1.1
		4.2-7	Conduct Swainson's hawk nest surveys and establish buffers around active nests		Replaces Mitigation3.4.1-8.2

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
		4.2-8	Plant replacement trees		New mitigation. Mitigation 3.4.1-8.2 no longer applicable.
4.2-13	Potential impacts to burrowing owls	4.2-9	Mitigation for potential impacts to burrowing owl	Same as Impact 3.4.2-9	Same as Mitigation 3.4.2-9
4.2-14	Potential impacts to white-tailed kite and northern harrier	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Same as Impact 3.4.2-10	Same as Mitigation 3.4.2-1.1
		4.2-10	Mitigation for potential impacts to nesting birds		Replaces Mitigation 3.4.2-11
4.2-15	Potential impacts to nesting birds	4.2-10	Mitigation for potential impacts to nesting birds	Same as Impact 3.4.2-11	Replaces Mitigation 3.4.2-11
4.2-16	Potential impacts to tri-colored blackbird	N/A	Less than significant. No mitigation required.	Same as Impact 3.4.2-12	Mitigation 3.4.1-12 no longer applicable
4.2-17	Potential impacts to California horned lark	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Revises Impact 3.4.2-13	Same as Mitigation 3.4.2-1.1
		4.2-10	Mitigation for potential impacts to nesting birds		Replaces Mitigation 3.4.2-11
4.2-18	Potential impacts to loggerhead shrike	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Revises Impact 3.4.2-14	Same as Mitigation 3.4.2-1.1
		4.2-10	Mitigation for potential impacts to nesting birds		Replaces Mitigation 3.4.2-11
4.2-19	Potential impacts to yellow-breasted chats and other songbirds of marsh and riparian habitats	4.2-1	Avoid and minimize effects of loss of irrigated pasture through Project timing and phasing	Same as Impact 3.4.2-15	Same as Mitigation 3.4.2-1.1

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
		4.2-11	Mitigation for potential impacts to yellow-breasted chats and other songbirds of marsh and riparian habitats		Same as Mitigation 3.4.2-15
4.2-20	Potential impacts to special-status wading birds	N/A	Less than significant. No mitigation required.	Revises Impact 3.4.2-16	Mitigation 3.4.2-16 no longer applicable
4.2-21	Potential impacts to California black rail	4.2-2	Minimize disturbance associated with maintenance of exterior levee	Revises Impact 3.4.2-17	Same as Mitigation 3.4.1-2.3
		4.2-3	Rock slope protection placement and backfill and riparian planting		New mitigation
		4.2-12	Mitigation for potential impacts to California black rail		Replaces Mitigation 3.4.2-17
4.2-22	Potential Impacts to California tiger salamander	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	Same as Impact 3.4.2-18	Replaces Mitigation 3.4.2-18
4.2-23	Potential Impacts to California red-legged frog	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	Same as Impact 3.4.2-19	Replaces Mitigation 3.4.2-19
4.2-24	Potential Impacts to northwestern pond turtle	4.2-2	Minimize disturbance associated with maintenance of exterior levee	Same as Impact 3.4.2-20	Same as Mitigation 3.4.1-2.3
		4.2-3	Rock slope protection placement and backfill and riparian planting		New mitigation
		4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard		Replaces Mitigation 3.4.2-20

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
4.2-25	Potential impacts to giant garter snake	4.2-2	Minimize disturbance associated with maintenance of exterior levee	Revises Impact 3.4.2-21	Same as Mitigation 3.4.1-2.3
		4.2-3	Rock slope protection placement and backfill and riparian planting		New mitigation
		4.2-14	Mitigation for potential impacts to giant garter snake		Replaces Mitigation 3.4.2-21
4.2-26	Potential impacts to silvery legless lizard	4.2-13	Surveys for California tiger salamander, California red-legged frog, western pond turtle, and silvery legless lizard	Same as Impact 3.4.2-22	Replaces Mitigation 3.4.2-22
4.2-27	Potential impacts to vernal pool invertebrates	N/A	No impact	Revises Impact 3.4.2-23	Mitigation 3.4.2-23 no longer applicable
4.2-28	Potential impacts to valley elderberry longhorn beetle	N/A	No impact	Revises Impact 3.4.2-24	Mitigation 3.4.1-24 no longer necessary
4.2-29	Potential impacts to heritage or other trees protected by local ordinance	4.2-15	Mitigation for potential impacts to protected trees	Same as Impact 3.4.2-25	Same as Mitigation 3.4.2-25
4.2-30	Cumulative Impacts (Terrestrial Resources)	N/A	Less than significant. No mitigation required.	Revises Cumulative Impacts in 2010 EIR	No mitigation identified
Biological Resources - Aquatic					
4.2-31	Decreased water quality due to construction / dredging activities	4.2-16	Develop a Storm Water Pollution Prevention Plan	Revises Impact 3.5.2-1	Revises Mitigation 3.5.1-1.1
		4.2-17	In-water construction windows		Replaces Mitigation 3.5.1-1.2; Mitigation 3.5.1-1.3 no longer necessary
4.2-32	Stranding or entrainment of fish in cofferdams	4.2-18	Implement fish rescue plan inside cofferdams	New impact	New mitigation

KEY:

SU = Significant and not mitigable impact SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact NI = No impact B = Beneficial impact ? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
4.2-33	Pile driving effects on fish species	4.2-19	Pile driving underwater sound pressure measures	New impact	New mitigation
4.2-34	Release of low quality water from Project during revegetation period	4.2-20	Release on-site water gradually	Same as Impact 3.5.2-2	Revises Mitigation 3.5.1-2.1
		4.2-21	Limit operation during migration periods of sensitive species		Same as Mitigation 3.5.1-2.2
		4.2-22	Maintain short residence time		Same as Mitigation 3.5.1-2.3
4.2-35	Entrainment of fish into areas disconnected from the delta	4.2-23	Install fish screens on pumps and culverts	Same as Impact 3.5.2-3	Replaces Mitigation 3.5.1-3
4.2-36	Mercury methylation could case bioaccumulation and toxicity to fish	N/A	Less than significant. No mitigation required.	Same as Impact 3.5.2-4	No mitigation identified
4.2-37	Disturbance of benthic habitats	N/A	Less than significant. No mitigation required.	Same as Impact 3.5.2-5	No mitigation identified
4.2-38	Creation of tidal habitat that benefits non-native fish species	4.2-24	Enhance tidal exchange	Same as Impact 3.5.2-6	Same as Mitigation 3.5.1-6
4.2-39	Endocrine disrupting chemicals and other contaminants entering the site from Marsh Creek or from fill soils could harm fish	4.2-25	Water quality monitoring	Same as Impact 3.5.2-7	Replaces Mitigation 3.5.1-7.1
4.2-40	Impacts to riparian woodland cover	N/A	Less than significant. No mitigation required.	New impact	N/A
4.2-41	Cumulative Impacts (Aquatic Resources)	N/A	Less than significant. No mitigation required	Revises Cumulative Impacts in 2010 EIR	No mitigation identified
Cultural Resources					
4.3-1	Potential disturbance of the Native American archaeological site on the Gilbert	4.3-1	Implement treatment plan	New impact	New mitigation

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR

LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

Supplemental EIR Impact		SEIR Mitigation Measures		Comparison with 2010 FEIR Impacts and Mitigation Measures	
Number	**Impact**	**Number**	**Mitigation Measure**	**Impact**	**Mitigation**
	Parcel (CCO-820/H)				
4.3-2	Potential disturbance of the Pre-historic habitation site in the Jose Vineyard	4.3-2	Implement treatment plan	New impact	New mitigation
4.3-3	Loss of unknown archaeological re-sources	4.3-3	Develop and Implement a Cultural Resources Monitoring and Inadver-tent Discoveries Plan	Same as Impact 3.12.2-1	Modifies Mitigation 3.12.1-1
		4.3-4	Worker awareness training		New mitigation
4.3-4	Demolition of historic structures / land-scape features that contribute to the rural historic landscape	4.3-5	Historic documentation	Same as Impact 3.12-2	Same as Mitigation 3.12.1-2.3
4.3-5	Disturbance of the Jose Vineyard	4.3-6	Implement treatment plan	New impact	New mitigation
4.3-6	Cumulative Impacts to Cultural Resources (less than significant)	N/A	No mitigation prescribed	Same as Impact 3.12.1-2.4	No mitigation prescribed

KEY:

SU = Significant and not mitigable impact
SM = Potentially significant impact that has been mitigated to a less-than significant level by incorporation of mitigation measures identified in the EIR
LS= Less than significant impact
NI = No impact
B = Beneficial impact
? = unknown/speculative impact

3 PROJECT DESCRIPTION

This chapter describes design and proposed construction methodology for the Dutch Slough Tidal Marsh Restoration Project (Project), with emphasis on the modifications to the Project design and construction methodology identified since completion of the 2010 Environmental Impact Report (EIR) for the Project.

3.1 BACKGROUND – PREVIOUS ENVIRONMENTAL REVIEWS

In March 2010, the California Department of Water Resources (DWR) certified the Dutch Slough Tidal Marsh Restoration Project Final EIR (SCH #2006042009) (referred to herein as 2010 EIR). The 2010 EIR considered the potential impacts of restoration of a 1,178-acre area owned by DWR in eastern Contra Costa County, and the Moderate Fill Alternative (Alternative 2 in the 2010 EIR), was selected by DWR for implementation. In the fall of 2010, after approval and certification of the EIR, DWR began detailed engineering design for the Project and initiated the Federal and state permit compliance process to authorize construction of the proposed restoration activities. The changes considered in this Supplemental EIR result from:

- Refined engineering design;
- Reconsideration of construction sequencing and project phasing, and;
- Project-specific feedback provided by the regulatory and resource agencies during formal and informal consultation and permitting.

Two adjacent and related projects also were evaluated in concept in the 2010 EIR, the City of Oakley's Community Park Project which involved construction of a community park on the 55-acre parcel located south of the Emerson parcel, and the Ironhouse Project, which involved restoration of a portion of the Marsh Creek Delta on a 100-acre parcel owned by the Ironhouse Sanitary District (ISD) located west of the Emerson parcel. The changes considered in this Supplemental EIR apply only to the Dutch Slough Tidal Marsh Restoration Project, and do not affect the analysis of either of those related projects, or their potential cumulative effects when considered in combination with Project. Therefore, those projects are not discussed further in this document.

3.2 PROPOSED PROJECT

3.2.1 Project Location

The Project would be located in the City of Oakley in northeast Contra Costa County (Figure 3-1). Proposed restoration activities would take place within an approximately 1,178-acre restoration area, which is bounded on the south by the Contra Costa Canal, on the west by Marsh Creek, on the north by Dutch Slough, and on the east by Jersey Island Road. The restoration area encompasses three separate parcels, each of which is protected from flooding by separate levee systems. The three parcels from west to east are the Emerson parcel (426 acres), Gilbert parcel (305 acres), and Burroughs parcel (447 acres). The restoration area also includes two dead-end sloughs, Emerson Slough and Little Dutch Slough, and portions of Marsh Creek and Dutch Slough.

Some of the soils to implement the proposed restoration activities within the restoration area may be taken from a 56-acre plot owned by ISD and located southwest of the Emerson parcel (Figure 3-1).

3.2.2 Surrounding Land Uses

The Project site is bordered to the south and east by open space and farmland. Jersey Island is located north of the Project site and used by ISD for reclamation of wastewater, cattle grazing, and hay production. The western portion of the Project site sits adjacent to Big Break, Marsh Creek, and additional ISD agricultural fields.

Most of the adjacent agricultural land to the south and east of the Project site is planned for conversion to other uses, and construction of residential development has occurred on many sites. The portion of the East Cypress Corridor Specific Plan area adjacent to the east side of the Project site is primarily agricultural land planned for development. Buildout of the 2,500-acre specific plan is anticipated over a 5 to 15 year horizon (i.e., 2016 to 2021)(City of Oakley 2006). Urban development is also planned for most of the agricultural land immediately south of the Project site, although some areas remain designated Agricultural Land. The Cypress Grove Development located south of the Emerson parcel was completed in 2008, and the majority of the vacant, fallow farmland between Marsh Creek and Jersey Island Road is designated for residential development that is anticipated to occur over the next ten years.

The Contra Costa Canal, which delivers water to large areas of Contra Costa County, is also located south of the Project site. The Contra Costa Water District (CCWD) is in the process of encasing 3.97 miles of the canal extending from Rock Slough to Pumping Plant No. 1 in a buried pipeline. Approximately 2,000 feet of the canal was encased by the CCWD in 2008. Encasement of the Canal reach adjacent to the Emerson Parcel is expected to begin in 2014.

3.2.3 Project Objectives

The Project is designed to restore historic, tidally influenced marsh plain, tidal channel, and adjacent riparian habitat in the Delta, thereby contributing to the overall ecological health of the region. The Project has the following overarching goals:

1. Benefit native species by re-establishing natural ecological processes and habitats;
2. Contribute to scientific understanding of ecological restoration by implementing the project under an adaptive management framework; and
3. Provide shoreline access, educational, and recreational opportunities.

With these goals in mind, the Project would be designed and implemented to maximize opportunities to assess the development of tidal marsh, tidal channel, and riparian habitats; to measure ecosystem responses so that future Delta restoration projects would be more successful; and to provide community access to the site.

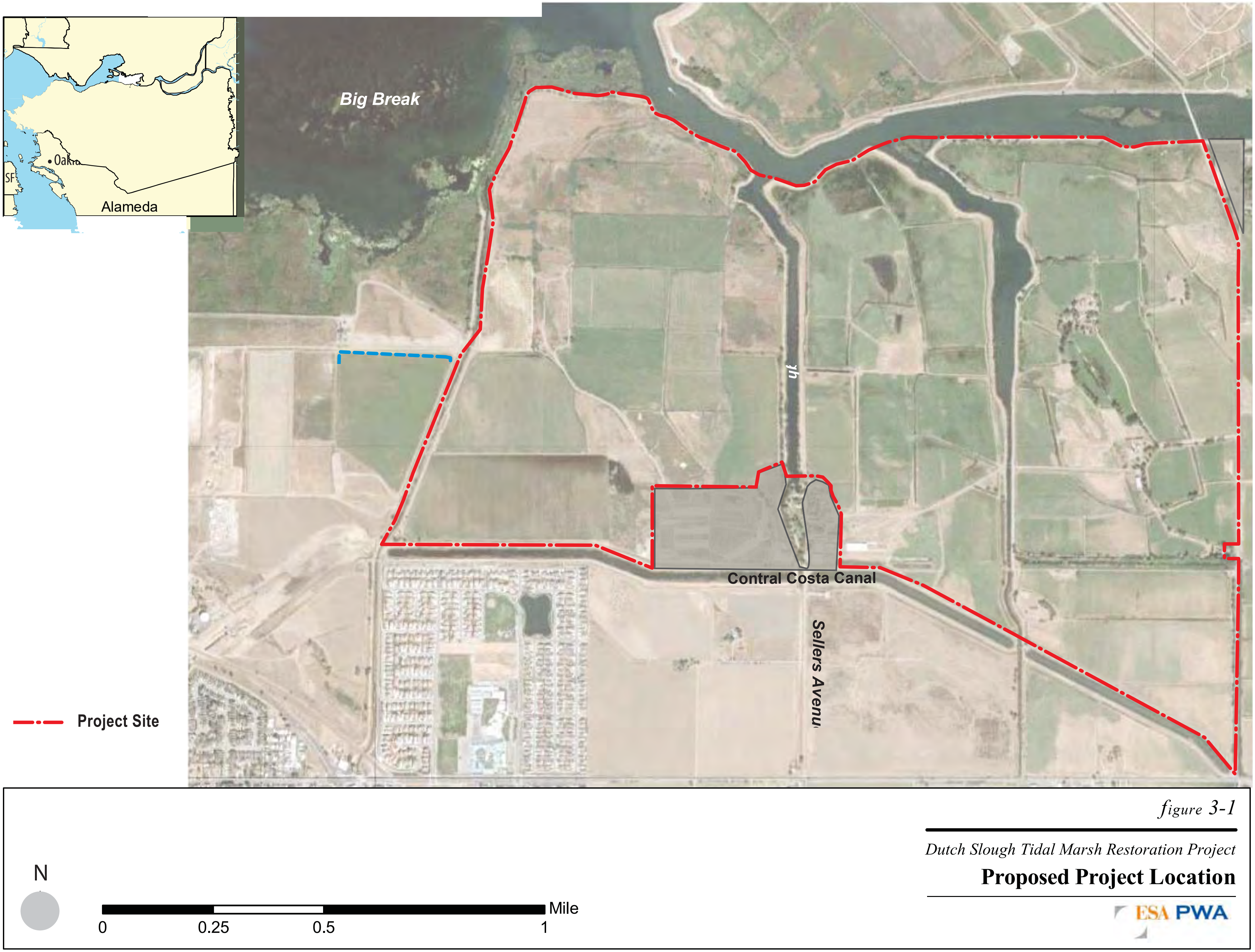


figure 3-1

Dutch Slough Tidal Marsh Restoration Project

Proposed Project Location

ESA PWA

3.2.4 Summary of Approved Project Description

As described above, DWR made the decision to implement Alternative 2 in the 2010 EIR. Alternative 2 included creation of a mix of marsh, open water, and upland habitats using on-site grading and a moderate amount of additional fill imported or borrowed onsite from low elevation areas. Major components of Alternative 2 included restoration of tidal marsh and tidal channels on the southern portions of each of the three parcels; open water management on the northern portions of each of the three parcels including options to create subtidal habitat through breaching levees, managing open water pond habitat, and constructing wide marsh “berms” to form tidal channel networks; restoring tidal circulation to the Gilbert and Burroughs parcels by dredging Little Dutch Slough and breaching perimeter levees; constructing levees along the eastern boundary of the Project site to protect existing infrastructure; and potential development of public access infrastructure around the Emerson parcel, and along the southern and eastern boundaries of the restoration area. Alternative 2 also included the option to reroute Marsh Creek onto the Emerson parcel to restore the physical processes and ecological values of a natural creek delta, provided it would not result in significant, unmitigable impacts to water quality.

Figure 3-2 illustrates the restoration components associated with Alternative 2 that were considered in the 2010 EIR. The Project considered in this Supplemental EIR, which is summarized below, builds on Alternative 2 and broadly reflects refined engineering design, revised construction methodologies, and project-specific feedback provided by the regulatory and resource agencies during formal and informal consultation and permitting.

3.2.5 Proposed Modifications to Approved Project Description

Figure 3-3 illustrates the current proposed restoration plan on the Emerson, Gilbert, and Burroughs parcels. Similar to Alternative 2 in the 2010 EIR, fill material would be imported or borrowed onsite to create a mix of marsh, open water and upland habitats within the Project site. The Emerson parcel would be comprised primarily of a mix of low, mid, and high marsh habitats, with a subtidal open water area located in the low-elevation area in the northeastern portion of the parcel. The subtidal open water area would be connected to adjacent tidal channels by breaching the Emerson perimeter levee in two locations, and would be isolated from the adjacent tidal marsh by a drainage divide planted with riparian and native vegetation. A new Marsh Creek channel network would also be constructed through the Emerson parcel to discharge into Dutch Slough. Public access would be provided by a loop trail around the perimeter of the Emerson parcel with bridges spanning all levee breaches.. The trail would be connected on the west to the Marsh Creek Regional Trail, and on the south to the future Dutch Slough Community Park (Figure 3-3).

The Gilbert parcel would be designed to provide tidal and non-tidal marsh habitats. The southern portion of the parcel would be comprised of a mix of low, mid, and high marsh habitats, separated by marsh drainage divides designed to facilitate adaptive management experiments. Distinct tidal channel networks would be excavated in the marsh habitats and connected to Little Dutch Slough on the east, which would be enlarged to accommodate the increased tidal volumes necessary to achieve full tidal exchange in the restored marshes on the Gilbert and Burroughs parcels. In addition, approximately 100 acres of existing freshwater marsh on the northern portion of the Gilbert parcel would be managed to provide enhanced habitat for California black rail (*Laterallus jamaicensis*

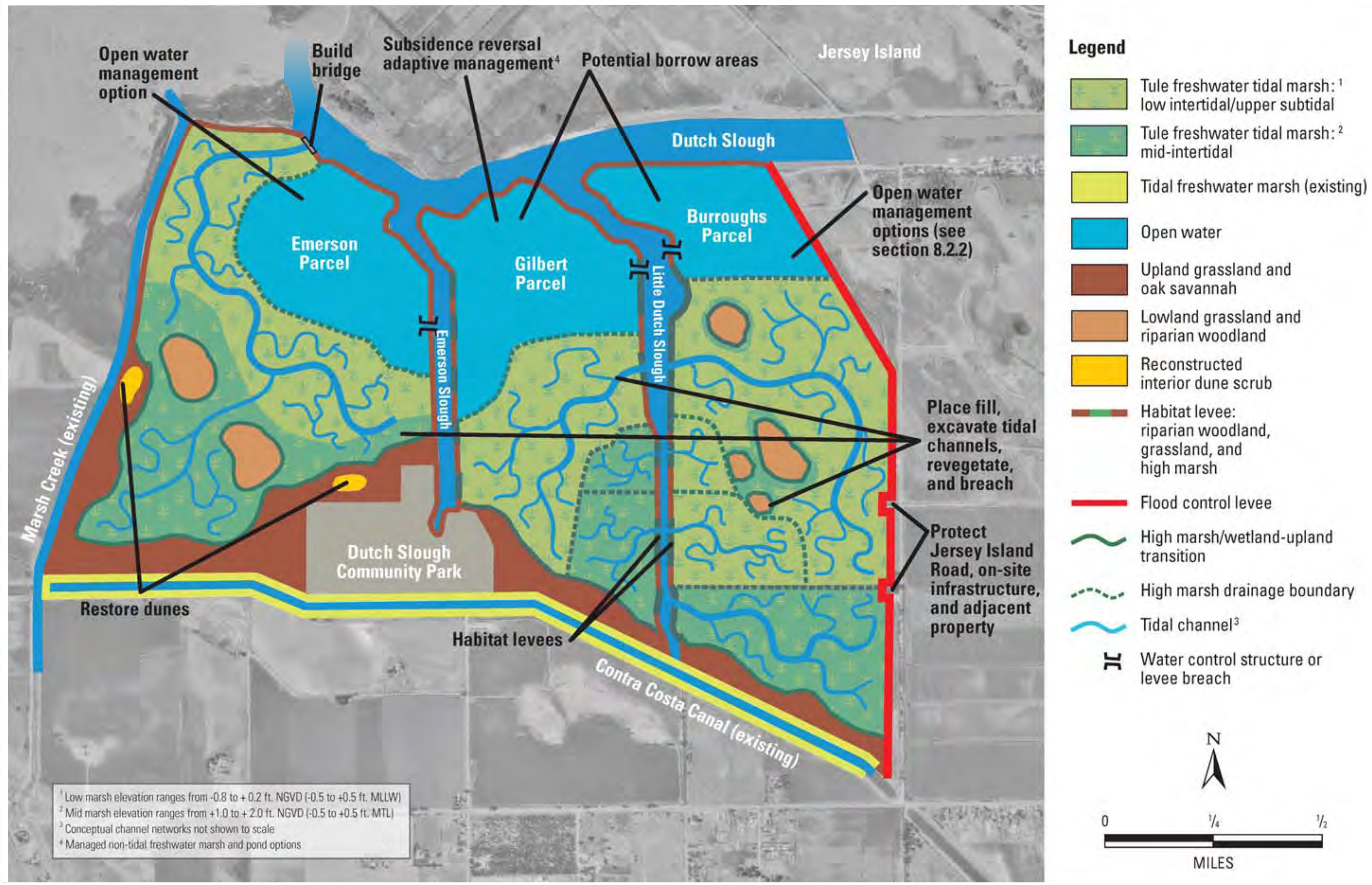


figure 3-2

Dutch Slough Tidal Marsh Restoration Project

2010 EIR Alternative 2 Restoration Components

ESA PWA

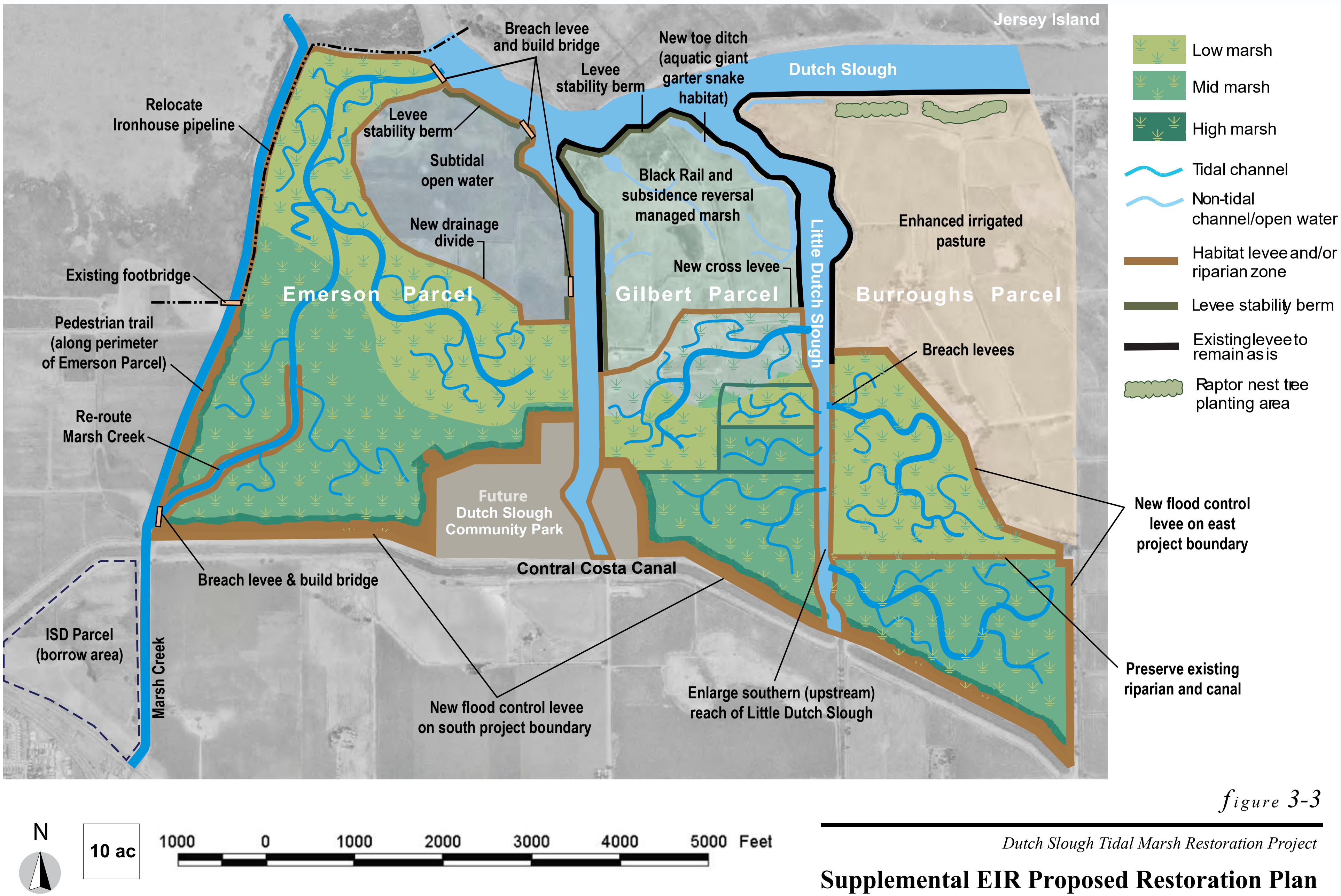


figure 3-3

Dutch Slough Tidal Marsh Restoration Project

Supplemental EIR Proposed Restoration Plan

ESA PWA

coturniculus) and giant garter snake (*Thamnophis gigas*). Components to enhance habitat in this area would include construction of a cross levee to isolate the northern non-tidal marsh area from restored tidal marsh to the south; installation of a screened and gated culvert to manage water levels and encourage natural vegetation recruitment; and minor grading of the managed non-tidal marsh for habitat enhancement, including excavation of a toe ditch along the northeast interior of the Gilbert levee to enhance giant garter snake habitat, and the creation of open water areas to benefit waterfowl species (Figure 3-3).

Similar to the other parcels, the southern portion of the Burroughs parcel would be managed as a mix of marsh habitats, each of which would be connected by an independent tidal channel network to Little Dutch Slough. The northern portion of the Burroughs parcel would be preserved and enhanced as irrigated pasture to provide foraging habitat for Swainson's hawk (*Buteo swainsoni*) and other bird species. Management activities in this area (grazing and mowing) would favor native plants and trees. Where possible nest trees would be preserved in place with additional trees planted in the first year of Project construction to supplement potential nesting trees affected by restoration activities. A toe ditch would also be excavated along the northwest corner of the Burroughs parcel to improve drainage and mosquito abatement in the irrigated pasture (Figure 3-3).

The Project would also include a number of levee and infrastructure improvement components, including construction of new flood protection levees along the eastern and southern restoration area boundaries; relocation and replacement of outboard levee armoring adjacent to the Emerson and Gilbert parcels to improve public safety, long-term stability, and flood protection; construction of upland transition zones between flood protection levee segments and tidal marsh areas; and relocation of ISD's effluent pipeline from the toe of the Marsh Creek levee to beneath the crown of the levee. Non-flood protection levee segments would generally be planted with riparian and native vegetation, with plantings dependent on the function and purpose of the levee (Figure 3-3).

The following summarizes the changes in the Project description considered in this Supplemental EIR compared to the description of the approved Project provided in the 2010 EIR. These changes are also summarized in Table 3-1. Figure 3-4 illustrates the approximate location of components modified by the Project refinements described above.

- DWR is proposing to construct a new flood protection levee along the southern boundary of the restoration area to maintain or improve the existing level of flood protection for properties to the south. The southern flood protection levee, which would generally follow the southern boundary of the Project site, would require crossing Little Dutch Slough and would include installation of one or two new drainage culverts and flap gates in Little Dutch Slough at the levee crossing. On the Emerson Parcel, this flood control levee would run parallel to the Contra Costa Canal on the south side of the City Park.

- DWR is proposing to shift the alignment of the eastern flood protection levee from the eastern Project boundary to an alignment on higher ground, and in a location that reduces cost and fill volumes. The new levee alignment would follow Jersey Island Road on the southern portion of the Burroughs parcel, bisect the parcel between the enhanced irrigated pasture and the restored marsh area, and connect with the existing flood protection levee on the east side of Little Dutch Slough.

- DWR is proposing to remove and replace portions of the existing outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough for public safety, stability, and flood protection purposes. Some in-water work would be required to replace armoring located below the mean tide line.

- DWR has refined the proposed management strategy on the northern portion of the Gilbert parcel to reflect management of non-tidal freshwater marsh, which would provide enhanced habitat for California black rail and giant garter snake. Specific components include:
- Construction of a cross levee to isolate existing freshwater marsh from restored tidal marsh to the south. The levee would bisect the parcel from west to east.
- Installation of a gated and screened culvert on Emerson Slough to supplement or replace the existing pump on the Gilbert parcel and provide periodic water supply to the managed marsh. This culvert, in combination with an existing drainage pump, would be used to manage water levels to encourage natural marsh vegetation recruitment.
- Construction of a stability berm along the interior of the existing perimeter levee on the north and west sides of the Gilbert parcel to strengthen the Gilbert levee.
- Minor grading of the managed non-tidal marsh for habitat enhancement, including excavation of a toe ditch along the northeast interior of the Gilbert levee to enhance giant garter snake habitat, and creation of open water areas to benefit waterfowl species.
- DWR has refined the proposed management strategy on the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat, which would be connected to adjacent tidal channels by breaching the Emerson perimeter levee in two locations. A wave break/stability berm would also be constructed along the perimeter levee to protect against wind-wave erosion.
- DWR has refined the proposed management strategy on the northern portion of the Burroughs parcel to select preservation and enhancement of foraging and nesting habitat for Swainson's hawk and other avian species. Specific components would include planting fast-growing riparian trees and preserving existing mature trees on northern Burroughs, and implementation of management approaches (grazing and mowing) that favor native plants and bird species. A toe ditch would also be constructed along the northwest corner of the parcel to improve drainage and mosquito abatement in the irrigated pasture.
- DWR has identified a preferred alignment for relocation of the Marsh Creek delta on the Emerson parcel. The existing Marsh Creek levee would be breached at the southwest corner of the parcel and a new channel network would be constructed through the Emerson parcel to discharge into Dutch Slough. The existing tidally influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is.
- DWR has revised the proposed in-water construction methodology for several Project components, including the temporary crossing of Marsh Creek and the enlargement of Little Dutch Slough. As described below, the revised construction methods would:
- To allow transport of borrow material from the ISD parcel to the Emerson parcel, the 2010 EIR considered construction of a temporary bridge over Marsh Creek at the southwest corner of the restoration area. Based on engineering and cost studies, DWR is now proposing to construct a temporary earthen berm outfitted with three culverts in Marsh Creek, rather than a bridge. This

construction method would require installation of a cofferdam and temporary dewatering of a portion of Marsh Creek.

- DWR is proposing to change the method for enlarging the southern reach of Little Dutch Slough from in-water dredging to excavation in the dry after installation of a cofferdam and dewatering the southern end of the slough. This revised approach would minimize water quality and turbidity impacts, and allow concurrent construction of several Project components.
- DWR is proposing to install temporary fish screens on water supply intakes that would be used for tule management. These include three existing pumps located on the southwest corners of the Gilbert and Burroughs parcels, and the southeast corner of the Emerson parcel.
- The 2010 EIR included a mitigation measure (Mitigation 3.1.1-5) that stated breaching of the Dutch Slough Project levees would not commence until encasement of the Contra Costa Canal had been completed. The Project now proposes to potentially breach the levees prior to encasement of the Contra Costa Canal.
- New cultural resources studies of the site identified additional resources that may be affected by Project construction, including a newly discovered Native American burial site. This Supplemental EIR clarifies impacts to these site-specific cultural resources and identifies new avoidance, minimization, and mitigation measures to reduce potential effects.

3.2.6 Detailed Description of Project Components

The following section describes each of the Project components considered in this Supplemental EIR in detail, including those components that have substantively changed (as summarized above), as well as those components that have not substantively changed since publication of the 2010 EIR. This section is intended to provide a comprehensive understanding of the currently proposed Project.

HABITAT RESTORATION AND ENHANCEMENT DESIGN COMPONENTS

Approximately 560 acres of tidal marsh, 26 acres of riparian forest, 76 acres of managed non-tidal marsh, 97 acres of subtidal open water, and 4 acres of native grassland would be restored using on-site grading, placement of fill material, and re-vegetation techniques. In addition, approximately 26 acres of managed non-tidal marsh and 173 acres of irrigated pasture would be enhanced by modifying their management to benefit wildlife species. To create these habitats, the topography of the restoration area would be significantly altered, primarily via on-site cut and fill and importation from an adjacent borrow area owned by ISD (soils borrow area). Excavation and fill would be used to create appropriate elevations, construct new levees and berms, and make necessary changes to the existing levees, as described below.

Table 3-1. Summary of Project Component Revisions Considered in the Supplemental EIR

Component	2010 EIR (Alternative 2)	Supplemental EIR	Component Detail
NEW COMPONENT			
Southern Flood Protection Levee	Southern flood protection levee not described in detail and deferred to other development projects to the south	New levee constructed along southern site boundary, except on Emerson Parcel where it will be located south of the City Park. Would require fill of a portion of Little Dutch Slough and installation of one or two permanent culverts and flap gates at Little Dutch Slough to prevent tidal water from flowing south of Project site.	▪ New levee segment would be constructed to DWR urban levee guidelines, including 300-year flood protection. ▪ New levee would cross Little Dutch Slough and require permanent fill of a 100 foot long by 50 foot wide section of the channel, as well as installation of a new drainage culverts and flap-gates at the levee. ▪ South of the restoration area, Little Dutch Slough transitions to an open drainage ditch which currently receives some muted tidal flow. The new culverts would allow the ditch to continue to drain runoff into Little Dutch Slough, but would prevent tidal waters from entering the ditch.
REFINED COMPONENTS			
Eastern Flood Protection Levee	Alignment depicted along the eastern boundary of the Burroughs parcel	Revised alignment proposed	▪ Alignment shifted slightly west to construct levee on higher ground, to reduce fill volumes and cost, and to provide pasture for Swainson's hawk. The new levee, aligned along higher ground, would represent the boundary between restored tidal marsh on the southern portion of the Burroughs parcel and irrigated pasture on north. The new alignment would follow Jersey Island Road on the southern portion of parcel, bisect the parcel between the enhanced irrigated pasture and restored marsh, and connect with the existing flood protection levee on Little Dutch Slough on the west.
Perimeter Levee Improvements	Retain armoring on outboard side of perimeter levees (possibly move around to accommodate riparian plantings)	Additional detail on relocation / replacement of armoring for public safety, long-term stability, and flood protection purposes	▪ Portions of existing outboard levee armoring (i.e., large slabs of concrete) along Dutch Slough and Emerson Slough on the Emerson perimeter levee would be removed and replaced with rock armoring. Additional rock protection would also be placed along Emerson Slough, Dutch Slough, and Little Dutch Slough on the Gilbert parcel for long-term stability and flood protection purposes. ▪ Pole planting would occur within rock voids above mean higher high water and the upper slope would be planted with riparian vegetation.
Managed Non-Tidal Marsh - Northern Gilbert Parcel	Subsidence reversal area with several open water manage-	Refined components to provide enhanced habitat for California black rail and giant	Approximately 27 acres of existing, freshwater marsh on the northern end of the Gilbert parcel would be enhanced as follows (a total of 102 acres of freshwater marsh would exist after the project is complete):

Component	2010 EIR (Alternative 2)	Supplemental EIR	Component Detail
	ment options	garter snake	▪ Construction of a new east-west cross levee to isolate existing freshwater marsh from restored tidal marsh to the south. ▪ Installation of a new gated, screened intake culvert (4-foot diameter reinforced concrete pipe) to manage water levels and encourage natural vegetation recruitment. ▪ Construction of a stability berm (100 feet wide by 5,000 feet long) along the interior of the existing perimeter levee on the north and west sides of the Gilbert parcel to protect the perimeter levee from wind/wave erosion. ▪ Minor grading of the managed, non-tidal marsh for habitat enhancement, including: (1) a toe ditch along the northeast interior of the Gilbert levee to enhance and create approximately 3.4-acres of aquatic habitat for giant garter snake; and (2) creation of two ponds, up to 3 acres each and with connecting ditches, to benefit waterfowl species.
Subtidal Open Water – Northern Emerson Parcel	Options for construction of sub-tidal and deep sub-tidal areas	Refined to include construction of subtidal area on the northern portion of the Emerson parcel	Approximately 100-acres of subtidal open water habitat would be created in the northern portion of the Emerson parcel. The subtidal area would be connected to adjacent tidal channels by breaching the perimeter levee in two locations (a single breach described in 2010 EIR). A drainage divide would isolate open water from adjacent tidal marsh, and a wave break / stability berm would be constructed along the interior of the perimeter levee to protect against wind-wave erosion.
Irrigated Pasture – Northern Burroughs Parcel	Various options for Burroughs parcel described in 2010 EIR, including the "No Burroughs" option, which would retain Burroughs as terrestrial and wetland habitat	Preservation / enhancement of irrigated pasture to provide foraging and nesting habitat for Swainson's hawk and other bird species	▪ Preservation and enhancement of 173-acres of irrigated pasture, including: o Management activities (grazing and mowing) that favor native plants. o Preservation of a substantial portion of mature trees on northern Burroughs for nesting raptors. o Planting tall riparian tree species along north Burroughs during the first year to provide additional nest trees o Excavation of a toe ditch along the northwest corner of the parcel, adjacent to the interior of the existing perimeter levee, to improve drainage and mosquito abatement in irrigated pasture
Marsh Creek Delta Relocation	Included restoration of a natural delta at the mouth of Marsh Creek, but re-route of channel undetermined	The option of relocating Marsh Creek onto the Emerson parcel was selected.	New distributary channel of Marsh Creek constructed on the Emerson parcel to create one large, continuous marsh habitat area. The existing Marsh Creek levee would be breached at the southwest corner of the parcel to divert a portion of Marsh Creek flows onto the parcel. A new Marsh Creek channel network would be constructed through the Emerson parcel, discharging into Dutch Slough. The existing tidally-influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is.

Component	2010 EIR (Alternative 2)	Supplemental EIR	Component Detail
Contra Costa Canal Encasement	Included mitigation measure that no breaching occur until Contra Costa Canal encased	Considers new hydrologic study prepared in 2012 which may alter mitigation measure in 2010 EIR	The 2010 EIR included a mitigation measure (Mitigation 3.1.1-5) that stated breaching of the Dutch Slough Project levees would not commence until encasement of the Contra Costa Canal had been completed. The Project now proposes to potentially breach the levees prior to encasement of the Contra Costa Canal.
REVISED CONSTRUCTION METHODOLOGY			
In-Water Work – Temporary Marsh Creek Crossing	Bridge	Earthen fill with three culverts up to 4-feet in diameter. Would require installation of cofferdam and dewatering	▪ The purpose of the temporary, Marsh Creek crossing is to allow transport of borrow material from the ISD parcel (soils borrow area) to the Emerson parcel. The proposed revision in construction methodology is based on engineering and cost studies. ▪ Crossing would require temporary fill of the Marsh Creek channel (up to 2,000 CY) during low flows (May). The crossing would be removed prior to the onset of the rainy season (October or earlier), which would require the crossing be installed and removed twice during two construction seasons. ▪ Temporary sheet pile cofferdams spanning channel would be installed on both sides of the crossing using a vibratory hammer and excavator staged on the perimeter levee. Seine and block nets would be used on an outgoing tide to herd fish downstream / out of the work area prior to placing the downstream cofferdam. Any remaining fish would be removed using nets and backpack electrofishing. ▪ During construction of the crossing, upstream flows would be routed downstream of the crossing via bypass piping. Water would be removed from area and pumped, as needed, onto the Emerson parcel, contained within the existing levee and/or temporary berm, and allowed to infiltrate and evaporate.
In-Water Work - Method for Enlarging Little Dutch Slough	In-water dredging	Excavation in the dry after installation of a cofferdam and dewatering	▪ Revised approach proposed to minimize water quality and turbidity effects associated with excavation of Little Dutch Slough, and to allow concurrent construction of several Project components in the area (i.e., Little Dutch Slough enlargement, construction of the new berm on the Gilbert parcel, construction of the south levee crossing, and levee breaching on the Gilbert parcel). ▪ Cofferdams installed using excavator and vibratory hammer. Fish rescue and dewatering similar to that described for the temporary Marsh Creek crossing. ▪ Channel deepened and widened using bucket excavation equipment with temporary construction access pads placed in the channel to stage equipment if necessary. ▪ Excavated material would be used as fill for marsh restoration on the Gilbert parcel.

Component	2010 EIR (Alternative 2)	Supplemental EIR	Component Detail
			▪ Storm drain flows from the ditch that connects to the south end of Little Dutch Slough would be pumped downstream of the cofferdam. Water removed from cofferdam would be pumped onto the Gilbert or Burroughs parcels, contained within the existing levee, and allowed to infiltrate and evaporate. ▪ Enlargement to occur in one construction season (May 15 – October 1).
Temporary Fish Screens	Not described	Installation of temporary fish screens on intakes for tule management	Temporary fish screens would be installed on water intakes in the restoration area to allow for tule management. A total of up to six screens would be placed on existing pumps: four on the southwest corners of the Gilbert and Burroughs parcels, one on the southeast corner of the Emerson parcel, and one on the northeast corner of the Emerson parcel.
NEW INFORMATION			
Cultural Resources	Described impacts to rural historic landscape and potential unknown resources.	Clarifies impacts specific to the restoration area and identifies potential impacts to a newly discovered Native American burial site	Since publication of the 2010 EIR, a Native American burial site was discovered on the Gilbert parcel and additional archaeological studies have been conducted on the Project site. These additional resources are considered in the Supplemental EIR.

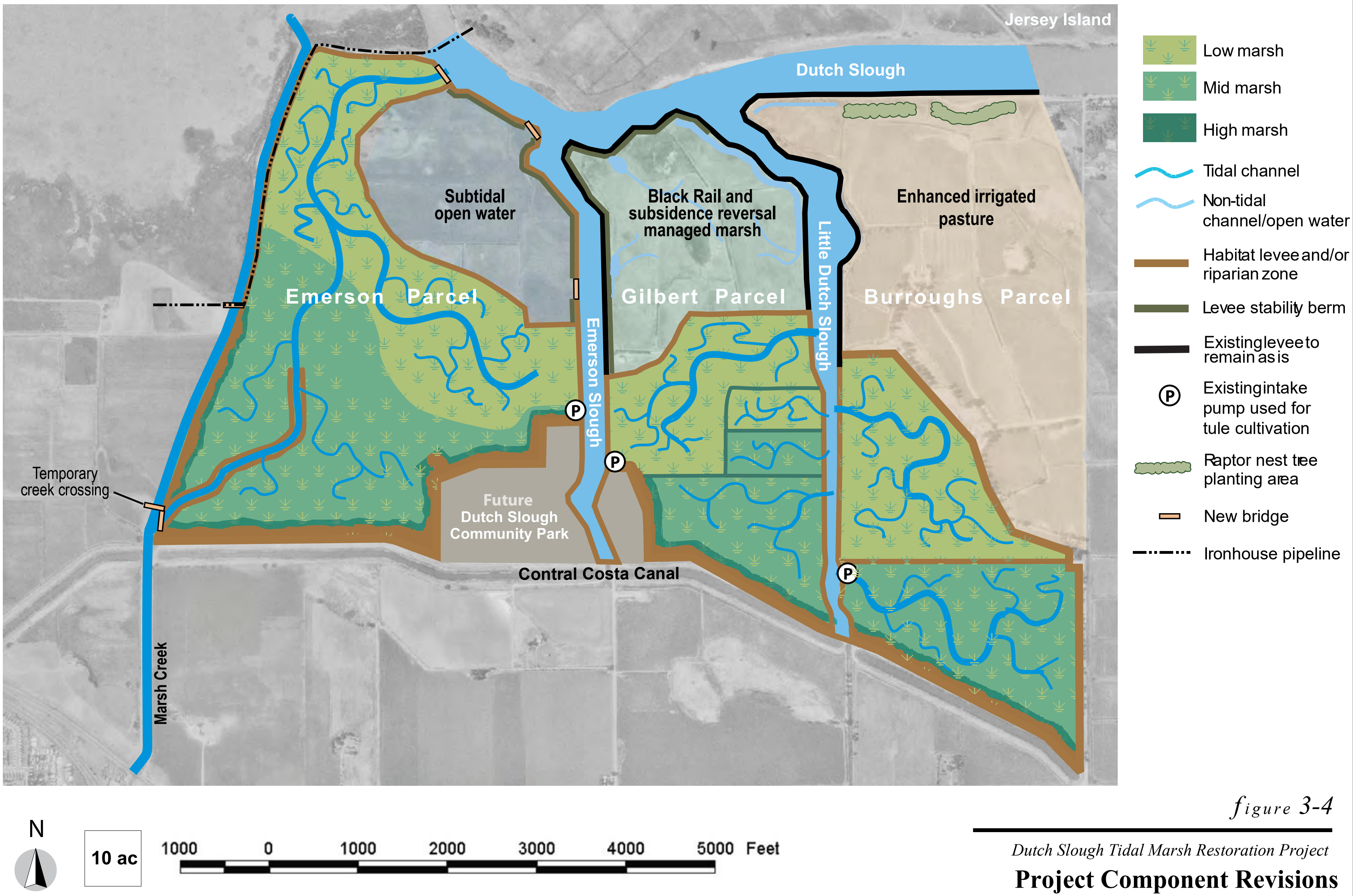


figure 3-4

Dutch Slough Tidal Marsh Restoration Project

Project Component Revisions Considered in Supplemental EIR

ESA PWA

Marsh Plains

The tidal marsh portions of the restoration area would be graded to elevations suitable to support low marsh, mid marsh, and high marsh by placing 2.0 million cubic yards (CY) of fill material. Approximately 1.3 million CY of material would be made available through excavation of high elevation areas onsite (e.g., south end of the Emerson parcel). Generally, it is expected that the material excavated from each parcel would be used as fill within the same parcel. Any excavated material that is high in lean clay would be used first for levee construction and rehabilitation. A grading plan for the restoration area is provided in Figure 3-5.

Approximately 700,000 CY of supplemental fill would be needed to complete the proposed restoration activities, most of which would be used on the Gilbert parcel. About 200,000 CY of supplemental fill would be imported from the ISD soils borrow area and transported to the restoration area over Marsh Creek (Figure 3-5). Another 400,000 CY of supplemental fill material would be generated through a combination of additional import from the soils borrow area, excavating the subtidal open water habitat on the Emerson parcel, and/or excavating the high area in the enhanced irrigated pasture on the Burroughs parcel (Figure 3-5).

Average design elevations for marsh plain grading would be mean lower low water (MLLW, -0.3 feet National Geodetic Vertical Datum [NGVD] for low marsh and the mean tide level (MTL, 1.5 feet NGVD) for mid marsh. Elevations throughout the marsh plains would vary 0.25 to 0.5 feet from design elevations to create beneficial micro-topography, and to reduce construction costs.

MARSH DRAINAGE DIVIDE BERMS

Marsh drainage divide berms would be constructed on the Gilbert parcel (Figure 3-5). The primary function of the berms would be to define marsh cells of different sizes and elevation (i.e., small and medium cells, and low marsh and mid marsh elevations) for the purpose of adaptive management experimentation. These cells would facilitate comparison between different types of marsh areas and would allow isolated experimentation in the future. The crest elevation of the drainage divide berms would be mean higher high water (MHHW) (approximately +3.2 feet NGVD) which would allow tidal exchange between adjacent marsh areas only during high tide. Marsh drainage divide berms would also provide high marsh habitat.

TIDAL CHANNEL NETWORKS

To create tidal channels, either fill will be placed around the channel footprint, or after the marsh plains are graded, the tidal channel systems would be excavated (Figure 3-3). The channel networks would be sinuous and branching, similar to the forms of natural channel networks in freshwater and saline tidal marshes. Each marsh cell on the Burroughs and Gilbert parcels would have a distinct channel network. On the Emerson parcel, a single large tidal channel network would connect low marsh, mid marsh, and riparian habitats, and connect Marsh Creek and Dutch Slough. Marsh plains would generally slope towards the channels for effective drainage.

LITTLE DUTCH SLOUGH ENLARGEMENT

The narrow southern reach of Little Dutch Slough would be enlarged to accommodate the increased tidal volumes necessary to achieve full tidal exchange in the restored marshes on the Gilbert and Burroughs parcels (Figure 3-3). The bottom of the slough would be deepened, and the slough widened toward the Gilbert parcel (west). Approximately 2,500 feet of the existing Gilbert levee would

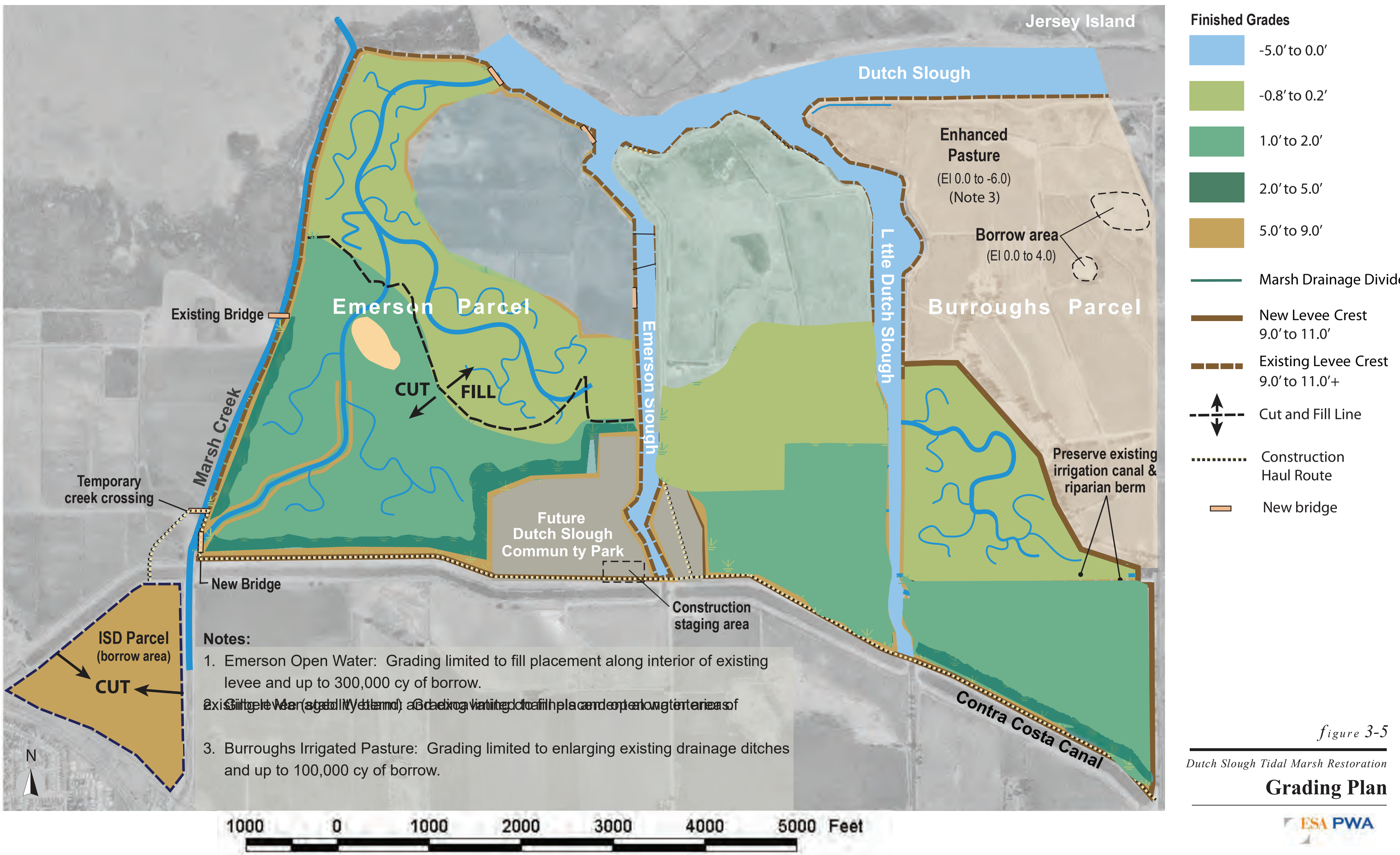


figure 3-5

Dutch Slough Tidal Marsh Restoration

Grading Plan

ESA PWA

be removed and replaced with a low berm set back 50 feet (average) from the existing channel. The new berm would be constructed to approximately 4 feet NGVD and would be breached in multiple locations. New channel networks would extend from the breaches and convey tidal flows into the restored marsh plains (Figure 3-3). High marsh would establish on the new lower levees through natural recruitment.

Material removed to enlarge Little Dutch Slough would be used to fill in the tidal marsh restoration areas on the Burroughs and Gilbert parcels.

MARSH CREEK CHANNEL

A new branch of Marsh Creek would be constructed on the Emerson parcel to restore the creek delta and create one large, continuous marsh habitat area (Figure 3-3). The existing Marsh Creek levee would be breached near the southwest corner of the Emerson parcel to divert a portion of Marsh Creek flows onto the parcel. A new Marsh Creek channel network would be constructed through the Emerson parcel, discharging into Dutch Slough. The existing tidally influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as it is. The new channel on the Emerson parcel would include low riparian berms along the upstream portion of the channel banks to mimic natural levees.

SUBTIDAL OPEN WATER

Approximately 100 acres of subtidal open water habitat would be created in the northern portion of the Emerson parcel (Figure 3-5). Some grading within the subtidal open water area would be required to place fill along the interior of the existing perimeter levee for additional levee stability and wave dissipation. There may be some excavation in this area to supply supplemental fill for levee and intertidal marsh construction. Up to 300,000 CY of material could be excavated, as needed, and placed on the Emerson parcel, in low marsh areas, and/or along the interior of the perimeter levee as a stability berm. A drainage divide would isolate the open water from the adjacent tidal marsh.

The subtidal open water area would be connected to the adjacent tidal channels by breaching the perimeter levee in two locations (Figure 3-3).

MANAGED NON-TIDAL MARSH

A new east-west levee would be constructed to isolate approximately 102 acres of the northern portion of the Gilbert parcel from the tidally inundated southern portion (Figure 3-3). The freshwater marsh on the northern portion of the Gilbert parcel would be enhanced and enlarged into areas that are currently irrigated pasture to provide more habitat for California black rail and other shore birds. This would be accomplished by managing water levels to encourage natural vegetation recruitment, which would be at or above the ground surface year-round. One gated, screened culvert (4-foot diameter reinforced concrete pipe) would be installed to supplement or replace the existing pump for periodic water supply. The existing drainage pump would be used to manage water levels as needed.

A stability berm would be constructed along the interior of the existing perimeter levee on the north and west sides of the Gilbert parcel to strengthen the levee Figure 3-4). The footprint of the stability berm would be approximately 100 feet wide and 5,000 feet long.

A toe ditch would also be excavated along the northeast interior of the Gilbert levee to enhance giant garter snake habitat (Figure 3-4). The toe ditch would be an extension of the existing drainage ditch in this area, would be approximately 25 feet wide by 2,000 feet long, and would create approximately 3.4 acres of aquatic habitat for giant garter snake (Figure 3-4). The toe ditch would be designed to be sufficiently deep to discourage vegetation establishment and minimize maintenance requirements.

Open water areas would also be created within the managed non-tidal marsh to provide habitat diversity. Two patches – up to 3 acres each and with connecting ditches up to 4,000 feet long by 25 feet wide – would be excavated to a variety of depths to benefit waterfowl species.

ENHANCED IRRIGATED PASTURE

About 173 acres of irrigated pasture within the northern portion of the Burroughs parcel would be preserved and enhanced to provide foraging and nesting habitat for Swainson's hawk and other foraging and nesting bird species. Management activities in irrigated pasture, such as grazing or mowing, would favor native plant species. Rather than year-round grazing, the pasture areas would be grazed or mowed only a few times a year. In between grazing and mowing events, grasses would be allowed to grow tall and prey populations (e.g., rodents, insects) would increase. In turn, prey species would be exposed to predation by raptors and other species following grazing or mowing. Grazing or mowing would be timed to avoid disturbing ground nesting birds and to benefit native plant species in the seasonal wetlands.

Tall riparian tree species would be planted along the north side of the Burroughs parcel to provide additional nesting trees (Figure 3-4). These trees would be planted during the first year of Project implementation to allow time for the trees to mature. Within approximately 10 years, it is anticipated these trees would be large enough to provide hunting perches and nesting habitat for Swainson's hawk, white-tailed kite, and other raptor species. In addition, a substantial portion of the mature trees on the northern portion of the Burroughs parcel would be preserved. These preserved trees would provide important nesting habitat since some trees on the Emerson and Gilbert parcels would be removed during Project construction.

In addition to these enhancements, a new drainage ditch would be excavated along the interior of the existing perimeter levee to improve drainage and mosquito abatement in the irrigated pasture (Figure 3-6). This ditch would be located in the northwest corner of the parcel, would connect to the existing drainage ditch, and would be designed to be sufficiently deep to discourage vegetation establishment and minimize maintenance requirements.

LEVEE IMPROVEMENTS

As part of the Project, existing levees on all three parcels would be breached in a number of places. Remaining levee segments would be treated differently, depending on their intended function, as described below.

NON-FLOOD PROTECTION LEVEE SEGMENTS

EMERSON PERIMETER LEVEE AND DRAINAGE DIVIDE LEVEE

Although flood protection would no longer be needed, the perimeter levee on the Emerson parcel would be maintained to serve as a public access trail, to improve the stability of the levee, and to improve habitat value. The levee will be located just north of the property boundary with the Contra Costa Canal, along the south side of the Project and the south side of the Community Park. Adjacent to the new tidal marsh, the inboard levee slopes would be filled and graded to create a new levee bench and lessen the slope. Existing trees would be preserved to the extent possible. Adjacent to the open water area, fill would be placed along the inboard levee slopes to create a 40-foot wide stability berm, which would dissipate wind and wave action on the levee (Figure 3-4) and provide

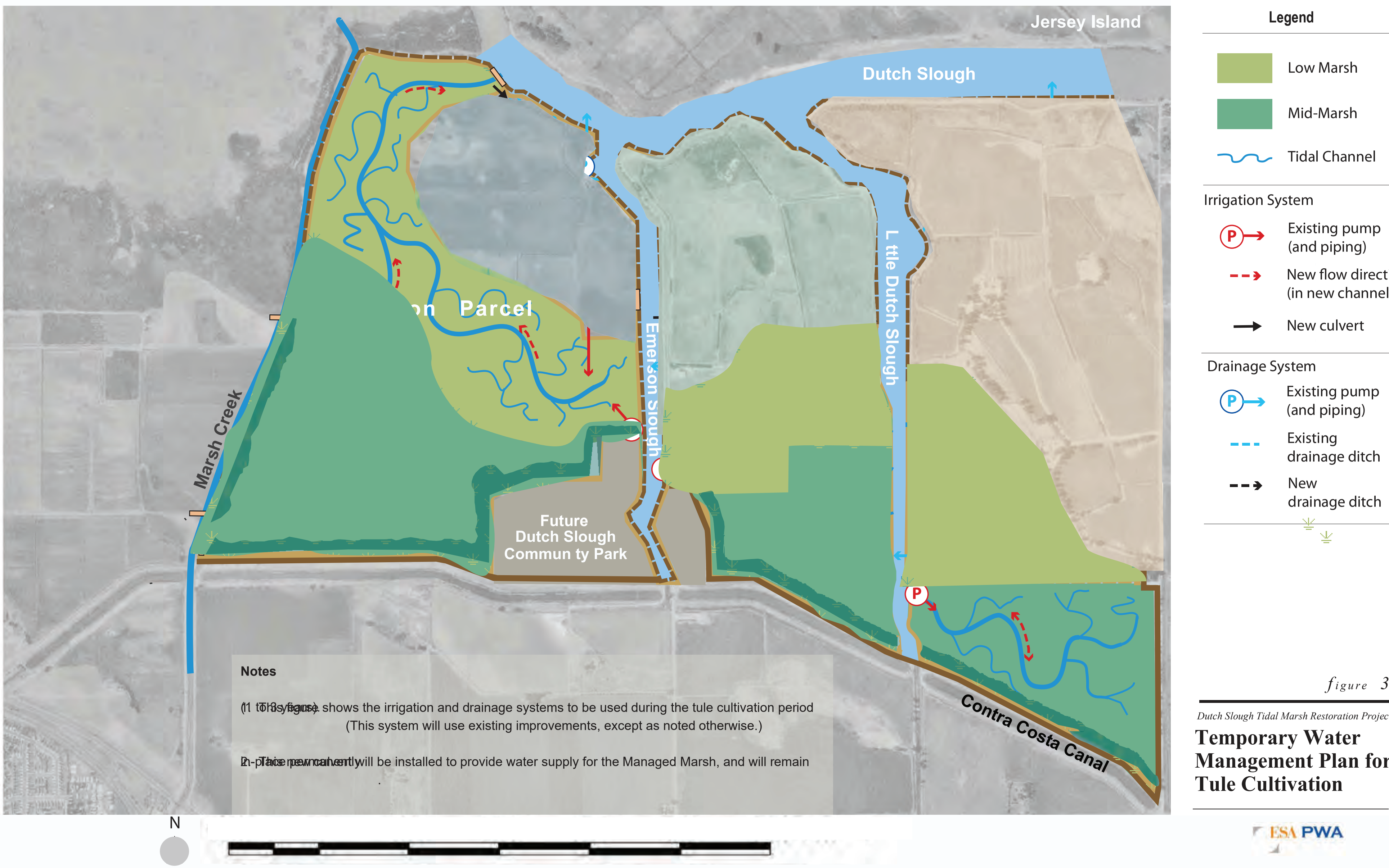


figure 3-6

Dutch Slough Tidal Marsh Restoration Project

Temporary Water Management Plan for Tule Cultivation

ESA PWA

emergent marsh habitat. Levee crests would be surfaced with gravel and would be used as a public trail and to provide vehicle access for periodic inspection and maintenance.

On the Emerson parcel, most of the outboard levee armoring along Dutch Slough and Emerson Slough is currently composed of large slabs of concrete placed by past landowners. Because this armoring would be adjacent to the public access trail, existing armoring that presents a safety hazard (e.g., protruding rebar and/or concrete shards) would be removed and replaced (Figure 3-4). While much of the existing riprap below the MTL would remain, some in-water work below the MTL would be required. Rock armoring would extend 10 to 22 feet into Emerson and Dutch Sloughs, respectively (as measured horizontally from the existing bank at the MTL). The new rock armoring would be placed to allow for interspersed planting above the tidal zone to create shaded riverine aquatic (SRA) habitat where possible.

An earthen berm (drainage divide) would also be constructed on the interior of the Emerson parcel to separate restored tidal marsh from subtidal open water habitat (Figure 3-3). This drainage divide would be constructed to limit hydraulic connection between the two areas, to minimize channel formation, and to prevent fish access from the subtidal open water habitat to the restored tidal marsh.

GILBERT PERIMETER LEVEE AND NEW CROSS LEVEE

Much of the perimeter levee on the Gilbert parcel would be maintained to contain and provide vehicle access to the managed non-tidal marsh. The remainder of the perimeter levee adjacent to the restored tidal marshes along Little Dutch Slough would be removed and replaced with a low berm set back from the existing channel, which would be breached in multiple locations and planted with riparian woodland and native grassland (Figure 3-3). Suitable material excavated from the existing levees would be sidecast into the parcel and graded to match design elevations.

A stability berm and toe ditch also would be constructed along the inboard slope of the existing perimeter levee (Figure 3-4), as described above.

The Gilbert perimeter levee is relatively narrow and has outboard slopes that are too steep for long-term stability and flood protection purposes. Therefore, additional rock protection would be placed as needed (up to 8,900 linear feet) on the outboard side of most of the perimeter levee to create a flatter, more stable slope and improve levee stability (Figure 3-4). Rock armoring would extend approximately 15 feet into Emerson and Little Dutch Sloughs, and 22 feet into Dutch Slough. Similar to Emerson Slough, the new rock armoring would be placed to allow for interspersed planting along the tidal zone to create SRA where possible.

Finally, a new levee would bisect the Gilbert parcel from east to west to divide the restored tidal marsh and the managed non-tidal marsh areas (Figure 3-3).

BURROUGHS PERIMETER LEVEE

As described above, the existing levee segments on the west side of the Burroughs parcel adjacent to the restored tidal marshes would be breached, lowered and planted with riparian and woodland and native grassland to enhance its habitat value. Suitable material excavated from the modified levee would be sidecast into the parcel and graded to match design elevations. The existing flood protection levee around the northern enhanced irrigated pasture would remain as it is.

FLOOD PROTECTION LEVEE SEGMENTS

EASTERN FLOOD PROTECTION LEVEE SEGMENT

A new flood protection levee segment would be built on the Burroughs parcel to protect existing on-site infrastructure (i.e., natural gas wells, transmission lines, etc.) and lands to the east from flooding (Figure 3-3). The new levee would be constructed along Jersey Island Road on the southern portion of the Burroughs parcel, would bisect the parcel between the enhanced irrigated pasture and restored marsh, and would connect with the existing flood protection levee on the east side of Little Dutch Slough. The new levee would be constructed to DWR Urban Levee Design Criteria (California Department of Water Resources, Floodsafe California, May 2012), including 200-year flood protection standards.

SOUTHERN FLOOD PROTECTION LEVEE SEGMENT

A new levee segment would be constructed along the southern boundary of the restoration area to protect properties to the south(Figure 3-3). This new levee would follow the southern edge of the restoration area and the southern Community Park boundary, and would tie into Sellers Avenue at the end of Emerson Slough.

This levee would cross Little Dutch Slough and require permanent fill of a 100-foot long by 50-foot wide section of the channel, as well as installation of one or two new drainage culverts and flap-gates at the levee. Just south of the restoration area, Little Dutch Slough transitions to an open drainage ditch which receives some muted tidal flow. The drainage culverts would be installed in the new levee segment to allow the ditch to continue to drain runoff into Little Dutch Slough, but prevent tidal waters from entering the ditch.

This levee segment would improve the existing level of flood protection for these areas. It would be constructed to +10 ft NGVD (see below) and improve the existing level of flood protection for these areas (low spots in the existing outboard levees around the Emerson and Gilbert parcels are as low as +7.6 ft NGVD). The preliminary design for the levee follows DWR's *Urban Levee Design Criteria (http://www.water.ca.gov/floodsafe/leveedesign/ULDC_May2012.pdf*) which proposes a crest elevation of approximately +10 feet NGVD, which would provide 3 feet freeboard above the 100-year flood level (Federal Emergency Management Agency [FEMA] base flood elevation). The final levee design would accommodate the 300-year flood elevation as determined by the U.S. Army Corps of Engineers (USACE), plus additional height to accommodate wind-waves. The levee would have a base wide enough to support the construction of additional height to accommodate future sea-level rise plus freeboard. An upland transition zone would be graded and planted between the marsh and crown of this new southern levee segment.

LEVEE BREACHES

Once the marsh plains and channels have been graded, tules established, and new flood protection levees constructed, the existing levees would be breached at the mouth of each tidal channel network to restore tidal flows to the interior of each parcel (Figure 3-3). Breaches would be sized to provide full tidal exchange between the sloughs and the restored marsh and open water areas. For the large marsh areas on the Gilbert and Burroughs parcels, breaches would be approximately 60 to 80 feet wide at MHHW and 8 feet below MHHW. Breaches on the small marsh areas on the Gilbert parcel would be 20 feet wide at MHHW and 5 feet below MHHW. The large restored tidal marsh on the Emerson parcel would have two levee breaches at both the upstream and downstream end of the realigned Marsh Creek. The upstream breach would be along the existing Marsh Creek, and the downstream breach would be connected to Dutch Slough. The subtidal open water area on the Emerson parcel would include two additional breaches to Emerson Slough. Each of these four breaches would be approximately 150 to 200 feet wide at MHHW and 12 to 15 feet deep below MHHW. After breaching, the flood protection function of the existing perimeter levees would be replaced by the new east and south boundary levees, as described above.

INFRASTRUCTURE PROTECTION, RELOCATION, AND REPLACEMENT DESIGN COMPONENTS

Utility infrastructure located on site would be protected or relocated to allow for completion of restoration and levee improvement components. An existing ISD effluent pipeline would be relocated to beneath the crown of the Marsh Creek levee to provide access for service and maintenance. Various PG&E power poles (and associated overhead) lines would be removed, relocated, or preserved, depending on their function. Active gas wells and pipe lines in areas that would be restored on the Gilbert and Burroughs parcels would be capped and decommissioned prior to construction. Buried pipelines would be abandoned in-place by capping the ends. Buildings, sheds, barns, fences, posts, concrete pads and any other such materials within the construction footprint would be demolished and hauled to a nearby landfill or used onsite, as appropriate.

PUBLIC ACCESS COMPONENTS

For public access on the Emerson Parcel trail, all four levee breaches would be bridged. Three of the bridges would be approximately 150 to 200 feet long and would be designed for pedestrian use and maintenance vehicle access. The bridge over the mouth of Marsh Creek would be longer, possibly up to 300 feet, and would be designed for pedestrian access. Bridges would have prefabricated decking, concrete abutments, and support piers as needed. The breach openings would likely have rock armoring on side slopes for erosion protection. The bridges would be constructed on the landside of planned perimeter breaches to reduce special-species impacts and improve constructability.

VEGETATION PLAN

TULE ESTABLISHMENT

For the tidal marsh, as each parcel is graded, existing tules would be salvaged and moved to a designated planting area where water levels would be managed to encourage spread of the tule clumps. Construction would be phased within each parcel and across the restoration area to allow a 1 to 2 year period between marsh plain grading and levee breaching to allow tules to establish in the marsh areas. Tule marsh would be grown on the marsh plains and adjacent levee benches of each parcel. Tule marsh would provide vegetative protection against potential scour following each levee breach and the initial introduction of tidal waters.

RIPARIAN AREAS

Riparian areas would be planted with native woody and herbaceous species. Following initial control of weeds and planting of riparian trees and shrubs, a seed mix of native riparian grasses, sedges, and wildflowers would be seeded in areas at appropriate elevations. Weed control would be implemented at least one year before planting and could include applications of herbicides, mechanical disking, or mowing.

Riparian trees that have the potential to grow tall, such as Fremont cottonwood (*Populus fremontii*), would be planted on the north side of the Burroughs parcel to provide hunting perches and nesting habitat for raptor species.

NATIVE GRASSES

Following initial weed control, native grasses would be seeded and mulched on clay soils in upland areas of the Project site. Annual wildflowers could be seeded after the grasses become established.

LEVEES AND BERMS

The rock armoring along Emerson and Dutch Sloughs would be spaced to allow for interspersed planting above the tidal zone to create SRA habitat where possible. Pole planting would occur within rock voids and portions of the upper slope would be planted with riparian vegetation. Planting on the Emerson perimeter levee would be limited to trees and grasses, with little or no shrub cover. Trees such as valley oak (*Quercus lobata*), coast live oak (*Quercus agrifolia*), and box elder (*Acer negundo*) would be planted along both side slopes of the Emerson perimeter levee. The drainage divide berm would be planted with riparian vegetation and native grasses.

To allow vehicle access, the Gilbert perimeter levee crown would not be planted with vegetation. The inboard levee slope and stability berm would be seeded with native grasses. The new levee that would bisect the Gilbert parcel from east to west would be planted with riparian vegetation. The new low berm that would be set back from the existing Little Dutch Slough channel and breached in several locations would be planted with riparian woodland and native grass species.

The lowered levee bench on Little Dutch Slough on the Burroughs parcel would be planted with riparian and woodland vegetation and native grasses. The slopes of the new flood protection levees would be seeded with native grasses.

CONSTRUCTION METHODOLOGY

The most significant construction activities required for the proposed Project would consist of earthmoving and grading activities associated with marsh creation, levee construction, and improvements to existing levees. The following outlines the general sequence of Project construction activities:

- Vegetation clearing within earthwork limits, including selected tree removal on perimeter levee segments as required for armoring replacement.
- Minor demolition, including structures on the Burroughs parcel, the Emerson pump station, and abandoned utilities.
- Construction of four public access bridges on the Emerson parcel.
- Relocation of the sanitary sewer force main in the existing levee on the Emerson parcel.
- Installation of a temporary construction crossing through Marsh Creek.
- Existing levee armoring removal and replacement with rock slope protection on the Emerson and Gilbert parcels.
- Surfacing new and existing levee crests with aggregate base or similar material.

- Temporary pump installation for tule cultivation on the Emerson parcel.
- Installation of one culvert for the managed non-tidal marsh on the Gilbert parcel.
- Installation of temporary irrigation systems for selected riparian plantings.

A more detailed discussion of in-water construction methods, which has been revised since preparation of the 2010 EIR, is provided in the following section.

IN-WATER WORK

While most construction would be performed within the confines of the existing perimeter levees, the following limited in-water work would be required:

- Installation and subsequent removal of a temporary construction crossing of Marsh Creek;
- Installation of one intake culvert and fish screen for water management in the managed non-tidal marsh on the Gilbert parcel;
- Installation and removal of up to six temporary fish screens on diversions in Emerson and Little Dutch Slough to be used during tule cultivation;
- Removal, replacement, and/or placement of rock slope protection levee armoring on the Emerson and Gilbert parcels;
- Enlargement of Little Dutch Slough;
- Construction of the southern flood protection levee across Little Dutch Slough; and
- Breaching of levees.

For the most part, in-water work would be performed using equipment staged on the crest of the perimeter levees (e.g., long-reach excavators, drag line and/or cranes). The construction areas for installing the Marsh Creek crossing and enlargement of Little Dutch Slough would be isolated using cofferdams. Equipment would only be operated within the banks of Marsh Creek while constructing and decommissioning the temporary Marsh Creek crossing, and within Little Dutch Slough while constructing the new southern flood control levee crossing and during the enlargement process.

TEMPORARY MARSH CREEK CROSSING

A temporary crossing would be installed in and removed from Marsh Creek to allow the transport of borrow material from the soils borrow area to the Emerson parcel. The crossing would be located near the southern boundary of the Emerson parcel within the disturbance area of the proposed levee breach required for the new Marsh Creek alignment (Figure 3-5). The temporary crossing would be constructed of an earthen embankment containing three culverts up to 4-feet in diameter. Temporary sheet pile cofferdams, spanning approximately 60 feet across the channel, would be installed on both sides of the crossing using a vibratory hammer and excavator staged on the perimeter levee. Before placing the downstream cofferdam, seine and block nets would be used on an outgoing tide to herd fishes toward the northern (downstream) end of the work area. The downstream cofferdam would then be placed at low tide, and remaining fishes removed from the area using nets and backpack electrofishing, before and during dewatering of the work area, and before construction activities occur.

If dewatering is needed, it would last for approximately 5 to 7 days. Upstream flows would be routed downstream of the crossing via bypass piping. Water removed from within the construction area would be pumped, as needed, onto the Emerson parcel and contained within the existing levee and/or temporary berm(s). Removed water would be allowed to infiltrate and evaporate. Culvert installation would require minor dredging of the channel bottom to create a flat pipe bed. Gravel would be placed on the surface of the crossing, and rock slope protection would be used on the embankment.

The Contra Costa Flood Control and Water Conservation District requires that flows to Marsh Creek be returned prior to October 1, and that the Marsh Creek crossing be removed by that date. To allow for transport of the necessary material from the soils borrow area, this temporary crossing would need to be installed (and removed) twice during two consecutive construction seasons. At the end of each construction season, all temporary crossing materials (earth embankment, culverts, gravel, and rock slope protection) would be removed, and the channel would be graded to match pre-construction grades.

CULVERT INSTALLATION

One new screened and gated culvert (4-foot diameter reinforced concrete pipe) would be installed in the perimeter levee on the Gilbert parcel adjacent to the drainage pump along Emerson Slough to provide intake water for the managed non-tidal marsh area. The new culvert would be installed in the perimeter levee system below the tide level, so construction would require a temporary cofferdam on the water-side of the levee. The cofferdam would be constructed of sheet piles or similar, installed at the toe of the levee, and would be up to 40-feet long (parallel to the levee). The culvert and sheet pile cofferdam would be installed using an excavator (or similar) staged on the perimeter levee. The sheet piles would be driven using an excavator equipped with a vibratory hammer. Tidal water would be pumped from within the cofferdam and discharged onto each parcel inside of the levee to infiltrate and evaporate.

PERIMETER LEVEE IMPROVEMENTS

Improvements to the outboard side of the perimeter levee segments along Dutch Slough and Emerson Slough on both the Emerson and Gilbert parcels, and along Little Dutch Slough on the Gilbert parcel, would include the removal of existing riprap, minor grading to flatten over-steepened slopes, placement of new rock armoring, pole planting in rock voids, and vegetating the upper slope. All work would be performed using equipment (e.g., long-reach excavators, dragline, or similar) staged on the top of the levee or on the earthen bench on the levee interior.

To armor the levees, rock (from 75 pounds to 1 ton) would be dumped on levee slopes from the levee crest and then shaped and placed using an excavator. For the most part, existing rip rap below the water line would remain in-place, and serve as the foundation for new armoring placed upslope. Concrete rip-rap removed from the Emerson perimeter levee would be placed on the inboard side of the levee, and buried in the new stability berm under at least 2 feet of fill.

All levee work would be performed prior to tidal inundation of the restoration area (which would determine both the elevation and timing of levee lowering).

LITTLE DUTCH SLOUGH ENLARGEMENT

Prior to enlargement, the portion of Little Dutch Slough planned for enlargement (i.e., the upstream 2,500 feet) would be isolated and dewatered using cofferdams. Isolating the slough channel would minimize water quality and turbidity effects, and allow concurrent construction of several Project components, including slough enlargement, construction of the new berm on the Gilbert parcel, construction of the south levee crossing, and levee breaching on the Gilbert parcel, which would reduce potential construction-related water quality impacts and project costs. Temporary coffer-dams, which would span approximately 80 feet across the channel, would be constructed of sheet piles or similar material, and installed using an excavator and vibratory hammer, as described for the temporary Marsh Creek crossing.

After isolation, fish rescue, and dewatering (see *Marsh Creek Crossing* above), the channel would be widened and deepened using bucket excavation equipment (e.g., drag line or long-reach excavator). If needed, temporary construction access pads may be constructed in the channel to temporarily stage equipment. All temporary construction access pads would be removed as part of final channel grading. Wet excavated material would be placed and dried on areas to be graded on the Gilbert parcel and on non-wetland areas (upland irrigated pasture and ruderal lands) on the Burroughs par-cel, and used as fill for tidal marsh restoration.

Any storm drain flows from the ditch that connects to the south end of Little Dutch Slough would be pumped downstream of the cofferdam. If the construction area associated with enlarging Little Dutch Slough requires dewatering, water would be pumped, as needed, onto the Gilbert or Bur-roughs parcels and contained within the existing levee. Removed water would be allowed to infiltrate and evaporate and would not be discharged offsite.

Little Dutch Slough would be enlarged during one construction season (August 1 – October 31) following marsh grading and tule management on the Gilbert parcel and prior to breaching of the Gilbert parcel. When all work (channel enlargement, construction of new berm and south levee, and breaching) is complete, the cofferdam would be removed.

SOUTH LEVEE CROSSING OF LITTLE DUTCH SLOUGH

The south end of Little Dutch Slough would be filled to allow for a continuous south levee between the Gilbert and Burroughs parcels. The disturbance area for levee construction would overlap with the disturbance for Little Dutch Slough enlargement and would be performed at the same time (see *Little Dutch Slough Enlargement* above). Levee construction would require that the bottom of the slough be excavated by 3 feet, and the levee backfilled and compacted with competent levee material (the fill placement area would cover up to 5,000 square feet). The flap-gated culverts would be in-stalled in coordination with the levee fill placement and compaction. Levee construction would con-tinue until the design levee height is achieved and related work (i.e., slough enlargement and tidal breaching) is complete.

PERIMETER LEVEE BREACHES

Perimeter levees on the Emerson and Burroughs parcels would be breached using bucket excavation equipment (e.g., drag line or long-reach excavator) staged on the perimeter levees. Equipment would not be operated in the channel and dewatering would not be required. Excavation of each levee breach would start during low tide and would be completed within one tide cycle to minimize tur-bidity. Excavated material would be sidecast into each parcel interior and roughly graded to be com-patible with the restoration design.

As described above, perimeter levee breaching on the Gilbert parcel would be conducted concur-rently with the Little Dutch Slough enlargement and south levee crossing construction, while the temporary cofferdam is in place and the slough channel is isolated from tidal waters. The newly con-structed perimeter levee breaches would be included in the new setback berm constructed as part of the slough enlargement, using an excavator or similar equipment.

PROJECT SCHEDULE

The Project would be built out over a 6 to 10 year period, with construction beginning in 2013. It is anticipated that each parcel would require approximately 4 years for full restoration (2 years for construction and 2 years for tule management); however, the timing would overlap so various parcels would undergo restoration simultaneously.

In general, perimeter levee improvements and tidal marsh restoration would start on the Emerson parcel in Year 1 (2013) and continue through Year 2 or 3, followed by two years of tule management. Levee improvements on the Gilbert parcel would commence between Year 1 and 3. Tidal marsh earthwork on the Gilbert parcel would occur during Years 2 and 3 or 3 and 4, followed by two years of tule management. Burroughs parcel construction would start 4 to 7 years after construction is initiated. Trail construction would begin after work on the Emerson Parcel is complete.

4. ENVIRONMENTAL SETTING, IMPACTS, AND MITIGATION MEASURES

4.1 HYDROLOGY AND WATER QUALITY

This section updates the hydrologic and water quality conditions on and in the vicinity of the Project site, including tidal action, Marsh Creek flows, groundwater flows and seepage, erosion, sedimentation, and water quality to take into account the proposed changes to the Project described in this Supplement EIR. The impacts and mitigations in this section replace those in the 2010 EIR.

Water quality background and the effects of the Project on hydrologic and water quality resources were identified in the 2010 EIR, Chapters 3.1 and 3.2, on the basis of studies conducted by Phillip Williams Associates (PWA, 2006), LSCE (2006), Hultgren-Tillis Engineers (2005), Natural Heritage Institute (2002, 2003, 2004), planning reports for the East Cypress Corridor and Holland Tract, and analysis of these reports by Wetlands and Water Resources (WWR), the chapters' authors. A new study (HydroFocus, 2013) of potential seepage effects of the Project on the adjacent section of the Canal has been prepared and is discussed herein. Additionally, this section discusses possible changes to impacts resulting from the following proposed changes to the Project description. The proposed changes to the Project with respect to potential hydrologic and water impacts are summarized as follows:

- Construction of a new flood protection levee along the southern boundary of the Project site, which would include installation of a new drainage culverts and flap gates in Little Dutch Slough at the levee crossing.
- Removal and replacement of portions of the existing outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough, including some located below the mean tide level (MTL).
- Refinement of the proposed management strategy on the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat connected to adjacent tidal channels by breaching the perimeter levee in two locations.
- Refinement of the proposed management strategy on the northern portion of the Gilbert parcel to allow for restoration and enhancement of non-tidal freshwater marsh habitat, installation of a gated, screened culvert on the Gilbert parcel at Emerson Slough for water supply, and creation of a toe ditch and open water areas to enhance California black rail (*Laterallus jamaicensis coturniculus*) and giant garter snake (*Thamnophis gigas*) habitat.
- Identification of a preferred alignment for the relocation of Marsh Creek delta the Emerson parcel.
- Revisions to the in-water construction methodologies associated with the temporary crossing of Marsh Creek onto the Emerson parcel and enlargement of the southern reach of Little Dutch Slough.
- Installation of temporary fish screens on water-supply intakes for tule management.
- Phasing of project implementation, as follows:
    - Emerson parcel:
        - 2014/2015: grading
        - 2015 (spring): plant tules and initiate tule management

        - 2016 (fall): breach parcel
    - Gilbert parcel:
        - 2015/2016: grading
        - Fall 2016 or spring 2017: plant tules and initiate tule management
        - 2018: breach parcel
    - Burroughs parcel:
        - Schedule to be determined.
        - Grading likely to be initiated after breaching of Gilbert parcel (2018).

This section includes a summary of impacts and mitigations considered in the 2010 EIR, and has been updated to include impacts and mitigations that are new or have been substantially altered by changes in the proposed Project. Because the selected Project now reflects a modified iteration of Alternative 2, Moderate Fill Alternative, from the 2010 EIR, only impacts to that modified alternative are reviewed herein. Where appropriate, avoidance, minimization, and mitigation measures provided by regulatory and resources agencies during Project-specific discussions have been incorporated into this analysis and reflected in the discussion of avoidance, minimization, and mitigation measures.

The only water quality impacts discussed in the 2010 EIR that are subject to significant revision in this SEIR are those that relate to water quality within the Contra Costa Water District Canal (Canal). The 2010 EIR identified no potentially significant impacts to water quality in the Canal from implementation of the project because the project would have only been breached to tidal action once the Canal was fully encased south of the project site. This encasement would have effectively isolated the Canal from local groundwater seepage that may be increased by breaching. Subsequent to the release of the 2010 EIR, encasement of the Canal south of the project site was delayed. The current schedule is for the portion of the Canal adjacent to the Emerson Parcel (Segment 2) to be encased in 2014-2015, prior to breaching of the Emerson parcel. However, the encasement schedule for the Canal adjacent to the Gilbert and Burroughs parcels (Segment 3) is unknown. Therefore, tidal action could be restored to these parcels before encasement of the adjacent Canal is complete. The potential impacts of this project staging (construction sequencing) are discussed below in Section 4.1.2. The SEIR also contains additional information about potential DOC/TOC export from the site. The impacts from the other activities analyzed in this SEIR do not have potential significant adverse environmental effects on water quality as discussed in this section.

4.1.1 Affected Environment

Hydrology

The 2010 EIR described the regional hydrology of the Sacramento-San Joaquin Delta, and upper reaches of the San Francisco Estuary, tidal ranges and influences, sea level rise, hydrology onsite and in adjacent sloughs and creeks, groundwater connectivity, flooding, and regulatory setting. Most of those discussions remain current and, if unchanged, are not repeated in this Supplemental EIR. More recent studies have been conducted on groundwater connectivity. Those studies are described in the updated discussion below.

CONNECTION TO THE CONTRA COSTA CANAL

Multiple studies have investigated the hydraulic connections between surface water in the Canal and groundwater at the Project site. In 2006, Luhdorff and Scalmanini Consulting Engineers (LSCE) prepared an initial assessment

of the relationship between shallow groundwater in the restoration area and the Canal *(Groundwater Investigation and Monitoring Program, Dutch Slough Restoration Area,* LSCE 2006). This study included (1) installing six monitoring wells 25 feet in depth (two on the Emerson parcel, two on the Gilbert parcel, one on the Burroughs parcel, and one south of the Canal opposite the Gilbert parcel) and monitoring their water level hourly from September 2004 to April 2006; (2) installing one stilling well in Emerson Slough and monitoring tide stage hourly from September 2004 to March 2005, and utilizing DWR monitoring data from Rock Slough after March 2005; and (3) sampling the monitoring wells and surface water in the Canal, Marsh Creek, Emerson Slough, and the Gilbert Pond and analyzing samples for a suite of mineral and nutrient water quality indicators.

The 2006 study indicated two general trends in the region. First, groundwater generally flows from south to north, i.e., from the low-lying alluvial plain of the lower watershed to the Delta. As described in the 2010 EIR, management on individual parcels north and south of the canal, most notably winter pumping and summer irrigation, mediate these regional flow patterns at the site scale. Second, local soils generally exhibit relatively high permeability, facilitating groundwater exchange with surface water. This permeability is evident from the groundwater data at all six monitoring wells, as water levels exhibit a daily tidal signal (water levels rise and fall with the tides) on the order of 0.1 to 0.2 feet from adjacent tides in Marsh Creek, Dutch Slough, or the Canal.

For the Emerson and Gilbert parcels, the study found that hydraulic conditions favor net flow from groundwater into the Canal during wet periods (termed "discharge") and from the Canal into groundwater during dry periods (termed "recharge"). As an exception, period summer irrigation activities raise groundwater levels on these parcels higher than water surface elevations within the Canal, creating the potential for temporary groundwater flow into the Canal. At the Burroughs parcel, the study found year-round flux from the Canal (recharge).

For salt loading into the Canal, the study found results similar to prior investigations mentioned but not cited in the LSCE report, namely, that the Canal accumulates salts during low- and no-flow periods that originate from a broad source or sources of dissolved salts available in the vicinity of the unlined portions of the Canal. The report identifies these sources to include soils, seawater intrusion, wastewater application, and agricultural runoff. The study confirmed the Dutch Slough site groundwater to be generally brackish. The study also noted that two predominant soil types in the area, Marcuse Clay and Sycamore Silty Clay Loam, are characterized as poorly drained, saline, and alkali by the Natural Resources Conservation Service (NRCS). The study did not attempt to identify the relative contributions of these different sources of salt.

The 2006 LSCE Report was an initial assessment of site conditions, and concluded with recommending additional monitoring and analysis. In 2011, after the 2010 EIR was certified, HydroFocus initiated a more comprehensive groundwater monitoring program for the Project Site that included the wells installed by LSCE. This study (HydroFocus 2013) investigated the potential seepage and total dissolved solids and chloride loading to the Canal due to the Project (see Appendix B).

The HydroFocus study reviewed stage data for the Canal and groundwater conditions in seven shallow monitoring wells adjacent to the Canal, and evaluated hydraulic gradients and conductivity in six segments paralleling both sides of the Canal. The HydroFocus report stated that when mean canal stage and groundwater levels are approximately equal, the continuously fluctuating Canal water level induces cyclic changes in the seepage and leakage rates. For example, during high tides, and when Canal water levels are relatively higher than the adjacent shallow groundwater, Canal water leaks to groundwater. In contrast, during low tides and when Canal water levels are below the adjacent groundwater level, the flow direction reverses and induces an equal volume of groundwater to seep into the Canal. In this hypothetical scenario, the mean or net movement of water between Canal and groundwater during a complete tidal cycle is therefore essentially zero. In contrast, when adjacent mean groundwater levels are consistently greater or lower than Canal stage, the instantaneous flux rate changes with the tides but the net direction of water movement over the tidal cycle does not. Under this latter scenario, the longer temporal scale changes (for example, seasonal transients) and their influence on mean groundwater levels and gradients determine the net flux of water between the Canal and groundwater over time.

In order to calculate monthly seepage and leakage to/from the Cana, HydroFocus utilized measured and previously reported hydraulic conductivity values from wells installed adjacent to the Canal on ISD property west of the Dutch Slough property, mean monthly estimated canal stage, and mean monthly measured groundwater elevations (HydroFocus 2013.). Available boring logs for monitoring wells indicate a shallow water-bearing zone comprised of silty sand deposits with silt and clay layers overlain by a clay cap that is 4 to 7 feet thick. Hydraulic conductivity values ranged from 0.5 to 6 feet per day. The study utilized this range of hydraulic conductivity values, and assumed the saturated thickness of the adjacent sediments that horizontally transmit seepage or leakage to be 12 feet. The study utilized stage data from Rock Slough to estimate Canal stage, and measured water levels in monitoring wells to represent groundwater elevations. Continuous data monitored over time periods spanning the daily tidal cycles were filtered to eliminate tidal effects and calculate monthly mean water levels.

HydroFocus used a one-dimensional Darcian flow model and monthly data for existing conditions to determine that almost all of the calculated seepage occurs within the reach east of Marsh Creek to Emerson Slough. Most of the seepage (77 percent) is from the south. From Emerson Slough east to Jersey Island Road, a small amount of seepage also occurs in the western portion of the reach nearest the slough, but over most of the reach, Canal water leaks to groundwater located north and south of the Canal. The estimated annual average daily seepage rate ranged from a minimum of 180 cubic feet per day (ft^3/d) (0.002 cubic feet per second [cfs]) to a maximum of about 4,950 ft^3/d (0.058 cfs). The greatest seepage rate occurred during February when maximum seepage was 6,355 ft^3/d.

HydroFocus also estimated daily groundwater fluxes to the Canal using daily Canal stage (estimated from hourly estimates from the HEC-RAS model). Values ranged from -8,849 to 5,227 cubic feet per day. The mean estimated value is -1219 ft^3/d. Maximum flux values from monthly estimates for the overlapping period were consistently higher than the daily estimates.

CONNECTION TO LANDS SOUTH OF THE CANAL

A stormwater management plan produced for the property immediately south of the Canal across from the Emerson parcel (Balance Hydrologics 2004) describes persistent groundwater elevations along the northern boundary of this property around +2.0 feet NGVD29, although no data are given to support this assertion. Data collected between September 2004 and April 2006 on the property south of the Gilbert parcel (at a location approximately 400 feet south of the Canal) showed groundwater levels between about -0.7 to +3.3 feet NGVD29 with higher levels in the winter and lower levels in the summer (LSCE 2006). As described above, over half of the inflow to the Canal adjacent to the Project site is from land south of the Canal.

CONNECTION TO LANDS EAST OF JERSEY ISLAND ROAD

ENGEO Inc (2005), which conducted a study for the adjacent Cypress Corridor Specific Plan Area (CCSPA) east of Jersey Island Road, concluded that that Emerson and Little Dutch Sloughs "do not currently contribute to significant groundwater recharge in [the CCSPA] because drainage tiles and lift pumps used to dewater the lands below sea level exist adjacent to these sloughs that provide a point of hydraulic control with zero net effect. In other words, the amount of water recharges from the sloughs equals, or is less than, the amount of water being removed by the drainage tiles and drainage lift pumps." The same study also concludes that the Canal recharges groundwater in the CCSPA because water surface elevations in the Canal are typically higher than groundwater elevations. ENGEO (2005) estimated the amount of this recharge to be approximately 335 acre-feet per year. Hultgren-Tillis (2005) indicated that recharge from Dutch Slough via porous underlying sandy soils contributes to groundwater in these lands.

CONNECTION TO LANDS WEST OF MARSH CREEK

Across Marsh Creek from the Dutch Slough site are un-irrigated Ironhouse Sanitation District (ISD) lands used for the production of cattle feed. Existing groundwater levels on ISD lands are around mean tide level (Hultgren-Tillis 2005, HydroFocus 2003). Marsh Creek is likely to be a drainage boundary between ISD lands and the Dutch Slough Project site (Hultgren-Tillis 2005).

Water Quality

The water quality setting as described in the 2010 EIR remains unchanged, with the exception of (1) an updated understanding of groundwater seepage at the site (discussed in Impacts 4.1-5 and 4.1-6), and (2) updated information describing dissolved and total organic carbon in the Delta (discussed in Impact 4.1-13).

As described in the 2010 EIR, water quality in the Project area is governed by both natural conditions and human land use. Local areas drain a mix of open space, rural and suburban landscapes to Marsh Creek, Emerson, Little Dutch and Dutch Sloughs, and the Sacramento/San Joaquin Delta. The net flow of water in the San Joaquin and Sacramento Rivers is downstream; however, incoming tides can transport water and its constituents into the Project area as well as into the Canal. Chemical, physical, and biological water quality parameters are affected by land use and both human and natural processes.

The Marsh Creek watershed transports runoff from the undeveloped lands on the northeast side of Mt. Diablo as well as the rapidly urbanizing areas of Brentwood and Oakley. Contaminants from these areas are transported via the Marsh Creek flood control channel to the Delta at Big Break. Runoff from an abandon mercury mine site in the upper watershed is also a potential problem because it could lead to unhealthy concentrations of mercury in organisms in the Delta and at Dutch Slough and Marsh Creek. The Marsh Creek Dam forms the Marsh Creek Reservoir, located approximately 10.5 miles upstream of Big Break. The reservoir acts as a sediment sink, capturing runoff from much of the watershed including that from the historic mercury mine located well upstream of the reservoir.

Agricultural areas in the Marsh Creek watershed are being converted to suburban uses resulting in increased impervious surfaces and reduced infiltration of rainfall and runoff into the ground. As a result, natural filtration processes are decreased and pollutants are transported more directly to surface waters and increased erosion into these surface waters can occur, especially where vegetation has been degraded or removed. Increased erosion can, in turn, lead to increased turbidity and nutrients, while reduced shade from vegetation impacts can increase water temperature, lower pH, and increase biological oxygen demand. Remaining agricultural landscapes provide greater rainfall and runoff infiltration than developed areas but continue to be a source of fertilizers, pesticides, nutrients and other pollutants, including high concentrations of dissolved organic carbon that can contribute to the formation of chlorination by-products known as trihalomethanes.

Municipal wastewater discharges from the Brentwood Waste Water Treatment Plant into Marsh Creek are a potential source of pollutants, including endocrine disrupting chemicals that can have biological impacts that are not fully understood (Sumpter 2005). ISD has discharged treated wastewater to Ironhouse Project lands and lands adjacent to Marsh Creek and Dutch Slough for nearly 30 years, potentially increasing concentrations of endocrine disrupting chemicals, metals, and other pollutants to groundwater and surface waters in the Project site. In particular, treated wastewater has been used for irrigation on the Ironhouse parcel.

Please refer to Chapter 3.2 of the 2010 EIR for additional discussion of these topics.

4.1.2 Impacts and Mitigations

Significance Criteria

Significance criteria for the relevant hydrology and water quality impacts are based upon the CEQA guidelines and professional judgment. Potentially significant impacts could occur if the Project results in one or more of the following.

HYDROLOGY

- Substantial modifications to existing hydrological conditions, including surface water inputs and outputs, drainage network, or channel alignment resulting in substantial erosion or siltation on or off-site.
- Substantial modifications to existing infiltration rates and interference with groundwater recharge that would deplete groundwater supplies or lower the local groundwater table level.
- Substantial modifications to existing site drainage and groundwater infiltration that would raise the local groundwater table level and necessitate increased groundwater pumping to drain adjacent properties.
- Substantial alterations to an existing drainage pattern of the Project site or area that would increase surface runoff resulting in on-site or off-site flooding.
- Runoff that would exceed stormwater drainage systems or act as source of polluted runoff

- Structures placed within a 100-year flood hazard area that would impede or redirect flood flows.
- Exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of levee failure.

WATER QUALITY

- Violation of any water quality standard indicated in the Regulatory Framework section in the 2010 EIR, or any Waste Discharge Requirement or National Pollutant Discharge Elimination System (NPDES) permit condition.
- Discharge of any toxic substances into the water in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota.
- Degradation of the existing high quality of water in any waters of the State, in violation of the Anti-degradation Policy.
- Any change of water quality that would adversely affect designated beneficial uses.

Discussion of Impacts and Mitigation Measures

As described above, this section includes a summary of impacts and mitigations considered in the 2010 EIR, and has been updated to include impacts and mitigations that are new or have been substantially altered by changes in the proposed Project. To facilitate review of the section and comparison of analyses between the 2010 EIR and this document, the heading for each impact or mitigation measure reflects whether that impact is the same, revised, replaced, or new. For example, the heading for Impact 4.1-1 is "Impact 4.1-1 (**Same as** 2010 EIR Impact 3.1.2.1)"; the heading for Impact 4.1-6 is "Impact 4.1-6 (**Replaces** 2010 EIR Impact 3.1.1-5).

HYDROLOGY

IMPACT 4.1-1 (SAME AS 2010 EIR IMPACT 3.1.2-1): EROSION IN TERMINAL SLOUGHS DUE TO INCREASED TIDAL PRISMS

The 2010 EIR describes that breaching levees adjacent to the Emerson Slough and Little Dutch Slough levees would increase the tidal prism (i.e., the volume of water that flows past a given point during a tidal cycle), which, in turn, would result in erosion of these terminal sloughs as the channel geometry evolves to accommodate the larger post-restoration tidal prisms. Although erosion could provide a sediment source for deposition on the restored marsh plain, it could also result in adverse effects if it does not happen within an expected period of time (i.e., resulting in a muted tidal signal that would delay marsh plain accretion, threaten the integrity of the upland areas or berms adjacent to the sloughs, or result in local water quality impairment).

The proposed refined design includes features that reduce the potential for increased tidal prism to cause erosion of Emerson and Little Dutch sloughs:

- The open water area on Emerson parcel will only have one breach to Emerson Slough near the mouth of the slough (with an additional breach to Dutch Slough), and
- The lower elevation, northern portions of the Gilbert and Burroughs parcels would remain non-tidal (and therefore would not contribute additional tidal prism to Little Dutch Slough).

Nonetheless, the proposed refined Project increases tidal prisms in Emerson and Little Dutch sloughs over existing conditions by approximately 200 and 850 acre-feet respectively. However, the final design of the Project includes enlarging Little Dutch Slough as needed to accommodate this increased tidal prism (based on hydraulic geometry relationships).

Implementation of Mitigation 4.1-1 would reduce this impact to a less than significant level, similar to that described in the 2010 EIR. 2010 EIR Mitigation 3.1.2-1.1, which required development of erosion and sediment design and performance standards, is no longer necessary given that those standards have been incorporated into the revised Project considered in this SEIR.

MITIGATION 4.1-1 (REPLACES 2010 EIR MITIGATION 3.1.2-1.2) EROSION MONITORING AND ADAPTIVE MANAGEMENT OF EMERSON SLOUGH

The existing perimeter levees along Emerson Slough shall be monitored for erosion by the Project for at least 5 years post-construction. This will allow for adaptive management of the Project site. If erosion is so great that it undermines levees, or causes water quality impairments, improvements such as channel armoring shall be implemented to manage and reduce erosion.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-2 (REPLACES 2010 EIR IMPACT 3.1.2-3) POINT BAR FORMATION IN MARSH CREEK

The 2010 EIR described that a point bar could be created if sediment is deposited at or near the Marsh Creek diversion point on the Emerson Parcel, and that accumulated sediments could reduce the flood conveyance capacity of Marsh Creek.

The refined design of the Marsh Creek distributary channel on the Emerson parcel reduces the likelihood of a point bar forming by leaving the existing channel intact. In addition, the revised configuration would increase the flood conveyance capacity of Marsh Creek by adding the distributary channel capacity. As a result, the likelihood for point bar formation, and the potential resulting impacts on flood conveyance, are minimal, and less than that described in the 2010 EIR. However, the splitting of flood flows between the existing channel and the proposed distributary channel has the potential to reduce the sediment transport capacity of Marsh Creek, which could result in increased deposition of fluvial sediments at the point of diversion. Any potential impact on flood flow conveyance is considered potentially significant, so a mitigation measure is provided to address the potential for deposited sediments to reduce flood conveyance capacity.

Implementation of Mitigation Measure 4.1-2 would reduce this potential impact to a less than significant level. Mitigation 4.1-2 replaces Mitigation 3.1.2-3 and 3.1.2-4.1 in the 2010 EIR, which provided specifications for channel design and monitoring. The revised mitigation measure only reflects monitoring requirements, as the channel design requirements are reflected in the current Project.

MITIGATION 4.1-2 (REPLACES 2010 EIR MITIGATION 3.1.2-3 AND 3.1.2-4.1) MARSH CREEK CHANNEL MONITORING

Monitoring of the new Marsh Creek channel shall be performed at least yearly for five years minimum to ensure that sedimentation is not negatively affecting flood flow conveyance. The monitoring shall include regularly spaced (maximum interval of 500 feet) cross-section surveys and a thalweg survey. Additionally, monitoring the original six channel cross-sections established by NHI in 1999

(NHI 2002) shall be conducted to allow for detection of sedimentation farther upstream from the new channel. If monitoring indicates that sedimentation in the Marsh Creek channel is adversely affecting flood flow conveyance, DWR shall coordinate with the Contra Costa County Flood Control and Water Conservation District (CCCFCWCD) to develop a plan to dredge the creek (and beneficially re-use dredged sediments within the Project site) in order to restore flood flow conveyance to pre-sedimentation levels.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-3 (SAME AS 2010 EIR IMPACT 3.1.2-4) SEDIMENTATION IN TIDAL PORTION OF RELOCATED MARSH CREEK CHANNEL

The 2010 EIR described that sedimentation within the new Marsh Creek channel may adversely affect the 100-year design flow conveyance of the channel. However, as noted previously, the existing reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is with no change to its design flow conveyance. The refined design of the distributary channel would provide additional flow conveyance through the Emerson parcel. As a result, potential impacts on flood conveyance from sedimentation in the relocated Marsh Creek channel are minimal, and less than that described in the 2010 EIR. None-the-less, any potential impact on flood flow conveyance is considered potentially significant.

Implementation of Mitigation Measure 4.1-2 would reduce this potential impact to a less than significant level. Mitigation 4.1-2 (above) replaces Mitigation 3.1.2-4.1 in the 2010 EIR, which provided specifications for channel design and monitoring. The revised mitigation measure only reflects monitoring requirements, as the channel design requirements are reflected in the current Project.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-4 (REPLACES 2010 EIR IMPACT 3.1.2-5) PEAK FLUVIAL-TIDAL DEPOSITION

The 2010 EIR described that the point of peak tidal-fluvial deposition in Marsh Creek would move south (upstream) due to increased tailwater elevations in Marsh Creek from the relocation of the Creek's delta. As described under Impact 4.1-3 above, the splitting of flood flows between the existing channel and the proposed distributary channel has the potential to reduce the sediment transport capacity of Marsh Creek, which could result in increased deposition of fluvial sediments at the point of diversion. Any potential impact on flood flow conveyance is considered potentially significant, so Mitigation 4.1-2 (above) is provided to address the potential for deposited sediments to change the location of peak tidal-fluvial deposition.

IMPACT SIGNIFICANCE

Implementation of Mitigation Measure 4.1-2 would reduce this potential impact to a less than significant level. Less than significant with mitigation.

IMPACT 4.1-5 (REPLACES 2010 EIR IMPACT 3.1.2-7) POSSIBLE WATER QUALITY DEGRADATION IN CONTRA COSTA CANAL DUE TO GROUNDWATER SEEPAGE

Studies reviewed in the 2010 EIR concluded that the permeable soils and geologic formations within and around the Project site would allow for potentially significant subsurface hydraulic connectivity between the site and its surrounding properties (LSCE 2006). This connectivity would likely increase local groundwater elevations once the site is inundated by Delta waters, and create the potential for seepage into surrounding properties. The conclusions of the 2010 EIR are updated to include the conclusions of the more detailed 2013 HydroFocus seepage analysis.

For the proposed restoration effort, the groundwater elevations beneath land areas flooded by water from Dutch Slough would be greater than the Canal stage. HydroFocus' monthly calculations indicated that the maximum annual daily seepage rate would increase from about 4,950 ft^3/d to 8,070 ft^3/d (a 63 percent increase). The maximum estimated total dissolved solids (TDS) would increase from the existing 839 lbs/d to 1,095 lbs/d, and the maximum chloride load would increase from 120 lbs/d to almost 170 lbs/d. The net increase in TDS load (256 lbs/d) and chloride load (47 lbs/d) is due to increased seepage into the Canal

While tidal restoration of each parcel would likely result in increased seepage into the Canal, the net increase over existing conditions varies by parcel. Because there is currently no seepage from the Burroughs parcel into the Canal throughout the year, the net increase under Project conditions is the greatest for Burroughs. There are times when groundwater seepage from the Emerson and Gilbert parcels under current conditions is actually greater than Project conditions, most notably during summertime irrigation. Therefore, the net increased seepage from Emerson and Gilbert (averaged throughout the year) is less than that from the Burroughs parcel.

The Project includes an interim establishment phase whereby tule would be cultivated through managed irrigation. Irrigation would consist of flooding the marsh area and maintaining water level elevations between 2 and 3 feet NGVD (average water level assumed equal to 2.5 feet NGVD). Using monthly data, HydroFocus estimated that tule cultivation would increase the maximum average daily seepage from the existing 4,953 ft^3/d to 11,672 ft^3/d (an increase of 6,719 ft^3/d). The increased seepage would increase TDS from the existing 839 lbs/d to 1,476 lbs/d, and chloride load from 120 to 237 lbs/d.

It should be noted that under all scenarios – existing, tule cultivation phase and tidal breaching - a substantial portion of the total TDS load and chloride load to the Canal south of the Project site originates in the south, and would be independent of Project conditions (HydroFocus 2013).

The Canal is shut down during periods of high Delta salinity. As noted above, the entire unlined reach of the Canal currently accumulates salts during low- and no-flow periods that originate from a range of sources including saline soils, seawater intrusion, and agricultural runoff (LSCE, 2006). HydroFocus determined that if the Canal is shutdown during the tule cultivation period, TDS concentrations can increase to levels of concern. HydroFocus estimated water quality effects for a range of water-level elevations (2 to 3 feet NGVD) during tule cultivation. For the hypothetical worst case scenario - tule cultivation on all three parcels simultaneously and at the highest water level - they estimated a maximum Canal TDS concentration increase of 77 mg/L (21.5 %) and an average increase of 8 mg/L (3.0 %). Scenarios in which only Emerson and Gilbert are under tule cultivation concurrently resulted in substantially lower estimated average concentration increases ranging from 0.8 to 3.8 mg/L (0.3 to 1.4 %). Estimated maximum concentration increases during April ranged from 7.6 to 37 mg/L (3 to 11 %). Tule cultivation solely on Gilbert would result in TDS concentration increases of 5 % or less.

Estimated water quality impacts would be substantially less for project conditions (tidal breaching of all three parcels) than for the hypothetical worst-case scenario described above. HydroFocus estimated an average TDS concentration increase of 1.7 mg/L (0.6%) for project conditions. Values ranged from -1 (decrease) to 17 mg/L. Greatly increased concentrations that occurred during November, January and early February and April were due to zero or minimal flow in the Canal. For Project conditions, the maximum TDS concentration increase of 4.5 % was during late April after a month of zero flow conditions.

It should be noted that the 2013 HydroFocus study did not include any site-specific hydraulic conductivity estimates, and Canal stage was not measured. In addition, the seepage calculations assume one-dimensional horizontal flow from beneath the Project site to the Canal, which ignores variability in hydraulic gradients along flow paths between the Canal and groundwater. The analysis therefore determined a range in seepage and loads based solely on uncertainty in hydraulic conductivity and Canal stage. To err on the conservative side, the results stated herein are generally based on calculations derived from the high end of the hydraulic conductivity range. Additional, site-specific conductivity estimates and measured Canal stage can therefore substantially reduce seepage uncertainty.

Based on the studies summarized above, any potential increase in salt loading into the Canal via groundwater discharge from the project site is likely to be small relative to current loading conditions except during periods of reduced or zero flow in the Canal. This impact is considered potentially significant, and mitigation prescribed to reduce the effects of this impact to less than significant. The planned encasement of the Canal, which is addressed in the 2010 EIR, would remove the risk of changes in groundwater levels on the Project site affecting the water supply quality. That encasement project also would protect the water supply from other potential sources of contamination such as agricultural runoff, municipal runoff, and salt leaching from soils throughout the region. CCWD will begin encasing the section of Canal that is adjacent to the Emerson parcel in 2013, with a projected completion date for this reach in 2015. Tule cultivation will occur on the Emerson parcel beginning in 2015, and the parcel will be breached in 2016. Thus there will be no effects to the Canal from the restoration of the Emerson parcel.

MITIGATION 4.1-3 (REPLACES 2010 EIR MITIGATION 3.1.1-5): PHASE 1, EMERSON PARCEL, BREACH AFTER ENCASEMENT

Mitigations 4.1-3 through 4.1-5, below, replace Mitigation 3.1.2-7 in the 2010 EIR, and are based on the results of the HydroFocus 2013 study. Mitigation measures 4.1-4 and 4.1-5 are intended to be implemented in the sequence in which they are presented, that is, Mitigation 4.1-4 would occur first, and Mitigation 4.1-5 would only be considered if 4.1-4 does not satisfactorily reduce the impact to less than significant. These mitigations would be individually applied to each parcel, and would no longer be necessary on any parcel after the adjacent Canal has been encased.

Construction of the Emerson Parcel and Segment 2 of the Canal Encasement project (adjacent to Emerson Parcel) are expected to proceed concurrently. CCWD will not be operating the Canal throughout the encasement construction period (expected to be from Jan 2014 through Dec 2015). Therefore the Canal would not be in service or will be encased during the planned tule cultivation period or breaching on Emerson, so no mitigation would be required. The mitigation measure for Emerson is similar to that in the 2010 EIR: the perimeter levee shall not be breached until the Canal adjacent to the Emerson portion of the Project site is encased. Thus the impact on hydrology and water quality from Project activities on Emerson parcel is anticipated to be less than significant.

If, however, Segment 2 of the Canal Encasement project has not begun when tule cultivation is initiated on Emerson, then mitigation measures 4.1-4 and 4.1-5 will apply to the Emerson Parcel.

MITIGATION 4.1-4 (NEW MITIGATION): MANAGE AND MONITOR WATER DURING TULE CULTIVATION ON GILBERT AND BURROUGHS PARCELS

Phasing. As summarized above, the groundwater seepage analyses (HydroFocus 2013) demonstrated that the tule cultivation phase would have the greatest potential for increased groundwater seepage into the adjacent unlined Canal. To limit the potential seepage impacts to the Canal, tule cultivation shall only occur on one parcel at a time when the adjacent Canal is un-encased and operational.

Monitoring. If a parcel is flooded for tule cultivation while the Canal is unencased and in service, the Project shall perform continuous monitoring in the Canal to assess potential water quality (salinity) impacts. DWR will establish stage and EC (electrical conductivity, a surrogate for salinity) monitoring stations in the Canal adjacent to the parcel undergoing tule cultivation and just east of the Project site, telemetered to provide real-time measurements to DWR and CCWD.

> Determine Baseline EC Degradation. DWR and CCWD shall cooperatively examine existing data sets to determine baseline (existing) degradation in Canal EC that occurs within the unlined Canal. This baseline degradation will be determined for each month of the year, or each season of the year, as appropriate.
>
> Monitor Project Impacts. Salinity impacts from the restoration will be measured by subtracting the baseline degradation from the difference between real-time measurements of daily average EC at the mouth of the Canal and the EC adjacent to the restoration site.
>
> No impact shall be considered to have occurred at any time when the chloride concentration at CCWD's Pump Plant #1 is at or below 40.0 mg/liter (equivalent to EC of 315 μS/cm). During these times monitoring and impact assessment are not required. CCWD will provide DWR with the EC and chloride data from Pump Plant #1 on a regular basis.
>
> Significant Impacts. Salinity impacts as a result of the Project shall be deemed significant if the increase in daily average EC due to the Project as quantified using the methods described above (Determine Project impacts) exceeds 17.5 μS/cm or is greater than a 5% increase for more than one day and the measured chloride concentration at CCWD's Pump Plant 1 is greater than 40.0 mg/l. If this threshold is reached, measures identified in Mitigation 4.1-5, below, shall be implemented.

Water Management. During the tule cultivation period, the Project shall gradually increase water levels at the site until they reach their maximum elevation (approximately +3.0 ft NGVD29)[1].

---

[1] Most of the marsh plain will be at approximately +2 ft NGVD29, and water levels for tule cultivation are expected to be at +2.5 ft NGVD on average. Mean Tide Level at the site is +1.93 ft NGVD, so this analysis will result in a conservative assessment of the potential effects of Project water surface elevations on water quality within the Canal.

Periods of No-diversion in the Canal. During CCWD's annual no-diversion period (typically the month of April), the water level on the parcel under tule cultivation shall not exceed +2.0 NGVD29 as measured at a staff gage in the southernmost region of tule cultivation. CCWD will notify DWR at least 14 days in advance of any time that it anticipates that daily average pumping at Pump Plant 1 will be below 50 cfs until CCWD notifies DWR that pumping has been greater than 50 cfs for 5 days.

MITIGATION 4.1-5 (NEW MITIGATION): REDUCE OR ELIMINATE SEEPAGE EFFECTS

If monitoring and assessment described in Mitigation 4.1-4 indicates that the Project (either during tule cultivation phase or after breaching) is causing significant water quality impacts that have not been controlled by changes in Project water levels, then DWR shall implement the following measures:

(1) Mitigate the impacts to CCWD water quality by paying for an alternate source of water if impacts exceed the following threshold. Where salinity exceeds the greater of 5% or 17.5 μS/cm, over 40 mg/l of water as measured at Pump Plant #1, DWR will pay CCWD $54 (in 2013 dollars) per day per μS/cm over the 40 mg/l threshold,. The payments will be used to offset CCWD's cost of obtaining and conveying water from alternate sources including but not limited to diversions at CCWD's other intakes, releases from Los Vaqueros Reservoir, or transfers of water from another purveyor of water.. DWR shall pay this amount to CCWD by January 31st of each year for the previous year's impacts. DWR and CCWD will collaborate to determine the duration and quantification of significant impacts subject to payment.

(2) If tules are under cultivation and the significance criteria have been exceeded for a total of 30 or more days per calendar year the Project will be drained, no further water will be applied, and the levees will not be breached until the adjacent Canal is encased.

(3) If the levees have been breached and the significance criteria have been exceeded for a total of 30 or more days per calendar year, a soil bentonite cutoff wall or groundwater collection system shall be placed within the south levee or within the setback area between the levee and property line to minimize groundwater seepage into the unlined Canal.

IMPACT SIGNIFICANCE

Less than significant with mitigation

IMPACT 4.1-6 (REPLACES 2010 EIR IMPACT 3.1.2-8): GROUNDWATER INTRUSION ONTO ADJACENT PARCELS

As described in the 2010 EIR, connectivity of the shallow aquifer suggests that permanently raised Dutch Slough Restoration site groundwater levels would have some influence on groundwater flow to adjacent properties in all directions. These effects would be tempered to a great degree, however, because the tidal sloughs separating the restoration site from its adjacent parcels to the north, west, and south exert a far stronger hydraulic signal on groundwater (Hultgren-Tillis 2005). Groundwater pumping on adjacent properties steepens the hydraulic gradient, causing greater flow from the Dutch Slough site. Adjacent parcels to the east and, if the Canal is encased, to the south, could therefore have increased pumping volumes, especially outside the wet season when other contributing sources to groundwater diminish relative to the possible project contribution.

North. Dutch Slough to the north is a wide, deep channel with a relatively large daily flow and direct hydraulic connection via sandy soils underlying the levees for Jersey Island to the north and the Dutch Slough site to the south (Hultgren-Tillis 2005). Groundwater effects of the Project to Jersey Island are likely to be insignificant (Hultgren-Tillis 2005), therefore, and it is doubtful whether their signal could be detected amongst all the other controls on Jersey Island groundwater.

South. The Canal to the south has tides nearly identical to those at Emerson Slough, and recent data demonstrate the tidal connectivity to groundwater on both sides of the Canal (LSCE 2006, HydroFocus 2013). As discussed above in Impact 4.1-6, groundwater intrusion onto lands south of the Project site is governed by the relationship between groundwater elevations within these lands, and the water surface elevation in the unlined Canal. Water surface elevations on the Dutch Slough site would not influence groundwater elevations on parcels south of the Canal as long as the Canal is unlined. Therefore, under the current site configuration, there would be no impact.

Once the Canal is encased, it would be hydraulically isolated from local groundwater, and tidal action within the Project site would replace the Canal's influence to groundwater south of the Canal. Because of the greater horizontal distance between the project site and the property to the south, and because backfill soils in the Canal reduce hydraulic conductivity relative to open water of the Canal, there would be lower hydraulic gradients relative to the existing condition. As a result, this impact would be less than significant.

A proposed residential development south of the Canal that is partially below sea level intends to install and permanently operate a groundwater management infrastructure system. Though groundwater on that property is currently pumped, the new system would be operated to maintain a lower and consistent groundwater level that would act to steepen the hydraulic gradient to its north, towards the Canal and Project site. Under the current Canal configuration, increased groundwater levels at the Dutch Slough site would be dampened by groundwater flow to the Canal such that the restoration site's groundwater signal to this property would be reduced to the level of insignificance. Similarly, once the Canal is encased, the increased hydraulic distance and presence of low-permeability backfill soils would also result in a less-than-significant impact.

West. Marsh Creek to the west is fully tidal to the East Bay Regional Park District (EBRPD) bridge with minor tidal dampening south to the Canal (NHI 2002). Ironhouse Sanitary District groundwater data (as reported in PWA 2006) also show a strong tidal signal, with average levels (mean tide level) similar to those expected at the Project site. During most of the year, no detectable changes in groundwater levels are expected to the west (Hultgren-Tillis 2005). During winter storm periods, prolonged average tide levels and higher peak high tides associated with storms may increase groundwater levels a small amount relative to existing conditions (Hultgren-Tillis 2005). The magnitude of this potential effect, however, is likely to be less than significant since groundwater levels on remaining ISD lands would be similar to the restored marsh and existing conditions primarily because ISD does not pump its groundwater (i.e., a relatively small gradient).

East. To the east across Jersey Island Road are diked, subsided lands (the Hotchkiss Tract; RD 799) proposed for residential development; no tidal slough divides the Burroughs parcel from these properties. The revised design for the Project includes construction of a flood control levee extending north-south for approximately half a mile along the west side of Jersey Island Road from the Project's southeast corner, and then trending in a southeast-northwest direction across the rest of the Burroughs parcel to Little Dutch Slough (Figure 3-3). The northern portion of this levee would protect the remaining mile of Jersey Island Road north to the Jersey Island bridge. The Project is currently coordinating the location and design of the southern portion of this levee with the residential developers.

East of this levee, groundwater elevations are likely to increase during tule cultivation and after breaching. Increased groundwater elevations within the upland portions of the Burroughs parcel would not cause negative impacts to hydrology or water quality because these elevation increases would be consistent with the proposed management of those lands as enhanced irrigated pasture with improved wetland values. Due to the significant distances between the levee and Jersey Island Road, restoration of the southern part of the Burroughs parcel is not expected to impact groundwater elevations within the Hotchkiss Tract east of the northern mile of Jersey Island Road. However, it is likely to impact groundwater elevations in the Tract east of the southern half-mile of the Road. The proposed Hotchkiss development intends to use groundwater as a resource to support water feature amenities, and plans on constructing a new "dry" (internal) levee similar to the one at the nearby Summer Lake development. The proposed development includes a toe drain east of the new internal levee. If that project proceeds, then the impact on groundwater within the southern portion of the Hotchkiss Tract is likely not to be significant. If Hotchkiss development does not proceed, then the impact would remain significant and similar to that described in the 2010 EIR.

2010 Mitigation Measures that are No Longer Applicable to Revised Project. Mitigation Measures 3.1.1-6.1 and 3.1.1-6.2 in the 2010 EIR required a monitoring program to measure groundwater level and quality on the project site and to the west, north, east and south of the site. A monitoring program began in 2009, is continuing, and is detailed in Appendix C. This program meets the monitoring requirement in Mitigation Measures 3.1.1-6.1 and 3.1.1-6.2.

Mitigation 3.1.1-6.1 in the 2010 EIR, which provided groundwater intrusion protection measures (monitoring, compensatory mitigation) in the event ISD irrigation on fields adjacent to the Project site was not discontinued prior to implementation of the Project, is no longer applicable since irrigation of those fields was discontinued in 2009-2010. Mitigation 3.1.1-6.3 in the 2010 EIR, which provided for delay of the Project until cessation of irrigation on the ISD parcel and construction of the Jersey Island Road Levee, is accordingly no longer applicable in consideration of Mitigation 4.1-6 below.

MITIGATION 4.1-6 (SAME AS 2010 EIR MITIGATION 3.1.1-6.2): GROUNDWATER INTRUSION PROTECTION– EAST OF SITE

If deemed necessary by the adjacent landowners to the east, the Project shall participate in a joint study to quantify the relative contributions of all possible sources of groundwater intrusion into the parcels east of the restoration site, thereby quantifying the relative role of the Project in contributing to groundwater pumping needs. This study shall include field monitoring to measure actual flux into the eastern parcel. If this study determines a significant contribution from the Project that would adversely affect hydrologic conditions east of the Project site that cannot be addressed with existing or planned groundwater management systems, then the technical and economic feasibility of constructing an effective means of reducing flux into the parcels shall be evaluated and a feasible system shall be implemented. Measures that may be considered include a groundwater cutoff wall, toe drain, or financial contribution to the operations and maintenance of groundwater collection systems currently in place or anticipated to be in place with new residential development, at levels commensurate with the documented percent contribution of the Project to increased groundwater levels and volumes to the south requiring abatement.

MITIGATION 4.1-7 (REPLACES 2010 EIR MITIGATION 3.1.1-6.1 AND 3.1.1-6.2): GROUNDWATER MONITORING

The 2010 EIR required groundwater monitoring of the lands to the south, west, north, and east of the project site, to determine baseline groundwater levels and quality. Data will be used to determine baseline and post-project groundwater levels, hydraulic gradients, flow directions, and water quality (salinity, major ions, nitrogen species and stable isotopes). The study was to be conducted for at least one year prior to project implementation, and for at least one year after.

Groundwater monitoring began in 2011 and continued for five quarters to establish the baseline conditions. Fifteen existing and nine new wells were monitored, as well as two control wells located over 1 mile from the project site and unlikely to be impacted by project implementation. Wells are located on Ironhouse Sanitary District (west), Jersey Island (north), Hotchkiss Tract (east), and parcels south of the Canal. Wells monitor the shallow (within 30' of the surface) aquifer, which is known to be of higher salinity than local surface water, and which shows changes in the hydraulic gradient as local water management practices change.

Post project monitoring of these wells shall commence after the levee of Emerson parcel is breached.

IMPACT SIGNIFICANCE

Less than significant with mitigation

IMPACT 4.1-7 (REPLACES 2010 EIR IMPACT 3.1.2-9): WIND-WAVE DRIVEN LEVEE OVERTOPPING INTO CONTRA COSTA CANAL

The 2010 EIR describes that low points along the existing levee system that borders the southern portion of the Project site may be subject to overtopping during extreme high tide events, or during major storm water runoff events. However, the Project has been revised to include construction of a new levee segment along the southern boundary of the restoration area to protect properties to the south, including the City of Oakley's proposed Dutch Slough Community Park site. This new levee would follow the southern edge of the restoration area and the northern Community Park boundary. The levee would tie into Sellers Avenue at the end of Emerson Slough because recent improvements to Sellers Avenue brought the road up to +9 feet NGVD. This levee would be constructed to +10 ft NGVD (see below) and improve the existing level of flood protection for these areas (low spots in the existing outboard levees around the Emerson and Gilbert parcels are as low as +7.6 ft NGVD).

The preliminary design for the levee follows DWR's *Urban Levee Design Criteria (http://www.water.ca.gov/floodsafe/leveedesign/ULDC_May2012.pdf*) which proposes a crest elevation of approximately +10 feet NGVD, which would provide 3 feet freeboard above the 100-year flood level (Federal Emergency Management Agency [FEMA] base flood elevation). The final levee design would accommodate the 300-year flood elevation as determined by the U.S. Army Corps of Engineers (USACE), plus additional height to accommodate wind-waves. The levee would have a base wide enough to support the construction of additional height to accommodate future sea-level rise plus freeboard. As a result, this impact would no longer occur under the Project, and Mitigation 3.1.2-9 in the 2010 EIR is no longer necessary to mitigate for this impact.

IMPACT SIGNIFICANCE

No impact

IMPACT 4.1-8 (SAME AS 2010 EIR IMPACT 3.1.2-10): INSUFFICIENT SEDIMENTATION IN NEW TIDAL WETLANDS

As described in the 2010 EIR, accretion can occur through mineral deposition and biomass accumulation (plant matter). Mineral sedimentation rates are expected to be relatively low (PWA 2006, Stralberg et al. 2011), leading to long time periods over which the restored marsh is expected to accrete. Plant biomass accumulation can be aided through management efforts (which is the general idea behind the non-tidal managed marsh on the Gilbert parcel). Because the tidal marsh will initially be graded to low to mid-marsh elevations, no adverse impact is expected from insufficient sedimentation. The proposed refinements to the Project would not change this impact.

It should be noted that even the highest rates of natural sedimentation processes may not be able to keep up with global/local sea level rise. The most recent guidance for sea level rise in coastal California south of Cape Mendocino (NRC 2012) projects SLR of 4 to 30 cm (1.6 to 11.8 in) by 2030, 12 to 61 cm (4.7 to 24.0 in) by 2050, and 42 to 167 cm (16.5 to 65.7 in) by 2100. A number of features that are likely to minimize the impact of sea-level rise on marsh restoration and its physical evolution have been incorporated into Project design. These features include:

- Construction of a gradually sloping marsh surface (i.e., the terrestrial ecotone along grassland edges) that provides an elevation gradient over which elevation zones of tidal marsh may shift upslope as sea level rises;
- The Project's external levees would be designed to ensure that they can be adapted to anticipated sea level rise. Current projections predict that sea level rise in this area would be between 42 to 167 cm (16.5 to 65.7 in) by 2100 (NRC 2012). The levee alignment would include adequate setback on the inboard side of the levee to allow future levee raising to keep pace with sea level rise for the next 50 years.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-9 (SAME AS 2010 EIR IMPACT 3.1.2-11): LIMITED PERSISTENCE OF SHALLOW TIDAL MARSH CHANNELS

As described in the 2010 EIR, vegetation such as tules tend to dominate and fill in shallow tidal marsh channels (i.e., those channels with invert elevations around mean lower low water [MLLW] and higher) in many Delta wetlands. Vegetation infilling can but does not always lead to the channel disappearing as a geomorphic feature. However, it would reduce water exchange and limit access for aquatic organisms into the channel and marsh areas upstream of the vegetation. Such infilling, therefore, can detrimentally affect the ecological outcomes of the restoration effort, and is considered potentially significant. The proposed refinements to the Project include designing channels with invert elevations at least 20 centimeters below MLLW, to prevent emergent vegetation from filling in the channels (based on local vegetation surveys). The channels are also sized to flood and drain the entire marsh plain during each tidal cycle. These design standards have been incorporated into the Project, so Mitigation Measure 3.1.2-11 in the 2010 EIR is no longer necessary.

IMPACT SIGNIFICANCE

Less than significant

WATER QUALITY

IMPACT 4.1-10 (REPLACES 2010 EIR IMPACT 3.2.2-1): DEGRADATION OF WATER QUALITY DUE TO RELEASE OF CONTAMINANTS AND SEDIMENT FROM CONSTRUCTION ACTIVITIES

As described in the 2010 EIR, construction activities could leave soils exposed to rain or surface water runoff that may carry soil contaminants (e.g., nutrients, metals, hydrocarbons, or other pollutants) into waterways adjacent to the site, degrade water quality, and potentially violate water quality standards. The majority of site construction activities (e.g. site clearing, demolition, grading and revegetation) would be confined within the site perimeter levees, which would protect adjacent water bodies from surface water runoff from the construction areas. However, some construction activities would occur on or outside of perimeter levees, such as tide gate installation, levee breaching and lowering, levee armoring, and Little Dutch Slough enlargement.

The changes considered in this Supplemental EIR include specific measures to reduce water quality impacts during in-channel construction. Cofferdams and dewatering would be used to construct a temporary crossing over Marsh Creek and to enlarge the southern end of Little Dutch Slough. The use of cofferdams to dewater Marsh Creek and Little Dutch Slough would limit turbidity in both areas during construction, which would reduce the potential for construction-related water quality impacts. Impacts to water quality during construction of the Project would still occur, and are considered potentially significant. These impacts would be similar, but somewhat reduced, compared to what was described in the 2010 EIR.

Mitigation 4.1-8 replaces Mitigation 3.2.1-1.1 as it provides updated reference to the most recent process for preparing a Storm Water Pollution Prevention Plan (SWPPP), and includes a requirement that a Hazardous Materials Management Plan (HMMP) be prepared.

MITIGATION 4.1-8 (REPLACES 2010 EIR MITIGATION 3.2.1-1.1): DEVELOP A STORM WATER POLLUTION PREVENTION PLAN

Prior to construction, DWR shall prepare a site-specific SWPPP consistent with the State Water Resources Control Board (SWRCB) and RWQCB requirements to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction Activities. The SWPPP shall identify best management practices (BMP) for controlling soil erosion and the discharge of construction-related contaminants before, during and after construction. BMPs shall be monitored as specified in the SWPPP.

The SWPPP prepared for the Project shall include a Hazardous Materials Management Plan (HMMP) for the storage of liquefied petroleum gas and other hazardous materials above threshold quantities required for project operation. The HMMP shall include a hazardous materials inventory, Material Safety Data Sheets for hazardous materials, and contact information; identify requirements for servicing and refueling equipment and employee training; and describe evacuation and emergency response procedures. Fuel and lubricants shall be stored in containers that conform to state and local regulations, and storage areas shall have secondary containment of a size sufficient to contain a spill and prevent spreading. Spill prevention kits shall always be in close proximity when using hazardous materials (e.g., in crew trucks).

MITIGATION 4.1-9 (SAME AS 2010 EIR MITIGATION 3.2.1-1.2): DEWATERING RESTRICTION

Ponded storm or groundwater in construction areas shall not be dewatered directly into adjacent surface waters or to areas where they may flow to surface waters unless authorized by a permit from the RWQCB. In the absence of a discharge permit, water removed for construction purposes shall be disposed by land application (within perimeter levees) for irrigation and/or infiltration. Alternatively, water may be pumped into baker tanks or other receptacles, characterized by water quality analysis, and disposed of appropriately based on results of analysis. Removed water may also be used on-site for the purpose of dust control.

MITIGATION 4.1-10 (SAME AS 2010 EIR MITIGATION 3.2.1-1.3): CONTRACTOR TRAINING FOR PROTECTION OF WATER QUALITY

All contractors that will be performing demolition, construction, grading, road building, in-water work, or other work that could cause increased water pollution conditions at the site (e.g., dispersal of contaminated soils, oiling of access roads) shall receive training regarding the environmental sensitivity of the site and need to minimize impacts. Contractors shall also be trained in implementation of stormwater best management practices (BMP) and dewatering/coffer dam construction and operation techniques for protection of water quality.

MITIGATION 4.1-11 (SAME AS 2010 EIR MITIGATION 3.2.1-1.4): MINIMIZE POTENTIAL POLLUTION CAUSED BY INUNDATION OF SITE

Sites shall not be inundated (connected to tidal water sources) until surface soil conditions have been stabilized and all construction debris removed. In addition, areas of the created marshplain most vulnerable to erosion will be revegetated with tules and other emergent marsh vegetation prior to breaching the site to minimize erosion of the marshplain and transport of soils from the site.

IMPACT SIGNIFICANCE

Less than significant with mitigation. Implementation of Mitigation Measures 4.1-8 through 4.1-11 would reduce this potential impact to a less than significant level.

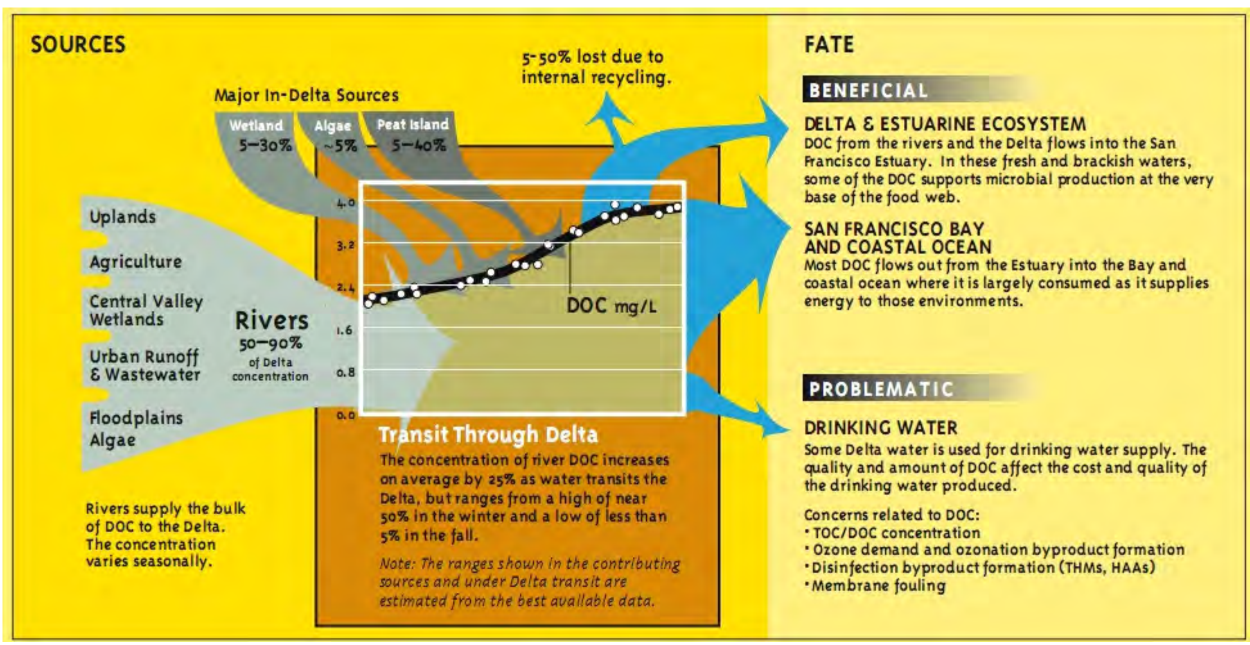
IMPACT 4.1-11 (REPLACES 2010 EIR IMPACT 3.2.2-2): DEGRADATION OF WATER QUALITY DUE TO INCREASED DISSOLVED ORGANIC CARBON IN DELTA WATERS

As described in the 2010 EIR, the proposed Project is expected to result in production and export of organic carbon as part of natural, and typically desirable, wetland processes. While organic carbon is considered a critical foundation for the aquatic food chain, the dissolved fraction of organic carbon (DOC) can adversely impact drinking water sources by increasing production of trihalomethanes (THMs) and other by-products during water disinfection. The Project is located approximately 10 water-miles from the Rock Slough intake to the Canal, and so the potential export of organic carbon was raised as a concern by CCWD. Source water from Rock Slough is an important untreated water supply source during wet months, when salinity levels in the Delta are low. Supplies diverted through the Canal also are used to blend with Los Vaqueros Reservoir water during dry months and droughts, when salinity levels are higher in the Delta.

There are currently no water quality objectives for DOC or total organic carbon (TOC) for the western Delta. However, the SWRCB suggests a goal of average total organic carbon (TOC) concentrations of 3.0 mg/L at drinking water intakes in the southern and central Delta (SWRCB 2006). The

RWQCB is in the process of developing a new policy to protect sources of drinking water and appropriate levels of DOC are one of the chief concerns that will be addressed.

DOC/TOC cycling and the potential for related impacts on the development of disinfection byproducts are two fields of active study within the Delta. Currently, there are no reliable methods that can be used to definitively predict quantities of DOC/TOC export from Delta marshes, nor to predict how DOC/TOC from these marshes might affect resultant concentrations of THMs and other byproducts. Predictions about how DOC/TOC would change in the face of large scale restoration (such as that proposed at Dutch Slough) as well as changed Delta water operations (e.g., proposed diversion of Sacramento River water around the Delta) are particularly challenging, because they represent a substantial departure from current conditions. A report by ESA PWA in 2010 for the Solano County Water Agency provides a helpful "snapshot" of the current state of science surrounding DOC/TOC export from tidal marshes, and the factors that influence the development of disinfection byproducts. The following conceptual model was developed by the US Geological Survey in 2008 to illustrate the potential sources and fates of DOC in the Delta:



A conceptual model of DOC in the Delta, from USGS 2008.

Whether the organic carbon produced by the restored marshes on the Project site could adversely affect the drinking water source at the Rock Slough intake would depend on the amount of organic carbon, its character (e.g., the percent in dissolved or otherwise reactive form), and whether it could reach the Rock Slough intake in sufficient concentration to be discernable from "background" levels. A recent study by Downing et al. (2009) of DOC export at Brown's Island (10 miles west of Dutch Slough) made discrete measurements of DOC concentrations in a range of 2.5 to 3.9 mg/L during a neap cycle, and predicted a range during a spring cycle of less than 2 to almost 6 mg/L, bounding the goal of TOC proposed by the SWRCB. The study calculated a total export of approximately 1.8×10^6 g DOC over the entire wintertime spring-neap cycle (21 days in January 2006), or about 0.03 g DOC/m^2/day for the 2.8 km^2 site. However, it is extremely difficult to extrapolate this rate to predictions of yearly loadings from the Dutch Slough site, as loadings can vary by elevation (Downing et al. 2009), season (Kraus et al. 2008), and precipitation and discharge (Roy et al.

2006). The percentage of this carbon that may be reactive and form disinfection byproducts (such as THMs) is dependent on many factors, including type of soil, amount of vegetation, wetland construction method, age of the wetland, and the degree to which the carbon has been processed by bacteria and other micro-organisms (Brown 2003, Orr et al. 2003, Chow et al. 2008, Engalage et al. 2009, and many others). The quality of DOC, as determined by its composition of different types of organic compounds, affects the production of disinfection byproducts in two ways. First, the combination of the initial composition of the DOC sources and their distance from the drinking water intakes will determine the degree of degradation as flows transport DOC from the sources to the intakes. Second, the composition that arrives at the intakes would affect the amount and type of byproducts that are produced when water is treated.

As described in the 2010 EIR, in order for DOC generated at the Project site to reach the water supply intakes at Rock Slough, it would have to be transported 10 miles upstream through tidal channels – first north into Dutch Slough, eastward six miles into Old River, and southward another five miles, then more than a mile westward into the Rock Slough Intake. A permanent tide gate on Sand Mound Slough prevents Dutch Slough water from reaching Rock Slough more directly via Sand Mound Slough. Although it is possible for DOC to move upstream in a tidal environment, the quantity of DOC reaching the Rock Slough intake when the canal is operating is likely to be small. Furthermore, the extent of mixing across this transport distance would substantially dilute DOC concentrations from Dutch Slough given the very small tidal prism of the Project compared to the very large volume of water into which restoration site waters would mix.

The likely transport and dilution of DOC from Dutch Slough to Rock Slough has not been calculated, but as described above, transport is likely to be low, and dilution is likely to be high. More precise estimates of marsh and open water areas and tidal flow volumes and transport to the Rock Slough intakes are currently being developed as the Project design proceeds. HydroFocus is collecting monthly samples to monitor DOC and THM (see Mitigation 4.1-13 below) concentrations in drainage water leaving the three parcels, and is using the results of drainage pump tests and electrical consumption records to estimate drainage volumes and monthly loads of these constituents. These data will be used to better estimate and compare (1) existing DOC export from agricultural drainage water at the site, and (2) potential future DOC export under restored conditions.

The phased project implementation described at the introduction of this section, and the water quality monitoring described in Mitigation 4.1-4, replace Mitigation 3.2.1-2.1 in the 2010 EIR and reduce this impact to less than significant. Mitigation Measure 3.2.1-2.2 in the 2010 EIR has been deleted from this SEIR.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-12 (REPLACES 2010 EIR IMPACT 3.2.2-3): OPERATIONAL DEGRADATION OF WATER QUALITY DUE TO INCREASED EROSION AND TURBIDITY

As described in the 2010 EIR, several Project elements could result in post-construction erosion and increased turbidity, including levee breaches and skeletal marsh channels. Erosion and increased turbidity also could occur in Dutch, Emerson and Little Dutch Sloughs, and Marsh Creek due to increased tidal prisms, as described in Impact 4.1-1. Secondary water quality impacts due to elevated turbidity could include increased temperature and lower dissolved oxygen (DO). This impact is similar to that described in the 2010 EIR.

In general, any channel erosion is expected to occur over time and should not greatly increase turbidity. Mitigation 4.1-1 would minimize the potential for the degradation of water quality due to erosion resulting from increased tidal prisms.

Mitigation 3.2.1-3 in the 2010 EIR, which noted that deepening Little Dutch Slough could reduce sediment input from scour, is no longer necessary as that component is included in the current Project design. Mitigation 4.1-1 in this SEIR (3.1.1-1 in the 2010 EIR) describes erosion monitoring in the terminal sloughs, which would help reduce this impact.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-13 (SAME AS 2010 EIR IMPACT 3.2.2-4): POTENTIAL DEGRADATION OF WATER QUALITY DUE TO INCREASED MERCURY METHYLATION

As described in the 2010 EIR, mercury methylation is a concern for wetland restoration Projects in the Delta because certain types of wetland habitats are known to support the biological processes that transform mercury into methylmercury (MeHg). Although total mercury concentrations should not change as a result of the Project, there could be an increase in MeHg loads to water in Dutch Slough or Big Break, as well as localized increased concentrations of mercury in sediment. Localized increases in MeHg may result in damage to nervous, reproductive, and immune systems of aquatic organisms that regularly inhabit the area, and/or top predators that are susceptible to biomagnification, including humans.

Certain aquatic habitats are more likely to serve as sources of MeHg than others. Mudflats and irregularly inundated areas such as high marsh zones and flooded bypasses seem to have the highest rates of MeHg export, while emergent tidal marshes and open water habitats appear to have the lowest rates of flux and can serve as MeHg sinks. Irrigated/flooded agricultural fields such as those currently found on the Project site are also known to produce and export MeHg, but as with wetlands, these mechanisms are not completely understood (Delta Methylmercury TMDL Nonpoint Source Working Group 2013). Since the amount of high marsh and mudflat habitat created would be minimal under the Project (approximately less than 10% of the 560 acres of habitat that would be restored as marsh, with very little or no mudflat), the change in the amount of MeHg exported from the Project site would likely be negligible relative to existing conditions.

In addition, DWR would monitor for mercury and MeHg levels in water and sediments in the Dutch Slough vicinity, both before and after restoration activities take place, as well as in Marsh Creek (see below). This monitoring would provide baseline conditions at the site and would allow for comparison of pre- and post-restoration MeHg levels.

MONITORING PROGRAM

The Bay-Delta Science Program and Project partners have funded several years of baseline monitoring studies to determine the existing levels of methylmercury in bio-sentinel organisms (fish). DWR's water quality monitoring program, discussed in the 2010 EIR would continue bio-sentinel monitoring along with measurements of MeHg levels in water in the Dutch Slough vicinity both before and after restoration activities take place. This monitoring would provide baseline conditions at the site and would allow for comparisons between pre and post restoration MeHg levels. The information would aid in determining potential site management changes in the future, as well as advance the general body of knowledge on the subject of MeHg creation and export in restored tidal marshes. It is likely that these monitoring activities will be coordinated with the creation of the Delta Mercury Total Maximum Daily Load (TMDL).

The water-quality monitoring plan also includes monitoring for mercury and MeHg levels in Marsh Creek. Methods to minimize/avoid impacts to the project from poor water quality in Marsh Creek (including MeHg) are discussed in Mitigations 4.1-12 and 4.1-13 below.

IMPACT SIGNIFICANCE

Less than significant.

IMPACT 4.1-14 (REPLACES 2010 EIR IMPACT 3.2.2-5): DEGRADATION OF DRINKING WATER QUALITY DUE TO ALTERATION TO SALINITY LEVELS IN DELTA WATERS

As described in the 2010 EIR, open water areas may result in greater tidal prism and more inputs of Bay water. This could potentially cause small increases in salinity in the Delta by increasing tidal flows from the Bay. Increased Delta salinities could negatively impact drinking water and irrigation water quality.

In 2001, the CALFED Suisun Marsh Levee Investigation Team hired Resource Management Associates, Inc. (RMA) to conduct modeling on the salinity impacts of a Dutch Slough tidal restoration. The modeling results were presented in a January 2002 draft document titled "Mathematical Modeling of Hydrodynamic and Water Quality Impacts of a Dutch Slough Levee Breach", hereafter referred to as "Model Report" (RMA 2002). The report was never finalized nor made available to the team that prepared the Draft and Final Environmental Impact Reports for the Dutch Slough Project. Modeled salinity increases are summarized in Table 4-1.1.

Table 4.1-1: Modeled Salinity Increases at Select Delta Locations (from RMA 2002).

RMA Station	Location	Simulated Salinity Concentration (ppt) (approximate only)				Salinity Increase %	
		Existing Conditions		Design Conditions			
		Min	Max	Min	Max	Average	Max
RSAN007	Antioch	0.2	4	0.2	4	1.0	2.4
RSAN014	Blind Point	0.1	1.7	0.1	1.8	2.8	4.9
RSAN018	Jersey Point	0.1	1.3	0.1	1.3	>1.0	1.9
SLUD009	Dutch Slough	0.13	0.82	0.13	0.9	6.6	10.3
ROLD014	Old River (at Little Mandeville)	0.13	0.5	0.13	0.51	0.7	1.8
ROLD024	Old River (at Rock Slough)	0.13	0.5	0.13	0.51	0.7	1.8

Summary of the Model Report and its findings:

- The model was calibrated for salinity, stage, velocity, bathymetry, and flow through previous studies.
- Simulations of a base condition (no Dutch Slough levee breaches) and a Project condition (with Dutch Slough breaches) were performed.
- The Project conditions as modeled were similar to the current restoration design, with certain exceptions discussed below.
- Salinity results from the base simulation were checked against observed data to assure proper model calibration.
- The modeled period was February through September 1992, a critical water year.
- Daily observed salinity and base simulation salinity was graphed for 15 monitoring stations from Carquinez Strait to Middle River.
- The seven monitoring stations closest to the Dutch Slough site (within approximately 8 miles) showed salinity increases with the Dutch Slough project. The Model Report included graphs of the base simulations and the Dutch Slough conditions for those monitoring sites. The other eight stations showed no effect on salinity or showed a decrease in salinity due to the project.

Discussion

The Project conditions in the model assumed tidal inundation of the Dutch Slough Restoration site similar to the current restoration design. However, the modeled conditions assumed site breaching without performing any of the site grading (excavation or fill placement) proposed in the restoration design. The modeled Project conditions therefore assume that a larger area would be tidally inundated as compared to the actual restoration design, as shown in Table 4-1.2.

Table 4.1-2 – Comparison of RMA 2002 Model and Dutch Slough Restoration Design

	Tidally Inundated Area (acres)		Tidal Prism (acre-feet)	
	RMA Model	Restoration Design	RMA Model	Restoration Design
Emerson parcel	271	375	870	1,063
Gilbert parcel	249	135	781	351
Burroughs parcel	384	167	1,217	460
Dutch Slough Total	**904**	**677**	**2,868**	**1,874**

The tidal prism – the total volume of water that flows in and out of the site in one tide cycle - is a critical parameter for evaluating influence on salinity intrusion. As described above, the estimated tidal prism used in the model simulation is approximately 50% greater than expected for the restoration design for Dutch Slough.

Because of the larger-than-expected tidal prism in the model simulation, it is assumed that the modeled salinity effects are larger than what will actually occur.

Conclusions

Chris Enright, modeling expert for the Delta Science Program, reviewed the Model Report and concluded that the model produced a reasonable representation of "worst case" post-project salinity, since the model simulated a critically dry water year when salinity changes are most significant. In addition, the differences between modeled Project conditions and actual restoration design (larger tidally-inundated area and greater tidal prism in the model) also probably resulted in slightly elevated salinity impacts in the modeled condition. There is high confidence that salinity will change as predicted—that is, salinity is likely to increase or decrease as predicted for any particular area, though actual salinity outcome depends on tidal volume exchange, breach location and geometry, and tidal current asymmetry between the project and Dutch Slough. In general, we would expect the region near new levee breaches to exhibit increased salinity mixing. At some distance away from the project, we would expect decreased salinity due to the reduction in tidal range caused by the project. The model does in fact predict small salinity *decreases* in the area around the usual location of X2[2], so the project is not expected to create regulatory restrictions on water exports, which might occur if salinity were to increase in that area.

The report was also reviewed by Mark Bettencourt and Ted Swift of DWR's Municipal Water Quality Program Branch, to assess possible impacts to local drinking water sources. They concluded that the small salinity changes predicted by the modeling should not result in a significant effect on drinking water quality. Given the dynamism of a tidal system, it is highly likely that the effects of the restoration would be small compared to other variables such as Delta river inflow, tides, wind, climate change, and barometric pressure. Since the model prediction shows X2 moving downstream, regulatory actions (via Biological Opinions) will not be triggered.

IMPACT SIGNIFICANCE

Less than significant.

IMPACT 4.1-15 (REPLACES 2010 EIR IMPACT 3.2.2-6): DEGRADATION OF WATER QUALITY DUE TO INCREASED SALINITY CONCENTRATIONS IN THE CONTRA COSTA CANAL (FROM ELEVATED GROUNDWATER)

See discussion of Impact 4.1-5, Possible Water Quality Degradation in Canal due to Groundwater Seepage. Mitigations 4.1-3 through 4.1-5 would reduce impacts associated with degradation of water quality due to increased salinity concentrations in the Canal.

[2] * *X2* refers to the location in the estuary where the salinity concentration equals 2 parts salt per 1,000 parts water, and relates to the extent of salinity movement into the Delta. The location of X2 is important to both aquatic life and water supply beneficial uses. State Water Project (SWP) facilities are operated to meet numerous water quality objectives, including the location of X2. When X2 moves upstream, toward the Delta, the SWP may be required to release more water for environmental benefits, which reduces the volume of water available for export south of the Delta.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.1-16 (REPLACES 2010 EIR IMPACT 3.2.2-7): DEGRADATION OF WATER QUALITY DUE TO ELEVATED METALS, ENDOCRINE DISRUPTING CHEMICALS, OR OTHER POLLUTANTS

Wastewater that may contain endocrine disrupting chemicals (EDCs) reaches the Project area from the Brentwood Wastewater Treatment Plant (BWWTP) tertiary treated wastewater that is discharged into Marsh Creek. In addition, soils on ISD lands were formerly irrigated with treated wastewater.

As described in the 2010 EIR, metals and other contaminants (including EDCs) at levels exceeding regulatory criteria were not found in investigations of the ISD parcel soil (Stellar Environmental Solutions, 2006); therefore, no impact would occur from excavation and replacement of that material on the Project site. The results of the soil investigation also indicate that the spatial variation in contaminants is low enough that no further sampling is necessary before soils are excavated and reused.

While tertiary treated wastewater is usually free from harmful levels of most common pollutants, many EDCs are not effectively removed. The Dutch Slough site would receive some input of these pollutants from the BWWTP via Marsh Creek even without it being routed directly onto the property since the mouth of the creek is adjacent to the site. As described the 2010 EIR, water samples have not been analyzed for EDCs and no regulatory criteria have been established for many of the potential contaminants.

Baseline surface water quality monitoring in Marsh Creek found levels of coliform bacteria (10,000-41,000 MPN/100ml or Most Probable Number per 100 milliliters) and pyrethroids (10-39 ng/l or nanograms per liter) that raised some concerns that routing Marsh Creek onto the restoration site may result in impacts to resident invertebrates. To determine if these levels would be harmful, Tessa Fojut and Trevor Cleak at the CVRWQCB were consulted on August 14, 2013. These CVRWCB staff stated that the monitored coliform levels would not pose any threat to the restored marsh. The pyrethroid levels are similar to those found throughout the Delta and are also not of particular ecological concern. The project will not increase levels of pyrethroids, and may actually decrease levels in local waterways due to accumulation in the sediments within the marsh. Although this accumulation may be an exposure risk for benthic organisms, it is not expected to be significantly higher than marsh sediments elsewhere in the Delta. CVRWCB staff stated that neither coliform bacteria nor pyrethroids are at significant levels, and no project design changes are required.

MITIGATION 4.1-12 (REPLACES 2010 EIR MITIGATION 3.2.1-2.1 AND 3.2.1-7): MARSH CREEK WATER QUALITY TESTING AND EVALUATE FEASIBILITY OF MARSH CREEK RELOCATION BASED ON WATER QUALITY CONSIDERATIONS

If and when the RWQCB establishes criteria for EDCs of concern, the Marsh Creek water-quality testing program described in Impact 4.1-13 shall be expanded to include these compounds. The program shall identify scientifically sound and appropriate water quality thresholds to maintain the ecological integrity of restored habitats. These thresholds will be defined in consultation with CVRWQCB and other resource protection agencies. If the water-quality monitoring program indicates that Marsh Creek contains levels of metals, MeHg, EDCs, coliforms, pesticides, or other pollutants that threaten the ecological health of habitats within the Dutch Slough site, then Mitigation 4.1-13 below will be implemented.

New Mitigation 4.1-13: Do Not Relocate Marsh Creek onto Dutch Slough Site

If the water-quality monitoring program described in Impact 4.1-13 indicates that water in Marsh Creek has concentrations of metals, EDCs, coliforms, pesticides, or other pollutants that exceed the thresholds defined in Mitigation 4.1-12 above, then Marsh Creek will not be relocated onto the site, and will remain in its existing location.

Impact Significance

Less than significant with mitigation.

Impact 4.1-17 (Same as 2010 EIR Impact 3.2.2-8): Cumulative Impacts

Cumulative Water Quality Effects of the Project and Proposed Urban Development

The Project would take place in an area that is experiencing rapid urbanization. Several housing developments immediately adjacent to the Project site have either been constructed or have been approved, though the recent economic slowdown has put many of these Projects on hold indefinitely. In 2010, ISD constructed a new wastewater treatment plant to handle continued growth in Contra Costa County, and eliminated land-based wastewater irrigation on the mainland adjacent to the Project site (treated effluent is not applied to Jersey Island, and discharged through a surface water discharge located downstream of Jersey Point (on Jersey Island). The RWQCB adopted an NPDES permit (Order No. R5-2008-0057) on 25 April 2008 authorizing a surface water discharge from the wastewater treatment plant.

These proposed developments could have potential impacts on water quality in the Dutch Slough site and the greater Project vicinity. The new housing developments could impact water quality in several ways. During construction of these developments, there could be increased pollution, as described in 4.1-10. Due to a greater amount of impervious surfaces, these new housing developments would cause more stormwater runoff laden with the contaminants common in urban/suburban areas (i.e., pesticides, lawn fertilizers, hydrocarbons). The increased volume of municipal sewage from the new developments would introduce more pollutants to surface waters through the new ISD discharge, which could exacerbate Impact 4.1-16 above.

Maintenance of the City's Community Park, if constructed, would involve the use of herbicides and pesticides that may be washed into the wetland restoration area. Similarly, oil, grease and heavy metals may be washed into the wetlands and sloughs from the proposed Community Park parking lots and roadways. This could result in a significant impact to receiving water quality. It is expected that the City of Oakley's CEQA review of the proposed park would identify and require implementation of appropriate mitigation measures and best management practices (BMPs) that would reduce these impacts to less than significant.

Cumulative Water Quality Effects of the Project and Other Proposed Wetland restoration Projects

There are currently multiple tidal marsh restorations being planned in the San Francisco Bay Delta that have the potential cumulative effect of increasing salinity levels in the Delta due to increased tidal exchange. Current marsh restoration projects in planning and/or design in the Bay Delta include:

<u>Cache Slough Complex</u>: Lower Yolo Restoration (1200 acres in planning/design), Prospect Island (900 acres in planning) and Lindsey Slough (87 acres in design)

<u>Suisun Marsh</u>: Tule Red Restoration (350 acres in design), Mallard Farms Conservation Bank (650 acres in design), and Hill Slough Restoration (900 acres in design)

<u>West Delta</u>: Marsh Creek Restoration (90 acres in planning)

As discussed in Impact 4.1-14, prior salinity modeling indicates that the Dutch Slough restoration is only expected to increase salinities within approximately 8 miles of the site and may slightly decrease salinity elsewhere. With the exception of the Marsh Creek Restoration, all of these projects are located at least 12 miles from the Dutch Slough site, and therefore considered beyond the potential influence of the Dutch Slough Project. Furthermore, environmental documentation from Mallard Farms (RD 2130, 2013) and Yolo Ranch (SFCWA 2013) indicate that increased salinities due to that project are not expected:

> Mallard Farms: "There are no expected effects from additional levee breaches on the Bay Delta as a whole. Previously, the Bay Delta Model predicted that there could be increased salinity intrusion into the Delta due to levee inundations in the Suisun Marsh, but recent updates of the model do not predict increased intrusion from breaches at Honker Bay."
>
> Lower Yolo: "The tidal prism afforded by the TMC [Tidal Marsh Complex] alternative results in a 0.3% increase in the mean ebb flow or tidal prism at Rio Vista. This very small increase in the tidal prism is not expected to significantly affect the salinity regime in the north Delta."

Therefore, given its proximity to the site, the Marsh Creek Restoration is the only current project considered to have a potential cumulative effect on increased salinities. Prior salinity modeling performed for the Dutch Slough project (discussed under Impact 4.1-14) provides a good representation of combined effect of both projects. (As shown in Table 4.1-3, the Project conditions modeled by RMA in 2002 assume roughly 40% larger tidal prism increase as compared to the combined Dutch Slough and Marsh Creek projects.) Therefore, given the limited size of the restoration area (approximately 90 acres) and the expected limited increase in tidal prism (approximately 200 acre-feet), the Marsh Creek project is not expected to increase local salinities beyond previously reported herein for the Dutch Slough Project (see Impact 4.1-14).

Significant tidal marsh restoration in being initiated in the Bay Delta to satisfy the OCAP biological opinion (BiOps) (8,000 acres), as well as the Bay Delta Conservation Plan (approximately 55,000 acres of tidal and subtidal habitats). While this scale of restoration has potential to modify Bay Delta hydrodynamics and increase salinity levels, the restoration locations have not been sufficiently defined - except for the projects listed above - to evaluate cumulative salinity impacts in the this document.

Implementation of Mitigations described in this section would reduce the Project's contribution to cumulative impacts to less than significant levels by either eliminating the project's impacts or reducing them to *de minimus* levels, as described in the mitigation measures.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

Table 4.1-3. Comparison of RMA 2002 Model and Dutch Slough and Marsh Creek Restoration Design

	Tidally Inundated Area (acres)		Tidal Prism (acre-feet)	
Dutch Slough Site	RMA Model	Restoration Design	RMA Model	Restoration Design
Dutch Slough Total	896	677	2,868	1,873
Marsh Creek Site	NA	88	NA	195
Total (both projects)	**896**	**765**	**2,868**	**2,069**

4.2 BIOLOGICAL RESOURCES

This section updates the 2010 EIR analyses of biological resource conditions on and in the vicinity of the Project site, including terrestrial resources (wildlife and vegetation communities, including wetlands) and aquatic resources (fish and invertebrates). Existing terrestrial and wetland resources within the Project vicinity and the potential effects of the Project on sensitive vegetation and wildlife communities were identified in Chapter 3.4, Terrestrial and Wetland Biological Resources, in the 2010 EIR. Existing aquatic resources and the potential effects of the Project on fish, invertebrates and aquatic habitats were considered in Chapter 3.5, Aquatic Biological Resources, in the 2010 EIR. The analyses in the 2010 EIR were based primarily on literature review; site reconnaissance, including plant and bird surveys; a number of technical reports prepared by the California Department of Water Resources (DWR) and others for the Project parcels; and extensive studies of fish distribution, abundance and habitat conditions completed for the Sacramento-San Joaquin Delta (Delta) and San Francisco Estuary by DWR and others.

In 2011, DWR updated the wetland delineation of the restoration area and soils borrow area based on existing site conditions. The primary reason for the updated wetland delineation was that the first delineation assumed, erroneously, that there was natural wetland hydrology across the entire Project area. The results of the revised wetland delineation are reflected in this section. This section also provides a revised impact assessment based on the Project Description changes described in Chapter 2, Project Description, which have the potential to affect biological resources. These changes include:

- Construction of a new flood protection levee along the southern boundary of the Project site, which would include installation of one or two new drainage culverts and flap gates in Little Dutch Slough at the levee crossing.
- Removal and replacement of portions of the exiting outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough, including some located below the mean tide level (MTL).
- Refinement of the proposed design for the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat connected to adjacent tidal channels by breaching the Emerson Slough perimeter levee in two locations.
- Refinement of the proposed management strategy on the northern portion of the Gilbert parcel to allow for preservation and enhancement of non-tidal freshwater marsh habitat to benefit California black rail (*Laterallus jamaicensis coturniculus*) and giant garter snake (*Thamnophis gigas*) habitat. This will include water management to preserve and expand existing freshwater marsh; installation of a gated, screened culvert on Emerson Slough for water supply; and creation of a toe ditch and open water areas.
- Refinement of the proposed management strategy on the northern portion of the Burroughs parcel to allow for preservation and enhancement of grassland to provide foraging and nesting habitat for Swainson's hawk (*Buteo swainsoni*) and other avian species.
- Identification of a preferred alignment for the relocation of the Marsh Creek delta onto the Emerson parcel.
- Possible elimination of a bridge that would span the levee breach at the mouth of the new Marsh Creek distributary channel on the Emerson parcel.

- Revisions to the in-water construction methodologies associated with the temporary crossing of Marsh Creek onto the Emerson parcel and enlargement of the southern reach of Little Dutch Slough to include dewatering.
- Installation of temporary fish screens on water-supply intakes for tule management.

This section includes a summary of impacts and mitigations considered in the 2010 EIR, and has been updated to include impacts and mitigations that are new or may be substantially altered by changes in the proposed Project. Because the Project now reflects a modified iteration of Alternative 2, Moderate Fill Alternative, from the 2010 EIR, only impacts to that modified alternative are reviewed herein. Where appropriate, avoidance, minimization, and mitigation measures provided by regulatory and resources agencies during Project-specific discussions have been incorporated into this analysis and reflected in the discussion of avoidance, minimization, and mitigation measures.

4.2.1 Affected Environment

Terrestrial Environment

The 2010 EIR (Section 3.4) describes the landscape setting and habitat trends in the Project vicinity, including the rapid loss of agricultural lands to residential and urban development, as well as vegetation and terrestrial wildlife typical of the Project site. In general, the vegetation of the Project site can be broadly classified into several types of terrestrial (upland) and wetland vegetation. The prevalent existing vegetation and habitat type at the Project site is irrigated cattle pasture, an altered form of grassland vegetation. These pastures are mostly managed through flood irrigation and are intensively grazed. Wetlands on site are mostly non-tidal seasonal and perennial wetlands formed within agriculturally reclaimed historic freshwater marshes. Remnants of freshwater tidal marshes are distributed in infrequent and discontinuous narrow fringes along the outer margins of the levees, with two large patches of mature tidal freshwater marsh habitat: one adjacent to the northwest side of the Emerson parcel, at the historic mouth (delta) of Marsh Creek, and the second at the mouth of Little Dutch Slough. Non-tidal freshwater wetlands are distributed in large and small patches within reclaimed agricultural lands. These areas correspond with topographic depressions, and are generally saturated or flooded for most of the summer growing season.

A delineation of Waters of the U.S. within the restoration area was prepared by DWR staff in 2006. In 2008, DWR staff observed conditions in the field that did not reflect the conditions recorded in the 2006 wetland delineation, particularly an assumption of natural wetland hydrology across the majority of the Project area. A revised delineation report, which included a characterization of wetland habitats within the soils borrow area (ISD parcel, located off the project site) was submitted to the U.S. Army Corps of Engineers (USACE) in 2010. A Preliminary Jurisdictional Determination for the restoration area and soils borrow area was issued by the Sacramento District on October 20, 2011 (Finan pers. comm.). The Preliminary Jurisdictional Determination identified 572.8 acres of Waters of the U.S in the restoration and soils borrow areas. All Waters of the U.S. identified onsite are also subject to regulation by the Regional Water Quality Control Board (RWQCB) and the California Department of Fish and Wildlife (CDFW).

With respect to wildlife, the Project site primarily supports a variety of species typical of grassland habitats, including a wide range of birds and small mammals. A comprehensive discussion of wildlife species typical of the Project site is provided in the 2010 EIR. An updated discussion of special-status species likely to occur in the Project site is provided below.

Aquatic Environment

The 2010 EIR described the location and condition of aquatic features in the Project vicinity, including Dutch Slough, Big Break, and Marsh Creek, as well as the fish and invertebrate populations typical of the Delta and San Francisco Estuary. Most of those discussions remain current and, if unchanged, are not repeated in this Supplemental EIR.

As described in the 2010 EIR, existing on-site fish habitat is limited to the non-tidal freshwater marsh that occurs in perennially flooded or ponded shallow depressions and channels throughout the interior of the diked areas on the Project site. Tidal freshwater marsh habitat occurs along the exterior edge of the diked areas, predominantly along unarmored levees, decrepit levees, narrow marsh or creek areas, and on in-channel islands in Dutch Slough. An extensive and high quality stand of tidal marsh exists in the abandoned channel of the former mouth of Marsh Creek along the north edge of the Emerson parcel. Some tidal marsh also occurs along Big Break's southeastern corner, directly across Marsh Creek from the Emerson parcel, as well as at the mouth of Little Dutch Slough.

Special-Status Species

Table 4.2-1 provides an updated list of special-status species that have the potential to occur in the Project vicinity and that could potentially be impacted by the Project, or otherwise benefit from proposed restoration actions. Special-status species include all plants or animals listed as threatened, endangered, or proposed for listing under the Federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); plants listed as rare under the California Native Plant Protection Act; plants considered by the California Native Plant Society to be "rare, threatened, or endangered in California"; species that meet the definition of rare or endangered under CEQA; animals fully protected in California; and nesting raptors protected in California. Species protected under ESA or CESA are shaded in gray in Table 4.2-1. Table 4.2-1 is similar to the lists of special-status species provided in Chapters 3.4 and 3.5 of the 2010 EIR, but has been updated to reflect the most recent listing status of the species.

A comprehensive discussion of the potential for each of the special-status species listed in Table 4.2-1 to occur on the Project site, including reference to species-specific surveys, are provided in the 2010 EIR. In addition, a Biological Assessment addressing the potential effects of the Project on federally-listed species was submitted to the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) in April 2012 (AECOM and ESA PWA 2012a). Similarly, a request for an incidental take permit in accordance with California Fish and Game Code Section 2081(b) was submitted to CDFW as part of the CESA compliance and permitting process in March 2012 (AECOM and ESA PWA 2012b). The Biological Assessment addresses the potential effects of the Project on five federally-listed species: North American green sturgeon, southern distinct population segment (DPS) (*Acipenser medirostris*); delta smelt (*Hypomesus transpacificus*); Central Valley steelhead DPS (*Oncorhynchus mykiss irideus*); two races of Chinook salmon (*O. tshawytscha*) [the Central Valley spring-run evolutionarily significant unit (ESU) and the Sacramento River winter-run ESU]; and giant garter snake. The CESA 2081(b) permit application to CDFW addresses potential effects on six state-listed species: delta smelt; longfin smelt (*Spirinchus thaleichthys*); Central Valley spring-run ESU Chinook salmon; Sacramento River winter-run ESU Chinook salmon; giant garter snake; and Swainson's hawk. The list of species to be considered in the Biological Assessment and incidental take permit application were developed in collaboration with the regulatory agencies, and refined to reflect potential impacts of concern to those agencies.

On November 19, 2012, USFWS provided a Biological Opinion to USACE on the effects of the proposed project on delta smelt and giant garter snake (USFWS 2012). Similarly, on February 7, 2013, NMFS provided USACE with a Biological Opinion on the effects of the proposed project on steelhead, salmon, and green sturgeon, as well essential fish habitat (EFH) for Pacific salmon (NMFS 2013). Both Biological Opinions found the proposed project not likely to adversely affect federally listed species, based on the project description and a series of terms and conditions included in both documents.

DWR is currently in the process of obtaining a permit from CDFW for incidental take (ITP) of longfin smelt, delta smelt, salmon, giant garter snake, and Swainson's hawk associated with the proposed project (CDFW 2013). The ITP provides specific Conditions of Approval to avoid, minimize and mitigate the effects of the incidental take.

The 2010 EIR's discussion of potential impacts to special-status species has been updated in this Supplemental EIR to reflect input from the regulatory agencies, including the analysis and terms and conditions provided in the USFWS and NMFS Biological Opinions, and in the CDFW ITP.

4.2.2 Impacts and Mitigations

Significance Criteria

Criteria for determining significant impacts to biological resources were based on the CEQA guidelines and professional judgment, including an understanding of ecology, conservation biology and related environmental sciences. The criteria used to assess the effect of the Project on terrestrial and aquatic resources are provided below. These criteria are the same as used in the 2010 EIR.

TERRESTRIAL RESOURCES (INCLUDING WETLANDS)

- Extirpation (local extinction) of a population of a rare, threatened, or endangered species, or substantial contribution to the reduction of its natural geographic range (contraction of its distribution, or elimination of disjunct [outlier] populations), population viability, or population size.
- Degradation of habitat occupied by a rare, threatened, or endangered species, to the point at which its population declines or becomes unstable.
- Artificial introduction or range extension of a rare, threatened, or endangered species to plant communities or floristic provinces in which it did not occur historically.
- Substantial reduction in distribution or abundance of a species of concern relative to its regional and local distribution.
- Loss or substantial reduction in area or distribution of a unique or rare plant or animal community.
- Major incremental loss of a widespread plant or animal community that is undergoing very rapid decline at a regional or subregional scale.

Table 4.2-1. Special-Status Species with the Potential to Occur on the Project Site or Vicinity[1]

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Plants				
Astragalus tener var *tener* Alkali milk-vetch	-- / -- / CNPS 1B	CA endemic. The historical distribution includes the S. Sacramento Valley, N. San Joaquin Valley, and the E. San Francisco Bay Area.	Associated with clay soils of alkaline flats and meadows, valley and foothill grasslands, and alkaline vernal pools. Blooms Mar-June.	Very low. Presumed extirpated from Contra Costa County. Surveys in 2004 did not find it in the restoration area.
Atriplex coronata var *coronate* Crownscale	-- / -- / CNPS 4	Central Valley and southern Coast ranges.	Chenopod scrub, alkali areas, valley and foothill grassland; vernal pools. Blooms Mar-Oct.	Low, though known to occur near the Project site, in similar habitats. Surveys in 2004 did not find it in the restoration area.
Atriplex joaquiniana San Joaquin spearscale	-- / -- / CNPS 1B	W side of the Central Valley from Glenn to Merced counties and in small valleys of the inner Coast Range.	Clay, often highly saline, soils in alkaline grasslands and alkali meadows or on the margins of alkali scrub.	Low, though known to occur in Contra Costa County. Surveys in 2004 did not find it in the restoration area.
Blepharizzonia plumose var *plumose* Big tarplant	-- / -- / CNPS 1B	CA endemic. The historical distribution extended from the NW San Joaquin Valley to the E SF Bay region.	Occurs on dry hills and grassy plains. Blooms July-Oct.	Low, though known to occur in Contra Costa County. Surveys in 2004 did not find it in the restoration area.
Lilaeopsis masonii Mason's lilaeopsis	Rare / -- / CNPS 1B	The intertidal zone of freshwater and brackish marshes of the Delta, Suisun Bay, Suisun Marsh, Mare Island, Carquinez Straits, and the Napa River.	Restricted to the littoral zone of freshwater and brackish marshes. It is most common on actively eroding slough banks, wave cut beaches, or earthen levees with a clay substrate.	Unlikely; bank conditions are not appropriate. Not found during surveys, but populations fluctuate with bank conditions. Surveys in 2004 did not find it in the restoration area.
Limosella australis Delta mudwort	-- / -- / CNPS 2	Intertidal zone of Suisun Marsh and the Delta.	Grows along eroding banks inundated by the tide, especially along edges of channel islands where competition is limited. Blooms May – August.	Possible. Not found during surveys, but surveys will be conducted again before Project construction. Surveys in 2004 did not find it on the restoration area.

[1] State or Federal listed species are shaded in grey

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Symphiotrichum lentum (Aster lentus) Suisun Marsh aster	-- / -- / CNPS 1B	Sacramento – San Joaquin Delta, Suisun Bay, Suisun Marsh, and the marshes associated with the Napa River north of San Pablo Bay. Populations have been documented in Sacramento, San Joaquin, Solano, Contra Costa, and Napa counties.	Occurs along brackish sloughs and riverbanks affected by tidal fluctuations, and within tidal wetlands.	Present. Known from restoration site, along Marsh Creek.
Invertebrates				
Branchinecta lynchi vernal pool fairy shrimp	-- / FT / --	Oregon and Central Valley and areas of southern CA.	Variety of vernal pool habitats from smaller, clear, sandstone pools to large, turbid, alkaline valley grassland pools.	Low. All potential habitat was surveyed in 2009-2011 and none were found
Desmocerus californicus dimorphus valley elderberry longhorn beetle	-- / FT / --	Streamside habitats below 3,000 feet throughout the Central Valley.	Riparian and oak savanna habitats with elderberry shrubs; elderberry is the host plant.	Unlikely. At least two elderberries within restoration area. USFWS to be within the beetle's range.
Fish				
Acipsenser medirostris Southern DPS green sturgeon	SC / FT / --	General southern distribution in the Colombia River in Wash- River and near Red Bluff. There is anecdotal support for a San considered uncommon.	Enter freshwater only to spawn, cold water. In the west Delta, adults will be confined to the the San Francisco tributaries juveniles migrate back to the before returning to spawn.	Assumed to be present.

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Archoplites interruptus Sacramento perch	SC / -- / --	Historically distributed throughout the Central Valley in sloughs and slow moving rivers, with additional catches in smaller creeks. Today the population is severely limited in number, and located primarily in manmade lakes and reservoirs. No Sacramento perch have been recorded in local fish monitoring efforts in the western Delta recently; however efforts by CDFW to reintroduce individuals have occurred in Suisun Marsh and Sherman Lake.	Spawning occurs primarily from March to August correlated with rising water temperatures, where males actively defend nests on various bottom substrates.	Potentially present.
Hypomesus transpacificus Delta smelt	SE / FT / --	Lower reaches of the Sacramento River, San Joaquin River, and the Delta; preference for low salinity areas with tidal influence. Spring/early summer individuals scattered throughout Suisun Marsh brackish water rearing habitat.	Spawn in shallow, fresh or slightly brackish water upstream of the mixing zone, typically in tidal portions of backwater, sloughs and channel edgewaters in the western Delta. Big Break is noted as a likely rearing region for delta smelt, where appropriately brackish, shallow, protected, food-rich environments are maintained.	Assumed to be present.
Oncorhynchus mykiss irideus Central Valley steelhead	-- / FT / --	Found throughout the Central Valley main river systems (Sacramento River and to a lesser extent San-Joaquin River). However , densities have been critically reduced by dam construction within the major tributaries and headwaters, and currently only a winter run persists.	Spawn in the smaller freshwater tributaries to the main rivers during January through March when flows are high and temperatures are cool. Juveniles remain in freshwater for several years before emigrating back to the ocean for adult growth.	Present.

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Oncorhynchus tshawytscha Chinook salmon	Central Valley spring-run ESU: ST / FT / -- Sacramento River winter-run ESU: SE / FE / -- Central Valley fall / late-fall run ESU: SC / FSC / --	Juvenile Chinook salmon migrate and rear in the western and central Delta.	Found along the margins of channels and shallow water habitats. Winter and spring runs favor open water areas and unvegetated habitats.	Present.
Spirinchus thaleichthys Longfin smelt	ST / -- / --	In the Sacramento-San Joaquin estuary, rarely found upstream of Rio Vista or Medford Island. Adults occur seasonally as far downstream as South Bay but are concentrated in Suisun, San Pablo, and North San Francisco Bays.	Most common in San Francisco estuary, preferring more saline waters, but capable of tolerating freshwater necessary for spawning.	Assumed to be present.
Pogonichthys macrolepidotus Sacramento splittail	SC / -- / --	Native populations are concentrated in the central and western Delta, Suisun Bay, and several of the San Pablo tributaries, particularly the Napa River, and Petaluma River.	Spawn on flooded terrestrial vegetation in the lower reaches of rivers and the Delta.	Assumed to be present.
Amphibians and Reptiles				
Ambystoma californiense California tiger salamander	ST / FT / --	From Sonoma County and the Colusa-Yolo County line, south to Tulare County. In the Coast Range, it occurs from Santa Cruz County south to Santa Barbara County, California.	Primary habitat is annual grasslands, and oak woodlands, but vernal pools and stock ponds in the vicinity are crucial to breeding.	Unlikely. Known throughout Contra Costa County. No adults or larvae found in seasonal pools during vernal pool invertebrate surveys 2009-2011.

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Rana aurora draytonii California red-legged frog	SC / FT / --	Historically from Redding to NW Baja California; in the Central Valley, the SF Bay area, and along the coast. Today found primarily in drainages of the central Coast Ranges.	Relatively shallow, slow moving water in streams, ponds, ditches.	Unlikely. Closest known populations are south of Antioch in Diablo foothills.
Anniella pulchra pulchra Silvery legless lizard	SC / -- / --	Interior ranges from Contra Costa to San Diego counties.	Found primarily in areas with sandy or loose organic soils or where there is plenty of leaf litter.	Low. Potential habitat on Emerson parcel.
Emys (=Clemmys) marmorata western pond turtle	SC / -- / --	Common in waterways throughout lower elevations of California. Northwestern and southwestern subspecies overlap throughout the Delta and Central Valley.	Ponds, marshes, rivers, streams, irrigation canals with muddy or rocky bottoms in woodlands, grasslands, and open forests.	Present. Species is known to occur, and breed, in the Project area.
Thamnophis gigas giant garter snake	ST, FP / FT / --	Central Valley from Fresno to Butte counties.	Sloughs, canals, low gradient streams and freshwater marsh habitats, irrigation ditches, and rice fields where there is a prey base of small fish and amphibians. Requires grassy banks and emergent vegetation for basking, and areas of high ground protected from winter flooding.	Unlikely. Potential habitat in Project area, but extensive surveys for the species in areas around the Project area have not been successful.
Birds				
Accipiter cooperi Cooper's hawk (nesting)	WL / -- / --	Occurs throughout CA except in high altitudes. Winters in Central Valley.	Nests in riparian woodlands, gray pine-oak woodlands, mixed conifer forests.	Present. Observed using restoration area and known to nest nearby.
Agelaius tricolor Tricolored blackbird	SC / -- / --	Permanent resident in Central Valley from Butte to Kern county.	Colonial nester near fresh water, in emergent wetland plants but also thickets of willow, blackberry, and wild rose. Feeds in grassland and cropland habitats.	Present. Uses restoration area for foraging; not known to nest on site.

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Athene cunicularia Burrowing owl	SC / -- / BCC	Lowlands throughout CA, including Central Valley.	Level, open, dry, heavily grazed or low stature grassland or desert vegetation with available rodent burrows.	Present. Have been observed on Project site in the past, though not during 2005-2012 surveys. Appropriate habitat with ground squirrel burrows is present in Project area.
Buteo swainsoni Swainson's hawk	ST / -- / BCC	Once found throughout lowland CA, now restricted to portions of the Central Valley and Great Basin regions.	Agricultural areas, (particularly alfalfa fields), juniper-sage flats, riparian areas, and oak savannas.	Present. Nest and forage in and near Project area.
Circus cyaneus Northern harrier	SC / -- / --	Occurs throughout lowland CA.	Grasslands, meadows, marshes, and seasonal wetlands and agricultural lands.	Present. Nest and forage on and near Project area. May benefit from the Project.
Elanus caeruleus White-tailed kite	FP / -- / --	Resident in low elevation areas west of Sierras throughout CA; rarely found away from agricultural areas.	Forages in open grasslands, meadows, farmlands and emergent wetlands. Nests in dense oak, willow, or other tree stands.	Present. Nest and forage on and near Project site.
Eremophila alpestris actia California horned lark	WL / -- / --	Found throughout California.	Occupies a variety of open habitats, usually where large trees and shrubs are absent.	Present. Observed on site in winter but not in summer. Not known to nest on site, though there is appropriate habitat and the species nests nearby.
Icteria virens Yellow-breasted chat	SC / -- / --	Throughout North America. Formerly bred throughout CA except in higher mountains and coastal islands. Now, an uncommon summer resident and migrant in coastal CA and in Sierra Nevada foothills.	Uses several habitats, especially riparian thickets and brush.	Present. Species observed and expected to nest on site.
Lanius ludovicianus Loggerhead shrike	SC / -- / BCC	Resident and winter visitor in lowlands and foothills of California.	Prefers open habitats with scattered shrubs, trees, fences, posts, utility lines, or other perches.	Present. Occur on Project site in winter and summer, and nest on site.

Species	Status (State / Federal / Other)[1]	Distribution	Habitat	Likelihood of Occurrence in Project Area
Laterallus jamaicensis californicus California black rail	ST, FP / -- / BCC	Permanent resident in the SF Bay/Delta region and in isolated areas of the Sierra foothills and S CA. Winter resident in central and southern coastal areas.	Fresh, brackish or tidal marshes with emergent vegetation.	Present. Has been observed and heard on site in summer. Is assumed to be breeding.
Mammals				
Antrozous pallidus Pallid bat	SC / -- / WBWG-H	Arid and semi-arid regions throughout N Mexico and the W US. Occurs throughout CA except in Sierras and the NW part of the state, most abundantly in deserts.	Most common in open, dry habitats with rocky areas for roosting. Roost in rock crevices, trees, buildings, and bridges in arid regions.	Possible. CNDDB has records of the species near Antioch, there is potential habitat for the species in the Project area.
Corynorhinus townsendii townsendii Townsend's western big-eared bat	SC / -- / WBWG-H	Common in W US. Throughout CA in numerous habitats except subalpine and alpine areas.	Most abundant in moist habitats. Roosts primarily in mines and caves, but also in buildings and other human structures.	Possible. No published records of the species in Contra Costa County.
Lasiurus blossevillii Western red bat	SC / -- / WBWG-H	Locally common from Shasta County to Mexican border, west of Sierra crest and deserts. Winter range includes western lowlands and coastal regions south of SF Bay.	Roosts in trees or shrubs in forests and woodlands from sea level up through mixed conifer forests. Common in riparian areas. Feeds over grasslands, shrublands, open woodlands and forests, and croplands.	Possible. Known to occur in general area. (CNDDB records from Brannan Island and Antioch).
Lasiurus cinereus Hoary bat	-- / -- / WBWG-M	Throughout North America. In CA, throughout the state.	May be found in any location in CA. Roosts in trees	Possible. Known to occur in general area. (CNDDB records from Brannan Island).

Source: DWR 2008, Moyle 2002, CDFW 2012, 2011

[1] **Explanation of Listing Codes**

Federal listing codes: FE - Federally listed as Endangered; FT - Federally listed as Threatened
California listing codes: SE - State listed as Endangered; ST- State listed as Threatened; SC - California Species of Special Concern; FP - Fully Protected; WL -Watch List
BCC: U.S. Fish and Wildlife Service Birds of Conservation Concern. List of migratory and nonmigratory bird species (beyond those already designated as federally threatened or endangered) that represent the Service's highest conservation priorities.
WBWG: The Western Bat Working Group. H – High Priority indicates species that are imperiled or are at high risk of imperilment based on available information on distribution, status, ecology and known threats; M – Medium Priority indicates a lack of information to assess the species' status; L – Low Priority indicates relatively stable populations based on available data. The WBWG also uses intermediary designations including MH – Medium-High and LM – Low-Medium priorities.

- Substantial loss of a composition or structure in a plant or animal community that is very old or mature, and very slow or uncertain to regenerate over many human generations.
- Major increase in the distribution, rate of spread, abundance, or impact of an invasive, non-native species.
- Major, long-term change in biogeochemical processes or productivity.
- Major, long-term reduction in diversity of native species and communities.

Significance criteria for impacts to special-status species consider potential impacts to existing populations (direct and indirect), impacts to suitable but unoccupied habitat for special-status species with narrow habitat requirements or very limited distribution, and impacts to high recovery areas or critical habitats. Impacts to special-status plant species that are certain or likely to cause local population extinction, or major long-term declines in local population size or stability are considered significant.

AQUATIC RESOURCES

- A substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, USFWS, or NMFS;
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or within established native resident or migratory wildlife corridors, or impede use of native wildlife nursery sites.

The CEQA guidelines do not define the term *substantial* because what is considered substantial depends on the species in question and the circumstances of individual Projects. It is therefore up to the agency preparing the EIR to determine standards for the threshold of significance.

Impacts to the fish assemblage in the vicinity of the Project were assessed by evaluating all potential direct, indirect, temporary and permanent impacts. The proposed Project is intended to produce tidal wetland habitat in an area that is currently diked and managed for agriculture, and thus has the potential to be a net benefit to fish. However, implementation of the Project could negatively impact fish through changes in water quality during construction; stranding or entrainment of fish in cofferdams during construction; noise and vibration impacts during pile driving; entrainment of fish in areas disconnected from the Delta; mercury methylation; disturbance of benthic habitats; or creation of habitat that benefits non-native invasive species at the expense of native species.

Discussion of Impacts and Mitigation Measures

As described above, this section includes a summary of all impacts and mitigation measures considered in the 2010 EIR, and has been updated to include impacts and mitigations that are new or may be substantially altered by changes in the proposed Project. To facilitate review of the section and comparison of analyses between the 2010 EIR and this document, impacts and mitigations have been given new numbers, and the heading for each impact or mitigation measure reflects whether that impact is the same, revised, replaced, or new. For example, the heading for Impact 4.2-1 is “Impact 4.2-1 (**Revises** 2010 EIR Impact 3.4.2.11)”; the heading for Impact 4.2-2 is “Impact 4.2-2 (**Replaces** 2010 EIR Impacts 3.4.2-1.2 and 3.4.2-2.2)”, and the heading for Mitigation 2.4 is “Mitigation 2.4 (**New** Mitigation)”.

TERRESTRIAL RESOURCES (INCLUDING WETLANDS)

IMPACT 4.2-1 (REVISES 2010 EIR IMPACT 3.4.2-1.1): POTENTIAL IMPACTS TO IRRIGATED PASTURE (INCLUDING JURISDICTIONAL SEASONAL WETLANDS) AND ASSOCIATED WILDLIFE SPECIES

Irrigated pasture makes up approximately 775 acres of the Project site, and the Project would result in a net loss of about 600 acres of this habitat type (including upland and farmed wetland components of irrigated pasture). These terrestrial habitats support common wildlife, such as rodents, coyotes, and raccoons, as well as birds including several special-status species (Table 4.2-1). The permanent loss and/or temporary disturbance of irrigated pasture is considered a potentially significant impact, particularly as it relates to effects on special-status species. Alternative 2 in the 2010 EIR generally addressed creation of tidal marsh on large portions of each of the three parcels in the restoration area, with an option to leave the Burroughs parcel as irrigated pasture if needed, either to benefit special-status avian species, or to reduce Project costs (i.e., the "No Burroughs" option). Since publication of the 2010 EIR, DWR has refined the management approach for the northern portion of the Burroughs parcel to allow for preservation and enhancement of irrigated pasture or native grassland. About 173 acres of grassland (including irrigation ditches and areas of perennial non-tidal marsh, riparian wetlands, and seasonal wetlands) would be preserved or enhanced as terrestrial habitat on the Burroughs parcel. Management activities in the enhanced grassland, such as grazing or mowing, would favor native plant species. Tall, tree species, such as Fremont cottonwood, would be planted along the north side of the Burroughs parcel to mitigate for loss of raptor nesting trees.

Although the refined management strategy for the Burroughs parcel is within the range of options considered in the 2010 EIR, the current proposal represents a reduced permanent loss of habitat loss for the following avian species dependant on irrigated pasture for nesting or foraging: Swainson's hawk, Northern harrier, white-tailed kite, tri-colored blackbird, loggerhead shrike, and California horned lark. Impact 4.2-12 below provides additional discussion of impacts specific to Swainson's hawk.

MITIGATION 4.2-1 (MODIFIED FROM 2010 EIR MITIGATION 3.4.2-1.1): AVOID AND MINIMIZE EFFECTS OF LOSS OF IRRIGATED PASTURE THROUGH PROJECT TIMING AND PHASING

Effects on resident wildlife within irrigated pasture shall be minimized through Project timing and phasing. Specifically:

- If earthmoving will be done the breeding/nesting season (February to August), vegetation shall be removed prior to the breeding season to discourage nesting and denning.
- The Project shall be phased so that impacts to terrestrial habitats do not occur throughout the Project area all in the same year.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-2 (REPLACES 2010 EIR IMPACTS 3.4.2-1.2 AND 3.4.2-2.2): RECREATION-RELATED WILDLIFE DISTURBANCE

The 2010 EIR describes that recreational use of the public access trail on the Emerson parcel would reduce the extent of undisturbed, contiguous blocks of habitat and may disturb wildlife inhabiting the area. Such disturbance could disrupt foraging, feeding, sheltering, and reproduction. Mitigations 3.4.2-1.2 and 3.4.2-2.2 in the 2010 EIR outlined specific design features that would need to be incorporated into the proposed Project during final design to offset the effects of recreation related impacts on terrestrial, riparian, and tidal-marsh dependant wildlife species. These include, but are not limited to:

- Distribution of enhanced natural or naturalistic cover features (brush piles, coarse and fine woody debris) in scattered patches throughout most terrestrial habitat;
- Retention of the maximum number of native riparian (levee) and upland trees;
- Revegetation with native riparian shrub cover along tidal marsh edges to screen wildlife from visual exposure to passing human visitors;
- Salvage and relocation of large snags and logs within restored or enhanced terrestrial habitats, as well as tidal sloughs and marsh ponds, where appropriate, to provide wildlife cover, basking sites, and roosting sites; and
- Placement of soil in gaps in rock-armoring on outboard levees (if needed) to provide rooting continuity and to maximize the feasibility of native riparian tree and shrub plantings.

These design components are reflected in the current, refined design considered in this Supplemental EIR. As a result, Mitigations 3.4.2-1.2 and 3.4.2-2.2 in the 2010 EIR, which required incorporation of specific design components, have already been reflected in the refined Project description and are no longer applicable. This impact is reduced from that described in the 2010 EIR and would be less than significant.

As noted in the Project Description, DWR also is evaluating the option of eliminating the bridge that would span the levee breach at the mouth of the new Marsh Creek distributary channel. If this option is implemented, recreation-related wildlife impacts may be further reduced from those described in the 2010 EIR.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-3 (REVISES 2010 EIR IMPACT 3.4.1-2.1): IMPACTS OF ENLARGING LITTLE DUTCH SLOUGH (TIDAL MARSH EROSION)

As described in the 2010 EIR, dredging is proposed to increase the tidal prism of Little Dutch Slough and minimize tidal damping in the restored tidal marshes. Widening the channel would remove any fringing marsh habitat and adversely impact wildlife nesting within these habitats. The reduction of fringing marsh habitat area and quality may reduce the size and viability of wildlife populations, which may, in turn, reduce the capacity of resident tidal marsh wildlife with limited dispersal ability. This is considered a potentially significant impact, and is the same as that provided in the 2010 EIR.

Of note, under the current Project, dredging of Emerson Slough is no longer proposed, as previously indicated under this impact in the 2010 EIR. The current proposal instead is to close the channel with coffer dams and excavate the channel while it is dry.

Mitigation Measures 3.4.1-2.1A and 3.4.1-2.1B in the 2010 EIR described Project design elements to minimize erosion along Little Dutch Slough, as well as impacts to tidal marsh habitats and species in the area. Measure 3.4.1-2.1A stated that the project would "self-mitigate" because the created tidal marsh acreage was so much larger than that of existing tidal marsh in Little Dutch Slough. Measure 3.4.1-2.1B was concerned primarily with reducing marsh bank slumping, and removing nonnative submerged aquatic vegetation in Little Dutch Slough. These considerations are reflected in the current, refined design considered in this Supplemental EIR. Specifically, Little Dutch Slough would be deepened and widened toward the Gilbert parcel at a 5:1 grade, which would minimize the potential for bank slumping and increased erosion. Deepening of the channel and increased tidal prism would create conditions less favorable for nonnative submerged vegetation. The Project has also been designed to substantially increase the area of tidal marsh habitat in the restoration area; once complete, the Project would result in a net increase of about 560 acres of tidal marsh. Although approximately 0.7 acres of existing tidal marsh habitat along the fringes of Little Dutch Slough would be removed to accommodate a widened channel, it is anticipated that marsh habitat would reestablish along the new berm and lowered levee adjacent to the Gilbert parcel, and along the new channel networks that would extend onto both the Gilbert and Burroughs parcels. The reestablishment of tidal marsh in and adjacent to Little Dutch Slough, as well as the restoration of large areas of tidal marsh throughout the restoration area, would reduce potential impacts to marsh dependent bird and wildlife species. As a result, impacts associated with enlarging Little Dutch Slough are considered less than significant, and reduced from those described in the 2010 EIR. Because the substantive measures from Mitigations 3.4.1-2.1A and 3.4.1-2.1B in the 2010 EIR have been integrated into the current Project design, they are no longer applicable.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-4 (REVISES 2010 EIR IMPACT 3.4.1-2.3): WILDLIFE DISTURBANCE ASSOCIATED WITH MAINTENANCE OF EXTERIOR LEVEE

As described in the 2010 EIR, levee stabilization and maintenance is proposed for some segments of levee, and may require placement of additional rock slope protection. Rock slope protection placed on the levee may remove some existing tidal marsh and riparian trees. Further, rock slope protection placed below the high tide line is likely to displace aquatic habitat for fish and invertebrate species.

Much of the existing outboard levee armoring on the Emerson and Gilbert parcels consists of large slabs of concrete, some of which includes protruding metal rebar. Since approving the 2010 EIR, it was decided that all such levee armoring on the Emerson parcel, which will be open to the public, must be removed and replaced with clean rip-rap.

. About 6,000 linear feet of armoring would be replaced adjacent to the Emerson Parcel, including 12,500 CY of rock below the mean tide line (MTL) (extending 10 to 22 feet into Emerson and Little Dutch Sloughs). Additional rock slope protection would also be placed along Emerson Slough, Dutch Slough, and Little Dutch Slough on the Gilbert parcel for long-term stability and flood protection purposes. About 8,900 linear feet of rock would be placed adjacent to the Gilbert parcel, including 16,200 CY below MTL (extending 15 feet into Emerson and Little Dutch Sloughs and 22 feet into Dutch Slough). This impact is considered potentially significant, and similar to that described in the 2010 EIR.

MITIGATION 4.2-2 (SAME AS 2010 EIR MITIGATION 3.4.1-2.3): MINIMIZE DISTURBANCE ASSOCIATED WITH MAINTENANCE OF EXTERIOR LEVEE

To the extent possible, rock placed on portions of the levee with high habitat value (tidal marsh or large trees) will be minimized. When rock placement in high value areas is necessary, work will occur in the smallest possible area and construction shall be timed to avoid nesting periods of sensitive species.

MITIGATION 4.2-3 (NEW MITIGATION): ROCK SLOPE PROTECTION PLACEMENT AND BACKFILL AND RIPARIAN PLANTING

Where feasible, both exterior and interior levee slopes shall be planted with native grasses and trees to increase available wildlife habitat. In areas where riparian vegetation shall be planted in riprap (i.e., the Emerson perimeter levee), rocks above the high tide line shall be backfilled with topsoil to provide a substrate for revegetation efforts, and increase survival of plants. Sand or gravel may be used to fill voids below the high tide line to reduce downward soil movement and water turbidity.

IMPACT SIGNIFICANCE

Less than significant with mitigation

IMPACT 4.2-5 (SAME AS 2010 EIR IMPACT 3.4.2-2.1): POTENTIAL IMPACTS TO TIDAL FRESHWATER MARSH HABITATS AND ASSOCIATED WILDLIFE SPECIES

There are about 4 acres of tidal marsh habitat in the restoration area. As described in the 2010 EIR, temporary disturbance of these areas during construction would affect the ability for fish, wildlife and plant species typical of these areas to transit, spawn, forage, nest, or otherwise utilize cover and habitat structures.

The current Project design includes construction of a new flood protection levee along the southern boundary of the restoration area to improve the existing level of flood protection for properties to the south. The southern flood protection levee, which would generally follow the southern boundary of the Project site, would require crossing Little Dutch Slough. South of the proposed levee location, Little Dutch Slough is a small channel that is somewhat tidal, though tidal flows are constrained by a crossing with culverts that constrict the channel approximately 700 feet north of the proposed flood protection levee location. This southern end of Little Dutch Slough is also fed by agricultural drainage, shallow groundwater, and precipitation, and the channel supports thick growth of emergent wetland vegetation. The refined project would include installation of a new drainage culvert and flap gate in Little Dutch Slough at the levee crossing, which may significantly limit flows in the channel south of the culvert and have a negative impact on the existing wetland vegetation. Though the culverts and flapgate would limit tidal inundation of the channel south of the flood protection levee, any resulting loss of wetlands in this area would be self-mitigated by the restoration of significantly more tidal wetlands throughout the Project site. Once complete, the Project would result in a net gain of approximately 560 acres of tidal marsh habitat, including creation of large areas of low and mid elevation marsh areas and interconnected tidal channel networks. As a result, impacts to this habitat type are considered less than significant, and similar to that described in the 2010 EIR.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-6 (REVISES 2010 EIR IMPACT 3.4.2-3): POTENTIAL IMPACTS TO NON-TIDAL FRESHWATER MARSH AND RIPARIAN WOODLAND/SCRUB AND ASSOCIATED WILDLIFE SPECIES

There are approximately 62 acres of non-tidal marsh habitat in the restoration area, and 27 acres of riparian forest and scrub habitats. As described in the 2010 EIR, temporary disturbance of these areas during construction, or habitat conversion as a result of the Project, would affect the ability for wildlife and plant species typical of these areas to forage, nest, aestivate, or otherwise utilize cover and habitat structures. In addition, construction activities may harm plants and less mobile wildlife species not able to evacuate the area prior to earthmoving.

DWR has refined the management strategy for the northern portion of the Gilbert parcel to emphasize preservation and expansion of non-tidal marsh habitat, largely for the benefit of California black rail and giant garter snake. Additional wildlife habitat features of this area would include a toe ditch along the northeast interior of the Gilbert levee to enhance garter snake habitat, and creation of open water areas (two ponds and connected new channels) for habitat diversity and to benefit waterfowl species. A new gated, screened culvert on Emerson Slough would be used in combination with an existing drainage pump to manage water levels to encourage natural vegetation recruitment.

Further, the relocation of the Marsh Creek delta onto the Emerson parcel would increase the interspersion of riparian, marsh, and channel/open water habitats. The relocated tidal network would be designed, constructed, and monitored to ensure that diversion points are located so that flood deposits are unlikely to obstruct terminal sloughs, form large or deep undrained pools or ponds, or result in significant mosquito production.

In the long-term, the Project is expected to "self mitigate" many temporary impacts to existing non-tidal freshwater marsh and riparian habitats on site. After restoration activities are complete, it is anticipated the restoration area would support up to 48 additional acres of non-tidal marsh and 18 acres of riparian habitats, compared to existing conditions. As a result, impacts to these habitat types are considered less than significant, and similar to those described in the 2010 EIR.

The revised Project design described in this Supplemental EIR is consistent with the design specifications provided in Mitigation 3.4.2-3 in the 2010 EIR, which were intended to minimize impacts to non-tidal freshwater marsh and riparian habitats. As a result, that mitigation is no longer applicable.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-7 (REVISES 2010 EIR IMPACT 3.4.2-4): POTENTIAL IMPACTS TO ALKALI MEADOW AND SEASONAL WETLAND FLATS AND ASSOCIATED WILDLIFE SPECIES

The 2010 Final EIR identified approximately 2.2 acres of alkali meadow and 17 acres of seasonal ponds on the restoration area site. The updated wetland delineation identified 0 acres of alkali meadow and 26.7 acres of seasonal ponds on the restoration area site. Protocol-level surveys of seasonal ponds in the restoration area were conducted from 2009 to 2011 with negative results (DWR 2010, 2011) (see Impact 4.2-27). In addition, the proposed refined management strategy on the northern portion of the Burroughs parcel would preserve and enhance all seasonal wetlands located in that area (acreage varies annually). In consideration of the survey results and refined management strategy on Burroughs, it is anticipated that Project impacts to alkali meadows and seasonal wetlands would be less than significant, and reduced from those described in the 2010 EIR. Because the substantive actions from Mitigation 3.4.2-4 in the 2010 EIR, which required re-creation of these habitat features onsite, have been incorporated into the Project design, this measure is no longer necessary.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-8 (NEW IMPACT): FILL OF LITTLE DUTCH SLOUGH TO ACCOMMODATE SOUTHERN LEVEE

The refined Project considered in this Supplemental EIR includes construction of a new flood protection levee along the southern boundary of the restoration area to improve the existing level of flood protection for properties to the south. The southern flood protection levee, where it crosses Little Dutch Slough, would include installation of a new drainage culvert and flap gate. . Installation of the levee, culvert, and flap gate would require permanent fill of a 100-foot long by 50-foot wide section of Little Dutch Slough (0.01 acre of waters of the U.S / State). This would also result in impacts to, and probable permanent loss of, about 2 acres of existing tidal marsh in the upstream (southern) portion of Little Dutch Slough between the new levee and East Cypress Road.

Although this component of the Project would result in the permanent loss of jurisdictional waters of the U.S. and State, in its entirety the Project would result in a net gain of jurisdictional waters and wetlands acreage and function, including a net gain of 322 acres of wetlands and 59 acres of subtidal and non-tidal open water areas. As a result, this impact is considered less than significant.

Please refer to Section 4.1, Hydrology and Water Quality, for a discussion of potential hydrologic impacts associated with construction of the southern boundary levee.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-9 (SAME AS 2010 EIR IMPACT 3.4.2-5): POTENTIAL IMPACTS TO SPECIAL-STATUS PLANTS

As described in the 2010 EIR, only one special-status plant species, Suisun aster (*Aster lentus*), has been observed in the restoration area (i.e., at the tidal edges of the Emerson parcel). However, several other special-status plant species (e.g., Mason's lilaeopsis [*Lilaeopsis masonii*], Delta mudwort [*Limosella subulata*], rose mallow [*Hibiscus lasiocarpus*], and Delta tule pea [*Lathyrus jepsonii* var. *jepsonii*]) may occur on site (Table 4.2-11), and, if present, would likely be removed during Project construction. This impact is considered potentially significant, and similar to that described in the 2010 EIR.

MITIGATION 4.2-4 (SAME AS 2010 FEIR MITIGATION 3.4.2-5): MITIGATION FOR POTENTIAL IMPACTS TO SPECIAL-STATUS PLANTS

Significant impacts to special-status plant species present or likely to be present onsite shall be minimized, avoided, and contingently compensated for by complying with the following:

- Potential habitat for special-status plant species shall be surveyed in appropriate seasons for optimal species-specific detection prior to excavation/dredging, fill, drainage, or flooding activities associated with Project construction. Survey methods shall comply with California Native Plant Society / CDFW rare plant survey protocols, and shall be performed by qualified field botanists. Surveys shall be modified to include detection of juvenile (pre-flowering) colonies of perennial species when necessary. Any populations of special-status species that are detected shall be mapped.

- If special-status plant populations are detected where construction would have unavoidable impacts, a compensatory mitigation plan shall be prepared and implemented in coordination with USFWS or CDFW. Such plans may include salvage, propagation, on-site remediation in restored habitats, and monitoring.
- If USFWS or CDFW require propagation or transplantation, scientifically sound genetic management guidelines and protocols for rare plants shall be applied to propagation and transplant plans, possibly including the following:
    - Maintain some reserve clonal stock of perennial special-status plant populations during the monitoring period to offset the risk of failure in establishing populations in the wild;
    - Set aside reserve seed of annual special-status plants from impacted populations;
    - Conduct long-term monitoring to determine the fate of managed special-status plant populations.

No special-status plant species shall be introduced to the site beyond their known geographic range unless such introduction is recommended in a final recovery plan or conservation plan prepared and adopted by USFWS or CDFW in formal consultation with USFWS.

Impact Significance

Less than significant with mitigation.

Impact 4.2-10 (Same as 2010 EIR Impact 3.4.2-6): Potential Impacts to Special-Status Bat Species

As described in the 2010 EIR, existing buildings and mature trees and snags on the Project site provide potential roosting habitat for several special-status bat species (see Table 4.2-1). If bats occupy abandoned buildings, cavity trees, or other structures on the site, they would be disturbed or displaced, and their local habitats diminished or destroyed. Although many of these impacts would be minimized by the preservation of potential roost trees on the Burroughs parcel (as provided for in the refined management strategy for that parcel), if special-status bat species are present, this impact would be considered significant, although somewhat reduced from that described in the 2010 EIR given the tree preservation requirements associated with the refined Project considered in this Supplemental EIR.

Mitigation 4.2-5 replaces 2010 EIR Mitigation 3.4.2-6, and reflects the most recent direction from CDFW on the Project.

Mitigation 4.2-5 (replaces 2010 FEIR Mitigation 3.4.2-6): Minimization and Compensation for Potential Impacts to Special-Status Bat Species

- A qualified biologist shall conduct a habitat assessment for bats at work sites where culverts, structures and/or trees would be removed or otherwise disturbed for a period of more than two hours. The habitat assessment shall include a visual inspection of features within 50 feet of the work area for potential roosting features (bats need not be present) no more than 48 hours prior to disturbance of such features. Habitat features found during the survey shall be flagged or marked.

- If any habitat features will be altered or disturbed by Project activities, a phased disturbance strategy shall be employed. Specifically, non-habitat trees or structural features shall be removed one day prior to removal of habitat features. Roosting features shall not be directly disturbed (e.g. shaken, prodded).

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-11 (SAME AS 2010 EIR IMPACT 3.4.2-7): POTENTIAL IMPACTS TO COOPER'S HAWK

As described in the 2010 Final EIR, Cooper's hawk are not known to nest on the project site, so are unlikely to be impacted by removal of large, mature trees. However, to mitigate for the loss of 20 potential raptor-nesting trees, 60 new trees would be planted on the northern portion of the Burroughs parcel (see Mitigation 4.2-8), which would benefit Cooper's hawk.

MITIGATION 4.2-6 (SAME AS 2010 EIR MITIGATION 3.4.2-7): MITIGATION FOR POTENTIAL IMPACTS TO COOPER'S HAWK

- Annual avian surveys shall continue to estimate the level of use and local population size of Cooper's hawks prior to commencement of any construction activities. Results of these surveys shall be used to prioritize the sequence of habitat retention and disturbance during Project construction phasing.
- If nesting Cooper's hawks are observed on site during pre-construction surveys, CDFW shall be consulted regarding appropriate avoidance and mitigation measures to meet the specific needs of nesting birds. Measures may include establishing a buffer zone around occupied trees, adapting restoration plans or timing to preserve nesting trees, or delay of construction disturbance until after young have fledged.
- No occupied nest trees will be removed during the nesting season.

Implementation of Mitigations 4.2-1 and 4.2-10 would further minimize impacts to Cooper's hawk foraging habitat and nesting birds, should they nest in the area.

IMPACT SIGNIFICANCE

Less than significant with or without mitigation.

IMPACT 4.2-12 (REVISES 2010 EIR IMPACT 3.4.2-8): IMPACTS TO SWAINSON'S HAWK

As described in the 2010 EIR, Swainson's hawks are known to forage and nest at the Project site. Foraging primarily occurs in irrigated pasture, which provides moderate to poor quality foraging habitat for the species (Estep 1989). Surveys conducted by DWR biologists in 2005, 2008, 2009, 2010, and 2011 observed anywhere from zero to two nests, dispersed between each of the three parcels in the restoration area, and with locations varying by year.

Construction of the Project would result in the loss of approximately 600 acres (77%) of irrigated pasture in the restoration area (see Impact 4.2-1 above). In addition, grading activities would require removal of one eucalyptus tree on the Gilbert parcel that has been used as a nest tree by Swainson's hawk in the past (2005, 2010, and 2011); no other known nest trees would be removed as a result of the Project. The Project could also result in reduced nesting habitat due to removal of potentially suitable nest trees. In total, approximately 20 large trees that may provide nesting habitat would be removed during construction.

The permanent loss of foraging habitat, one known nest tree, and potentially suitable nesting habitat is considered a potentially significant impact. This impact is reduced from what was described in the 2010 EIR in that management proposed on the northern portion of the Burroughs parcel has been refined to allow for preservation and enhancement of 173 acres of grassland, which would benefit Swainson's hawk. This refined management strategy eliminates the need for Mitigation 3.4.1-8.1 in the 2010 EIR, which required off-site mitigation for the loss of Swainson's hawk foraging and nesting habitat.

Implementation of Mitigation 4.2-1 was developed in collaboration with CDFW and would minimize impacts to Swainson's hawk foraging habitat. Mitigation 4.2-7 and 4.2-8, in combination with the nest surveys completed by DWR in 2005, 2008, 2009, 2010, and 2011, replaces 2010 EIR Mitigation 3.4.1-8.2, which required DWR to identify trees in the Project site that were used by Swainson's hawk. These mitigations are also consistent with the most recent direction provided by CDFW for the Project.

MITIGATION 4.2-7 (REPLACES 2010 EIR MITIGATION 3.4.1-8.2): CONDUCT SWAINSON'S HAWK NEST SURVEYS AND ESTABLISH BUFFERS AROUND ACTIVE NESTS

- <u>Preconstruction Surveys</u>. If work will occur during the nesting season (March 1 to July 31), a focused survey for active nests shall be conducted by a qualified biologist 5 days prior to construction. If a lapse in project-related work of 15 days or longer occurs, another focused survey shall be performed and the results sent to CDFW prior to resuming work. The biologist shall conduct a second monitoring of the potential nest trees and Swainson's hawk nests 72 hours prior to construction. Results of each survey/monitoring effort shall be documented and submitted to CDFW.

  Surveys shall be conducted in proposed work areas, staging and storage areas, haul routes, and stockpile and borrow areas, including the ISD parcel, and shall extend ¼-mile beyond the limits of work. The surveys shall be conducted at the appropriate times of day, during appropriate nesting times, shall be of sufficient duration to observe movement patterns, and shall concentrate on areas of suitable habitat. Surveys shall be conducted in accordance with CDFW guidelines, and Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley (Swainson's Hawk Technical Advisory Committee 2000).

- <u>Active Nests</u>. Construction activities within ¼-mile of an active nest should be limited to the greatest extent possible from egg-laying to post-hatching. If construction must occur in that time frame, construction should be initiated prior to egg-laying to allow time for hawks to acclimate to the disturbance before eggs are laid. Levee breaches shall be constructed after local Swainson's hawks have fledged their young to the extent feasible, and preferably after the birds have migrated south for the winter.

  Where construction cannot be sufficiently limited to avoid disturbing Swainson's hawks during nesting, 5 days and 3 days prior to the initiation of construction at any site where a nest is within ¼-mile of construction, a qualified biologist will observe the subject nest(s) for at least 1 hour. Nest status shall be determined and normal nesting behaviors observed. The results of preconstruction monitoring shall be reported to CDFW within 24 hours of each survey.

- No Contact. Physical contact with an active nest tree shall be prohibited from the time of egg-laying to fledging, unless CDFW consents to the contact. Construction personnel outside of vehicles shall be restricted to a distance greater than 660 feet from the nest tree unless construction activities require them to be closer. If personnel must come within 82 feet of an active nest tree for more than 15 minutes while adults are brooding, the nesting adults shall be monitored for stressed behavior. If stressed behavior is identified, personnel shall be removed until the behavior normalizes. Similar procedures shall be applied if personnel must come within 164 feet of an active nest for longer than 1 hour.

- Late Construction. If construction will occur within ¼-mile of an active nest site between March 15 and July 31, the following additional measures shall be implemented:

  - Staging areas for equipment, materials, and work personnel shall located ¼-mile away from the active nest site. These areas shall be flagged and identified to all work personnel during employee orientation.

  - If construction occurs within 328 feet of an active nest, no construction shall occur prior to 8:00 AM, and shall be discontinued by 5:00 PM each day.

  - A qualified biologist shall check on the nest site daily during project construction.

  - If a nest with eggs or young fledglings is abandoned during Project activities, DWR shall notify CDFW and initiate action to salvage any abandoned eggs and return the young to the wild. If the young have already hatched, they shall be retrieved and returned to the wild using methods acceptable to CDFW. Persons handling eggs and/or young birds shall have in their possession the appropriate scientific collecting permits from CDFW.

MITIGATION 4.2-8 (NEW MITIGATION): PLANT REPLACEMENT TREES

In addition to the 52 potential nest trees (i.e., trees greater than 30 feet tall and with lateral branches) that will be preserved on site, a total of 60 replacement nest trees (fast-growing trees, such as Freemont cottonwood) shall be planted along the northern edge of the Burroughs parcel during the first year of Project implementation, which will result in a replacement ratio of 3:1 (replacement nest trees: nest trees removed). All replacement nest trees shall be caged and irrigated if needed, and monitored for three years after planting. Any trees that die within this period shall be replaced. Additionally, about 6 acres of riparian forest habitat suitable for Swainson's hawk nesting shall be planted on habitat berms throughout the restoration area.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-13 (SAME AS 2010 EIR IMPACT 3.4.2-9): POTENTIAL IMPACTS TO BURROWING OWLS

As described in the 2010 EIR, burrowing owls have not been detected on the Project site. However, suitable habitat is found in irrigated pastures and levees with ruderal vegetation and ground squirrel burrows. Construction activities in these areas and eventual tidal inundation would result in a loss of habitat for this species, and is considered a potentially significant impact. This impact would be somewhat reduced compared to that described in the 2010 EIR by the refined management strategy for the northern Burroughs parcel, which would preserve and enhance 173 acres of grassland.

MITIGATION 4.2-9 (SAME AS 2010 EIR MITIGATION 3.4.2-9): MITIGATION FOR POTENTIAL IMPACTS TO BURROWING OWL

- Annual surveys for burrowing owls to determine foraging and nesting status and population size will be conducted. In addition, surveys shall be conducted within 30 days of commencement of earth-moving activities, or other construction activities, such as placement of fill. Preconstruction surveys shall be repeated if more than 30 days pass between survey dates and construction activities.
- Presence or sign of burrowing owls and all potentially occupied burrows shall be recorded and monitored according to CDFW guidelines. If burrowing owls are not detected by sign or direct observation, construction may proceed. If burrowing owls are present during surveys conducted between February 1 and August 31, grading shall not be allowed within 250 feet of any burrow, unless approved by CDFW.
- A compensatory mitigation plan shall be prepared and implemented if burrowing owls are confirmed to occur on site. Compensatory mitigation shall comply with guidelines accepted by CDFW. Mitigation may include placement of exclusion doors on occupied burrows (passive relocation), establishment of artificial burrows on or near the Project site, or monitoring of burrows.
- If burrowing owls are detected on the Project site, foraging habitat with natural or artificial burrows shall be acquired and permanently protected to compensate for the habitat loss. The protected lands shall be occupied burrowing owl habitat, or created habitat, in an area acceptable to CDFW.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-14 (SAME AS 2010 EIR IMPACT 3.4.2-10): POTENTIAL IMPACTS TO WHITE-TAILED KITE AND NORTHERN HARRIER

As described in the 2010 EIR, construction activities and conversion of irrigated pasture habitat would eliminate existing foraging habitat and impact nesting habitat for white-tailed kite and northern harrier on the Project site. Preservation of mature trees, where possible, and planting new trees on the northern portion of the Burroughs parcel would reduce potential impacts to nesting habitat for white-tailed kite. In addition, preservation and enhancement of grassland on the northern portion of the Burroughs parcel would provide foraging habitat for both species and nesting habitat for northern harriers. Although this impact would still be potentially significant, the proposed, refined management of the Burroughs parcel, including the planting of new trees, would reduce its intensity compared to that described in the 2010 EIR.

Implementation of Mitigations 4.2-1, which phases the project to avoid and minimize impacts on irrigated pasture, and 4.2-10, which requires surveys for nests and creates buffers around them, would minimize impacts to white-tailed kite and northern harrier as a result of the Project.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-15 (SAME AS 2010 EIR IMPACT 3.4.2-11): POTENTIAL IMPACTS TO NESTING BIRDS

Several special-status and common bird species have the potential to nest throughout the Project site. As described in the 2010 EIR, removal of vegetation, trees, or buildings; grading or earthmoving; and introduction of tidal action, have the potential to result in nest abandonment, nest failure, or premature fledging of young. This is considered a potentially significant impact, depending on the level of disturbance and the species disturbed, and is similar to that described in the 2010 EIR. Mitigation 4.2-10, below, replaces 2010 EIR Mitigation 3.4.2-11, and reflects the most recent direction from CDFW on when and how to conduct nesting bird surveys for the Project. Species-specific mitigation for potential impacts to nesting Swainson's hawks is described in Mitigation 4.2-8, above.

MITIGATION 4.2-10 (REPLACES 2010 EIR MITIGATION 3.4.2-11): MITIGATION FOR POTENTIAL IMPACTS TO NESTING BIRDS

- If work is to be completed during the nesting season of special-status bird species (generally February through August), a focused survey for active nests of such birds shall be conducted by a qualified biologist within 5 days prior of construction. If a lapse in Project related work of 15 days or longer occurs, another focused survey shall be performed and the results sent to CDFW prior to resuming work.
- Surveys shall be conducted in proposed work areas, including staging and storage areas, haul routes, and stockpile and borrow areas. For passerines and small raptors such as accipiters, surveys shall be conducted within a 250-foot radius surrounding work areas. For larger raptors such as buteos, the survey area shall be within ¼ mile beyond limits of work. Surveys shall be conducted at the appropriate times of day, during appropriate nesting times and shall concentrate on areas of suitable habitat.
- CDFW shall be contacted prior to commencing Project activities if active nests are found, to determine buffer and monitoring requirements.
- Nesting seasons shall be defined as February 15 to July 31 for most raptors, with the exception of February 1 to August 31 for burrowing owl; and March 15 to July 31 for smaller birds, such as passerines.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-16 (SAME AS 2010 EIR IMPACT 3.4.2-12): POTENTIAL IMPACTS TO TRI-COLORED BLACKBIRD

As described in the 2010 Final EIR, tricolored blackbirds are not known to nest on the site. Nonetheless, the proposed refined management of the northern portion of the Burroughs parcel would provide 173 acres of potential foraging habitat for the species, should they occur in the future. Further, increased tidal marsh acreage within the Project site would likely provide nesting habitat for the species in the long-term. Mitigation 3.4.1-12 in the 2010 EIR, which required off-site mitigation for loss of tricolored blackbird foraging habitat, is no longer necessary.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-17 (REVISES 2010 EIR IMPACT 3.4.2-13): POTENTIAL IMPACTS TO CALIFORNIA HORNED LARK

As described in the 2010 EIR, construction and tidal restoration activities would remove suitable foraging habitat for California horned lark (irrigated pasture). Although this impact is still considered potentially significant, the proposed refined management strategy for the northern portion of the Burroughs parcel would provide 173 acres of potential foraging habitat for the species, which would decrease this impact compared to that described in the 2010 EIR.

Implementation of Mitigations 4.2-1, which phases the project to avoid and minimize impacts on irrigated pasture, and 4.2-10, which requires surveys for nests and creates buffers around them, would minimize impacts to California horned lark as a result of the Project.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-18 (REVISES 2010 EIR IMPACT 3.4.2-14): POTENTIAL IMPACTS TO LOGGERHEAD SHRIKE

As described in the 2010 EIR, construction and tidal restoration activities would remove suitable foraging habitat for loggerhead shrike (irrigated pasture). Although this impact is still considered potentially significant, the proposed refined, management strategy for the northern portion of the Burroughs parcel would provide 173 acres of potential foraging habitat for the species, which would decrease this impact compared to that described in the 2010 EIR.

Implementation of Mitigations 4.2-1, which phases the project to avoid and minimize impacts on irrigated pasture, and 4.2-10, which requires surveys for nests and creates buffers around them, would minimize impacts to loggerhead shrike as a result of the Project.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-19 (SAME AS 2010 EIR IMPACT 3.4.2-15): POTENTIAL IMPACTS TO YELLOW-BREASTED CHATS AND OTHER SONGBIRDS OF MARSH AND RIPARIAN HABITATS

As described in the 2010 EIR, short-term loss of existing freshwater marsh and riparian habitat edges on site would reduce or eliminate habitat for yellow-breasted chat. This is considered a potentially significant short-term impact, as described in the 2010 EIR. Over the long-term, the Project would increase habitat for marsh dependent species.

Implementation of Mitigation 4.2-11 would minimize impacts to yellow-breasted chats.

MITIGATION 4.2-11 (SAME AS 2010 EIR MITIGATION 3.4.2-15): MITIGATION FOR POTENTIAL IMPACTS TO YELLOW-BREASTED CHATS AND OTHER SONGBIRDS OF MARSH AND RIPARIAN HABITATS

Annual bird surveys shall be conducted to assess use of the Project site by yellow-breasted chats and other special-status marsh songbirds. If those surveys document any special-status marsh songbirds prior to construction, DWR shall conduct additional surveys for yellow-breasted chats and avoid disturbance of high use habitats during the nesting season.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-20 (REVISES 2010 EIR IMPACT 3.4.2-16): POTENTIAL IMPACTS TO SPECIAL-STATUS WADING BIRDS

Special-status wading birds include snowy egrets and white-faced ibis (Table 4.2-1). Currently, the site offers little foraging habitat for these species, but there would be a short-term habitat loss in the period between site grading and inundation, and some potential roosting habitat for egrets would be lost due to elimination of existing riparian woodland near foraging areas.

The restored tidal marshes, channels, and ponds would provide much more foraging habitat than is currently available on the Project site. The refined management strategy for the northern portion of the Gilbert parcel, which preserves and promotes expansion of the existing marsh habitat, is likely to also provide substantial benefits for these species, consistent with the overall benefits anticipated once the Project is complete. In addition, the current description of the Project includes salvage and relocation of large snags and logs to restored or enhanced habitats (see Impact 4.2-2), which would reduce loss of roosting habitat. Since the substantive measures in Mitigation 3.4.2-16 in the 2010 EIR, which required placement of large woody debris that would provide riparian roosting habitat, have been incorporated into the Project design, this measure is no longer necessary. This impact is considered less than significant, and reduced from that described in the 2010 EIR.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-21 (REVISES 2010 EIR IMPACT 3.4.2-17): POTENTIAL IMPACTS TO CALIFORNIA BLACK RAIL

As described in the 2010 EIR, construction of the proposed Project has the potential to temporarily disturb California black rails that may nest and forage in the Project vicinity, and would modify their habitat. DWR has refined the management strategy for the northern portion of the Gilbert parcel to emphasize preservation and expansion of non-tidal marsh habitat, largely for the benefit of this species. This management strategy would offset some of the temporary impacts to California black rail and their habitat, and contribute to the anticipated, long-term beneficial effects the Project would have on the population. However, given the special-status of the species, this impact is still considered potentially significant, although somewhat reduced from that described in the 2010 EIR.

Mitigation 4.2-12, below, replaces 2010 EIR Mitigation 3.4.2-17, and reflects the most recent direction from CDFW on the Project. In addition, Mitigations 4.2-2 and 4.2-3, which govern in-water construction in tidal areas, would reduce potential impacts on California black rail and their habitat during construction.

MITIGATION 4.2-12 (REPLACES 2010 EIR MITIGATION 3.4.2-17): MITIGATION FOR POTENTIAL IMPACTS TO CALIFORNIA BLACK RAIL

To avoid impacts to California black rails, activities within or adjacent to marsh areas shall be avoided during the breeding season from February 1 through August 31 each year unless surveys are conducted to determine California black rail presence or absence, locations and territories that can be avoided, or the area is determined to be unsuitable California black rail breeding habitat by a qualified biologist. If breeding California black rails are detected within 500 feet of proposed construction sites, CDFW shall be contacted regarding appropriate action to avoid disturbance or other impacts to California black rails. All survey methods and results shall be submitted to CDFW for review and written approval.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-22 (SAME AS 2010 EIR IMPACT 3.4.2-18) POTENTIAL IMPACTS TO CALIFORNIA TIGER SALAMANDER

As described in the 2010 EIR, California tiger salamanders are not known to the Project site. However, if a relict population were to occur in marginally suitable habitat (alkali meadow, seasonal pools near ground squirrel burrows), they would be impacted by Project construction. Although unlikely, this is considered a potentially significant impact, as described in the 2010 EIR.

Mitigation 4.2-13 reflects the most recent direction from CDFW on the Project, and replaces 2010 EIR Mitigation 3.4.2-18, which prescribed a mitigation strategy for potential impacts to California tiger salamanders.

MITIGATION 4.2-13 (REPLACES 2010 EIR MITIGATIONS 3.4.2-18, 3.4.2-19, 3.4.2-20, AND 3.4.2-22): SURVEYS FOR CALIFORNIA TIGER SALAMANDER, CALIFORNIA RED-LEGGED FROG, WESTERN POND TURTLE, AND SILVERY LEGLESS LIZARD

If habitat for California tiger salamander, California red-legged frog, western pond turtle, or silvery legless lizard exist at a given work area and the species is known to exist on or within a reasonable dispersal distance, a qualified biologist shall conduct a reconnaissance level survey within 48 hours of the commencement of Project activities. A reasonable dispersal distance is considered the distance from a particular location, such as a California Natural Diversity Database (CNDDB) occurrence, that a given species would be expected to disperse for mating, breeding, foraging, nesting, or other activities. At work areas where heavy equipment shall be used, upland access routes and staging areas should also be surveyed if habitat for special-status species is present. All survey methods and results shall be submitted to CDFW for review.

If special-status species are found during surveys or construction and could be adversely impacted by work activities, work shall be placed on hold until further notice from CDFW.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-23 (SAME AS 2010 EIR IMPACT 3.4.2-19): POTENTIAL IMPACTS TO CALIFORNIA RED-LEGGED FROG

As described in the 2010 EIR, construction, water management, and tidal restoration would modify isolated, freshwater marsh habitats on site, which may be suitable for California red-legged frogs. California red-legged frog have not been observed on or near the Project site, and dispersal corridors from remote off-site populations to the site's isolated patches of suitable habitat are densely populated with bullfrogs (heavy predation "sink"), so the on-site habitat patches are unlikely to be occupied by California red-legged frogs. If, however, small, isolated, remnant populations of California red-legged frog persist on the site, they would likely suffer local extirpation during Project construction.

The refined management strategy on the Gilbert parcel, which preserves and expands existing marsh habitat, would likely benefit this species; however, construction-related impacts to the species, should they occur on site, are considered potentially significant, and similar to those described in the 2010 EIR.

Mitigation 4.2-13 reflects the most recent direction from CDFW on the Project, and replaces 2010 EIR Mitigation 3.4.2-19, which prescribed a mitigation strategy for potential impacts to California red-legged frogs..

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-24 (SAME AS 2010 EIR IMPACT 3.4.2-20): POTENTIAL IMPACTS TO NORTHWESTERN POND TURTLE

As described in the 2010 EIR, occupied onsite habitats and populations of northwestern pond turtles would be impacted by earth moving and tidal marsh restoration activities. Existing habitats below sea level would be submerged by restored tides, which would increase aquatic habitat, but likely reduce basking and nesting habitats. Although the Project would likely benefit the species in the long-run, construction-related impacts are considered potentially significant, and similar to those described in the 2010 EIR.

Mitigation 4.2-13 reflects the most recent direction from CDFW on the Project, and replaces 2010 EIR Mitigation 3.4.2-20, which prescribed a mitigation strategy for potential impacts to northwestern pond turtles.. Implementation of Mitigations 4.2-2 and 4.2-3, which govern in-water construction methods, would also reduce impacts to this species during construction.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-25 (REVISES 2010 EIR IMPACT 3.4.2-21): POTENTIAL IMPACTS TO GIANT GARTER SNAKE

Giant garter snakes have occasionally been observed in the western Delta, but not in the vicinity of the Project area. The closest record of giant garter is a 2002 sighting on Webb Tract, which is located about 3.3 miles from the Project site (CNDDB 2011). Although the occurrence of the snake at the Project site is unlikely, potential aquatic and upland habitat for giant garter snake occurs within the restoration area. If undetected populations of giant garter snakes were present in suitable existing habitats on site (particularly on the Emerson parcel), conversion of the site to tidal marsh would eliminate the majority of existing giant garter snake aquatic habitat, and could cause mortality of individual garter snakes or extirpation of the local population.

Over the long-term, restoration of the site would likely benefit the species, particularly the refined management strategy on the northern portion of the Gilbert parcel, which would provide non-tidal marsh habitat interspersed with ponds and irrigation ditches that may be utilized by giant garter snake. However, potential impacts to this species, should they occur on site, are still considered potentially significant, and similar to those described in the 2010 EIR.

Mitigation 4.2-14 replaces 2010 EIR Mitigation 3.4.2-21, and is consistent with the Biological Assessment and CESA 2081(b) permit application for the Project, which were developed in collaboration with USFWS and CDFW, respectively. Implementation of Mitigations 4.2-2 and 4.2-3, which govern in-water construction methods, would also reduce impacts to this species during construction, should they occur onsite.

MITIGATION 4.2-14 (REPLACES 2010 EIR MITIGATION 3.4.2-21): MITIGATION FOR POTENTIAL IMPACTS TO GIANT GARTER SNAKE

The following measures shall be implemented to avoid, minimize, and mitigate potential adverse impacts giant garter snake:

- Worker awareness training for construction personnel shall be conducted by a qualified biologist approved by USFWS and CDFW before commencement of construction activities and as needed when new personnel begin work on the Project. The program shall inform all construction personnel about the life history and status of the snake, the need to avoid damaging suitable habitat or causing snake mortality, measures to avoid and minimize impacts on the species and its habitats, the conditions of relevant regulatory permits, and the possible penalties for not complying with these requirements.

- Unless authorized by USFWS, construction and other ground-disturbing activities within 200 feet of suitable aquatic habitat for the giant garter snake shall not commence before May 1, with initial ground disturbance expected to correspond with the snake's active season (as feasible in combination with minimizing disturbance of nesting Swainson's hawks). Initial ground disturbance shall be completed by October 1.

- Some components of the Project may occur prior to the beginning of the defined giant garter snake active season. Site preparation activities, such as utility relocations, removal of residential or agricultural structures, and removal and planting of trees, shall be conducted before April 15, typically farther than 200 feet from aquatic habitat for giant garter snakes or in unsuitable wintering areas.

- Some components of the Project may occur beyond the end of the defined giant garter snake active season and up to November 30 of all construction years. Some of these activities, such as demobilization and site restoration, may extend through December of all years. DWR also acknowledges that unanticipated construction delays could occur and result in the need to extend construction work into the giant garter snake inactive season. Should construction need to occur in snake habitat outside of the active season, DWR shall notify USACE, USFWS, and CDFW by August 15 to reinitiate consultation. Further, DWR recognizes that it may be necessary to implement additional avoidance and minimization measures for Project activities that occur beyond October 1, such as dewatering of aquatic habitat, continuous disturbance in construction areas for the last two weeks in September, installation of exclusionary fencing prior to October 1, or other measures to minimize the potential for giant garter snakes in construction areas.

- Any aquatic habitat for the snake that is dewatered shall remain dry for at least 15 consecutive days after April 15 and before excavating or filling of the dewatered habitat. If complete dewatering is not possible, potential snake prey (e.g., fish and tadpoles) shall be removed so that snakes and other wildlife are not attracted to the construction area.

- Within 48 hours before the commencement of ground-disturbing activities, areas within 200 feet of suitable aquatic habitat for giant garter snake shall be surveyed for giant garter snakes by a qualified biologist. The biologist will provide USFWS with written documentation of the monitoring efforts within 48 hours after the survey is completed. The area shall be re-inspected by a qualified biologist whenever a lapse in construction activity of 2 weeks or greater has occurred. A qualified biologist shall be present on-site during initial ground disturbance activities. The biologist shall be available throughout the construction period and shall conduct weekly monitoring visits to ensure avoidance and minimization measures are being properly implemented.

- Before the commencement of construction activities, high-visibility fencing shall be erected to protect suitable giant garter snake habitat that is located adjacent to construction areas, but can be avoided, from encroachment of personnel and equipment. The fencing shall be removed only when the construction within a given area is completed. This fencing shall conform to the specifications detailed in the measure below.

- Tightly woven fiber netting (mesh size less than 0.25 inch) or similar material shall be used for erosion control and other purposes at the Project site to ensure that giant garter snakes are not trapped or become entangled by the erosion control material. Coconut coir matting is an acceptable erosion control material. No plastic mono-filament matting shall be used for erosion control. The edge of the material shall be buried in the ground to prevent giant garter snakes from crawling underneath the material. The number of access routes, the number and size of staging areas, and the total area of the proposed Project activity shall be limited to the minimum necessary. Routes and boundaries shall be clearly demarcated. Movement of heavy equipment to and from the Project site shall be restricted to established roadways and designated staging areas to minimize habitat disturbance. Project-related vehicles shall observe a 20-mile-per-hour speed limit within construction areas, except on county roads and on state and federal highways.

- All giant garter snakes encountered shall not be harassed, harmed, or killed and shall be allowed to leave the construction area on their own volition. If any snake is observed retreating into an underground burrow within the Project limits, no construction shall be allowed within a 50-foot radius of the burrow. A 50-foot radius non-disturbance buffer zone shall be established until a qualified biologist can make a determination that the snake is or is not a giant garter snake. If a qualified biologist determines that a giant garter snake has retreated into an underground burrow within the Project limits, and the area of the burrow cannot be avoided by the Project, then under the approval, supervision, and direction of USFWS and a qualified biologist, the burrow shall be excavated to allow personnel with appropriate authority to capture and handle the giant garter snake to relocate the giant garter snake outside of the area. The biologist shall notify the USFWS immediately if any listed species are found on-site, and will submit a report, including date(s), location(s), habitat description, and any corrective measures taken to protect the species found.

- Stockpiling of construction materials, including portable equipment and supplies, shall be restricted to designated staging areas.
- To eliminate an attraction to predators of the giant garter snake, all food-related trash items, such as wrappers, cans, bottles, and food scraps, will be disposed of in closed containers.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-26 (SAME AS 2010 EIR IMPACT 3.4.2-22): POTENTIAL IMPACTS TO SILVERY LEGLESS LIZARD

As described in the 2010 EIR, silvery legless lizards have the potential to inhabit areas of sandy soils, which can be found onsite. Although all of these areas are moderately to heavily disturbed, some potential habitat remains, and lizards, should they occur on site, could be harmed during construction, or otherwise displaced after the Project site is inundated. This impact is considered potentially significant, and similar to that described in the 2010 EIR.

Mitigation 4.2-13 replaces 2010 EIR Mitigation 3.4.2-22, which prescribed a mitigation strategy for potential impacts to silvery legless lizards, and reflects the most recent direction from CDFW on the Project.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-27 (REVISES 2010 EIR IMPACT 3.4.2-23): POTENTIAL IMPACTS TO VERNAL POOL INVERTEBRATES

In 2009/10 and 2010/11, DWR surveyed seasonal ponds in the restoration area for the presence of special-status brachiopods, including Conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), vernal pool fairy shrimp (*Branchinecta lynchi*), and vernal pool tadpole shrimp (*Lepidurus packardi*). Surveys were completed in accordance with USFWS protocol (USFWS 1996) over two wet seasons, and submitted to USFWS for review in 2010 and 2011 (DWR 2010, 2011). No special-status branchiopods were observed during the surveys. The seasonal ponds appeared to have high organic contents, low invertebrate species diversity, and an artificially extended hydrology that was affected by the irrigation regime of pastures in the restoration area. These species are therefore not expected to be affected by the Project.

In consideration of the survey result, no impacts to special-status vernal invertebrates are anticipated as a result of the Project. 2010 EIR Mitigation 3.4.2-23, which required surveys and compensatory mitigation for the species, is no longer applicable.

IMPACT SIGNIFICANCE

No impact.

IMPACT 4.2-28 (REVISES 2010 EIR IMPACT 3.4.2-24): POTENTIAL IMPACTS TO VALLEY ELDERBERRY LONGHORN BEETLE

Valley elderberry longhorn beetle are endemic to the Central Valley of California, and only found in association with its host plant, the elderberry shrub (*Sambucus* spp.). Although there are several elderberry shrubs on site that have stems of sufficient size to support beetles (one shrub that would be removed and a small patch of elderberry shrubs indirectly affected by construction activities), the Project site is not located within the range of the valley elderberry longhorn beetle (Hansen, pers. comm.) and there are no known occurrences of this subspecies within the vicinity of the Project site. Therefore, the Project is not anticipated to impact this species. 2010 EIR Mitigation 3.4.1-24, which required a stem count and measurement of elderberry shrub and replacement of impacted shrubs, is no longer necessary.

IMPACT SIGNIFICANCE

No impact.

IMPACT 4.2-29 (SAME AS 2010 EIR IMPACT 3.4.2-25): POTENTIAL IMPACTS TO HERITAGE OR OTHER TREES PROTECTED BY LOCAL ORDINANCE

As described in the 2010 EIR, a number of trees within the Project site would be removed directly or killed by tidal inundation. Some of these may qualify as Heritage or Protected Trees under the City of Oakley Tree Ordinance. This impact is considered potentially significant, and similar to that described in the 2010 EIR.

MITIGATION 4.2-15 (SAME AS 2010 EIR MITIGATION 3.4.2-25) MITIGATION FOR POTENTIAL IMPACTS TO PROTECTED TREES

Once design plans for the Project are finalized, an assessment shall be made to determine which trees will be removed or killed by the Project. All protected trees shall be mitigated for as outlined in the ordinance.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-30: CUMULATIVE IMPACTS (TERRESTRIAL RESOURCES)

As described in the 2010 EIR, cumulative impacts to wetland and terrestrial biological resources include:

- Cumulative reduction in the amount and quality of foraging habitat (open grassland-like habitats) utilized by special-status birds, including Swainson's hawk, burrowing owls, California horned lark, and loggerhead shrike.

- Cumulative reductions to the population size and viability of special-status birds dependent on pasture and ruderal habitat (open grassland-like habitats) utilized by special-status birds, including Swainson's hawk, burrowing owls, California horned lark, and loggerhead shrike.

- Cumulative reductions in the stability and persistence of established clonal populations of Suisun aster.

The revised management strategies on the northern portion of the Burroughs parcel would reduce the project's contribution to cumulative impacts of development on grassland habitats and associated wildlife species in the project area by preserving and enhancing an additional 173 acres of grassland. This would reduce the Project's contribution to cumulative impacts to bird species listed above to a less than significant level. The Project's mitigation measures for Suisun Marsh aster also would reduce its contribution to cumulative impacts to that species to less than cumulatively considerable.

In summary, implementation of Mitigations described in this section would reduce the Project's contribution to cumulative impacts to less than significant levels by either eliminating the project's impacts or reducing them to *de minimus* levels, as described in the mitigation measures.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

AQUATIC RESOURCES

IMPACT 4.2-31 (REVISES 2010 EIR IMPACT 3.5.2-1) DECREASED WATER QUALITY DUE TO CONSTRUCTION / DREDGING ACTIVITIES

The 2010 EIR describes that construction activities could impact fish and macroinvertebrates through suspension of sediment, increased levels of dissolved oxygen (DO), increased water temperatures, and/or through the accidental introduction of contaminants, such as petroleum products, into waterways. These impacts may still occur under the Project and would be reduced to less than significant levels through implementation of mitigations prescribed in the 2010 EIR.

The changes considered in this Supplemental EIR include use of cofferdams and dewatering to construct a temporary crossing over Marsh Creek and to enlarge the southern end of Little Dutch Slough. The temporary crossing of Marsh Creek would consist of an earthen berm outfitted with three culverts, rather than a bridge as previously described in the 2010 EIR. To construct the berm, temporary sheet pile cofferdams spanning the channel would be installed on both sides of the crossing using a vibratory hammer. Upstream flows would be routed downstream of the crossing via bypass piping, with groundwater from within the cofferdams pumped, as needed, onto the Emerson parcel, where it would be contained within the existing levee and/or temporary berm and allowed to infiltrate and evaporate. At the end of the construction season, all crossing materials would be removed and the channel graded to match pre-construction contours. Similarly, cofferdams would be installed along the southern reach of Little Dutch Slough to facilitate slough enlargement, which would eliminate the need to conduct in-water dredging, as described in the 2010 EIR. The cofferdam on Little Dutch Slough would also be installed using a vibratory hammer, and dewatering would be accomplished in a manner similar to that described for the Marsh Creek crossing.

The use of cofferdams to dewater Marsh Creek and Little Dutch Slough would limit turbidity and sedimentation in both areas during construction, which would reduce the potential for fish and macroinvertebrates to be exposed to adverse water quality conditions. Nonetheless, impacts to water quality during construction of the Project would still occur, and are considered potentially significant. Construction-related water quality impacts would be similar, but somewhat reduced, compared to what was described in the 2010 EIR.

Mitigation 4.2-16 replaces 2010 EIR Mitigation 3.5.1-1.1, as it provides updated reference to the most recent process for preparing a Storm Water Pollution Prevention Plan (SWPPP), and includes a requirement that a Hazardous Materials Management Plan (HMMP) be prepared. Mitigation 4.2-17 replaces 2010 EIR Mitigation 3.5.1-1.2 which limited construction activities to the dry season (April 15 to October 15). The revised work window provided in Mitigation 4.2-17 is consistent with the most recent guidance from CDFW, USFWS, and NMFS, and is reflected in the Biological Assessment and CESA 2081(b) permit application prepared in support of the Project. Finally, the use of cofferdams in Little Dutch Slough and Marsh Creek, as described above, would reduce water quality impacts associated with in-water construction. As a result, 2010 EIR Mitigation 3.5.1-1.3, which broadly required installation of cofferdams at all levee breaches, is no longer necessary.

MITIGATION 4.2-16 (REVISES 2010 EIR MITIGATION 3.5.1-1.1): DEVELOP A STORM WATER POLLUTION PREVENTION PLAN

Prior to construction, DWR shall prepare a site-specific SWPPP consistent with the State Water Resources Control Board (SWRCB) and RWQCB requirements to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction Activities. The SWPPP shall identify best management practices (BMP) for controlling soil erosion and the discharge of construction-related contaminants before, during and after construction. BMPs shall be monitored as specified in the SWPPP.

The SWPPP prepared for the Project will include a HMMP for the storage of liquefied petroleum gas and other hazardous materials above threshold quantities required for project operation. The HMMP will include a hazardous materials inventory, Material Safety Data Sheets for hazardous materials, and contact information; identify requirements for servicing and refueling equipment and employee training; and describe evacuation and emergency response procedures. Fuel and lubricants will be stored in containers that conform to state and local regulations, and storage areas will have secondary containment of a size sufficient to contain a spill and prevent spreading. Spill prevention kits will always be in close proximity when using hazardous materials (e.g., in crew trucks).

MITIGATION 4.2-17 (REPLACES 2010 EIR MITIGATION 3.5.1-1.2): IN WATER CONSTRUCTION WINDOWS

With the exception of the construction of the temporary crossing of Marsh Creek, all in-water work shall be restricted to a work-window from August 1 through October 31, which is timed to occur when sensitive fish species or life stages are not present or are least susceptible to disturbance. The temporary crossing of Marsh Creek shall be removed by October 15 each year, or earlier if required by the Contra Costa County Flood Control and Water Conservation District.

In addition, all in-water work shall be conducted, to the extent possible, during the lowest tide possible (preferably the spring low tides). In-water work occurring in shallow waterways (approximately 4 feet deep or less) should be conducted when water is at its lowest level, and presumably the chance of fish being present is low.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-32 (NEW IMPACT): STRANDING OR ENTRAINMENT OF FISH IN COFFERDAMS

As described above, the changes considered in this Supplemental EIR include use of cofferdams to construct a temporary crossing over Marsh Creek and to enlarge the southern end of Little Dutch Slough. Installation of cofferdams and dewatering of in-water work areas on Marsh Creek and Little Dutch Slough could result in fish entrainment and/or stranding. This impact is considered potentially significant.

MITIGATION 4.2-18 (NEW MITIGATION): IMPLEMENT FISH RESCUE PLAN INSIDE COFFERDAMS

DWR shall prepare a Fish Rescue Plan for review and approval by CDFW, USFWS, and NMFS. (As of February 2013, a draft Fish Rescue Plan has been prepared and is undergoing agency review.) The Fish Recue Plan shall describe the methods that shall be used to capture and relocate fishes from in-water work areas prior to and during dewatering, and shall include establishment of seine and block nets on an outgoing tide to herd fish downstream and out of the work area prior to placement of the downstream cofferdam. The fish rescue effort shall be implemented by a qualified biologist before and during the dewatering activities and shall involve capture and return of those fishes not excluded from the dewatered area by the seines or nets to suitable habitat downstream of the work area.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-33 (NEW IMPACT): PILE DRIVING EFFECTS ON FISH SPECIES

Steel sheet piles, installed using an excavator and vibratory hammer staged on the perimeter levee, would be used to construct the cofferdams needed to temporarily dewater portions of Marsh Creek and Little Dutch Slough during Project construction. Pile driving activities create underwater sound pressure levels that may kill or otherwise injure. The specific effects of pile driving on fish depend on a wide range of factors including the type of pile, type of hammer, fish species, environmental setting, and many other factors. This impact is considered potentially significant.

An interagency working group, including members from NMFS and USFWS, has established interim criteria for evaluating underwater noise impacts from pile driving on fish. These criteria are defined in the document entitled *Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities* (Fisheries Hydroacoustic Working Group 2008), which identifies a peak sound pressure level of 206 decibels (dB) and an accumulated sound exposure level (SEL) of 187 dB as thresholds for injury to fish. For fish weighing less than 2 grams, the accumulated SEL threshold is reduced to 183 dB. Although there has been no formal agreement on a "behavioral" threshold, NMFS uses 150 dB as the threshold for adverse behavioral effects (NMFS 2009).

MITIGATION 4.2-19 (NEW MITIGATION): PILE DRIVING UNDERWATER SOUND PRESSURE MEASURES

The following measures shall be implemented to avoid and minimize potential adverse effects that could otherwise result from in-water pile-driving activities:

- The contractor shall develop a plan for in-water pile-driving activities to minimize impacts on fishes. The plan will be developed to allow sufficient time in the schedule for coordination with regulatory agencies. Measures shall be implemented to minimize underwater sound pressure to levels below thresholds for peak pressure and accumulated SEL. Threshold levels established by USFWS and NMFS that will not be exceeded are:
  - Peak pressure = 206 dB
  - Accumulated SEL = 183 dB
- Underwater sound monitoring shall be performed during pile-driving activities. A qualified biologist/natural resource specialist shall be present during such work to monitor construction activities and compliance with terms and conditions of permits.
- The contractor shall perform any in-water construction activities during identified in-water work window (with the exception of the construction of the temporary Marsh Creek crossing). When in-water work is conducted, the qualified fisheries biologist shall be present to monitor construction activities and ensure compliance with mitigation requirements and the permit terms and conditions.
- Sheet piles shall be driven by vibratory or nonimpact methods (hydraulic) that result in sound pressures below threshold levels to the extent feasible.
- Hammers shall be used only during daylight hours and initially shall be used at low energy levels and reduced impact frequency. Applied energy and frequency shall be gradually increased until necessary full force and frequency are achieved.
- The use of impact hammer cushion blocks may be required by USFWS if underwater sound monitoring indicates that underwater sound levels exceed threshold levels.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-34 (SAME AS 2010 EIR IMPACT 3.5.2-2): RELEASE OF LOW QUALITY WATER FROM PROJECT DURING REVEGETATION PERIOD

Low DO concentrations and high temperature can be common in shallow, isolated bodies of water experiencing limited hydraulic exchange with surrounding areas. Temporary reductions in DO concentrations below an organism's tolerance can cause undue stress, impede movement, and lead to death if conditions persist. Similar effects on fish may be associated with prolonged exposure to elevated temperatures.

The 2010 EIR describes that during pre-breach water management periods, water would be periodically released from the Project site during drawdown. The release of stagnant water with low DO and high temperature compared to the surrounding waters could be harmful to sensitive aquatic species residing in the vicinity. This impact is considered potentially significant, and the same as that described in the 2010 EIR.

Mitigations 4.2-20, 4.2-21, and 4.2-22 would reduce these impacts. Mitigation 4.2-20 revises 2010 EIR Mitigation 3.5.1-2.1 to reflect the most recent guidance from CDFW on releasing water from the restoration area.

MITIGATION 4.2-20 (REVISES 2010 EIR MITIGATION 3.5.1-2.1): RELEASE ON-SITE WATER GRADUALLY

Any water that may need to be released from the restoration area shall be tested for DO prior to release to the surrounding water body. If the DO of the release water is higher than or up to 0.5 mg/L below surrounding water DO levels, the water may be released without restriction. If the DO of the release water is lower than 0.5 mg/L below surrounding water DO levels, the water shall be released on low tides, to facilitate water movement out of the sloughs, and release shall stop one (1) hour before the rising tide.

MITIGATION 4.2-21 (SAME AS 2010 EIR MITIGATION 3.5.1-2.2): LIMIT OPERATION DURING MIGRATION PERIODS OF SENSITIVE SPECIES

Release of water from managed marsh to adjacent open channels shall be limited during migration periods for sensitive species such as salmon to reduce potential impacts to these species from exposure to water that may have lower levels of dissolved oxygen or higher levels of turbidity, salinity, or other constituents.

MITIGATION 4.2-22 (MODIFIED FROM 2010 EIR MITIGATION 3.5.1-2.3): INSTALL FISH SCREENS

The Project shall utilize appropriate water control structures such as pumps with fish screens that allow flexibility in management to provide adaptive management capacity.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-35 (SAME AS 2010 EIR IMPACT 3.5.2-3) ENTRAINMENT OF FISH INTO AREAS DISCONNECTED FROM THE DELTA

As described in the 2010 EIR, water would be drawn onto the site from adjacent sloughs during the revegetation period, potentially entraining fish through intake structures and passive (tidal) flow gated culverts. Entrainment involves the diversion of fish from a water body into habitats that may be unsuitable, or into one from which they are unable to escape. If fish are diverted into an area isolated from the surrounding water body, they may be subject to stressors such as poor water quality and increased predation pressure from other fishes, birds, and mammals. Entrainment can also prevent fish from completing important life history events such as spawning and rearing migrations. This impact is considered potentially significant, and the same as that described in the 2010 EIR.

Mitigation 4.2-23 replaces Mitigation 3.5.1-3 in the 2010 EIR, which required development of measures to minimize entrainment of fish in collaboration with CDFW, USFWS, and NMFS. This revised mitigation reflects the outcome of that collaboration, and is reflected in the Biological Assessment and CESA 2081(b) permit applications for the Project.

MITIGATION 4.2-23 (REPLACES 2010 EIR MITIGATION 3.5.1-3): INSTALL FISH SCREENS ON PUMPS AND CULVERTS

DWR shall install fish screens designed to meet criteria developed by NMFS and CDFW (and selected by USFWS) on any pump intakes that could be used temporarily for pre-breach water management activities, pumping out temporary construction areas, and on the gated culvert used for water management in the managed non-tidal marsh area on the Gilbert parcel. Screens shall be in place at all times when pumps or culverts are in use, and to the greatest extent practicable, at all times regardless of operational status. Screen mesh size shall be 1.75 millimeters (mm) (0.0689 inch) and the design approach velocity shall be less than 0.2 feet per second. Screens shall be cleaned as frequently as necessary to maintain the required approach velocity.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-36 (SAME AS 2010 EIR IMPACT 3.5.2-4): MERCURY METHYLATION COULD CAUSE BIOACCUMULATION AND TOXICITY TO FISH

As described in the 2010 EIR, mercury methylation is a concern for wetland restoration Projects in the Delta because certain types of wetland habitats are known to support the biological processes that transform mercury into methylmercury (MeHg). Although total mercury should not change as a result of the Project, there could be an increase in MeHg loads to water in Dutch Slough or Big Break, as well as localized increased concentrations of mercury in sediment. Localized increases in MeHg may result in damage to nervous, reproductive, and immune systems of aquatic organisms that regularly inhabit the area, and/or top predators that are susceptible to biomagnification.

Certain aquatic habitats are more likely to serve as sources of MeHg than others. Mudflats and irregularly inundated areas such as high marsh zones and flooded bypasses seem to have the highest rates of MeHg export, while emergent tidal marshes and open water habitats appear to have the lowest rates of flux and can serve as MeHg sinks. It is expected that the restored Project marshes, most of which will be at low elevation and therefore inundated constantly, will be MeHg sinks rather than sources. Approximately 10% of the 560 acres of tidal marsh will be higher elevation marsh that will be only intermittently inundated, and this small portion may be a source for MeHg. However, since the amount of this high marsh and mudflat habitat would be minimal (approximately 56 acres), and because most of the site is expected to be a MeHg sink, the amount of MeHg exported from the Project site would likely be negligible.

In addition, DWR would monitor for mercury and MeHg levels in water and sediments in the Dutch Slough vicinity, both before and after restoration activities take place, as well as in Marsh Creek. This monitoring would provide baseline conditions at the site and would allow for comparison of pre- and post-restoration MeHg levels.

This impact is considered less than significant, and the same as that described in the 2010 EIR.

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-37 (SAME AS 2010 EIR IMPACT 3.5.2-5): DISTURBANCE OF BENTHIC HABITATS

As described in the 2010 EIR, enlargement of the southern reach of Little Dutch Slough would require disruption and removal of the benthic habitat and associated macroinvertebrate community in the area. Similarly, the relocation of the Marsh Creek tidal network onto the Emerson parcel would temporarily eliminate benthic habitat at the new outfall to Dutch Slough. However, impacts to benthic habitats in these areas would be temporary and short-term, and it is anticipated benthic macroinvertebrates and fish would rapidly recolonize both areas after tidal flow is restored. In addition, once complete, the Project would create additional and improved habitat for macroinvertebrates, which would reflect a net benefit to these species. As a result, this impact is considered less than significant, and the same as that described in the 2010 EIR.

Impact Significance

Less than significant. No mitigation required.

Impact 4.2-38 (Same as 2010 EIR Impact 3.5.2-6): Creation of Habitat That Benefits Non-Native Fish Species

As described in the 2010 EIR, the proposed Project may create some habitat types that favor non-native species that prey on native species. Native species are associated more with shallow, intertidal habitats, while deep, subtidal areas tend to support more invasive species (Simestad et al. 2000). In addition, shallow water habitats dominated by invasive SAV, such as Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), may support higher densities of invasive fish species, limiting the ability for native fish populations to uses these areas as spawning or rearing habitat.

This impact applies mainly to the open-water and subtidal portions of the Project site. With the exception of the subtidal area on the northern portion of the Emerson parcel, tidal open-water areas within the Project site would be shallow, planted with native plants prior to tidal inundation, and managed to reduce the potential for occupation by invasive species. The subtidal open water area on the northern portion of the Emerson parcel may be used as a source of fill material, which would increase water depths and may reduce likelihood of SAV establishment. To reduce the potential for non-native fish predators to inhabit this area, DWR would construct two breaches in the Emerson perimeter levee to facilitate greater tidal exchange and promote habitat favorable to the establishment of native species. The addition of an extra breach in the perimeter levee would reduce this impact, and would be consistent with Mitigation 3.5.1-6 in the 2010 EIR.

The ability to fully manage the establishment of invasive plant and animal species in the Project area is unknown. Because the final outcome of the created aquatic habitat cannot be determined, the significance of this impact is considered potentially significant, and the same as that described in the 2010 EIR.

Mitigation 4.2-24, which is the same as 2010 EIR Mitigation 3.5.1-6, is provided in the event non-native fish or vegetation begin to dominate the project site. However, the design of the open water area on the Emerson Parcel has been refined since the 2010 EIR to include two breaches to Emerson Slough, rather than one, based on direction from USFWS. This additional breach will facilitate greater tidal exchange and reduce the potential for non-native predatory fish and/or invasive plants to persist on site.

Mitigation 4.2-24 (Modified from 2010 EIR Mitigation 3.5.1-6): Enhance Tidal Exchange

In the event that non-native vegetation and fish predators become dominant in the tidal marshes of the Project site, measures to facilitate greater tidal exchange to the marsh and promote habitat favorable to the establishment of native SAV and native fish, such as additional breaches, will be undertaken. The corrective actions taken will be based upon the feasibility, hydrologic benefits, and ecological values of the actions.

IMPACT SIGNIFICANCE

Potentially significant. The problems caused by non-native fishes are ubiquitous throughout the Delta and the subsequent invasion of the site by these species may be a significant and unavoidable consequence of habitat restoration.

IMPACT 4.2-39 (REPLACES 2010 EIR IMPACT 3.5.2-7): DEGRADATION OF WATER QUALITY DUE TO ELEVATED METALS, ENDOCRINE DISRUPTING CHEMICALS, OR OTHER POLLUTANTS

As described in the 2010 EIR, endocrine-disrupting chemicals and heavy metals could enter waterways on or adjacent to the Project site via soil imported from the ISD parcel (which was formerly sprayed with treated wastewater that may have contained those compounds) or from Marsh Creek. Marsh Creek may also contain other constituents that could be harmful to aquatic life if found in high enough concentrations, such as hydrocarbons, excessive nutrients from agriculture operations and lawn fertilizers, and pathogens from agricultural operations and municipal water.

This issue is addressed in Impact 4.1-16, in the Hydrology and Water Quality chapter.

Mitigation Measures 4.1-12 and 4.1-13 in the Hydrology and Water Quality chapter replaces Mitigation 3.5.1-7.1 in the 2010 EIR, which required development of the described plan.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.2-40 (NEW IMPACT): IMPACTS TO RIPARIAN WOODLAND COVER

Riparian forest and scrub is an important component of the land-water interface between aquatic and terrestrial ecosystems and contributes to aquatic habitat quality for native fish species, providing shade, instream cover, and food to fishes (USFWS 1992). Approximately 3.7 acres of riparian forest, 1.1 acres of scrub shrub, and 17.1 acres of blackberry, (which CDFW is considering to be scrub-shrub) would be removed as a result of the proposed project. However, these habitats would be replaced as required by CDFW (it is currently unclear if the blackberry habitat would be replaced), and an additional 18.3 acres of riparian habitat would be created. In addition, the distribution of riparian habitat would be much more advantageous to fishes after restoration than it currently is, and would result in net increase to Shaded Riparian Area (SRA) cover (and resulting benefit to fish species) (NMFS 2013).

IMPACT SIGNIFICANCE

Less than significant. No mitigation required.

IMPACT 4.2-41: CUMULATIVE IMPACTS (SAME AS 2010 FEIR IMPACT 3.5.1-8)

As described in the 2010 EIR, the Project would be located in an area that is experiencing rapid urbanization. Several housing developments immediately adjacent to the site are either currently under construction or are scheduled to begin soon. In 2010, ISD expanded their sewage treatment capacity to 8.0 million gallons per day (MGD) to accommodate growth in Contra Costa County, including new housing developments in the vicinity of the Project. New and proposed development may adversely affect aquatic resources through introduction of more pollutants to waterways (e.g., stormwater runoff from new impervious surfaces, additional wastewater discharges from expanded ISD treatment plant, etc), or increased recreational pressures on aquatic population (e.g., increased angling, litter). Encasement of the Contra Costa Canal near and adjacent to the project site also could cumulatively affect fish species. The proposed project, with mitigation, would not contribute substantially to these cumulative impacts to aquatic species.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

4.3 CULTURAL RESOURCES

This section provides an updated discussion of known and potential cultural resources in the Project site and vicinity, including prehistoric and historic sites, structures, and landscapes. Cultural resources known to the Project site were described in Chapter 3.12, Cultural Resources, in the 2010 EIR. The characterization of cultural resources in the 2010 EIR was based on an evaluation of prehistoric resources on the Emerson, Gilbert, and Burroughs parcels completed in 2004 (California Department of Water Resources [DWR] 2004); a 2005 archaeological resources survey of property located adjacent to the Project site and owned by the Ironhouse Sanitary District (ISD) (Holman & Associates 2005); and an evaluation of the historic architectural and landscape resources of the Project site and vicinity (Hill and Dobkin 2008).

Since publication of the 2010 EIR, additional surveys of the Project site and adjacent ISD parcel have been completed, and five new resources, have been discovered. They include a prehistoric archaeological site containing human burials, a prehistoric habitation site, a historic vineyard, a historic ditch segment, and oil well pad. *A Historical Properties Inventory, Evaluation, Assessment of Effects, Treatment Plans, and Inadvertent Discoveries Procedures Report* (DWR 2013) and *Emerson Vineyard Report: Recordation and National Registrar of Historical Places Evaluation* (ESA 2014) were prepared incorporating this new information. This section has been updated to reflect this new information and includes a summary of impacts and mitigations considered in the 2010 EIR, as well as impacts and mitigations that are new or may be substantially altered by changes in the proposed Project. Because the Project now reflects a modified iteration of Alternative 2, Moderate Fill Alternative, from the 2010 EIR, this section reviews only impacts associated with that modified alternative.

4.3.1 Affected Environment

The 2010 EIR provides a detailed description of the prehistoric context, ethnographic background, and historic background of the region. This characterization was updated, in part, by DWR (2013) in a revised historical resources inventory and treatment plan for the proposed Project. In summary, the project site lies within the ethnogeographic territory of the Bay Miwok (Levy 1978), where the home village of the *Julpun* Bay Miwok tribelet was mapped on the south bank of the San Joaquin River, at the approximate location of the City of Oakley (Milliken 1995, Whipple et al. 2012 *in* DWR 2013). As with most locations in the Delta, the only locations suitable for prehistoric habitation were found in either ancient Piper sand dunes, or on high spots created above the marshland. In the general vicinity of the Project site, all recorded prehistoric sites are on these high spots, usually identified as ancient stabilized dunes of Piper Sand (DWR 2013).

In the mid to late 1800s, the Project site was drained and leveed in support of agricultural operations, and has supported dairies for over 100 years. As a result, numerous dairy-related structures exist on and adjacent to the Project site, along with homes and associated out-buildings. All historic buildings associated with the Burroughs parcel are located on the Project site. Only one historic building, a large 1960's barn, was located within the Project area on the Gilbert parcel, but it has been demolished; all other buildings associated with the Gilbert parcel housing and dairy farm clusters are located on the future City of Oakley Community Park site (south and west of the restoration area). None of the historic buildings associated with the Emerson parcel housing or dairy farm clusters are located on the Project site; similar to the Gilbert parcel, these structures are located south and east of the restoration area.

4.3.2 Identification Efforts and Identified Resources

The following provides a summarized and updated discussion of the prehistoric and historic-era resources identified within the Project site.

Native American Correspondence

As described in the 2010 EIR, the Native American Heritage Commission (NAHC) was contacted on March 1, 2004 to request a search of their files for sacred sites or locations of cultural importance to local Native American communities. The NAHC reported no Native American cultural resources were known to exist within the Project site. Three members of the Native American community, identified by the NAHC, were contacted by letter to solicit input about the Project. A telephone response was received from one of the individuals contacted, requesting information about the status of the environmental document. Due to project delays, and the length of time between initial consultation and the finalization of study documents, follow-up phone calls were made on August 6, 2009 to the three members of the Native American community that had been identified in 2004 by the NAHC. The U.S. Army Corps of Engineers (USACE) conducted follow-up correspondence with the individuals in August 2013.

Prehistoric Resources- Newly Identified

In October 2010, previously unknown human remains were discovered on a remnant dune on the Gilbert parcel, on an area of Piper loamy sands where cattle had been wallowing. Pursuant to California Health and Human Safety Code Section 7050.5(b), the Contra Costa County Coroner was contacted. Subsequent visits to the site by DWR archaeologists, in coordination with the Coroner's office and the NAHC, determined the human remains were of an archaeological nature (i.e. Native American). The NAHC assisted DWR in identifying the Most Likely Descendent (MLD), who requested the remains and associated prehistoric artifacts be reburied in place. In January 2011, DWR verified the remains had been reburied in place and the area fenced to prevent further disturbance. The site also has a historic-era component that appears to date sometime between 1915 and the 1920s. This site is identified as CA-CCO-820/H.

CA-CCO-820/H has not been formally evaluated for National Register/California eligibility. However, due to the presence of human remains and other associated habitation artifacts, it contains unique potential to contribute data that is scientifically important to understanding cultural and chronological questions about prehistoric subsistence, settlement, social organization, and other topics. The site's data potential is also rare because many prehistoric archaeological sites in the Delta were plundered or plowed by the public, or excavated by archaeologists long before modern scientific analysis methods were invented. Thus, the understanding of Bay/Delta cultural patterns and how they changed over time has not benefited from radiocarbon dating, obsidian hydration analysis, DNA studies, carbon isotope studies, archaeobotanical, faunal, and other micro-constituent studies among others. The presence of human remains in an archeological site also gives the site added importance as a burial site or cemetery, and the values associated with burial sites need to be fully considered. The presence of human remains and other potential data classes at CA-CCO-820/H make it a potential historic property/historical resource under Criterion D/4 of National Register of Historic Places (National Register)/California Register of Historical Resources (California Register).

In November 2013, the California State Historic Preservation Officer (SHPO) concurred that CA-CCO-820/H was eligible under Criterion D/4 (Roland-Nawi 2013).

In October 2013, a previously unknown prehistoric habitation site was discovered on a remnant dune on the Emerson parcel in an area of Piper sands within the Jose Vineyard. The site was identified when DWR excavated three shovel test pits to assess the potential for buried deposits at this location. The approximate boundary of the site was marked. In December 2013, eleven 4-8' deep test trenches were excavated with a backhoe, just outside the site perimeter. Soil samples from each pit were screened for prehistoric artifacts; debitage and bone fragments, presumed to be animal, were found in soils from two of the trenches. In December 2013, ESA revisited the site to further delineate the site boundary. Twenty-five shovel test pits were excavated near the presumed site boundary to more accurately determine the extent of the site. Test pits reached a maximum depth of 80 cm. All excavated soils were screened. An intact buried deposit was encountered at approximately 40 cm below the ground surface, and was found to extend slightly beyond the surface manifestation of the site. The maximum depth of the deposit was not determined, but extends beyond 80 cm below the ground surface. The prehistoric constituent of the site is a sparse scatter of bone (mostly large mammal and burned), shell, lithics, fire affected rock, and possible groundstone. The most prevalent constituent is highly fragmented, burned, non-diagnostic bone. Lithics were also non-diagnostic, and included basalt, quartzite, chert, and obsidian. No features were observed.

The prehistoric habitation site within the Jose Vineyard is a potential historical resource under Criterion D/4 of the National Register/California Register, for its potential to contribute data that is scientifically important to understanding cultural and chronological questions about prehistoric subsistence, settlement, social organization, and other topics. For the Project, the prehistoric habitation site will be treated as eligible.

Additional Surveys

The adjacent soils borrow areas on Ironhouse Sanitary District (ISD) property were investigated in 2011 (Holman & Associates 2011). The sandy soils on the south side of the ISD soils-borrow area are identified as Delhi sands, known to be sensitive for prehistoric resources. It was recommended that during excavation, a qualified archaeologist monitor soils removal from this area and the transition area between these Delhi sands and the lower elevation hay field to identify potentially buried cultural resources.

Due to the discovery of human remains in 2010, the Piper soil areas on the Emerson, Gilbert, and Burroughs parcels were surveyed in September 2012 to identify potential additional prehistoric archaeological sites. No evidence of archaeological resources was observed in any of the survey areas; however, in consideration of the dense vegetation present during the survey, it was recommended that all high spots of Piper soils in the Project site be considered archaeologically sensitive (DWR 2013).

Historic-era Resources- Previously Identified

As described in the 2010 EIR, Hill and Dobkin (2008) evaluated the Project site and vicinity for potential historic architectural and landscape resources. The Project site was identified as a potential Rural Historic Landscape (RHL), which is defined in the *Guideline for Evaluating and Documenting Rural Historic Landscapes* (National Park Service 1999) as a "geographical area that historically has been used by people, or shaped or modified by human activity, occupancy, or intervention, and that possess a significant concentration, linkage, or continuity of areas of land use, vegetation, buildings and structures, road and waterways, and natural features." The approximate boundaries of the district were defined as Cypress Road on the south, Jersey Island Road on the east, Dutch Slough on the North, and Marsh Creek on the West. The evaluation concluded that the Project site, together with the adjacent City Park property and two buildings south of the Project site appear to qualify as a RHL under Criterion A of the National Register and Criterion 1 of the California Register. Twenty-seven buildings were identified as contributing to the RHL. In addition to being contributing elements to the RHL, the main houses on the Gilbert and Burroughs parcels were also recommended individually eligible for the National Register/California Register under Criterion C/3.

The report also identifies a number of significant landscape features that contribute to the RHL. These include the levee system and major waterways that act as both boundary defining and flood control features. Open fields near the building clusters define the relationships between the agricultural and the work/living areas. Other contributing features include palm trees and other vegetation in the vicinity of the housing cluster on the Gilbert Parcel and the roads and driveways on all parcels that are part of the circulation patterns of the RHL (Hill and Dobkin 2008).

In November 2013, the SHPO concurred that the RHL was eligible under Criterion A/1 and the Gilbert and Burroughs main houses were also individually eligible under Criterion C/3 (Roland-Nawi 2013).

Historic-era Resources- Newly Identified

The adjacent soils borrow area on Ironhouse Sanitary District property south of the Contra Costa was also investigated (Holman & Associates 2011). The 2011 report on the southern portion identified two potential cultural resources: a historic ditch segment and a former oil well pad. In November 2013, the SHPO determined that the ditch segment and oil well pad do not meet the criteria for listing in either the National Register or the California Register (Roland-Nawi 2013).

A vineyard planted with historic vines has also been identified within the Project site. The Jose Vineyard is approximately 14 acres along the western edge of the Emerson Parcel, adjacent to Marsh Creek, and was originally established as a 70 acre vineyard by a Basque or Portuguese rancher Joaquin Jose over 100 years ago. While formal evaluation to determine whether the vineyard qualifies as eligible for listing in the National Register or California Register has not been conducted, information exists to suggest that the site may qualify as historic property/historical resource. The SHPO concurred in November 2013 that Jose Vineyard is eligible for the National Register/California Register under Criterion A/1 (Roland-Nawi 2013).

4.3.3 Impacts and Mitigations

Significance Criteria

Significance criteria for cultural resource impacts are based upon the CEQA guidelines and professional judgment. Potentially significant impacts could occur if the Project results in one or more of the following:

- A substantial adverse change in the significance of a historical resource that is either listed or eligible for listing in the National Register, the California Register, or a local register of historic resources;
- A substantial adverse change in the significance of a unique archeological resource;
- Disturbance or destruction of a unique paleontological resource or site or unique geologic feature; or
- Disturbance of any human remains, including those interred outside of formal cemeteries.

CEQA provides that a project may cause a significant environmental effect where the project could result in a substantial adverse change in the significance of a historical resource (Public Resources Code [PRC] Section 21084.1). CEQA Guidelines Section 15064.5 defines a "substantial adverse change" in the significance of a historical resource to mean physical demolition, destruction, relocation, or alteration of the resource or its immediate surrounding such that the significance of a historical resource would be "materially impaired". CEQA Guidelines Section 15064.5(b)(2) define "materially impaired" for purposes of the definition of "substantial adverse change" as follows:

- Demolishes or materially alters in an adverse manner those physical characteristic that account for its inclusion in a local register of historical resources pursuant to PRC Section 5020.1(k), or its identification in a historical resources survey meeting the requirements of PRC Section 5024.1(g), unless the public agency reviewing the effects of the project establishes the preponderance of evidence that the resource is not historically or culturally significant; or
- Demolishes or materially alters in an adverse manner those physical characteristic of a historical resource that convey its historical significance and that justify its eligibility for inclusion in the California Register as determined by a lead agency for purposes of CEQA.

In accordance with CEQA Guidelines Section 15064.5(b)(3) a project that follows the Secretary of Interior's Standards for the Treatment of Historic Properties is considered to have mitigated impacts to historical resources to a less-than-significant level.

DISCUSSION OF IMPACTS AND MITIGATION MEASURES

As described above, this section includes a summary of impacts and mitigations considered in the 2010 EIR, and is updated to include impacts and mitigations that are new or may be substantially altered by changes in the proposed Project. To facilitate review of the section and comparison of analyses between the 2010 EIR and this document, the heading for each impact or mitigation measure reflects whether that impact is the same, modified, or new. For example, the heading for Impact 4.3-1 is "Impact 4.3-1 (**New Impact**)"; the heading for Impact 4.3-2 is "Impact 4.3-2 (**Same as 2010 EIR Impact 3.12.2-1**).

IMPACT 4.3-1 (NEW IMPACT): POTENTIAL DISTURBANCE OF THE PREHISTORIC ARCHAEOLOGICAL SITE ON THE GILBERT PARCEL (CA-CCO-820/H)

As described above, a prehistoric archaeological site (CA-CCO-820/H), which includes human remains, was discovered on the Gilbert parcel in 2010. In collaboration with NAHC and the MLD, DWR reburied the remains and associated artifacts in place, and fenced the area to prevent continuing cattle disturbance. Further disturbance of this site during Project construction would be considered a potentially significant impact. The Project as originally designed would have adversely affected this site. However, the Project has since been redesigned to reduce the impacts to the historical resource. Although the structures on the site were determined not to be eligible for the National Register or California Register, their removal could affect possible underlying archaeological resources.

MITIGATION 4.3-1 (NEW MITIGATION): DEVELOP AND IMPLEMENT TREATMENT PLAN FOR CA-CCO-820/H TO MINIMIZE SITE DISTURBANCE

Project construction will result in no excavation of site CA-CCO-820/H; specifics of how this will be achieved will be described in a treatment plan for the site that will be developed in consultation with DWR, SHPO, USACE (which is issuing permits for the Project), and the MLD. The treatment plan will be implemented prior to the start and during Project construction.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.3-2 (NEW IMPACT): POTENTIAL DISTURBANCE OF THE PREHISTORIC HABITATION SITE IN THE JOSE VINEYARD

As described above, a prehistoric habitation site was discovered in the Jose Vineyard in 2013. The Project as originally designed would have adversely affected this site by excavation to achieve proper elevations for tidal marsh. The Project has since been redesigned to reduce the effects to the potential historical resource.

MITIGATION 4.3-2 (NEW MITIGATION): DEVELOP AND IMPLEMENT TREATMENT PLAN FOR PREHISTORIC HABITATION SITE IN THE JOSE VINEYARD TO MINIMIZE SITE DISTURBANCE

Project construction will result in little or no disturbance of this site; specifics of how this will be achieved will be described in a treatment plan for the prehistoric habitation site in the Jose Vineyard, that will be developed in consultation with DWR, SHPO, and USACE. The treatment plan will be implemented prior to the start and during Project construction.

IMPACT SIGNIFICANCE

Less than significant with mitigation.

IMPACT 4.3-3 (MODIFIES 2010 EIR IMPACT 3.12.2-1): LOSS OF UNKNOWN ARCHAEOLOGICAL RESOURCES

As described in the 2010 EIR, Project activities, including excavation and channel construction, have the potential to disturb archaeological materials not currently known to the Project site. The 2010 discovery of human remains and the 2013 discovery of the prehistoric habitation site within the Project site confirm the potential for additional subsurface discoveries during construction. This impact is considered potentially significant.

MITIGATION 4.3-3 (MODIFIES 2010 EIR MITIGATION 3.12.1-1): DEVELOP AND IMPLEMENT A CULTURAL RESOURCES MONITORING AND INADVERTENT DISCOVERIES PLAN

A Cultural Resources Monitoring and Inadvertent Discoveries Plan will be developed in consultation with DWR, SHPO, USACE, and the Native American community. This plan will include required monitoring of sensitive soils within the Project area and the protocol to follow in the event of inadvertent discovery of archaeological material. The treatment plan will be implemented prior to the start and during Project construction.

MITIGATION 4.3-4 (NEW MITIGATION): WORKER AWARENESS TRAINING

Prior to construction, DWR staff shall meet with construction supervisors to explain the potential for discovering previously unidentified cultural resources, particularly in areas mapped as sensitive soils. Worker awareness training shall include an explanation of the circumstances and process for notifying DWR, USACE, and/or the County Coroner of the discovery of a potential cultural resource, as provided in Mitigation 4.3-3.

IMPACT SIGNIFICANCE

Mitigation Measures 4.3-3 and 4.3-4 would reduce the impacts to unknown archaeological resources; however, if archaeological materials are found during excavation, the characteristics that may make it significant could be destroyed before the mitigation measures can be implemented. Therefore, this impact is considered significant and unavoidable.

IMPACT 4.3-4 (MODIFIED FROM 2010 EIR IMPACT 3.12.2-2): DEMOLITION OF HISTORIC STRUCTURES/LANDSCAPE FEATURES THAT CONTRIBUTE TO THE RURAL HISTORIC LANDSCAPE

The 2010 EIR considered impacts to historic structures and landscape features from both the proposed Project, and the future City of Oakley Community Park project. This Supplemental EIR does not address potential impacts of the Park project. As a result, the impacts and mitigations prescribed in the 2010 EIR are beyond those considered in this document. In addition, three of the mitigation measures provided in the 2010 EIR required close coordination between the proposed Project and the Park project, and these measures are no longer available to DWR, because the City of Oakley does not currently own the Community Park site (it remains in private ownership), and Park development may not occur in the foreseeable future. These include Mitigation 3.12.1-2.1, which required relocation of historic structures onto the Community Park site; Mitigation 3.12.1-2.2, which required salvage of material and features of buildings that contribute to the RHL; and Mitigation 3.12.1-2.4, which required the creation of museum-style exhibit of the Dutch Slough dairy on the Community Park Site. The following provides an updated impact assessment for the Project, and revised mitigation in consideration of the current Community Park status.

The Project will dramatically alter and adversely impact many of the contributing elements of the RHL. All of the Burroughs parcel's contributing buildings would be demolished; levees, roads, and water courses would be modified; and most of the open fields would be replaced by marsh or open water.

A construction staging area is proposed south of the Project site, in the future Community Park Site. The staging area would be located on the Emerson parcel near the end of Sellers Avenue, in the area of a modern hay barn, a structure that does not contribute to the RHL. Activities within the staging area would be confined to the pavement within and surrounding the barn and would avoid impacts to all buildings that contribute to the RHL, including the historic vehicle shed evaluated in Hill and Dobkin (2008), which is located behind the hay barn.

The Emerson, Gilbert, and Burroughs perimeter levees, which contribute to the RHL, would be modified (e.g., widened, raised, reinforced, breached) by the Project.

MITIGATION 4.3-5 (NEW MITIGATION): DEVELOP AND IMPLEMENT TREATMENT PLAN FOR THE RURAL HISTORIC LANDSCAPE

A treatment plan for the RHL will be developed in consultation with DWR, SHPO, USACE, and the National Park Service. The treatment plan will be implemented prior to the start of, and during Project construction.

IMPACT SIGNIFICANCE

Mitigation 4.3-5 would reduce impacts to the RHL by documenting its significance; however, given the dramatic and expansive nature of the restoration activities, and the impacts they would have on the current landscape, this impact is considered significant and unavoidable.

IMPACT 4.3-5 (NEW IMPACT): DISTURBANCE OF THE JOSE VINEYARD

The proposed project will result in the removal of the Jose Vineyard in order to achieve proper elevation and vegetation consistent with the tidal marsh restoration, which would be considered a substantial adverse change to the property under CEQA. Project redesign in order to avoid this impact while still meeting restoration goals has been determined infeasible.

MITIGATION 4.3-6 (NEW MITIGATION): DEVELOP AND IMPLEMENT TREATMENT PLAN FOR THE JOSE VINEYARD

A treatment plan for documentation of the Jose Vineyard will be developed in consultation with DWR, SHPO, and USACE. The treatment plan will be implemented prior to the start and during

Project construction. Treatment will include allowing private or public entities to salvage vines and propagules for transplantation to other sites.

IMPACT SIGNIFICANCE

Mitigation Measure 4.3-6 would document the Jose Vineyard and allow salvage of vines and propagules; however, the plants would need to be removed to achieve proper elevations. This impact is considered significant and unavoidable.

CUMULATIVE IMPACTS TO CULTURAL RESOURCES (MODIFIED FROM 2010 EIR CUMULATIVE IMPACT):

As described in the 2010 EIR, recent and planned residential development throughout the local area would have a cumulative effect on historic and prehistoric resources. Eastern Contra Costa County is undergoing a significant land use change from rural to suburban, resulting in land clearing and disturbance of many hundreds (or thousands) of acres.

As noted above, the future disposition of the City of Oakley Community Park is not known and its impacts to the RHL are not specifically considered in this document. However, it is anticipated the Community Park project will move forward as legal considerations are resolved and funding is made available from fees on future urban developments. Implementation of that project would impact historic structures and contribute to adverse cumulative impacts on the RHL. Currently (winter 2013) the Emerson Ranch housing development is being constructed on the land immediately south of the Dutch Slough Emerson parcel. This development project plans to remove some buildings that contribute to the RHL identified in Hill and Dobkin 2008. It is unknown how the Emerson Ranch development and the Community Park will mitigate for their incremental impacts to the RHL. Although the mitigation measures discussed above would reduce the Dutch Slough Project's contribution to cumulative impacts, the cumulative loss of historic landscapes would remain significant and unavoidable.

There are few intact archaeological sites in the area, and the known prehistoric sites associated with the Project would be preserved in place. This is expected to result in cumulative impacts to archaeological resources that would be less than significant. However, if additional archaeological materials are found during excavation, this impact may be significant and unavoidable.

4.4. EFFECTS FOUND NOT TO BE SIGNIFICANT

A Notice of Preparation (NOP) was circulated for the Project beginning on December 14, 2012. Written comments received on the NOP during the scoping period, which ended on January 14, 2013, were considered in developing the scope and content of the environmental resources and topics to be studied in this Supplemental EIR. The environmental topics analyzed in Sections 4.1 through 4.3 represent those topics that generated potential controversy and expectation of adverse impacts beyond or different than those described in the 2010 EIR. For the remaining topics, the proposed Project would not result in new significant impacts beyond those already identified in the 2010 EIR.

The discussions for each of the environmental topics listed below identify any applicable mitigation measures from the 2010 EIR, or any changes to those measures that would reduce significant environmental effects of the Project to a less-than-significant level.

4.4.1. Air Quality

The overall quantities of earthmoving (the primary generator of air pollutants associated with the Project) would be similar to, or slightly reduced from, those considered in the 2010 EIR. Changes in levee design, channel excavation, and creek crossings would not substantively affect emissions of air pollutants or greenhouse gasses compared with the previously approved project. The Bay Area Air Quality Management District (BAAQMD) adopted new guidelines for assessing air pollutants and greenhouse gasses in 2010, however implementation of those new guidelines has been stayed by litigation on non-technical issues.

Project emissions of air pollutants (other than greenhouse gasses [GHGs]) shown in Table 3.6-5 of the 2010 EIR would fall below levels of significance as defined in the 2010 BAAQMD Guidelines. Mitigations 3.6.1-2, 3.6.1-3.1, 3.6.1-3.2, 3.6.2-2.1, and 3.6.2-2.2 from the 2010 EIR would apply to the currently proposed Project.

4.4.2. Greenhouse Gas Emissions

In May 2012, DWR adopted the DWR Climate Action Plan-Phase I: Greenhouse Gas Emissions Reduction Plan (GGERP), which details DWR's efforts to reduce its greenhouse gas (GHG) emissions consistent with Executive Order S-3-05 and the Global Warming Solutions Act of 2006 (Assembly Bill (AB) 32). DWR also adopted the Initial Study/Negative Declaration prepared for the GGERP in accordance with the CEQA Guidelines review and public process. Both the GGERP and Initial Study/Negative Declaration are incorporated herein by reference and are available at: http://www.water.ca.gov/climatechange/CAP.cfm. The GGERP provides estimates of historical (back to 1990), current, and future GHG emissions related to operations, construction, maintenance, and business practices (e.g. building-related energy use). The GGERP specifies aggressive 2020 and 2050 emission reduction goals and identifies a list of GHG emissions reduction measures to achieve these goals.

DWR specifically prepared its GGERP as a "Plan for the Reduction of Greenhouse Gas Emissions" for purposes of CEQA Guidelines section 15183.5. That section provides that such a document, which must meet certain specified requirements, "may be used in the cumulative impacts analysis of later projects." Because global climate change, by its very nature, is a global cumulative impact, an individual project's compliance with a qualifying GHG Reduction Plan may suffice to mitigate the project's incremental contribution to that cumulative impact to a level that is not "cumulatively considerable." (See CEQA Guidelines, § 15064, subd. (h)(3).)

More specifically, "[l]ater project-specific environmental documents may tier from and/or incorporate by reference" the "programmatic review" conducted for the GHG emissions reduction plan. "An environmental document that relies on a greenhouse gas reduction plan for a cumulative impacts analysis must identify those requirements specified in the plan that apply to the project, and, if those requirements are not otherwise binding and enforceable, incorporate those requirements as mitigation measures applicable to the project." (CEQA Guidelines § 15183.5, subd. (b)(2).)

Section 12 of the GGERP outlines the steps that each DWR project will take to demonstrate consistency with the GGERP. These steps include: 1) analysis of GHG emissions from construction of the proposed project , 2) determination that the construction emissions from the project do not exceed the levels of construction emissions analyzed in the GGERP, 3) incorporation into the design of the project DWR's project level GHG emissions reduction strategies, 4) determination that the project does not conflict with DWR's ability to implement any of the "Specific Action" GHG emissions reduction measures identified in the GGERP, and 5) determination that the project would not add electricity demands to the State Water Project (SWP) system that could alter DWR's emissions reduction trajectory in such a way as to impede its ability to meet its emissions reduction goals.

Consistent with these requirements, a GGERP Consistency Determination Checklist is on file with DWR and is available upon request.

In preparing the GGERP Consistency Determination Checklist, the GHG emissions analysis refined and updated the calculations from the 2010 EIR based on current knowledge about the types of equipment and how long they will be operated, as well as better data available about the emissions released by the different equipment. The updated calculations estimated GHG's emitted by project construction to be approximately 2900 tons, a more accurate estimate than that of 800 tons that was in the 2010 EIR.

Determination

Based on the analysis provided in the GGERP and the demonstration that the proposed project is consistent with the GGERP (as shown in the Consistency Determination Form), DWR as the lead agency has determined that the proposed project's incremental contribution to the cumulative impact of increasing atmospheric levels of GHGs is less than cumulatively considerable and, therefore, less than significant.

4.4.4. Noise

The overall level of construction activities, including construction equipment and vehicle operation (the primary sources of noise associated with the Project) would be similar to, or slightly reduced from, those considered in the 2010 EIR. Therefore, noise levels of the current Project would be similar to those described in the 2010 EIR. Mitigation 3.7-1 from the 2010 EIR would continue to apply to the Project.

4.4.5. Aesthetics

The current Project includes changes and refinements to certain Project features, including modified construction of levees (including a new southern levee), relocation of the Marsh Creek channel onto the Emerson parcel, construction of a subtidal open water area on the Emerson parcel, and use of coffer dams and dewatering to implement improvements along Marsh Creek and Little Dutch Slough. However, once constructed, the Project would be similar in overall aesthetic appearance to that described in the 2010 EIR. Changes in levee location and height may be noticeable to some viewers, but would not represent a substantive change in views compared to the Project described in the 2010 EIR. No changes in night lighting or removal of structures would occur. A new temporary crossing of Marsh Creek would be constructed for several seasons to allow transfer of material from the Ironhouse Sanitary District (ISD) parcel to the Emerson parcel; this crossing, however, would not result in different of more substantial adverse impacts to visual quality or views compared with the previously proposed crossing. Therefore changes in aesthetics impacts compared to those described in the 2010 EIR would be less-than-significant. No mitigation is required.

4.4.6 Land Use and Socioeconomics

The revised Project would have the same land uses as described in the 2010 EIR (Alternative 2, No Burroughs Option). Therefore, as described in that document, the Project would not result in any potentially significant land use impacts and no mitigation is required.

4.4.7 Agricultural Resources

The revised Project would have the same effects on conversion of agricultural land as described in the 2010 EIR (Alternative 2, No Burroughs Option). Therefore, as described in that document, the Project would not result in any potentially significant impacts to agricultural resources and no mitigation is required.

4.4.8 Recreation

As described in the 2010 EIR, the creation of a loop trail around the perimeter of the Emerson parcel would provide improved shoreline access, education, and recreational opportunities, consistent with the City of Oakley's General Plan. Although the Project could generate conflicts between non-motorized watercraft and motorized watercraft, recreational impacts would be less than significant or would be mitigated to less-than-significant levels by implementation of mitigation measures identified in this 2010 EIR. As a result, impacts to recreational resources are considered similar to those described in the 2010 EIR, and would be less-than-significant.

4.4.9 Transportation/Traffic

The revised Project would have the same effects on transportation as described fin the 2010 EIR (Alternative 2, No Burroughs Option). Therefore, as described in that document the Project would not result in any potentially significant transportation impacts and no mitigation is required.

4.4.10 Public Services

The revised Project would have the same effects on public services as described in the 2010 EIR (Alternative 2, No Burroughs Option). Therefore, as described in that document, the Project would not result in any potentially significant impacts to public services and no mitigation is required.

4.4.11 Hazards

The revised Project would have the same effects on hazards as described in the 2010 EIR (Alternative 2, No Burroughs Option). Mitigations 3.15.1-1, 3.15.1-2, 3.15.1-3, 3.15.1-4.1, 3.15.1-4.2, and 3.15.1-4.3, and 3.15.2-4 in the 2010 EIR would continue to apply to the Project.

4.4.12 Cumulative Impacts/Mitigation

The 2010 EIR assessed the cumulative impacts of the Project on all the areas analyzed in that EIR. DWR has evaluated the potential for cumulative impacts resulting from the changes to the Project analyzed in the technical section of this Supplemental EIR and found that no new cumulative impacts would result from these changes.

As discussed in Section 2.2, Proposed Project, agricultural land to the south and east of the Project site is planned for conversion to other uses. The area to the east of the Project site is planned for development. Buildout of the 2,500-acre specific plan is anticipated over a 5 to 15 year horizon (i.e., 2016 to 2021)(City of Oakley 2006) and changes to the levees on the Project site would not significantly impact these developments.

Proposed changes to the Project to allow restoration of the area before encasement of the Contra Costa Canal are not expected to have significant cumulative effect on any resource areas. As described in Sections 4.1, and 4.2, changes in construction methods and design would not adversely affect water quality or biological resources compared to the 2010 EIR, and thus would not alter cumulative effects identified in the 2010 EIR. Protection of the additional historic resource identified in Section 4.3, Cultural Resources, also would not have a cumulatively significant environmental effect. The revised project would continue to contribute to a cumulatively significant loss of historic landscapes. For the non-significant resources area discussed above, no changes in the cumulative impact analysis would occur.

5.0 LIST OF PREPARERS AND CONTRIBUTORS

The following agencies and individuals participated in the preparation of this SEIR:

California Department of Water Resources

1416 Ninth Street, 11th Floor
Sacramento, CA 95814

Patty Finfrock, Staff Environmental Scientist

California State Coastal Conservancy

1330 Broadway, 13th Floor
Oakland, CA 94612-2530

Jeff Melby, Project Manager

Jonathan Gurish, Staff Attorney

Technical Consultants

Grassetti Environmental Consulting
Richard Grassetti, SEIR Project Manager

Environmental Science Associates
Ann Borgonovo, Environmental Hydrology Leader

Christina Toms, Ecological Engineer, Hydrology and Water Quality

Lux Environmental Consulting
April Zohn, Principal, Biological Resources

6. REFERENCES

3.0 PROJECT DESCRIPTION

City of Oakley. 2006. East Cypress Corridor Specific Plan. Adopted March 13. Available at: http://www.ci.oakley.ca.us/subpage.cfm?id=265696.

4.1 HYDROLOGY AND WATER QUALITY

Balance Hydrologics. 2004. Stormwater Management Plan, Cypress Grove Project, City of Oakley, California. Prepared for Sycamore Associates LLC. Berkeley, CA. June.

Brown, L.R. 2003. Potential effects of organic carbon production on ecosystems and drinking water quality. San Francisco Estuary Tidal Wetlands Restoration, San Francisco Estuary and Watershed Science. Volume 1, Issue 1 (October 2003), Article 3. Available at: http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art3.

California State Water Resources Control Board (SWRCB). 2006. Revised Draft Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. November.

Chow AT, Leech DM, Boyer TH, Singer PC. 2008. Impact of Simulated Solar Irradiation on Disinfection Byproduct Precursors. Environ. Sci. Technol. 42(15):5586-5593.

Delta Methylmercury TMDL Nonpoint Source Working Group. 2013. Methylmercury Control Study Collaborative Workplan. Technical Advisory Committee Draft. April 19.

Downing BD, Boss E, Bergamaschi BA, Fleck JA, Lionberger MA, Ganju NK, Schoellhamer DH, Fujii R. 2009. Quantifying Fluxes and Characterizing Compositional Changes of Dissolved Organic Matter in Aquatic Systems in situ Using Combined Acoustic and Optical Measurements. Limnology and Oceanography: Methods:119-131.

Engelage SK, Stringfellow WT, Letain T. 2009. Disinfection Byproduct Formation Potentials of Wetlands, Agricultural Drains, and Rivers and the Effect of Biodegradation on Trihalomethane Precursors. J Environ Qual 38(5):1901-1908.

ENGEO, Inc. 2005. Groundwater Study, Cypress Corridor Specific Plan Area, Contra Costa County, California. October 31.

ESA PWA. 2010. Dissolved organic carbon literature review and evaluation of Liberty Island Conservation Bank Negative Declaration. Prepared for the Solano County Water Agency. December 17.

Hultgren-Tillis Engineers. 2005. Geotechnical Consultation, Seepage and Levees, Dutch Slough Tidal Marsh Restoration, Oakley, CA.

HydroFocus, Inc. 2003. Beneficial Use Impact Study, Well Construction Report, Ironhouse Sanitary District, Wastewater Treatment Facility, Contra Costa County. June 26.

HydroFocus, Inc. 2013. Analysis of Seepage and Total Dissolved Solids and Chloride Loading to Contra Costa Canal. Prepared for the California Department of Water Resources, Reclamation District 2137, and ESA-PWA. February.

Jassby, A.D. and J.E. Cloern. 2000. Organic Matter Sources and Rehabilitation of the Sacramento-San Joaquin Delta (California USA). Aquatic Conservation: Marine and Freshwater Ecosystems 10:323-352.

Kraus TEC, Bergamaschi BA, Hernes PJ, Spencer RGM, Stepanauskas R, Kendall C, Losee RF, Fujii R. 2008. Assessing the Contribution of Wetlands and Subsided Islands to Dissolved Organic Matter and Disinfection Byproduct Precursors in the Sacramento-San Joaquin River Delta: A Geochemical Approach. Organic Geochemistry 39(9):1302-1318.

Luhdorff and Scalmanini Consulting Engineers (LSCE). 2006. Groundwater investigation and monitoring program, Dutch Slough restoration area. Prepared for the Department of Water Resources and the Contra Costa Water District. Woodland, CA. May 22.

Lux Environmental. 2012. Draft Application for Individual Permit: Supplemental Attachment: Dutch Slough Tidal Marsh Restoration Project (SPK-2004-00043). March. Prepared for the US Army Corps of Engineers.

Mount, J. 2007. Sea Level Rise and Delta Planning. Technical Memo for the CALFED Independent Science Board. http://science.calwater.ca.gov/pdf/isb/meeting_082807/ISB_response_to_ls_sea_level_090707.pdf

National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. http://dels.nas.edu/besr

Natural Heritage Institute (NHI). 2002. Marsh Creek Delta Preliminary Conceptual Restoration Plan.

_____. 2003. Marsh Creek Watershed Report, 3rd Edition. Prepared for the California State Coastal Conservancy, the San Francisco Bay Fund, and the CALFED Bay-Delta Program. November.

_____. 2004. Dutch Slough Tidal Marsh Restoration Project Preliminary Opportunities and Constraints Report. Prepared for the California State Coastal Conservancy. February 20.

Orloff, Leah. 2009. Letter to Patty Quickert, California Department of Water Resources, form Orloff, Contra Costa Water District, providing comments on the 2010 Draft EIR for the Dutch Slough Project. February 17.

Orr, J.C., O. Aumont, A. Yool, G. K. Plattner, F. Joos, E. Maier-Reimer, M.F. Weirig, R. Schlitzer, K. Caldeira, M.E. Mickett, R.J. Matear, B. Mignone, J.L. Sarmiento, J. Davison. 2003. The GOSAC project to predict the efficiency of ocean CO2 sequestration using 3-D ocean models. Proceedings of the Sixth International Conference on Greenhouse Gas Control Technologies.

Phillip Williams Associates (PWA). 2006. Dutch Slough Tidal Marsh Restoration Conceptual Plan and Feasibility Report.

Reddy, K.R. 2005. Review of Delta wetlands water quality: release and generation of dissolved organic carbon from flooded peatlands. Wetland Biogeochemistry Laboratory Soil and Water Science Department, University of Florida, Gainsville, FL. 32611. Final Report prepared for In Delta Section, Division of Planning and Local Assistance, Department of Water Resources, Sacramento, CA.

Roy S, Heidel K, Creager C, Chung C, Grieb T. 2006. Conceptual Models for Constituents of Drinking Water Concern in the Central Valley and Delta: Organic Carbon, Nutrients and Pathogens. Prepared for US Environmental Protection Agency.

Stellar Environmental Solutions, Inc. 2006. Soil Sampling and Analytical Results. Dutch Slough Restoration Project. Draft Report.

Stralberg D, Brennan M, Callaway JC, Wood JK, Schile LM, et al. (2011) Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay. PLoS ONE 6(11): e27388. doi:10.1371/journal.pone.0027388

Sumpter, J. P. 2005. Endocrine Disrupters in the Aquatic Environment: An Overview. Acta hydrochim. hydrobiol., 33: 9–16. doi: 10.1002/aheh.200400555

United States Geological Survey (USGS). 2008. Tracking Organic Matter in Delta Drinking Water. Science Action: News from the CALFED Science Program, April 2008. Sacramento, CA: State of California, CALFED Science Program.

4.2 BIOLOGICAL RESOURCES

AECOM and ESA PWA 2012a. Biological Assessment and Essential Fish Habitat Assessment – Dutch Slough Tidal Marsh Restoration Project. Prepared for the California Department of Water Resources for submittal to the U.S. Army Corps of Engineers. March.

AECOM and ESA PWA 2012b. Application for California Endangered Species Act Section 2081(b) Incidental Take Permit – Dutch Slough Tidal Marsh Restoration Project. Prepared for the California Department of Water Resources for submittal to the U.S. Army Corps of Engineers. March.

California Department of Fish and Game (CDFW). 2013. Dutch Slough Tidal Marsh Restoration Project - California Endangered Species Act Incidental Take Permit No. 2081-2012-014-03. Provided to Gail Newton, California Department of Water Resources. DATE.

_____. 2012. California Natural Diversity Database Special vascular plants, bryophytes, and lichens list. October. Available at: http://www.dfg.ca.gov/wildlife/nongame/list.html.

______. 2011. California Natural Diversity Database Special Animals. January. Available at: http://www.dfg.ca.gov/wildlife/nongame/list.html.

Estpe, J. A. 1989. Biology, movements, and habitat relationships of the Swainson's Hawk in the Central Valley of California, 1986-87. California Department of Fish and Game, Nongame Bird and Mammal Section. 52 pp.

Finan, Michael, Wetland Specialist, Regulatory Division. 2011. Letter from Finan, U.S. Army Corps of Engineers, to Patty Quickert, California Department of Water Resources, responding to the request for a Preliminary Jurisdictional Determination for the Dutch Slough Tidal Marsh Restoration Project site. October 20.

Fisheries Hydroacoustic Working Group. 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities. Memorandum to applicable agency staff. National Marine Fisheries Service Northwest and Southwest Regions, U.S. Fish and Wildlife Service Regions 1 and 8, California/Washington/ Oregon Departments of Transportation, California Department of Fish and Game, and U.S. Federal Highway Administration. June 12.

Grassetti Environmental Consulting, Wetlands and Water Resources, Ward Hill, Giroux and Associates, Abrams Associates, RMC Water and Environmental, and Cheung Environmental Consulting. 2008. Draft Environmental Impact Report: Dutch Slough Tidal Marsh Restoration Project (SCH# 2006042009). Prepared for the California Department of Water Resources and the California State Coastal Conservancy. November.

HydroFocus. 2011. Dutch Slough Draft Surface Water Quality Monitoring Plan. July 25, Davis, CA.

Moyle, P. B. 2002. Inland Fishes of California. Revised and Expanded. University of California Press. Berkeley, CA.

National Marine Fisheries Service (NMFS). 2013. Biological Opinion for the Dutch Slough Restoration Project (Ref No. 2012/1681).). Provided to William Guthrie, U.S. Army Corps of Engineers, Sacramento District. February 7.

______. 2009. Pile Driving Analysis Spreadsheet. Available: http://www.wsdot.wa.gov/NR/rdonlyres/1C4DD9F8-681F-49DC-ACAFABD307DAEAD2/0/BA_NMFSpileDrivCalcs.xls.

Simenstad, C.J. Toft, H. Higgins, J. Cordell, M. Orr, P. Williams, L. Grimaldo, Z. Hymanson, D. Reed, and others (BREACH Interdisciplinary Team). 2000. Sacramento/San Joaquin Delta Breached Levee Wetland Study (BREACH). Preliminary Report to CALFED.

Stellar Environmental Solutions. 2006. Soil Sampling and Analytical Results, Dutch SlougH Restoration Project. Draft Report.

Swainson's Hawk Technical Advisory Committee. 2000. Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley. Available: http://www.dfg.ca.gov/wildlife/nongame/docs/swain_proto.pdf. Accessed March 20, 2012.

U.S. Fish and Wildlife Service. 2012. Biological Opinion for the Dutch Slough Restoration Project (Ref No. 08FBDT00-2012-F-0008). Provided to William Guthrie, U.S. Army Corps of Engineers, Sacramento District. November 19.

4.3 CULTURAL RESOURCES

California Department of Water Resources. Negative Archaeological Survey Report, Dutch Slough Wetland Restoration Project. April 2004.

California Department of Water Resources. Historical Properties Inventory, Evaluation, Assessment of Effects, Treatment Plans, and Inadvertent Discoveries Procedures Report. March 2013.

Hill, Ward and Dr. Marjorie Dobkin. 2008. Historic Architecture/Landscape Report for the Dutch Slough Restoration Project, City of Oakley, Contra Costa County, California. Prepared for Grassetti Environmental Consulting. 2008.

ESA Associates, Inc. Emerson Vineyard Report: Recordation and National Registrar of Historical Places Evaluation. January 2014.

Holman & Associates. Cultural Resources Study of the Proposed Ironhouse Sanitary District 50-Acre Wetlands Conversion Project, Oakley, Contra Costa County, California. June 28, 2011.

_____. A Report of Findings of Cultural Resources Survey of the Ironhouse Sanitary District Project, Oakley and Jersey Island, Contra Costa County, California. Prepared for Jones & Stokes. September 2005.

Levy, R.S. Eastern Miwok. In *Handbook of North American Indians, Volume 8, California*, edited by R.F. Heizer, pp. 398-413. Smithsonian Institution, Washington, D.C. 1978.

Milliken, R.T. Report of the 1994 archaeological excavation on the skirt of the Souza Mound, Sac-2, Sacramento County, California. Far Western Anthropological Research Group, Inc. Davis, CA. Report on file at the North Central Information Center, California Historical Resources Information System, Sacramento State University. 1995.

National Park Service. Guidelines for Evaluating and Documenting Rural Historic Landscapes. Available at: http://www.nps.gov/nr/publications/bulletins/nrb30/. 1999.

Roland-Nawi, C. Letter to William Guthrie, Senior Project Manager, California South Branch, Army Corps of Engineers, Regarding Section 106 Consultation for the Dutch Slough Wetland Restoration Project in the City of Oakley, Contra Costa County, California. Document on file at DWR. 2013.

Whipple, A., R. Grossinger, D. Rankin, B. Stanford, and R. Askevold. Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process. Prepared for the California Department of Fish and Game and Ecosystem Restoration Program. SFEI-ASC Historical Ecology Program, Publication #672. San Francisco Estuary Institute- Aquatic Science Center, Richmond, CA. 2012.

APPENDIX A: NOTICE OF PREPARATION AND RESPONSES

NOTICE OF PREPARATION

DUTCH SLOUGH TIDAL MARSH RESTORATION PROJECT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

To: California Office of Planning and Research, Responsible and Trustee Agencies, Other Interested Parties

Subject: Notice of Preparation of a Supplemental Environmental Impact Report

Project: Dutch Slough Tidal Marsh Restoration Project

Lead Agency: California Department of Water Resources

Date: December 13, 2012

This Notice of Preparation (NOP) has been prepared to notify agencies and interested parties that the California Department of Water Resources (DWR) as the Lead Agency pursuant to the California Environmental Quality Act (CEQA) is beginning preparation of a Supplemental Environmental Impact Report (Supplemental EIR) for the Dutch Slough Tidal Marsh Restoration Project (Project). The Supplemental EIR will supplement the Dutch Slough Tidal Marsh Restoration Project Final EIR, which was certified by DWR on March 17, 2010 (SCH #2006042009). Since certification of the Final EIR, modifications to the Project design and construction methodology, and updated information specific to cultural resources in the Project area, have been identified. The key purpose of the Supplemental EIR is to determine whether the environmental effects of the Project as currently proposed would result in new, significant physical environmental effects or a substantial increase in the severity of previously identified physical environmental effects pursuant to Section 15163 of the CEQA Guidelines.

The Project is located on a 1,178-acre area owned by DWR in eastern Contra Costa County, on the historic delta of Marsh Creek. Figure 1 shows the Project location. The Project is proposed to restore tidal marsh and riparian habitats on the Project site to improve conditions for native fishes and other aquatic and wetland species; provide an improved understanding of restoration science in tidal marsh wetland ecosystems in the region; and provide public access to the restored area.

DWR is soliciting the views of interested persons and agencies as to the scope and content of the environmental resources and topics to be studied in the Supplemental EIR. DWR currently proposes to focus the Supplemental EIR analyses on potential impacts to biological resources, hydrology and water quality, and cultural resources. It is anticipated that impacts to other environmental resources will be either minor or unchanged. No new alternatives are proposed for evaluation in the

Supplemental EIR. In accordance with CEQA, agencies are requested to review the project description provided in this NOP and provide comments on environmental issues related to the statutory responsibility of the agency. Recommendations to consider potential effects on resource areas in addition to the three noted above will be considered by DWR. The Supplemental EIR will be used by DWR when considering approval of the Project.

DWR requests comments be received no later than the close of business on January 12, 2013. Please include a return address and contact name with your comments. Please send comments via mail or email to the address shown below:

California Department of Water Resources
c/o Patty Finfrock
1416 9th Street, Room 1623
Email: pfinfroc@water.ca.gov
Telephone: (916) 651-0851
Fax: (916) 651-9678

PROJECT LOCATION

The Project will be located in the City of Oakley in northeast Contra Costa County (Figure 1). Proposed restoration activities will take place within an approximately 1,178-acre restoration area, which is bounded on the south by the Contra Costa Canal, on the west by Marsh Creek, on the north by Dutch Slough, and on the east by Jersey Island Road. The restoration area encompasses three separate parcels, each of which is protected from flooding by separate levee systems. The three parcels from west to east are the Emerson Parcel (426 acres), Gilbert Parcel (305 acres), and Burroughs Parcel (447 acres). The restoration area also includes two dead end sloughs, Emerson Slough and Little Dutch Slough, and portions of Marsh Creek and Dutch Slough.

Soils to implement some of the proposed restoration activities within the restoration area may be taken from a 56-acre plot owned by the Ironhouse Sanitary District (ISD) and located southwest of the Emerson Parcel (Figure 1).

SUPPLEMENTAL EIR BACKGROUND

For over 100 years, the Dutch Slough property was used for grazing and dairy operations. In the 1990s, as rapid urbanization of eastern Contra Costa County continued to increase, the former landowners began securing approvals for the eventual development of the property. In 2001, the National Heritage Institute (NHI) and DWR identified the Project site as an important restoration opportunity and began working cooperatively with the landowners to obtain grant funding to acquire and restore the property. In 2006, a consultant team led by Philip Williams & Associates (PWA) completed the *Dutch Slough Tidal Marsh Restoration Conceptual Plan and Feasibility Report,* which identified a range of restoration alternatives to meet the habitat restoration and adaptive management goals for the Project. The Feasibility Report, in turn, served as the basis for the alternatives described in the 2010 EIR for the Project.

In the fall of 2010, after approval and certification of the Final EIR, and a decision to implement Alternative 2, Moderate Fill Alternative, DWR collaborated with PWA-ESA to complete detailed

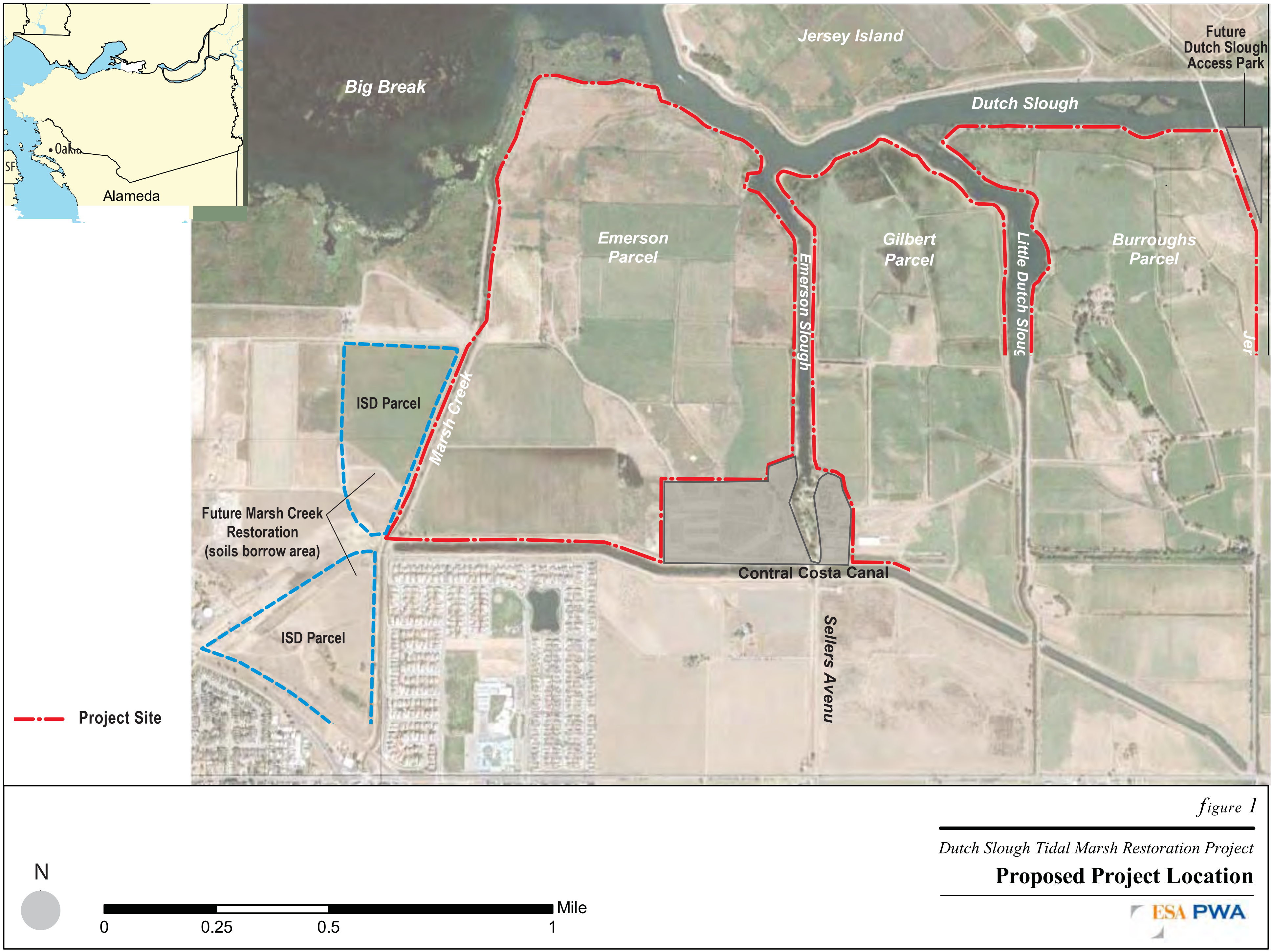


figure 1

Dutch Slough Tidal Marsh Restoration Project

Proposed Project Location

ESA PWA

engineering design for the Project, and to begin the Federal and state permit compliance process to authorize construction of the proposed restoration activities. The changes to be considered in the Supplemental EIR are a result of refined engineering design, project timing, and project-specific feedback provided by the regulatory and resource agencies during formal and informal consultation and permitting.

The 2010 EIR also addressed a proposed City park and an ecological restoration project on the adjacent ISD parcel. Those adjacent projects will not be addressed in the Supplemental EIR.

PROJECT DESCRIPTION

As described in the 2010 EIR, the Project would restore and enhance tidal marsh habitat within a 1,178-acre restoration area, most of which is currently irrigated pasture. Major components of the Project include restoration of tidal and non-tidal marsh habitats, tidal channels, riparian forest, subtidal open water habitat, and native grassland; enhancement of existing managed non-tidal marsh and irrigated pasture habitats, including habitat for California black rail (*Laterallus jamaicensis coturniculus*), giant garter snake (*Thamnopsis gigas*), and Swainson's hawk (*Buteo swainsoni*); protection of neighboring properties and existing infrastructure through construction and rehabilitation of flood protection levees; and development of public access infrastructure. The proposed restoration plan is shown in Figure 2.

As described in the 2010 EIR, restoration activities will be accomplished by excavating soils from high areas across the three parcels and from the ISD parcel, and distributing the soils in low-lying portions of the restoration area. After the restoration area has been graded, the parcels will be inundated to levels suitable for establishing tules (*Schoenoplectus* spp.). Once tules have established (one to two years), the levees that surround the restoration area will be breached in several locations to open the area to tidal influence. In addition, Marsh Creek will be rerouted through the restored marsh plain on the Emerson parcel to a new outlet at Dutch Slough. Little Dutch Slough will also be enlarged to facilitate tidal exchange with restored marshes on the Gilbert and Burroughs parcels.

Subtidal open water will be created in the northern portion of the Emerson parcel where restoration of marsh habitat is not practical due to the high level of subsidence. The existing non-tidal marsh in the northern portion of the Gilbert parcel will be maintained and enhanced to provide habitat for native and sensitive species, such as California black rail and giant garter snake. The northern portion of the Burroughs parcel will be maintained as irrigated pasture and managed to provide enhanced nesting and foraging habitat for Swainson's hawk and other avian species. Other elements of the Project include widening and reconfiguring portions of existing levees to improve levee protection, provide safe public access, and enhance habitat conditions; constructing new flood control levee segments along the southern and eastern Project boundaries; constructing bridges over levee breaches; and relocating and/or protecting existing infrastructure on-site. Figure 3 illustrates the approximate location of these revised components, where appropriate, within the larger restoration area.

Since the certification of the 2010 Final EIR, a number of refinements have been made to the Project design and proposed construction methodologies that may affect the analysis of impacts provided in that document. In addition, new information about cultural resources in the area has been obtained. The following summarizes the Project changes DWR will consider in the Supplemental EIR.

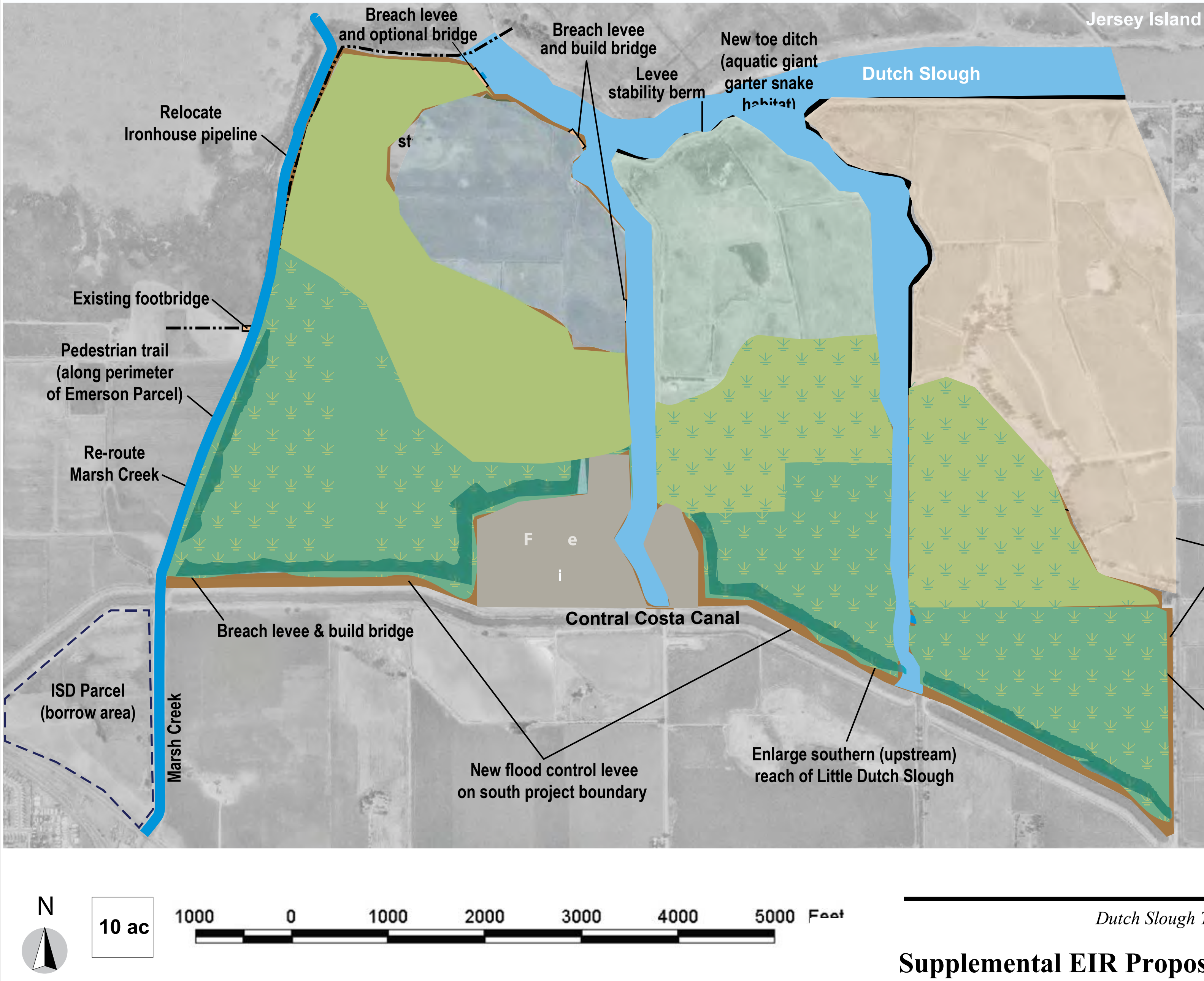


figure 2

Dutch Slough Tidal Marsh Restoration Project

Supplemental EIR Proposed Restoration Plan

ESA PWA

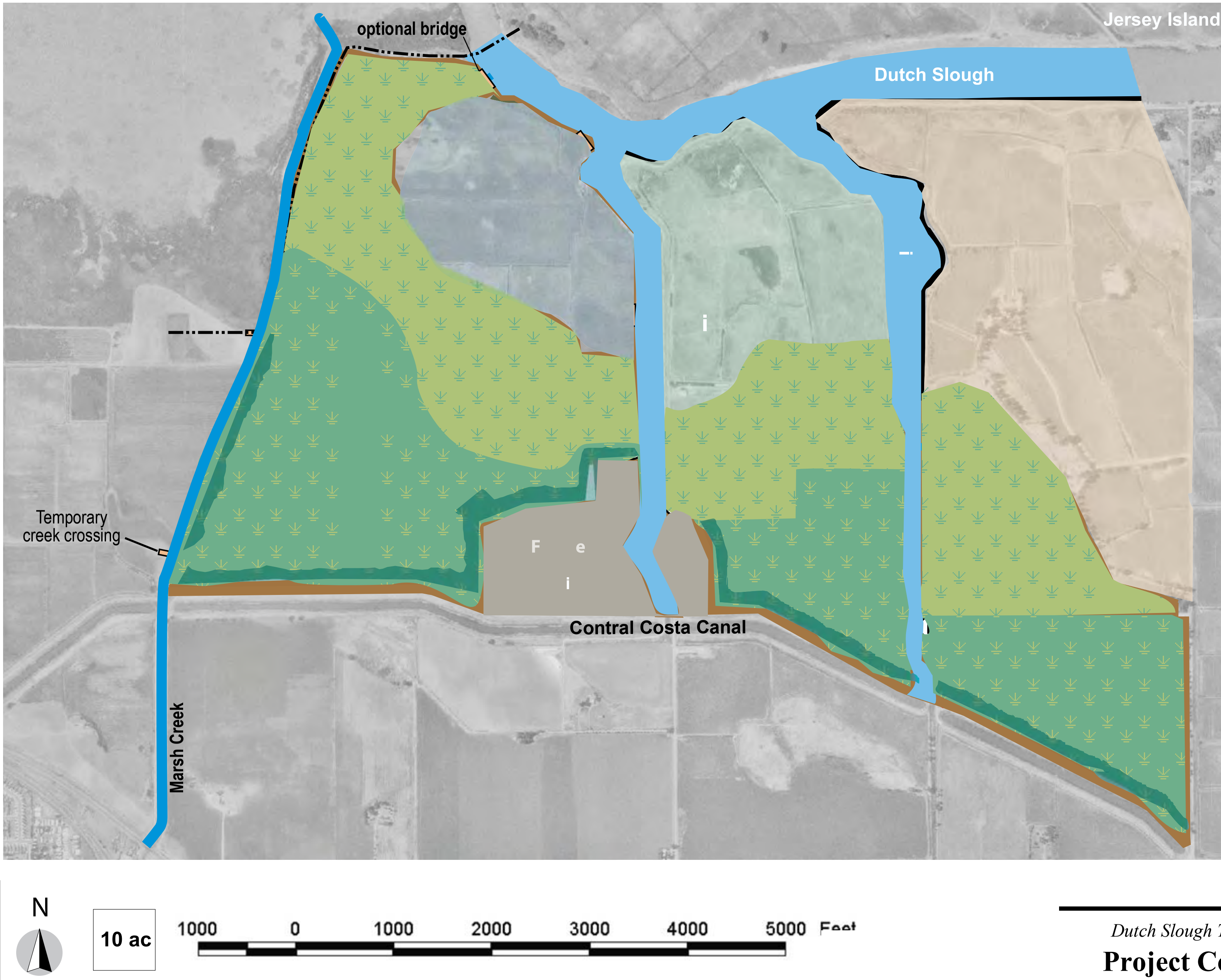


figure 3

Dutch Slough Tidal Marsh Restoration Project

Project Component Revisions Considered in Supplemental EIR

ESA PWA

- DWR is proposing to construct a new flood protection levee along the southern boundary of the restoration area to maintain or improve the existing level of flood protection for properties to the south. The southern flood protection levee, which would generally follow the southern boundary of the Project site, would require crossing Little Dutch Slough and would include installation of a new drainage culvert and flap gate in Little Dutch Slough at the levee crossing.
- DWR is proposing to shift the alignment of the eastern flood protection levee from the eastern Project boundary to an alignment on higher ground, and in a location that reduces cost and fill volumes. The new levee alignment would follow Jersey Island Road on the southern portion of the Burroughs parcel, bisect the parcel between the enhanced irrigated pasture and the restored marsh area, and connect with the existing flood protection levee on the east side of Little Dutch Slough.
- DWR is proposing to remove and replace portions of the existing outboard levee armoring along Dutch Slough, Emerson Slough, and Little Dutch Slough for public safety, stability, and flood protection purposes. Some in-water work would be required to replace armoring located below the mean tide line.
- DWR has refined the proposed management strategy on the northern portion of the Gilbert parcel to reflect management of non-tidal freshwater marsh, which would provide enhanced habitat for California black rail and giant garter snake habitat. Specific components include:
    - Construction of a cross levee to isolate existing freshwater marsh from restored tidal marsh to the south. The levee would bisect the parcel from west to east.
    - Installation of a gated, screened culvert on Emerson Slough to supplement or replace the existing pump on the Gilbert parcel and provide periodic water supply. This culvert, in combination with an existing drainage pump, would be used to manage water levels to encourage natural vegetation recruitment.
    - Construction of a stability berm along the interior of the existing perimeter levee on the north and west sides of the Gilbert parcel to protect the Gilbert levee and isolate the non-tidal managed marsh areas from tidal inundation.
    - Minor grading of the managed non-tidal marsh for habitat enhancement, including excavation of a toe ditch along the northeast interior of the Gilbert levee to enhance giant garter snake habitat, and creation of open water areas to benefit water fowl species.
- DWR has refined the proposed management strategy on the northern portion of the Emerson parcel to include approximately 100-acres of subtidal open water habitat, which would be connected to adjacent tidal channels by breaching the Gilbert perimeter levee in two locations. A wave break / stability berm would be constructed along the perimeter levee to protect against wind-wave erosion.
- DWR has refined the proposed management strategy on the northern portion of the Burroughs parcel to select preservation and enhancement of foraging and nesting habitat for Swainson's hawk and other avian species. Specific components would include planting fast-growing riparian trees and preserving existing mature trees on northern Burroughs, and implementation of management approaches (grazing and mowing) that favor native plants and bird species. A toe ditch

would also be constructed along the northwest corner of the parcel to improve drainage and mosquito abatement in the irrigated pasture.

- DWR has identified a preferred alignment for relocation of the Marsh Creek delta on the Emerson parcel. The existing Marsh Creek levee would be breached at the southwest corner of the parcel and a new channel network would be constructed through the Emerson parcel to discharge into Dutch Slough. The existing tidally influenced reach of Marsh Creek along the western perimeter of the Emerson parcel would remain as is.
- DWR is considering modifying the loop trail that was proposed around the Emerson parcel to include two separate destination trails extending along the perimeter of the parcel, and that end on either side of the Marsh Creek outlet breach (i.e., no bridge over the outlet breach would be constructed).
- DWR has revised the proposed in-water construction methodology for several Project components:
  - To allow transport of borrow material from the ISD parcel to the Emerson parcel, the 2010 EIR considered construction of a temporary bridge over Marsh Creek at the southwest corner of the restoration area. Based on engineering and cost studies, DWR is now proposing to construct a temporary earthen berm outfitted with three culverts in Marsh Creek, rather than a bridge. This construction method would require installation of a cofferdam and temporary dewatering of a portion of Marsh Creek.
  - DWR is proposing to change the method for enlarging the southern reach of Little Dutch Slough from in-water dredging to excavation in the dry after installation of a cofferdam and dewatering the southern end of the slough. This revised approach would minimize water quality and turbidity impacts, and allow concurrent construction of several Project components.
  - DWR is proposing to install temporary fish screens on water supply intakes that would be used for tule management. These include three existing pumps located on the southwest corners of the Gilbert and Burroughs parcels, and the southeast corner of the Emerson parcel.
- The 2010 EIR included a mitigation measure (Mitigation 3.1.1-5) that stated breaching of the Dutch Slough Project levees would not commence until encasement of the Contra Costa Canal had been completed. The Project now proposes to potentially breach the levees prior to encasement of the Contra Costa Canal.
- New cultural resources studies of the site identified additional resources that may be affected by Project construction.

DISCUSSION OF POTENTIAL IMPACTS

The Supplemental EIR will assess the environmental effects that would likely result from construction and operation of the Project, including direct, indirect, and cumulative impacts that would be different than those previously described in the 2010 EIR. As noted above, DWR anticipates the proposed changes to the Project considered in the Supplemental EIR may result in changes to impacts on three environmental resource areas: biological resources, hydrology and water quality, and cultural resources. These potential impacts are summarized below. It is important to note that because the Project as currently proposed reflects a modified iteration of Alternative 2, Moderate Fill Alternative, from the 2010 EIR, the analysis of impacts presented in the Supplemental EIR will be focused on impacts associated only with that alternative.

As noted above, the 2010 EIR also addressed two related projects, the City of Oakley's Community Park and ISD's proposed restoration of creek and wetlands habitat on an adjacent site. No changes are being proposed for those projects at this time, and they will not be addressed in the Supplemental EIR.

Hydrology and Water Quality

The Supplemental EIR will consider the proposed changes in the Project design, and determine if any new or additional impacts to hydrology or water quality may result from these changes. A key assessment in the Supplemental EIR will be potential impacts to water quality in the Contra Costa Canal if the Project is constructed before the canal is encased. The Supplemental EIR also will review the changes in the Project to determine if they would alter the 2010 EIR's identified Project impacts with respect to groundwater intrusion, tidal prism, levee overtopping, flood flow conveyance, sea level rise, erosion/sedimentation, salinity of groundwater, endocrine-disrupting chemicals, dissolved organic carbon, and mercury methylation.

Biological Resources

The Supplemental EIR will consider impacts of the proposed changes in the Project design to terrestrial and aquatic species and determine if any new or additional impacts to biological resources may result from these changes. A key assessment in the Supplemental EIR will be potential impacts to aquatic species resulting from the installation of temporary cofferdams on Little Dutch Slough and Marsh Creek during construction, as well as Project design revisions on the northern portion of the Gilbert parcel targeted at improving habitat for giant garter snake and California black rail.

The Supplemental EIR also will review the changes in the Project to determine if they would alter the 2010 EIR's identified Project impacts with respect to disturbing or eliminating existing freshwater marsh and seasonal wetlands, riparian woodland/scrub, and/or upland habitat for foraging raptors; creation of habitat for non-native fishes; entrainment of fish into water intake systems during construction; and injury or displacement of fish during levee repair, or from water quality degradation during construction. Changes in the 2010 EIR's identified impacts on special-status species, including Swainson's hawk, California black rail, giant garter snake, salmonids, delta smelt (*Hypomesus transpacificus*), and green sturgeon (*Acipsenser medirostris)*, will be assessed.

Cultural Resources

Since publication of the 2010 Final EIR, a Native American burial site was discovered on the Gilbert parcel and additional archaeological studies have been conducted on the Project site. The Supplemental EIR will consider changes to potential impacts to this resource and proposed mitigation measures.

RESPONSES TO NOTICE OF PREPARATION

From: Jim Starr [mailto:Jim.Starr@wildlife.ca.gov]
Sent: Monday, January 14, 2013 4:40 PM
To: Finfrock, Patricia@DWR
Cc: Crystal Spurr; Debbie Hultman
Subject: Dutch Slough CEQA Comment Email

Patty,

Here are the California Department of Fish and Wildlife comments on the supplemental EIR for the Dutch Slough Project.

The California Department of Fish and Wildlife (CDFW) has reviewed the Notice of Preparation (NOP) for the Dutch Slough Tidal Marsh Restoration Project Supplemental Environmental Impact Report (Supplemental EIR). The Department of Water Resources (DWR) indicated in the NOP that "Since certification of the Final EIR, modifications to the Project design and construction methodology, and updated information specific to cultural resources in the Project area, have been identified."

The project proposes to restore and enhance tidal marsh habitat within a 1,178-acre restoration area owned by DWR in Contra Costa County. The project area is bounded on the south by Contra Costa Canal, on the west by Marsh Creek, on the north by Dutch Slough, and on the east by Jersey Island Road. The project would restore tidal marsh and riparian habitats in an area encompassing three parcels (Emerson Parcel, Gilbert Parcel, and Burroughs Parcel) to improve conditions for native fishes and other aquatic and wetland species, provide an improved understanding of restoration science in tidal marsh wetland ecosystems in the region, and provide public access to the restored area.

CDFW is providing comments on the Supplemental EIR as a Trustee Agency and Responsible Agency. As Trustee for the State's fish and wildlife resources, CDFW has jurisdiction over the conservation, protection and management of the fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species for the benefit and use by the people of California. CDFW is also considered a responsible agency if a project would require a discretionary approval, such as a California Endangered Species Act (CESA) Permit pursuant to Fish and Game Code sections 2080 et seq., or a Lake and Streambed Alteration Agreement (LSAA) pursuant to FGC Section 1600 et seq.

The DWR is currently consulting with CDFW on the preparation of a Streambed Alteration Agreement (SAA) and Incidental Take Permit (ITP) for the Dutch Slough Tidal Marsh Restoration Project. The CDFW as a responsible agency under CEQA will consider the Supplemental EIR for the project when issuing the SAA and ITP.

The CDFW has previously comments on January 21, 2009 on the Draft EIR dated November 2008 for the Dutch Slough Tidal Marsh Restoration Project. The CDFW offers this one comment to the DWR and that is to encourage retention of large trees on the project site suitable for nesting raptors, particularly Swainson's hawk.

If you have any questions, please contact Ms. Crystal Spurr, Senior Environmental Scientist, at (209) 948-3777.
Sincerely,

Jim Starr

Jim Starr
Environmental Program Manager I
209-941-1944(Office#)
209-948-7800 (Main Office#)
209-946-6355 (Facsimile#)
4001 North Wilson Way, Stockton, CA 95205
jim.starr@wildlife.ca.gov

Please note that as of Jan 1, 2013, our new name is the California Department of Fish and Wildlife (CDFW) and new department web and email addresses took effect.

CONTRA COSTA
WATER DISTRICT

1331 Concord Avenue
P.O. Box H2O
Concord, CA 94524
(925) 688-8000 FAX (925) 688-8122
www.ccwater.com

January 14, 2013

Patty Finfrock
Department of Water Resources
Delta-Suisun Marsh Office
1416 9th Street, Room 1623
Sacramento, CA 95814

Subject: Contra Costa Water District comments on Notice of Preparation of the Supplemental Environmental Impact Report for the Dutch Slough Tidal Marsh Restoration Project

Dear ~~Ms. Finfrock~~: Patty -

Contra Costa Water District (CCWD) appreciates the opportunity to comment on the Notice of Preparation (NOP) of the Supplemental Environmental Impact Report (SEIR) for the Dutch Slough Tidal Marsh Restoration Project (DSTMRP).

CCWD provides drinking water for 450,000 people in central and eastern Contra Costa County. It is CCWD's highest priority to protect the safety and quality of water delivered to our customers.

CCWD's water conveyance system includes the Contra Costa Canal, constructed by the United States Bureau of Reclamation in 1939. The Canal carries water from CCWD's Rock Slough Delta intake and pumping station to CCWD's water treatment plants and service area. The upstream 4 miles of the Canal, including the segment directly adjacent to the proposed DSTMRP, is unlined, i.e. it is an open earthen canal that is subject to groundwater intrusion. Activities on adjacent land that will change the quantity or quality of groundwater that seeps into the unlined Contra Costa Canal can and do adversely affect the water quality in the Canal.

From inception of the DSTMRP, CCWD has expressed its concerns about impacts on its drinking water quality from the DSTMRP. The NOP lists assessment of "potential impacts to water quality in the Contra Costa Canal if the Project is constructed before the canal is encased" as a key element of the SEIR. In response to concerns expressed by CCWD, Mitigation Measure 3.1.1-5 from the 2010 DSTMRP EIR provides that "*to avoid potential negative impacts to water quality within the Contra Costa Canal from groundwater intrusion, breaching of the Dutch Slough project site will not commence until encasement of the Canal south of the site is complete.*" We understand from conversations with you that the Department of Water Resources (DWR) may be attempting to remove this measure from Project mitigation in the SEIR; if this is done, the DSTMRP will have potentially significant impacts on the quality of the water in CCWD's Contra Costa Canal. The Canal segment adjacent to the DSTMRP has not been encased, and as the prior EIR recognized, it is impossible to rule out the potential for adverse effects on drinking water quality from groundwater intrusion regardless of how many additional studies are conducted.

The best solution to this problem would be to encase the portion of the Canal adjacent to the DSTMRP in a pipe before water quality impacts arise. As you know, CCWD has completed the first segment of a project to encase the unlined portion of the Contra Costa Canal (Canal Project). We have received a Proposition 1E Round 1 Stormwater Flood Management Grant to encase the next segment of the Canal, and are now working with DWR to amend that grant agreement so that the funds can be used to encase the portion of the Canal adjacent to the Emerson Parcel, where Phase 1 work on the DSTMRP is scheduled to begin. If the grant is amended, DWR and CCWD can coordinate our Project schedules to allow us both to proceed without impacts on drinking water quality from the DSTMRP. Later DSTMRP phases and Canal Project segments could be similarly coordinated. The mitigation measure identified in the EIR remains feasible, and should not be eliminated.

The SEIR must include analysis of the DSTMRP's potential impacts due to groundwater intrusion into the Contra Costa Canal, as well as those due to increased seawater intrusion into the Delta. We offer the following comments on the water quality analysis to be included in the SEIR:

Groundwater Intrusion

The SEIR analysis of Canal water quality impacts should include consideration of the following issues:

- **Historical Water Quality Degradation in the Contra Costa Canal**
  Historical observations and reports indicate that the soils along the Canal are highly conductive, and that groundwater intrusion from adjacent properties is a significant source of salinity and other constituents that degrade water quality in the Canal. Parameters assumed for the DSTMRP water quality analysis must be tested against the historical data.
- **Evaluation of Groundwater Intrusion on a Sub-Tidal Timescale**
  Analyzing groundwater intrusion from the DSTMRP into the Contra Costa Canal on a monthly or daily time step can correctly approximate the net flow of water to the Canal while underestimating the net movement of salt into the Canal. The difference in water surface elevation between the Canal and the groundwater drives the net flux of water into and out of the Canal; however the difference in salinity concentration between groundwater and Canal water drives the net flux of salt. If, for example, the daily average water surface elevation in the Canal is equal to the adjacent groundwater elevation, the net flow of water into the Canal over the day will be zero whether it is calculated on an hourly or daily basis. However there would be a net increase of salt in the Canal: when the Canal water surface is lower than the groundwater elevation, high-salinity water enters the Canal, but when the

Canal water surface is higher than the groundwater, lower-salinity water will flow back into the ground, leaving a net gain of salt in the Canal. The evaluation of water quality impacts from groundwater intrusion into the Contra Costa Canal should be done on an hourly time step to focus on the net flux of salt.

- **Impacts of Water Quality Degradation in Contra Costa Canal**
  Degradation of water quality in the Contra Costa Canal impacts drinking water quality, and also results in changes to CCWD operations and statewide CVP/SWP operations. The impacts to Delta water quality, water supply, and fisheries from changes in CCWD and CVP/SWP operations due to groundwater intrusion into the Contra Costa Canal should be evaluated in the SEIR.
  In addition, CCWD has encased a portion of the unlined Contra Costa Canal at a cost of 19 million dollars and is preparing to encase another portion at a cost of 20 million dollars, with funding from CCWD and State and federal grants. If the groundwater intrusion from the DSTMRP degrades the water quality in the Canal, the benefits achieved by these investments will be diminished.

A more detailed discussion of these issues is included as Attachment 1 to this letter.

Seawater Intrusion
The SEIR should include analysis of the potential for the DSTMRP to cause increased seawater intrusion into the Delta, leading to Delta-wide impacts on drinking water quality and aquatic resources. In the DSTMRP Final EIR, this impact[1] was found to be insignificant, but no modeling analysis was performed. However, modeling analysis of tidal marsh restoration projects similar to the DSTMRP have shown that they can cause significant increases in Delta salinity; see Attachment 2 for a discussion of impacts disclosed in the November 2011 Suisun Marsh Habitat Management, Preservation, and Restoration EIR. Increases in Delta salinity can adversely impact CCWD's water quality, water supply, power usage and greenhouse gas emissions; the City of Antioch's Delta diversions; the operations of the State Water Project and Central Valley Project; and aquatic species in the low salinity zone. These impacts should be analyzed.

Sincerely,

Leah Orloff
Water Resources Manager

LO/MM:wec

Attachments

---

[1] Impact 3.2.1-5: Degradation of Drinking Water Quality Due to Alteration to Salinity Levels in Delta Waters

ATTACHMENT 1
ANALYSIS OF GROUNDWATER INTRUSION IMPACTS

Historical Water Quality Degradation in Contra Costa Canal

Historical observations and reports indicate that the soils along the Canal are highly conductive and groundwater intrusion from adjacent properties has been identified as a significant source of salinity and other compounds that degrade water quality in the Canal. Historical land use practices adjacent to the Canal, specifically land disposal of waste water from the Ironhouse Sanitation District, elevated groundwater levels on the adjacent lands relative to the water level in the Canal and created a net flow of groundwater into the Canal. CCWD has worked with the Ironhouse Sanitation District to reach an agreement that limits the amount of water applied to land directly adjacent to the Canal. The DSTMRP would raise groundwater levels relative to the Canal and create a similar situation on the Dutch Slough properties, undermining the water quality benefits that have been achieved through previous cooperative efforts.

Evaluation of Groundwater Intrusion on a Sub-Tidal Timescale

The supplemental EIR should evaluate the potential water quality impact in the Canal associated with increasing groundwater on a sub-tidal timescale. The difference in water surface elevation between the Canal and the groundwater drives fluxes into and out of the Canal. The water surface elevation in the Canal varies up to 4 feet with the tides. If the groundwater on the Dutch Slough properties is at mean tidal level (as proposed in the final design of DSTMRP), the water flux into and out of the Canal approximately averages out to zero over the tidal cycle. However, the net salt flux over the same period does not average out to zero over the tidal cycle because the groundwater is significantly saltier than the water in the Canal. This leads to persistent flux of salt into the Canal even when there is not a significant water flux into the Canal on a long term basis. The supplemental EIR should evaluate the *salt* flux, not just the water flux, on a sub-tidal time step to avoid underestimating the true water quality impact in the unlined Canal.

Impacts Associated with Water Quality Degradation in Contra Costa Canal

Water quality in the Contra Costa Canal affects both CCWD operations and statewide CVP/SWP operations; increases in Canal salinity are offset by increased water and power usage on a local a statewide basis. CCWD operates to meet a water quality goal for water delivered to customers; the current water quality delivery goal is 65 mg/L of chlorides. Under most conditions, the response to an increase in Canal salinity would be to decrease diversions at Rock Slough, and to increase diversions at other CCWD intakes or increase releases from Los Vaqueros Reservoir, which in turn would change the location of Delta diversions, increase power usage, and increase greenhouse gas emissions. In addition, there are also conditions when water quality in the Canal affects State Water Project and federal Central Valley Project operations. The state and federal water projects are required to meet the water quality objectives defined in California State Water Resources Control Board Decision 1641 that specify that water quality in the Contra Costa Canal as measured at Pumping Plant 1 (PP1) must be below 150 mg/L chlorides for a minimum of 155 days per year and up to 240 days per year, depending on water year type, and that water quality at municipal intakes must be below 250 mg/L chlorides at all times to comply with secondary MCL standards designated by the Department of Public Health. Compliance with these standards may dictate releases from SWP or CVP upstream reservoirs, particularly during the late fall when seawater intrusion into the Delta is relatively high. Because compliance is measured at PP1, which is at the downstream end of the unlined Canal, degradation incurred along the unlined portion of the Canal makes it more difficult to meet the standards and can result in increased releases from upstream reservoirs. If DSTMRP precedes the Canal encasement and groundwater intrusion degrades Canal water quality, CCWD and CVP/SWP operations could be impacted such that more water and more power is required to offset the effects of the groundwater intrusion.

CCWD has taken steps towards limiting groundwater intrusion into the Canal. CCWD has designed and approved a program to encase the entire 21,000 feet of Canal; however, only a portion of the Canal has been encased to date. In 2009, CCWD encased 1,900 feet of the Canal between Pumping Plant 1 and Marsh Creek adjacent to the Ironhouse Sanitation District facility. Construction of this segment cost nearly $20M. CCWD is preparing to encase an additional 7,000 feet of the Canal at an additional cost of $20M. CCWD is also trying to secure funding to encase the remaining portion of the unlined Canal. If the DSTMRP precedes the completion of the Canal encasement and groundwater intrusion deteriorates the quality in the Canal, the benefits achieved by the investment made to date will be diminished and as a result CCWD and the CVP/SWP will incur ongoing additional costs in terms of water and power to offset the degradation.

ATTACHMENT 2
ANALYSIS OF SEAWATER INTRUSION IMPACTS

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan Environmental Impact Report was finalized in November 2011. The Suisun Marsh EIR modeled the hydrodynamic and salinity consequences of several different tidal marsh restoration scenarios. Some of the hydrodynamic modeling showed that creating tidal wetlands in Suisun Bay approximately 2,000 – 3,000 acres in size with a bottom elevation of -4ft NGVD could significantly increase salinity in the western Delta including the salinity at CCWD's intakes by as much as 150 µS/cm, or up to 12%. A salinity increase of this magnitude would significantly impact CCWD water quality and potentially impact CCWD and CVP/SWP as described above in Attachment 1.

DSTMRP proposes to create a similar type of habitat at a similar elevation but on a smaller scale, approximately 1,000 acres. Given the similarities of the proposed restoration habitat types and the significant water quality impacts of the Suisun Marsh scenarios modeled, the SEIR should evaluate changes in Delta salinity that might occur as a result of the habitat restoration activities proposed in the DSTMRP.

APPENDIX B: CONTRA COSTA CANAL SEEPAGE STUDY

HYDROFOCUS INC.

Solutions for Land and Water Resources

ANALYSIS OF SEEPAGE AND TOTAL DISSOLVED SOLIDS AND CHLORIDE LOADING TO CONTRA COSTA CANAL, FINAL DRAFT

February 1, 2013

By

HydroFocus, Inc., Davis, California

John Fio, Principal Hydrologist

Steven Deverel, P.G., Principal Hydrologist

For

California Department of Water Resources, Reclamation District 2137 and ESA-PWA

ANALYSIS OF SEEPAGE AND TOTAL DISSOLVED SOLIDS AND CHLORIDE LOADING TO CONTRA COSTA CANAL

HydroFocus, Inc., February 1, 2013

Contents

List of Figures

Figure 15. Estimated Monthly Groundwater Chloride Loads to the Contra Costa Canal for
Figure 16. Estimated Daily Total Dissolved Solids Concentration Increases in the Contra Costa Canal for Tule Cultivaiton and Project.
Figure 17. Estimated Percent Daily Increase in TDS Concentrations in the Contra Costa Canal During Tule Cultivation and the Project.

EXECUTIVE SUMMARY

The unlined Contra Costa Canal is incised within shallow water-bearing sediments, and the water in the canal is hydraulically connected to the adjacent groundwater. The Dutch Slough project plans to restore tidal marsh in the land parcels north of the canal approximately east of Marsh Creek to Jersey Island Road. As a result, the hydraulic gradients between the canal and planned marsh area will change relative to existing conditions. Accordingly, the flux of water in and out of the canal will also change due to altered hydraulic gradients.

This report describes calculated seepage and leakage rates for the canal reach between Marsh Creek and Jersey Island Road (the Dutch Slough study area). We utilized estimated canal stage and geohydrologic data to calculate the net flux of water and dissolved constituents into and out of the canal under variable hydrologic conditions.

When mean canal stage and groundwater levels are approximately equal, the continuously fluctuating canal water level induces cyclic changes in the seepage and leakage rates. For example during high-tide, when canal water levels are relatively higher than the adjacent shallow groundwater, canal water leaks to groundwater. In contrast, during low-tide and when canal water levels are below the adjacent groundwater level, the flow direction reverses and induces an equal volume of groundwater to seep into the canal. In this hypothetical scenario, the mean or net movement of water between canal and groundwater during a complete tidal cycle is therefore essentially zero. Alternatively, when adjacent mean groundwater levels are consistently greater or lower than canal stage, the instantaneous flux rate changes with the tides but the net direction of water movement over the tidal cycle does not. Under this latter scenario, the longer temporal scale changes (for example, monthly or seasonal transients) and their influence on mean groundwater levels and gradients determine the net flux of water between the canal and groundwater over time.

We initially utilized measured hydraulic conductivity values, mean estimated canal stage, and mean observed groundwater elevations to calculate monthly seepage and leakage. Available boring logs for monitoring wells indicate a shallow water-bearing zone comprised of silty sand deposits with silt and clay layers overlain by a clay cap that is 4- to 7-feet thick. Previously reported aquifer test results for shallow wells in similar materials located at nearby Ironhouse Sanitary District indicate hydraulic conductivity values that range from 0.5 to 6.5 feet per day. We utilized this range of hydraulic conductivity values for our analysis, and assumed the saturated thickness of the adjacent sediments that horizontally transmit seepage or leakage is 12 feet. Previous agreement of independent Contra Costa Water District and HydroFocus analyses point to the validity of these assumptions. We utilized stage data from Rock Slough to estimate canal stage, and measured water levels in monitoring wells to represent groundwater elevations. Continuous data monitored over time periods spanning the daily tidal cycles were filtered to eliminate tidal effects and calculate monthly mean water levels.

After review of the draft report, we received hourly stage estimates adjacent to the Dutch Slough project from Contra Costa Water District. We used these data to estimate the

effects of the Dutch Slough project on Canal water quality during Water Year 2012. Therefore, we herein present the results of the analysis using the monthly calculations and hourly data. Since the median residence time for the volume of water in the Canal adjacent to the Dutch Slough project is about 19 hours, we averaged the hourly data to estimate daily water quality effects on the Canal. We estimated daily hydraulic gradients based on the difference in water-level elevations in the canal and adjacent wells for each segment based on the monthly or 15-minute groundwater-elevation data

Under existing conditions, almost all of the calculated seepage occurs within the reach east of Marsh Creek to Emerson Slough. Most of the seepage (77-percent) is from the south. From Emerson Slough to Jersey Island Road, a small amount of seepage also occurs in the western portion of the reach nearest the slough, but over most of the reach canal water leaks to groundwater located north and south of the canal. Based on the monthly data, the estimated annual average daily seepage rate ranges from a minimum of 180 ft^3/d (0.002 cfs) to a maximum of about 4,950 ft^3/d (0.058 cfs). The greatest seepage occurred during February when maximum seepage was 6,355 ft^3/d.

Using estimated daily groundwater fluxes to the Canal using the hourly estimated Canal stage data provided by Contra Costa Water District, existing seepage rates ranged from -8,849 to 5,227 ft^3/d. The mean estimated value is -1,219 ft^3/d. Maximum flux values from monthly estimates for the overlapping period are consistently higher than the daily estimates.

We utilized the maximum monthly seepage rates and maximum observed total dissolved solids (TDS) and chloride (Cl) concentrations in monitoring well samples to estimate the resulting TDS and Cl load to the canal. Under existing conditions and using the result of monthly calculations, seepage transmits a maximum load of 839 lbs/d TDS and 120 lbs/d of Cl. Most of the TDS load (98-percent) occurs between Marsh Creek and Emerson Slough, of which 77-percent (644 lbs/d) originates south of the canal.

For the proposed restoration effort, the groundwater elevations beneath land areas flooded by water from Dutch Slough will be greater than the canal stage. Our calculations indicate the maximum annual daily seepage rate increases from about 4,950 ft^3/d to 8,070 ft^3/d (a 63-percent increase). The maximum estimated salt load increases from the existing 839 lbs/d to 1,095 lbs/d TDS, and the maximum Cl load increases from 120 to almost 170 lbs/d. The net increase in TDS load (256 lbs/d) and Cl load (47 lbs/d) is due to increased seepage. However, most of the total TDS load (59-percent) and Cl load (50-percent) originates south of the canal and is independent of marsh restoration.

The Dutch Slough project includes an interim establishment phase whereby the tules will be irrigated. Irrigation will consist of flooding the marsh area and maintaining water level elevations between 4.35 to 5.35 feet (average water level assumed equal to 4.85 feet). Our calculations using monthly data indicate that irrigation increases maximum average daily seepage from the existing 4,953 ft^3/d to 11,672 ft^3/d (an increase of 6,719 ft^3/d). The total salt load in the seepage increases from the existing 839 lbs/d to 1,476 lbs/d TDS, and the Cl load increases from 120 to 237 lbs/d. A substantial portion of the total TDS load (44-

percent) and Cl load (35-percent) originates in the south, and are therefore independent of tule cultivation.

Reported canal data indicate that during the period May 2008 through May 2012, the average monthly daily TDS and Cl loads were almost 38,650 and 8,680 lbs/d, respectively. Relative to these average loads, project conditions increase TDS and Cl loads in pumped canal water over existing conditions by 0.66 and 0.58 percent, respectively. Similarly, tule cultivation increases TDS and Cl loads 0.99 and 0.77 percent, respectively. Monthly project TDS and Cl estimated load increases range from 0.19 to 1.6 percent, respectively. Monthly tule cultivation TDS and Cl load increases range from 0.14 to 1.1 percent, respectively.

To place these load increases in perspective, we estimated the monthly concentration changes. If the entire monthly load is added to the monthly canal load, project conditions increases TDS concentrations by an average of 1.7 mg/L and Cl concentrations by 0.3 mg/L. Similarly, tule cultivation increases TDS concentrations by an average of 3.5 mg/L and Cl concentrations by 0.6 mg/L. These concentration changes are likely not detectable in canal water samples under normal operations and are below suggested levels of significance indicated previously by Contra Costa Water District.

Using the hourly data indicated that there could be increases in concentration above the CCWD threshold[1] during periods of zero and/or minimal Canal flow when residence times are greater that about 48 hours. For project conditions using daily and hourly data, the estimated average TDS concentration increase was 1.7 mg/L and ranged -1 to 17 mg/L. Greatly increased concentrations occurred during November, January and early February and April due to zero or minimal flow in the Canal. For tule cultivation, the estimated daily concentration increase for the high water scenario averaged 8 mg/L and ranged from a minimum of 0 to a maximum of 77 mg/L. For additional tule cultivation scenarios, results were as follows for estimated average TDS concentration increases: 5.4, 4.0 and 2.4 mg/L for the average water level scenario with and without Burroughs and the low water-level scenario without Burroughs, respectively. Tule cultivation solely on Gilbert results in maximum concentration increases that we less than 26 mg/L relative to existing conditions. Peak concentration increases for all tule cultivation scenarios corresponded to when there was minimal or zero flow in the Canal.

The daily estimated percent Canal TDS concentration increase for tule cultivation and project conditions were 3 % or less for all scenarios (including Project conditions) except when there was minimal or zero flow in the Canal. For Project conditions, the maximum TDS concentration increase of 4.5 % would occur during late April after a month of low or zero flow conditions. The average TDS concentration for Project conditions increase was 0.6 %. For tule cultivation with the high-water scenario, we estimated a maximum increase of 21.5 % and an average increase of 3.0 %. For average water levels with and without Burroughs and low water levels without Burroughs, estimated maximum concentration increases during April were 14.0, 10.3 and 6.4 %, respectively. For high, average and low

[1] Letter to Patty Quickert from Leah Orloff, Contra Costa Water District, February 17, 2009 providing comments on the Draft EIR for the Dutch Slough Project stated "CCWD earlier suggested that an increase in chlorides of the greater than 5 mg?l chlorides or 5 % of baseline salinity (baseline established by the monitoring prior to opening to tidal action should be used as the appropriate threshold."

water for Emerson and Gilbert only, the average percent increases relative to existing conditions ranged from 0.3 to 1.4 percent. The maximum percent concentration increase ranged from 3 to 11 percent. We estimated that tule cultivation solely on Gilbert will result in maximum concentration increases of 5 % or less.

Our seepage and load calculations utilized observed hydrogeologic and water quality data extrapolated over six canal segments having relative distances equivalent to 15- to 48-percent of the total canal length in the Dutch Slough Study Area. There are no site specific hydraulic conductivity estimates, and canal stage is not measured. Lastly, our seepage calculations assume one-dimensional horizontal flow from beneath the project area to the canal, which ignores variability in hydraulic gradients along flow paths between the canal and groundwater. Our monthly analysis therefore determined a range in seepage and loads based solely on uncertainty in hydraulic conductivity and canal stage.   For the daily estimates, we used a hydraulic conductivity value of 6 feet per day and gradients estimated from Canal stage and groundwater elevations data. Site specific conductivity estimates and measured canal stage can substantially reduce seepage uncertainty.

INTRODUCTION

The earthen, unlined Contra Costa Canal (Canal) supplies untreated water for Contra Costa Water District. We herein report seepage and leakage analysis results for the canal reach between Marsh Creek and Jersey Island Road (the Dutch Slough study area). The canal and general features in the Dutch Slough study area are shown in **Figure 1**.

The unlined canal is incised within Holocene and upper Pleistocene alluvial and eolian sediments that form the shallow water-bearing deposits. Surface water in the canal is hydraulically connected to groundwater from its inlet located at Rock Slough to Marsh Creek. Along canal reaches where adjacent mean groundwater elevations are greater than the mean canal stage, groundwater and dissolved constituents can seep into the canal. In reaches where mean canal stage is greater than adjacent groundwater, surface water and dissolved constituents can leak into the adjacent shallow aquifer.

We utilized estimated canal stage and measured groundwater data (well boring logs, water levels, hydraulic conductivity, and TDS and Cl concentrations in monitoring well samples) to calculate the net flux of water and dissolved constituents into and out of the canal under variable hydrologic conditions. The July 17, 2012 draft report utilized a historical relation for Canal and Rock Slough stage to estimate monthly groundwater flow and loads of total dissolved solids (TDS) and chloride (Cl) to and from the Canal. Review of that report by Contra Costa Water District staff resulted in the revelation of more recent data that required consideration and additional analysis. These data include estimated hourly stage and canal volume and water-level data collected during canal drawdown in 2007. We have analyzed these data and the results have been appropriately incorporated into this report.

DATA

Canal Stage

East of the Dutch Slough project area, stage is measured and recorded near the canal intake located at Rock Slough. However, stage is not currently monitored within the portion of the canal adjacent to the Dutch Slough project. We used two data sets for estimated values for canal water surface elevation (stage). First, previously as part of Ironhouse Sanitary District's Beneficial Use Impact Study,[2] HydroFocus deployed a pressure transducer to monitor changes in canal stage on 15-minute intervals (September 2002 to August 2003). Their monitoring location was west of Marsh Creek and near Pumping Plant 1 (**Figure 1** shows the approximate transducer location). We analyzed the HydroFocus stage data to assess the Rock Slough stage data for estimating canal stage. Second, Contra Costa Water District (CCWD) provided hourly estimates for stage using a HEC-RAS model for Water Year 2012.[3] These data are shown in Figure 2.

[2] HydroFocus, 2003, "Beneficial Use Impact Study, Ironhouse Sanitary District, Oakley, California."
[3] Maureen Martin, CCWD, 2012, Memo to Leah Orloff, 11/26/2012, Review of Potential Water Quality Impacts to Canal Associated with Implementation of Dutch Slough Tidal Restoration Project.

Canal water levels are influenced by stage at Rock Slough, pumping at Contra Costa Water District Pumping Plant 1, and tidal fluctuations. The predominant tidal fluctuations are the semi-diurnal (every 12 hours and 25 minutes) and diurnal cycles (every 24 hours and 50 minutes). Groundwater that is hydraulically connected to the canal is also affected by tides. The magnitude of the tidal influence is determined by the water transmitting and storage properties of the shallow sediments. Additional factors that influence canal stage and groundwater elevations include barometric pressure changes, rainfall, and land and water use activities such as irrigation and drainage.

Comparisons between HydroFocus' measured canal stage near Pumping Plant 1 and the reported stage at Rock Slough indicate a similar tidal response in the canal to Rock Slough but lagged in time by about 90 to 105 minutes. We lagged the Rock Slough stage data and employed a 25-hr moving average to smooth the data and remove most of the lunar and solar tide frequencies (**Figure 3a**).[4] We then calculated the differences between mean daily canal and Rock Slough stages (**Figure 3b**). Canal stage was always lower than at Rock Slough, and the difference was temporally variable; canal stage was 0.4 to over 1.0 foot lower than Rock Slough stage, with an average difference of 0.76 feet. Estimating the canal stage from Rock Slough data is therefore a source of uncertainty in the seepage analysis.

Groundwater

Seven shallow monitoring wells are located adjacent to the unlined canal from Marsh Creek to Jersey Island Road (**Figure 1**). Four of the seven wells are located 370 to 470 feet north of the canal, and the three remaining wells are located 70 to 340 feet south of the canal. Two of the northerly wells (Emerson 2 and Burroughs 1) are instrumented with transducers that measure and record water levels every 15-minutes. One of the southerly wells (Gilbert 3) is also instrumented with a transducer. The water levels in the other four wells (Emerson 1, Gilbert 2, PZ-1, and PZ-2) have been measured approximately monthly by hand using an electronic sounder.

The transducer data show that shallow groundwater responds to the tidally induced changes in canal stage, but the responses are time delayed and substantially lower in magnitude. Like the canal and slough data, we filtered the monitoring well data to remove the tidal effects. The other four wells have only point-in-time measurements collected approximately monthly using a sounder, and we used the hand-measured water levels directly. Below is a summary of water level observations at the transducer-equipped monitoring wells.

Emerson 2

Figure 4 compares Rock Slough stage, estimated canal stage, and groundwater elevations in the Emerson 2 monitoring well. A portion of the raw data is plotted in **Figure 4a** and shows that tidally induced groundwater level changes are transmitted through the shallow aquifer and affect groundwater levels in Emerson 2. The timing and amplitude of the groundwater

---

[4] Michael E. Serfes, 1991, "Determining the Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations," Journal of Groundwater, vol. 29, no. 4, pp. 549-555.

response is delayed and damped owing to the well's distance from the canal and the water storage and transmitting properties of the intervening shallow aquifer.

The filtered canal stage (estimated as Rock Slough stage less 0.8 feet) and filtered well data are plotted in **Figure 4b**. **Figure 4b** also includes manual measurements collected in the Emerson 1 monitoring well (also located north of the canal). Most of the record from Emerson 1 indicates groundwater elevations generally similar to or greater than at Emerson 2. Estimated canal stage was usually lower than water levels in Emerson 1 and 2 indicating seepage of groundwater into the canal.

Figure 4 also includes manual measurements collected in the PZ-1 and PZ-2 monitoring wells located south of the canal. The water levels in PZ-1 were similar to or greater than the estimated canal stage, whereas the water levels in PZ-2 were lower than or similar to estimated canal stage up until about December 2011. Because PZ-1 is located near the western most edge of the unlined canal and near the siphon that transports canal water beneath Marsh Creek, for the purposes of our seepage analysis we utilized average water levels in PZ-1 and -2 to represent groundwater elevations south of the canal between Marsh Creek and Emerson Slough (see **Figure 1** for monitoring well locations relative to the Canal, and Marsh Creek).

Figure 4 shows the canal stage estimated as 0.8 feet less than the stage at Rock Slough. However, the actual canal stage could be greater or less than shown In **Figure 4**. Our seepage calculations therefore consider a potential range in estimated canal stage from 0.4 to 1.0 feet less than the measured stage at Rock Slough.

Gilbert 3

Figure 5 compares Rock Slough stage, estimated canal stage, and water levels in the Gilbert 3 monitoring well. A portion of the raw data is plotted in **Figure 5a** and shows that tidally induced water level changes in the canal are transmitted through the shallow aquifer and effect groundwater levels in Gilbert 3. The timing and amplitude of the groundwater response is delayed and damped owing to the well's distance from the canal and the water storage and transmitting properties of the intervening shallow aquifer. The filtered canal stage (estimated as Rock Slough stage less 0.8 feet) and well data are plotted in **Figure 5b**. The estimated canal stage was almost always greater than the groundwater elevation in the Gilbert 3 well, indicating leakage from the canal to groundwater south of the canal.

Figure 5 also includes the manual measurements collected in the Gilbert 2 monitoring well, which is located approximately across the canal from Gilbert 3 (Gilbert 2 is located north of the canal as shown in **Figure 1**). The manually measured water levels in Gilbert 2 indicate greater groundwater elevations north of the canal than south of the canal in Gilbert 3. Prior to November 2011, the northerly groundwater levels were often greater than the estimated canal stage indicating seepage of groundwater into the canal. After November 2011, the northerly groundwater levels were generally similar to the estimated canal stage.

Figure 5 shows the canal stage estimated as 0.8 feet less than the stage at Rock Slough. However, the actual canal stage could be greater or less than shown In **Figure 4**. Our seepage calculations therefore consider a potential range in estimated canal stage from 0.4 to 1.0 feet less than the measured stage at Rock Slough.

Burroughs 1

Figure 6 compares Rock Slough stage, estimated canal stage, and water levels in the Burroughs 1 monitoring well. A portion of the raw data is plotted in **Figure 6a** and shows that tidally induced water level changes in the canal are transmitted through the shallow aquifer and effect groundwater levels. The timing and amplitude of the groundwater response is delayed and damped owing to the well's distance from the canal and the water storage and transmitting properties of the intervening shallow aquifer.

The filtered canal stage (estimated as Rock Slough stage less 0.8 feet) and well data are plotted in **Figure 6b**. The estimated canal stage is almost always greater than the water level in the Burroughs 1 well, with the exception of relatively short times associated with agricultural activities and rainfall. The actual canal stage is therefore probably greater than groundwater elevations north of the canal indicating leakage from the canal to groundwater. There are no groundwater data southwest of the canal in the vicinity of the Burroughs Parcel. For the purposes of our seepage analysis we assumed hydraulic gradients south of Burroughs 1 are similar to those measured at Gilbert 3.

Figure 6 shows the canal stage estimated as 0.8 feet less than the stage at Rock Slough. However, the actual canal stage could be greater or less than shown In **Figure 5**. Our seepage calculations therefore consider a potential range in estimated canal stage from 0.4 to 1.0 feet less than the measured stage at Rock Slough.

SEEPAGE AND LEAKAGE FOR EXISTING CONDITIONS

Under the hypothetical condition when mean canal stage and groundwater levels are approximately equal, the continuously fluctuating canal water level induces cyclic changes in seepage and leakage. For example during high-tide, when canal water levels are relatively greater than adjacent groundwater, canal water leaks into the shallow aquifer. In contrast, during low-tide and when canal water levels are below the adjacent groundwater, the flow direction reverses and induces an equal volume of groundwater to seep into the canal. In this hypothetical scenario, the mean or net movement of water between canal and groundwater during a complete tidal cycle is essentially zero.

Alternatively, when adjacent mean groundwater levels are consistently greater or lower than canal stage, the instantaneous flux rate changes with the tides but the net direction of water movement over the tidal cycle does not. Under this scenario, the longer temporal scale changes (for example, seasonal transients) and their influence on mean groundwater levels and gradients determine the net flux of water between the canal and groundwater over time. [5]

---

[5] Yim, Chan S. and M.F.N. Mohsen, 1992, "Simulation of Tidal Effects on Contaminant Transport in Porous Media," Journal of Groundwater, vol. 30, no. 1, pp. 78-96.

We considered spatial variability in water flux in and out of the canal (seepage and leakage, respectively) by considering conditions along six canal segments corresponding to monitoring well locations. The segments and associated monitoring wells are shown in **Figure 7** (the resulting segment lengths range from 1,650 to almost 5,000 feet). We utilized average canal stage and groundwater elevations and employed Equation (1) to determine the monthly direction and rate of water movement in or out of the canal:

$$\mathbf{Qc} = \mathbf{k}*\mathbf{b}*\mathbf{d}*\mathbf{G}\text{; where} \qquad (1)$$

Qc is the monthly groundwater flux in or out of the canal, in ft3/d;
k is the hydraulic conductivity of the saturated sediments, in ft/d;
b is the saturated thickness of sediments adjacent to the canal that transmit water horizontally to and from the canal, in ft;
d is the canal segment distance, in ft; and,
G is the average monthly hydraulic gradient; a gradient less than zero indicates leakage from the canal, and a gradient greater than zero indicates groundwater seepage to the canal.[6]

The data sources and values we utilized in Equation (1) are described below.

Aquifer Properties

Numerous borings, CPT's, tests pits, and hand auger samples have been collected as part of the Dutch Slough levee and grading design effort. Additional subsurface data is available from CCWD Canal projects and other site specific investigations.[7,8,9,10] Available boring logs demonstrate the presence of a shallow water-bearing zone comprised primarily of silty sand and sand deposits with silt and clay lenses often overlain by a clay cap that can be 4- to 7-feet thick.

In 2003, HydroFocus reported aquifer test results from Ironhouse Sanitary District monitoring wells constructed in similar sediments next to the canal in the reach west of Marsh Creek to Pumping Plant 1. They reported hydraulic conductivity (**k**) values ranging from 0.5 to 6.3 feet per day which were used to determine seepage rates into that reach of the canal. Ten aquifer tests were conducted in wells adjacent to the canal. Because hydraulic conductivity values are not available from tests conducted within the reach within

---

[6] The northern monitoring wells are located at distances between 400 to 500 feet of the canal. However, under marsh restoration the flooded conditions will encroach between 100 to 600 feet of the north side of the canal. In order to compare hydraulic gradients under existing and project conditions, existing gradients were extrapolated to the edge of the restored marshland adjacent to t he canal. This approach ensured gradients under existing and project conditions are compared at the same distances from the canal.
[7] Hultgren – Tillis Engineers. 2012. Geotechnical Data Report, Revision 02, Dutch Slough Tidal Marsh Restoration, Contra Costa County, California, January 6, 2012. Prepared for Reclamation District 2137. (HTE No. 608.04).
[8] DCM Engineering. 2007. Geotechnical Engineering Investigation, Contra Costa Water District, Canal Replacement Project, Oakley, California, April 2007.
[9] Hultgren – Tillis Engineers. 2012. Geotechnical Data Report, Revision 02, Dutch Slough Tidal Marsh Restoration, Contra Costa County, California, January 6, 2012. Prepared for Reclamation District 2137. (HTE No. 608.04).
[10] DCM Engineering. 2007. Geotechnical Engineering Investigation, Contra Costa Water District, Canal Replacement Project, Oakley, California, April 2007.

our Dutch Slough Project area, we utilized the range of hydraulic conductivity values from the 2003 HydroFocus report in Equation (1) for our seepage analysis. We also assumed the saturated thickness (**b**) of each canal segment is constant and represented by the maximum water column height in the canal reported by HydroFocus (almost 12 feet). Equation 1 assumes horizontal groundwater movement to and from the canal.

Previous collaborative work with CCWD provides supporting evidence for the model assumptions and inputs. Specifically, CCWD measured salinity increases in the Canal adjacent to the ISD property in 2003 and estimated that 0.03 cubic feet per second (cfs) of groundwater flow to the Canal[11]. Consistently, using higher (and measured) groundwater salinity values than those used by CCWD and hydraulic conductivity values ranging from 0.5 to 6.3 feet per day. HydroFocus estimated a rate of groundwater flow into the canal of 0.02 cfs. The hydraulic conductivity values were derived from aquifer testing using wells in segments along the reach adjacent to ISD. The hydraulic gradient was the primary factor influencing the range of influx estimates. This comparison indicated that the maximum seepage value was probably appropriate during the CCWD measurements and that the range of hydraulic conductivity values used was appropriate.

Hydraulic Gradients

The hydraulic gradient (**G**) was calculated from canal stage and observed groundwater levels in adjacent monitoring wells. We used Canal stage calculated 1) from the Rock Slough stage data and 2) hourly HEC-RAS model estimates provided by CCWD. We utilized stage data from Rock Slough and monitoring well water level data for April 2011 through March 2012 to represent Canal stage and groundwater conditions, respectively. The CCWD HEC-RAS estimated canal stage was for Water Year 2012 (October 1, 2011 to September 30, 2012). In order to accurately characterize gradients, we utilized continuous data monitored over time periods spanning the daily tidal cycles when available for both data sets for existing conditions.

In the first case, we estimated canal stage, lagged the Rock Slough data 105 minutes and characterized uncertainty in estimated Canal stage by subtracting 0.4- and 1.0 feet from Rock Slough stage for minimum and maximum gradient and seepage calculations, respectively. In the second case, daily averages of hourly HEC-RAS stage estimates were used. The transducers in the monitoring wells continuously measured water levels every 15-minutes. For the first case, we filtered the data using a 25-hour moving average to smooth the tidal effects in the Canal and monitoring well water levels and then calculated monthly mean water levels to characterize the net effect of seasonally changing regional gradients. For calculations with the hourly HEC-RAS Canal stage estimates, we averaged the 15-minute groundwater-elevation data to produce daily values for comparison with estimated Canal stage for WY 2012 provided by CCWD and calculation of gradients.

---

[11] Contra Costa Water District Interoffice Memorandum from David Briggs to Greg Gartrell, December 10, 2003, "Estimate of Salt Load to the Canal from Local Groundwater."

RESULTS

Flux calculations were completed for the six canal segments mapped in **Figure 7**. Using the Rock Slough estimated Canal stage, an example calculation is provided below in **Table 1** for segment 2-N; monthly calculations for all segments are tabulated in **Appendix A**. The monitoring well associated with 2-N (Emerson 2) was instrumented with a transducer. Hence, the mean monthly gradient between the canal and groundwater was calculated from monthly averages of filtered water levels measured in 15-minute intervals at the slough and monitoring well. The maximum canal stage (Rock Slough stage-0.4 ft) and minimum conductivity (**k**) generally results in the minimum absolute gradient (**G**) and calculated flux, whereas the minimum canal stage (Rock Slough stage -1.0 ft) and maximum conductivity generally results in the maximum absolute gradient and flux. For the HEC-RAS-estimated Canal stage data provided by CCWD, we estimated daily hydraulic gradients based on the difference in water-level elevations in the canal and adjacent wells for each segment based on the monthly or 15-minute groundwater-elevation data.

Table 1. Example calculations of average daily flux for segment 2-N under existing conditions (east of Marsh Creek to Emerson Slough).

Month	Hydraulic Conductivity (**k**)		Gradient (**G**)		Flux (**Qc**)	
	Minimum	Maximum	Emerson 2		Minimum	Maximum
	-ft/d-		RS stage- 0.4	RS stage - 1.0	- ft^3/d-	
Apr-11	0.5	6.0	0.0001	0.0015	2	352
May	0.5	6.0	0.0021	0.0035	41	824
Jun	0.5	6.0	0.0013	0.0027	25	632
Jul	0.5	6.0	0.0018	0.0032	35	751
Aug	0.5	6.0	0.0009	0.0023	17	537
Sep	0.5	6.0	0.0026	0.0039	50	938
Oct	0.5	6.0	0.0017	0.0031	34	738
Nov	0.5	6.0	0.0021	0.0035	42	837
Dec	0.5	6.0	0.0004	0.0018	8	422
Jan	0.5	6.0	-0.0003	0.0011	-6	260
Feb	0.5	6.0	-0.0002	0.0012	-3	292
Mar-12	0.5	6.0	-0.0011	0.0002	-23	59
Average Annual Seepage (ft3/d)					21	554

Thickness (**b**) = 12 feet; Length (**d**) = 3,300 feet.
RSs is "Rock Slough stage."
Gradients and fluxes greater than zero indicate seepage to the canal; gradients and fluxes less than zero indicate leakage from the canal.

For the stage data based on the Rock Slough stage during the 12-month analysis period (April 2011 – March 2012), the minimum flux along segment 2-N ranged from 50 ft^3/d of seepage (September, 2011) to -23 ft^3/d of leakage (March, 2012). The cumulative minimum seepage summed for the entire year (i.e., the sum of all monthly fluxes greater than zero) totals 7,725 ft3, which corresponds to an average annual seepage rate of 21 ft^3/d. In contrast, the maximum seepage ranged from a low of 59 ft3/d (March 2012) to 938 ft3/d (September 2011); the cumulative maximum seepage summed for the entire year across segment 2-N totals more than 202,000 ft^3, and corresponds to an average maximum annual seepage rate of 554 ft^3/d.

We completed similar calculations for the remaining five segments (see **Appendix A**) and summarize their average daily seepage rates below in **Table 2**. Almost all the estimated seepage occurs within the reach east of Marsh Creek to Emerson Slough (across segments 1-N, 2-N, and 1-S). From Emerson Slough to Jersey Island Road, a small amount of seepage also occurs from the north across segment 3-N, whereas leakage occurs to the north across segment 4-N and to the south across segment 2-S. The cumulative total average daily seepage rates range from a minimum of 180 ft^3/d (0.002 cfs) to a maximum of about 4,950 ft^3/d (0.058 cfs), respectively. Most of the seepage (77-percent) is from the south and across segment 1-S.

Table 2. Average daily seepage: existing conditions, Marsh Creek to Jersey Island Road.

Segment		Flux (Qs)	
		Minimum	Maximum
		- ft^3/d-	
East of Marsh Creek to Emerson Slough	1-N	18	372
	2-N	21	554
	1-S	138	3,798
	SUM (ft^3/d)	177	4,724
	SUM (cfs)	0.002	0.055
Emerson Slough to Jersey Island Road	3-N	3	229
	4-N	0	0
	2-S	0	0
	SUM (ft^3/d)	3	229
	SUM (cfs)	0.00004	0.003
	SUM (ft^3/d)	180	4,953
	SUM (cfs)	0.002	0.057

The canal reach from East of Marsh Creek to Emerson Slough includes three segments (1-N, 2-N, and 1-S). The total annual seepage across these reaches ranges from a minimum of 177 to a maximum of 4,724 ft^3/d (0.002 to 0.055 cfs). The greatest monthly seepage occurred during February (see **Appendix A**) when maximum annual seepage was 6,355 ft^3 (almost 210 ft3/d).

In September 2011, the calculated monthly seepage ranged from about 5,800 to 173,300 ft^3 (0.002 to 0.065 cfs). Observed 2003 canal water salinity changes within the same reach adjacent to the ISD property were previously analyzed independently by HydroFocus and Contra Costa Water District.[12] Their calculations determined seepage rate likely ranged from 0.02 to 0.03 cfs. These results suggest estimated seepage in the reach between Marsh Creek and Emerson Slough corresponds more closely to the upper range of our calculations (maximum flux). Figure 8 shows estimated daily groundwater fluxes (calculated with HEC-RAS data) to the Canal which ranged from -8,849 to 5,227 cubic feet per day. . The mean estimated value is -1219 ft^3/d. Maximum flux values from monthly estimates for the overlapping period are consistently higher than the daily estimates.

Seepage and Leakage – Proposed Dutch Slough Restoration

The Dutch Slough project plans to restore tidal marsh in the land parcels north of the canal approximately east of Marsh Creek to Jersey Island Road. As a result, the hydraulic gradients between the canal and planned marsh area will change relative to existing conditions. Accordingly, the flux of water in and out of the canal will also change as a result of the altered hydraulic gradients.

[12] Contra Costa Water District Interoffice Memorandum from David Briggs to Greg Gartrell, December 10, 2003, "Estimate of Salt Load to the Canal from Local Groundwater."

We estimated the impact from the restoration effort by re-calculating the monthly and daily flux to and from the canal as a result of the proposed flooding using both Canal stage estimates (stage estimated from Rock Slough and the CCWD HEC-RAS estimates). For the area north of the canal, in-lieu of observed groundwater levels we utilized observed Dutch Slough stage data. The observed Dutch Slough stage readings were smoothed using a 25-hour moving average to remove most of the tidal effects, and the resulting average monthly stage was assumed equal to the average monthly groundwater level beneath the restored marsh. We then utilized this groundwater level estimate to calculate hydraulic gradients and fluxes between the water-bearing sediments beneath the edge of the marsh and the canal. The monthly gradients and fluxes for the monthly calculations are summarized for each reach in **Appendix A**, and the average daily seepage summarized and reported below in **Table 3**.

Table 3. Average daily seepage: marsh restoration,
Marsh Creek to Jersey Island Road.

Segment		Flux (Qs)	
		Minimum	Maximum
		- ft^3/d-	
East of Marsh Creek to Emerson Slough	1-N	23	868
	2-N	9	347
	1-S	138	3,798
	SUM (ft^3/d)	170	5,013
	SUM (cfs)	0.002	0.058
Emerson Slough to Jersey Island Road	3-N	36	1,375
	4-N	44	1,682
	2-S	0	0
	SUM (ft^3/d)	64	3,057
	SUM (cfs)	0.0007	0.035
	SUM (ft^3/d)	250	8,070
	SUM (cfs)	0.001	0.035

Figure 9 shows the filtered data for Dutch and Rock sloughs and the estimated Canal stage; the canal stage was estimated by lagging the Rock Slough stage by 105 minutes and subtracting 0.8 feet. Groundwater elevations beneath land areas flooded by water from Dutch Slough will be greater than the adjacent canal stage thereby increasing seepage. Our calculations indicate that marshland restoration will increase the maximum annual daily seepage rate from about 4,950 ft^3/d to 8,070 ft^3/d (a 63-percent increase). Almost half of the estimated current maximum seepage is from the south across segment 1-S (47-percent), and not influenced by flooding the land areas to the north. The greatest seepage increase occurs in segment 4-N, where the canal leaked under existing conditions but under flooded conditions the canal intercepts about 1,680 ft3/d of maximum average daily seepage. The greatest seepage rates occur during the winter months, with the greatest maximum seepage occurring in February (10,755 ft^3, or about 350 ft^3/d).

Seepage and Leakage – Tule Cultivation Period

The Dutch Slough project includes an interim wetland-vegetation establishment phase, whereby after grading the area the tules will be irrigated. Irrigation will consist of flooding the marsh area and maintaining water level elevations between 4.35 to 5.35 feet (average water level assumed equal to 4.85 feet). Using the Canal stage estimated from Rock Slough stage, we initially assumed the average irrigation water level is equal to the average monthly groundwater level beneath the cultivated tules. Accordingly, for the area north of the canal we utilized a constant water level elevation of 4.85 feet in-lieu of observed groundwater elevations; the average observed water levels in monitoring wells were used for groundwater south of the canal. The groundwater hydraulic gradients were calculated using the distance from the Canal to the edge of the proposed marsh. We then calculated hydraulic gradients and fluxes between groundwater and the canal. The results are summarized for each reach in **Appendix A**, and the average daily seepage rates reported below in **Table 4**.

Table 4. Average estimated daily seepage during tule cultivation,
Marsh Creek to Jersey Island Road.

Segment		Flux (Qs)	
		Minimum	Maximum
		- ft^3/d-	
East of Marsh Creek to Emerson Slough	1-N	84	1,600
	2-N	34	640
	1-S	138	3,798
	SUM (ft^3/d)	255	6,038
	SUM (cfs)	0.003	0.070
Emerson Slough to Jersey Island Road	3-N	133	2,534
	4-N	162	3,100
	2-S	0	0
	SUM (ft^3/d)	295	5,634
	SUM (cfs)	0.003	0.065
	SUM (ft^3/d)	550	11,672
	SUM (cfs)	0.006	0.135

Irrigation of the tule plantings north of the canal increases maximum average daily seepage from an existing 4,953 ft^3/d to 11,672 ft^3/d (an increase of 6,719 ft^3/d). More than 30-percent of the maximum average daily seepage is from the south (segment 1-S), which occurs independently of the marsh restoration effort. Most of the increase in maximum average daily seepage occurs in the reach from Emerson Slough to Jersey Island Road (5,405 ft^3/d). The greatest seepage rates occur during the winter months, with the greatest maximum seepage occurring in February (16,145 ft^3, or 530 ft^3/d).

After receiving comments and data from CCWD staff, we revised our analysis of tule cultivation. Figure 10 shows the daily estimates of increased seepage to the canal with tule cultivation relative to existing conditions with the estimated high water level elevation of 5.35 feet, average elevation of 4.85 feet and low elevation of 4.35 feet. We also included the results of calculations without Burroughs tule cultivation with low and average water levels. The monthly estimate generally agreed with the daily high water tulle cultivation during the overlapping time period. The monthly mean was 9,600 ft^3/day whereas the daily mean for the high water scenario was 8,330 ft^3/day. The mean values for the average water-level scenario was 5,896 ft^3/day. The two scenarios without Burroughs with average and low water levels resulted in mean values of 3,892 and 2,416 ft^3/day, respectively. The mean flow in the canal during WY 2012 was 7,045,954 ft^3/day and ranged from 0 to 15,849,000 ft^3/day. For the tule cultivation scenarios, maximum estimated values for groundwater flow the canal ranged from 12,500 ft^3/day for the high water scenario to 4,870 ft^3/day for the Burroughs low water scenario.

Salt Loads Under Existing and Proposed Project Conditions

We utilized our maximum calculated monthly seepage rates summarized in **Table 2, Table 3** and **Table 4** (monthly values reported in **Appendix A**) and the maximum observed constituent concentrations in monitoring well samples (TDS and Cl concentrations) to estimate the change in existing salt load to the canal as a result of flooding the northern land area between Marsh Creek and Jersey Island Road (monthly values reported in **Appendix B** and **Appendix C**). **Figure 11** shows the monitoring well locations and maximum TDS and Cl concentrations in well samples collected quarterly during the period April 2011 through March 2012.

Using the stage data estimated from the correlation with Rock Slough, the calculated salt load for existing seepage is reported in **Table 5**. Under existing conditions, the maximum average daily seepage rate (about 4,950 ft3/d) carries a maximum load estimate of 839 lbs/d TDS and 120 lbs/d of Cl. Most of the TDS load (98-percent) occurs between Marsh Creek and Emerson Slough (segments 1-N, 2-N, and 1-S), of which 77-percent (644 lbs/d) originates south of the canal.

Using the hourly HEC-RAS estimated Canal stage and flow data, we determined that the median residence time in the canal adjacent to Dutch Slough (residence time equals the volume of water in the canal divided by flow at Pumping Plant Number 1) was about 19 hours. Therefore, for estimating effects on Canal TDS loads and concentrations, we used daily stage data because groundwater contributions to the Canal will generally mix within the volume of Canal water adjacent to the Dutch Slough project during one day. Figure 12 shows the estimated daily TDS load for current conditions using WY 2012 hourly HEC-RAS stage estimates and monthly estimates for the overlapping period. The mean for daily values (490 lbs/day) is smaller than for the monthly value (1,093 lbs/day). The estimated monthly values are more consistent with the maximum daily values (Figure 12) because the monthly calculations estimated the net load to the Canal during the month due to the average difference in water levels. In contrast, the daily-value estimated loads average hourly values which include fluxes in and out of the canal.

Table 5. Maximum average existing salt loads in seepage, Marsh Creek to Jersey Island Road.

Segment	Maximum Seepage (ft^3/d)	Monitoring Well	Maximum Concentration (mg/L)		Maximum Load (lbs/d)	
			TDS	Cl	TDS	Cl
1-N	372	Emerson-2	3,100	590	72	14
2-N	554	Emerson-2	3,100	590	107	20
1-S	3,798	PZ-2	2,720	350	644	83
				Sum	822	117
3-N	229	Burroughs-1	1,140	205	16	3
4-N	0	Burroughs-1	1,140	205	0	0
2a-S	0	Gilbert-3	4,180	1,000	0	0
2b-S	0	Gilbert-3	4,180	1,000	0	0
				Sum	16	3
				TOTAL	839	120

The calculated monthly average salt load for proposed project marshland restoration is reported in **Table 6**. Under proposed flooded conditions, we estimated that the maximum average salt load will increase from 839 lbs/d to 1,095 lbs/d TDS, and the maximum Cl load will increase from 120 to almost 170 lbs/d. The net average increase in TDS load (about 256 lbs/d) and Cl load (47 lbs/d) is due to increased seepage between Emerson Slough and Jersey Island Road (segments 3-N and 4-N). However, most of the total TDS load (59-percent) and Cl load (50-percent) originates south of the canal and enters along reach 1-S. These TDS and Cl contributions to the canal are independent of the marsh restoration north of the canal.

Table 6. Maximum projected TDS load in seepage after flooding, Marsh Creek to Jersey Island Road.

Project Conditions						
Segment	Maximum Seepage (ft^3/d)	Monitoring Well	Maximum Concentration (mg/L)		Maximum Load (lbs/d)	
			TDS	Cl	TDS	Cl
1-N	868	Emerson-2	3,100	590	168	32
2-N	347	Emerson-2	3,100	590	67	13
1-S	3,798	PZ-2	2,720	350	644	83
				Sum	878	127
3-N	1,375	Burroughs-1	1,140	205	98	18
4-N	1,682	Burroughs-1	1,140	205	119	21
2a-S	0	Gilbert-3	4,180	1,000	0	0
2b-S	0	Gilbert-3	4,180	1,000	0	0
				Sum	217	39
				TOTAL	1,095	167

The calculated average salt and chloride loads for the tule cultivation period are reported in **Table 7**. During the tule cultivation period, the estimated average total salt load increases from existing conditions of 839 lbs/d to 1,476 lbs/d TDS, and the Cl load increases from 120 to 237 lbs/d. A substantial portion of the TDS load (44-percent) and Cl load (35-percent) originates in the south and enters the canal along the reach 1-S. These TDS and Cl contributions to the canal are independent of tule cultivation north of the canal.

Figure 13 shows the percentage of the total annual maximum chloride load to the canal for existing, project and tule cultivation by segment. The majority of estimated Cl loading to the canal under existing conditions (69%) is from south of the canal (**Figure 13A**). Secondarily, groundwater on Emersion contributes about 29%. There is minimal contribution from the Gilbert and Burroughs parcels. In contrast, for project conditions (**Figure 13B**) the estimated percentages increased for Gilbert and Burroughs and decreased for Emerson (segment 1-S and 2-N). Almost 50% of the estimated load originates south of the canal for project conditions. Estimated load percentages for tule cultivation (**Figure 13C**) increased to almost 35% for Emerson (segments 1- and 2-N) and to almost 31% for Gilbert (segment 3-N) and Burroughs (segment 4-N). Thirty-five percent of the estimated load originates south of the canal (segment 1-S). **Figure 13** demonstrates that loads can be reduced during tule cultivation by phasing one or two parcels sequentially.

Table 7. Maximum projected TDS load in seepage during tule cultivation, Marsh Creek to Jersey Island Road.

Tule Cultivation						
Segment	Maximum Seepage (ft^3/d)	Monitoring Well	Maximum Concentration (mg/L)		Maximum Load (lbs/d)	
			TDS	Cl	TDS	Cl
1-N	1,600	Emerson-2	3,100	590	309	59
2-N	640	Emerson-2	3,100	590	124	24
1-S	3,798	PZ-2	2,720	350	644	83
				Sum	1,076	165
3-N	2,534	Burroughs-1	1,140	205	180	32
4-N	3,100	Burroughs-1	1,140	205	220	40
2a-S	0	Gilbert-3	4,180	1,000	0	0
2b-S	0	Gilbert-3	4,180	1,000	0	0
				Sum	400	72
				TOTAL	1,476	237

We used data posted on the California Data Exchange Center website[13] to calculate that during the period April 2011 through March 2012 the average daily TDS and Cl loads in the canal were about 46,335 and 10,251 lbs/d, respectively.[14] Relative to these average loads, project conditions, we estimated that annual TDS and Cl loads in pumped canal water will increase by 0.66 and 0.58 percent, respectively. Similarly, we estimated that tule cultivation will increase TDS and Cl loads 0.99 and 0.77 percent, respectively.

We also compared the estimated monthly increases in Dutch Slough TDS and Cl loads (**Appendix B**) and resultant calculated concentration increases using conditions during April 2011 through March 2012 (**Appendix C**) with measured Contra Costa Canal loads. **Figures 14** and **15** show the estimated monthly loads from the Dutch Slough Project and Contra Costa Canal loads for TDS and Cl. For project conditions, the increased TDS and Cl loads range from 0.28 to 1.6% and 0.27 to 1.1%, respectively. To estimate the resultant average monthly concentration increase from these load increases for project conditions and tule cultivation, we divided the total TDS and Cl load (existing canal load plus seepage load) by the monthly flow volume. For months when there was minimal or no flow in the canal (May, June and July 2011), we added the constituent mass in the seepage load to that in the stagnant canal volume[15] and divided the mass load by the canal volume.

We estimated the daily increase in salt load for a range of hydraulic head values for tule cultivation of 5.35 (high), 4.35 (average) and 3.35 (low) feet. We also excluded the

[13] http://cdec.water.ca.gov/

[14] Fifteen (15) minute electrical conductivity (EC) data were obtained from CDEC for “Rock Slough Abv Contra Costa Canal (RSL).” Daily pumpage and dissolved chloride concentration data were obtained for “CCWD Rock Slough PP Near Brentwood (INB).” Average monthly TDS was estimated as 64 percent of the averaged EC data reported for RSL; average Cl was determined from daily reported Cl at INB.

[15] We utilized the dimensions provided by CCWD for estimating the canal volume.

contribution by Burroughs for the average and low water levels and calculated the effects for tule cultivation solely on Emerson and Gilbert for high, average and low water levels. For those periods when there was minimal pumping from Pumping Plant Number1, we assumed that salt would accumulate hourly in the volume of Canal water adjacent to the Dutch Slough Project. We therefore averaged the hourly cumulative contribution during the days when there was low-residence time to estimate a daily average load and concentration in the Canal.

Figure 16 shows the daily and monthly estimated TDS concentration increases for the project and tule-cultivation conditions. For project conditions using daily and hourly data, the estimated average TDS concentration increase was 1.7 mg/L and ranged from -1 to 17 mg/L (**Table 8**) . Greatly increased concentrations that occurred during November, January and early February and April were due to zero or minimal flow in the Canal. Using the monthly data, the average estimated TDS concentration increase over all 12 months was 1.7 mg/L. The average estimated Cl concentration increase over the 12 month period was.0.63 mg/L.

For tule cultivation, for the monthly calculations, we estimated increased TDS concentrations ranging from 0.87 to 8.6 mg/L and 0.16 to 1.6 mg/L for chloride. The monthly average estimated TDS concentration increase was 3.5 mg/L. The average monthly estimated Cl concentration increase over the 12 month period was 0.63 mg/L. Using the hourly stage data, we estimated the daily concentration increase for the high water scenario averaged 8 mg/L and ranged from a minimum of 0 to a maximum of 77 mg/L (**Figure 16 and Table 8**). For the different tule cultivation scenarios, estimated average TDS concentration increases were 5.4, 4.0, and 2.4 mg/L for the average water level scenario with and without Burroughs and low water-level scenarios without Burroughs, respectively. Peak concentration increases for all tule cultivation scenarios correspond to when there was minimal or zero flow in the Canal during April 2012. The maximum values for these four scenarios were 53, 40 and 25 mg/L for the average water level scenario with and without Burroughs and low water-level scenarios, respectively. We also estimated the concentration increases for scenarios with only Gilbert and Emerson under tule cultivation.

Figures 16 and 17 and **Table 8** show the daily estimated TDS concentration and percent concentration increases for tule cultivation and project conditions and the TDS concentration in the Canal estimated from electrical conductivity measurements. In general, percent concentration increases were less than 3 % for all scenarios including Project conditions except when there was minimal or zero flow in the Canal. For Project conditions, the maximum TDS concentration increase of 4.5 % was during late April after a month of low or zero flow conditions. The average TDS concentration increase was 0.6 %. For tule cultivation with the high-water scenario, we estimated a maximum increase of 21.5 % and an average increase of 3.0 %. For the average water-level with and without Burroughs scenarios and low water level scenario without Burroughs, estimated maximum concentration increases during April were 14.0, 10.3 and 6.4 %, respectively.

Table 8 and **Figures 16 and 17** indicate that scenarios in which only Emerson and Gilbert are under tule cultivation will result in substantially lower average concentration increase ranging from 0.8 to 3.8 mg/L (0.3 to 1.4 %). Estimated maximum concentration increases ranged from 7.6 to 37 mg/L (3 to 11 %). Based on our calculations, tule cultivation solely on Gilbert will result in percent TDS concentration increases of 5 % or less. Also, tule cultivation solely on Emerson with low water levels will also result in concentration increases less than 5 %.

Table 8. Estimated concentration increases for the HEC-RAS estimated daily stage data

Scenario	Average concentration increase (mg/L)	Average percent concentration increase	Maximum concentration increase (mg/L)	Maximum percent concentration increase
Project	1.6	0.6 %	16	4.5
Tules, high water level	8.0	3.0	77	22
Tules, average water level	5.4	2.0	53	14
Tules, average water level without Burroughs	4.0	1.4	35	10
Tules, low water level without Burroughs	2.3	0.8	25	6.4
Tules, high water level Emerson only	3.8	1.4	37	11
Tules, average water level Emerson only	2.5	0.9	25	6.8
Tules, low water level Emerson only	1.4	0.5	14	4.2
Tules, high water level Gilbert only	1.8	0.7	17	5.0
Tules, average water level Gilbert only	1.3	0.5	12	3.8
Tules, low water level Gilbert only	0.8	0.3	7.6	3.0

UNCERTAINTY IN CALCULATED SEEPAGE AND LOADS

Our seepage and load calculations utilize observed hydrogeologic and water quality data extrapolated over six canal segments having relative distances equivalent to 15- to 48-percent of the total canal length in the Dutch Slough Study Area. Groundwater conditions adjacent to each segment are represented with data from a single monitoring well – one segment (2b-S) has no well. There are no site specific hydraulic conductivity estimates, therefore we utilized previous estimates for similar sediments adjacent to the canal at Ironhouse Sanitary District. Canal stage is not measured, but stage data is available for Rock Slough; available information indicates Canal stage can be 0.4- to 1.0-feet lower than at Rock Slough. Also hourly Canal stage estimates from surface water modeling were provided by CCWD. Additionally, the saturated thickness of sediments that transmit water to the canal was assumed to be 12 feet, and seepage water quality was represented by maximum TDS and Cl concentrations in the monitoring well samples.[16]

Our analysis determined a range in seepage and loads based solely on uncertainty in hydraulic conductivity and canal stage. Specifically, we calculated the monthly minimum and maximum seepage during the period April 2011 through March 2012 based on an estimated range in conductivity and hydraulic gradients. Results indicated that total annual seepage could range from 180 to about 4,950 ft3/d. Previous findings by HydroFocus and Contra Costa Water District suggest that actual seepage is likely near the upper end of our calculated range. Hourly estimates for WY 2012 are generally consistent with this upper end.

The hydraulic conductivity values we utilized ranged by about an order of magnitude (0.5 to 6.3 feet per day). If conductivity were known, then seepage uncertainty would be attributed primarily to uncertainty in canal stage and depth of groundwater flow. The 0.6-foot range in estimated canal stage translates into maximum seepage rates that range from about 2,200 to 4,950 ft3/d (a range of over 75-percent owing to canal stage uncertainty). Conversely, if canal stage were measured then uncertainty would be attributed primarily to uncertainty in hydraulic conductivity and calculated maximum seepage could range from about 410 to 4,950 ft3/day (a range of more than one order of magnitude owing to uncertainty in hydraulic conductivity). Measured canal stage and site specific conductivity estimates can therefore substantially reduce seepage uncertainty.

Our seepage calculations assume one-dimensional horizontal flow from beneath the project area to the canal. This assumption ignores spatial variability in hydraulic gradients along the multi-directional groundwater flow paths that originate at the marsh bottom to its exit point into the canal. The significance of these variable gradients and flow rates on seepage estimates could be assessed using a two-dimensional analysis of groundwater flow. This could be accomplished using a numerical groundwater-flow model developed using representative water levels (surface and groundwater) and water-transmitting properties for the study area.

---

[16] Uncertainty in the saturated thickness of sediments that transmit water to the canal and representative TDS and Cl concentrations in groundwater also contribute to uncertainty in calculated seepage and loads. Their effect is approximately equal to their level of uncertainty. For example, an assumed 10-percent uncertainty in saturated thickness resulted in an approximately 10-percent change in seepage. Measured canal stage can improve the estimated saturated depth. Similarly, observed TDS and Cl concentrations varied in monitoring well samples by about 3- to 30-percent. Assuming a 15-percent increase in the representative TDS concentrations, the maximum calculated salt load increases from 838,500 to 964,300 lbs/d (a 15-percent increase).

Hultgren and Tillis utilized a two-dimensional finite-element groundwater flow model, SEEP-2W (see Appendix E) to assess groundwater flow to the Canal during a 2007 drawdown test.[17] Their analysis of the water-level recovery data resulted in a hydraulic conductivity value of 6 feet per day for the aquifer adjacent to the ISD property. The appropriate values for the Dutch Slough property groundwater system are unknown. However, the subsurface texture is similar and the K value of 6 feet/day is reasonable. The Hultgren-Tillis analysis also indicated groundwater flow paths to the Canal that are deeper than the 12 feet assumed for our analysis.

Our one-dimensional analysis ignores the potential contribution of deep groundwater flow paths potentially intercepted by the Canal. The deep flow paths, which originate below the depth of the Canal, may also contribute to seepage. We therefore employed the following equation to estimate the effective depth of groundwater captured by the Canal[18]:

$$D = [(2WH)/(\pi GR)]^{1/2} \qquad (2)$$

where:,

D is the effective depth of capture, in feet;
W is the width of the Canal (50 feet);
H is the water level difference between the aquifer and canal, in feet;
G is the regional hydraulic gradient; and,
R is the ratio between horizontal and vertical hydraulic conductivity.

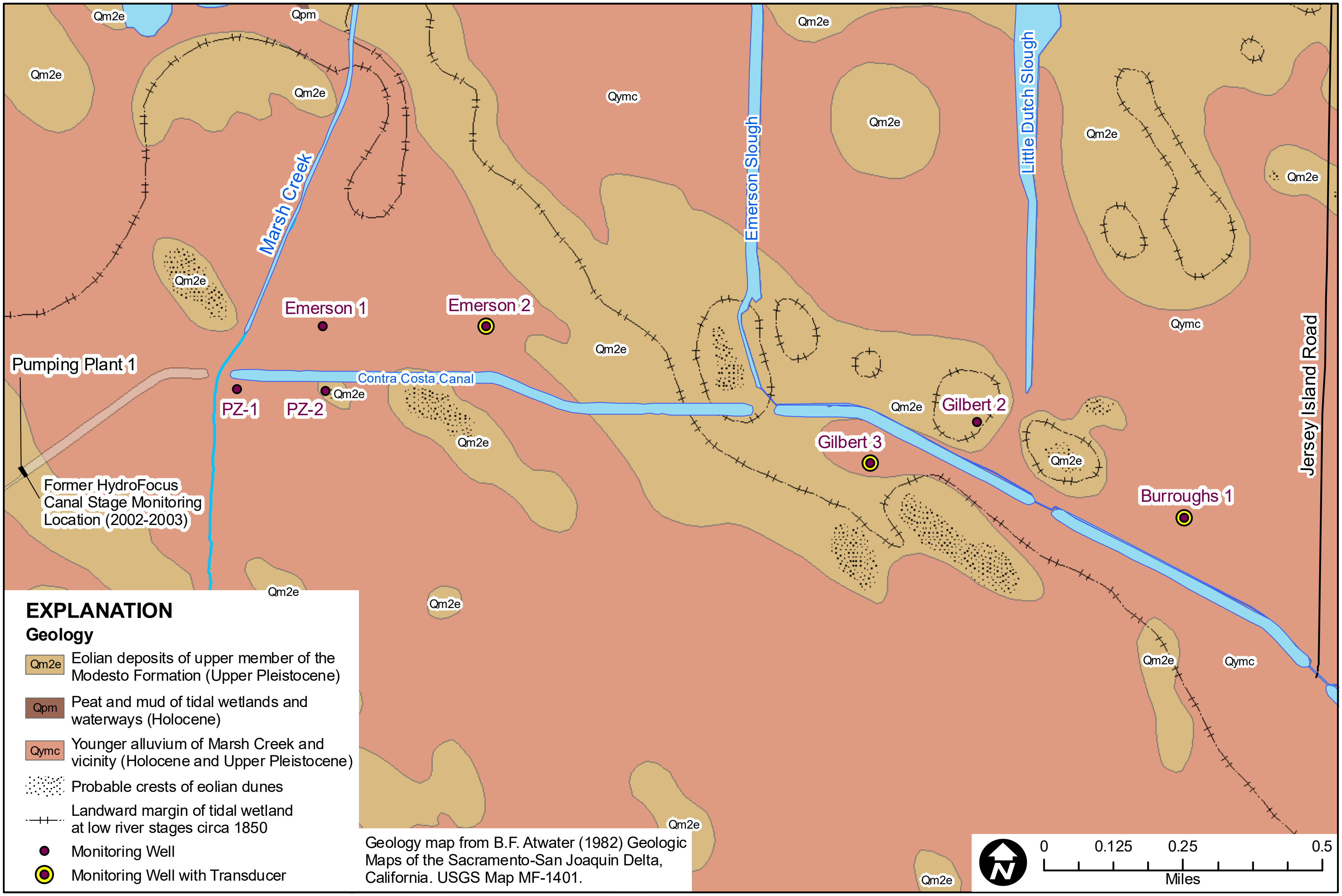
For the tule cultivation with average water levels without Burroughs when ponding is most likely to cause salt increases in the canal, we estimated a regional groundwater gradient of 0.01. The average water-level difference between the canal and the adjacent groundwater levels is about 1.04 feet. We used a value of 10 for R to account for anisotropy due to fine-grained layers in the silty-sand aquifer which result in a decreased vertical permeability. With these inputs, we estimated an effective depth of 18 feet. Using this value, results in an average change in Canal TDS of 3 % and a maximum change of 21.6 %. For comparison, using the effective depth of 12 feet resulted in an average value of 1.44 % and maximum value of 10.3 %. Using a plausible higher anisotropy (R) value of 25 resulted in an estimated D value of 11.5 feet which is consistent with the value used in the calculations. .

Notably, the canal drawdown test described above and in Appendix C surely resulted in much deeper effective depths. Using similar values for the input parameters in equation 2 except for a 4.73-foot difference between the Canal water level and groundwater level resulted in an effective depth of 46 feet. This helps explain the large rate of influx to the canal during this test.

[17] Stabb, Peter, November 19, 2007, Contra Costa Water District Interoffice Memorandum to Dan Owre, Canal Replacement Project – Draw Down Test, November 14, 2007

[18] Zheng, C., H. F. Wang, M.P. Anderson, and K. R. Bradbury, 1988, "Analysis of interceptor ditches for control of groundwater pollution", Journal of Hydrology, vol. 98, pp. 67-81

FIGURES



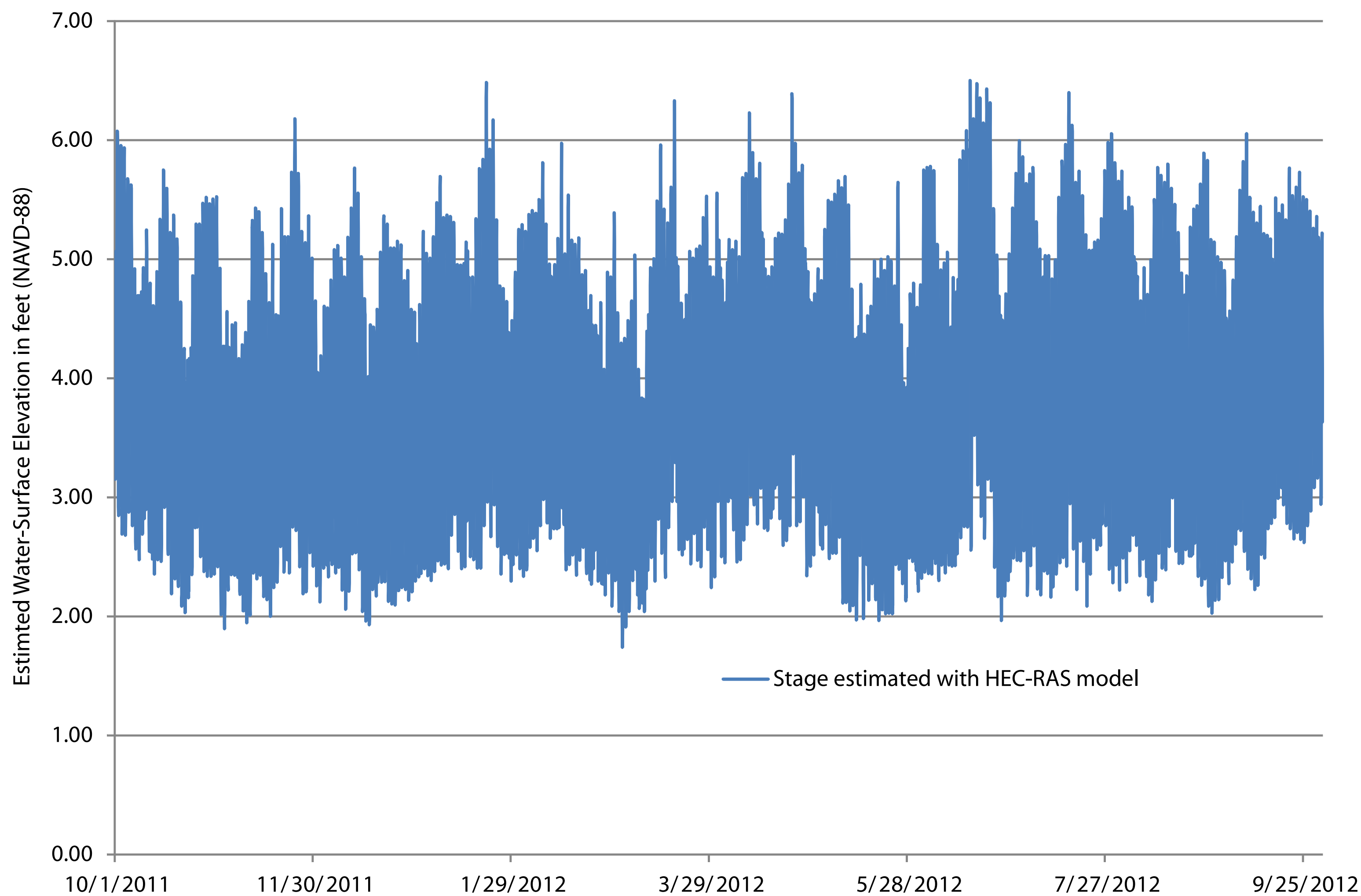
HYDROFOCUS INC. Solutions for Land and Water Resources

Location Map Showing Well Locations, Contra Costa Canal, and Geology.

Figure 1

PROJECT: 5565

DATE: 5/2/12



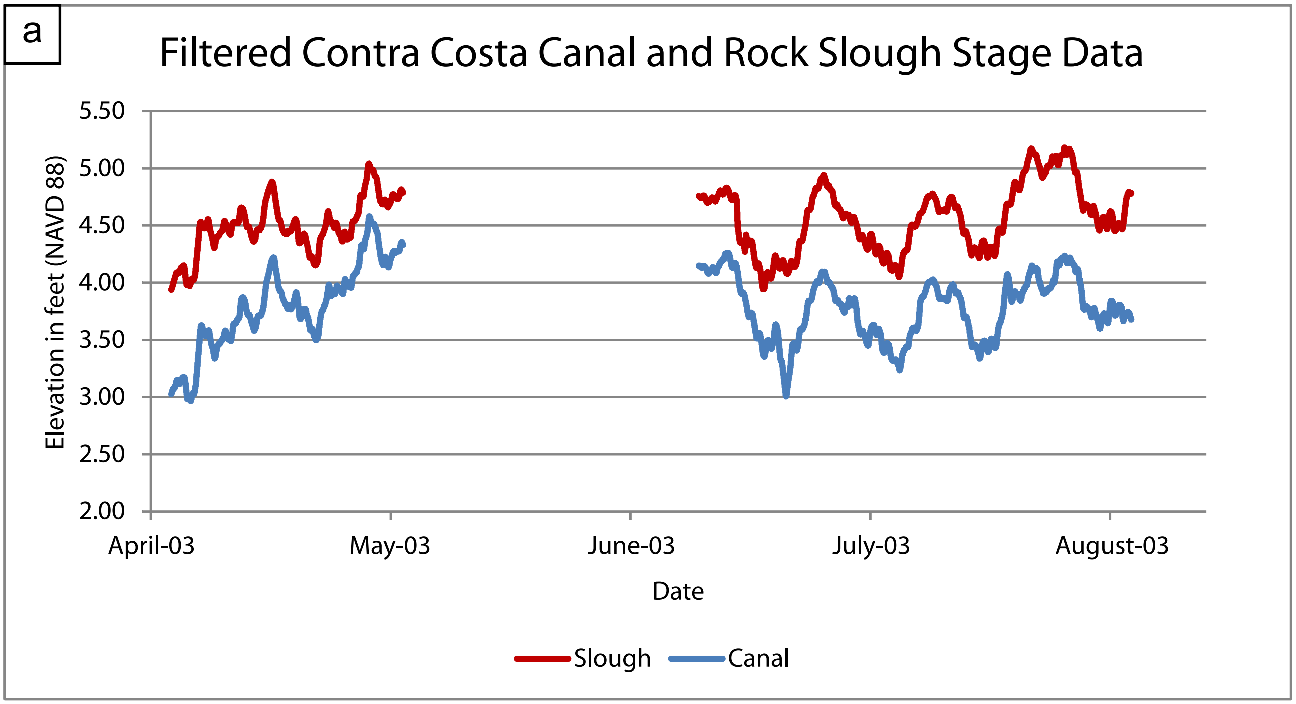
HYDROFOCUS INC. Solutions for Land and Water Resources

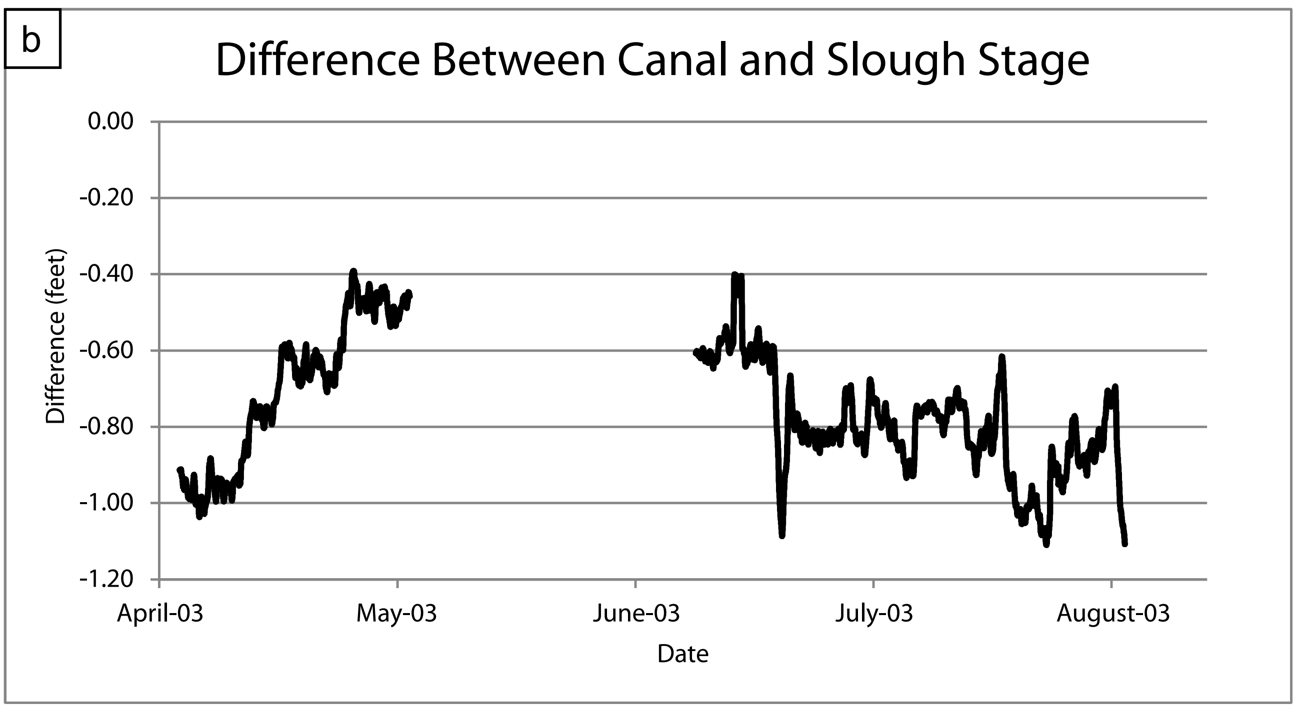
Hourly Contra Costa Canal stage estimate (NAVD-88) adjacent to Dutch Slough.

Figure 2

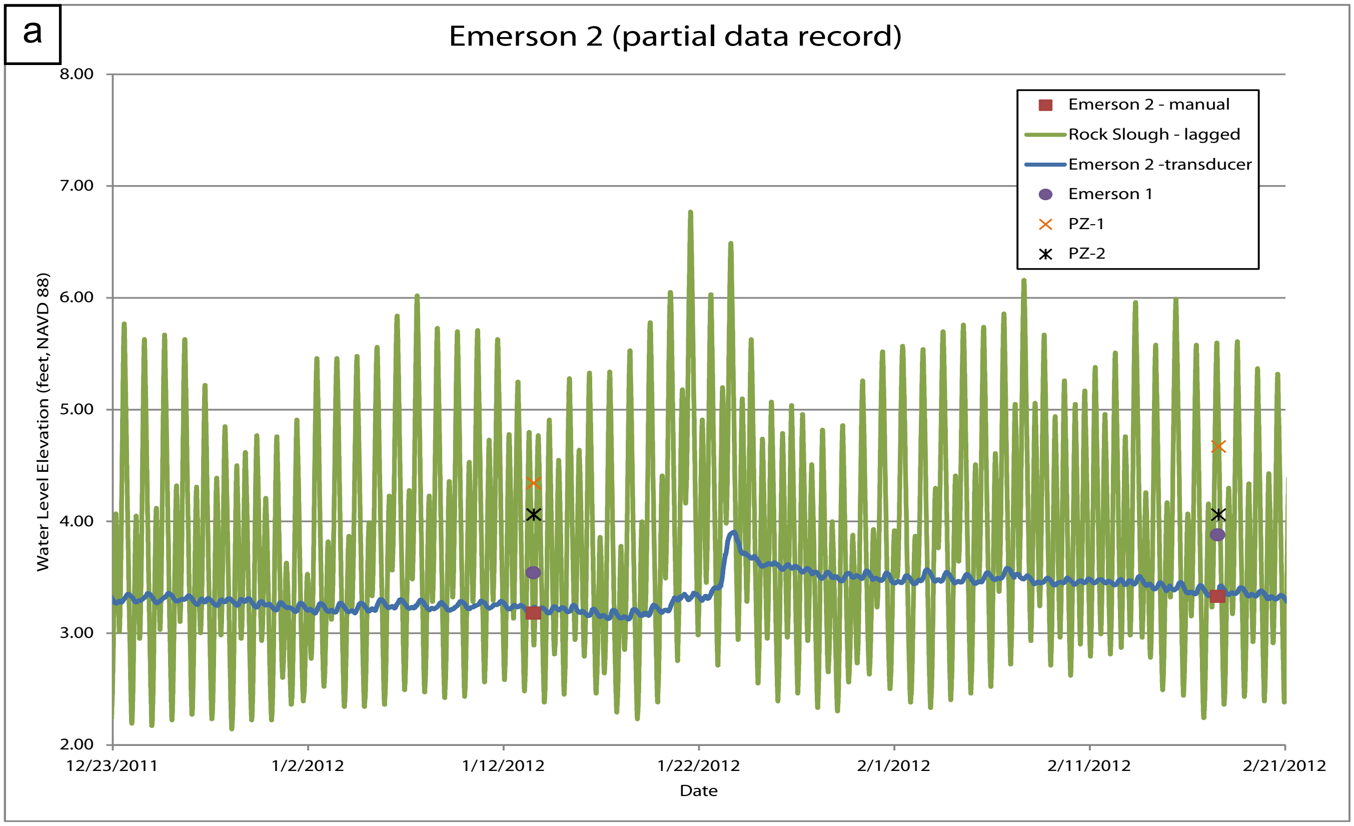
PROJECT: 5565

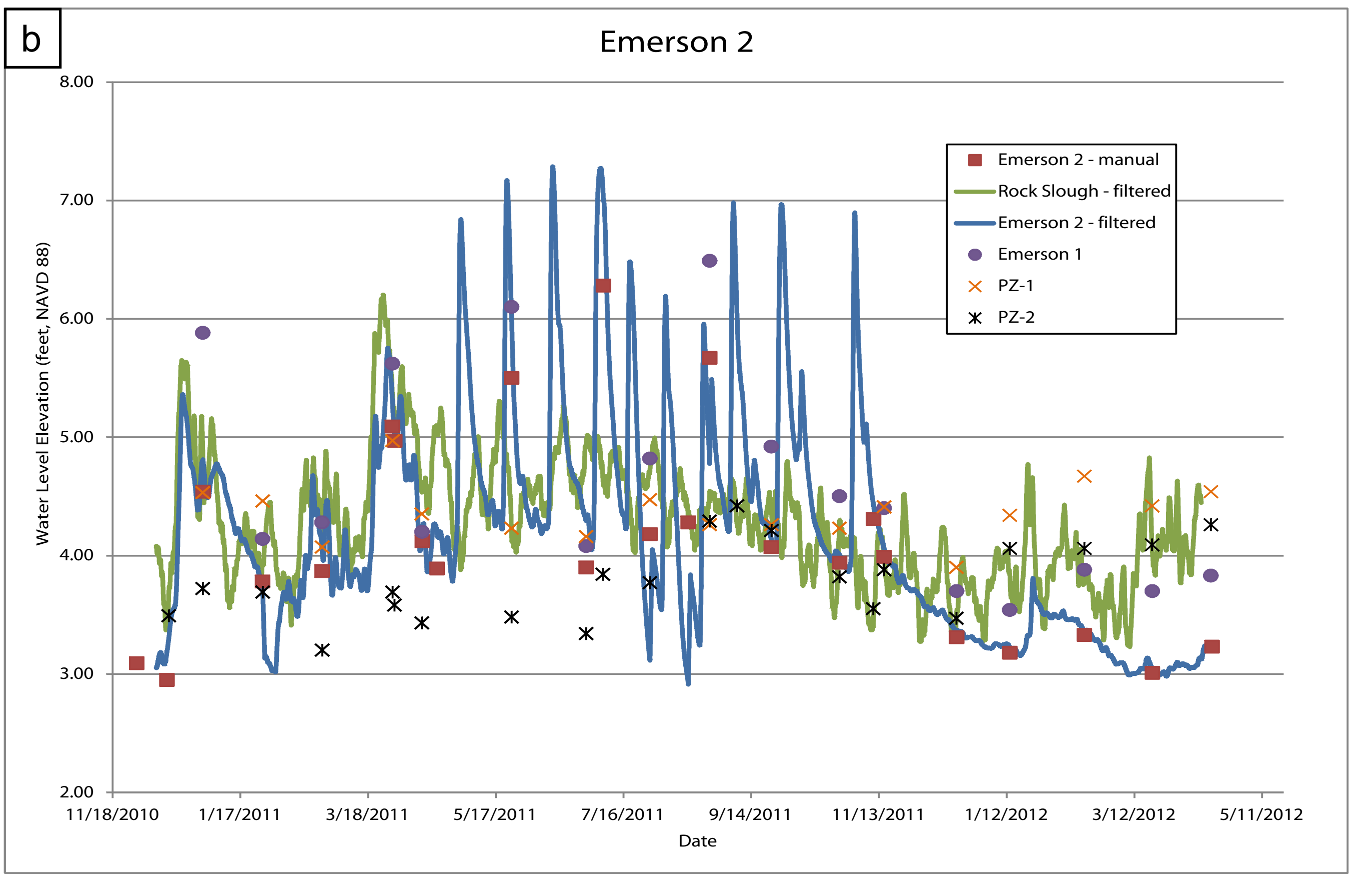
DATE: 1/17/13



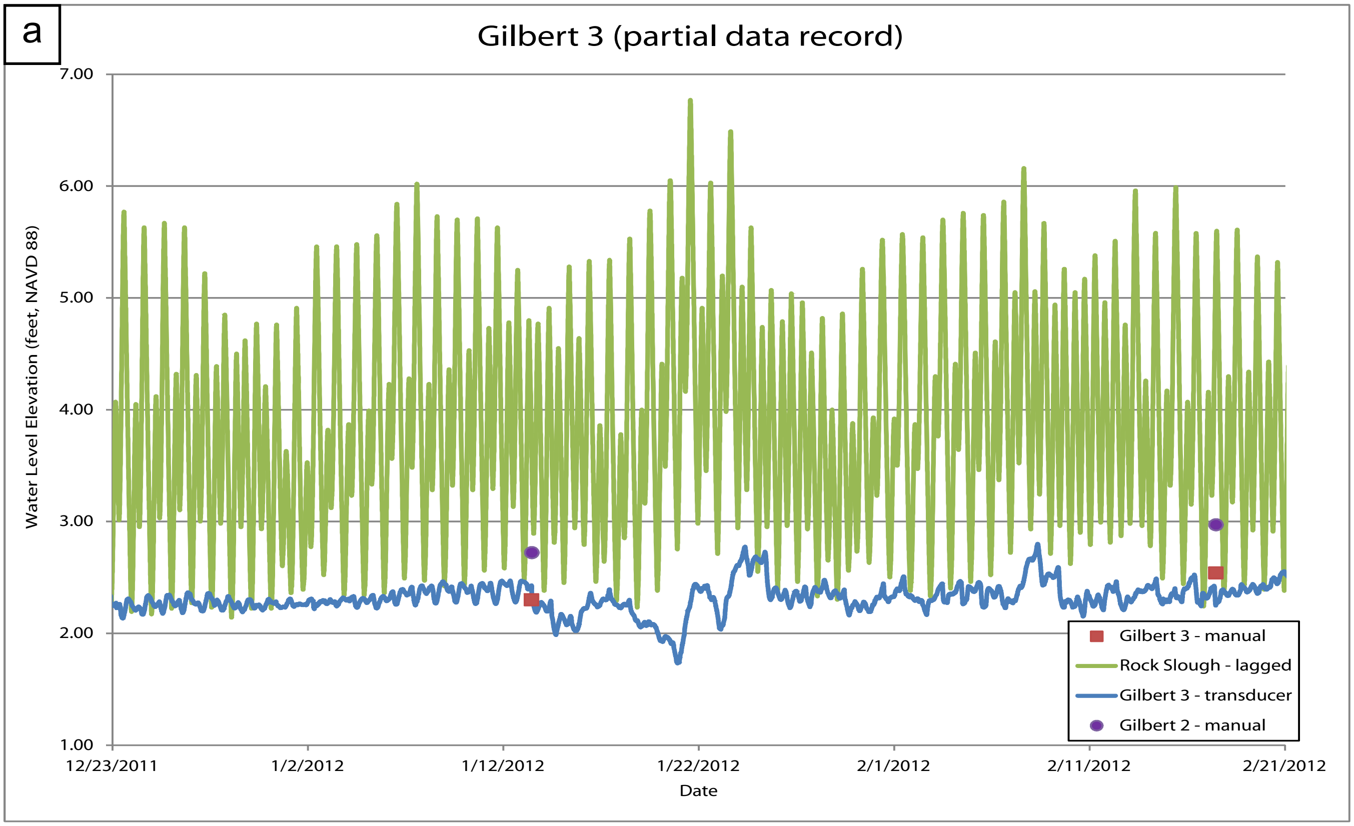


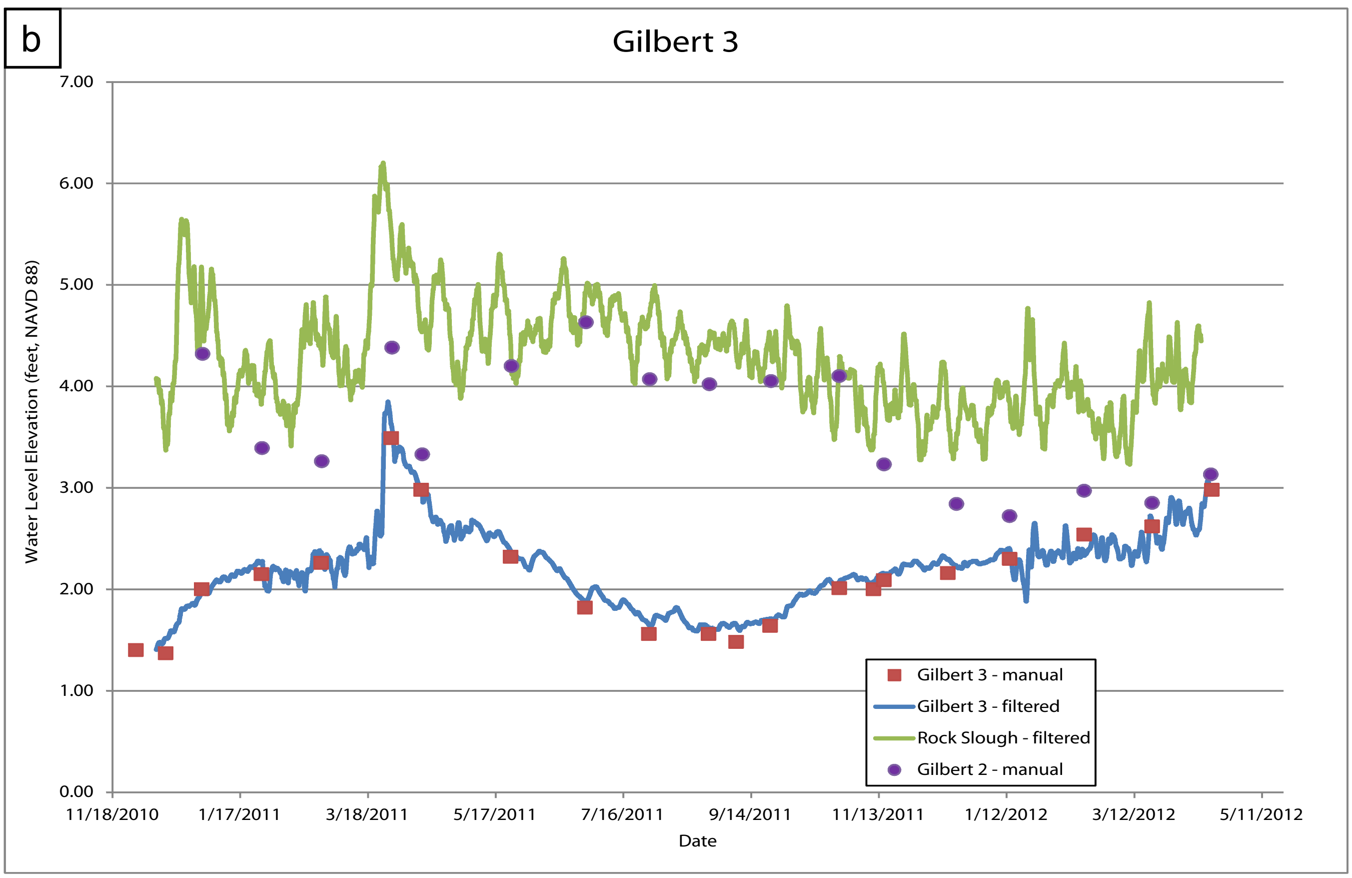
HYDROFOCUS INC. Solutions for Land and Water Resources	Contra Costa Canal and Rock Slough Stage Data Comparison	Figure 3
PROJECT: 5565	DATE: 5/1/12	





HYDROFOCUS INC. Solutions for Land and Water Resources	Emerson 2 Groundwater Levels.	Figure 4
PROJECT: 5565	DATE: 5/1/12	





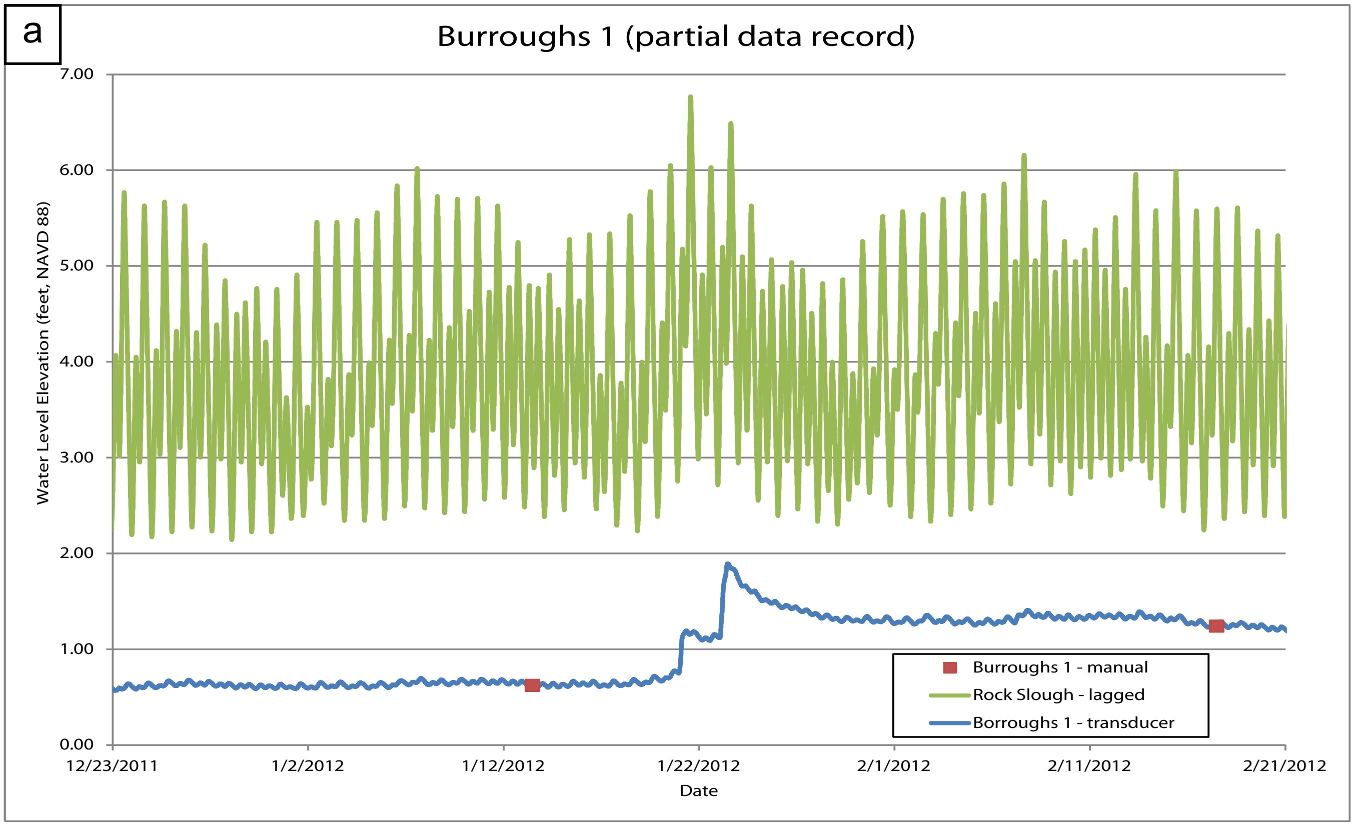
HYDROFOCUS INC.
Solutions for Land and Water Resources

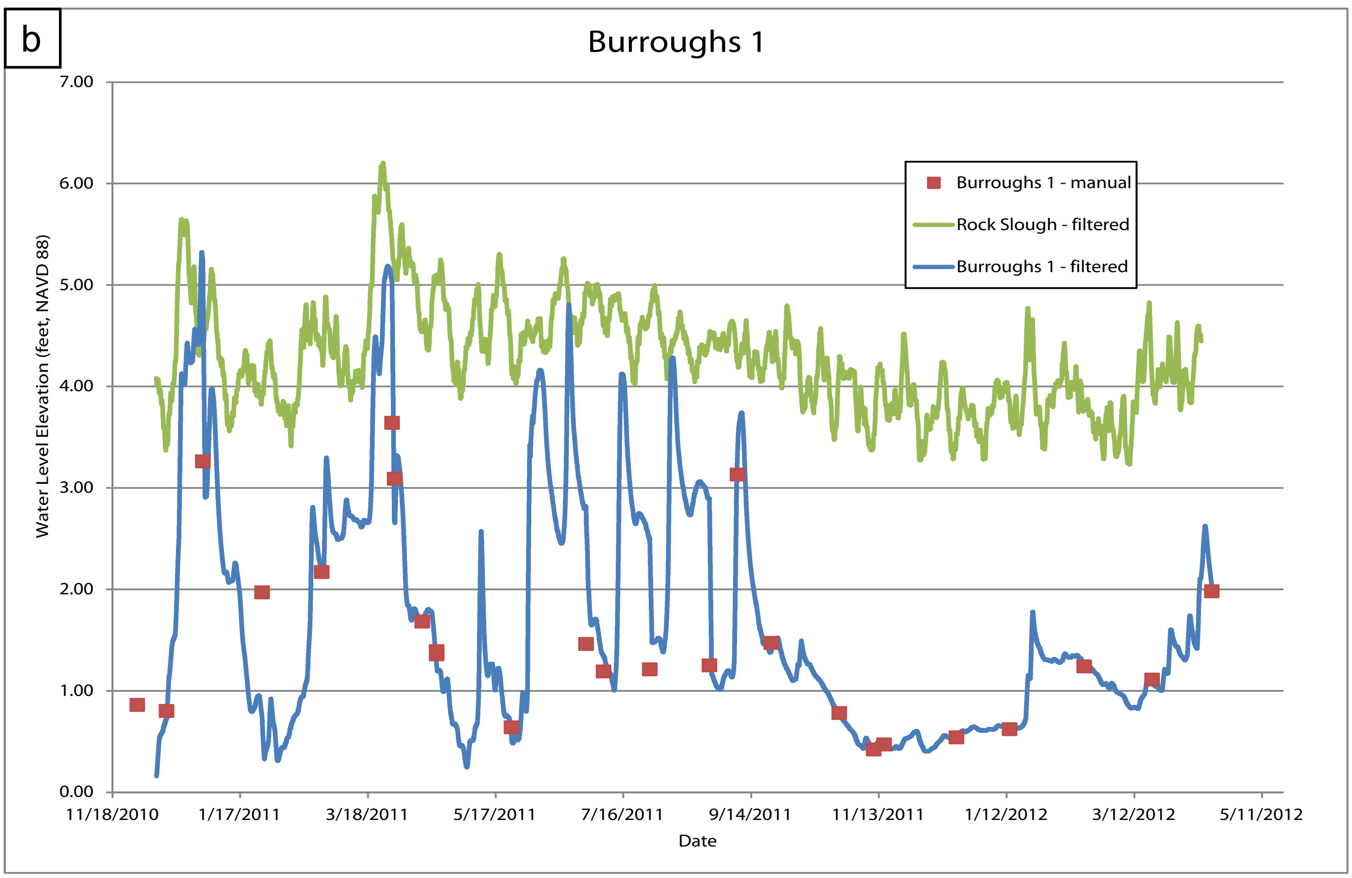
Gilbert 3 Groundwater Levels.

Figure 5

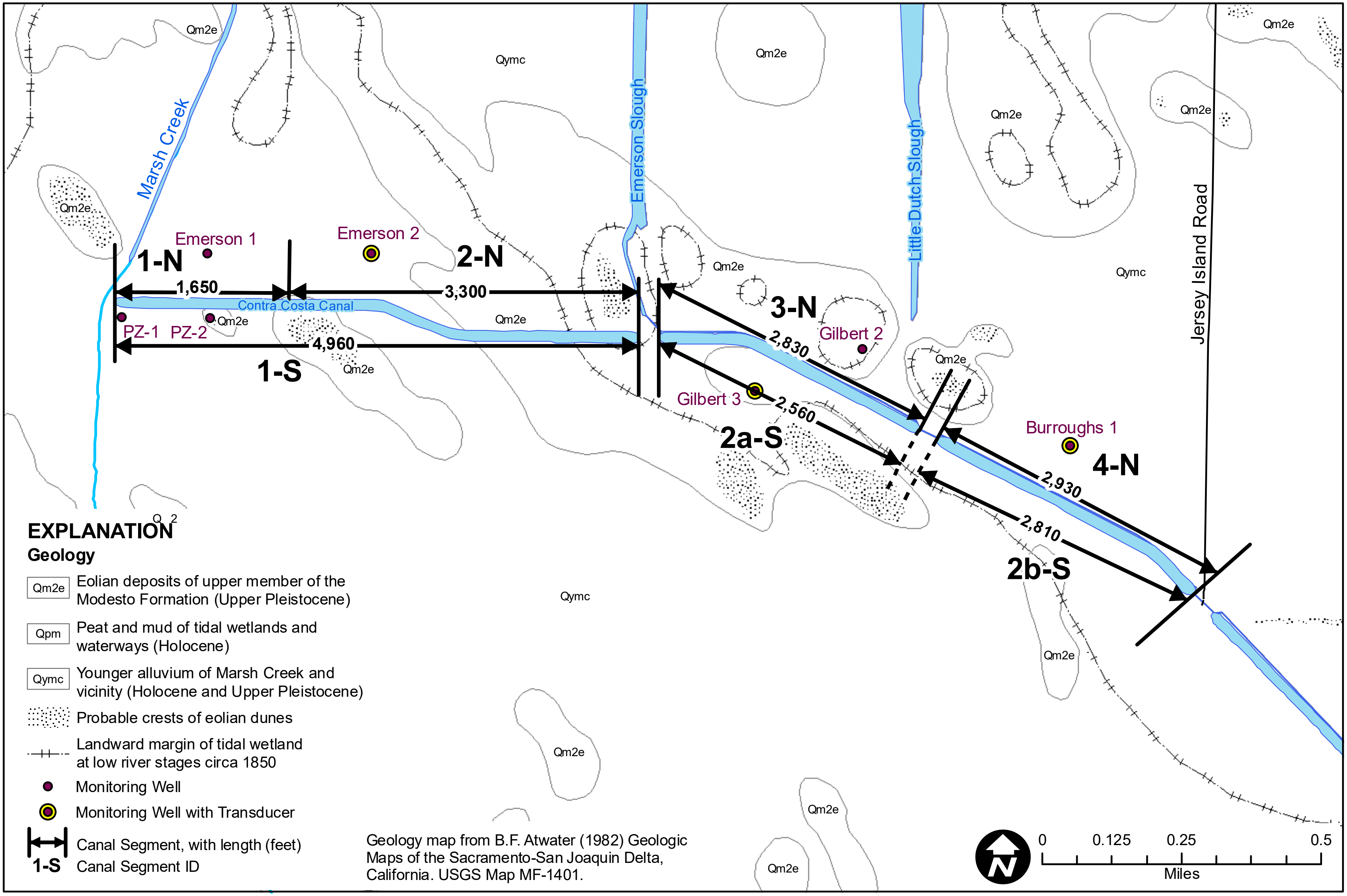
PROJECT: 5565

DATE: 5/1/12





HYDROFOCUS INC. Solutions for Land and Water Resources	Burroughs 1 Groundwwater Levels.	Figure 6
PROJECT: 5565	DATE: 5/1/12	



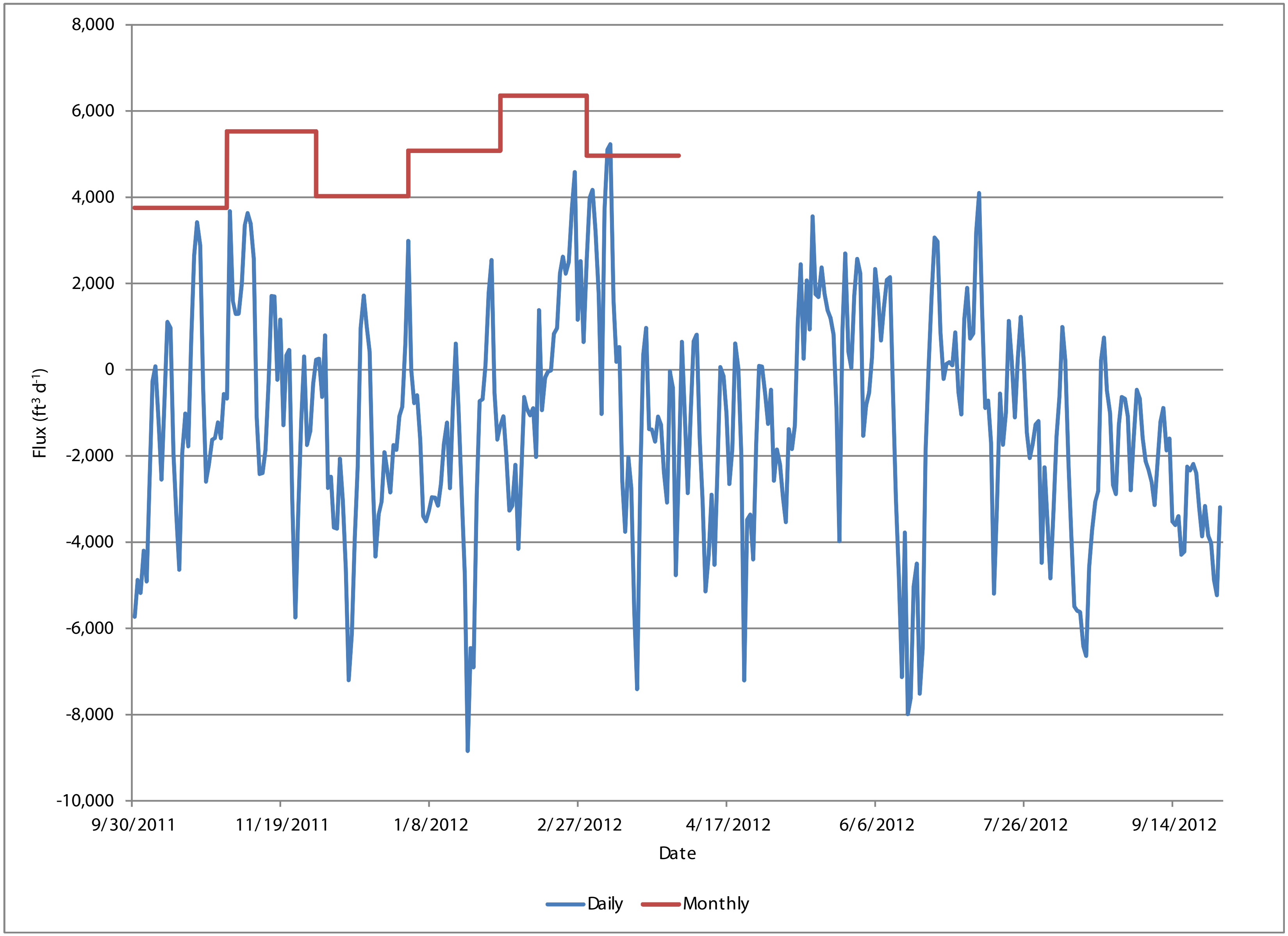
HYDROFOCUS INC.
Solutions for Land and Water Resources

Canal Segments for Seepage Analysis.

Figure 7

PROJECT: 5565

DATE: 5/2/12



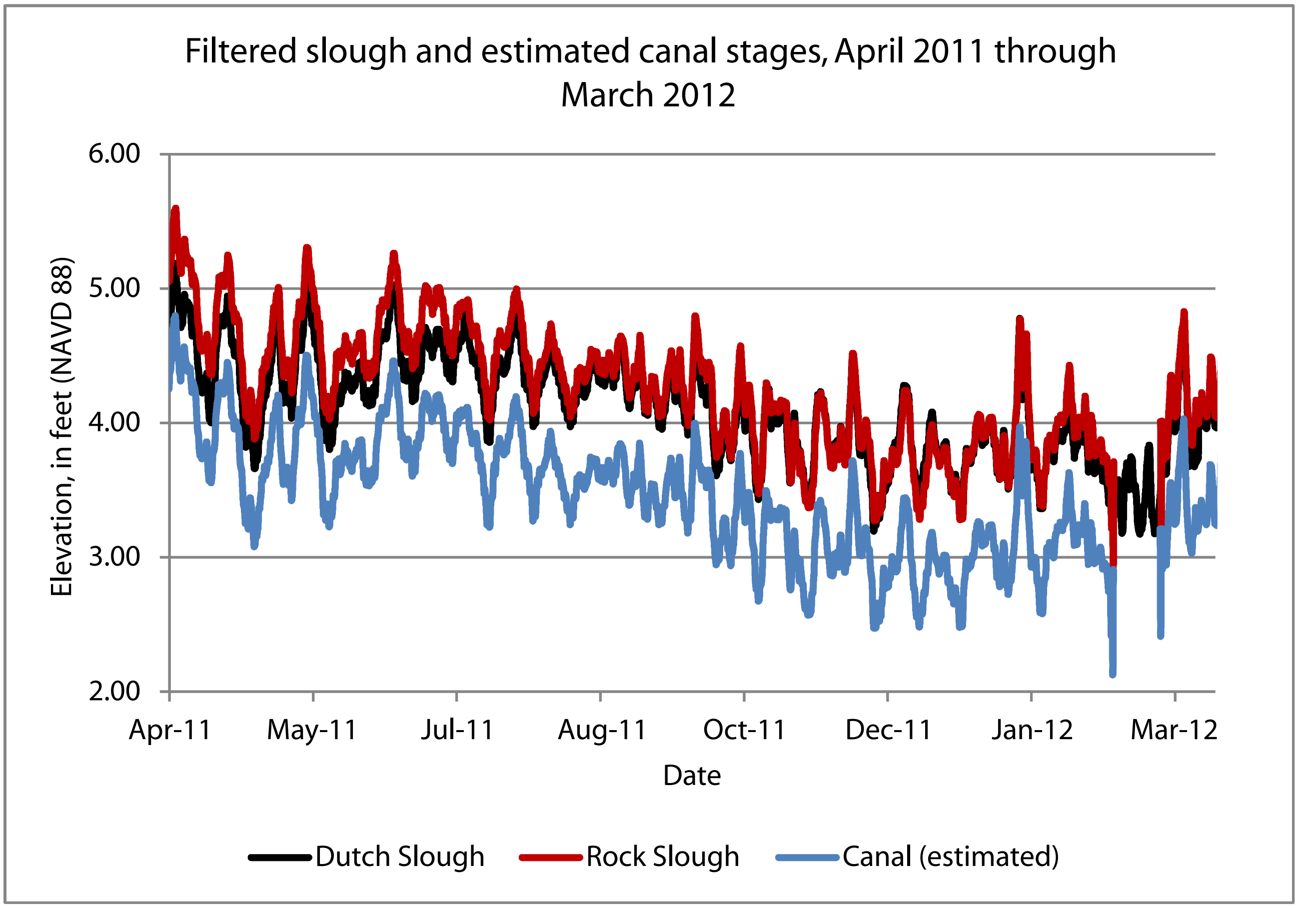
HYDROFOCUS INC. Solutions for Land and Water Resources

Estimated daily and monthly groundwater flux to the canal for existing conditions.

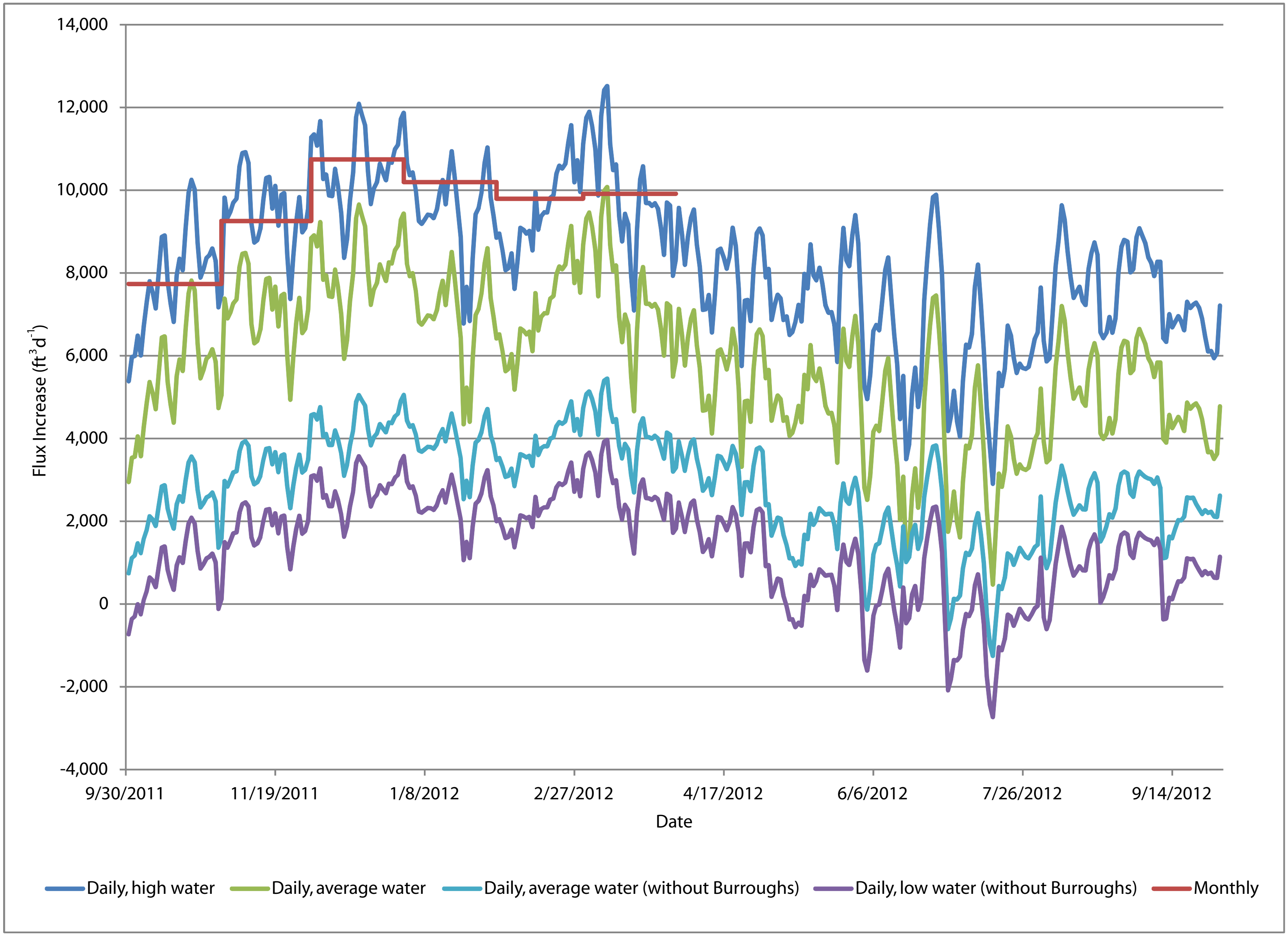
Figure 8

PROJECT: 5565

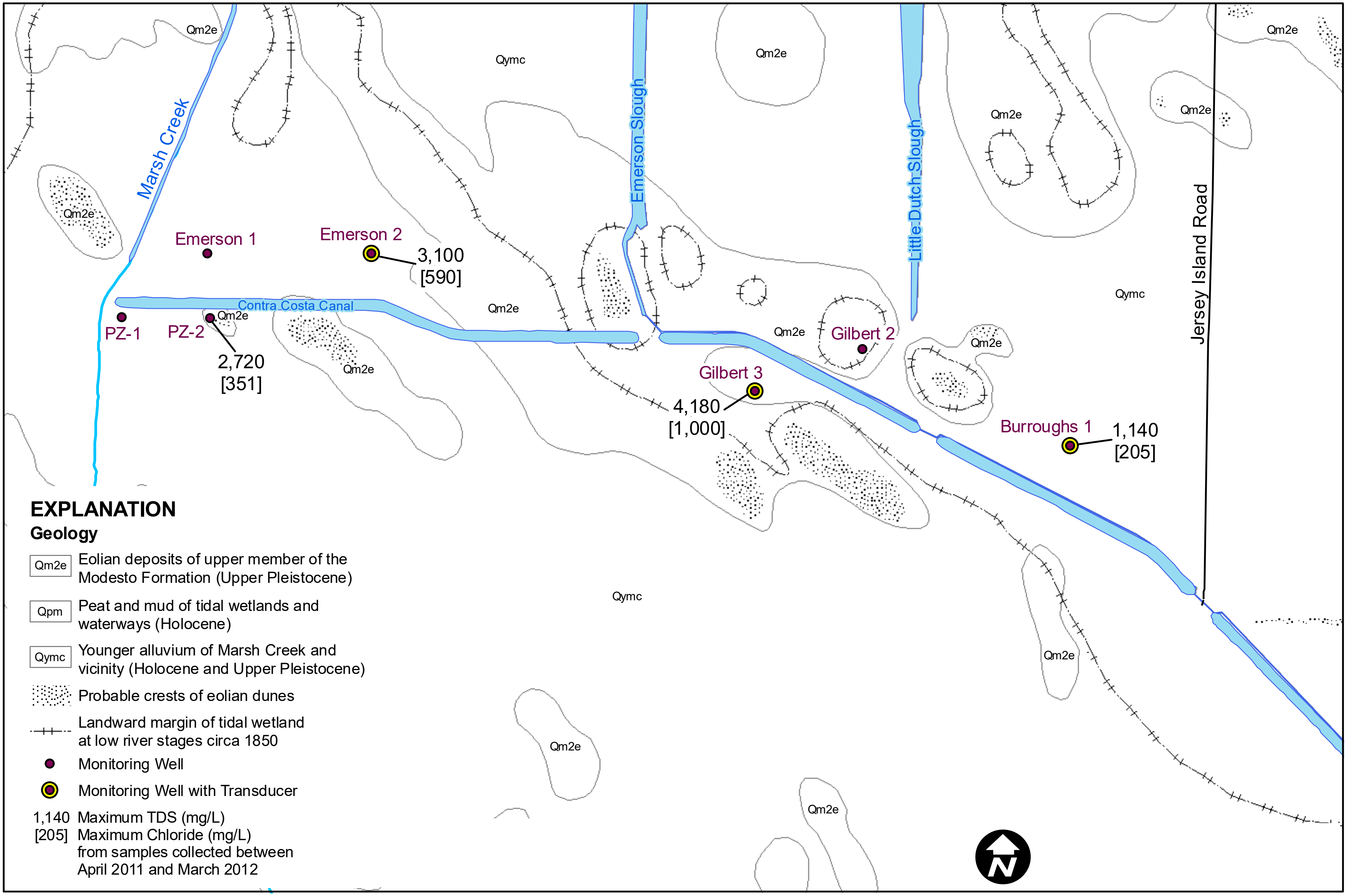
DATE: 1/25/13



HYDROFOCUS INC. Solutions for Land and Water Resources	Filtered Slough and Estimated Canal Stages	Figure 9
PROJECT: 5565	DATE: 6/27/12	



HYDROFOCUS INC. Solutions for Land and Water Resources	Estimated daily increased groundwater flux to the Contra Costa Canal with tule cultivation.	Figure 10
PROJECT: 5565	DATE: 1/31/13	



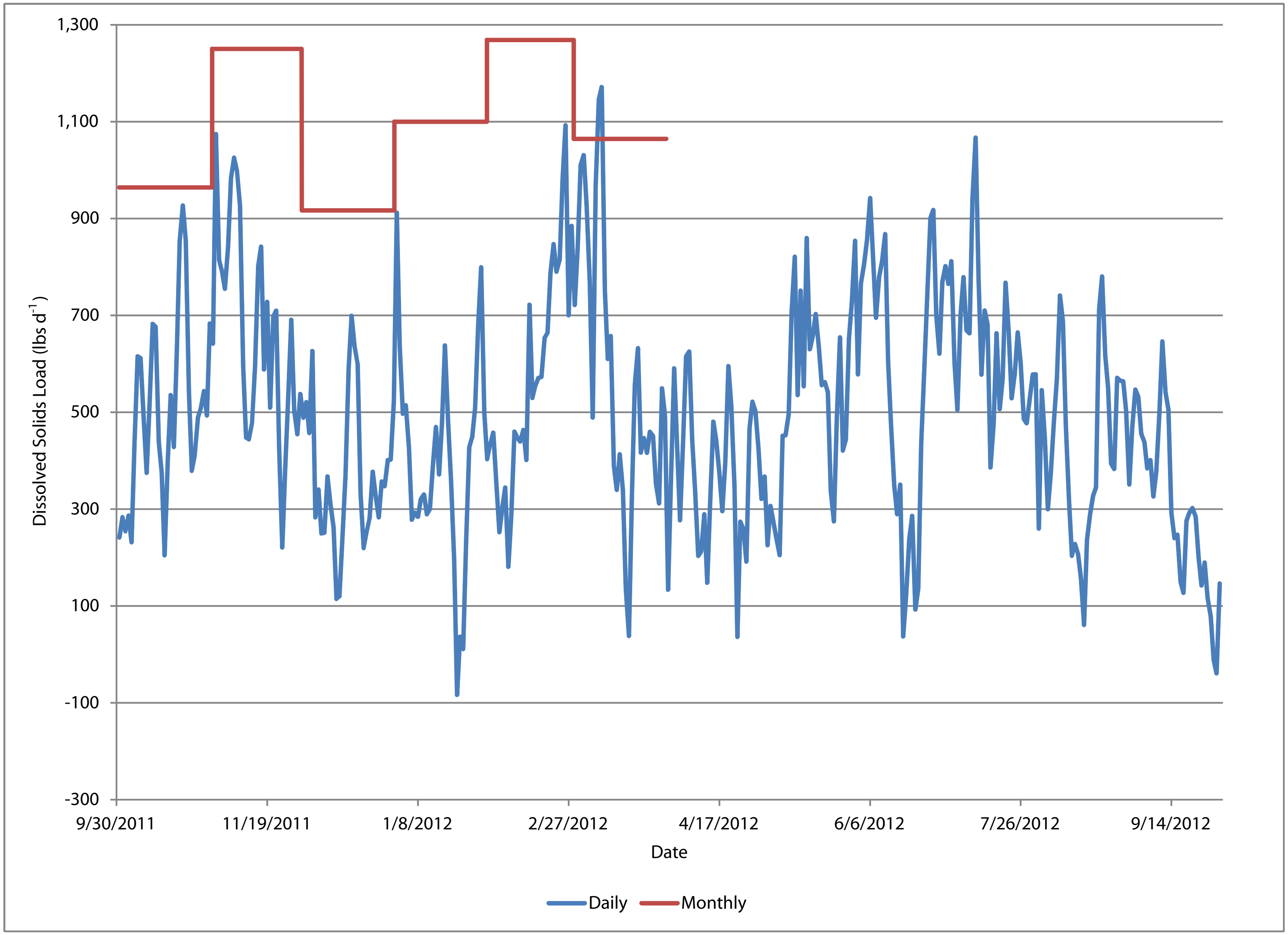
HYDROFOCUS INC. Solutions for Land and Water Resources

Maximum Total Dissolved Solids and Chloride Values from Wells.

Figure 11

PROJECT: 5565

DATE: 6/27/12



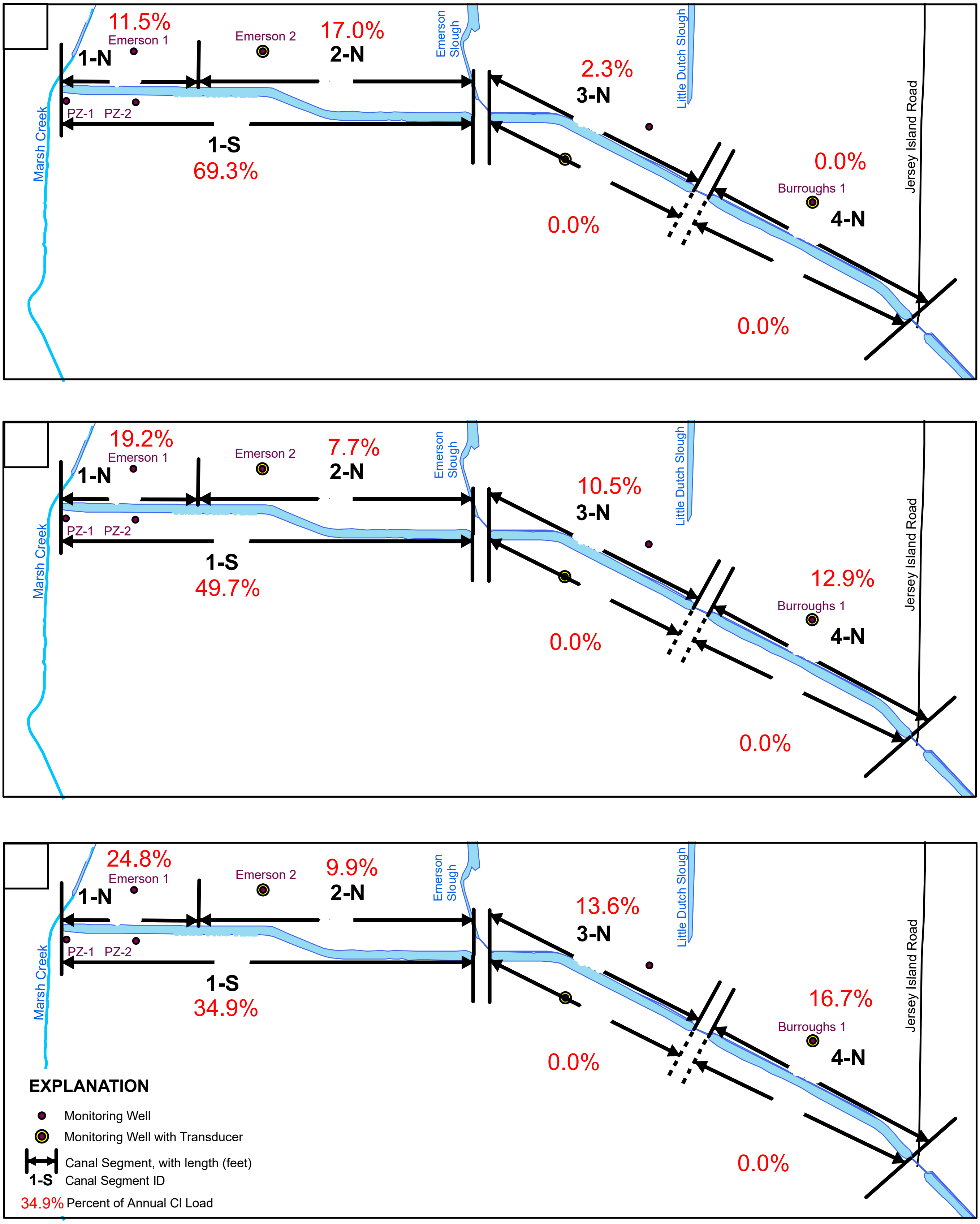
HYDROFOCUS INC. Solutions for Land and Water Resources

Estimated daily dissolved solids load into the Contra Costa Canal for existing conditions.

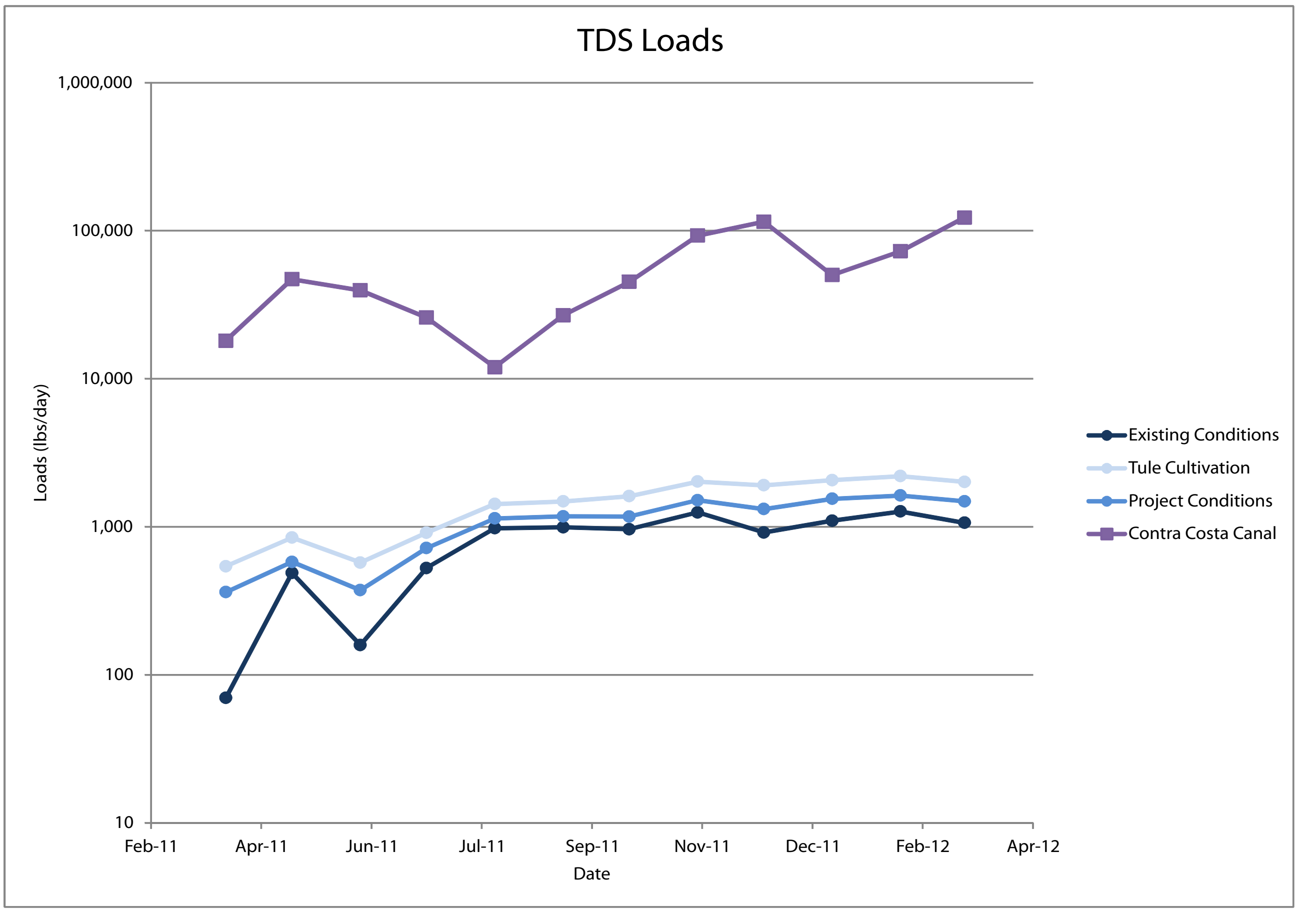
Figure 12

PROJECT: 5565

DATE: 2/1/13



HYDROFOCUS INC. Solutions for Land and Water Resources	Percentages of the Total Annual Chloride Load to the Contra Costa Canal.	Figure 13
PROJECT: 5565	DATE: 7/13/12	



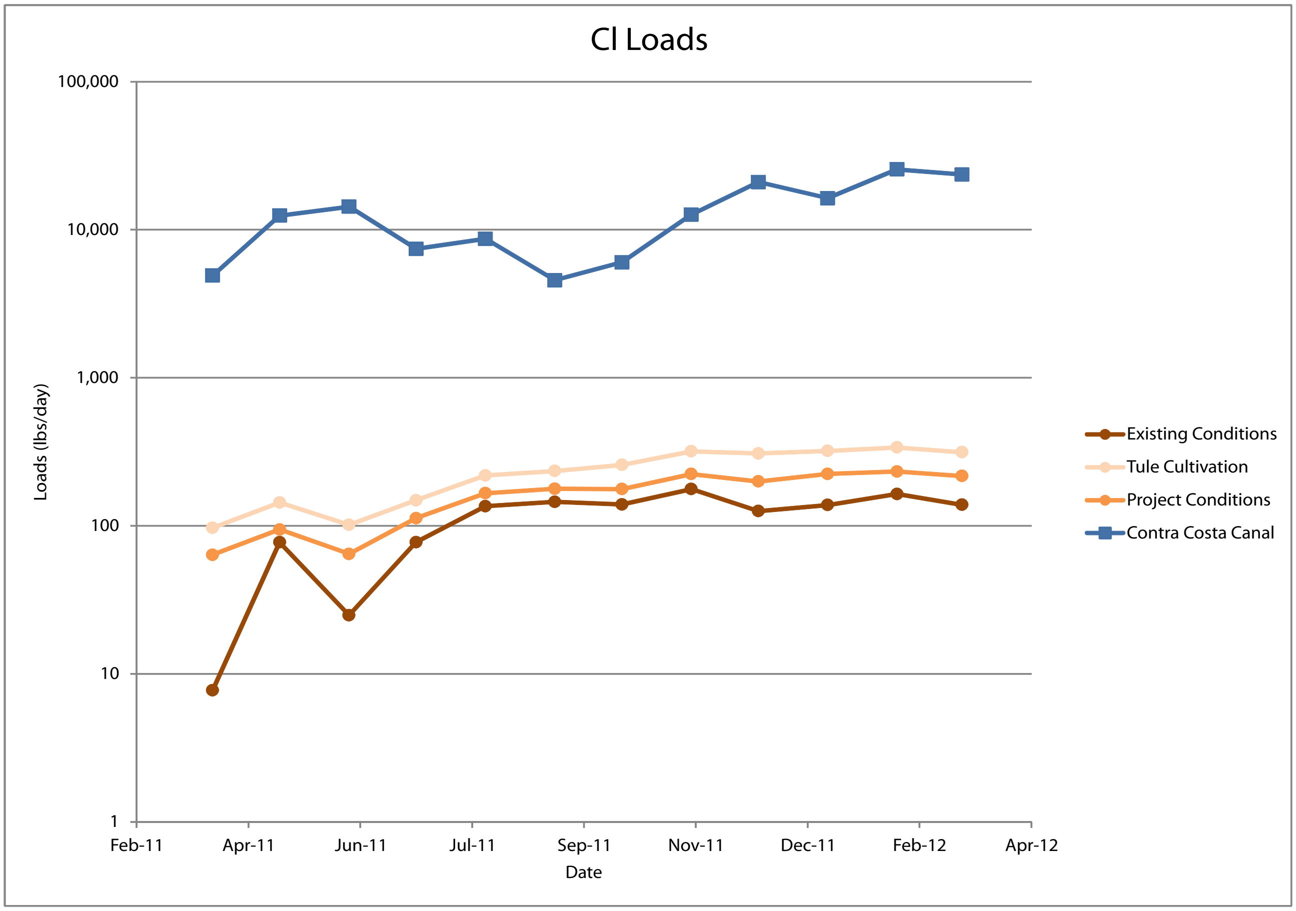
HYDROFOCUS INC. Solutions for Land and Water Resources

Estimated Dissolved Solids Loads.

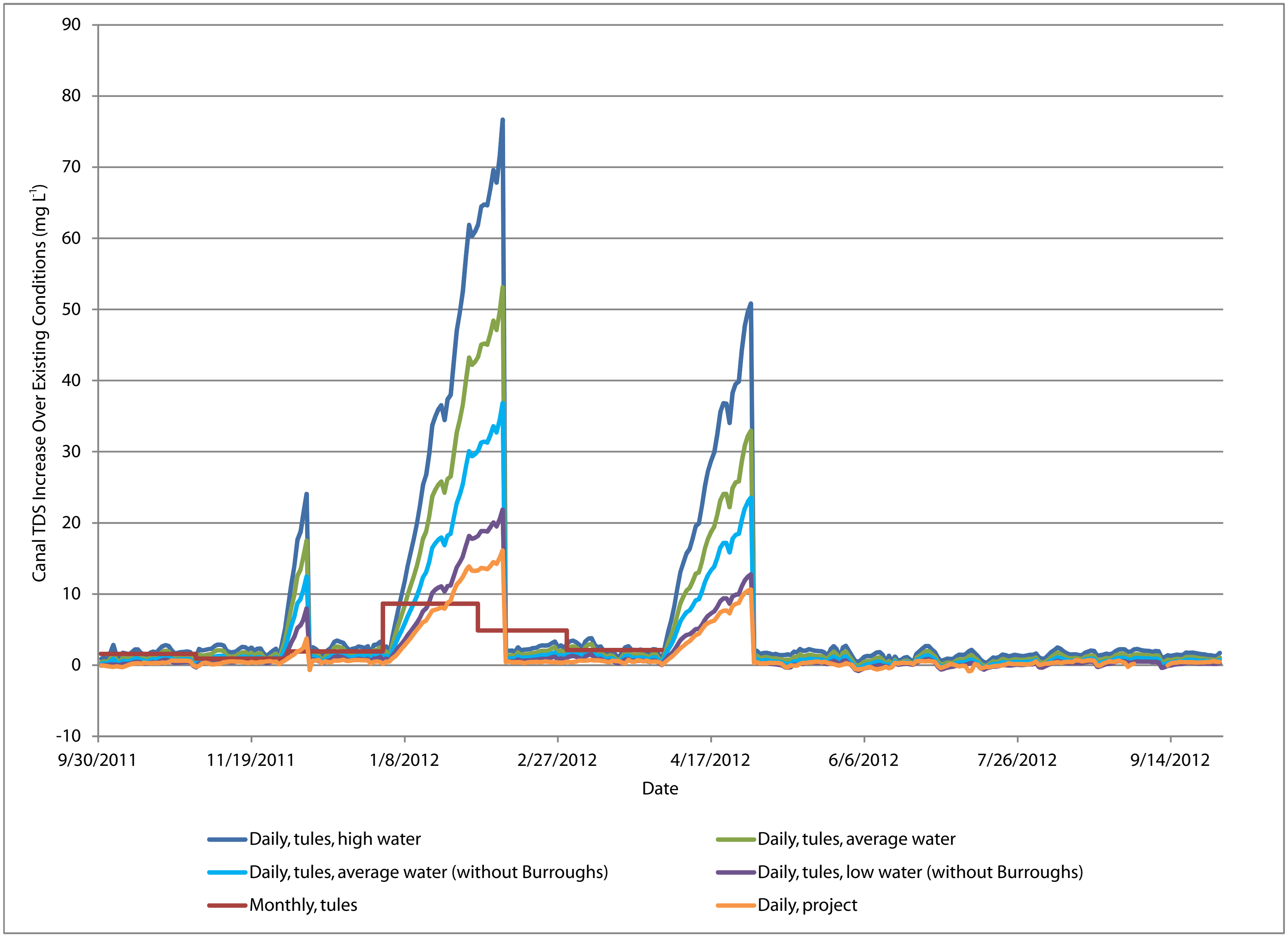
Figure 14

PROJECT: 5565

DATE: 7/13/12



HYDROFOCUS INC. Solutions for Land and Water Resources	Estimated Chloride Loads.	Figure 15
PROJECT: 5565	DATE: 7/13/12	



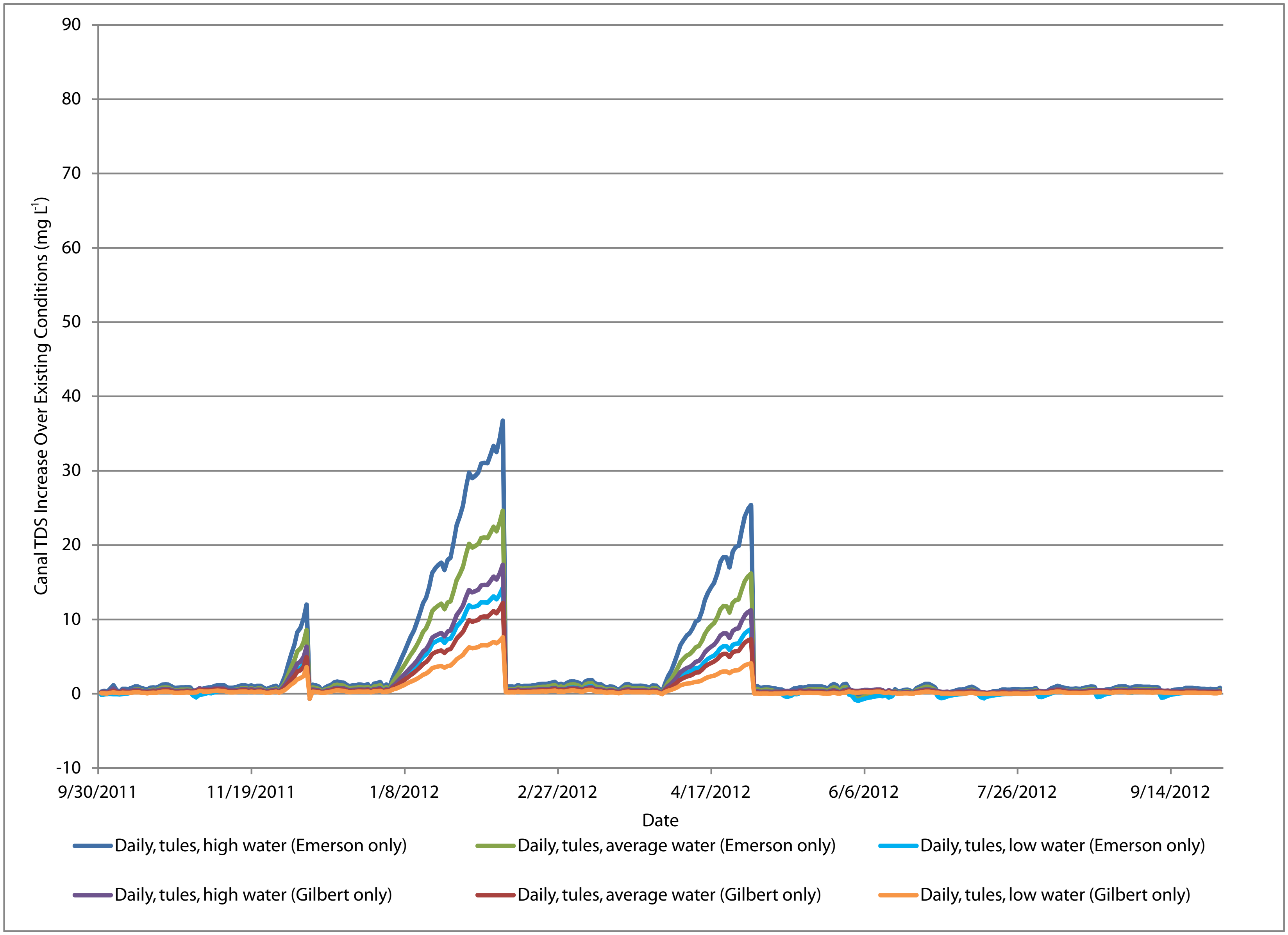
HYDROFOCUS INC. Solutions for Land and Water Resources

Estimated daily and monthly increase in total dissolved solids concentrations in the Contra Costa Canal with tule cultivation.

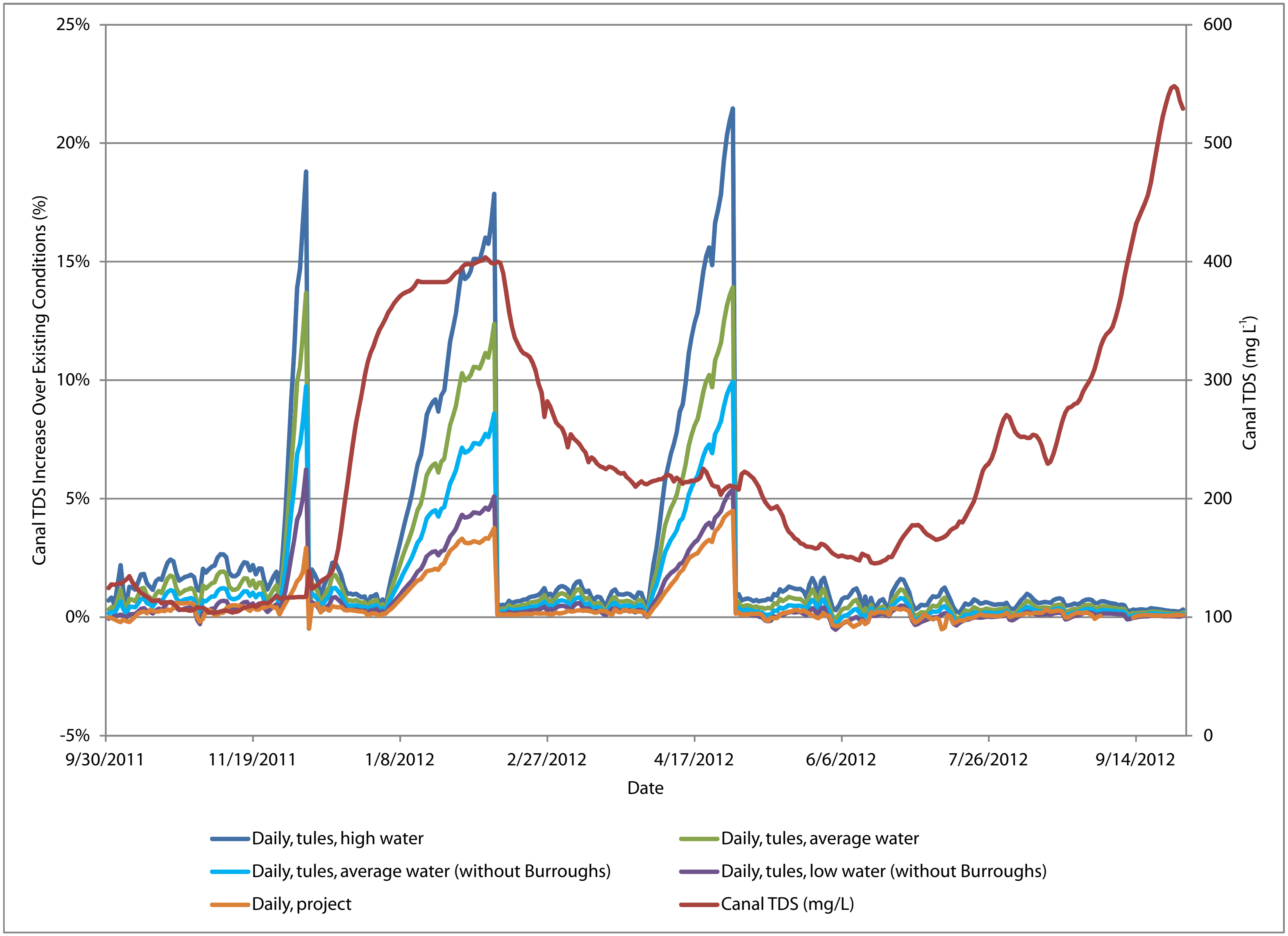
Figure 16a

PROJECT: 5565

DATE: 2/1/13



HYDROFOCUS INC. Solutions for Land and Water Resources	Estimated daily and monthly increase in total dissolved solids concentrations in the Contra Costa Canal with tule cultivation.	Figure 16b
PROJECT: 5565	DATE: 2/1/13	



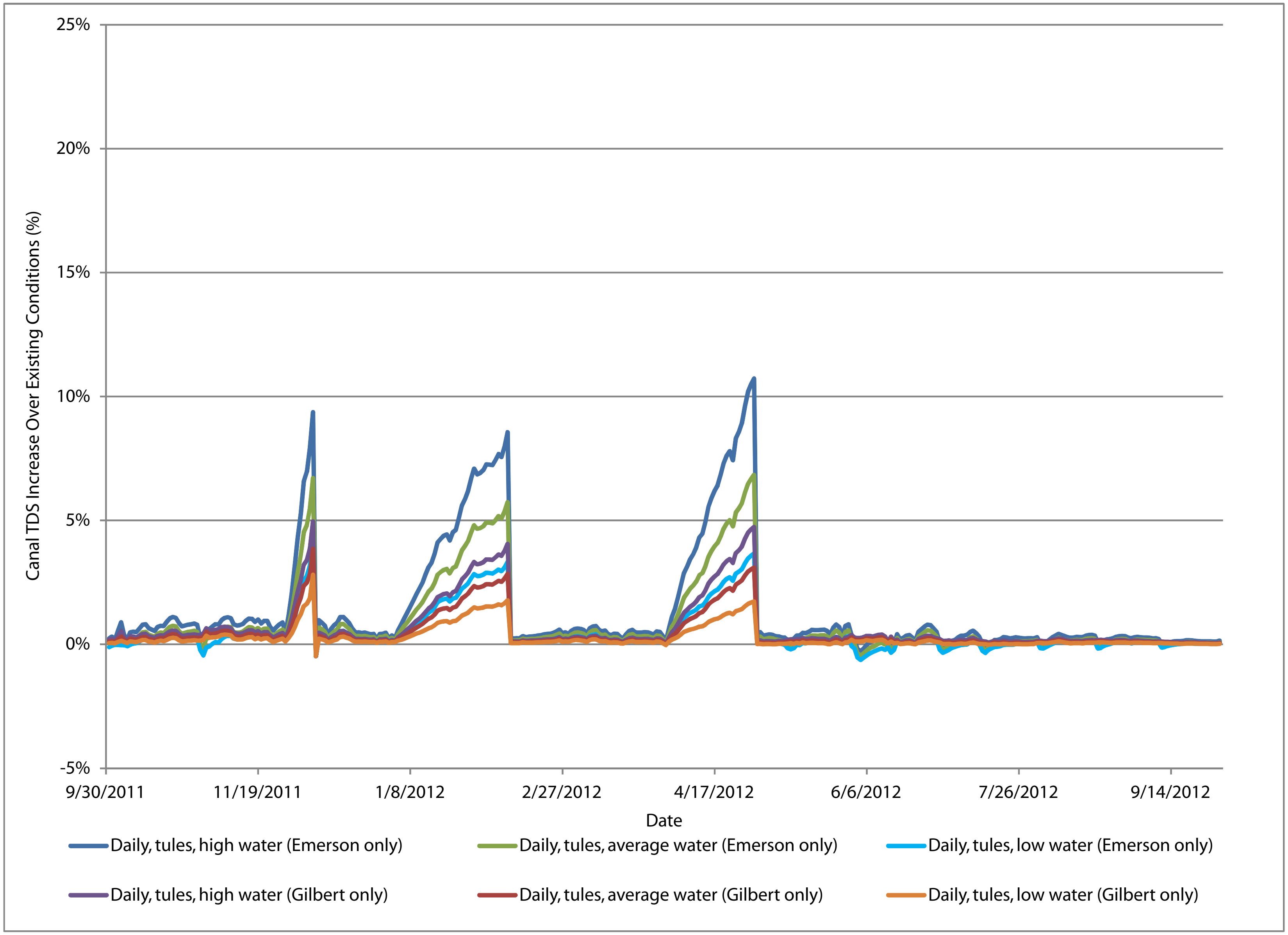
HYDROFOCUS INC.
Solutions for Land and Water Resources

Estimated percent daily increase in total dissolved solids concentrations in the Contra Costa Canal with the Project and tule cultivation.

Figure 17a

PROJECT: 5565

DATE: 2/1/13



HYDROFOCUS INC. Solutions for Land and Water Resources	Estimated percent daily increase in total dissolved solids concentrations in the Contra Costa Canal with tule cultivation.	Figure 17b
PROJECT: 5565	DATE: 2/1/13	

APPENDICES

APPENDIX A - Existing Conditions

	Segment 1-N (1,650 ft)				Segment 2-N (3,300 ft)				Segment 3-N (2,830 ft)				Segment 4-N (2,930 ft)			
	Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	-0.0005	0.0009	-5	111	0.0001	0.0015	2	354	-0.0030	-0.0013	-50	-269	-0.0061	-0.0048	-107	-1013
May	0.0047	0.0061	46	729	0.0021	0.0035	41	823	0.0001	0.0017	2	353	-0.0069	-0.0057	-122	-1192
Jun	-0.0005	0.0009	-5	108	0.0013	0.0027	25	632	0.0009	0.0025	15	515	-0.0023	-0.0010	-40	-217
Jul	0.0013	0.0028	13	329	0.0018	0.0032	35	751	-0.0006	0.0011	-10	218	-0.0044	-0.0031	-77	-656
Aug	0.0060	0.0075	60	887	0.0009	0.0023	17	537	0.0000	0.0017	1	342	-0.0032	-0.0019	-56	-407
Sep	0.0024	0.0038	24	456	0.0026	0.0039	50	938	0.0003	0.0020	5	399	-0.0044	-0.0031	-77	-656
Oct	0.0019	0.0034	19	402	0.0017	0.0031	34	738	0.0011	0.0027	18	555	-0.0057	-0.0044	-100	-927
Nov	0.0023	0.0037	22	443	0.0021	0.0035	42	837	-0.0006	0.0010	-11	205	-0.0063	-0.0050	-110	-1057
Dec	0.0010	0.0025	10	295	0.0004	0.0018	8	422	-0.0012	0.0005	-20	93	-0.0058	-0.0045	-101	-951
Jan	0.0002	0.0016	2	196	-0.0003	0.0011	-6	260	-0.0020	-0.0004	-34	-78	-0.0054	-0.0042	-95	-876
Feb	0.0010	0.0025	10	296	-0.0002	0.0012	-3	292	-0.0013	0.0003	-22	66	-0.0047	-0.0034	-82	-716
Mar-12	0.0004	0.0018	4	219	-0.0011	0.0002	-23	59	-0.0019	-0.0002	-32	-50	-0.0052	-0.0040	-92	-840
	Seepage	ft3	6,400	135,959			7,725	202,035			1,248	83,494			0	0
		ft3/d	18	372			21	554			3	229			0	0
	Leakage	ft3	-320	0			-974	0			-5,457	-397			-32,226	-289,229
		ft3/d	-1	0			-3	0			-15	-1			-88	-792

	Segment 1-S (4,960 ft)				Segment 2-S (5,380 ft)				Sum of All Segments	
	Gradient		Flux (Qs)		Gradient		Flux (Qs)		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	-0.0074	0.0005	-220	162	-0.0045	-0.0027	-145	-1062	-525	-1717
May	-0.0045	0.0033	-135	1189	-0.0049	-0.0032	-158	-1220	-326	681
Jun	-0.0078	0.0001	-231	35	-0.0063	-0.0046	-203	-1764	-440	-691
Jul	-0.0025	0.0054	-74	1919	-0.0072	-0.0054	-231	-2092	-343	469
Aug	0.0035	0.0114	105	4069	-0.0068	-0.0050	-219	-1953	-93	3474
Sep	0.0039	0.0118	117	4205	-0.0066	-0.0048	-212	-1867	-93	3474
Oct	0.0040	0.0118	118	4220	-0.0049	-0.0032	-160	-1237	-70	3750
Nov	0.0086	0.0165	257	5890	-0.0038	-0.0021	-123	-795	78	5523
Dec	0.0051	0.0130	153	4641	-0.0030	-0.0012	-96	-475	-47	4027
Jan	0.0095	0.0174	284	6211	-0.0034	-0.0016	-110	-637	41	5075
Feb	0.0116	0.0194	345	6946	-0.0031	-0.0014	-100	-528	147	6355
Mar-12	0.0092	0.0170	273	6081	-0.0031	-0.0013	-99	-505	31	4963
	Seepage	ft3	50,232	1,386,183			0	0	297	37,791
		ft3/d	138	3,798			0	0	1	104
	Leakage	ft3	-20,073	0			-56,447	-430,017	-1,937	-2,408
		ft3/d	-55	0			-155	-1,178	-5	-7

APPENDIX A - Project Conditions

	Segment 1-N (1,650 ft)				Segment 2-N (3,300 ft)				Segment 3-N (2,830 ft)				Segment 4-N (2,930 ft)			
	Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	0.0007	0.0057	7	683	0.0001	0.0011	3	273	0.0007	0.0053	12	1081	0.0008	0.0063	14	1323
May	0.0014	0.0064	14	761	0.0003	0.0013	6	304	0.0013	0.0059	22	1205	0.0015	0.0070	27	1474
Jun	0.0013	0.0063	13	750	0.0003	0.0013	5	300	0.0012	0.0058	21	1187	0.0014	0.0069	25	1453
Jul	0.0016	0.0066	16	787	0.0003	0.0013	6	315	0.0015	0.0061	25	1245	0.0018	0.0072	31	1524
Aug	0.0024	0.0074	24	882	0.0005	0.0015	10	353	0.0022	0.0069	38	1396	0.0026	0.0081	46	1708
Sep	0.0027	0.0077	27	913	0.0005	0.0015	11	365	0.0025	0.0071	42	1446	0.0029	0.0084	52	1769
Oct	0.0025	0.0075	25	888	0.0005	0.0015	10	355	0.0023	0.0069	39	1406	0.0027	0.0082	47	1721
Nov	0.0033	0.0083	33	988	0.0007	0.0017	13	395	0.0031	0.0077	52	1564	0.0036	0.0091	64	1914
Dec	0.0036	0.0086	36	1025	0.0007	0.0017	14	410	0.0033	0.0080	57	1623	0.0040	0.0094	70	1986
Jan	0.0032	0.0082	32	974	0.0006	0.0016	13	390	0.0030	0.0076	50	1542	0.0035	0.0089	61	1887
Feb	0.0024	0.0074	24	881	0.0005	0.0015	10	353	0.0022	0.0068	38	1395	0.0026	0.0081	46	1707
Mar-12	0.0025	0.0075	24	886	0.0005	0.0015	10	355	0.0023	0.0069	39	1403	0.0027	0.0081	47	1717
	Seepage	ft3	7,720	316,929			2,363	126,772			4,913	379,280			0	0
		ft3/d	21	868			6	347			13	1,039			0	0
	Leakage	ft3	621	0			973	0			8,293	4,027			16,159	613,952
		ft3/d	2	0			3	0			23	11			44	1,682

	Segment 1-S (4,960 ft)				Segment 2-S (5,380 ft)				Sum of All Segments	
	Gradient		Flux (Qs)		Gradient		Flux (Qs)		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	-0.0074	0.0005	-220	162	-0.0045	-0.0027	-145	-1062	-329	2461
May	-0.0045	0.0033	-135	1189	-0.0049	-0.0032	-158	-1220	-224	3714
Jun	-0.0078	0.0001	-231	35	-0.0063	-0.0046	-203	-1764	-370	1961
Jul	-0.0025	0.0054	-74	1919	-0.0072	-0.0054	-231	-2092	-226	3697
Aug	0.0035	0.0114	105	4069	-0.0068	-0.0050	-219	-1953	4	6455
Sep	0.0039	0.0118	117	4205	-0.0066	-0.0048	-212	-1867	35	6831
Oct	0.0040	0.0118	118	4220	-0.0049	-0.0032	-160	-1237	79	7353
Nov	0.0086	0.0165	257	5890	-0.0038	-0.0021	-123	-795	296	9957
Dec	0.0051	0.0130	153	4641	-0.0030	-0.0012	-96	-475	234	9211
Jan	0.0095	0.0174	284	6211	-0.0034	-0.0016	-110	-637	330	10365
Feb	0.0116	0.0194	345	6946	-0.0031	-0.0014	-100	-528	362	10755
Mar-12	0.0092	0.0170	273	6081	-0.0031	-0.0013	-99	-505	294	9937
	Seepage	ft3	50,232	1,386,183			0	0	1,282	78,273
		ft3/d	138	3,798			0	0	4	214
	Leakage	ft3	-20,073	0			-56,447	-430,017	-797	4,422
		ft3/d	-55	0			-155	-1,178	-2	12

APPENDIX A - Tule Cultivation

	Segment 1-N (1,650 ft)				Segment 2-N (3,300 ft)				Segment 3-N (2,830 ft)				Segment 4-N (2,930 ft)			
	Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)		Gradient		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	0.0036	0.0086	36	1025	0.0007	0.0017	14	410	0.0033	0.0080	57	1623	0.0040	0.0094	70	1986
May	0.0057	0.0107	56	1270	0.0011	0.0021	23	508	0.0052	0.0099	89	2010	0.0062	0.0117	109	2459
Jun	0.0045	0.0095	45	1132	0.0009	0.0019	18	453	0.0042	0.0088	71	1793	0.0049	0.0104	87	2194
Jul	0.0048	0.0098	47	1159	0.0010	0.0020	19	464	0.0044	0.0090	75	1836	0.0052	0.0106	91	2246
Aug	0.0070	0.0120	70	1428	0.0014	0.0024	28	571	0.0065	0.0111	110	2261	0.0077	0.0131	135	2767
Sep	0.0076	0.0126	76	1500	0.0015	0.0025	30	600	0.0070	0.0117	120	2375	0.0083	0.0138	146	2906
Oct	0.0095	0.0145	94	1728	0.0019	0.0029	38	691	0.0088	0.0134	150	2735	0.0104	0.0159	183	3347
Nov	0.0116	0.0166	114	1968	0.0023	0.0033	46	787	0.0107	0.0153	181	3115	0.0126	0.0181	222	3812
Dec	0.0131	0.0181	130	2154	0.0026	0.0036	52	862	0.0121	0.0167	206	3411	0.0143	0.0198	252	4173
Jan	0.0116	0.0166	115	1970	0.0023	0.0033	46	788	0.0107	0.0153	182	3119	0.0126	0.0181	222	3816
Feb	0.0116	0.0166	115	1977	0.0023	0.0033	46	791	0.0107	0.0154	182	3130	0.0127	0.0182	223	3830
Mar-12	0.0109	0.0159	108	1890	0.0022	0.0032	43	756	0.0101	0.0147	171	2992	0.0119	0.0174	209	3662
	Seepage	ft3	28,149	584,113			8,131	233,645			16,408	689,505			0	0
		ft3/d	77	1,600			22	640			45	1,889			0	0
	Leakage	ft3	2,458	0			4,112	0			32,049	7,734			59,291	1,131,537
		ft3/d	7	0			11	0			88	21			162	3,100

	Segment 1-S (4,960 ft)				Segment 2-S (5,380 ft)			
	Gradient		Flux (Qs)		Gradient		Flux (Qs)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Apr-11	-0.0074	0.0005	-220	162	-0.0045	-0.0027	-145	-1062
May	-0.0045	0.0033	-135	1189	-0.0049	-0.0032	-158	-1220
Jun	-0.0078	0.0001	-231	35	-0.0063	-0.0046	-203	-1764
Jul	-0.0025	0.0054	-74	1919	-0.0072	-0.0054	-231	-2092
Aug	0.0035	0.0114	105	4069	-0.0068	-0.0050	-219	-1953
Sep	0.0039	0.0118	117	4205	-0.0066	-0.0048	-212	-1867
Oct	0.0040	0.0118	118	4220	-0.0049	-0.0032	-160	-1237
Nov	0.0086	0.0165	257	5890	-0.0038	-0.0021	-123	-795
Dec	0.0051	0.0130	153	4641	-0.0030	-0.0012	-96	-475
Jan	0.0095	0.0174	284	6211	-0.0034	-0.0016	-110	-637
Feb	0.0116	0.0194	345	6946	-0.0031	-0.0014	-100	-528
Mar-12	0.0092	0.0170	273	6081	-0.0031	-0.0013	-99	-505
	Seepage	ft3	50,232	1,386,183			0	0
		ft3/d	138	3,798			0	0
	Leakage	ft3	-20,073	0			-56,447	-430,017
		ft3/d	-55	0			-155	-1,178

	Sum of All Segments	
	Flux (Qs)	
	Minimum	Maximum
Apr-11	-189	4144
May	-16	6216
Jun	-214	3843
Jul	-73	5531
Aug	228	9144
Sep	276	9720
Oct	423	11484
Nov	698	14777
Dec	697	14767
Jan	738	15266
Feb	812	16145
Mar-12	706	14875
Seepage ft3	2,953	117,925
Seepage ft3/d	8	323
Leakage ft3	1,133	7,987
Leakage ft3/d	3	22

APPENDIX B - Estimated Maximum Monthly TDS and Cl Loads - Existing Conditions

	Segment 1-N (1,650 ft)		Segment 2-N (3,300 ft)		Segment 3-N (2,830 ft)		Segment 4-N (2,930 ft)	
	Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	22	4	69	13	-5	-1	-21	-6
May-11	141	27	159	30	25	5	-19	-5
Jun-11	21	4	122	23	37	7	-3	-1
Jul-11	64	12	145	28	16	3	-6	-2
Aug-11	172	33	104	20	24	4	-2	-2
Sep-11	88	17	181	35	28	5	-5	-1
Oct-11	78	15	143	27	39	7	-6	-1
Nov-11	86	16	162	31	15	3	-7	-1
Dec-11	57	11	82	16	7	1	-13	-2
Jan-12	38	7	50	10	-2	-1	-24	-8
Feb-12	57	11	57	11	5	1	-17	-6
Mar-12	42	8	11	2	-1	0	-14	-3
Average	72	14	107	20	16	3	-11	-3

	Segment 1-S (4,960 ft)		Segment 2-S (5,380 ft)	
	Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl
Apr-11	28	4	-22	-6
May-11	202	26	-20	-5
Jun-11	6	1	-24	-9
Jul-11	326	42	-19	-5
Aug-11	691	89	-11	-8
Sep-11	714	92	-14	-2
Oct-11	717	92	-8	-1
Nov-11	1,000	129	-5	-1
Dec-11	788	101	-6	-1
Jan-12	1,055	136	-18	-6
Feb-12	1,180	152	-12	-4
Mar-12	1,033	133	-8	-2
Average	645	83	-14	-4

Sum of All Segments	
Maximum Loads In (lbs/d)	
TDS	Cl
70	8
489	77
159	25
526	78
977	136
993	145
962	139
1,251	177
915	126
1,099	138
1,269	164
1,063	139
815	113

APPENDIX B - Estimated Maximum Monthly TDS and Cl Loads - Project Conditions

	Segment 1-N (1,650 ft) Maximum Loads In (lbs/d)		Segment 2-N (3,300 ft) Maximum Loads In (lbs/d)		Segment 3-N (2,830 ft) Maximum Loads In (lbs/d)		Segment 4-N (2,930 ft) Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	132	25	53	10	77	14	94	17
May-11	147	28	59	11	86	15	105	19
Jun-11	145	28	58	11	85	15	103	19
Jul-11	152	29	61	12	89	16	108	20
Aug-11	171	32	68	13	99	18	122	22
Sep-11	177	34	71	13	103	19	126	23
Oct-11	172	33	69	13	100	18	122	22
Nov-11	191	36	77	15	111	20	136	25
Dec-11	198	38	79	15	116	21	141	25
Jan-12	189	36	75	14	110	20	134	24
Feb-12	171	32	68	13	99	18	122	22
Mar-12	172	33	69	13	100	18	122	22
Average	168	32	67	13	98	18	120	22

	Segment 1-S (4,960 ft) Maximum Loads In (lbs/d)		Segment 2-S (5,380 ft) Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl
Apr-11	28	4	-22	-6
May-11	202	26	-20	-5
Jun-11	6	1	-24	-9
Jul-11	326	42	-19	-5
Aug-11	691	89	-11	-8
Sep-11	714	92	-14	-2
Oct-11	717	92	-8	-1
Nov-11	1,000	129	-5	-1
Dec-11	788	101	-6	-1
Jan-12	1,055	136	-18	-6
Feb-12	1,180	152	-12	-4
Mar-12	1,033	133	-8	-2
Average	645	83	-14	-4

Sum of All Segments Maximum Loads In (lbs/d)	
TDS	Cl
362	64
579	94
373	65
718	113
1,140	166
1,176	178
1,172	177
1,511	224
1,317	199
1,545	224
1,627	233
1,487	217
1,084	163

APPENDIX B - Estimated Maximum Monthly TDS and Cl Loads - Tule Cultivation

	Segment 1-N (1,650 ft)		Segment 2-N (3,300 ft)		Segment 3-N (2,830 ft)		Segment 4-N (2,930 ft)	
	Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	198	38	79	15	116	21	141	25
May-11	246	47	98	19	143	26	175	31
Jun-11	219	42	88	17	128	23	156	28
Jul-11	224	43	90	17	131	23	160	29
Aug-11	276	53	111	21	161	29	197	35
Sep-11	290	55	116	22	169	30	207	37
Oct-11	334	64	134	25	195	35	238	43
Nov-11	381	72	152	29	222	40	271	49
Dec-11	417	79	167	32	243	44	297	53
Jan-12	381	73	153	29	222	40	272	49
Feb-12	383	73	153	29	223	40	273	49
Mar-12	366	70	146	28	213	38	261	47
Average	310	59	124	24	180	32	221	40

	Segment 1-S (4,960 ft)		Segment 2-S (5,380 ft)		Sum of All Segments	
	Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)		Maximum Loads In (lbs/d)	
	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	28	4	-22	-6	541	97
May-11	202	26	-20	-5	845	143
Jun-11	6	1	-24	-9	573	102
Jul-11	326	42	-19	-5	912	149
Aug-11	691	89	-11	-8	1,425	219
Sep-11	714	92	-14	-2	1,483	235
Oct-11	717	92	-8	-1	1,610	258
Nov-11	1,000	129	-5	-1	2,022	318
Dec-11	788	101	-6	-1	1,906	308
Jan-12	1,055	136	-18	-6	2,065	320
Feb-12	1,180	152	-12	-4	2,199	339
Mar-12	1,033	133	-8	-2	2,010	314
Average	645	83	-14	-4	1,466	233

APPENDIX C - Estimated TDS and Cl Concentration Changes - Project Conditions

	Load Change lbs/d		Prev. Canal Load lbs/d (or *lbs)*		Load Increase %		Flow or Volume	Total Load lbs/d (or *lbs*)		New Concentration mg/L		Meas. Conc. mg/L	
	TDS	Cl	TDS	Cl	TDS	Cl	ft^3/mo (or *ft* ^{3})	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	292	56	18,052	4,900	1.62%	1.14%	27,043,200	18,344	4,956	331	89	326	88
May-11	91	17	*47,018*	*12,451*	0.19%	0.14%	*2,918,520*	*47,109*	*12,468*	259	69	258	68
Jun-11	214	40	*39,546*	*14,315*	0.54%	0.28%	*2,918,520*	*39,760*	*14,355*	219	79	217	79
Jul-11	192	35	*25,878*	*7,419*	0.74%	0.47%	*2,918,520*	*26,070*	*7,454*	143	41	142	41
Aug-11	162	30	11,968	8,676	1.36%	0.35%	62,121,600	12,130	8,707	95	68	94	68
Sep-11	183	33	26,822	4,553	0.68%	0.72%	108,086,400	27,005	4,586	122	21	121	21
Oct-11	210	38	45,151	6,017	0.46%	0.63%	203,731,200	45,361	6,054	109	15	108	14
Nov-11	260	47	92,760	12,638	0.28%	0.37%	437,616,000	93,019	12,684	104	14	103	14
Dec-11	402	74	114,946	20,976	0.35%	0.35%	260,236,800	115,348	21,050	216	39	216	39
Jan-12	446	86	50,181	16,319	0.89%	0.53%	55,209,600	50,627	16,405	448	145	444	144
Feb-12	358	69	72,645	25,584	0.49%	0.27%	94,608,000	73,003	25,653	377	132	375	132
Mar-12	423	78	122,585	23,593	0.35%	0.33%	225,158,400	123,009	23,671	267	51	266	51

	Conc. Increase mg/L		Conc. Increase %	
	TDS	Cl	TDS	Cl
Apr-11	5.23	1.02	1.60%	1.15%
May-11	1.10	0.09	0.43%	0.14%
Jun-11	1.68	0.22	0.78%	0.28%
Jul-11	1.38	0.19	0.97%	0.47%
Aug-11	1.29	0.24	1.37%	0.36%
Sep-11	0.84	0.15	0.69%	0.73%
Oct-11	0.51	0.09	0.47%	0.63%
Nov-11	0.30	0.05	0.29%	0.38%
Dec-11	0.78	0.14	0.36%	0.36%
Jan-12	3.99	0.77	0.90%	0.54%
Feb-12	1.88	0.37	0.50%	0.28%
Mar-12	0.94	0.17	0.36%	0.34%
Average	1.66	0.29	0.73%	0.47%

APPENDIX C - Estimated TDS and Cl Concentration Changes - Tule Cultivation

	Load Change lbs/d		Prev. Canal Load lbs/d (or *lbs)*		Load Increase %		Flow or Volume	Total Load lbs/d (or *lbs*)		New Concentration mg/L		Meas. Conc. mg/L	
	TDS	Cl	TDS	Cl	TDS	Cl	ft^3/mo (or *ft* ^{3})	TDS	Cl	TDS	Cl	TDS	Cl
Apr-11	471	89	18,052	4,900	2.61%	1.82%	27,043,200	18,523	4,989	334	90	326	88
May-11	356	66	*47,018*	*12,451*	0.76%	0.53%	*2,918,520*	*47,374*	*12,518*	261	69	258	68
Jun-11	414	77	*39,546*	*14,315*	1.05%	0.54%	*2,918,520*	*39,960*	*14,392*	220	79	217	79
Jul-11	386	71	*25,878*	*7,419*	1.49%	0.96%	*2,918,520*	*26,264*	*7,490*	144	41	142	41
Aug-11	448	83	11,968	8,676	3.74%	0.96%	62,121,600	12,415	8,759	98	69	94	68
Sep-11	489	89	26,822	4,553	1.82%	1.96%	108,086,400	27,311	4,642	123	21	121	21
Oct-11	647	119	45,151	6,017	1.43%	1.97%	203,731,200	45,799	6,135	110	15	108	14
Nov-11	771	141	92,760	12,638	0.83%	1.12%	437,616,000	93,530	12,779	104	14	103	14
Dec-11	991	183	114,946	20,976	0.86%	0.87%	260,236,800	115,937	21,159	218	40	216	39
Jan-12	966	182	50,181	16,319	1.92%	1.12%	55,209,600	51,146	16,501	452	146	444	144
Feb-12	930	174	72,645	25,584	1.28%	0.68%	94,608,000	73,574	25,758	380	133	375	132
Mar-12	947	175	122,585	23,593	0.77%	0.74%	225,158,400	123,532	23,768	268	52	266	51

	Conc. Increase mg/L		Conc. Increase %	
	TDS	Cl	TDS	Cl
Apr-11	8.45	1.62	2.59%	1.83%
May-11	2.56	0.36	0.99%	0.53%
Jun-11	2.78	0.42	1.28%	0.54%
Jul-11	2.45	0.39	1.73%	0.96%
Aug-11	3.53	0.66	3.75%	0.97%
Sep-11	2.22	0.41	1.83%	1.97%
Oct-11	1.56	0.29	1.44%	1.98%
Nov-11	0.87	0.16	0.84%	1.13%
Dec-11	1.88	0.35	0.87%	0.88%
Jan-12	8.58	1.63	1.93%	1.13%
Feb-12	4.83	0.91	1.29%	0.69%
Mar-12	2.08	0.39	0.78%	0.75%
Average	3.48	0.63	1.61%	1.11%

Appendix D
Response to comments by CCWD

1 Measured Groundwater Fluxes

The maximum fluxes in the HydroFocus Report are one to two orders of magnitude smaller than fluxes measured in the field. A drawdown test of the Canal between PP1 and Marsh Creek was performed on November 14, 2007, to measure the groundwater re-charge flow rate. The initial water elevation before draw down pumping was NAVD88 +5.2ft. The water elevation at the conclusion of the draw down was -1.6ft; leaving a water depth of 6.2ft in the Canal. Groundwater re-charge was measured at 1 inch per hour for the first four hours. The average recharge rate over the course of a full day was 0.5 inches per hour.

CCWD also drew down the water level in the Canal as part of hydraulic testing at PP1 October 19-20, 2010 during the Rock Slough Fish Screen construction. Almost the entire Canal from Rock Slough to Marsh Creek was included. Recharge rates were measured during three periods. The recharge rates for the three periods were 0.13 inches per hour, 0.07 inches per hour, and 0.63 inches per hour, for an average of 0.28 inches per hour.

Table 1 compares these recharge rates to estimates of flux using the HydroFocus method as applied to Segment 1 of the Canal. The length of Segment 1 is approximately 1,900 ft. The groundwater gradients were obtained from wells 19 & 20 on ISD's property. As shown in Table 1, the fluxes estimated using the field measured recharge rates are one to two orders of magnitude larger than those estimated using the HydroFocus method.

Table 1 Measured groundwater recharge rates in the Canal during recent construction projects.

Conditions	Average Measured Recharge Rate [in/hr]	Equivalent Flux into Segment 1 [ft^3/d]	Groundwater Gradient South	Groundwater Gradient North	Calculated Groundwater Flux Using HydroFocus Max K*b [ft^3/d]
2007 Seg 1 Construction Pump Test	0.50	120,836	0.035	0.027	8,522
2010 Fish Screen Construction Pump Test	0.28	66,863	0.028	0.005	3,862

The HydroFocus method relies on the following equation to determine the groundwater fluxes into the Canal:

Where *K* is the hydraulic conductivity, *b* is the saturated depth, *L* is the length of the Canal segment and *G* is the hydraulic gradient (difference in groundwater and Canal water levels divided by distance). The hydraulic conductivity and saturated depth were assumed to calculate the flux; maximum *K* was 6 ft/d and saturated depth was assumed to be 12ft. If the measured groundwater fluxes presented in above are used to infer the hydraulic conductivity, the values are one to two orders of magnitude larger than what HydroFocus assumed. Table 2 compares the inferred aquifer properties from the various methods.

Table 2 Inferred hydraulic conductivity of the Canal calculated by using measured groundwater gradients and groundwater fluxes.

Method	K * b [ft^2/d]
Max HydroFocus	72
2007 Measured	1,021
2010 Measured	1,061

Although a hydraulic conductivity (*K*) of nearly 90 ft/d is outside the text book range for the given soil type surrounding the Canal, the comparison in Table 2 is useful to demonstrate that observed groundwater intrusion into the Canal is much larger than HydroFocus modeled. CCWD remains concerned over potential impacts associated with the Dutch Slough Restoration Project preceding the encasement of the Canal. To advance the understanding of potential impacts, Section 2 describes technical issues in the HydroFocus Report that should be addressed and Section 3 presents a common set of data and assumptions that should be used to re-calculate maximum potential groundwater flux into the Canal.

Response

During the 2007 canal drawdown test, water levels in the canal were measured hourly during the first four hours after the water level in the canal was drawdown to -1.6 feet (NAVD-88) . During this time, the rate of water-level rise was about 1.1 inch per hour. During the next 18 hours, the rate of water-level rise was about 0.1 inch per hour.[1] The transmissivity values reported in Table 2 result from the use of 12 foot high seepage face used by HydroFocus in the estimates of seepage and loading to the canal using a one-dimensional version of Darcy's Law using a hydraulic conductivity of 6 feet per day. The use of 12-foot seepage face is appropriate when the canal stage is close the average groundwater level. However, the Canal behaves similarly to a drainage ditch and drawing the water-level down results in deeper groundwater flow paths to the Canal.[2] Because the sand/silty sand aquifer in which groundwater flows to the canal extends to at least an elevation of -30 feet, there is ample opportunity for groundwater to flow deeper than the 12-foot seepage face when the canal water-level drops substantially below normal levels as was the case during the 2007 drawdown test. Therefore, an alternative method of analysis is required to analyze the drawdown results.

[1] CCWD Interoffice Memo from Peter Stabb to Dan Owre, November 19, 2007.

[2] Fio and Deverel, 1991 and Deverel and Fio, 1991, demonstrated this for drains installed at different depths below land surface. For example, for a drain six feet deep, groundwater flowed entirely from within 30 feet of land surface. For a deeper drain at 9-feet below land surface, groundwater flowed from 60 feet below land surface.

Specifically, Hultgren and Tillis used a two-dimensional groundwater flow model to match the changes in canal water levels by adjusting the K value. For the later time data for a rate in water level increase of 0.1 inch per hour, they estimated a K value consistent with HydroFocus' value of 6 feet/day.[3]

Moreover, we employed the following equation to estimate the effective depth of groundwater captured by the Canal during the 2007 drawdown test[4]*:*

$$D = [(2WH)/(\pi GR)]^{1/2} \qquad (1)$$

where:,

D is the effective depth of capture, in feet;
W is the width of the Canal (50 feet);
H is the water level difference between the aquifer and canal, in feet (6.8 feet);
G is the regional hydraulic gradient (0.01); and,
R is the ratio between horizontal and vertical hydraulic conductivity.

Using the values shown above resulted in a D value of 46 feet whereas the CCWD analysis assumed a depth of flow or b value of 12 feet. The available boring logs adjacent to the Canal indicate the sand, silty sand aquifer extends to -30 feet. However, boring logs from other locations such as Twitchell Island indicate that the sand/silty sand aquifer extends to over -100 feet. If we use a b value of 46 feet to estimate seepage using our 1-dimensional flow equation, we estimate a hydraulic conductivity value consistent with the value used when the latter time data is employed. It is more appropriate to use the last 18 hours of the test results because the first four hours were likely influenced by surface water movement within the Canal unrelated to groundwater inflow as the water surface adjusted to the pump shutdown. Using equation 1 and a hydraulic conductivity of 6 ft/day, we estimated a transmissivity of 280 ft^2/day using an estimated value for b of 45 ft. Multiplying this number by the length of the Canal reach (1900 feet) and the average gradient of 0.036 resulted in a flux into the Canal of about 18,468 ft^3/day which is in agreement with one-half of the measured flux of 34,111 ft^3/day during the last 18 hours.[5]

Previous collaborative work with CCWD provides supporting evidence for the HydroFocus model assumptions and inputs. Specifically, CCWD measured salinity increases in the Canal adjacent to the ISD property in 2003 and estimated that 0.03 cubic feet per second (cfs) of groundwater flowed to the Canal. Consistently, using higher (and measured) groundwater salinity values than those used by CCWD and hydraulic conductivity values ranging from 0.5 to 6.6 feet per day. HydroFocus estimated a rate of groundwater flow into the canal of 0.02 cfs. The hydraulic conductivity values were derived from aquifer testing using wells in segments along the reach adjacent to ISD. The hydraulic gradient was the primary factor influencing the range of influx estimates. This comparison indicated that the

---

[3] Hultgren and Tills Memorandum

[4] Zheng, C., H. F. Wang, M.P. Anderson, and K. R. Bradbury, 1988, "Analysis of interceptor ditches for control of groundwater pollution", Journal of Hydrology, vol. 98, pp. 67-81

[5] Width of wetted canal (60.74+61.34 feet) x increase in canal stage (0.15 feet/day) x length of the reach (1,900 feet) = 34,111 ft^3/day. We divided the measured flux by 2 to compare with groundwater flux because the groundwater flux was estimated from one side of the Canal.

maximum seepage value was probably appropriate during the CCWD measurements and that the range of hydraulic conductivity values used was appropriate.[6]

In summary, the preponderance of evidence suggests that the value for hydraulic conductivity of 6 ft/day is appropriate in light of the subsurface lithologic similarity between the ISD and Dutch Slough properties. The value of hydraulic conductivity for the Dutch Slough property has not been determined however and this points to the need for data collection .

2 Canal Geometry & Volume in Canal

The HydroFocus Report did not use an appropriate volume to calculate changes in concentration associated with the restoration project. Change in concentration was applied to the volume pumped at PP1 except when there was no pumping and during those months a stagnant canal volume was assumed. The stagnant volume assumed an incorrect geometry.

The geometry of the Canal should be assumed to be a trapezoidal channel with a bottom width of 24ft, a bottom invert elevation of -10.1 ft NGVD, a total depth of 14 ft, and sides at a 3:1 slope. The volume of water within the Canal is dependent on the rate of pumping at PP1, tidal flow and groundwater influx. The rate of pumping is measured and reported by CCWD. The tidal volume and groundwater influx are dependent on the water surface elevation or tidal stage within the control. In the absence of measured stage information adjacent to the Dutch Slough properties, CCWD proposes using a calibrated HEC-RAS hydraulic model of the Canal to simulate water surface elevation and volume within the Canal adjacent to the Dutch Slough properties. The water surface elevation and volume output by the model reflect tidal forcing, measured pumping and frictional losses. More details are provided in Section 3 and in the attached disk.

Response

In the revised calculations for the report, we have used the correct volume based on the data provided by CCWD.

3 Water Management during Tule Cultivation

The HydroFocus Report assumes an average groundwater surface elevation of 4.85 ft NAVD for the entire duration of tule cultivation although it is stated that there will be a range of water levels depending on the irrigation. It is not clear from the information presented if this assumption is valid. A water management plan should be provided to justify this assumption. A water management plan should include the evapotranspiration rate of tules, the extent of area that will be irrigated, a map showing the ground surface elevation and the proposed water surface elevation, the location of the monitoring wells relative to the tule cultivation area, description of the existing irrigation system that will be used and calculations used to determine the desired level of inundation. In the absence of a detailed water management plan, the maximum water surface elevation of 5.35 ft, rather than

[6] Contra Costa Water District Interoffice Memorandum from David Briggs to Greg Gartrell, December 10, 2003, “Estimate of Salt Load to the Canal from Local Groundwater.”
Appendix A: Seepage Estimate from Canal Water Salinity Changes attached to letter from HydroFocus to Tom Williams, Ironhouse Sanitary District, August 20, 2004 described HydroFocus analysis.

the average of 4.85 ft, would be a more conservative and appropriate assumption to use to calculate the maximum potential impacts.

Response

Additional analysis contained in the report incorporated a range of water surface elevations that include the high, intermediate and low values for water levels during tule cultivation.

It is also unclear from the information presented if the monitoring wells are located at the southern border of the anticipated tule habitat. The distance used to calculate the hydraulic gradient, *G*, should be the distance from the southernmost extent of tule habitat to the Canal. If the planned tule habitat extends further to the south than the monitoring wells, the hydraulic gradient should be re-calculated using the distance between the planned tule habitat and Canal.

Response

The distances used in the calculations are the distances from the southernmost extent of the tule habitat to the Canal as provided by Ann Borgonovo of ESA-PWA.

4 Monthly Average Values

Changes in concentration should be evaluated on an hourly or daily time step rather than as a monthly average. The head difference between the Canal and the groundwater is tidally driven and to the extent possible calculations should capture that mechanism. Furthermore, CCWD operations are driven by daily changes in water quality rather than monthly changes. Changes in salinity associated with groundwater seepage can be rapid over the course days to a week rather than months. Averaging out these brief but important periods of degradation underestimates the true impact to CCWD water quality and operating costs. CCWD has provided an hourly data set for water year 2012 that should be used to re-evaluate the groundwater fluxes to ensure the tidal dynamics are captured.

Response

In the revised report, we have included the results of daily calculations based on the stage and volume data provided by CCWD.

5 Proposed Re-evaluation of Groundwater Fluxes

CCWD proposes re-calculating the groundwater fluxes on an hourly or daily time-step using data collected during water year 2012 (October 1, 2011 through September 30, 2012). HydroFocus evaluated a period in 2011 during the construction of the Rock Slough fish screen when pumping operations were not typical; water year 2012 was selected because major construction was complete and operations were not disrupted. In the absence of measured stage information adjacent to the Dutch Slough properties, CCWD proposes using a recently calibrated a HEC-RAS model to simulate water surface elevation and volume of Canal adjacent to Dutch Slough. The field measured groundwater recharge rates presented in Table 2 should be included in the range hydraulic conductivities evaluated. Table 3 contains the values and data sources to be used.

Table 3 Summary of assumptions to be used in calculating groundwater fluxes and Canal control volume salinity

Variables	**Values & Data Sources**
Period of Analysis	October 1, 2011 – Sept 30, 2012
Time step	Hourly or daily depending on available data
PP1 Pumping	Measured by CCWD at PP1
Water Surface Elevation of Canal Adjacent to Dutch Slough	Modeled by CCWD using HEC-RAS (measured pumping and tidal boundary condition as input)
Volume of Canal Adjacent to Dutch Slough	Modeled by CCWD using HEC-RAS (measured pumping and tidal boundary condition as input)
Length of Canal Adjacent to Dutch Slough (L)	~10,000 ft
Groundwater Surface Elevation Existing Conditions	Measured by HydroFocus
Groundwater Elevation during Tule Cultivation	5.35 – 4.35 ft NAVD 88 depending on water management plan
Horizontal Distance used to Calculate Hydraulic Gradient (G)	Determined by HydroFocus
Groundwater Water Quality	Measured by HydroFocus
Water Quality at Rock Slough	Measured by DWR at Rock Slough
Water Quality at PP1	Measured by CCWD at PP1
Aquifer Properties ($K*b$)	72 & 1,000 ft^2/d

Hourly data collected or modeled by CCWD are provided in the attached C.D. The DWR team should provide CCWD with hourly or daily groundwater elevations where available and water quality data for those wells. Re-evaluating the potential maximum groundwater fluxes using a common set of data and assumptions will help CCWD and DWR understand the potential impacts and inform management decisions to avoid and mitigate impacts.

Response

We have incorporated the analysis of the hourly data into our revised report. We have not included analysis using higher hydraulic conductivity values because, as discussed in response to comment 1 above, the preponderance of evidence does not support a higher hydraulic conductivity value. We propose instead to determine hydraulic conductivity values for the Dutch Slough property and assess changes in Canal water quality.

APPENDIX C: WATER QUALITY MONITORING PROGRAM

Dutch Slough Surface-water Quality Monitoring Plan

HydroFocus Inc., September 27, 2011

Introduction and Background

The Dutch Slough Restoration Project will create approximately 640 acres of tidal marsh and riparian floodplain habitat, 90 acres of sub-tidal open water habitat, 100 acres of managed non-tidal marsh for black rail habitat enhancement and subsidence reversal, and 240 acres of enhanced irrigated pasture on three parcels; Emerson, Gilbert and Burroughs. Marsh Creek will be re-routed to restore the creek delta on the Emerson parcel, providing seasonal freshwater flows to cue out-migrating salmon into the restored marsh. A new Marsh Creek distributary channel will be constructed through the Emerson marsh, with low riparian berms or "natural levees" along the channel banks.

The levee of north Emerson will be breached to create sub-tidal open water. North Emerson is expected to be used as a borrow area, to supply needed fill for levee and intertidal marsh construction. The site will be graded to the habitat elevations for low marsh, mid marsh, and high marsh. On Gilbert and Burroughs, fill will be placed to raise lower-elevation areas to low marsh and mid marsh elevations. The northern part of Gilbert will be managed to enhance black rail habitat and provide subsidence reversal benefits in the creation of permanently flooded wetlands. Management of irrigated pasture and seasonal wetlands on north Burroughs will be optimized for Swainson's hawk's foraging and will remain in cattle grazing or forage crops. The southern parts of Gilbert and Burroughs will be restored to tidal marsh, riparian floodplain and sub-tidal open water habitat.

The project will be constructed and implemented over several years. Because of the large size of the site and timing of project funding (and possibly project approvals), the three parcels will be on different schedules.

Water Quality Concerns and EIR Monitoring Requirements

Project surface water quality concerns are related primarily to potential effects on Dutch Slough and influence of Marsh Creek. From a drinking water perspective, dissolved organic carbon (DOC) and associated disinfection byproducts (DBPs) represent a concern for Contra Costa Water District at the Rock Slough intakes. Methyl mercury (MeHg) is a potential threat to delta fisheries; the Central Valley Regional Water Quality Control Board proposed water quality objective of 0.06

nanograms MeHg /L is to prevent excessive mercury accumulation in fish. The Regional Board objective is based on the correlation between levels in fish and methyl mercury concentrations in water.

Dissolved Organic Carbon

Available information indicates that DOC production will likely be greatest on mid elevation marshes and during extreme low tides characterized by alternate wetting and drying and lowest on perennially inundated emergent marsh and in open water areas. Wetting and drying of highly organic sediments results in oxidation and generation of labile organic carbon. Data collected by both USGS and the Moss Landing Marine Laboratory indicate that fluxes of DOC from tidal marshes vary substantially across the tidal cycle and that exports from marshes are greatest during extreme low tide events when tidal sloughs, banks, and associated pore water drain from the marsh. Fleck and others[1] demonstrated decreasing DOC concentrations in a non-tidal permanently flooded wetland on oxidized peat soils. Historically, Delta DOC concentrations have been highest during winter. For example at Rock Slough during 2009 and 2010, DOC concentrations ranged from 1.9 mg/L during summer to 6.4 mg/L during winter. During winter, precipitation flushes DOC from organic soils resulting large drain-water DOC concentrations and loads from Delta islands[2].

Entrainment of increased DOC concentrations in drinking water diversions is likely if DOC is transported from the restoration site to the drinking water intake at Rock Slough when water is being diverted. Due to Dutch Slough's westerly Delta location, DOC produced at Dutch Slough will most often be transported westward into Suisun Marsh and San Francisco Bay and therefore is generally unlikely to increase DOC at drinking water intakes. The potential for eastward flow and dispersion is greatest when net-flow is lowest (summer and fall) when CCWD diversions have historically been the highest[3]. Evaluation of the timing of net DOC production at Dutch Slough is directly relevant to questions regarding the impact on DOC concentrations at the Delta drinking water diversion. Since the

---

[1] Fleck, Jacob A., Miranda S. Fram, and Roger Fujii, 2007, Organic Carbon and Disinfection Byproduct Precursor Loads from a Constructed, Non-Tidal Wetland in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 5, Issue 2 [May 2007], Article 1. http://repositories.cdlib.org/jmie/sfews/vol5/iss2/art1

[2] Deverel, Steven J., David A. Leighton and Mark R.Finlay. Processes Affecting Agricultural Drainwater Quality and Organic Carbon Loads in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 5, Issue 2 [May 2007]. Article 2. http://repositories.cdlib.org/jmie/sfews/vol5iss2/art2

[3] Data provided by CCWD shows maximum Delta diversions during May – August of over 15,000 acre feet per month. During the remaining months, diversions are generally less than 10,000 acre feet per month.

nature of the DOC influences formation of DBPs[4], some monitoring attention should be given to potential transport of DBP precursors[5].

We researched the literature for DOC concentrations and loads for tidal and permanently flooded wetlands (Table 1). Table 1 shows that surface-water DOC concentrations are generally less than 10 mg/L. Few load estimates were available which ranged from 7 to 140 g/m^2-year. Agricultural DOC concentrations ranged from less than 10 to over 90 mg/L and agricultural loads the Delta ranged from 1 to 150 g/m^2-year[6]. Based on the literature, DOC loads from Dutch Slough tidal marsh are likely to be similar to Delta agricultural DOC loads. However, Fleck et al.[7] showed higher DBP levels per unit DOC for marsh surface water are greater than for agricultural drainage waters.

---

[4] Fleck et al (2007) showed higher proportions of DBP formation potential per unit of DOC in the Twitchell Island demonstration wetland.

[5] Contra Costa Water District uses chloramines for disinfection. Key potential byproducts include trihalomthanes, and haloacetic acids,

[6] Deverel, Steven J., David A. Leighton and Mark R.Finlay. Processes Affecting Agricultural Drainwater Quality and Organic Carbon Loads in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 5, Issue 2 [May 2007]. Article 2. http://repositories.cdlib.org/jmie/sfews/vol5iss2/art2

[7] Fleck, Jacob A., Miranda S. Fram, and Roger Fujii, 2007, Organic Carbon and Disinfection Byproduct Precursor Loads from a Constructed, Non-Tidal Wetland in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 5, Issue 2 [May 2007], Article 1. http://repositories.cdlib.org/jmie/sfews/vol5/iss2/art1

Table 1. DOC concentrations and loads for marshes.

Location	Reference citation	DOC (mg/L)	DOC loads (g DOC/m2-year)
Great Sippewissett Marsh, Massachusetts	Howes and Goehringer[1]	1 to 5	-
Two marshes adjacent to Rhode River, Massachusetts	Jordan et al.[2]	5.2 to 7.0	21 to 43
Liberty Island, Sacramento, California	Lehman et al.[3]	2 to 5	-
Salt marshes along the south-eastern and eastern US coasts	Nixon[4]		8.4 to 140
Canary Creek salt marsh, Lewes, Delaware	Roman and Daiber[5]	2 to 8.1 with an average of 3.2 for flood tidal cycle and 4.6 for ebb tidal cycle	-
Riverine mangrove wetland and the Shark River, Everglades National Park, Florida	Romigh et al.[6]	1.7 to 17.9	-
Sacramento-San Joaquin Delta, California, Browns Island and Mandeville Tip	Stepanauskas et al.[7]	3.78 to 4.39	-
Marshes (in general)	Thurman[8]	10 to 20	
Rhode River estuary and Kirkpatrick marsh, Chesapeake Bay, Massachusetts	Tzortziou et al.[9]	11.15	-
Twitchell Island subsidence reversal wetland on oxidized agricultural soils[10]	Fleck et al.[11]	3 to 200	7 to 37
Three marshes, offshore Georgia	Wheeler[12]	0.8 to 4.5 (largest filter size)	-

[1] Howes, BL and Goehringer, DD, 1994, Porewater drainage and dissolved organic carbon and nutrient losses through the intertidal creek banks of a New England salt marsh. *Marine Ecology Progress Series* 114: 289-301.
[2] Jordan, TE, Correll, DL, Whigham, DF, 1983, Nutrient Flux in the Rhode River: Tidal Exchange of Nutrients by Brackish Marshes. *Estuarine, Coastal and Shelf Science* 17: 651-667.
[3] Lehman, PW, Mayr, S, Mecum, L, 2010, The freshwater tidal wetland Liberty Island, CA was both a source and sink of inorganic and organic material to the San Francisco Estuary. *Aquatic Ecology* 44(2): 359-372.
[4] Nixon, SW, 1980, Between Coastal Marshes and Coastal Waters – A Review of Twenty Years of Speculation and Research on the Role of Salt Marshes in Estuarine Productivity and Water Chemistry *in* Hamilton, P and Macdonald, KB (Eds). Estuarine and Wetlands Processes with Emphasis on Modeling. Plenum Press: New York, pgs. 437-526.
[5] Roman, CT and Daiber, FC, 1989, Organic carbon flux through a Delaware Bay salt marsh: tidal exchange, particle size distribution, and storms. *Marine Ecology Progress Series* 54: 149-156.
[6] Romigh, MM, Davis, SE, Rivera-Monroy, VH, Twilley, RR, 2006, Flux of organic carbon in a riverine mangrove wetland in the Florida Coastal Everglades. *Hydrobiologia* 569: 505-516.
[7] Stepanauskas, R, Moran, MA, Bergamaschi, BA, Hollibaugh, JT, 2005, Sources, bioavailability, and photoreactivity of dissolved organic carbon in the Sacramento-San Joaquin River Delta. *Biogeochemistry* 74: 131-149.
[8] Thurman, EM, 1985, Organic Geochemistry of Natural Waters. Martinus Nijhoff/Dr W. Junk Publishers, The Netherlands.
[9] Tzortziou, M, Osburn, CL, Neale, PJ, 2007, Photobleaching of Dissolved Organic Material from a Tidal Marsh-Estuarine System of the Chesapeake Bay. *Photochemistry and Photobiology* 83: 782-792.
[10] Fleck et al (2007) projected decreasing DOC concentrations with time as DOC is flushed from the formerly agricultural organic soils.
[11] Fleck, JA, Fram, MS, Fujii, R, 2007, Organic Carbon and Disinfection Byproduct Precursor Loads from a Constructed, Non-Tidal Wetland in California's Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 5(2): Article 1. http://repositories.cdlib.org/jmie/sfews/vol5/iss2/art1
[12] Wheeler, JR, 1976, Fractionation by molecular weight of organic substances in Georgia coastal water. *Llimnology and Oceanography* 21(6): 846-852.

Mercury

Concern over Delta mercury Hg pollution has resulted in posting of fish advisories recommending limited human consumption.[8] The Hg species of greatest concern to human health in the Delta is monomethylmercury (MeHg) in fish.[9] In aquatic systems, MeHg production is typically microbially mediated[10] and is readily bioaccumulated by phytoplankton and zooplankton and biomagnified up the food web, ultimately posing a threat to fish consumers.[11] The source of MeHg is the microbial transformation of elemental Hg present in Delta soils and sediments and input from the atmosphere. Wetlands can be regions of high MeHg production potential. However, there is little information about MeHg contributions from Delta tidal wetlands.

In 2010, the Central Valley Regional Water Quality Control Board (CVRWQCB) adopted an amendment to the Water Quality Control Plan for the Sacramento and San Joaquin River Basins for control of MeHg and total Hg in the Delta.[12] The amendment proposes numeric objectives for MeHg in fish tissue.[13] To achieve the proposed fish tissue objectives, the CVRWQCB proposes an implementation plan with actions and time schedules to reduce methyl and total Hg sources to the Delta. Available information indicates that achieving an annual average MeHg (unfiltered) concentration of 0.06 nanograms per liter (ng/L) in ambient Delta waters should enable attainment of the proposed fish tissue objectives.

Based on current Hg levels in fish and the correlation of aqueous MeHg concentrations with fish tissue concentrations, the CVRWQCB has proposed

---

[8] OEHHA (Office of Environmental Health Hazard Assessment), 1994, California Environmental Protection Agency, Sacramento, CA.

[9] Fitzgerald, W.F., Engstrom, D.R., Mason, R.P., and E.A. Nater, 1998. The case for atmospheric mercury contamination in remote areas. *Environ. Sci. Technol.* 32: 1-7.

[10] Compeau, G.C. and R. Bartha, 1985, Sulfate-reducing bacteria: Principal methylators of mercury in anoxic estuarine sediment. *Appl. Envirn. Microbiol.* 50: 498-502.; Berman, M. and R. Bartha, 1986, Levels of chemical versus biological methylation of mercury in sediments. *Bull. Environ. Contam. Tox.* 36: 401-404.; Gilmour, C. C., Henry, E.A., and R. Mitchel, 1992, Sulfate stimulation of mercury methylation in freshwater sediments. *Environ. Sci. Technol.* 26(11): 2281-2287.

[11] Hall, BD, Bodaly, RA, Fudge, RJP, Rudd, JWM, and DM Rosenberg, 1997, Food as the dominant pathway of methylmercury uptake by fish. *Water Air Soil Pollut.* 100: 13-24.

[12] Wood, M, Morris, P, Cooke, J, and S Louie, 2010, Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento-San Joaquin Delta Estuary. Central Valley Regional Water Quality Control Board, Staff Report. Sacramento. April. Available at: http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_bpa_staffrpt_final.pdf

[13] The recommended alternative would establish Delta-specific methyl mercury fish tissue objectives of 0.08 and 0.24 milligrams per kilogram (mg/kg), wet weight, in fish tissue for large trophic level 3 and 4 fish (150-500 millimeters [mm] total length) and 0.03 mg/kg, wet weight, for small trophic level 2 and 3 fish (less than 50 mm). The proposed objectives are protective of threatened and endangered wildlife species that consume large and small Delta fish.

reductions needed to meet proposed MeHg goals. In the Marsh Creek area, a 73 percent reduction is proposed. For achieving reductions, the CVRWQCB plans to proceed with a two part implementation program, in which Phase 1 encourages studies that develop and evaluate best management practices to reduce MeHg. Phase 2 will require dischargers to take actions and change management practices to achieve their allocations. A key relevant issue is the requirement for new MeHg sources that include wetland restoration projects to evaluate their potential effects and implement on-site projects to minimize any increase in total mercury loading. The primary goal of monitoring programs would be to estimate the sum of annual MeHg and total (inorganic) mercury loads produced by the multitude of agriculture and wetland areas in each subarea for comparison to the subarea allocations.

Methylation of inorganic Hg to produce methyl mercury occurs primarily near the wetland water-sediment interface, where there is an abundance of organic matter and ideal oxidation-reduction conditions.[14] [15,16] Therefore, the MeHg flux from the restored marsh will likely be highest on small-scale, mid elevation marshes that drain frequently and lowest on large-scale, low marshes that seldom drain completely.

The US Geological Survey and others measured and modeled MeHg concentrations and fluxes in slough waters on Browns Island in the western Delta[17]. Reported measured concentrations ranged from about 0.04 to 0.13 ng/L. Modeled concentrations of MeHg in the dissolved fraction also varied over several timescales and the highest concentrations of the dissolved fraction occurred at the lowest tides when the greatest proportion of island water was in the channels. Their results also indicated higher concentrations of reactive dissolved organic carbon as represented by higher values for specific UVA absorbance at 250 nm resulted in greater proportions of MeHg in the dissolved phase. The primary factors controlling methylation of dissolved mercury are concentrations of dissolved organic matter and chloride which influence the release of Hg from sediments.

The dissolved MeHg flux for Brown's Island is largely driven by pressure events such as barometric and hydraulic conditions. In the spring, the fluxes of dissolved MeHg were greatest during the neap but this was also the period of relatively

---

[14] Heyes, A, Moore, TR, Rudd, JWM, and JJ Dugoua, 2000, *Can. J. Fish Aquat. Sci*. 57: 2211–2222; Mason, R, Bloom, N, Cappellino, S, Gill, G, Benoit, J, and C Dobbs, 1998, Investigation of porewater sampling methods for mercury and methyl mercury. *Environ. Sci. Technol.* 32: 4031-4040.

[15] Marvin-DiPasquale, M.C., Agee, J.L., Bouse, R.M., and B.E. Jaffe, 2003, Microbial cycling of mercury in contaminated pelagic and wetland sediments of San Pablo Bay. *California Environmental Geology* 43:260–267.

[16] Gilmour, C.C., Henry, E.A., and R. Mitchel, 1992, Sulfate stimulation of mercury methylation in freshwater sediments. *Environ. Sci. Technol.* 26(11): 2281-2287.

[17] Jacob Fleck, George Aiken, Brian Bergamaschi, and Doug Latch, 2007, Mercury Release from Delta Wetlands: Facilitation and Fluxes, Draft Final Report, Task 5.3a Methyl mercury loading studies in Delta Wetland, Calfed Project 2000-G01

high barometric pressure. During autumn the quiescent flow and weather conditions led to a slow and steady off island flux of dissolved MeHg. In the winter the dominant factor was river stage. Browns Island varied from being a net source to net sink of for MeHg during different time scales.

Impounded marshes for subsidence reversal and carbon sequestration can be large exporters of MeHg relative to current discharges from farmed delta islands.[18] However, subsurface agricultural drainage loads from peat soils will likely increase over time with ongoing subsidence. Continuing subsidence will increase drain flows and mercury loads due to increased hydraulic gradients across levees. This will likely result in increased subsurface MeHg drainage loads. Moreover, recent data from the Twitchell Island Rice Project demonstrates that using drainage control and recirculation can greatly reduce MeHg export loads from impounded marshes.

Slotton and Ayers[19] determined mercury levels in fish at 5 locations in the Dutch Slough and Marsh Creek area in 2008; three sites located within the planned restoration zone. At two sites (Marsh Creek at Big Break and Little Dutch Slough) fish mercury concentrations were lower than at the control site at Big Break. Data for Emerson Slough site showed concentrations similar to concentrations measured in fish from Big Break. Fish collected at the Marsh Creek site at Delta Road above the tidal prism had the lowest concentrations, though this may have been a temporary condition linked to recent low-flow drought conditions.

Fish mercury concentrations for the March 2008 sample collection event were intermediate in relation to comparative data from other sites in the Delta. Data from the August 2008 event were relatively low relative to comparable data from other Delta locations. Slotton and Ayers concluded that current conditions within the proposed Dutch Slough restoration area do not apparently contribute to elevated MeHg exposure to the aquatic food web in relation to conditions at adjacent Big Break. Their results provide baseline measures of MeHg exposure.

Hypoxia

In addition to MeHg and DOC, there are concerns for deep water areas for development of anoxic conditions. Increases in phytoplankton blooms enhance organic matter sedimentation, which accelerates microbial oxygen consumption and results in bottom-water hypoxia. The San Joaquin River has shown signs of

---

[18] Heim, W.A., Deverel, S., and M. Stephenson, 2009, Farmed Islands and Monomethylmercury in the Sacramento-San Joaquin Delta Draft Final Report submitted to the Central Valley Regional Water Quality Control Board. Heim and others sampled agricultural drains from eight Delta islands and found that MeHg loads were correlated with depth of subsidence.

[19] Slotton, Darell, G. and Shaun M. Ayers, 2009, Lower Marsh Creek and Dutch Slough Region 2008 Biosetinel Mercury Monitoring,

increased phytoplankton blooms, which are attributed to increases in nutrient loading, especially nitrate and phosphorus and changes in river flow. Increased phytoplankton growth in response to nutrient loading leads hypoxic or anoxic conditions. Once phytoplankton begins consuming dissolved oxygen, the bottom of the channel becomes reduced, causing iron oxide sediments to release phosphorus, which adds to the anoxic system. Reduced mixing causes vertical salinity and temperature gradients, which extend the residence times of the bottom waters and increase the anoxic conditions. The extent to which hypoxic conditions develop at Dutch Slough will depend on nutrient inputs, phytoplankton growth and mixing.

Marsh Creek

Marsh Creek water quality concerns include methyl mercury and other constituents associated with urban and agricultural activities. The EIR states that exceedance of acceptable criteria for endocrine disrupter chemicals shall prevent relocation of Marsh Creek. Endocrine disrupter chemicals include an array of organic chemicals such as pesticides, pharmaceuticals and personal care products and plasticizers.

Stellar Environmental Solutions reported water quality data[20] for 5 locations in Marsh Creek for sampling conducted during 2007. MeHg was consistently above the proposed Regional Board objective of 0.06 ng/L. However, concentrations decreased substantially at the most downstream sampling location which is downstream of the Brentwood Wastewater Treatment Facility discharge. At this location, MeHg concentrations ranged from 0.068 to 0.126 ng/L.[21]. These values are within the range of previously reported concentrations of 0.05 – 0.25 nanograms/liter (ng/L) reported for the San Joaquin River. Fecal and total coliform and E. Coli values were also generally high for all samples. Concentrations of priority trace elements (arsenic, lead, zinc, chromium, cadmium, copper, nickel, selenium) were not measured at levels of concern.

Recently, Friends of Marsh Creek Watershed initiated regular water quality monitoring nitrate, pH, conductivity, dissolved oxygen and temperature. Volunteers also report numbers of live and dead fish. Fish kills occurred in 2005, 2007 and 2008. Yet despite these problems, Marsh Creek supports substantial

[20] Stellar Environmental Solutions, 2007, MARSH CREEK SEDIMENT AND WATER QUALITY BASELINE MONITORING Y2006-Y2007 MARSH CREEK, CALIFORNIA. Water samples were analyzed for ammonia (as nitrogen), chloride, DOC and total organic carbon (TOC), bromide, total mercury, dissolved mercury, and methyl mercury, nitrate and total Kjeldahl nitrogen (TKN), total dissolved solids (TDS), total coliform, fecal coliform, and e. coli, priority 13 metals (zinc, arsenic, copper, cadmium, chromium, lead, nickel, selenium), iron, aluminum, manganese, total phosphorus and orthophosphate.

[21] Measured concentrations were 0.080 ng/L 0.089 ng/L 0.087 ng/L 0.126 ng/L 0.068 ng for samples collected on 11/1/06, 1/5/07, 2/14/07, 5/4/07, 8/8/07.

biological diversity including fall-run Chinook salmon, river otters, muskrats, green herons, western pond turtles, and other fish and wildlife[22].

Current Site Activities

Current site activities most likely contribute water-quality constituents of concern to Dutch Slough, Emerson Slough and Little Dutch Slough. Specifically, DOC, MeHg and nutrients in drain water are likely discharged primarily through subsurface drainage ditches to pump stations where drainage water is discharged to adjacent channels. One drainage pump station on each of the three parcels regularly removes drainage water.

Monitoring requirements listed in the EIR

The EIR states that "should the monitoring program study find that Marsh Creek mercury levels are outside the acceptable range, diverting Marsh Creek onto the Emerson Parcel may be prohibited." *Preliminary analysis of available data for Marsh Creek indicates methyl mercury levels are not outside the acceptable range. Also, "*If and when the RWQCB establishes criteria for EDCs of concern, the Marsh Creek water-quality testing program described in Mitigation 3.2.1-4 shall be expanded to include these compounds. Marsh Creek shall not be relocated if EDC levels exceed acceptable criteria." The ER requires that monitoring shall be used to estimate the potential TOC and DOC export from the site in relation to possible effects on DOC and TOC at the CCWD intakes at Rock Slough.

Summary and Key Questions to be Addressed by Monitoring

Based on the available information summarized above, key relevant concepts for the monitoring approach follow.

- DOC and MeHg concentrations and export loads will likely be greatest on mid elevation marshes and during extreme low tides. Tidal wetlands can be a net sink or source of DOC and MeHg and the measurement timescale influences which condition is applicable.
- The range of reported DOC loads for tidal marshes is generally similar to Delta agricultural loads.
- Concentrations of MeHg in Marsh Creek samples collected nearest the Dutch Slough project are within the range of values reported for the San Joaquin River.
- Fish MeHg concentrations in 2008 in the Dutch Slough Project area and Marsh Creek were generally low relative to other Delta locations.

Key questions about water-quality impacts of the Dutch Slough project follow.

[22] Friends of Marsh Creek Watershed, The State of the Marsh Creek Watershed 2010 Summary Report

- How will DOC and MeHg concentrations and loads on the three parcels change with project implementation?
- How will fish MeHg levels be affected by the project?
- What are the concentrations and loads of other constituents of concern in Marsh Creek (e.g. pesticides, pharmaceuticals, etc.) and how might they impact Dutch Slough water quality and biota?
- Will water quality deteriorate in the deep water area on the Emerson Parcel and result in anoxia?

Proposed Monitoring and Reporting

The proposed monitoring will:

1. Assess baseline conditions under agricultural conditions;
2. Determine project concentrations and loads and compare with baseline conditions;
3. Collect water quality data for Marsh Creek;
4. Conduct MeHg biosentinal monitoring and
5. Asses water quality conditions in the sub-tidal open water area on Emerson Tract.

Task descriptions follow.

Task 1 Baseline Monitoring

Primary tasks during the one year of baseline monitoring include the following.

1. Measure concentrations of MeHg, TOC and DOC in drainage ditches on Emerson, Gilbert and Burroughs parcels and estimate loads using power derived flow estimates. Grab samples in drainage ditches will be collected monthly.
2. Monitor Marsh Creek water quality for MeHg, DOC, TOC, pesticides, pharmaceuticals and personal care products, trace elements and field parameters (pH, conductivity, dissolved oxygen, turbidity). Monitoring will include unfiltered and filtered samples and discharge weighted sampling based on flow measurements.[23] Field parameter data will include pH, conductivity, dissolved oxygen and turbidity.

Task 2 Project Monitoring

The following subtasks are proposed.

1. Measure MeHg, DOC and TOC concentrations and flow at selected locations within selected mid-marsh areas to estimate project loads for DOC, TOC and MeHg. Field parameter data will include pH, conductivity, dissolved oxygen

[23] Discharge is currently measured at the USGS gaging station about 3 miles upstream of Emerson.

and turbidity. To address the DOC and TOC concerns for CCWD intakes, it is proposed that current DOC and TOC loads from the three parcels be compared with loads from mid-marsh areas on the Emerson Parcel.
2. Measure MeHg, DOC, TOC and nutrient concentrations and flow from subsidence reversal wetlands and estimate loads. Field parameter data will include pH, conductivity, dissolved oxygen and turbidity.
3. Monitor water quality in the sub-tidal open water area on Emerson. Constituents and parameters include nutrients (nitrogen and phosphorus species), pH, dissolved oxygen, conductivity, temperature chlorophyll.
4. Biosentinel monitoring for MeHg.

Task details follow.

Task 1.0 – Baseline Monitoring

Subtask 1.2 Baseline Concentrations and Loads of MeHg, TOC and DOC for Dutch Slough parcels

Drain Water samples will be collected monthly for the purpose of determining MeHg, DOC and TOC concentrations and loads from the individual parcels.   For methyl mercury, grab samples will be collected using ultra clean sampling techniques[24]. On each parcel, drain water will be collected from the main drainage ditches that flow to drainage pumps (Figure 1). For mercury, samples will be collected in a double bagged 250 mL pre-cleaned borosilicate bottle and the bottle and cap will be triple rinsed with ambient water just prior to collecting a sample. Samples will be immediately placed on ice and kept in the dark for shipping to the laboratory. Samples will be preserved within 48 hours of collection with 0.5 percent hydrochloric acid**.** Grab samples for TOC and DOC will be collected in amber glass bottles and placed on ice. Samples for DOC will be filtered through 0.45 micron nitrate cellulose filters within 24 hours. All grab samples will be collected at a depth of about 4 inches below the surface.

Monthly drain outflow estimates will be calculated by using power consumption records and pump-efficiency test data. We will obtain monthly power consumption records from Pacific Gas and Electric, reported in kilowatt-hours. We propose to subcontract with Power Services Inc. to conduct pump-efficiency tests for all discharging pumps which will provide a value for acre feet pumped per kilowatt-hour. By multiplying the power consumed by the pump test value, we will obtain a monthly outflow estimate in acre-feet. Previous investigations[25],

---

[24] Gill GA, Fitzgerald WF. Mercury sampling of open ocean waters at the picomolar level. Deep-Sea Res. 1985; 32: 287-297

[25] Heim, W.A., Deverel, S., Ingrum, T., Piekarski, W., and Stephenson, M., 2009, Assessment of Methylmercury Contributions from Sacramento-San Joaquin Delta Farmed Islands. Report submitted to Chris Foe and the Central Valley Regional Water Quality Control Board. Also, Templin WE, Cherry DE.

demonstrated good comparability of flow values obtained using power consumption estimates with metered flow. Loads will then be calculated by multiplying the monthly outflow pump estimates by the measured MeHg, TOC and DOC concentrations. Field parameters (pH, electrical conductivity, dissolved oxygen and turbidity) will be measured during each visit using a YSI multimeter at a depth of about 8 inches. The meter will be calibrated in the field with standards with values close to the sampled water. Samples will also be collected for nitrogen and phosphorus (nitrate, ammonia, organic nitrogen and phosphate).

Subtask 1.2 Marsh Creek water quality.

At the USGS gaging station on Marsh Creek (Figure 1)., water quality samples will be collected monthly and during selected precipitation events such as the first flushing rain During each sampling event for 1 year, samples will be collected and analyzed for constituents listed in Table 2. We recommend flow weighted sampling. Specifically, water samples will be collected using an isokinetic D-77 bottle sampler[26]. To accurately represent the average conditions in the channel, equal discharge-increment sampling is desired. By collecting depth-integrated samples at discharge centroids, the EDI method approximates the channel-average conditions. Knowledge of the flow distribution in the channel allows for the collection of these samples so sampling should be coordinated with USGS flow measurements. Five equally spaced centroids should satisfactory. The sampler is lowered to just above the bed and raised to the surface at an appropriate transit rate such that an equal water volume is collected in the bottle at each centroid location. This provides a vertically integrated sample at five points across the section.

Drainage-Return, Surface-Water Withdrawal, and Land-Use Data for the Sacramento-San Joaquin Delta, with Emphasis on Twitchell Island, California. U.S. Geological Survey Open-File Report 97-350, 1997.
[26] EDWARDS, T. K. AND G. D. GLYSSON. 1999. Field methods for measurement of fluvial sediment, p. 1–89. In Techniques of Water-Resources Investigations, Book 3. U.S. Geological Survey, Reston, Virginia.

Table 2. Proposed constituents and field parameters for determination in Marsh Creek samples.

Constituent and field parameter	Justification
Methyl mercury	Key constituent of concern for western Delta and Marsh Creek area
Total mercury	Source for methyl mercury production
Dissolved organic carbon	Generally related to methyl mercury production.
Pesticides; organo-phosphates, organo-chlorines, carbamates and pyrethroids	Substantial quantities of pesticides applied in the Marsh Creek watershed as per the Department of Pesticide Regulation. Possible aquatic toxicity effects.
Herbicides List of specific constituents to be developed based on products applied in watershed.	Substantial quantities of herbicides applied in the Marsh Creek watershed as per the Department of Pesticide Regulation. Possible aquatic toxicity effects.
Nitrogen species (nitrate, ammonia, organic nitrogen)	Fertilizer sources in Marsh Creek water shed
Phosphorus (ortho-phosphate and total phosphorus)	Fertilizer sources in Marsh Creek water shed
Pharmaceuticals, personal care products, plasticizers	Regulatory concerns about endocrine function disruption.
Filed parameters (pH, turbidity, conductivity, dissolved oxygen)	General water chemistry and identification of water sources
Major ions (calcium, magnesium, sodium, bicarbonate, chloride, sulfate)	General water chemistry and identification of water sources
Total dissolved solids	General water chemistry and identification of water sources
Water isotopes (oxygen-18 and deuterium)	General water chemistry and identification of water sources
Coliform bacteria (total, fecal and E. coli)	Marsh Creek is known to have high levels.

Task 2.0 – Project Monitoring

Subtask 2.1 Measure MeHg and DOC concentrations and flow at selected locations within selected mid-marsh areas.

Mid-tidal marsh areas are the likely predominant sources of MeHg and DOC from the project. We recommend flow measurement and sampling during selected tidal cycles and periods especially when export loads are likely the highest such as during lowest tides. To measure flow, we recommend using the index velocity method[27] using an upward looking acoustic Doppler velocity meter for continuous velocity, stage and channel area determination and an acoustic Doppler current profiler for periodic discharge measurements for calibration. We recommend measurement and sample collection at 2 sites.

Depth integrated water samples for DOC and MeHg will be collected using isokinetic D-77 bottle sampler or auto sampler every few hours during several tidal cycles during the year. DOC and ultra violet absorption at 254 nanometers (UVA-254)[i] will be measured as there is often a correlation of MeHg with concentrations of these constituents and field parameters such as oxidation-reduction potential. Disinfection byproduct formation potential will be determined on selected samples. Concentrations and discharge estimates will be used to estimate loads for key periods during the year. Continuously collected field parameter data will include pH, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity. The USGS on Brown's Island successfully used continuous in-situ dissolved organic matter (DOM) measurements using commercially available instrumentation. MeHg and DOC concentrations and loads can thus be estimated for longer periods. In light of the adaptive management and transferability value, we recommend use of in-situ DOM measurements.

Subtask 2.2 Measure MeHg, DOC, TOC and nutrient concentrations and flow from subsidence reversal wetlands and estimate loads.
Permanently flooded wetland for subsidence reversal can be sources of MeHg and DOC. We recommend measuring concentrations of these and additional key constituents and flow at the surface and subsurface drain-water outlets to estimate per area loads. The wetland should be constructed to facilitate control of wetland outflows for measurement, flow restriction and if possible, drain-water recirculation. Flow measurements and estimates and sampling similar to that described Gamble and others, Deverel and others, and Heim and others[28] using a combination of weirs, flow meters and transducers to record stage is

---

[27] Simpson, M. R. and R. Bland. Methods for accurate estimation of net discharge in a tidal channel. Institute of Electrical and Electronics Engineers Journal of Oceanic Engineering 25:437–445. This methodology was used by Neil K. Ganju, David H. Schoellhamer, and Brian A. Bergamaschi, 2006, Suspended Sediment Fluxes in a Tidal Wetland: Measurement,
Controlling Factors, and Error Analysis Estuaries Vol. 28, No. 6, p. 812–822.

[28] Heim, W.A., Deverel, S., Ingrum, T., Piekarski, W., and Stephenson, M., 2009, Assessment of Methyl mercury Contributions from Sacramento-San Joaquin Delta Farmed Islands. Report submitted to Chris Foe and the Central Valley Regional Water Quality Control Board.
Deverel, Steven J., David A. Leighton and Mark R.Finlay. Processes Affecting Agricultural Drainwater Quality and Organic Carbon Loads in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 5, Issue 2 [May 2007]. Article 2.
http://repositories.cdlib.org/jmie/sfews/vol5iss2/art2
Gamble, J.M., Burow, K.R., Wheeler, G.A., Hilditch, R., Drexler, J.Z., 2003, Hydrogeologic data from shallow flooding demonstration project, Twitchell Island, California, 1997-2001. U.S. Geological Survey Open-File Report 03-378, 42 p

recommended. Field parameter data will include pH, conductivity, dissolved oxygen and turbidity.

Subtask 2.3 Monitor water quality in the Emerson sub-tidal open water area. Vertical profiles, grab samples and continuous monitoring will be used to evaluate the water quality of the Emerson sub-tidal open water area. The measured constituents and parameters will include dissolved oxygen, temperature, pH, turbidity, 5-day biochemical oxygen demand, and chlorophyll a. Temperature, DO, pH and turbidity will be measured at mid-depth every 15 minutes at one continuous monitoring station. Vertical profiles will be used to measure temperature, DO, pH, and electrical conductivity every foot. Sampling for vertical profiles will take place at all sites before 10:00 a.m. to ensure that, as much as possible, the minimum daily DO concentrations are observed. Vertical profiles generally will be conducted weekly initially. Monthly samples will be collected for determination of nutrient concentrations (nitrogen and phosphorus species). Frequency can change depending on results.

Subtask 2.4 Biosentinel monitoring for MeHg.

We recommend implementing project biosentinel monitoring similar to the baseline analysis conducted by Slotten and Ayers[29] for the Dutch Slough area conducted in two seasonal periods: March and August of 2008. During each of these periods small fish biosentinels were collected from five sites:
• Marsh Creek above tidal influence at Delta Road, upstream of Oakley
• Marsh Creek within tidal influence, near the confluence with Big Break and within the planned restoration area
• Emerson Slough (mid-slough within the planned restoration area)
• Little Dutch Slough (mid-slough within the planned restoration area)
• Big Break, adjacent to Dutch Slough restoration region
The five sites were sampled similarly in each of the two seasonal collections, for a total of 10 individual site-sampling events. Approximately 36 individual fish were collected, prepared, and individually analyzed from each site-sampling, with 358 total samples analyzed for the overall project. We recommend also sampling at key locations within the project such as mid marsh channels and open water areas.

Fish were collected by boat electroshocking, backpack electroshocking, and seining. Samples of the species and size ranges targeted for analytical work were separated by species, cleaned, and frozen directly in the field in sealed Ziploc bags with water surrounding, using dry ice. Samples were analyzed for total mercury, which has been established as an acceptable and advised measure of MeHg in fish, as virtually all of the mercury in fish is in the form of

[29] Slotton, Darell, G. and Shaun M. Ayers, 2009, Lower Marsh Creek and Dutch Slough Region 2008 Biosetinel Mercury Monitoring,

MeHg, so the two analyses deliver equivalent results, while the total Hg analysis is typically more precise. The fish samples were analyzed as dry powders for consistency. Moisture percentage was carefully determined, through sequential weighings, to allow conversion to fresh/wet weight concentrations. Samples were analyzed for total mercury with standard cold vapor atomic absorption (CVAA) spectrophotometry,

Quality Assurance and Control

A final quality assurance project plan (QAPP) will present functions, procedures, and specific quality assurance (QA) and quality control (QC) activities designed to achieve the data quality objectives (DQOs) for the site investigation activities to be conducted prior to and after project implementation. Key elements of the QAPP are included here.

Data Quality Objectives and Quality Assurance Assessment

Data quality objectives (DQOs) describe the quality of data needed from a data collection activity to support decisions. We propose DQOs to ensure that the data collected meets the project goals of 1) establishing credible and defensible baseline water quality conditions and 2) assessing any project water-quality impacts. Field and laboratory analytical results collected during one year will be used to establish the baseline water-quality conditions prior to project implementation. The DQOs are designed to obtain sufficient data of defensible quality to meet the project objectives.

Data quality indicators (DQIs) include precision, accuracy, representativeness, comparability, completeness and sensitivity. Data will be considered valid if DQO's for each indicator are achieved. The effectiveness of the QA/QC program will be assessed by the quality of the data generated by the analytical laboratory and determination of field parameters. Table 3 summarizes the types and frequency of collection of field QC samples and laboratory QC samples for this investigation.

Table 3. Types and frequency of quality control samples.

Analysis	QC Type	Frequency
Field QC		
	Field Duplicates	1/10 samples
	Equipment Blanks	1/day
Laboratory QC		
	Method blanks	1/20 samples
	MS/MSD	1/20 samples
	LCS or blank spikes	1/20 samples

Precision and Accuracy

Precision is a measurement of the agreement of a set of replicate results. Accuracy is defined as the nearness of a result or the mean of set of results to the true, known, or reference value. We will evaluate precision and accuracy by assessing the results of the analyses quality control (QC) samples. We propose to assess precision and accuracy through the use of laboratory and field duplicates (split), laboratory matrix spike (MS) and matrix spike duplicate (MSD) and control samples and control-sample duplicates (LCS and LCSD).

Matrix spikes (MS), matrix spike duplicates (MSD), laboratory control samples (LCS) and laboratory control sample duplicates (LCSD) will be analyzed by the laboratory to evaluate the accuracy and precision of the sample extraction and analysis procedures and to evaluate potential matrix interference. Matrix interference, the effect of the sample matrix on the analysis, may partially or completely mask the response of analytical instrumentation to the target constituents. Matrix interference may have a varying impact on the accuracy and precision of the extraction and/or analysis procedures, and may bias the sample results high or low. The MS or MSD samples are prepared by adding a known quantity of the target compound(s) to an environmental sample. The samples are then extracted and/or analyzed as a typical environmental sample and the results are reported as percent recovery.

The spike percent recovery is the primary measure of accuracy and is defined as:

$$\text{Recovery (\%)} = \frac{\text{spike analysis result - original sample concentration}}{\text{concentration of spike addition}} \text{x}100\%$$

We will review the MS and MSD recoveries for compliance with laboratory-established control limits to evaluate the accuracy of the extraction and analysis procedures. Laboratory control samples (LCS) are prepared like MS samples except a clean control matrix is used instead of an environmental sample. Typical control matrices include Reagent Grade Type II water. LCS and LCSD samples are used to evaluate laboratory accuracy independent of matrix effects. The DQO for percent recovery should be within the standard range from 80 to 115 %. For some constituents, the range is narrower and this will be described the QA/QC report.

The laboratory performs duplicate analyses of MS and LCS samples are to evaluate the precision of analytical procedures. Precision is evaluated by calculating a relative percent difference (RPD) using the following equation:

$$\text{RPD (\%)} = \left| \frac{(\text{Spike Concentration} - \text{Spike Duplicate Concentration})}{\frac{1}{2}(\text{Spike Concentration} + \text{Spike Duplicate Concentration})} \right| \text{ x 100\%}$$

To evaluate analytical precision, we will compare the RPD to laboratory-established control limits for the MS/MSD and LCS/LCSD duplicate pairs. Depending on the constituent, the DQO for acceptable maximum RPD values will range from 10 to 20 %. The QA/QC review will identify RPD values outside laboratory control limits. Precision will also be assessed using field duplicates. Field duplicate samples are processed identically to regular samples and submitted to the laboratory with dummy site identification labels. The acceptable limit for RPD values for field duplicates in 35 %.

In addition to the above, for major ion, salinity and dissolved solids data will be used when applicable to assess the accuracy of the data using the following calculations and criteria.

Anion-Cation Charge Balance. Charge imbalance indicates problems or omissions in the analyses of major ions and cations. It is calculated as the difference between the sums of anions and cations in milliequivalents per liter (meq/L) as a percentage:

$$\text{Charge Imbalance (\%)} = \frac{Anions - Cations}{Anions + Cations} \times 100$$

We use a maximum percent difference of 5 % as a DQO's and guideline for an acceptable charge balance.

Ratio of Calculated Sum of Dissolved Solids to Specific Conductance. The sum of dissolved solids (in mg/L) divided by the specific conductance should fall within the DQO which ranges from 0.55 to 0.81. Values substantially outside this range suggest an error in the analysis. We multiply the bicarbonate concentration by 0.4918 to estimate carbonate on ignition. We add the concentrations (in mg/L) of the major ions plus iron.

Ratio of the Sum of Reacting Constituents to Specific Conductance. The ratio of the sum of reacting cations <u>or</u> anions to 0.01 x specific conductance should be within the DQO range 0.92 to 1.24.

Ratio of the Residue on Evaporation (ROE) to Specific Conductance. The ratio of the ROE to the specific conductance should be within the DQO range of 0.55 to 0.86. Samples with a high organic content may have ratios higher than 1.0 in some cases.

Ratio of the Residue on Evaporation (ROE) to the Calculated Sum of Dissolved Solids. The ratio of the ROE to the calculated sum of dissolved solids should be within the DQO range 0.90 to 1.12. Ideally, the ratio should be equal to 1. We divide the ROE at 180 ^{o}C (in mg/L) by the sum of the concentrations (in mg/L) of the major anions and cations plus iron.

Representativeness

Representativeness is the degree to which the data effectively represent the characteristics of a population, variations in a parameter at a sampling point or an environmental condition. The representativeness of the data is insured through the consistent application of established field and laboratory procedures. We will ensure representativeness by using proper sampling procedures and collection of field blank samples. Field blank samples will be evaluated to assess the potential for contamination. Blank contamination indicates the potential for false positive results at low concentrations and the potential for a high bias in detected results. False-negative results will be reduced through proper sample handling, preservation, use of proper sample containers, and analyses within prescribed holding times.

The frequency of field blank samples for this investigation is listed in Table 3. Samples stored in coolers on ice will be delivered daily to the laboratory. The laboratory will prepare method blanks for each parameter analyzed. The method blank is used to evaluate whether or not contaminants are present in the laboratory and the possibility of false-positive results. We will report and analyze the effect of anomalies reported by the laboratory either on receipt of the samples at the laboratory or during analytical processes. Anomalies include adherence to recommended holding times of samples before analysis; calibration of laboratory instruments; adherence to analytical methods; quantitation limits used for samples; and completeness of data documentation.

Completeness

The completeness of the data consists of an estimate of the amount of data expected from the field program versus the amount of data actually entered into the database that is available for interpretation. We will assess completeness as:

Percent Complete (% C) =v/t x 100
where:
v = number of valid measurements
t = total number of measurements

The DQO for completeness for this project is 90 %.

Comparability

Comparability expresses the confidence with which one data set can be compared to another data set. Comparability of data for this investigation will be achieved by consistently following standard field sampling, laboratory analyses, QA/QC, data reporting, reviewing, and validating procedures in adherence with the requirements of this QAPP. The use of U.S. EPA-approved analytical methods, specified and well-documented analyses, approved laboratories and the standardized process of data review and validation ensure a high degree of analytical comparability.

Sensitivity

Sensitivity is the ability to assess the measurement result against established criteria. The required sensitivity is a function of assessment criteria, sample size, and analytical detection limits. Detection limits will be at or below applicable regulatory goals, the primary assessment criteria. The sample sizes are such that the collected volume is greater than the sample volume required for each analytical method to obtain an acceptable quantitation limit for the investigation.

Reporting

Quarterly reports will provide the following information.

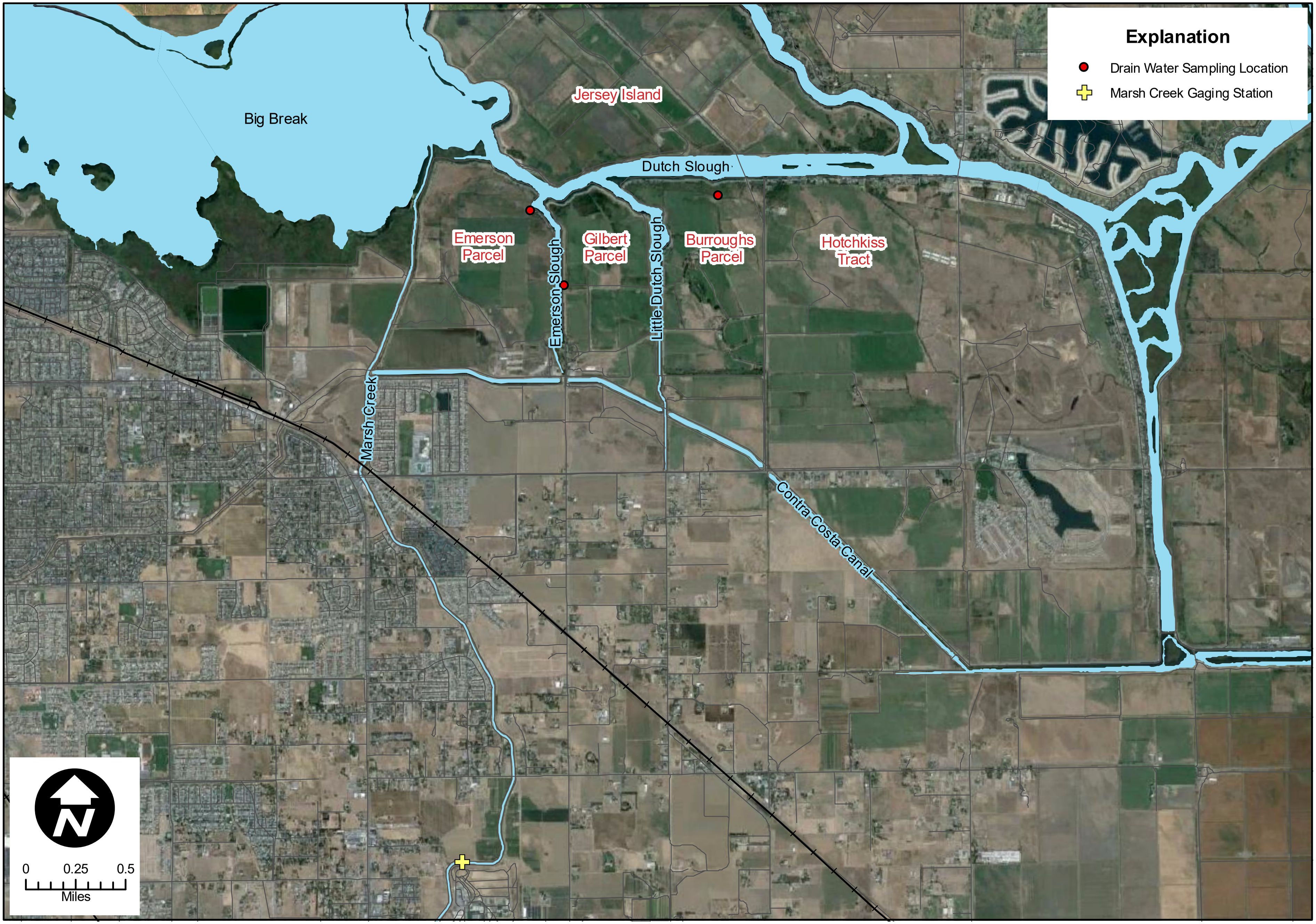
Baseline Monitoring

- Sample locations
- Sampling and measurement methods, instrument calibration results
- Results: concentrations, flow measurements and estimates, load calculations, stage data
- QA/QC results
- Laboratory reports and chain of custody forms
- Field sheets

Project Monitoring

- Sample locations
- Sampling and measurement methods, instrument calibration methods and results

- Results: concentrations, flow measurements and estimates, load calculations, stage and flow data, biosentenal monitoring results, load comparison with baseline results in mass per unit area and unit time.
- QA/QC results
- Laboratory reports and chain of custody forms
- Field sheets



HYDROFOCUS INC. Solutions for Land and Water Resources

Baseline Sampling Locations, Dutch Slough Project Area, Oakley, CA.

Figure 1

APPENDIX D: DISTRIBUTION LIST

First Name	Last Name	Affiliation/Organization	Title/Position
Mike	Anderson	East Bay Regional Park District	Assistant General Manager - Planni
Lars	Anderson	UC Davis, USDA Agricultural Research Service, Exotic and Invasive Weed Research Laboratory	
Shakoora	Azimi-Gaylon	Delta Conservancy	
Peter R.	Baye		Coastal Plant Ecologist
Bryan	Begun	National Marine Fisheries Service (NOAA Fisheries)	
Frank	Bellecci	Bellecci and Associates, engineers	
Andrea	Boertien	DFG Bay-Delta Region	
Erica	Brand	Pacific Gas & Electric	Environmental Support and Services
Diane	Burgis	FOMCW Friends of Marsh Creek Watershed	FOMCW Coordinator
John	Cain	American Rivers	
Catherine	Caldwell	Delta Protection Commission	Asst Exec Director
Dave	Carrion	tenant	
Trevor	Cleak	Central Valley Regional Water Quality Control Board	
Matthew	Cline		
Patti	Clinton	US Bureau of Reclamation - South-Central California Office	Natural Resource Specialist
Mark	DeSaulnier	CA State Senate, District 7, State Senator	
Paul	Detjens	Contra Costa County Department of Public Works	Senior Civil Engineer
Christopher	Emerson	Emerson Properties Inc.	Landowner
Fred	Etzel	ISD Attorney	
Susan	Euing	USFWS - Alameda and Antioch Dunes NWR	Biologist
Michael	Finan	ACOE, Sacramento District	Project Manager Regulatory Bra
Joan	Florsheim	UC Davis, Geology Department	Fluvial Geomorphologist
Kathleen	Forrest	State Parks	
Jim	Frazier	CA State Assembly, District 11, State Assemblyman	
Ted	Frink		
Roger	Fujii	USGS, WRD	PhD
Brent	Gilbert	Landowner	
Suzanne	Gilmore	CA DFG, Region 3 (Bay-Delta Region)	Environmental Scientist Contra Cos
Alexander	Glazer	UC Berkeley	Director
Bill	Guthrie	ACOE, Sacramento District	Project Manager Regulatory Bra
Brian	Hansen	USFWS - Sacramento Fish and Wildlife Office	
Lauren	Hastings	Delta Science Program	
Anna	Hawatky	SWRCB	Division of Water Quality

Paul	Helliker		
Erin	Hess	ACOE, Sacramento District	
Nadine	Hitchcock	CA Coastal Conservancy	
Al	Hoslett	RD 2137	Legal counsel
Greg	Howard	Contra Costa Mosquito and Vector Control District	
Julie	Hugel	Bethel Island Municipal Improvement District	Interim District Manager
Beth	Huning	San Francisco Bay Joint Venture	Coordinator
Amy	Hutzel	CA Coastal Conservancy	Director of Bay Area Program
Campbell	Ingram	Delta Conservancy	
Dee	Kerry	RD 799	Landowner
John	Kopchik	Contra Costa County	Community Development Director
David	Lewis	Save The Bay	Executive Director
Thomas	Lindemuth, Sr.		
Leonard	Lloyd	FOMCW and Dutch Slough supporters	
Doug	Lovell	Striped Bass Guides Association; Federation of Fly Fishers;	Fishing Activist
Jeff	McCreary	Ducks Unlimited, San Francisco Bay Joint Venture and Central Valley Habitat Joint Venture	
Gail	Newton		
Eva	Olin	DFG Bay-Delta Region	
Bob	Orcutt	CA DFG, Region 2 (Sacramento Valley-Central Sierra Regior	Project Manager, Delta Levee H
Leah	Orloff	Contra Costa Water District	
Owen	Poole		
Sarah	Puckett		Restoration Ecologist
Anne	Rivoire	East Bay Regional Park District	
Kevin	Romick	Mayor City of Oakley	
Ed	Schmit	DWR	
Curt	Schmutte	Metropolitan Water District of Southern CA	
Mitch	Schweickert	Los Medanos College	Chemistry Professor
David	Sedlak	UC Berkeley, Department of Civil & Environmental Engineering	Associate Professor
Mark	Seedall	Contra Costa Water District	
Paul	Seger	Delta Greens	
Stuart	Siegel	Wetlands and Water Resources	Principal
Charles (Si)	Simenstad	University of Washington, School of Aquatic and Fishery Sciences	Research Associate Professor
Jenny	Skrel	Ironhouse Sanitary District	Engineer
Crystal	Spurr	DFG Bay-Delta Region	
Mark	Stacey	UC Berkeley, Department of Civil & Environmental Engineering	

Richard	Stephens	Richard Stephens	
Jen	Stern	Contra Costa Resource Conservation District	watershed coordinator
Susan	Stratton	State Parks	
Ken	Strelo	City of Oakley	Community Development Director
John	Takekawa	USGS	
Angelia	Tant	RD 799	District Secretary
Jessica	Tudor	State Parks	
Linda	Weekes	Knightsen Community Services District	
Nancy	Wenninger	East Bay Regional Park District	Land Acquisition Manager
Keith	Whitener	Robertson-Bryan, Inc	
Tom	Williams	Ironhouse Sanitary District	General Manager
Erica	Yelensky	US Environmental Protection Agency	
Mike	Yeraka	Diablo Water District	General Manager