ADAPTIVE MANAGEMENT AND MONITORING PLAN

Draft

TULE RED
TIDAL RESTORATION

Grizzly Bay, Solano County, California

March 1, 2016

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March 1, 2016

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LIST OF ACRONYMS

BDCD	Bay Conservation and Development Commission
BDCP	Bay Delta Conservation Plan
BiOp	Biological Opinion
CALFED	CALFED Bay-Delta Program
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CNLM	Center for Natural Lands Management
CRAM	California Rapid Assessment Methodology
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CWA	Clean Water Act
CY	cubic yard
DFG	California Department of Fish and Game
DFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
ESA	Endangered Species Act
FAST	Fishery Agency Strategy Team
HCP	Habitat Conservation Plan
HOWL	highest observed water level
LiDAR	light detection and ranging
LOWL	lowest observed water level
MBTA	Migratory Bird Treaty Act
MHW	mean high water
MHHW	mean higher high water
MLW	mean low water
MLLW	mean lower low water
MMP	Management and Monitoring Plan
MTL	mean tide level
MOA	Memorandum of Agreement
MWD	Metropolitan Water District of Southern California
NCCP	Natural Community Conservation Plan
NCCPA	Natural Communities Conservation Planning Act

NEPA	National Environmental Policy Act
NHP	Natural Heritage Program
NMFS	National Marine Fisheries Service
Project	Tule Red Tidal Restoration Project
Prospectus	Crediting Prospectus
PRC	Public Resources Code
RD	Reclamation District
Reclamation	U.S. Bureau of Reclamation; see also USBR
RPA	Reasonable and Prudent Alternative
RWQCB	Regional Water Quality Control Board
SCWA	Solano County Water Agency
SFCWA	State and Federal Contractors Water Agency
SHPO	State Historic Preservation Officer
SLC	State Lands Commission
Suisun Marsh Plan	Suisun Marsh Habitat Management, Preservation, and Restoration Plan
SWP	State Water Project
SWRCB	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation; see also Reclamation
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WWD	Westlands Water District

I. INTRODUCTION

A. PURPOSE OF PROJECT

The Tule Red Tidal Restoration Project (Project) is a collaboration of the State and Federal Contractors Water Agency (SFCWA), California Department of Fish and Wildlife (CDFW), and Westervelt Ecological Services (WES) to restore and enhance approximately 420 acres of tidal wetlands to benefit listed fishes (delta smelt, longfin smelt, and salmonids). The goal of the Project is to partially fulfill the 8,000-acre tidal restoration obligations of the Fish Restoration Program Agreement (FRPA) in satisfaction of the requirements in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BiOp) for delta smelt and the 2009 National Marine Fisheries Service (NMFS) BiOp for listed salmonids and green sturgeon (*Acipenser medirostris*) potentially affected by the Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP). The Project also partially fulfills requirements of the Incidental Take Permit (ITP) for longfin smelt (*Spirinchus thaleichthys*) potentially affected by the SWP. A secondary purpose is to create transitional and refugia habitat for the salt marsh harvest mouse (SMHM; *Reithrodontymys raviventris*) consistent with the requirements in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (Suisun Marsh Plan, or SMP) (USBR et al., 2013). The Project is identified as a Priority Restoration Project under the California EcoRestore Program. The Project is being designed to become a naturally self-regulating system that would not require extensive management or intervention. SFCWA and WES will manage the Project for an interim management period before turning the property over in fee title to CDFW.

B. PURPOSE OF THIS PLAN

The purpose of this adaptive management and monitoring plan (Plan) is to ensure that the restored habitats are protected, managed, monitored, and maintained for purposes and benefits of the species listed above. This Plan establishes objectives, priorities, and tasks to manage, monitor, maintain, and report on the habitats and species at the Project site. The monitoring component of this Plan identifies the metrics of functional outcomes from Project construction and operation that will be measured to evaluate progress toward desired or hypothesized outcomes, and to inform corrective measures if criteria are not met. Monitoring categories include physical processes, vegetation, food web (nutrients, primary and secondary productivity), fish, and water quality (DWR et al., 2012, IEP in development).

Specifically, this Plan provides:

1. A descriptive inventory of plant, wildlife, and fish habitats that occur on the site prior to construction.

2. An overview of the Project site operation and maintenance, and personnel requirements to implement management activities.

3. Monitoring metrics and methods for the restored habitats during the interim management period.

4. A process for initiating adaptive management actions in consultation with cooperating and regulatory agencies.

The Project has been developed in partial fulfillment of permit requirements for the coordinated operation of the CVP and SWP. The restoration is anticipated to generate habitat “credits” to apply against restoration obligations of the water projects. SFCWA, under its Memorandum of Agreement (MOA) with the California Department of Water Resources (DWR), will sell or transfer credits granted SFCWA for the restoration in exchange for DWR reimbursing SFCWA for development costs for the restoration and a commitment to provide management funds for the Project in perpetuity. Funding will come from SWP operational funds, and will be part of the Statement of Charges from DWR to the various State Water Contractors. Funding arrangements will be detailed in a Credit Purchase Agreement with DWR. Execution of a Credit Purchase Agreement is contingent upon SFCWA delivering a fully executed project with attendant credits, which also includes all necessary permit authorizations, such as the U.S. Army Corps of Engineers (USACE or Corps) permit. Until such time as a Credit Purchase Agreement is executed, SFCWA will be responsible for funding and executing all of the management and maintenance activities as described in this Plan until the Tule Red property is turned over to CDFW. SFCWA will also be responsible for funding and executing some, but not all, of the monitoring activities as described in this Plan.

The Fishery Agency Strategy Team (FAST) approving the Project consists of representatives from the USFWS, NMFS, CDFW, and the U.S. Bureau of Reclamation (USBR). Substantive changes in this Plan are subject to review and written approval by the FAST. This Plan is a binding and enforceable instrument for the Project site upon completion of construction.

This Plan is intended to be consistent with federal, state, and local permits and, to the extent any discrepancies arise between this Plan and the permits, the permits shall govern absent written approval from the agency of jurisdiction allowing a permit deviation.

C. Management Objectives

The general objectives of this Plan are to:

1. guide management of the constructed landscape to promote the objectives of the Project and

2. assure preservation of restoration benefits that are consistent with an evolving landscape.

D. Project Goals and Objectives

The restoration goal of the Project is to benefit native fish species by establishing tidal connectivity to the Project site as described below. The restoration objectives to achieve this goal include:

1. Enhance regional food web productivity and export to Grizzly Bay in support of delta smelt and longfin smelt recovery.

2. Provide rearing habitats for out-migrating juvenile salmonids.

3. Provide rearing, breeding, and refugia habitats for a broad range of other aquatic and wetland-dependent species that utilize or depend upon the combination of brackish aquatic-tidal marsh habitat, including Sacramento splittail.

4. Provide ecosystem functions associated with the combination of Delta brackish water aquatic, tidal marsh, and upland interfaces that these species require.

5. Provide topographic variability to allow for habitat succession and resilience against future climate change and sea level rise.

E. Plan Implementation Strategy

The Plan implementation strategy relies on the following concepts to guide the implementation and development of the site:

1. Utilize natural processes for habitat establishment.

2. Utilize best available science to manage the site.

3. Practice adaptive management of the site utilizing input from monitoring data in conjunction with adaptive review of restoration goals and objectives.

4. Review monitoring reports annually with the FAST and identify needed management actions that will promote achievement of restoration goals and objectives.

5. To the extent practicable, minimize effects that would lead to improved conditions for nonnative invasive species such as common reed (*Phragmites australis*) and perennial pepperweed (*Lepidium latifolium*).

F. Implementation Mechanisms

During the interim management period, SFCWA will provide physical management actions under contract with appropriate, competent entities. The monitoring activities may be conducted by public, private, or non-profit entities.

G. Responsible Parties

1. Land Owner and Responsibilities

The Project site is owned by WES, under contract with SFCWA, and CDFW. After construction is complete, SFCWA intends to transfer fee title of the Tule Red portion of the site to CDFW who will become responsible for all of the management and maintenance activities for the entire site.

SFCWA is the party responsible for ensuring execution of the restoration, management, and certain monitoring of the site during the interim management period, and is therefore sometimes referred to as the Land Owner. CDFW will take over Land Owner responsibilities after the interim management period. The Land Owner may cooperate with public, private, or non-profit entities to perform all or some of the tasks identified in this Plan.

The Land Owner's responsibilities shall include but not be limited to the following:

- Implementing or causing to be implemented all habitat creation and management activities.
- Executing the management, monitoring, maintenance, and reporting responsibilities as described in this Plan.
- Performing general inspections to ensure restored habitat values are protected and maintained.
- Performing or causing to be performed some of the monitoring actions and surveys as described in the monitoring component of this Plan.
- Analyzing portions of the monitoring data resulting from the monitoring activities and implementing any remedial or adaptive management actions as agreed to by the FAST.
- Filing annual reports with the FAST describing the status and evolution of the restored habitats, general plant and tidal area health, presence and abundance of invasive flora and fauna, hydrologic conditions, wildlife utilization, trespass and trash problems, and other management, maintenance, monitoring and reporting activities.
- Maintaining a file on the Project detailing management, maintenance, monitoring, and reporting activities, correspondence, and determinations. The file will be available to the FAST for inspection.
- Coordinating and approving any research activities proposed on the site.
- Other similar duties not specifically described above.

2. QUALIFIED PERSONNEL/MONITORING BIOLOGISTS

The Land Owner shall retain professional biologists, botanists, restoration ecologists, and other specialists ("Qualified Personnel"), including "Monitoring Biologists" to conduct specialized tasks and monitoring as described in this Plan. The Monitoring Biologists shall be familiar with wetland biology and have knowledge relative to monitoring protocols, management techniques, endangered species needs, and fisheries ecology.

Monitoring Biologists must have current USFWS, NMFS and/or CDFW authorizations and permits to conduct monitoring surveys for listed species.

Duties of the Qualified Personnel may include, but are not limited to:

- Monitoring and maintaining habitat function.
- Monitoring and maintaining erosion control.
- Identifying and evaluating the presence of invasive species and developing management recommendations.
- Conducting surveys that are required by this Plan.
- Evaluating site conditions and recommending remedial actions and or adaptive management actions to the Land Owner.
- Assisting in the review or planning of any additional restoration actions following initial construction.
- Preparing annual reports.

3. Changes in Personnel

Significant personnel changes will be reported in annual reports to the FAST. If needed or desired by the FAST, any related transfer of management responsibilities will be coordinated with a site visit with the FAST.

II. PROPERTY AND RESTORATION PROJECT DESCRIPTION

A. REGIONAL SETTING

The Project is located on Grizzly Island in the Suisun Marsh (**Figure 1**), which is an unincorporated portion of Solano County, California. Grizzly Island is primarily comprised of duck clubs and the Grizzly Island Unit of the CDFW Grizzly Island Wildlife Area (Refuge). The Project is located on the eastern shoreline of Grizzly Bay, immediately adjacent to the Refuge, and lies within Region 4 as demarcated in the Suisun Marsh Plan (**Figure 2**). The Project focuses on the restoration of tidal wetlands to directly benefit federally and state listed delta smelt, longfin smelt, and salmonids.

The Project site is covered in two U.S. Geological Survey 7.5-minute quadrangle maps: Denverton and Honker Bay (**Figure 3**), and the coordinates for the center of the site are Latitude 38° 07′ 29.47″ North, Longitude 121° 59′ 15.86″ West. The Project site is located within the Suisun Marsh and outside the legal Delta.

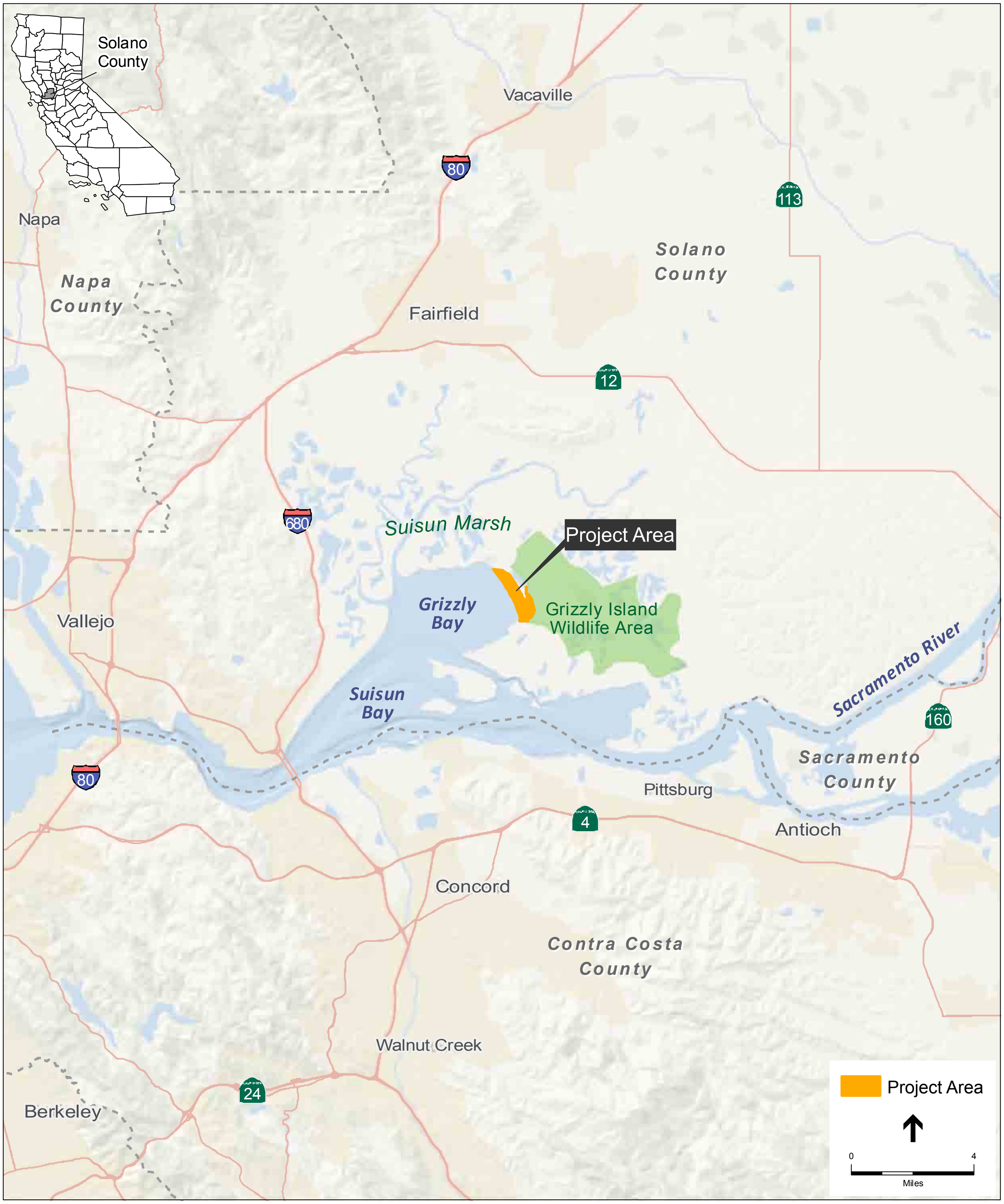
Suisun Marsh (approximately 102,000 acres) is generally characterized by tidal marsh, muted tidal, and diked managed wetlands and associated uplands intersected by channels and sloughs that connect with the adjacent Suisun Bay, Grizzly Bay, and Honker Bay. Suisun Marsh historically was a tidal marsh system comprising brackish marshes with higher salinities towards the west and in the fall, and lower salinities in the east and in winter and spring (Siegel et al., 2010). Much of Suisun Marsh is now disconnected from direct tidal influence by constructed berms and levees. These structures allow water levels within the marsh to be manipulated to meet a variety of environmental and recreational objectives including duck hunting, which is one of the primary land uses in Suisun Marsh. Currently, less than 8,000 acres of tidal marsh remain in Suisun Marsh. Many properties adjacent to, and including, the Project site have been managed as duck clubs for decades.

B. SITE SETTING AND LAND USES

The Project site consists of approximately 2,000 acres owned by Westervelt Ecological Services (WES), and 70 acres owned by CDFW. Within the WES property boundary, approximately 1,600 acres lie within the intertidal and sub-tidal zone of Grizzly Bay. The area proposed to be restored to tidal influence is comprised of a crescent of land adjacent to Grizzly Bay, roughly 1,500 feet wide and 10,000 feet long, totaling approximately 420 acres of managed marsh habitat currently managed as a duck club.

C. HISTORICAL SITE CONDITIONS

The Suisun Marsh historically was a tidal marsh system ranging in salinity, vegetation composition, and species utilization, based upon local geography and Sacramento/San Joaquin River inputs. In the late 1800’s, the Suisun Marsh, including Grizzly Island, was diked for water management capabilities to support agriculture and duck club management. Over time, duck clubs became more prevalent as agricultural lands decreased in productivity.



SOURCE: ESRI, 2012; ESA, 2015

Tule Red Restoration Project . 150158

Figure 1
Project Vicinity and Area

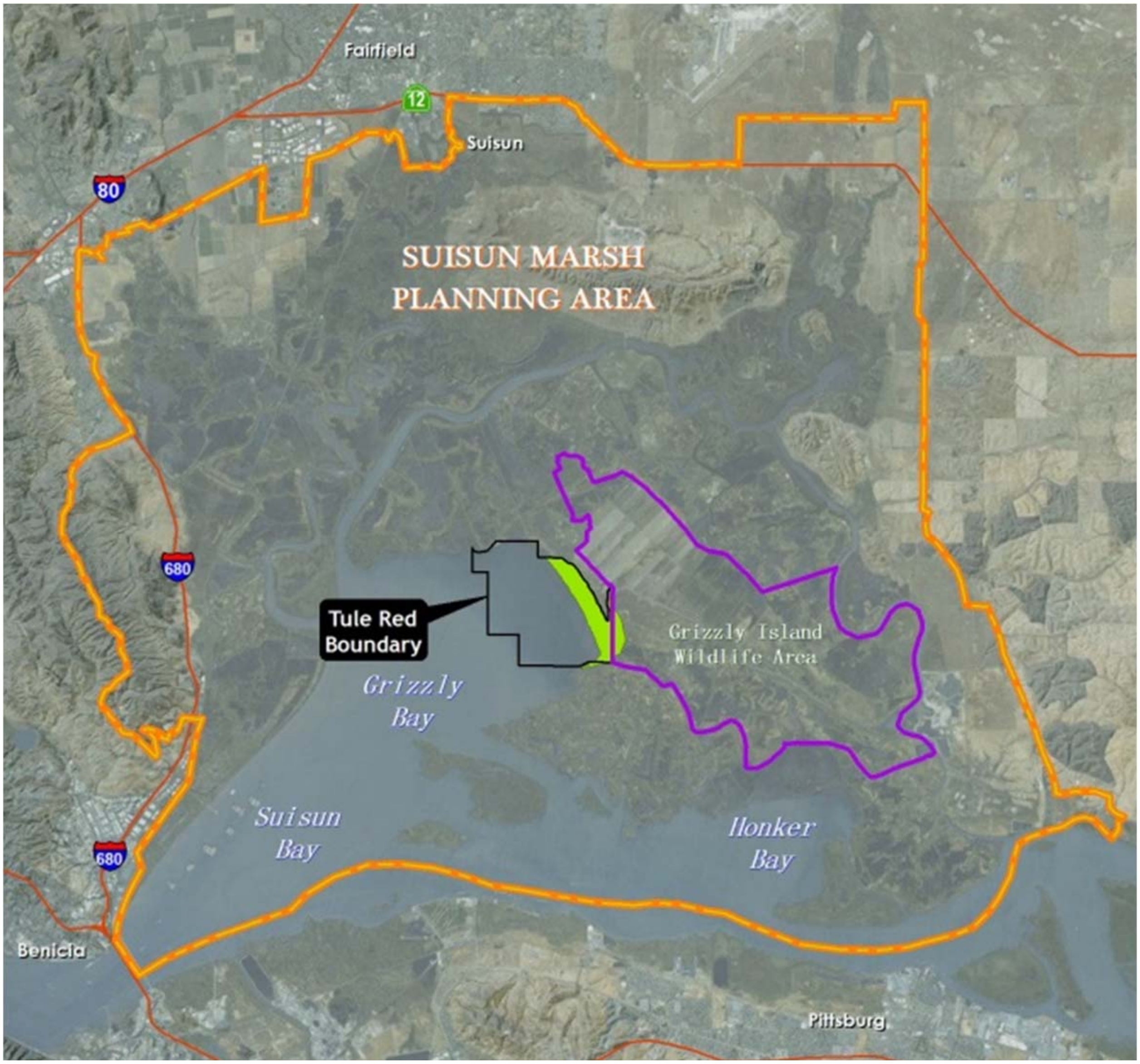
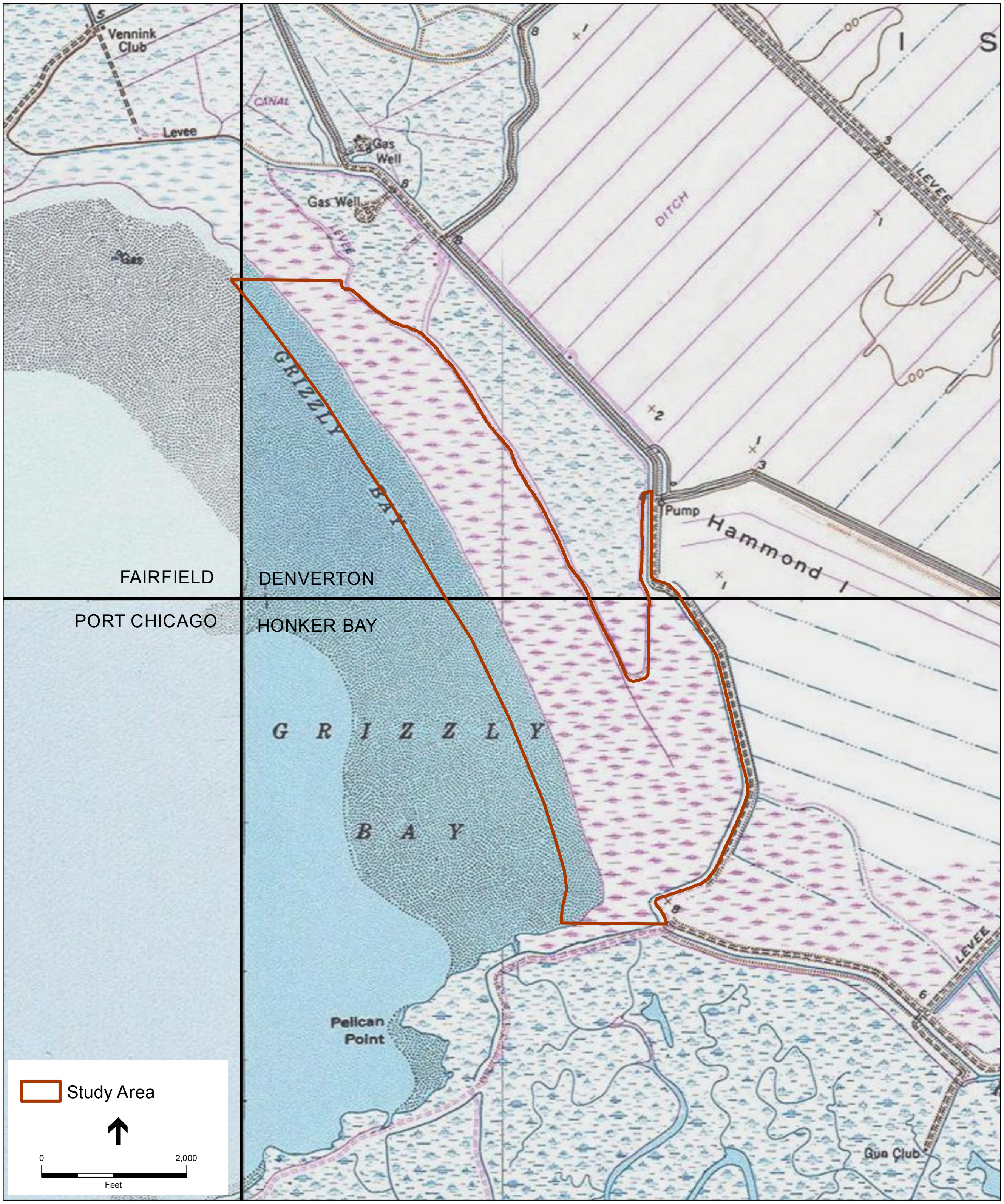


Figure 2
Site Setting within the Suisun Marsh



SOURCE: USGS 7.5' Topo Quad (Fairfield, 1985; Denverton, 1987; Honker Bay, 1985; Port Chicago, 1986); ESA, 2016

Tule Red Restoration Project . 150158

Figure 3
Project Location

Prior to the 1850's gold rush, Grizzly Bay extended almost 2 miles further east into the center of Grizzly Island. Extreme sediment loads associated with hydraulic mining began flushing down the Sacramento River and accumulating on the mudflats on the eastern edge of Grizzly Bay; in the 1870's, Grizzly Bay was filling along the eastern edge at a rate of 250 feet/year. Although this rate has slowed dramatically in recent years, the entire property associated with this Project was intertidal or sub-tidal as recently as 1940. Sediments continue to accrete on the bay-side edge of the property, and the vegetated acreage continues to increase each year.

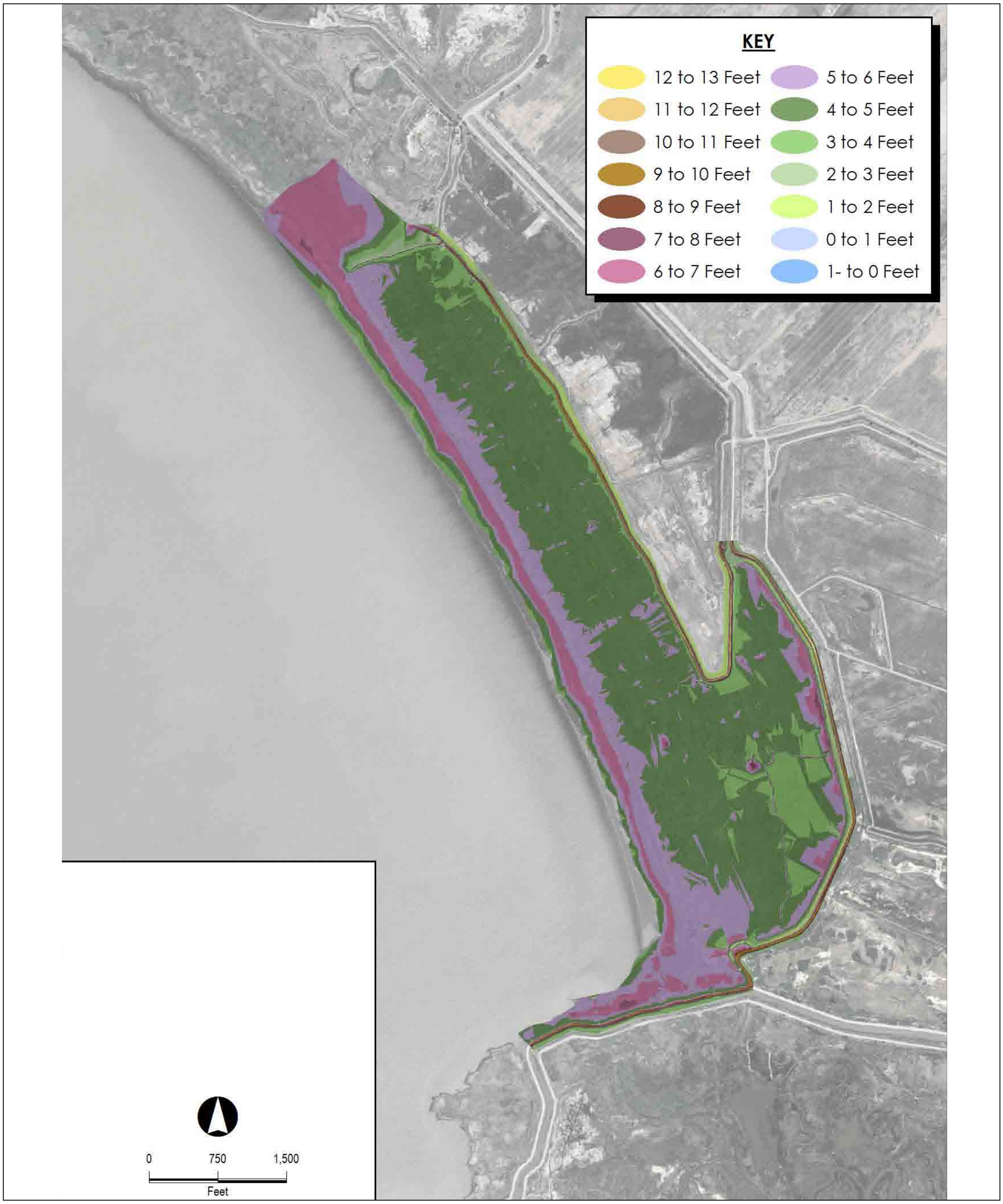
Notable features of the Project site are the active and rapid accretion of sediments along the shoreline and the absence of an artificial berm between Grizzly Bay and the managed marsh. "Centennial marsh" such as this formed along bay margins from accretion of Sierra Nevada hydraulic mining sediment in the late 19th and early 20th centuries (Siegel et al., 2010). Their fairly rapid formation has resulted in relatively low geomorphic complexity including much less sinuous tidal channels. The accumulation of sediments along the shore is a result of the natural tidal hydrology of Grizzly Bay and is influenced by other factors such as wind, downstream water flow from the Sacramento River, and sediment supply. This accretion has extended the area of tidal marsh and tidal mud flat at an estimated average rate of 6.5 feet per year from 1979 to 2012. Sediments have built up to create a natural berm of 5.5-6.6 feet (North American Vertical Datum [NAVD]88) that is overtopped only by extreme high tides, and otherwise effectively separates the tidal marsh along the shoreline from the managed marsh in the interior of the Project site.

D. Topography

The Project site is defined by a natural berm approximately 6 feet in elevation on the western edge of the property, where daily tidal accretion occurs (**Figure 4**). The site gradually slopes eastward to an elevation of 3 to 4 feet; the eastern boundary is defined by levees established for water management on the adjacent Grizzly King Duck Club and CDFW Refuge. Topographical elevations at the Project site range from 0 feet in the tidal mudflat and tidal channels up to 10 feet on the constructed levee where the access roads are located (along the east side of the Project site).

E. Hydrology

The Project site includes two tidal channels and extensive areas of tidal marsh at the north and south ends and along the western side. These areas are exposed to daily tidal fluctuations. In addition, the tidal marsh along the bay margin experiences wave action at high tide during storms or high wind. According to the Port Chicago tide gauge data (NOAA, 2015; 9415144), the mean high water (MHW) measured in NAVD88 in the vicinity of the Project site is 5.51 feet and the mean higher high water (MHHW) is 6.01 feet. The Port Chicago tide gauge is located on the south side of Suisun Bay approximately 5.6 miles south/southwest of the Project site.



SOURCE: Westervelt Ecological Services, 2015

Tule Red Restoration Project . 150158

Figure 4

Pre-construction Site Topography

F. SOILS

A thorough soils investigation was conducted by Hultgren-Tillis Engineers in 2014 and 2015 as part of the geotechnical investigation into the stability of the existing levee and the suitability of the soils to create the habitat berm. The test pits were excavated in the existing parcel where the new channel is planned. Borings were taken down the levee centerline and test pits were dug in the marsh plain to sample the soils. The levee borings were drilled to depths of between 30 and 50 feet. The test pits were excavated to depths of 7 to 9 feet below existing grade. Soils in the test pits consist of marsh deposits. The marsh deposits consist predominately of elastic silt. The base of the marsh deposits ranges from about Elevation -3.5 feet to Elevation -34.1 feet. The marsh deposits have a very soft to soft consistency and are moderately to highly compressible. The marsh soils contain little to no organics. The marsh deposits are underlain by variable zones of silty sand, clayey sand, sandy silt, elastic silt, and elastic silt with sand. The consistency of the sand is variable and ranges from loose to dense. The consistency of the sandy silt ranges from soft to very stiff and the lower elastic silt layers are generally very soft to medium stiff.

G. LAND USES

The property on which the Project is being proposed is currently, and has been historically, managed as the Tule Red Duck Club.

Land uses adjacent to the Project site consist of tidal marsh (north), a privately-owned duck club, Grizzly King Gun Club (Club #513), and the Grizzly Island Wildlife Area owned and managed by CDFW to the east. An existing levee borders the site on the east and a portion of the south. The levee protects the adjoining lands from tidal flooding. At the southern end of the Project site, the levee also protects the Roaring River Distribution System from tidal flooding.

H. CULTURAL RESOURCES

Peak and Associates completed a cultural resources survey and report for the Project in 2015. A field reconnaissance of the Area of Potential Effect (APE) was conducted on June 25 to 27, 2015, by Peak & Associates' Senior Archeologist Robert Gerry, assisted by Michael Lawson. No evidence of prehistoric occupation or use of this area was observed. Although the land is generally heavily disturbed due to maintenance of the perennially water logged property, ground visibility is generally good due to sparse or low vegetation.

The Project area was inspected by walking transects spaced at no more than 30 meters across areas of good visibility and reducing the spacing to 20 meters in areas in which visibility was somewhat impeded. Soils throughout were clearly recent alluvium from flooding episodes.

The only area of the property that could see deep excavation (up to 10 feet in depth) is the relatively small area in the northwest where a channel will be cut to break the existing natural berm and allow tidal flows back into the Project area. This is an area that was part of Grizzly Bay prior to the 1850's gold rush. It is unlikely that prehistoric resources are present.

The only structures in the APE are the clubhouse and associated structures. The base of the clubhouse is the hull of a barge that was hauled in for this purpose at an unknown date. It is now covered by a two story wood superstructure providing living quarters that was constructed in 1991. The caretaker's trailer is adjacent to the clubhouse as are two smaller structures for shop and storage use. There are also numerous hunting blinds on the property consisting of small cylindrical borings with metal covers. These all date to the 1990s or later.

Due to the recent development of the marsh habitats (since 1945) it is not surprising that the survey found no significant historic or prehistoric resources. The buildings associated with the Tule Red Duck Club are not eligible for the National Register of Historic Places. It is worth noting that the survey of Suisun Marsh duck clubs identified 153 clubs extant in 2013, none of them were evaluated as eligible for the National Register.

I. Existing Easements

The only existing easement encumbering the property is an easement for CDFW to use the portion of the road adjacent to the clubhouse area that is within the property boundary of the Tule Red Duck Club. The Tule Red Duck Club also has an easement for ingress and egress along the road within the CDFW-owned property leading north to the entrance gate and Grizzly Island Road.

J. Consistency with Local Planning Efforts

One regional conservation plan (Habitat Conservation Plan/Natural Community Conservation Plan, or "HCP") in the vicinity of the Project has been approved and another has been proposed. These plans are generally sponsored by governmental agencies to address the mitigation and conservation needs of terrestrial, aquatic, and wetland plant and wildlife species. The regional conservation plans in the vicinity of the Project site are the following:

- Suisun Marsh Habitat Management, Preservation and Restoration Plan (Suisun Marsh Plan) (approved)
- Solano County HCP (in preparation)

1. Suisun Marsh Habitat Management, Preservation and Restoration Plan

The Suisun Marsh Habitat Management, Preservation and Restoration Plan (Suisun Marsh Plan) is a comprehensive 30-year plan to restore and enhance Suisun Marsh. The Suisun Marsh Plan addresses concerns over use of resources within about 50,000 acres of Suisun Marsh, which is the largest contiguous brackish marsh on the West Coast. The Suisun Marsh Plan focuses on achieving an acceptable multi-stakeholder approach to habitat conservation by providing the stakeholder coordination and environmental compliance foundation for tidal marsh restoration and managed wetland enhancements. The Suisun Marsh Plan creates a framework for a broad partnership to restore 5,000 to 7,000 acres of the marsh to tidal wetlands and enhance and protect more than 40,000 acres of managed wetlands. The Suisun Marsh Plan's objectives include improving habitat for multiple special-status species, maintaining the heritage of waterfowl hunting and other recreational opportunities, improving water quality to assist fish migration and spawning, and improving and maintaining the levee system to protect property, infrastructure and wildlife habitats from flooding.

Work on the Suisun Marsh Plan began in 2003. The Draft EIS/EIR was released for public review in 2010, and the Final EIS/EIR was released for public review in 2011. The Record of Decision was signed and the Suisun Marsh Plan was approved in 2014.

2. SOLANO COUNTY HCP

Solano County Water Agency was required to prepare the Solano County Habitat Conservation Plan (HCP) as part of renewing the water supply contract from the Solano Project (Lake Berryessa). The Solano Project is the most important water resource to Solano County. Since the Solano Project is owned by the United States Government, compliance with the Federal Endangered Species Act was required resulting in the need for an HCP to deal with potential impacts to endangered species caused by water supply contract renewal.

The purpose of the Solano HCP is to: (a) promote the conservation of biological diversity and the preservation of endangered species and their habitats consistent with the recognition of private property rights; (b) provide for a healthy economic environment for the citizens, agriculture, and industries; and (c) allow for the ongoing maintenance and operation of public and private facilities in Solano County. The HCP encompasses approximately 577,000 acres of Solano County and 8,000 acres of Yolo County, and there are 36 species proposed for coverage. A Final Administrative Public Draft HCP was released in October 2012; however, the HCP has not yet been approved.

3. OTHER ENFORCEABLE REGIONAL-BASED ECOSYSTEM MANAGEMENT PLANS

a) SUISUN MARSH PLAN OF PROTECTION

The Suisun Marsh Plan of Protection was developed by the Bay Conservation and Development Commission (BCDC) in 1976 and defines and limits development within primary and secondary management areas for the “future of the wildlife values of the area as threatened by potential residential, commercial and industrial development”. The Plan recommends that the State purchase 1,800 acres, and maintain water quality. While the focus of the Plan is on maintaining waterfowl habitat, the Plan also addresses the importance of tidal wetlands and recommends restoring historical marsh areas to wetland status (managed or tidal). The plan states that “if, in the future, some of the managed wetlands are no longer needed for waterfowl hunting, they should also be restored as tidal marshes” (page 29). (http://www.water.ca.gov/suisun/program/.)

b) SUISUN MARSH PRESERVATION AGREEMENT

In 1987, the Suisun Marsh Preservation Agreement, a contractual agreement between DWR, USBR, DFG, and SRCD, was entered into. The Suisun Marsh Preservation Agreement contains provision for DWR and USBR to mitigate the effects on Suisun Marsh channel water salinity from the SWP and CVP operations and other upstream diversions. The Suisun Marsh Preservation Agreement requires DWR and USBR to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. The Suisun Marsh Monitoring Agreement and the Suisun Marsh Mitigation Agreement were also signed at this time. The Suisun Marsh Mitigation Agreement defined habitat requirements to mitigate effects of facilities and operations and the Suisun Marsh Monitoring Agreement defines requirements for monitoring salinity and species in the Marsh. (http://www.water.ca.gov/suisun/program/.)

c) Delta Plan

The Delta Plan is a comprehensive, long-term management plan for the Delta. Required by the 2009 Delta Reform Act, it creates new rules and recommendations to further the state's coequal goals for the Delta: Improve statewide water supply reliability, and protect and restore a vibrant and healthy Delta ecosystem, all in a manner that preserves, protects and enhances the unique agricultural, cultural, and recreational characteristics of the Delta.

The Delta Plan is guided by the best available science. The Delta Plan is founded on cooperation and coordination among affected agencies. The Delta Plan is also enforceable through regulatory authority, as spelled out in the Delta Reform Act, that requires state and local agencies to be consistent with the Delta Plan. The Delta Plan was adopted by the Delta Stewardship Council on May 16, 2013. The Delta Plan became effective with legally-enforceable regulations on September 1, 2013. (http://www.deltacouncil.ca.gov/delta-plan-0.)

d) San Francisco Bay Basin Water Quality Control Plan (Basin Plan)

By law, the Regional Water Quality Control Board San Francisco Bay Region (Water Board or RWQCB) is required to develop, adopt, and implement a Water Quality Control Plan (Basin Plan) for the Region. The Basin Plan is the master policy document that contains descriptions of the legal, technical, and programmatic bases of water quality regulation in the Region. The plan must include:

- A statement of beneficial water uses that the Water Board will protect;
- The water quality objectives needed to protect the designated beneficial water uses; and
- The strategies and time schedules for achieving the water quality objectives.

The Basin Plan identifies existing and potential beneficial uses for surface waters and groundwater basins within the Basin Plan area. The Basin Plan also identifies narrative and numerical water quality objectives that define the level of water quality that shall be maintained within the region.

The Water Board participates in a number of wetland restoration projects in the Region, both in a regulatory role regarding proposed wetland fill and/or discharges, and in the role of an interested party or stakeholder, recognizing the multiple benefits of wetland restoration for water quality and beneficial uses. Major restoration projects include former salt ponds adjacent to South San Francisco Bay and San Pablo Bay, former Department of Defense sites such as Hamilton Field in Marin County, and the Bair Island Ecological Reserve in South San Francisco Bay. While restoration projects are expected to have a positive impact on water quality and beneficial uses, certain challenges must be addressed, such as minimizing uptake of mercury into the food web, meeting water quality objectives for salinity and dissolved oxygen in discharges from ponds (impounded bay waters), protecting existing tidal mudflats, and controlling harmful invasive species such as smooth cordgrass (*Spartina alterniflora*) and its hybrids. (http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch1-7_print.shtml.)

K. ECOLOGICAL HISTORY AND RESTORATION POTENTIAL

The Suisun Marsh historically was a tidal marsh system ranging in salinity, vegetation composition, and species utilization, based upon local geography and Sacramento/San Joaquin River inputs. In the late 1800's, the Suisun Marsh, including Grizzly Island, was diked for water management capabilities to support agriculture and duck club management. Over time, duck clubs became more prevalent as agricultural lands decreased in productivity.

Prior to the 1850's gold rush, Grizzly Bay extended almost 2 miles further east into the center of Grizzly Island. Extreme sediment loads associated with hydraulic mining began flushing down the Sacramento River and accumulating on the mudflats on the eastern edge of Grizzly Bay; in the 1870's, Grizzly Bay was filling along the eastern edge at a rate of 250 feet/year. Although this rate has slowed dramatically in recent years, the entire property associated with this Project was intertidal or subtidal as recently as 1940. Sediments continue to accrete on the bay-side edge of the property, and the vegetated acreage continues to increase each year. The site was developed as a duck club with controlled water sometime in the late 1950's and early 1960's, and has been managed for winter waterfowl use and spring brood habitat since that time by an on-site caretaker.

A majority of the site lies in the intertidal zone (3.5'-5.5' NAVD elevations) that are ideal for colonization by brackish tidal wetland vegetation. An opportunity for introducing direct tidal influence to the site is available by connecting a channel through the natural berm at the western boundary of the managed marsh to the mudflats of Grizzly Bay. An existing exterior levee on the eastern boundary of the Project site protects neighboring properties, but will be sloped to become a "habitat berm" to provide high-water refuge for terrestrial species and to accommodate sea level rise in the near future.

L. RESTORATION PROJECT DESCRIPTION

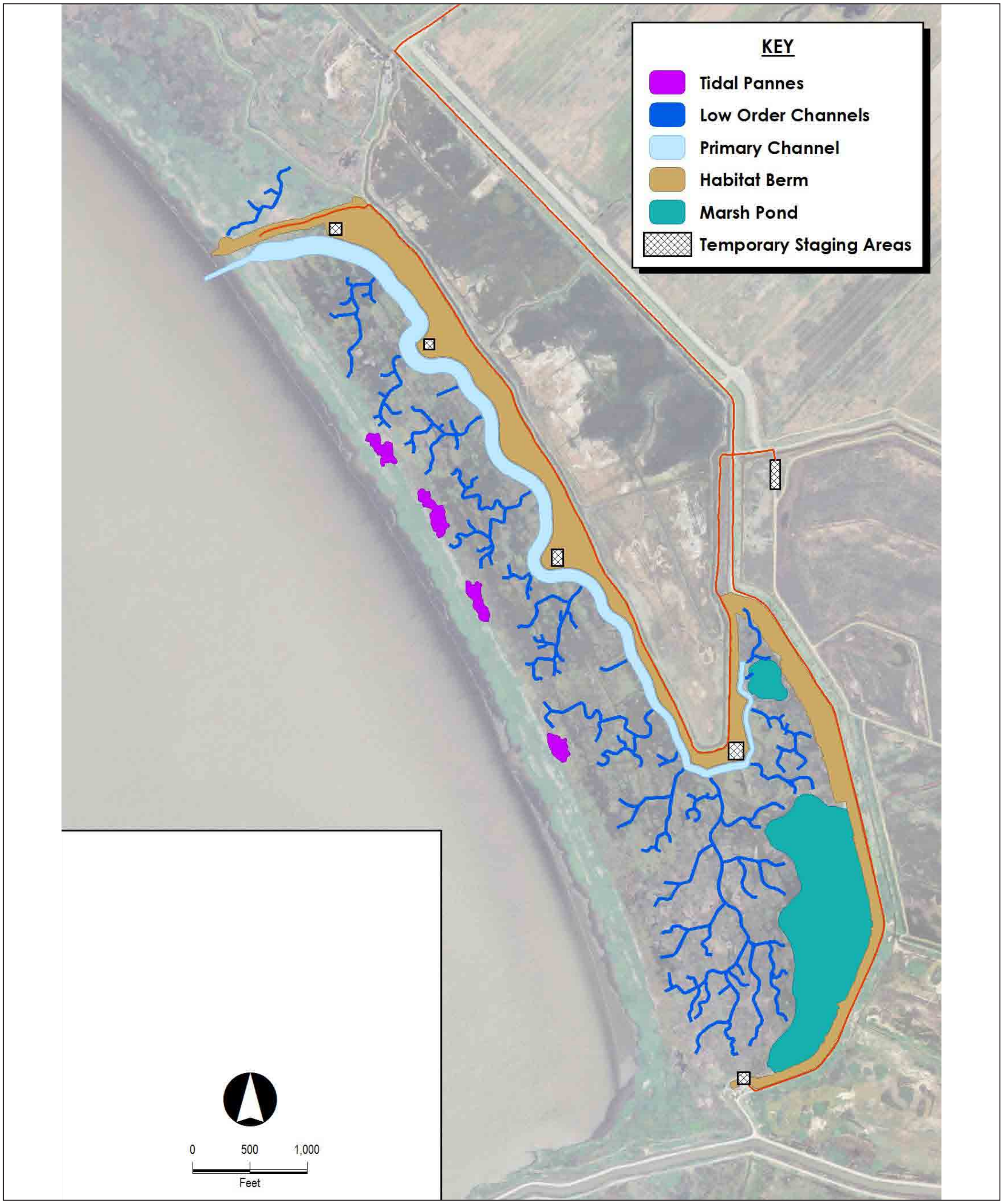
The Project is being designed to become a naturally, self-regulating system that would not require active management or intervention. The Project Concept Plan has the following primary habitat features (**Figure 5**):

1. a permanent breach of the natural berm to allow for full daily tidal exchange through the interior of the Project site;

2. a network of tidal channels that supports a full tidal exchange (i.e., tidal prism) on the Project site;

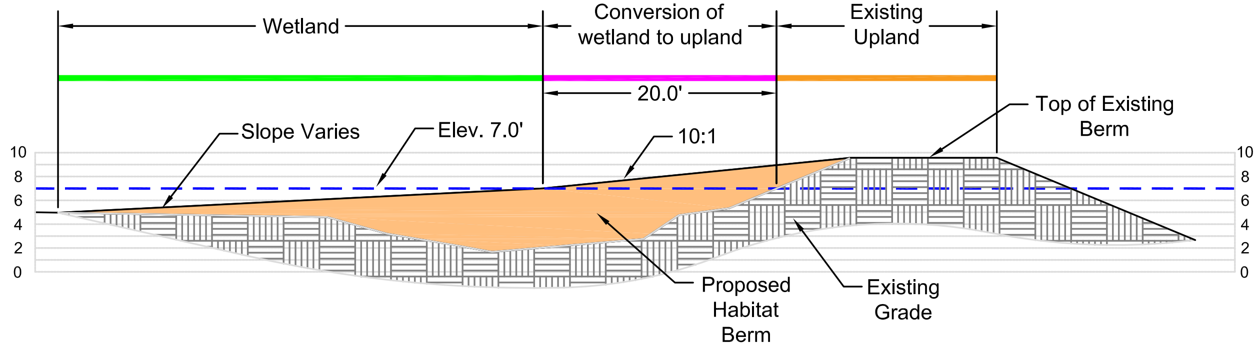
3. a series of tidal pannes/basins intended to retain water for periods up to 2 weeks to maximize aquatic food production and export; and

4. a habitat berm created along the eastern perimeter of the property, which is designed to provide a gradient from marsh to upland habitat and to maintain flood protection for adjacent properties (**Figure 6**).

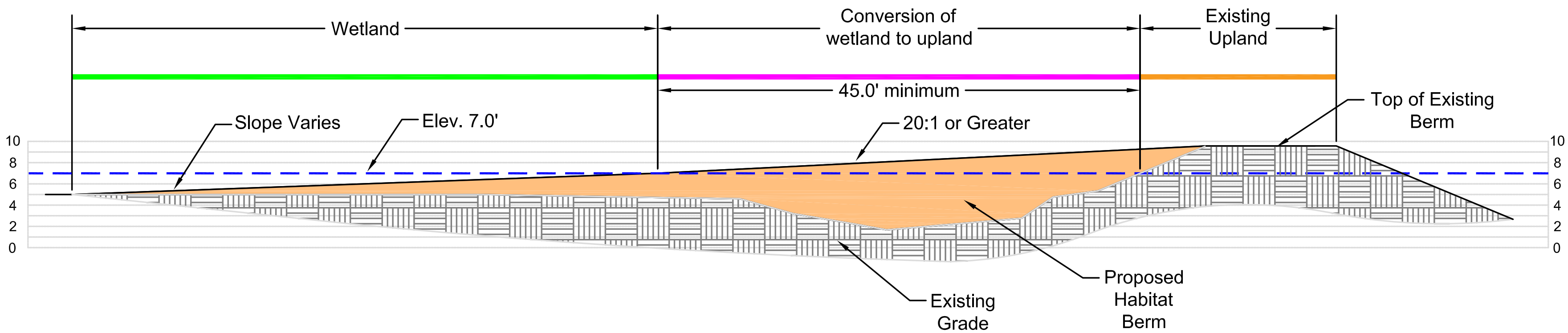


SOURCE: Westervelt Ecological Services, 2015

Figure 5
Concept Design



10:1 - Proposed Habitat Berm



20:1 or Greater - Proposed Habitat Berm

SOURCE: Westervelt Ecological Services 2015

Figure 6
Conceptual Cross Section – Moderate Habitat Berm

In addition, the Project has an array of measures to reduce impacts of low dissolved oxygen drain water received from the CDFW drain pump including, potentially, an aeration structure and retention pond.

The Project's restoration effort is at a significant scale, both in acreage (420 acres) and in volume of earthmoving (estimated at 300,000 yd^3). The design is a balanced cut-and-fill, with key considerations involving both the width/slope of the habitat berm and the amount of channel excavation necessary to avoid tidal muting. The as-built conditions will be surveyed following construction to quantify the actual amount (acres) and condition (topography and channel bathymetry) of tidal wetlands and associated habitat features. These values will form the basis for monitoring physical habitat status and change.

Numerous other factors incorporated into the design include, but are not limited to:

- Accretion/erosion of the channels and marsh plain, for both stability and accommodating sea level rise;
- Construction phasing, with the interior work occurring in summer 2016 and the breach occurring in late summer 2018, to allow for vegetation establishment and control of non-target species (*Phragmites*) prior to tidal inundation;
- Consistency with the Suisun Marsh Plan; and
- Methods to clear vegetation prior to construction that are consistent with protection measures for salt marsh harvest mouse.

III. HABITATS AND SPECIES PRESENT

A. WETLAND DELINEATION

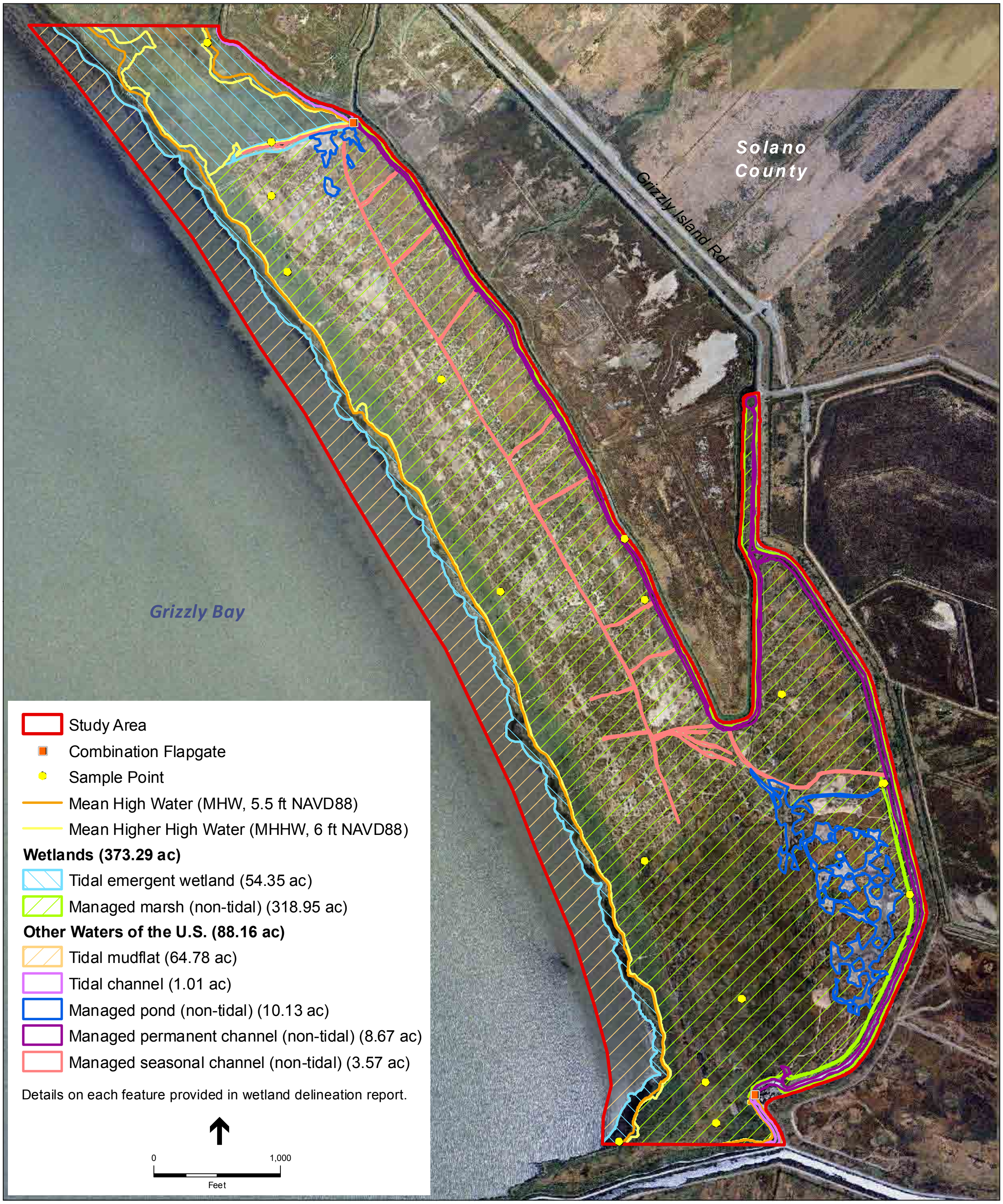
A wetland delineation survey for U.S. Army Corps of Engineers (Corps) jurisdiction under the Clean Water Act (CWA) and Rivers and Harbors Act has been conducted for the Project site (ESA 2015). The delineation identified nearly the entire Project site as Wetlands and Waters of the United States (**Figure 7**).

The wetland delineation identified 461.45 acres of potentially jurisdictional features within the 472-acre study area (**Table 1**). Potentially jurisdictional features include 373.29 acres of wetlands and 88.16 acres of other waters of the U.S. and of the State, all of which are expected to be subject to regulation under Sections 404 and 401 of the CWA and the Porter-Cologne Water Quality Control Act. Potentially jurisdictional features within the study area include tidal emergent wetland, managed marsh (non-tidal), tidal mudflat, tidal channel, managed ponds (non-tidal), managed permanent channel (non-tidal), and managed seasonal channel (non-tidal). A subset of these potentially jurisdictional features, totaling 121.52 acres, is also expected to be subject to regulation under Section 10 of the Rivers and Harbors Act.

Table 1. Potentially Jurisdictional Wetlands and Other Waters of the U.S. and of the State in the Project Area

	Extent	
Feature Type	**Linear feet**	**Area (acres)**
Wetlands		
Tidal emergent wetland		54.35
Managed marsh (non-tidal)		318.95
Total Wetlands		**373.29**
Other Waters of the U.S.		
Tidal mudflat		64.78
Tidal channel	1,837	1.01
Managed pond (non-tidal)		10.13
Managed permanent channel (non-tidal)	14,141	8.67
Managed seasonal channel (non-tidal)	14,428	3.57
Total Other Waters	**30,406**	**88.16**
Total Area of Wetland and Other Waters Features:		**461.45**

SOURCE: ESA, 2015a. Area totals subject to rounding.



SOURCE: Westervelt, 2014; ESA, 2015

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Figure 7
Potentially Jurisdictional Waters

B. SPECIAL STATUS PLANT SPECIES

To date, there have been no records of special-status plants, including listed Suisun thistle and soft bird's-beak, within the action area. In 2015, special-status plant surveys were conducted in accordance with the CDFW's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG, 2009). The surveys were floristic in nature, meaning that every plant taxon that occurred in the survey area at the time of the survey was identified to the taxonomic level necessary to determine rarity and listing status. The two surveys in 2015 have completed the first year of the two-year protocol, with second year surveys scheduled for 2016.

The early season special-status plant survey was conducted on May 19, 2015 in the tidal emergent wetland along the southern margin of Grizzly Bay. The early season survey focused on evaluating habitat and surveying the tidal emergent wetland for Mason's lilaeopsis (*Lilaeopsis masonii*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), and Suisun marsh aster (*Symphyotrichum lentum*) (ESA, 2015b). These three special-status plants begin to flower in the late-spring/early summer and occur in tidal emergent wetlands.

The late season special-status plant survey was conducted on August 5, 2015 in the managed marsh between the mean higher high water (MHHW) line to the west and the managed permanent channel to the east. The late season survey focused on evaluating habitat and surveying the managed marsh for papoose tarplant (*Centromadia parryi* subsp. *parryi*), saltmarsh water hemlock (*Cicuta maculata* var. *bolanderi*), soft bird's beak (*Chloropyron molle* subsp. *molle*), and Suisun thistle (*Cirsium hydrophilium* var. *hydrophilium*). The late season survey also revisited suitable tidal emergent wetland habitat for Mason's lilaeopsis (*Lilaeopsis masonii*) and Suisun marsh aster (*Symphyotrichum lentum*) (ESA, 2015c).

No special-status plants were observed during the two 2015 surveys. The tidal emergent wetland along the shoreline supports low plant diversity, with the exception of an area at the south end of the study area. The managed marsh within the study area between the MHHW line to the west and the managed permanent channel to the east supports low plant species diversity and provides little suitable habitat for the late season special-status plants papoose tarplant, saltmarsh water hemlock, soft bird's beak, and Suisun thistle. The manipulation of the managed marsh area to increase duck hunting opportunities decreases the suitability of habitat for special-status plants

Suitable habitat for Suisun marsh aster and Mason's lilaeopsis (along with early season blooming species Delta tule pea) is found near the southern boundary of the study area where low banks occur within the mean high water line that are somewhat protected from wave scour because of their topographic location. This area was surveyed on May 19 and August 5, 2015. This small area supports nearly twice the number of plant taxa of the tidal emergent wetland to the north and the cover of common reed (*Phragmites australis*) is less dense. California native plants in this area include low bulrush (*Isolepis cernua*), creeping sea arrow-grass (*Triglochin maritima*), and Baltic rush (*Juncus balticus*), with wooly hedge nettle (*Stachys albens*), mugwort (*Artemisia douglasiana*), and San Francisco gumplant (*Grindelia stricta*) further up the bank above the MHHW line. No special-status species were observed in this area.

C. FISH

The listed and other special-status fish species with potential to occur in Suisun Marsh include Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley fall-/late fall–run Chinook salmon, delta smelt, longfin smelt, Sacramento splittail, and green sturgeon (RBI, 2011; USBR, et al. 2011).

Delta smelt and longfin smelt are documented in Grizzly Bay and the larger Suisun Marsh by various surveys by IEP and UC Davis (O'Rear and Moyle, 2009, 2010, 2012, 2013a, 2013b, 2013c; Merz et al., 2011; RBI, 2011). The Suisun Marsh Fish Monitoring program, conducted monthly since 1980 by UC Davis, has monitored fish in shallow, brackish-water habitat (O'Rear and Moyle, 2009, 2010, 2012, 2013a, 2013b, 2013c). Longfin smelt can occur in the marsh year-round, but the marsh is mostly used during the spring larval stage when longfin smelt utilize brackish marshes as rearing areas. Delta smelt and longfin smelt are generally regarded as pelagic fish that typically occupy open water (Moyle, 2002). Delta smelt may also be caught in shoal and shallow areas such as Suisun Bay and Liberty Island (reviewed by Sommer and Mejia, 2013). Their use of tidal marshes is likely limited to consumption of productivity exports, although some direct, opportunistic utilization of shallow water habitats may occur. Connectivity of the tidal marshes to the tidal aquatic environment is the key process linking delta smelt and longfin smelt to tidal marsh productivity (Raabe et al., 2010). Delta smelt can occur in relatively small channels; the smallest channel where adults and juveniles have been reported is Spring Branch Slough (average 15-m wide) in Suisun Marsh (Sommer and Mejia, 2013).

Adult and juvenile Chinook salmon utilize Suisun Marsh, particularly Montezuma Slough, along with Suisun and Grizzly Bays as migration routes (O'Rear and Moyle, 2009; Raabe et al., 2010). Juveniles are believed to enter Suisun Marsh at a smolt stage, although fall-run smolts are generally smaller in size compared to listed Chinook salmon smolts. Juveniles likely utilize the Marsh for foraging, migration and potentially minimal rearing. Juvenile Chinook salmon are known to forage in shallow areas with protective cover such as intertidal and subtidal mudflats, marshes, channels, and sloughs. The primary drivers that likely influence Chinook salmon habitat connectivity throughout the Marsh are physical barriers and adverse water quality conditions, rendering the water column unsuitable for occupancy by this species.

In addition to listed species, many native and non-native species occur in the vicinity of the Project site and are captured by various sampling methods. The UC Davis fish study captured 55 species between 1980 and 2012, of which 29 are native and 26 are non-native (O'Rear and Moyle, 2012) (**Table 2**). The most abundant native species, listed in order of highest capture rates, include splittail, threespine stickleback, tule perch, longfin smelt, staghorn sculpin, Sacramento sucker, and starry flounder. The most abundant non-native fish include striped bass, Mississippi silversides, yellowfin goby, shimofuri goby, threadfin shad, and common carp.

UC Davis biologists sampled in the ditch at the south end of Tule Red on May 13, 2011, above and below a water control structure, to assess the aquatic community within a managed wetland (O'Rear and Moyle, 2012). The ditch was quite narrow and shallow and contained fairly lush growths of submerged aquatic vegetation. No delta smelt were captured. Threespine stickleback (*Gasterosteus aculeatus*) were the dominant fish (**Table 3**).

Table 2. Fish Species Caught in Suisun Marsh by UC Davis from 1979 to 2011

Common Name	Scientific Name	Common Name	Scientific Name
American shad	*Alosa sapidissima*	**prickly sculpin**	***Cottus asper***
bay pipefish	***Sygnathus leptorhynchus***	**rainbow trout**	***Oncorhynchus mykiss***
bigscale logperch	*Percina macrolepida*	rainwater killifish	*Lucania parva*
black bullhead	*Ameiurus melas*	redear sunfish	*Lepomis microlophus*
black crappie	*Pomoxis nigromaculatus*	**river lamprey**	***Lampetra ayresi***
bluegill	*Lepomis macrochirus*	**Sacramento blackfish**	***Orthodon macrolepidotus***
brown bullhead	*Ameiurus nebulosus*	**Sacramento pikeminnow**	***Ptychocheilus grandis***
California halibut	***Paralichthys californicus***	**Sacramento splittail**	***Pogonichthys macrolepidotus***
channel catfish	*Ictalurus punctatus*	**Sacramento sucker**	***Catostomus occidentalis***
Chinook salmon	***Oncorhynchus tshawytscha***	shimofuri goby	*Tridentiger bifasciatus*
common carp	*Cyprinus carpio*	**shiner perch**	***Cymatogaster aggregata***
delta smelt	***Hypomesus transpacificus***	shokihaze goby	*Tridentiger barbatus*
fathead minnow	*Pimephales promelas*	**speckled sanddab**	***Citharichthys stigmaeus***
golden shiner	*Notemigonus crysoleucas*	**staghorn sculpin**	***Leptocottus armatus***
goldfish	*Carassius auratus*	**starry flounder**	***Platichthys stellatus***
green sturgeon	***Acipenser medirostris***	striped bass	*Morone saxatilis*
green sunfish	*Lepomis cyanellus*	**surf smelt**	***Hypomesus pretiosus***
hardhead	***Mylopharadon conocephalus***	threadfin shad	*Dorosoma petenense*
hitch	***Lavinia exilicauda***	**threespine stickleback**	***Gasterosteus aculeatus***
largemouth bass	*Micropterus salmoides*	**tule perch**	***Hysterocarpus traski***
longfin smelt	***Spirinchus thaleichthys***	wakasagi	*Hypomesus nipponensis*
longjaw mudsucker	***Gillichthys mirabilis***	warmouth	*Lepomis gulosus*
Mississippi silverside	*Menidia audens*	western mosquitofish	*Gambusia affinis*
northern anchovy	***Engraulis mordax***	white catfish	*Ameiurus catus*
Pacific herring	***Clupea harengeus***	white crappie	*Pomoxis annularis*
Pacific lamprey	***Lampetra tridentata***	**white croaker**	***Genyonemus lineatus***
Pacific sanddab	***Citharichthys sordidas***	**white sturgeon**	***Acipenser transmontanus***
plainfin midshipman	***Porichthys notatus***	yellowfin goby	*Acanthogobius flavimanus*

Note:

Native species in **bold**

Source: O'Rear and Moyle, 2013

Table 3. Fish Species Captured at the Tule Red Restoration Site (South Ditch at Water Control Structure)				
Common Name	**Above WCS (otter trawl)**	**Above WCS (seine)**	**Below WCS (seine)**	**Total**
Mississippi silverside		11	6	17
prickly sculpin		2	3	5
redear sunfish			1	1
Sacramento pikeminnow		1	4	5
threespine stickleback	248	455	121	824
tule perch	3	3	9	15
western mosquitofish		50	9	59
Total Fish	251	522	155	928
Source: O'Rear and Moyle, 2012				

D. WILDLIFE

Wildlife species observed at the Project site are listed in **Table 4**.

Several special-status wildlife species have the potential to occur on the site, but the only special status wildlife species observed on the site is the salt marsh harvest mouse (*Reithrodontomys raviventris*).

Table 4. List of Bird and Wildlife Species Observed at the Tule Red Restoration Site	
Common Name	**Scientific Name**
BIRDS	
Anseriformes (Swans, Geese, Ducks)	
Canada Goose	*Branta canadensis*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Ring-necked Duck	*Aythya collaris*
Bufflehead	*Bucephala albeola*

Table 4. List of Bird and Wildlife Species Observed at the Tule Red Restoration Site

Common Name	Scientific Name
Galliformes (Quail, Grouse, Turkeys, Partridges)	
Ring-necked Pheasant	*Phasianus colchicus*
Podicipediformes (Grebes)	
Pied-billed Grebe	*Podilymbus podiceps*
Western Grebe	*Aechmophorus occidentalis*
Suliformes (Frigatebirds, Boobies, Cormorants, Darters)	
Double-crested Cormorant	*Phalacrocorax auritus*
Pelecaniformes (Pelicans, Herons, Ibises)	
American White Pelican	*Pelecanus erythrorhynchos*
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Accipitriformes (Hawks, Kites, Eagles)	
Turkey Vulture	*Cathartes aura*
White-tailed Kite	*Elanus leucurus*
Northern Harrier	*Circus cyaneus*
Red-tailed Hawk	*Buteo jamaicensis*
Gruiformes (Rails & Cranes)	
American Coot	*Fulica americana*
Common Morehen	*Gallinula chloropus*
Sora	*Porzana carolina*
Charadriiformes (Shorebirds, Gulls, Auks)	
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Common Snipe	*Gallinago gallinago*
Wilson's Phalarope	*Phalaropus tricolor*
Black Tern	*Chlidonias niger*
Columbiformes (Pigeons & Doves)	
Mourning Dove	*Zenaida macroura*
Strigiformes (Owls)	
Barn Owl	*Tyto alba*
Great Horned Owl	*Bubo virginianus*
Short-eared Owl	*Asio flammeus*

Table 4. List of Bird and Wildlife Species Observed at the Tule Red Restoration Site	
Common Name	**Scientific Name**
Apodiformes (Swifts & Hummingbirds)	
Anna's Hummingbird	*Calypte anna*
Coraciiformes (Kingfishers)	
Belted Kingfisher	*Ceryle alcyon*
Falconiformes (Caracaras & Falcons)	
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Prairie Falcon	*Falco mexicanus*
Peregrine Falcon	*Falco peregrinus*
Passeriformes (Passerine Birds)	
Black Phoebe	*Sayornis nigricans*
American Crow	*Corvus brachyrhynchos*
Tree Swallow	*Tachycineta bicolor*
Cliff Swallow	*Petrochelidon pyrrhonota*
Marsh Wren	*Cistothorus palustris*
Red-winged Blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
American Goldfinch	*Spinus tristis*
Barn Swallow	*Hirundo rustica*
White-crowed Sparrow	*Zonotrichia leucophrys*
HERPETOLOGY AND REPTILES	
SNAKES	
Green Racer Snake	*Coluber constrictor*
Gopher Snake	*Pituophis catenifer*
Valley Gartersnake	*Thamnophis sirtalis fitchi*
LIZARDS	
Western Fence Lizard	*Sceloporus occidentalis*
TURTLES	
Pacific Pond Turtle	*Actinemys marmorata*
FROGS & TOADS	
Northern Pacific Treefrog	*Pseudacris regilla*
MAMMALS	
Lagomorpha	
Audobon's (Desert) Cottontail	*Sylvilagus audobonii*

Table 4. List of Bird and Wildlife Species Observed at the Tule Red Restoration Site	
Common Name	**Scientific Name**
Rodentia	
Beaver	*Castor canadensis*
Botta's Pocket Gopher	*Thomomys bottae*
California Ground Squirrel	*Spermophilus beecheyi*
California Meadow Vole	*Microtus californicus*
Mole (Broad-footed)	*Scapanus latimanus*
Muskrat	*Ondatra zibethicus*
Rat	*Rattus*
Salt Marsh Harvest Mouse	*Reithrodontomys raviventris*
Carnivora	
Coyote	*Canis latrans*
Raccoon	*Procyon lotor*
River Otter	*Lutra canadensis*
American Mink	*Neovison vison*
Artiodactyla	
Tule Elk	*Cervus canadensis nannodes*

IV. MONITORING

A. INTRODUCTION

The Project includes monitoring elements to serve multiple purposes:

- Compliance Monitoring: Mandatory monitoring elements driven by permit requirements.
- Effectiveness Monitoring: High priority monitoring elements to track progress towards Project objectives
- Special Studies: Desirable discretionary (supplementary) monitoring elements. These are noted in the event that additional funding or research partners become available.

In addition, all monitoring will be used to identify the need for management actions necessary for the development and maintenance of the site (i.e., "adaptive management") and to learn whether or not the stated objectives of the Project are being met.

1. COMPLIANCE MONITORING

The Project's goal is to partially fulfill the 8,000-acre tidal restoration obligations of the FRPA in satisfaction of the BiOps (USFWS 2008, NMFS 2009) and ITP, as credited by the FAST through the Prospectus. The Project will verify implementation by post-construction monitoring of constructed outputs (acres restored, as-built topography and elevations, and hydrology).

In addition, regulatory permits obtained for constructing the Project have associated conservation and mitigation measures that require specific monitoring actions to satisfy compliance. These monitoring elements focus on permitting requirements and mitigation measures under the Suisun Marsh Plan, USACE, RWQCB, Section 7 consultations, and BCDC permits. These will be incorporated once the final permits have been issued.

2. EFFECTIVENESS MONITORING

Effectiveness monitoring will track progress towards objectives by measuring indicators of ecological status and function ("metrics") and comparing the measurements to expected or hypothesized outcomes. Sampling techniques ("methods") will include annual terrestrial surveys, continuous hydrologic and water quality monitoring via instrumentation, and seasonal sampling of aquatic food web components and fish presence. Measurements of physical and biological components will be used to evaluate the evolution of habitat on the site including tidal channel and marsh morphology, vegetation response (including non-native invasive plants) to the reconnected tidal influence, habitat component contributions to the food web and identification of occupied fish habitat.

Again, the objectives of the Project are to provide:

1. **Food Web Contribution**: Enhance regional food web productivity and export to Grizzly Bay in support of delta smelt and longfin smelt recovery.

2. **Salmon Rearing Habitat**: Provide rearing habitats for out-migrating juvenile salmonids.

3. **Habitat for Other Species**: Provide rearing, breeding, and refugia habitats for a broad range of other aquatic and wetland-dependent species that utilize or depend upon the combination of brackish aquatic-tidal marsh habitat, including Sacramento splittail.

4. **Ecosystem Functions**: Provide ecosystem functions associated with the combination of Delta brackish water aquatic, tidal marsh, and upland interfaces that these species require.

5. **Habitat Succession**: Provide topographic variability to allow for habitat succession and resilience against future climate change and sea level rise.

3. Special Studies

Regional monitoring of reference or comparison sites and applied studies would be designed to address questions or uncertainties that require more in-depth investigation than basic monitoring could provide. The Project site will be made available for these studies by investigators, and results from regional studies will be incorporated into design of on-site monitoring and management of the Project site. Design and implementation of special studies, however, are outside the scope of this monitoring plan and would depend on available funding and partners. Due to the labor and resource-intensive nature of these studies, they would occur on a limited basis, and would be developed to address other questions and hypotheses with guidance from the FAST. For example, measurements of material flux onto and off of the restoration site could be collected during a series of load studies, following the general methodology of DWR's methylmercury study (DWR, 2013) and other flux studies conducted by USGS. Methyl mercury bioaccumulation could be monitored using biosentinel fish species, similar to studies by SFEI and USGS (e.g., Robinson et al., 2014).

Examples of special studies may include:

- **Nutrient exchange** - transport and exchange of nutrients
- **Food web flux –** transport and exchange of dissolved and particulate organic carbon, phytoplankton, and/or zooplankton from the Project site to adjacent waters, to evaluate the magnitude and dynamics of food web subsidy from restored tidal marsh
- **Mercury –** total and methyl mercury fluxes from tidal wetlands, mercury cycling in different habitats and hydrologic regimes, bioaccumulation in biosentinel fish species

B. Monitoring and Adaptive Management Approach

The monitoring framework within this Plan is *objective-driven*. Indicators of functional outcomes from Project construction and operation (metrics) will be measured to evaluate progress toward expected outcomes and to inform corrective measures if thresholds for action are met. Monitoring categories include physical processes and hydrology, water quality, food web, fish, and wetlands and vegetation (DWR et al., 2012). Metrics have been selected to be ecologically meaningful, efficient, cost-effective, feasible to measure, and informative for management decisions.

Monitoring for the Project will follow an adaptive management approach. Adaptive management is a framework allowing for a flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation, leading to continuous improvements in management and implementation of a project to achieve specified objectives (Delta Reform Act, Water Code Section 85052).

Monitoring will be consistent with the FRPA Implementation Strategy (DWR et al., 2012), the SMP Adaptive Management and Monitoring Plan (USBR et al., 2013), the Delta Science Plan (Delta Stewardship Council, 2013), and guidance being developed by the IEP Tidal Wetlands Monitoring Project Work Team. The monitoring approach draws from examples such as the CDFW Ecosystem Restoration Program's Performance Measures (Spautz et al., 2012), the Dutch Slough Adaptive Management Plan (Cain, 2008), the Lower Yolo Project Long Term Management and Monitoring Plan (SFCWA, 2013), and evolving plans for Prospect Island and Dutch Slough. Comparability with regional monitoring standards and efforts will allow for a summary of findings that can improve understanding and management of habitat at the Delta-wide scale. However, certain parameters and sampling methods may not be readily applicable or transferable across the spatial and ecosystem scales of site-specific projects, or between the Suisun marsh, the Cache Slough Complex region, and Delta-wide scales.

1. CONCEPTUAL MODELS

The Project's restoration design and crediting has been based on an understanding of target fish species, Delta habitats, food webs, and tidal marsh evolution. This includes life history and habitat requirements of delta smelt, Chinook salmon, and longfin smelt, as well as ecological functions of tidal emergent wetlands and managed wetlands. Information from the Suisun Marsh Plan Conceptual Models was used to capture current understanding of how the ecosystem works and how species may respond to restoration (Raabe et al., 2010; Siegel et al., 2010). This understanding informed the design of sustainable habitat features that would increase rearing habitat for salmonids and food web productivity for delta smelt and longfin smelt, while minimizing potential negative effects on other species.

a) DELTA FOOD WEB

The declining productivity of pelagic food webs has likely contributed to population declines of native fishes including delta smelt (Bennett and Moyle, 1996; Baxter et al., 2008, IEP MAST, 2015). Increased production resulting from tidal wetland restoration is hypothesized to export as additional food resources for delta smelt. Pelagic fishes such as the delta smelt depend on phytoplankton-zooplankton food web pathways (Grimaldo et al., 2009; Durand, 2008). Primary production of diatoms, green algae and chrysophyte phytoplankton in wetlands provides food resources for calanoid copepods that are, in turn, important food for juvenile fish, especially delta smelt (especially *Eurytemora affinis* a major delta smelt prey species) (IEP MAST, 2015). Delta smelt also consume cladocerans, mysids, amphipods, and larval fish (IEP MAST, 2015).

In the estuary, stocks of zooplankton have declined significantly since the 1970s (Orsi and Mecum, 1996). A major reason for the decline in zooplankton after 1985 is the invasive overbite clam (*Potamocorbula amurensis*), a benthic filter-feeder that grazes on bacteria and phytoplankton (Alpine and Cloern, 1992; Thompson, 2010) and can also predate on early life stages (nauplii) of zooplankton (Kimmerer et al., 1994). Zooplankton may be food limited if phytoplankton concentrations drop below a level corresponding to 10 µg/L Chl a (Mueller-Solger et al., 2002). Primary production within the Delta estuary is inherently low because of high turbidity and low light levels, rather than nutrient limitations (Jassby et al., 2002; Lopez et al., 2006). Detrital inputs dominate the organic matter supply of the riverine and estuarine systems, but much of this is not readily bioavailable except via a microbial pathway (Sobczak et al., 2002, 2005). Phytoplankton comprise a small fraction of the Delta's organic matter supply, yet they provide the most significant food source for zooplankton (Mueller-Solger et al., 2002, Sobczak et al., 2005).

Tidal wetlands make significant contributions to estuarine food webs. The vegetation, plankton, microbes, and macroinvertebrates produced within tidal marshes become important subsidies for the food web of adjacent water bodies when transported to these water bodies on ebb tides (Kneib et al., 2008). In the San Francisco Estuary, seston (suspended phytoplankton/detrital matter in the water column) exported from tidal wetlands is of extremely high food quality for zooplankton consumers, and produced higher zooplankton growth rates than seston found in Delta river channel, flooded island, or floodplain habitats (Mueller-Solger et al., 2002). Shallow habitats sustain fast phytoplankton growth and net autotrophy (photosynthesis exceeds community respiration) (Cloern, 2007), whereas deep, light-limited habitats within the Delta channels sustain low phytoplankton growth (Jassby et al., 2002) and net heterotrophy. Surplus primary production in shallow habitats can provide potential subsidies that likely support zooplankton in neighboring habitats, except in areas heavily colonized by the invasive Asiatic clam (*Corbicula fluminea*) (Lopez et al. 2006).

High productivity originating from tidal wetlands can be exported to surrounding areas, but the magnitude, extent and direction of net transport is variable (Howe and Simenstad, 2007; Lehman et al., 2010; Lehman, 2013; Lehman et al., 2015). For example, small vegetated ponds at the north end of Liberty Island (Upper and Lower Beaver Ponds) had greater concentrations of organic and inorganic material, and were important sources to the adjacent open water pond, the unvegetated open waters of south Liberty Island (Lehman et al., 2015). Exchange between ponds was important to wetland flux. Lehman and others identified small vegetated ponds as an important source of inorganic and organic material to the wetland, and noted the importance of small scale physical processes within ponds to material flux of the wetland.

The Project will implement restoration actions designed to affect key physical processes on the restoration site, such as hydrodynamics and sedimentation. These restored processes will produce responses in physical and biological habitat, and have functional ecosystem outcomes for the food web and fishes. A breach constructed in the natural berm on the edge of Grizzly Bay is expected to increase tidal exchange of water and biota between the bay and the Project site. Incoming tides will bring nutrients, organic matter, sediment and organisms onto the restored site. During neap tides, the water in the marsh ponds and tidal pannes will have little or no tidal exchange creating high residence time, which will facilitate incubation and bloom of phytoplankton and zooplankton during this period. Other food resources in the tidal wetland include particulate organic matter, dissolved organic matter, and benthic invertebrates. Subsequent high spring tides will help "pump," or export, food out of the Project ponds into adjacent channels.

b) *TIDAL MARSH EVOLUTION*

Tidal marshes in Suisun Marsh consist of several distinct features: vegetated marsh plains, tidal channels, ponds and pannes within the marsh plain, and aquatic and upland edges (Siegel et al., 2010). Tidal exchange is the driving process that creates and sustains tidal wetlands (Siegel et al., 2010; IEP in development). Key elements include inundation regime, sediment delivery (erosion, deposition), and exchange of nutrients. At the most fundamental level, the frequency, magnitude, and duration of tidal inundation exerts the single greatest control on tidal marsh functions and processes. Inundation regimes are controlled through the interaction between relative marsh elevation and tidal action.

Once lands are restored to tidal action, tidal marsh habitats will evolve according to elevation and inundation regime (Siegel et al., 2010). Tidal networks form as a function of the tidal regime, vegetation type, sediment characteristics, and marsh elevations.

The conceptual underpinnings for the Project design are further detailed in the basis of design report (NHC, 2015). The long channel from the channel inlet through the natural marsh ridge was sized using empirical relationships from *Conceptual Design and Modeling of Restored Coastal Wetlands* (Odell et al., 2008). The width and depth of the channel will decrease from the channel inlet to the back of the site as the contributing drainage area decreased. The single high order channel connection is typical of other marsh sites in Suisun Marsh. Lower order channels (smaller distributary channels) will extend from the large higher order channel to connect the marsh plain. This layout is based on nearby marshes in Suisun and lower Sacramento River Delta. Low order drainages from these sites were scaled per drainage basin area using Odell and others (2008) relationships (NHC, 2015).

Transitional habitats such as the proposed marsh-upland habitat berm provide important refugia for tidal marsh-dependent species such as the federally-endangered salt marsh harvest mouse during extreme high tides and storm events. These transitional habitats also provide roosting habitat for several species of marsh birds such as the Ridgway’s rail and black rail. This habitat type is also important for many plant species that grow primarily in the transition zone, including soft bird’s-beak, a federally endangered species endemic to north San Pablo Bay and Suisun Bay.

c) *FISH USE OF TIDAL MARSHES*

Pelagic species such as delta smelt and longfin smelt are thought to derive indirect productivity benefits from tidal marshes within Suisun Marsh (Raabe et al., 2010). Therefore, connectivity between the tidal marshes and the tidal sloughs and access of delta smelt to the tidal sloughs from the southern bays are likely the most important drivers of that tidal marsh function. It is unlikely that delta smelt or longfin smelt would require the structural complexity provided by the marsh. However, they may benefit from prey production exported from the marsh (Raabe et al., 2010).

Juvenile salmonids likely utilize the Marsh for foraging, migration and potentially minimal rearing (Raabe et al., 2010). The ability of Chinook salmon to access the majority of tidal marsh areas in Suisun Marsh is limited by levees and gates. Marsh geomorphology such as edge habitat, channel networks of varying complexity and vegetated bank edges are known to be important habitat features for fish utilizing tidal marshes. Juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs. Levees obstruct hydraulic connectivity between tidal marshes and adjacent aquatic habitat and prevent the development of edge habitat. Areas of the Marsh with low dissolved oxygen concentrations are unlikely to be used, and could be fatal to Chinook salmon.

The availability of prey items will also influence the use of tidal marshes as foraging areas by Chinook salmon. In the Sacramento-San Joaquin Delta, juveniles primarily feed on terrestrial insects, although aquatic crustaceans are also eaten. In flooded areas during high tide, juveniles consume large amounts of zooplankton and small insect larvae (Moyle, 2002). Emergent vegetation communities can provide protective cover and support invertebrate populations, which provide an important food source for juveniles (Moyle, 2002).

As reviewed by Raabe and others (2010), inundation regime may also influence the use of tidal marshes by Chinook salmon. Within estuarine habitat, juvenile Chinook salmon movements are generally dictated by tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes. As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed.

2. UNCERTAINTIES AND HYPOTHESES

As with most restoration projects, there are some uncertainties associated with Project activities and expected outcomes. Focused studies were conducted to reduce uncertainties and refine the design, including geomorphic analysis and hydrodynamic modeling (NHC, 2015; RMA, 2015). Project elements have been designed and refined based on site-specific hydrodynamic models, existing ecological data, reviewed literature, and expert input from the FAST, an Expert Panel, and UC Davis Center for Watershed Sciences.

Uncertainties identified during review of the proposed design include:

- Will the breach fill in with sediment and close off leaving a stagnant pond?
- Will the main channel and lower order channels erode? If so, where, when, and how much?
- Will there be wave erosion on the habitat berm? If so, what effect, if any, might that have on neighboring properties?
- What are the anticipated production, type, and export of food from the restored habitats?
- Which restored habitat component contributes the most food web support?
- What control measures should be implemented for invasive plant species such as *Phragmites* and perennial pepperweed?
- Will methyl mercury production and bioaccumulation exceed ambient levels, compared to other habitats in Suisun Marsh?

In the longer term, there is uncertainty about how climate change and associated sea level rise could affect habitat outcomes. The resiliency of restored tidal marsh habitat to keep pace with sea level rise depends upon realized rates of accretion of inorganic sediment or organic material. If sea level rise exceeds expectations and accretion fails to keep pace, currently designed intertidal habitats could become subtidal.

The Project's adaptive management and monitoring program is designed to address remaining uncertainties. For the purpose of adaptive learning, a certain number of questions have been developed from the objectives and questions, and framed as hypotheses for evaluation to reduce areas of uncertainty and improve understanding of system functions.

The following hypotheses have been developed for the Project.

- **Hypothesis 1 Physical**: The channel inlet at the breach will self-adjust over time from an initial construction width of about 50 feet and invert of -2 feet NAVD88 to a final equilibrium width of about 160 feet and invert of -5 feet NAVD88 within 7 years after construction. This hypothesis will test the calculation of equilibrium breach dimensions based on tidal prism within the site, substrate shear strength, and tidal regime (boundary tidal condition).

- **Hypothesis 2 Food Web**: Primary and secondary productivity in the marsh ponds (mean residence time 6 -14 days) will be greater than in the tidal pannes (mean residence time about 3 days), the marsh plain (mean residence time about 3-9 hours), tidal channel, and Grizzly Bay. This hypothesis will test the value of tidal ponds and tidal pannes and increased residence time in the restoration design in terms of food web production.

- **Hypothesis 3 Fish:** The restored habitats at the Project site (tidal channel, marsh ponds, pannes) will support a fish community (including juvenile salmonids) similar in composition and relative abundance to that documented in comparable habitats in the Suisun Marsh region. This hypothesis will test habitat suitability and use by target fish species.

- **Hypothesis 4 Vegetation:** Elevation, hydrology, and existing vegetation within different habitat features will affect colonization of the site by *Phragmites*. This hypothesis will test which elevations within the created tidal regime are suitable for *Phragmites* colonization, and whether pre-inundation establishment of native vegetation such as tules may preempt establishment of undesirable invasive vegetation.

- **Hypothesis 5 Vegetation**: Soil organic matter and planting methods will influence vegetation establishment on the habitat berm. This hypothesis will test the difference between the use of organic matter from stockpiled topsoil and hydroseeding/drill seeding and mulch in establishing desired vegetation on the habitat berm.

3. Baseline, Pre-Construction, and Reference Data

A summary of the existing, baseline conditions (pre-construction) is presented in Section II, above. Baseline information and studies include:

- Location and mapping of existing infrastructure that facilitates managed wetland hydrology and vegetation management
- Detailed topographic surveys
- Vegetation survey
- Wetland delineation

- Tidal level monitoring at the main water control structures
- Water quality measurements for the CDFW drain water outfall
- Wildlife observations

Monitoring from regions where restoration is occurring can provide reference data, although comparability will depend on the parameter, sampling methodology, and site-specific conditions. Selection of reference sites will be guided by similarity of desired habitat, target species, proximity to the Project site, and/or ecological function. Potential reference sites include the tidal marsh just north of the Project site, the tidal marsh at the south end of lower Joice Island, First Mallard Slough, Peytonia Slough, Upper Hill Slough, Blacklock restoration site, Honker Bay analog site, and Mallard Farms Conservation Bank (in development).

C. MONITORING PROGRAM DESIGN

1. MONITORING CATEGORIES

The monitoring program described below is organized by the following five categories of compliance and effectiveness monitoring tasks:

- Physical Processes and Hydrology
- Water Quality
- Food Web
- Fish
- Wetlands and Vegetation

For each of these categories of monitoring tasks, progress toward meeting the objectives of the Project will be measured. Metrics for each category are identified as well at the methods for collecting data for each metric. Expected outcomes and thresholds for corrective action are also described.

Table 5 outlines the monitoring categories, the Project objectives that they address, metrics, and methods, as well as the proposed responsible party for each monitoring metric. Most of the metrics having to do with vegetation, hydrology, and food web contributions from the Project site will be the responsibility of SFCWA. Fish and benthic invertebrate sampling within the site may be conducted by agencies or landowners holding take permits for protected species. Sampling in the regional context will be undertaken by a variety of agency and academic personnel on a continuing basis. Each of the five categories of monitoring metrics will address one or more of the Project objectives.

2. SAMPLING PROGRAM

The sampling program will operate at three scales: (1) continuous monitoring of hydrologic metrics via automated stations, (2) seasonal sampling of aquatic food web, water quality and fish, and (3) annual or biennial surveys of terrestrial conditions and physical features (channel and vegetated habitat). Many of these metrics are related to one another and should be measured together to maximize ecological relevance, as well as sampling efficiency and resource use.

Table 5. Monitoring Tasks and Responsible Parties

Objectives: Food web	Objectives: Salmonid rearing habitat	Objectives: Habitat for other species	Objectives: Ecosystem functions	Objectives: Habitat succession	Metrics	Method	Proposed Responsible Parties[1]		
Physical Processes And Hydrology									
X	X	X	X	X	Topography and bathymetry, including channel morphology and pond depths	Ground-based GPS survey, or LiDAR if available, aerial photos	Land Owner		
					Tidal regime	Gauges or water level loggers	Land Owner		
					Residence time in ponds, other habitats	Calculated with data from level loggers	Land Owner		
Water Quality									
X	X	X			Water quality (temperature, EC, turbidity, pH, DO)	Continuous in-situ data sonde	Land Owner		
					Methyl mercury	Grab samples, biosentinel fish	Land Owner (water)	Regional (biosentinel)	Special Study (biosentinel, flux)
					Nutrients – NH4-PO4	Grab samples			Special Study
Food Web									
X	X				Chlorophyll a	In-situ data sonde, grab samples	Land Owner		
					Phytoplankton	Plankton tow net	Land Owner		
					Zooplankton	Plankton tow net	Land Owner		
					Benthic macroinvertebrates	Benthic grabs or sediment cores, lab sorting		Regional	
					Epibenthic macroinvertebrates	Sweep net		Regional	
					Particulate organic matter (POM), dissolved organic matter (DOM)				Special Study
					Transport of nutrients and organic matter	Flux-based sampling with USGS, if available			Special Study
Fish									
X	X	X			Fish (species, number, size) Chinook salmon presence	Larval fish trawl, beach seine, lampara net, otter trawl	Permitted agencies and individuals	Regional	Special Study
Wetlands and Vegetation									
		X	X		Aquatic habitat mapping = delineation	Aerial photo, field soil pits, photo points	Land Owner		
					Vegetation composition and cover	Percent cover in plots along transects	Land Owner		
					Invasive plants	Visual survey (aerial imagery, ground surveys)	Land Owner		
			X		General habitat conditions	Photo points (qualitative record)	Land Owner		

Note:
1. Responsible party may change over time, depending on ownership and agency involvement

Pre-construction monitoring will take place for one to two years prior to breaching (pre-breach conditions) (**Table 6**). Intensive post-construction monitoring will occur during the first five years after breaching (Interim Management Period) for at least three of the five years (Years 1, 3 and 5). The effectiveness monitoring program would be periodically evaluated during the first few years and adjustments would be made as necessary, based on interim findings and feedback on methods.

Surveys of terrestrial and physical conditions will be conducted annually during Years 1–5, with check-ins every five years following.

The schedule of the Tule Red monitoring program (**Table 7**) provides the maximum frequency of potential sampling. The actual schedule and sampling design (location and number of sampling sites and events) will be tailored to the Project needs prior to construction, and in coordination with IEP and other regional monitoring programs. A likely schedule will be fish and pelagic food web sampling 3 times a year (spring, summer and fall), and benthic invertebrate sampling twice a year (spring and fall).

Sampling will be stratified across habitat zones in the Project Area: tidal channel, marsh ponds, marsh pannes, and shoreline of Grizzly Bay. Up to 3 sites per habitat zone will be sampled during each event, for a maximum total of 12 sites (**Table 8**).

Table 6. Metrics, Methods, and Duration of Sampling for Interim Management Period

Monitor Category	Metric	Method	Time of Year, Frequency	Sampling Intervals: Pre-Breach[1]	Post-Breach	Years after Breach[2]: 1	2	3	4	5	Every 5 y	Sites and Samples
Physical Processes and Hydrology												
	Topography and bathymetry (e.g., channel morphology, pond depths)	Ground-based GPS survey, or LiDAR if available, aerial photos	Annual during summer	X	X	X		X		X	X	Project area, up to 9 cross-sections including breach, channels, tidal pannes, marsh ponds, habitat berm
	Tidal Regime	Gauges or water level loggers	All year, automatic measurements (may focus on spring-fall or tidal extremes)		X	X		X		X		3-4 sites (breach, main channel, marsh pond, marsh plain)
	Residence time in ponds and other habitats	Calculated with date from loggers	Annual during summer		X	X		X		X	X	Project area
Water Quality												
	Water quality (temperature, EC, turbidity, pH, DO)	Continuous data sonde	All year, automatic measurements (may focus on spring-fall period)		X	X	X	X	X	X	D	3-4 sites (breach, main channel, pond)
		Discrete seasonal samples	Up to 9 monthly events (Feb-Oct) with food web and fish sampling		X	X	X	X	X	X	D	3-4 sites (breach, main channel, pond)
	Methyl mercury in water	*Special Study* (e.g., participate in regional study if available)	To be determined	D (GB[2])		D		D				*Special study*, to be determined
	Nutrients (NH_4-PO_4)	*Special Study*	To be determined	D (GB[2])		D		D				*Special study*, to be determined
Food Web												
	Chlorophyll a	Optical sensor (if available); Grab samples	Up to 9 monthly events (Feb-Oct) Typical: 3 events (spring, summer, fall).	GB		X	D	X	D	X		Up to 12 sites (3 sites each in Grizzly Bay, main channel, marsh ponds, pannes)
	Phytoplankton	Plankton tows, lab sorting										
	Zooplankton	Zooplankton tows, lab sorting										
	Benthic macroinvertebrates	Benthic grab samples or sediment cores	2 events (spring and fall)	GB		X	D	X	D	X		Up to 12 sites (3 sites each in Grizzly Bay, main channel, marsh ponds, pannes)
	Epibenthic and epiphytic macroinvertebrates	Sweep net; leaf packs optional										

Table 6. Metrics, Methods, and Duration of Sampling for Interim Management Period

Monitor Category	Metric	Method	Time of Year, Frequency	Sampling Intervals								Sites and Samples
				Pre-Breach[1]	Post-Breach	Years after Breach[2]						
						1	2	3	4	5	Every 5 y	
	Particulate organic matter (POM), dissolved organic matter (DOM)	*Special Study*	To be determined	D	D	D	D	D	D	D		*Special study*, to be determined
	Transport of nutrients and organic matter	Flux-based sampling with USGS if available – *Special Study*	1-3 times per year (spring to fall), depending on partner and funding	D	D	D	D	D	D	D		*Special study*, to be determined
Fish												
	Larval fish (species, number, size)	Larval fish trawl	Up to 5 monthly events (Feb-June)	GB	X	X	X	X	X	X		Up to 6 sites (3 sites each in main channel and Grizzly Bay nearshore)
	Fish (species, number, size) Chinook salmon presence	Beach seines or lampara seine	Up to 9 monthly events (Feb-Oct)	GB	X	X	X	X	X	X		Up to 12 sites (3 sites each in Grizzly Bay, main channel, marsh ponds, pannes)
		Otter trawl	Up to 9 monthly events (Feb-Oct)	GB	X	X	X	X	X	X		Up to 6 sites (3 sites each in main channel and in Grizzly Bay nearshore credited habitat)
		Fyke net	Up to 9 monthly events (Feb-Oct)		X	X	X	X	X	X		Up to 2 sites (where secondary channels drain to main channel)
Wetlands and Vegetation												
	General habitat conditions	Photo points (qualitative record)	Annual during growing season (summer)	X		X	X	X	X	X	X	Up to 20 points across site
	Aquatic habitat mapping = delineation	Aerial imagery and ground-truthing surveys	Annual during growing season (summer)		X	X		X		X	D	Map entire site
	Vegetation composition and cover	Percent cover in plots along transects	Annual during growing season (summer)	X		X		X		X	D	4 transects with plots from top of habitat berm through channel to Grizzly Bay edge of vegetation
	Invasive plants	Visual survey (aerial imagery and ground surveys)	Annual during early growing season (spring)	X	X	X		X		X	X	Survey entire site. Annual checks to continue during qualitative site surveys.

Notes:

1. Years after breach: X = Sampling proposed in this year, D = Discretionary sampling, contingent on available resources, partners, and project needs.
2. GB = Pre-breach sampling in Grizzly Bay only

Table 7. Sampling Periods for Food Web and Fish

Metric	Method	Maximum Samples per year	Sampling events (1 per month or block)[1]											
			J	F	M	A	M	J	J	A	S	O	N	D
Larval Fish	Larval trawl	30		■	■	■	■	■						
Juvenile/adult fish	Otter trawl	54		■	■	■	■	■	■	■	■	■		
Juvenile/adult fish	Seine beach/lampara	81		■	■	■	■	■	■	■	■	■		
Juvenile/adult fish	Fyke net[2]	18		■	■	■	■	■	■	■	■	■		
Phytoplankton	Plankton trawl	378		■	■	■	■	■	■	■	■	■		
Zooplankton	Plankton trawl	378		■	■	■	■	■	■	■	■	■		
Epiphytic/epibenthic invertebrates	Sweep net/leaf pack	378				■					■			
Benthic invertebrates	Core/ponar grab	84				■					■			
If sampling only 3 times a year					Spring		Summer				Fall			

Notes:

1. Grey shading = intensive sampling program, 1 event per a month
2. Fyke net sampling is an optional method that could be deployed on smaller channels.

Table 8. Number of Samples by Habitat Zone and Method

	Fish Methods				Food Web Methods		
	Larval trawl	**Otter trawl**	**Beach/ Lampara Seine**	**Fyke net**	**Plankton trawl**	**Sweep/ dip net**	**Benthic core/ponar**
Sites by Habitat Zone							
Marsh ponds*	-	-	3	-	3	3	3
Marsh pannes*	-	-	-	-	3	3	3
Tidal channel	3	3	3	2	3	3	3
Grizzly Bay shore	3	3	3	-	3	3	3
Sampling Events							
Samples per site	1 trawl, 5 min.	1 trawl, 5 min.	1 haul	1 net, single tide (ebb or fall)	1 trawl, 10 min.	3 samples	3 samples
Total samples per event	6	6	9	2	12	36	36
Maximum events per year	5	9	9	9	9	2	2
Total samples per year	30	54	81	18	108	72	72

Note:

* Delta smelt and green sturgeon are not expected to occur at interior marsh pond and panne habitat. Salmonids are not expected to occur at pannes.

D. MONITORING METRICS AND METHODS

The following section details the proposed monitoring metrics and potential monitoring methods summarized in Table 4.

1. PHYSICAL PROCESSES AND HYDROLOGY

Purpose: Elevations within marsh plain, spatial distribution of created features, and bathymetry of features such as berms, ponds, and channels form the physical template upon which the driving forces of hydrology and hydrodynamics act to move the site from a managed wetland toward a brackish tidal wetland complex. Subsequent changes in topography and geomorphology that result from restored hydrology will influence whether or not the Project is meeting the following objectives:

1. **Food Web Contribution**
2. **Salmon Rearing Habitat**
3. **Habitat for Other Species**
4. **Ecosystem Functions**
5. **Habitat Succession**

Metrics: Monitor topography and channel planform to document development of the site, in particular the size and geometry of the tidal channels. Measure the tidal regime on the restoration site and compare it to the unrestricted tidal elevations at a reference site (i.e., the “boundary condition”) such as the tide gauge at Port Chicago, California. Utilize the measurements from the daily tidal fluctuations to estimate residence times in various locations throughout the Project site.

Methods: Up to eight permanent cross sections will be established and will run from the top of the habitat berm, across the marsh plain, through the natural berm and to the edge of the mudflat of Grizzly Bay. An additional cross-section will be established for the breach running north and south at the edge of the vegetation and mudflat. Surface elevations will be mapped using standard surveying techniques. Site elevation information will be collected prior to and immediately after construction of Phase 2. Site elevations and channel geometries will be measured again during years 1, 3, and 5 after breach. Aerial photographs will be obtained prior to restoration and immediately following Phase 2 construction (construction of the breach), and during years 3, and 5 after breach. Where possible, photo acquisition could be coordinated with other surveys in the Suisun Marsh. Photos should be ortho-rectified for use in GIS applications. Google Earth photos can also be used to provide a visual record in other years and seasons. Tidal regime will be measured continuously using Solinst pressure transducer level-loggers or similar, placed in several locations around the Project site, including the breach, tidal ponds, tide pannes, and on the marsh plain. Tidal regime will be measured continuously during years 1, 3, and 5 after breach, and will be compared with the boundary condition reference location of the Port Chicago tide gauge. Daily tidal elevation data collected at the restoration site from 2012 to 2014 indicates that the tidal range and timing at the site are nearly identical to those reported from Port Chicago.

2. WATER QUALITY

Purpose: Water quality within a tidal wetland can affect the vegetation response to the restored hydrology as well as potentially affecting fish and wildlife survival and reproduction within the restored site. Water quality can have a strong influence on whether or not the Project is meeting the following objectives:

1. **Food Web Contribution**
2. **Salmon Rearing Habitat**
3. **Habitat for Other Species**

A variety of water quality characteristics can influence the productivity, habitat suitability, or toxicity to fish or vegetation within a restored site. A basic set of water quality parameters will be recorded over several intervals after the breach to characterize water quality during habitat development to determine suitability of the habitats in supporting the objectives above.

Metrics: Measurements will be taken for temperature, dissolved oxygen, pH, turbidity, and conductivity (EC). Methyl mercury (MeHg) will also be sampled in spring, summer and fall.

Methods: 4-5 water quality measurement data sondes (e.g., YSI 6600 V2-4 Sondes) will be deployed at the breach and within the various restored tidal marsh habitat components in years 1, 3, and 5. Water quality will be monitored in the CDFW drain water outfall, the marsh ponds, the tidal pannes, the higher order channels and at the breach. One grab sample for MeHg will be collected seasonally during an outgoing tide to assist in characterization of MeHg production in years 1, 3, and 5. Methyl mercury will be sampled following SWAMP and CALFED methods.

3. FOOD WEB

Purpose: Restoration of tidal wetlands such as the Project site is hypothesized to support native fish species by increasing the production of nutritionally valuable phytoplankton, zooplankton and other invertebrates. In addition, recent studies have shown that shallow autotrophic habitats can export algal biomass and fuel secondary production in adjacent deep heterotrophic habitats, but only if these habitats are properly connected (Lopez et al., 2006; Lehman et al., 2010). Standing stock of primary productivity will be monitored along with the different phytoplankton species produced in the restoration site. Secondary productivity (zooplankton, benthic invertebrates) produced and exported from the restoration site will also be monitored.

Evaluating the quantity and quality of the food supply available at the Project site for larval and juvenile fish in Grizzly Bay will address the following objectives:

1. **Food Web Contribution**
2. **Salmon Rearing Habitat**

Metrics: Food web contributions will be measured by primary production (chlorophyll a and phytoplankton), zooplankton, and benthic and epibenthic invertebrates.

Methods: Where possible, food web sampling for the Project will be coordinated with the existing IEP monitoring program, UCD Suisun Marsh study, and/or the IEP Tidal Wetlands

Monitoring program for restoration sites. This sampling program is initially proposed to be conducted seasonally for at least three years and up to five years post-breach (Table 4). The scale and intensity of monitoring efforts, as summarized in Tables 5 and 6, will be re-evaluated following Year 3.

Water quality parameters, such as water temperature, dissolved oxygen, conductivity, turbidity, and nutrients, will be measured at time of survey (grab sample or instantaneous measures with a water quality probe). Collected plankton and benthic samples will be preserved in a solution of 95% ethanol. Samples will be analyzed in a laboratory for abundance and species composition, with all organisms identified to the lowest possible taxonomic level possible. Subsampling may be used to allow cost-effective and efficient enumeration.

Potential methods are described below, from pilot sampling plans by the IEP Tidal Wetlands Monitoring (Contreras et al., 2015). The sampling protocols for this seasonal food web monitoring will be refined as needed based on review of the final construction, data needs, and information from pre-construction monitoring.

a) Primary Production

Chlorophyll a concentrations will be measured as an indicator of primary productivity. At permanent water quality monitoring stations (2-4 stations) set up on-site, sondes will collect continuous chlorophyll a fluorescence. In addition, at each zooplankton trawling station, field crews will measure chlorophyll a in vivo fluorescence using a YSI sonde with chlorophyll a probe. Crews may take horizontal profiles of the site. At a subset of sampling stations, they may also take a sample to calibrate fluorescence readings in the lab. Field crews will fill a 2.8 L bottle approximately half full with water pumped from a depth of one meter, withdraw two 100 mL sub-samples and aspirate them through 47 mm diameter glass fiber filters of 0.3 µm pore size. The filters will then be frozen on dry ice for return to lab (IEP protocol: Brown, 2009). The details of water quality monitoring stations and instrumentation will be developed further in consultation with IEP and DWR.

Phytoplankton density and composition will be monitored near the discharge of the Project site and on the site. Phytoplankton sampling will be conducted in conjunction with high tide events that inundate the site and allow connectivity and export. At a subset of zooplankton trawling stations, field crews will collect phytoplankton samples with a submersible pump from a water depth of one meter (approximately three feet) below the water surface. Crews will store these samples in 50-milliliter glass bottles with two ml of Lugol's solution as a stain and preservative. Laboratory personnel will sort the samples in the lab to calculate percent composition of major taxonomic groups (diatoms, flagellates, blue-green algae, etc.) using a microscope or by photographing samples and using automated image recognition software.

Other methods may be considered, depending on available funding and partners. These could include using (1) a FluoroProbe to estimate community composition based on differences in photosynthetic pigment spectra among major classes of producers (green algae, cyanobacteria, diatoms, dinoflagellates and cryptophytes), or (2) a portable flow cytometer (FlowCam) to take images of cells passing through water. DWR's ongoing water quality monitoring has successfully used the FlowCAM to quantify live and preserved phytoplankton >15µm and preserved zooplankton.

b) Zooplankton

Zooplankton sampling will also be conducted at the same relative time and frequency as primary production sampling. Tow nets have been used extensively for measuring zooplankton community composition and biomass throughout the Delta, in order for data to be comparable to similar regional monitoring programs.

Field crews will sample zooplankton during daylight using a 1m long x 0.127m mouth diameter (153µm mesh) Clarke-Bumpus net to measure mesozoplankton and 1.48m x 30cm mouth diameter (0.505mm mesh size) mysid net to capture macrozooplankton. Nets will be attached to a flowmeter to measure sample volume and a float to keep the net off the bottom in shallow water.

At sites that boats can access (water depth greater than 0.7m (2.3 ft)), the crew will deploy the gear alongside the boat via a davit and, if possible, sample obliquely through the water column. In shallow water (0.2-0.7m (0.7-2.3 ft), the net and flowmeter will be attached to a 5m long rope. The investigator will throw the net to the full extent of the rope and retrieve five times.

After retrieval, the crew will rinse the net from the outside to wash down sample into the cod end. All content collected in a cod end will be preserved in 10% buffered formalin and rose bengal (IEP methology in Hennessy 2009). Crew will remove any fish that are visible in the sample before preserving. Laboratory personnel will identify a minimum of 6% of the sample to the lowest possible taxon in the lab either using a microscope or by photographing samples and using automated image recognition software (i.e., ZooImage, http://cran.r-project.org/web/packages/zooimage/index.html, as cited in Gislason and Silva, 2009).

c) Benthic and Epibenthic Invertebrates

Benthic and epibenthic invertebrates will be sampled at least twice seasonally (spring and fall), and up to quarterly based on seasonal occurrence of target fish species. The potential methods described below are from the IEP Tidal Wetlands Monitoring group’s pilot study proposal (Contreras et al., 2015), based on regional surveys and studies by CDFW, USFWS Liberty Island, DWR and others.

Benthic cores/Ponar grab**s** have been used extensively to quantify chironomid and amphipod populations, as well as bivalves and other infauna in tidal wetlands (Wells, 2015; Howe et al., 2014; CDFW, unpublished data). Three samples will be taken at each site to account for high variability in the benthic community. In shallow water (<1.5m), a 4in (20cm) diameter benthic core will be hand-deployed to a depth of 20 cm. In deep water(>1.5m), a 9x9 in ponar grab modified for use in hard substrates (as per USFWS Liberty Island Monitoring) will be used to collect three samples at each site. This may be in conjunction with substrate analysis during fish sampling to minimize disturbance and maximize efficiency. The core will be washed and sieved on board the boat to remove the sand/mud and preserve any organic detritus and invertebrates. Two crew members will estimate % silt, sand, and gravel in the field, and average the values. Effort as catch per surface area of substrate sampled will be calculated. The number of 4 in.

cores may be increased to create aggregate samples of areas equal to the ponar grab if catch of single cores is too low for analysis.

Sweep nets are another approach for sampling in shallow water (Katz et al., 2013; Contreras et al., 2015). In areas 1m mean lower-low water or less, a 500-micron d-frame net will be swept through the water approximately 3cm above the bottom 5 times (10 seconds of effort) with each sweep being approximately 1 m in length. In emergent vegetation, we will disturb the vegetation as much as possible to knock invertebrates off the stems. In submerged vegetation, we will collect any vegetation within the border of the net after the sweep is completed. The net will be rinsed into a pan to and remove all invertebrates. The sample will be preserved for later ID. Crew will remove and release any fish that are visible in the sample before preservation. Any vegetation captured in the sweep net will be dried to a constant weight to standardize the sample.

Leaf packs may also be used as an artificial substrate to sample epiphytic invertebrates, depending on results of the IEP Tidal Wetlands Monitoring pilot test (Contreras et al., 2013), and Project needs and resources. This method, however, is labor intensive. To prepare the leaf packs, clean, healthy tule leaves (or dominant emergent vegetation) will be harvested, any invertebrates removed, and the leaves will be dried to a constant weight in a drying oven. Thirty grams will be placed in a labeled, plastic mesh bag and the weight recorded. One leaf pack will be attached to a line (long enough to take tide range into account) and tied to a float. Each line will be attached to a separate anchor and set at least 50 m apart. Samplers will be suspended mid-way in the vegetation, or on the bottom in unvegetated habitat. WA GPS point will be taken to record their location for later collection. After six weeks, the leaf packs will be harvested by carefully surrounding them with a net or mesh bag (to prevent escapees), and removing the samplers from the buoy. Upon collection, the whole leaf pack will be preserved and disassembled and sorted it in lab. Any remaining vegetation will be dried to a constant weight to calculate a rate of decomposition. Effort as invertebrates per gram initial weight of vegetation will be calculated.

4. FISH

Purpose: The ultimate purpose of the Project is to meet regulatory requirements to benefit native fish species such as delta smelt, Chinook salmon and longfin smelt. Documenting the distribution and abundance of fish at the restored area would directly demonstrate the Project's habitat value and the link to food web support for at-risk native species (Chinook salmon, delta smelt, and longfin smelt). This will track progress toward meeting the following Project objectives:

1. **Food Web Contribution**
2. **Salmon Rearing Habitat**

Methods: The following monitoring methods may be used at the Tule Red Project area to monitor fish abundance and distribution. Methods will be selected for each fish life stage based on physical constraints, effectiveness, gear availability, permits, and cost. All gear types will be sampled in a consistent manner from year to year to ensure data are comparable. Potential methods described below are based on pilot sampling plans by the IEP Tidal Wetlands Monitoring (Contreras et al., 2015).

Basic water quality and habitat constituents will also be measured at the time and place of any fish collections including water temperature, electrical conductivity, turbidity, dissolved oxygen, depth, substrate, cover, and habitat types.

a) Larval Fish Trawling

Field crews will sample larval fish during daylight using a 2m long net (500µm nylon mesh) with a 0.2m mouth diameter attached to a metal O-ring frame and a flowmeter attached in the center. The crew will deploy the net alongside the boat via a davit and if possible, sample obliquely through the water column for 10 minutes. Upon gear retrieval, the crew will rinse the net from the outside with a water hose to wash down all contents into the cod end. The crew will remove, measure, and release any non-larval identifiable fish from the cod end, then pour the remainder of the cod end into a jar containing 10% buffered formalin and rose bengal. Lab personnel will identify all preserved fish to the lowest possible taxon; up to 100 of each taxon will be measured (fork length) and the remainder will be counted.

Larval sampling will occur between February to June. This time frame overlaps longfin smelt and delta smelt spawning periods and will also overlap with splittail spawning (Sommer et al. 2001). Larval fish sampling should coincide with zooplankton sampling.

b) Beach Seining

Beach seining will be used to sample for juvenile and adult fish in shallow water habitats on the restoration site (channels and ponds) or nearshore areas of Grizzly Bay.

Beach seine sampling will occur during daylight using a 15m long x 1.2m high (3mm delta square mesh) net using protocols developed by the USFWS (Speegle, et al., 2013). One person will walk out into the water (up to 1.2m in depth) holding one end of the net to measure the width and depth of the seine site. The second crew member will walk to the first crew member and place their seine pole where depth was recorded.

Alternatively, both crew members may enter the water from a boat starting at ~1m depth to avoid disturbing fish nearer the shore (“commando seining”) (Nobriga and Feyrer, 2007). The first crew member will walk parallel and the length of the shore and note seine length and site depth. Both crew members will haul the beach seine up on the shore, leaving the cod end bag in water. The crew will fill a tub with water and place the cod end bag in the tub along with any fish caught in the “wings” of the seine.

Lampara Net (beach seine) **-**The IEP Tidal Wetlands Monitoring group has been pilot testing a lampara net used as a beach seine (Contreras et al., 2015). The lampara net measures 70m long and consists of the following mesh sizes: 6mm at bag, 20mm at mid, and 76mm at end wings. If the site is accessible by boat, a crew member will safely enter the water from a vessel at ~1m depth while holding one side of the lampara net. The vessel will slowly drive away, deploying the gear in a circular pattern around a seine site. Once the net is fully deployed, the vessel will get into a parallel position with the crew member standing in the water. A second crew member will safely enter the water at ~1m depth and both crew members will haul the lampara net to shore leaving the cod end bag in the water (like a beach seine). The crew will fill a tub with water and place the cod end bag in the tub along with any fish caught in the “wings” of the lampara net.

c) TRAWLING

Open water sampling in Grizzly Bay may be conducted via trawling using methods similar to the UC Davis ARC study (Contreras et al., 2015). For all gear types, all captured ESA fish will be measured. Only 30 fish of other species will be measured; all remaining fish will be plus counted. A General Oceanics flowmeter deployed at the side of the “net boat” will be used to estimate the volume of water sampled.

Otter trawl (ARC): The ARC uses an otter trawl with a 1.5m x 4.3m mouth opening and 4.9m long, composed of 35mm stretch nylon mesh in the body and 6mm stretch mesh nylon in the cod end bag. The otter trawl doors are composed of 1.9cm thick plywood and measure 76.2 x 38.1 cm. The gear is deployed onboard a vessel where the net is tossed off the stern of the boat. Once the net is deployed, two crew members each hold onto an otter trawl board. The two crew members signal one another and deploy the otter trawl doors simultaneously off the stern of the vessel. A five minute tow is completed and the otter trawl boards and net are retrieved back onboard.

The otter trawl is smaller than other fish trawling nets, and can be deployed in habitats such as the main tidal channel. Otter trawling could be used to sample Grizzly Bay along the shore at higher tides, although submerged debris and tidal extremes on the mudflat make this approach less feasible (pers. comm., D. Contreras, CDFW, January 12, 2016). The ponds and smaller channel reaches within the site will be too shallow for the boat. Otter trawling samples fishes at the bottom, avoiding mid-water or surface-oriented fishes like delta smelt. In shallow water (i.e. less than 2 m deep), however, such as in marsh channels or nearshore habitat, the otter trawl could effectively sample most of the water column.

Lampara net (open water) (CDFW): The lampara net (described above under seining) could also be used for open water sampling. The net will be set in open water, where the vessel will deploy one side of the gear that is attached to an empty anchor bag (the bag fills with water) and buoy. The net will be deployed from the vessel in a straight line and then the vessel positions the net in a circular fashion. Once the vessel loops back around, the anchor bag side of the net will be brought back onboard and both sides of the net will be retrieved back onboard.

d) FYKE NET

This optional sampling method could be used to examine fish movement in and out of smaller tidal channels, if desired. The field crew will set fyke nets during daytime at depths <0.9m using 1.8m x 1.2m net composed of ¾“ stretch mesh (#126 knotless delta). Nets will be set perpendicular to the shore for up to 24 hours. The net will be retrieved aboard a vessel and fish will be placed in a water filled tub. The crew will measure (fork length) and weigh up to thirty fish of any single species, and count any additional fish. All shrimp and jellyfish species will be counted or estimated.

5. WETLANDS AND VEGETATION

Purpose: Vegetation sampling and aquatic habitat mapping, paired with aerial photography will provide a project-scale temporal and spatial understanding of estuarine processes after restoration action. The purpose of this work is to document the different wetland types restored and to assess how tidal wetland vegetation develops in response to the new hydrologic regime. Documentation of these trends in vegetation change will be a significant factor in influencing whether or not the Project is meeting the following objectives:

3. **Habitat for Other Species**
4. **Ecosystem Functions**

The data collected under this category of monitoring will be used to characterize plant community composition and structure, track changes in aquatic habitat and plant communities over time, and document the extent of tidal wetland and adjacent upland habitats.

Metrics: For habitat mapping, the total extent of wetlands and uplands within the Project area will be mapped and vegetation and wetland types within the Project area identified. For vegetation within the Project site, composition and extent will also be mapped and categorized.

Methods: Conduct habitat mapping over time to provide a project-scale temporal and spatial understanding of estuarine processes after restoration, track habitat development, monitor inundation of the site, and evaluate the functionality of the channels and breach.. High resolution aerial photography will be obtained prior to construction, prior to the breach, and in Years 1, 3, and 5 after the breach to demonstrate inundation over the Restoration Site as depicted in the as-built documentation. Photographs should be flown in late spring or early summer. If feasible, aerial photographs should be ortho-rectified for use in GIS applications. Google Earth photographs can also be used to provide a visual record in other years and seasons. Strategic ground-truthing will be carried out alongside GIS mapping to confirm feature and vegetation community boundaries.

a) HABITAT BERM

Vegetation establishment on the habitat berm will be conducted using plots along transects. Fixed, permanent transects, located along the elevation gradient of the marsh transition zone and oriented perpendicular to the main channel should be established at the eight cross-section topographic locations . Transect locations will be strategically placed to capture the diversity of the topographic gradient of the marsh transition zone throughout Tule Red. Transect length may vary depending on the size and shape of the transition zone at the transect location though a good target is 100 feet or more (30 meters or more). Based on the total length of the transect 3-5 plot locations should be identified for each transect. Each plot should be one square meter in size ($1m^2$), and the location of plots along the transects should be randomized, with a minimum distance of 2 meters between plots. The same plots should be monitored using visual estimations of plant cover, according to the CNPS relevè protocol (CNPS, 2000). All plant taxa observed should be recorded, along with their total cover value. Alternatively, cover can be recorded in cover classes, as determined appropriate by the vegetation ecologist performing the monitoring. The maximum canopy height of each species within the plot will also be recorded. Vegetation composition and cover monitoring should be conducted in years 1, 3, and 5.

b) Wetland Habitats

In order to evaluate the vegetation establishment and changes over time in newly restored habitats it is valuable to compare onsite conditions with suitable reference sites (other centennial marshes or recently restored sites). There are a number of existing tidal marsh wetlands in Suisun Marsh that may provide suitable reference sites. Locating an area of similar slope, substrate, and aspect at the reference site may be necessary to provide an accurate reference condition to the marsh at the Restoration Site. Monitoring of the reference site alongside the first year of monitoring at Tule Red will be sufficient to define climax vegetation composition, cover, and height characteristics for vegetation in the tidal unless environmental conditions are extreme during the first year following restoration (e.g. a drought year). Barring these extreme conditions, the reference site will be monitored during the first year only.

c) Non-native Invasives

Non-native invasive species can threaten the diversity and abundance of native species. Invasive plants can alter ecosystem functions such as nutrient cycles, hydrology, and sedimentation rates, outcompete and exclude native plants and animals, harbor invasive non-native animals, and hybridize with native species (Randall and Hoshovsky, 2000). Given the pervasiveness of invasive plant species in the region, complete suppression is impractical and impossible. However, a monitoring and control program will be maintained to detect and control invasive plant species that may diminish site quality and interfere with achievement of the Project's restoration objectives.

A number of invasive plant species have been found at the Project site and monitoring and mapping is included in this plan. Invasive plants found at the site will be evaluated to determine whether they should be a management priority. Particular attention should be given to species rated with a high negative ecological impact in California. High-impact invasive plant species known to occur in the Suisun Marsh include common reed (*Phragmites australis*) and perennial pepperweed (*Lepidium latifolium*).

Mapping shall be accomplished through the use of available technologies, such as GIS, aerial photography, and field surveys. Target invasive plant mapping will be conducted during years 1,3, and 5 after the breach is constructed to establish a baseline. Target invasive plant mapping will be conducted every five years after the habitat is established.

A qualified biologist will offer a qualitative assessment of observed noxious weeds or other unwanted terrestrial or aquatic plants and recommend measures to control such plants that may be adversely impacting the achievement of restoration objectives. The qualified biologist shall consult the California Invasive Plant Council's California Invasive Plant Inventory, Online Database (Cal-IPC 2015) or future updated publications for guidance for non-native invasive plant mapping field protocols and treatment plans. Any recommendations for treatment or control shall be included in the Annual Report. The Land Owner will discuss the recommendations with the FAST before undertaking treatment to remove invasives.

d) *Special-Status Plants*

Any occurrences of special-status plants will be mapped by GPS. Special-status plant species mapping will be conducted during years 1, 3, and 5 after the breach is constructed to establish a baseline. Mapping will utilize GIS, aerial photography, and biological survey data.

e) *Photo-Points*

Photo documentation with fixed, permanent digital photograph locations repeated over time is an economical method to provide a qualitative way to visually assess changes in the landscape. Photo documentation is also a useful tool in communicating these changes to the public. Photographs taken from fixed locations can be coordinated with aerial photos and used to calibrate aerial photographs as well as track the development of vegetation communities, channel structure, and other metrics such as invasive plants. Photo-points for ground level documentation will be established and correlated with aerial photographs. Several factors should be considered when establishing the location and number of photo point locations such as: site access for repeatability, number and stratification of photo points to represent areas of interest (i.e., different habitat types, channel development), elevation of photo point to clear expected height of mature vegetation, coordination with other surveys such as vegetation surveys and aerial photographs, coordination with tide (extent of inundation during high tide or tidal evacuation during low tide), or to capture extreme phenomena (i.e., extent of inundation during king tide events).

At least 20 photo-point locations will be identified, georeferenced with data suitable for use in GIS, and permanently marked in the field during the first year after construction. Photographs should be taken prior to restoration, immediately following Phase 1 construction, immediately following Phase 2 construction (construction of the breach), and in years 1 through 5 after breach.

E. Data Management, Analysis, and Assessment

Effective data management will be integral to the success of this monitoring plan. The integration of protocols, standards, and practices will help ensure that data will be scientifically valid and usable for the widest possible variety of assessments.

Detailed monitoring protocols will be developed prior to initiating monitoring activities, based on logistical constraints and precise locations of sampling locations. The protocols will be established for both field survey and laboratory tests, and will include a description of the measures that will ensure the quality of the data collected and how to implement those measures. These quality assurance techniques may include, but are not limited to, procedures for calibrating devices, procedures for recording and transferring data, and methods for ensuring proper operation of field equipment.

The data management activities for the Project monitoring will be the responsibility of the Land Owner during the Interim Management Period (first 5 years after breaching) and partnering agencies (e.g., CDFW, IEP, USGS) and can include database design and implementation. Data collection and information storage protocols will be standardized for such stages as data entry sheet design, data collection protocols, data entry, quality assurance/quality control, data processing, chart and graph generation, and metadata.

Data collected for the Project monitoring will be housed in a centralized location. Field measurements conducted by partnering agencies (e.g., USGS, IEP) will be conducted in a manner consistent with existing methodologies for regional monitoring. Data collected for the Project will be stored in commonly used and acceptable digital formats (e.g. databases in Access or Excel, documents in Microsoft Word or PDF) so that the collected information may contribute to existing datasets. Results will be synthesized and provided to the FAST in the annual report. The FAST will look at data annually and make recommendations and adjustments as needed for improved monitoring and management.

F. Annual Monitoring Report

Annual reports will be prepared for submittal to the FAST. The annual reports will include a summary of work completed to date, milestones, current status, constraints, and relative accrued benefits of the Project. The report will specify remedial actions or management responses. Further details are provided in the following section “V. Adaptive Management”.

V. ADAPTIVE MANAGEMENT

The overall goal of maintenance and management of the site is to promote the long-term trajectory of the site in providing functions and services associated with tidal wetlands. The approach to adaptive management of the site is to conduct regular site visits and monitor selected characteristics to determine the stability of the site and ongoing trends in physical and biological processes. Unexpected trends in the biological or morphological characteristics of the site will require examination to determine if they are compromising the goals and objectives of the site.

A. RESTORATION OBJECTIVES: INTERVENTION THRESHOLDS AND RESPONSES

While it is not anticipated that major modification to the site will be needed, an objective of this Plan is to guide monitoring and to identify any thresholds that may compromise the Project objectives, and to propose potential management responses or further focused monitoring efforts. This section summarizes the five Project objectives, the expected outcomes related to those objectives, the metrics by which progress towards meeting the objectives is measured, as well as thresholds for undertaking a management response if goals are not being met or problems occur which require intervention. The section below is summarized in **Table 9**.

1. FOOD WEB CONTRIBUTION

Objective: Enhance regional food web productivity and export to Grizzly Bay in support of delta smelt and longfin smelt recovery

Expected Outcome: The levee breach and new channels will increase tidal exchange and excursion on the site. This tidal exchange will increase the export of primary and secondary productivity from the site.

Monitoring Category: Physical Process and Hydrology

Metric: Elevation and topography, including channel cross sections. Hydrology measured with level-loggers in various locations throughout the Project site.

Goal: Breach channel erodes until reaching equilibrium and little or no tidal muting occurs within the site.

Intervention Threshold (trigger level): Breach channel declines in cross-section area for 2 or more years in a row from excessive sedimentation, resulting in tidal muting within the site. An obstruction such as a large tree or derelict boat or barge lodged in the breach could occur, resulting in tidal muting within the site.

Table 9. Adaptive Management Responses

Objectives	Expected Outcome or Hypothesis	Monitoring Category	Metrics	Goal	Trigger level	Potential Management Response
1. Enhance regional food web productivity and export to Grizzly Bay in support of delta smelt and longfin smelt recovery.	Constructed levee breaches and new channels will increase tidal exchange and excursion on the site. The tidal exchange will increase the export of primary and secondary productivity from the site	Physical and Hydrology	• Elevation and topography including channel morphology and pond depths • Tidal regime • Residence time in ponds and other habitats	Breach channel erodes until reaching equilibrium and little or no tidal muting occurs within the site.	Breach channel cross-section declines in area for 2 or more years in a row resulting in tidal muting within the site. An obstruction (tree, derelict vessel) lodged in the breach, resulting in tidal muting within the site.	The Land Owner will coordinate with the FAST on appropriate action(s) to take including, but not limited to, dredging to appropriate dimensions to maintain tidal exchange. Remove obstruction from channel.
		Food Web	• Chlorophyll a • Phytoplankton • Zooplankton	Food web contributions from the Project site are higher than from boundary conditions (Grizzly Bay). Food web contributions from the various habitat components within the site are maximized to the extent possible	Food web components in marsh ponds and tidal pannes are lower in concentration than those found in the primary channel.	Modify the height of the berm around the marsh ponds or tidal pannes (raise of lowever) to adjust residence time.
2. Provide rearing habitats for out-migrating juvenile salmonids	The Project site will create suitable aquatic habitat for and be occupied by juvenile Chinook salmon	Fish	• Chinook salmon presence	Find Chinook salmon juveniles within the site	No threshold for intervention	Release captive-reared juvenile salmonids with coded wire tag or ratio tags to determine habitat use and growth within the site.
		Water Quality	• Water quality (temperature, EC, turbidity, pH, DO)	Maintain suitable water quality conditions for outmigrating juvenile Chinook salmon	DO levels in CDFW drain water are below threshold for aquatic life; evidence of fish die-offs	Manage CDFW drainwater with water control structures. Repair or replace water control structures if damaged. Restrict flow of CDFW drain water at low tide by closing draingate or spillway. Provide alternate discharge of drain water to larger water body (Montezuma slough).

Table 9. Adaptive Management Responses

Objectives	Expected Outcome or Hypothesis	Monitoring Category	Metrics	Goal	Trigger level	Potential Management Response
3. Provide rearing, breeding, and refugia habitats for a broad range of other aquatic and wetland-dependent species	Habitats will become more suitable for a community of native fish and wildlife species due to natural succession of native wetland and upland plant species and their arrangement within the complex of tidal channels, tidal ponds, and tide pannes.	Wetlands and Vegetation	• Aquatic habitat mapping • Vegetation composition and cover • Invasive plants • General habitat conditions	Rate of colonization by native plant species is higher than that of non-native invasive plant species	Growth rate of percent cover of non-native invasive species is higher than that of native species for two years in a row	Chemical or physical control of non-native invasive species Replanting with native species
4. Provide ecosystem functions associated with the combination of Delta brackish water aquatic, tidal marsh, and upland interfaces that these species require.	Suitable wetland and upland habitats will be available.	Wetlands and Vegetation	• Aquatic habitat mapping • Vegetation composition and cover • Invasive plants • General habitat conditions	Rate of colonization by native plant species is higher than that of non-native invasive plant species	Growth rate of percent cover of non-native invasive species is higher than that of native species for two years in a row	Chemical or physical control of non-native invasive species. Replanting with native species
5. Provide topographic variability to allow for habitat succession and resilience against future climate change and sea level rise.	Topographic variability including transition corridor from intertidal to upland elevations will be maintained	Physical Processes and Hydrology	• Topography and planform of transition areas. • Tidal regime	Maintain habitat berm for its wildlife values and to protect adjacent properties and maintain access to allow for monitoring activities, control of non-native invasive plants, and for adaptive management activities, if necessary	Settling/compaction of more than 1’ below as-built ground levels on the habitat berm	Placement of material on the crown and slope of the existing levees may be required to repair damage from storms and to counteract subsidence of the levees

Potential Management Response: The Land Owner will coordinate with the FAST on appropriate action(s) to take including, but not limited to, dredging or removal of obstruction. Any dredging will be limited to the period between September1 and November 30. Any dredging will be reported in the Annual Report. Equipment may include long-reach excavator, barge-mounted dragline, suction dredge, or backhoe.

Monitoring Category: Food Web

Metric: Chlorophyll a, Phytoplankton, zooplankton, benthic macroinvertebrates, particulate and dissolved organic matter.

Goal: Food web contributions from the Project site are higher than from boundary conditions (Grizzly Bay). Food web contributions from the various habitat components within the site are maximized to the extent possible.

Intervention Threshold (trigger level): Food web components in marsh ponds and tidal pannes are lower in concentration than those found in the primary channel.

Potential Management Response: Increase intensity of water quality monitoring to determine conditions that may be leading to lower productivity. Modify the height of the berm around the marsh ponds or tidal pannes (raise or lower). Methods may include excavation by amphibious long-reach excavator, or other small mechanized aquatic equipment (e.g. “marsh master”). Prior to any modification to the features, the following information will be provided to FAST and the Corps:

- A description of the proposed work
- The elevation of the existing landforms
- The daily and monthly tidal range of the features to be modified
- Water quality measurements for the features
- The results of an on-site field inspection for protected plants located within the proposed area of disturbance including but not limited to:

  a. Soft bird’s beak (*Cordylanthus mollis* ssp. *mollis*)
  b. Salt marsh bird’s beak (*Cordylanthus maritimus* ssp. *maritimus*),
  c. Hispid bird’s beak (*Cordylanthus mollis* ssp. *hispidus*),
  d. Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)
  e. Mason’s lilaeopsis (*Lilaeopsis masonii*)
  f. Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*)
  g. Suisun Marsh aster (*Aster lentus*)
  h. Alkali milk-vetch (*Astragalus tener*)
  i. Heartscale (*Atriplex cordulata*)
  j. Brittlescale (*Atriplex depressa*)
  k. Valley spearscale (*Atriplex joaquiniana*)

2. SALMONID REARING HABITAT

Objective: Provide rearing habitats for out-migrating juvenile salmonids

Expected Outcome: The Project site will provide an increase of occupied habitat for outmigrating salmonids compared to the prior conditions of the managed marsh.

Monitoring Category: Fish

Metric: Chinook salmon presence

Goal: Find Chinook salmon juveniles within the site

Intervention Threshold (trigger level): No threshold for intervention is appropriate if Chinook salmon juveniles are not found within the site.

Potential Management Response: Release captive-reared juvenile salmonids with coded wire tag or ratio tags to determine habitat use and growth within the site.

Monitoring Category: Water Quality

Metric: Dissolved oxygen, temperature, pH,

Goal: Maintain suitable water quality conditions for out-migrating juvenile Chinook salmon

Intervention Threshold (trigger level): Dissolved oxygen (DO) from CDFW drain water is falls below the temperature dependent threshold for aquatic life for 24 hours or there is an observation of a fish kill within the basin receiving the CDFW drain water.

Potential Management Response: Restrict flow of CDFW drain water into the restoration site at low tide by closing the draingate/spillway. Inspect aeration facility, and repair and replace as necessary. Notify CDFW, and CDFW provides alternate discharge of drain water to larger water body (Montezuma slough) in the interim. If modification of water control structure is necessary, it will be conducted in compliance with the Suisun Marsh Regional General Permit conditions.

3. HABITAT FOR OTHER SPECIES

Objective: Provide rearing, breeding, and refugia habitats for a broad range of other aquatic and wetland-dependent species.

Expected Outcome: Habitats will become more suitable for a community of native fish and wildlife species due to natural succession of native wetland and upland plant species and their arrangement within the complex of tidal channels, tidal ponds, and tide pannes.

Monitoring Category: Vegetation

Metric: Vegetation composition and arrangement within the complex of uplands and wetlands

Goal: Increasing trend of native vegetation species diversity within the Project site

Intervention Threshold (trigger level): Little or no wetland vegetation establishes in the marsh plain, dominance of phragmites in wetlands (> 25%), failure of vegetation establishment on marsh/upland ecotone.

Potential Management Response:

Ensure no tidal muting is occurring by maintaining the breach area. Methods for re-establishing full tidal exchange are covered under Objective #1, above.

If non-native invasive plant species are inhibiting the value of the restored habitats and the qualified biologist recommends treatment, and the Land Owner and FAST agree that such treatment will benefit the site, control of targeted species may be proposed. Control techniques include hand or mechanical removal, biological control, or chemical treatment. Ground-based and aerial application of chemical treatments will be conducted as allowed under current State and Federal pesticide and water quality regulations. Only chemicals approved for such purposes in California may be used in any control action. Because funding and time to get to an infestation site may be limiting factors, monitoring may be done simultaneously with treatment to save time. Follow-up monitoring will occur at the time of year and frequency sufficient to detect change in the populations of invasive plants and the effects of any treatment.

If non-native invasive plant species are not inhibiting the values of the restored habitat, the Land Owner will work with the FAST to determine if there is any reason to propose control of these species. Any control of non-native invasive plant species would be reported in the Annual Report.

4. ECOSYSTEM FUNCTIONS

Objective: Provide ecosystem functions associated with the combination of Delta brackish water aquatic, tidal marsh, and upland interfaces that these species require.

Expected Outcome: Hydrology and vegetation characteristics mirror those found in regional brackish tidal marsh.

Monitoring Category: Vegetation

Metric: Vegetation composition and arrangement within the complex of uplands and wetlands

Goal: Increasing trend of native vegetation species and diversity within the Project site

Intervention Threshold (trigger level): Growth rate of percent cover of non-native invasive species is higher than that of native species for two years in a row.

Potential Management Response: Potential responses include chemical or physical control of non-native invasive species, and replanting with native species. Upland areas would be re-seeded with a mix of native and naturalized species, and mulched if the initial planting failed to survive through year 2. Maintain the levee and transplant tules to stop erosion at the waterline.

5. HABITAT SUCCESSION

Objective: Provide topographic variability to allow for habitat succession and resilience against future climate change and sea level rise.

Expected Outcome: Topographic variability including transition from intertidal to upland elevations will be maintained over time.

Monitoring Category: Physical processes

Metric: Topography, elevations, and plan-form arrangements of habitat components

Goal: Maintain habitat berm for its wildlife values and to protect adjacent properties and maintain access to allow for monitoring activities, control of non-native invasive plants, and for adaptive management activities, if necessary.

Intervention Threshold (trigger level): Settling/compaction of more than 1’ below as-built ground levels on the habitat berm.

Potential Management Response: Placement of material on the crown and slope of the existing levees may be required to repair damage from storms and to counteract subsidence of the levees.

The following activities on exterior levees may be required:

1. **Repair of Exterior Levees**: If maintenance or repair of interior (landward) or exterior levees is required, the following options may be considered: Placement of up to 1.5 cubic yards of levee material per linear foot (capped) up to a maximum of 3,000 cubic yards.

2. **Placement of New Riprap and Installation of Alternative Bank Protection**: Placement of new riprap along the tidal side of the exterior levee shall be authorized by the FAST and Corps after it has been determined that conditions of the site would not support other types of

erosion control. In cases where the FAST and Corps have determined erosion control measures are needed but alternative bioengineered erosion control options are available, alternative bank protection such as brush boxes, biotechnical wave dissipaters, and vegetation may be installed upon review and approval by the FAST and the Corps. Brush boxes shall use natural materials associated with native plantings. Brush box installations shall be done during summer months and at low tide.

3. **Coring of Levees**: Material excavated from the trench of a cored levee shall be temporarily sidecast onto the crown of the levee. The material shall be used to backfill the trench.

4. **Maintenance of Existing Roads**: Existing dirt roads may be mowed on an as-needed basis. Up to 5,000 cubic yards of earth or gravel material may be placed per year to maintain existing roads.

B. CDFW Drain Water Control Structures

Maintenance and eventual replacement of the water control structures associated with the CDFW drain will become necessary as the structures deteriorate by oxidation and rust in the brackish conditions of the marsh.

Expected Outcome: CDFW drain water quality will improve with diffuser, water control structure, and management of the Project site.

Metric: Dissolved Oxygen

Goal: The CDFW diffuser and drain will be maintained and managed to provide water quality sufficient to support the aquatic and wildlife functions of the Project site.

Intervention Threshold (trigger level): Physical structure of the diffuser and or drainage gate is damaged or does no longer function to control low dissolved oxygen conditions.

Potential Management Response: The Land Owner will inspect the CDFW diffuser and drain during regularly scheduled site visits to determine if any maintenance or repair is required. Maintenance of the diffuser and water control structure includes repair and/or replacement of the diffuser, a gate, bulkhead, flashboard riser, stub or coupler, or any other element of the outfall structure. Repair and replacement of the water control structure pipe shall consist of trenching across the habitat berm, removing an existing water control structure, placing the new water control structure, and backfilling the levee.

C. General Site Inspections

The Land Owner will conduct regularly scheduled site visits to monitor the conditions of the site. During these inspections, notes will be taken on general topographic conditions, hydrology, general vegetation cover and composition, invasive species, and erosion. Notes will include observations of plant and wildlife species observed, water quality, general extent of wetlands, and any occurrences of erosion and weed invasion. In addition, evidence of trash and trespass will be documented. Access for scientific and educational uses will be granted on a case-by-case basis after evaluation of the purpose, impacts, and need for the access. **Table 10** summarizes the frequency and details of the general inspections to be conducted on the site.

Table 10. Inspections and Maintenance Activities

	Pre-Construction	Internal Construction	Site Management	Breach Construction	Post Construction	
		2016	2017	2018	Year 1 2019	Years 2-5 2020-2023
Site visits	Monthly	Monthly	Monthly	Monthly	Monthly	Quarterly
Examine tidal channels	NA	NA	Monthly	Monthly	Monthly	Quarterly
Examine breach	NA	NA	NA	Monthly	Monthly	Quarterly
Remove trash	NA	Annually	Annually	Annually	Annually	Annually
Map non-native invasive plant species	Annually	Annually	Annually	Annually	Annually	Annually
Control non-native invasive plant species if impacting wetland habitat quality	Annually	Annually	Annually	Annually	Annually	Annually
Maintain and replace signs and gates, as needed	Annually	Annually	Annually	Annually	Annually	Annually

1. Trash

Due to its isolated and remote location, trash is most likely to float in from Grizzly Bay. During the regularly scheduled site visits, record occurrences of trash and floating debris.

Goal: The Restoration Site should remain free of trash and other debris that harms the aesthetic and ecological values of the site.

Intervention Threshold (trigger level): If trash or floating debris are observed and result in impairment of tidal exchange on the Restoration Site, corrective actions will be identified.

Potential Management Response: Debris may be removed by hand, backhoe, or by using a long-reach excavator, if necessary. Debris removal shall be done annually or on an as-needed basis, normally during the early fall season. The FAST and Corps shall review and approve proposals to remove trash and debris if the work proposed is outside the fall season.

2. TRESPASS

The Restoration Site is bounded by Grizzly Bay on the west and managed marsh to the north, south and east. The only access is from Grizzly Island Road. Access to the site from Grizzly Island Road is gated and locked. There is no reason to fence the site to deter unauthorized public access.

Signage will be installed along the perimeter of the Restoration Site to inform the neighbors of the restoration activities on the site. Three signs will be installed every mile along the perimeter of the Restoration Site. Signs will not be installed in the tidal habitat. The Land Owner will be responsible for maintenance and replacement of the signage.

Goal: Control access through maintenance of gates and discourage trespass with signage.

Intervention Threshold: Trespass levels threaten the biological stability of the Project site. Damage from unauthorized vehicle traffic is documented.

Potential Management Response During the regularly scheduled site visits, record conditions of the gates and signs as well as the access roads and habitats. Replace gates and signs on an as-needed basis. Increase frequency of site visits to determine source of trespass.

3. SCIENTIFIC AND EDUCATIONAL USE

Research and/or other educational programs or efforts shall be encouraged as deemed appropriate by the Land Owner and the FAST; however, these programs are not specifically authorized or funded by this Management and Monitoring Plan.

Goal: Provide limited access to the Project site for educational and research purposes to expand awareness of restoration, ecological values, and to reduce uncertainties associated with tidal restoration projects.

Intervention Threshold: Not applicable.

Potential Management Response: Individuals, groups, educational facilities, or researchers proposing to use the Project site for educational purposes will coordinate their use with the Land Owner and FAST. If the educational activities will passive in nature, such as a hike to discuss plants and animals, then the written consent of the Land Owner is sufficient. If active use (any earthmoving or ground disturbance) of the Restoration Site is proposed, or regular ongoing use of the Restoration Site is proposed, review and written approval by the Land Owner and the FAST is required.

D. Annual Monitoring and Management Report

Annual reports will be prepared for submittal to the FAST. The annual reports will include a summary of work completed to date, milestones, current status, constraints, and relative accrued benefits of the Project. The report will specify remedial actions or management responses.

The Land Owner will be responsible for preparing an annual report on all monitoring and management tasks. The annual report will be completed and submitted to the FAST no later than December 31st of each year following the initiation of physical restoration actions. The Land Owner and/or restoration ecologists and biologists shall make recommendations in the annual report regarding:

- Actions to resolve or reduce management problems (weed control, security, etc.), and
- Warranted changes in monitoring or management programs based on experience to date.

Elements of the report will include:

- General Project information including:
  - Project name;
  - Land Owner’s name, address, email and phone number;
  - Consultant name(s), address(es), email(s), and phone number(s):
  - Acres of impact and types of habitat impacted;
  - Date construction commenced and was completed for Phase 1 and Phase 2; and
  - Indication of monitoring year.
- Goals and objectives of the Project
- Monitoring and maintenance dates with information about activities completed, personnel, and time required to complete tasks
- Analysis of all quantitative and qualitative monitoring data
- Color photographs from each of the designated photo monitoring points
- Maps identifying monitoring areas, planting zones, etc., as appropriate
- Planned remedial action for the upcoming monitoring period
- A description of funds received and expended for management of the Restoration Site during the previous year
- Status of biological resources on the Restoration Site
- Results of biological monitoring or studies conducted on the Restoration Site including biological field data sheets and/or maps illustrating species observation locations

- Description of all management actions taken on the Restoration Site including any new practices, structures, or vehicle usage associated with the management actions

- Descriptions of any problems encountered in managing the Restoration Site

A final report to cover the entire restoration Project will be prepared at the end of the Interim Management Period (Year 5 after breaching). This final report will include data from all years, including copies of all previous reports and a delineation of the Restoration Site.

E. Special or Emergency Notifications

The Land Owner will provide notice to the FAST and U.S. Army Corps of Engineers (Corps) on any activities or emergency situations requiring action with the potential to adversely affect waters of the United States, including wetlands or other habitats.

Intervention Threshold: An "emergency situation" is present where there is a clear, sudden, unexpected, and imminent threat to life or property demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property or essential public services (i.e., a situation that could potentially result in an unacceptable hazard to life or a significant loss of property if corrective action requiring a permit is not undertaken immediately).

Potential Management Response: The Land Owner will provide notification to the FAST and Corps for any actions contemplated that (1) are deemed urgent and/or emergency in nature, and (2) are not part of activities recommended in this Plan or the annual report. Notification will be written and may be mailed or electronically transmitted. The notification will include a written description of the proposed action(s) and map(s) of the area affected. Methodology of the action shall be described in the letter. The FAST will have 30 days in which to discuss or object to the activity. The action(s) will be deemed approved if a written response is not received by the Land Owner within 30 days of transmittal. Any permits necessary for such action(s) are the responsibility of the Land Owner.

Provide notice of actions not initiated by the Land Owner that have affected resource values at the Restoration Site.

Where an action natural or otherwise initiated or occurring outside of the Land Owner’s control that affects resource values at the Restoration Site, and which are of a nature that timely reporting of these action(s) to the FAST is advisable, versus being reported in the annual report, the Land Owner shall report such action(s) to the FAST within 30 days of recognition of the action(s). The report will be written and may be mailed or electronically submitted. Any remedial actions recommended by the FAST shall be submitted to the Land Owner within 30 days of receipt and shall be included in the annual report for consideration.

The Land Owner shall be responsible for identifying emergency situations that require immediate action. Should an emergency situation arise that would otherwise require prior notification of the FAST prior to execution of remedial action(s), the Land Owner shall report the nature of the emergency and remedial action to the FAST by electronic mail or telephone within 48 hours with written confirmation within 5 days of initiation of the remedial action. An emergency situation for the purpose of this section is where there is an unacceptable risk to life, significant loss of property, or an immediate, unforeseen and significant economic hardship able to be addressed by the Land Owner consistent with restoration objectives.

Should an emergency situation arise that requires immediate action in a wetland or waters of the U.S., and would normally require that a permit be obtained from the Corps, the Land Owner shall be responsible for notifying the Corps and complying with the Corps requirements. As of 2015, the appropriate Corps permit is Regional General Permit Number 5 (Corps File No. 28218S) that authorizes discharges of dredged or fill material into Waters of the United States, including wetlands, and/or work or structures in Navigable Waters of the United States for necessary repair and protection measures associated with an emergency situation..

California Fish and Game Code Section 1600 also has emergency procedure stipulations that may apply.

VI. Transfer, Replacement, Amendment, and Notices

A. Transfer

Any subsequent transfer of responsibilities under this Plan to a different Land Owner shall be requested by the appropriate agency in writing to the FAST, shall require written approval of the FAST, and shall be incorporated into this Plan by amendment.

Any subsequent Land Owners assume all Land Owner responsibilities described in this Plan.

B. Replacement

If this Land Owner fails to implement the tasks described in this Plan and is notified in writing by the FAST, the Land Owner shall have 90 days to cure such failure. If failure is not cured within 90 days, the Land Owner may request a meeting with the FAST to resolve the failure. Such meeting shall occur within 30 days or a longer period if mutually agreed to by the FAST and the Land Owner.

If the Land Owner fails to cure the failure, and fails to communicate with the FAST about the situation, the FAST may designate a Land Manager to implement the tasks described in this Plan. A Land Manager designated by the FAST should be a public or private land or resource management organization acceptable to and as directed by the FAST. A Land Manager designated by the FAST may enter onto the Restoration Site at any time in order to fulfill the purposes of this Plan.

C. Amendment

The Land Owner and FAST may meet and confer from time to time, upon the request of any one of them, to revise this Plan to better meet management objectives and preserve the habitat and conservation values of the Restoration Site. Any proposed changes to this Plan shall be discussed with the Land Owner and the FAST. Any proposed changes will be designed with input from all parties. Amendments to this Plan shall be approved by the Land Owner and the FAST in writing, shall be required management components, and shall be implemented by the Land Owner.

If the FAST determines, in writing, that continued implementation of this Plan would jeopardize the continued existence of a state or federally listed species, any written amendment to this Plan, determined by the FAST as necessary to avoid jeopardy, shall be a required management component and shall be implemented by the Land Owner. Any permits, authorizations, and/or consultations shall be obtained prior to implementing the management component.

D. Notices

Any notices regarding this Plan shall be directed as follows.

1. LAND OWNER

Westervelt Ecological Services
600 North Market Boulevard, Suite 3
Sacramento, CA 95834
Attn: Vice President

2. APPLICANT

State and Federal Contractors Water Agency
1121 L Street, Suite 806
Sacramento, CA 95814
Attn: Executive Director

3. FAST AGENCY MEMBERS

U.S. Fish and Wildlife Service
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
Attn: Field Supervisor

National Marine Fisheries Service
Sacramento Area Office
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814
Attn: Regional Manager

California Department of Fish and Wildlife
Bay Delta Region
7329 Silverado Trail
Napa, CA 94558
Attn: Regional Manager

U.S. Bureau of Reclamation
Reclamation Mid-Pacific Region
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536
Attn: Regional Manager

4. OTHER INTERESTED AGENCIES

California Department of Fish and Wildlife
2548 Grizzly Island Road
Suisun, CA 94585
Attn: Land Manager

VII. LIST OF CONTRIBUTORS

A. STATE AND FEDERAL CONTRACTORS WATER AGENCY (SFCWA)

- Byron Buck, Executive Director
- Curt Schmutte, Curt Schmutte Consulting

B. WESTERVELT ECOLOGICAL SERVICES, LLC (WES)

- Greg Sutter, Executive Vice President
- Hal Holland, Senior Conservation Planner
- Kim Erickson, Conservation Planner
- Mark Young, Restoration Design and Construction Manager
- Matt Gause, Senior Ecologist
- Robert Capriola, Conservation Planner

C. ENVIRONMENTAL SCIENCE ASSOCIATES (ESA)

- Gerrit Platenkamp, Ph.D., Director of Biological Resources and Land Management
- Priya Finnemore, Senior Regulatory Specialist
- Ramona Swenson, Ph.D., Senior Restoration Ecologist

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