LOWER WALNUT CREEK RESTORATION PROJECT

Feasibility Study Report

Prepared for
Contra Costa Flood Control and Water Conservation District

April 2017

LOWER WALNUT CREEK RESTORATION PROJECT

Feasibility Study Report

Prepared for
Contra Costa Flood Control and Water Conservation District

April 2017

550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900
www.esassoc.com

D140703

OUR COMMITMENT TO SUSTAINABILITY | ESA helps a variety of public and private sector clients plan and prepare for climate change and emerging regulations that limit GHG emissions. ESA is a registered assessor with the California Climate Action Registry, a Climate Leader, and founding reporter for the Climate Registry. ESA is also a corporate member of the U.S. Green Building Council and the Business Council on Climate Change (BC3). Internally, ESA has adopted a Sustainability Vision and Policy Statement and a plan to reduce waste and energy within our operations. This document was produced using recycled paper.

TABLE OF CONTENTS

List of Attachments

List of Tables

List of Figures

Acronyms and Abbreviations

BCDC	San Francisco Bay Conservation and Development Commission
BNSF	Burlington Northern & Santa Fe (railway)
CCWD	Contra Costa Water District
CCCSD	Central Contra Costa County Sanitary District
District	Contra Costa County Flood Control and Water Conservation District
EBRPD	East Bay Regional Parks District
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
SAG	Stakeholder Advisory Group
SLC	California State Lands Commission
SLR	Sea-level rise
Corps	United States Army Corps of Engineers (also “USACE”)

This page intentionally left blank

SUMMARY

The Lower Walnut Creek Restoration Project (Project), led by the Contra Costa County Flood Control District (District), proposes to restore and enhance tidal wetlands along the southern shore of Suisun Bay and from Suisun Bay upstream along Walnut Creek and its tributary Pacheco Creek, to provide sustainable flood protection, and to create opportunities for future public access through the project area. Figure 1 shows the Lower Walnut Creek project area, located in unincorporated Contra Costa County approximately 3 miles east of the City of Martinez. Land use within the project area is largely industrial, with areas of open space. Key pieces of infrastructure and local land ownership are shown on Figure 2. The Project area extends along the lower 2.5 miles of Walnut Creek and along half a mile of Pacheco Creek just upstream of its confluence with Walnut Creek.

The District, with assistance from Environmental Science Associates (ESA), conducted project planning to develop and evaluate potential alternatives, and select the Preferred Alternative. This Feasibility Study Report documents the results. The District conducted extensive stakeholder and community outreach. The results presented here reflect input from local stakeholders, community groups, regulatory agencies, and the public.

For planning purposes, the Project area was divided in to three reaches – the South Reach, Middle Reach and North Reach (Figure 1). The North Reach is also referred to as the Pacheco Marsh Restoration Project site. Alternatives were developed and refined for each reach, with three alternatives for the South Reach, three for the Middle Reach and two for the North Reach. In addition, a Without Project Alternative was defined for each reach. The alternatives for each reach can be implemented separately or in any combination.

For the South and Middle Reaches, the alternatives reflect different approaches to reintroducing the tides to existing diked (non-tidal) former baylands, constructing new setback levees for flood protection of adjacent industrial lands, and accommodating potential future public access. In the North Reach, part of the restorable area has been filled due to past use for aggregate handling and processing. Both North Reach alternatives including reintroduction of the tides to existing diked former baylands and mass grading of the previously-filled areas to restore appropriate elevations for tidal wetland establishment. The North Reach alternatives reflect different relative extents of restored tidal marsh, transitional habitat and upland area. Project alternatives were compared and evaluated based on their ecological benefits, flood protection performance, consistency with potential future trail locations, and overall ecological sustainability and consistency with ongoing natural processes.

The Preferred Alternative, shown in Figure 3, will restore and enhance approximately 110 acres of tidal wetlands, 19 acres of non-tidal wetlands, 50 acres of transition habitat and 51 acres of uplands. The project will improve habitat quality, diversity, and connectivity along 2.5 miles of

Walnut Creek and 0.5 miles of Pacheco Creek and along the southern Suisun Bay shoreline. The Preferred Alternative will breach and lower levees and berms to reintroduce the tides to diked former baylands, construct new setback levees for flood protection, and grade filled areas to create new tidal wetland areas.

The Preferred Alternative will provide habitat for native and special-status species such as salt marsh harvest mouse, Ridgway's rail, California black rail and salmonids. The Project will restore important tidal marsh habitat for the State-listed Mason's lilaeopsis (observed in the area), and the Delta tule pea and Suisun marsh aster, which are rare or relatively uncommon plant species in the San Francisco Estuary. In addition to improved habitat for fish and wildlife, the preferred alternative will provide more sustainable flood protection that avoids significant dredging, and provide a trail corridor for future connection of the Iron Horse Trail and Bay Trail extension through the project area.

The Preferred Alternative requires future agreements between the District and private land owners. In the event that the District is unable to reach agreement with the private land owner within a given reach, the District may move forward with another alternative in that reach, or may elect to pursue the without-project alternative in that reach while proceeding with the Preferred Alternative in the other reaches. The Preferred Alternative will be refined and described in more detail in a Project Study Report prior to CEQA, permitting, and final design.

CHAPTER 1
Introduction

1.1 Project Background

In the 1960s, the lowest four miles of Walnut and Pacheco Creeks became part of a US Army Corps of Engineers (Corps) flood control project. Levees were constructed along the creek banks and the Walnut Creek channel was dredged to provide flood conveyance. The channel has since experienced extensive sedimentation and a wide band of tidal marsh has emerged adjacent to the open water channel. This fringing marsh provides habitat for sensitive fish and wildlife species, in the previously-dredged area, however the sediment accumulation in the marsh areas also reduces the channel conveyance capacity below the level mandated by the original Corps project Operations and Maintenance manual (Corps 1969). Ongoing dredging to restore creek capacity is not considered environmentally or economically feasible. The District was recently successful in "deauthorizing" the project area from the larger Corps-constructed project, returning management of Lower Walnut Creek to local control.

1.2 Project Need

The project responds to large historic losses of wetlands habitat, the recent deauthorization which has provided an opportunity to re-evaluate the District's flood protection strategy within the project area, and the limited public access and recreational opportunities in this region of Contra Costa County.

Loss of Wetland Habitat. Francisco Bay has lost 80% of its historic tidal wetlands, threatening native marsh-dependent fish and wildlife species, including special-status species such as salmonids, salt marsh harvest mouse, Ridgway's rail, and California black rail. The State-listed Mason's lilaeopsis, plus Delta tule pea and Suisun marsh aster, are rare or relatively uncommon plant species in the San Francisco Estuary that have been adversely affected by loss of marsh-to-upland transitional habitat. For the purposes of this document, transitional habitat is assumed to occur in the few feet just above tidal habitats.[1]

Sustainable Flood Protection. Areas adjacent to the west of Lower Walnut Creek are within the 100-year floodplain (FEMA 2009). While the 100-year flood event was the original design level of flood protection for the Lower Walnut Creek Flood Protection Project, maintaining this level of protection requires expensive and environmentally-destructive large-scale dredging to protect

[1] Up to Mean higher high water plus 3 feet.

relatively flood-tolerant land uses. For the current project, the District seeks to provide *appropriate* levels of flood protection that are suited to the existing land uses and also in line with ongoing natural geomorphic processes.

Public Access. The Lower Walnut Creek Project Area is located in a gap between several existing and planned regional trail connections. The regional Ironhorse Trail currently ends 1.5 miles south of the Project Area, and does not provide access to the Suisun Bay shoreline. An extension of the Ironhorse Trail along Lower Walnut Creek could connect to a trail network on Pacheco Marsh and provide shoreline access. In addition, the regional San Francisco Bay Trail passes 1.3 miles west of the project site. The Lower Walnut Creek Project presents an opportunity to link these two major regional trail networks, and would allow visitors on both trail systems to experience the natural amenities within the Lower Walnut Creek Project Area.

1.3 Stakeholder and Public Outreach

The District initiated a collaborative public planning process to facilitate communication and collaboration with local stakeholders, community groups, and regulatory agencies. The Center for Collaborative Policy (CCP), as a subcontractor to ESA, has helped to organize and facilitate this planning process. The public planning process includes community outreach efforts, the assembly of a stakeholder advisory group, and early coordination with regulatory agencies.

Through this planning process the District, CCP and ESA have participated in several outreach efforts to ensure that interested parties are informed about the ongoing planning efforts and are given a forum to provide comments and feedback. These efforts included interviews to identify potentially interested parties, and the preparation of a Stakeholder Assessment Report which has guided ongoing outreach efforts (CCP, 2015).

Stakeholder Advisory Group

A Stakeholder Advisory Group ("SAG") has been assembled to provide a forum for local stakeholders to receive information on the project and to provide feedback. The SAG includes representatives from local businesses and land owners, utilities and other interested local government entities, and representatives from interested community organizations. The SAG has met four times to date: October 2015, November 2015, March 2016, and September 2016. Additional SAG meetings are expected as the project proceeds to preliminary design.

The SAG consists of representatives from:

- ACME Landfill
- Burlington Northern Sante Fe (BNSF) Railroad
- Central Contra Costa Sanitary District (CCCSD)
- City of Martinez
- The Conco Companies

- Contra Costa County Public Works Maintenance Division
- Contra Costa Water District
- Diablo Valley Fly Fishermen
- East Bay Regional Parks District (EBRPD)
- John Muir Heritage Land Trust
- Plains Products LLC
- Tesoro Martinez Refinery
- Walnut Creek Watershed Council

SAG members have been generally supportive of the proposed project, and have noted that the SAG allows them to be kept informed as the project design is developed. The SAG has provided valuable input to the design team, including helping to characterize existing site conditions and constraints.

Community Outreach

Community Meetings

The District has created community meetings as forums for interested members of the public to provide feedback and comments on the Lower Walnut Creek Project. The District has held two public meetings.

- **December 2015** – to present and discuss project vision, goals, and objectives, and opportunities and constraints.
- **October 2016 –** to present and discuss preliminary project alternatives, and a preliminary Preferred Alternative. Feedback indicated an interest in a through-trail through the project area and a boat/kayak launch.

Site Tours

There is currently no public access to the Walnut Creek channel or Pacheco Marsh, except along Waterfront Road. In the fall of 2015, the District began leading public tours through the Lower Walnut Creek project area. Tour guests have expressed an interest in improving public access along Walnut Creek.

Web-based Outreach

The District hosts a Lower Walnut Creek website and Facebook page to provide project information. The District has produced a series of short videos titled "Lower Walnut Creek Adventures" which covers a range of educational topics related to Walnut Creek and the proposed restoration project.

Early Agency Coordination

The Lower Walnut Creek project team has met with representatives from regulatory agencies who are expected to have an interest in the proposed project, including: US Fish and Wildlife Service, US Army Corps of Engineers, National Marine Fisheries Service, San Francisco Regional Water Quality Control Board, California Department of Fish and Wildlife, BCDC, and California Coastal Conservancy. The District has also hosted several site visits to allow interested agency representatives to visit the project site. These meetings have allowed agency officials to understand the proposed restoration project and to provide feedback related to minimizing impacts to and increasing benefits to regulated natural resources.

CHAPTER 2
Project Goals and Objectives

The District developed project goals and objectives, which were refined with input from the community-based planning process.

2.1 Goal

The project goal is to:

> *Restore and enhance wetlands and associated habitats in Lower Walnut Creek and to provide sustainable flood management, while allowing opportunities for public access and recreation.*

Attachment A provides more information on the District's vision for a restored Lower Walnut Creek.

2.2 Objectives

Project objectives are to:

1. *Restore wetlands to improve ecological function and habitat quantity, quality, and connectivity (including upland transition zones) in the Lower Walnut Creek area for native, resident plant and animal species including special-status species.*

Special status species known to occur in the area include the salt marsh harvest mouse, California black rail, Ridgway's rail, and Mason's lilaeopsis.

2. *Maintain appropriate levels of flood protection along Lower Walnut and Pacheco Creeks, as warranted by the land use.*

This includes protecting the services provided by existing infrastructure (e.g., power lines, railroads, water lines) and maintaining access to infrastructure and adjacent private property. Open space areas may not require maintenance or improvement of flood protection levels.

3. *Allow for future public access, education, and recreational opportunities.*

The District is committed to developing a project that is compatible with regional goals for public access through the project area, such as a trail segment connecting two regionally-significant trails – the Ironhorse and Bay Trails. The District's charter, however, limits the ability of the District to directly fund the creation and maintenance of public access and restoration facilities.

While the District is not in a position to directly implement public access and recreational facilities, the District will provide opportunities for partners such as the EBRPD and the John Muir Land Trust to pursue future public access and recreation projects within the Lower Walnut Creek area.

4. Create sustainable benefits that consider future environmental changes such as sea level rise and sedimentation.

A guiding principle in planning the Lower Walnut Creek Restoration project is to design a system that works with nature, not against it. This means anticipating changes associated with estuarine and fluvial sediment deposition and increases in flooding from future sea level rise, and designing a system that is resilient to these changes without expensive and environmentally-disruptive management actions.

The District is committed to developing a project that will be resilient to future sea level rise through the year 2050, and adaptable to anticipated changes through 2100. For planning purposes, the project adopts a sea level rise projection of 2 feet by 2050 and will consider a range of sea level rise extents up to 5 feet by 2100. These values are consistent with the upper range of projected sea-level rise from National Research Council's 2012 report "Sea-Level Rise for the Coasts of California, Oregon and Washington" (NRC, 2012) and the Adapting to Rising Tides regional sea-level rise planning program (AECOM 2015).

The District seeks a planning process informed by local stakeholders, and the public. The District will solicit input and incorporate, to the extent feasible, other desires of potential partners, stakeholders, and the public.

2.3 Consistency with Regional Plans

In addition, the project team has coordinated with local and regional planning efforts to develop project alternatives that are consistent with regional planning priorities, including:

- *San Francisco Bay Area Wetlands Ecosystem Goals Project* (Goals Project 2015) in that the Project restores wetlands and broad transition zone in a way that is resilient to sea-level rise (see additional discussion below).
- *San Francisco Bay Plan* (Bay Plan; BCDC 2012) in that the project restores wetlands, improves shoreline public access, and includes features to increase sea-level rise resiliency.
- *Flood Control 2.0* (SFEI, 2016) in that the project is pursuing a multi-benefit approach to managing the Walnut Creek flood control channel as the creek transitions from the head of tide to Suisun Bay (see additional discussion below).
- *Adapting to Rising Tides* (BCDC, 2015) in that the project aims to accommodate future sea level rise through 2050 and include adaptive capacity through 2100 based on the ART guidance.
- *EcoRestore* (California Natural Resources Agency, et al., 2016) in that the project restores Sacramento-San Joaquin Delta habitat, including tidal wetlands, floodplain, upland and riparian.

- *San Francisco Bay Integrated Regional Water Management Plan* (Kennedy Jenks et al. 2013) in that the Project implements a priority project specified in the Plan
- *EBRPD Master Plan* (EBRPD 2013) in that the Project will provide an opportunity to link the Iron Horse Trail with existing recreational facilities at Waterbird Marsh, as well as planned future extensions of the San Francisco Bay Trail and the Great California Delta Trail.
- San Francisco Bay Area Water Trail Plan (California State Coastal Conservancy 2011) in that the Project may provide an opportunity to create a non-motorized boat launch near the mouth of Walnut Creek, which would increase access to the Water Trail.

The 1999 Goals Project provided a scientifically-based consensus vision of the kinds, amounts, and distribution of baylands habitats needed to sustain healthy populations of fish and wildlife for the entire region. The Goals Project 2015 updates the 1999 Goals Project based on a synthesis of the best available science. The Goals Project 2015 provides recommendations stemming from the science intended to guide the planning, restoration, and management of the baylands. The Lower Walnut Creek Restoration Project provides opportunities to implement the following regional-level actions recommended by the Goals Project:

1. Restore estuary–watershed connections
2. Design complexity and connectivity into the baylands
3. Restore and protect complete tidal wetlands systems
4. Restore the baylands to full tidal action before 2030
5. Plan for the baylands to migrate

At the subregional level, the project alternatives implement the Suisun Subregion Recommended Action for the Contra Costa shoreline, which is to restore full tidal action to muted and diked marshes to create a tidal marsh corridor along the shore, including broad transition zones with diverse plant communities; and to create terrestrial buffers along this corridor to protect baylands habitats and wildlife from disturbance.

Flood Control 2.0 is a grant funded project, led by the San Francisco Estuary Partnership, with the goal of improving flood control channel design by restoring wetland habitat, water quality, and shoreline resilience at creek mouths. The Flood Control 2.0 approach is (1) to conduct research (by the San Francisco Estuary Institute, SFEI) to characterize landscape processes and (2) to provide technical and scientific input to management decisions. Lower Walnut Creek is one of three San Francisco Bay case studies. A five-member Science Advisory Team provided input on the Lower Walnut Creek Restoration Project initial alternatives, recommending approaches to redistributing watershed sediment in areas where wetlands can be restored, improving habitat benefits, restoring watershed connections, and improving sustainability. The results of this work are presented in the "Resilient Landscape Vision for Lower Walnut Creek" report (SFEI, 2016). The District and ESA have carefully considered these recommendations and implemented them to the extent feasible in the current Project alternatives.

This page intentionally left blank

CHAPTER 3
Site Conditions

3.1 Location

The project area is located approximately 3 miles east of the City of Martinez along the lowest 2.5 miles of Walnut Creek and 0.5 miles of Pacheco Creek.[2] The project area consists of the South Reach, located between the BNSF Railroad embankment and the confluence of Pacheco and Walnut Creeks; the Middle Reach, located between Pacheco Creek and the Union Pacific Railroad Embankment; and the North Reach, located between Waterfront Road and Suisun Bay in the area historically called "Pacheco Marsh".

3.2 Surrounding Land Uses and Infrastructure

Figure 2 shows existing land use and infrastructure within the three project reaches and surrounding areas. Figure 4 shows General Plan land use zoning. The project area and adjacent lands consist primarily of publicly owned and privately owned open space, with existing and proposed future industrial land uses on adjacent parcels. Figure 2 shows the utilities and other infrastructure that exist in the project area for which map data has been made available to the project team, including:

- Central Sanitary District's underground Outfall Pipeline (North Reach)
- Contra Costa Water District's "Shortcut Pipeline" (South Reach)
- Underground and aboveground petroleum pipelines (South and North Reaches)
- PG&E overhead power lines (South and Middle Reaches)

Additional, unmapped subsurface infrastructure is believed to exist within the project area, including an underground petroleum pipeline operated by Chevron located in the South Reach. The project team continues to coordinate with utilities and other infrastructure operators to identify such unmapped subsurface infrastructure within the project area. There are also several transportation corridors passing near the project site:

- Waterfront Road - a county road located between the Middle and North Reach

[2] The potential project area consists of the lower 2.5 miles of Walnut Creek and 1.5 miles of Pacheco Creek. However, restoration alternatives were considered feasible in only the lower 0.5 miles of Pacheco Creek.

- Union Pacific Railroad – a single track railroad located between the Middle and North Reach
- BNSF Railroad – a double track railroad located immediately south of the South Reach

Several parcels adjacent to the Project Area support industrial land uses, including:

- Conco Inc.'s contractor yard (South Reach)
    - Conco Inc. has proposed a future expansion of their yard on the parcels west of the South Reach Project Area
- Acme Landfill (Middle Reach)
- Several Closed Landfills (South and Middle Reaches)
    - The closed IT Baker Landfill has leachate management system piping which passes through Conco owned parcels (South reach) and connects to Vine Hill hazardous materials processing site (Middle Reach).
- Martinez Gun Club (Middle Reach)
- Tesoro Oil Refinery (East bank of Walnut Creek, all reaches)
- Copart Auto Lot (North Reach)
- Central Contra Costa Sanitary District's Waste Water Treatment Plant (adjacent to the South Reach)

3.3 Property Ownership and Easements

While the District owns a large portion of the land within the proposed project area, the District is also pursuing opportunities to expand the project area through partnerships with other local landowners.

Figure 2 shows the portions of the Walnut Creek area that are owned by the District, and also identifies areas where the District has begun negotiations with land owners to potentially expand the project footprint to include portions of the adjacent privately-owned parcels.

There are several easements through the District-owned parcels within the project area. The South Reach contains several utility easements passing through the project area and across the Walnut Creek channel. Available records indicate that these easements benefit the following entities (listed from south to north): PG&E, Tidewater Oil Company (coincident with PG&E Easement), Contra Costa Water District, and California Water Service Company. We understand that a number of buried utility lines pass through these easements, including the "Shortcut Pipeline", a raw water pipeline operated by the Contra Costa Water District, and a petroleum products pipeline operated by Chevron (in the Tidewater Oil easement). The South Reach also includes overhead powerlines maintained by PG&E (within the PG&E easement).

An additional PG&E easement is believed to exist on the South Reach, running from north to south along the west side of the District's property. The approximate location of this easement is

shown on Figure 2, and the District is working to obtain additional information about this the easement.

3.4 Topography and Bathymetry

Several topographic and hydrographic surveys have been completed for some or all of the project area. In 2005, Towill Inc. performed topographic maps of the entire project area using aerial photogrammetry. Figure 5 shows the site elevations from the 2005 survey. Towill Inc. (2005) also conducted bathymetric surveys within Lower Walnut Creek and Pacheco Creek. Additional ground surveys have measured elevations at several cross sections on Walnut Creek. Historic cross section survey data was compiled by MBH in their 2009 study, and were supplemented by surveys conducted by ESA in 2015. Previous and recent channel cross sections are show in Figure 6. Note that elevation data presented in this report are referenced to the North American Vertical Datum of 1988 (NAVD88).

Table 1 lists the elevation of key landforms on the project site.

TABLE 1
ELEVATION OF KEY LANDFORMS

Feature	***Elevation***
Historic Marsh (North Reach, outside of channel dredging footprint)	5.5 to 6.5 ft NAVD
Acme Landfill (Middle Reach)	Max Elevation: 85ft NAVD (North Parcel); 80ft NAVD (East Parcel)
Baker Landfill (South Reach, Decommissioned)	Max Elevation: 32ft NAVD
Flood Control Levees (crest elevation)	9-13 ft NAVD (North Reach) Low point at 8.5ft NAVD between UPRR and Waterfront Road. 12.5 to 15 ft NAVD (Middle Reach) 12.5 to 15ft NAVD (South Reach)
Pacheco Marsh (North Reach)	Northeast basin: 5 to 8 ft NAVD Southeast basin: 5.5 to 10 ft NAVD Northwest basin: 9 to 11 ft NAVD Southwest basin: 6 to 8 ft NAVD (based on DEM adjusted with ESA ground survey data)
Acme buffer area (diked marsh)	3 to 5.5 ft NAVD (downstream to upstream)
Walnut Creek Channel Bed	-5 to 0 ft NAVD (Suisun Bay to BNSF Railroad Bridge)
Pacheco Creek Channel Bed	-1 to 3 ft NAVD (Walnut Creek Confluence to pond near Central Ave.)
Waterfront Road	6.5-11 ft NAVD Low point between 6.5ft and 7ft NAVD near Walnut Creek bridge

SOURCES: Elevations estimated from aerial-photography-based Digital Elevation Model (DEM) (Towill, 2005) and from ground surveys (ESA, 2015).

3.5 Soils and Geotechnical

Hultgren - Tillis Engineers (HT) developed a basis for key geotechnical parameters using topographic maps, published geologic maps, and available subsurface data for the Lower Walnut Creek Restoration Project area. Data points from the HT July 2007 report and the 2009 Corps evaluation are shown on Figure 7. Most of the project area was historically tidal marsh and is underlain by weak compressible clays and silts commonly referred to as bay mud. In general, areas within the historic marsh footprint that are now above natural marsh elevations have been subject to fill placement. The project area is underlain by marsh deposits of varying thicknesses. Inferred bottom of bay mud contours as depicted in Figure 7 are based on topographic maps, and Special Report 97. Bay mud is a deposit that has limited load bearing capacity and large settlement potential as the material consolidates under the weight of new loads.

The shear strength of the bay mud at shallow depths will change with consolidation. Normally consolidated bay mud that has not been loaded is typically very soft to soft. The existing tidal marsh on the west side of Walnut Creek along Pacheco Marsh is likely very soft to soft. Areas where fill has been placed for land use (e.g., landfills), dredged material disposal, or levee construction will have, over time, gained strength and become medium stiff. The amount of strength gain is directly related to the amount of fill and the length of time the fill has been in place. The bay mud underlying Pacheco Marsh where dredge material and other fill has been placed is medium stiff. Likewise bay mud south of Waterfront Road where fill was placed to build levees or placed for land use is also medium stiff. Transitional areas between thicker land use fill and levee fill is likely to be soft to medium stiff. The shear strength of the bay mud will affect project design and construction. Where very soft or soft materials are located, construction phasing may be needed to reduce the potential for bearing failure of the ground. In other areas where the bay mud has consolidated under the existing fill or previous loads it may be possible to place new fill without construction phasing.

Settlement of the underlying bay mud will occur wherever existing grades are raised. The amount will be directly related to the thickness of bay mud, previous loading and the amount of new fill. Soils in the project area have moderate, high, or very high settlement potential. In general terms, moderate settlement potential can be broadly characterized as 1-2 feet of settlement for 10 feet of new fill; high settlement as 2-3 feet of settlement for 10 feet of new fill and very high settlement as 3-5 feet of settlement for 10 feet of new fill. We would anticipate very high settlement in marsh areas that have never been filled. The areas of Pacheco Marsh where fill or dredge material has been placed would likely have moderate to high settlement. Existing levees where, for example, one foot of new fill were added would likely have settlement at the low end of the moderate range. Transitional areas between existing levees and large fills south of Waterfront Road would have moderate to high settlement. For all these areas, the total amount of settlement depends on the amount of new fill, with thicker fills resulting in greater settlement.

3.6 Soil Quality

Several prior studies, described below and listed in Table 2, have evaluated the quality of existing sediments within the project area. Soils within the project area have not been comprehensively

compared to current regulatory standards for exposure in the wetland environment. There are numerous industrial land uses near the project site and the state water board has records of several locations near the project area where contaminated groundwater or soils have been found and for which clean-up and remediation efforts are underway or have been completed (GeoTracker site, Sept 2015).

TABLE 2
PRIOR SOIL QUALITY STUDIES ALONG LOWER WALNUT CREEK

Author	*Year*	*Location*
State Water Board (GeoTracker Website)	2015	15+ sites near project area
Ninyo and Moore	2007	10 locations along Walnut Creek, from Pacheco Marsh to Pine Creek Confluence
USACE	2007, unpublished	Various locations between BNSF and Pacheco Marsh, including IT Baker parcel and ACME Landfill fringing marsh
H.T. Harvey and Associates (referencing sampling by Jonas and Associates, Inc., 2002)	2004	Pacheco Marsh
Engeo Inc.	1994	32 locations along Walnut Creek from Suisun Bay to Grayson Creek Confluence

In 2007 Ninyo and Moore evaluated soil samples collected from 9 locations along Lower Walnut Creek and Grayson Creek for a number of analytes including metals and petroleum products. While detectible quantities of analytes were found, none exceeded the regulatory criteria (Title 22) for hazardous waste (Ninyo and Moore, 2007). Further, the analytes were all at concentrations which were either less than the Effects Range-Low (ERL) value[3] or San Francisco Bay ambient values. Not all of the analytes for which standards exist were reviewed in the Ninyo and Moore report.

Unpublished soil testing conducted by the USACE in 2006-2007 along Lower Walnut Creek and on adjacent parcels (including the low-lying basins at the IT Baker and ACME landfills) did not reveal problematic levels of tested analytes (Paul Detjens, pers. coms. 2015).

In 2004, H.T. Harvey & Associates prepared a summary of the results of sediment quality testing by Jonas and Associates, Inc. (2002) in support of the development of the Pacheco Marsh Restoration Plan. Jonas and Associates collected and tested sediments from 27 subsurface sampling locations at the proposed Pacheco Marsh Restoration site, to depths up to 10 feet. Many samples exceeded the San Francisco Bay Regional Water Quality Control Board (RWQCB) recommended sediment chemistry screening guidelines for selenium at the time. In addition, a single sample exceeded the RWQCB's guidelines for mercury. HT Harvey & Associates suggested that it may be possible for the restoration to be designed to avoid exposing soils with elevated analyte levels. The one sample with mercury above RWQCB guidelines (at 0.73 mg/kg; criterion is 0.70 mg/kg) lies in an area (northwestern corner) that would remain upland in the 2004 design. HT Harvey further noted that elevated levels of selenium may be more likely to

[3] The ERL is the constituent concentration corresponding to a 10% likelihood of toxicity.

occur at greater depths in the soil column (beneath 4 feet below grade) and that it may be possible to overexcavate any areas with elevated concentrations of selenium and back fill with clean soil. Soils not suitable for wetland cover would need to be properly disposed of. HT Harvey & Associates recommended additional sediment testing required prior to excavation.

In 1993, Engeo collected and tested sediments from 32 sampling locations along the Walnut Creek channel in anticipation of future dredging of the Walnut Creek channel. The sediments were tested and compared to the USACE and EPA (1992) criteria for in-bay disposal of dredged material. Bivalve bioassay testing indicated that soil and water toxicity levels did not exceed permissible limits for dredge material disposal in the Bay.

3.7 Hydrology

Tides

The National Oceanographic and Atmospheric Administration (NOAA) maintains the Port Chicago tide gage (NOAA Station #9415144), which is located three miles to the east of the mouth of Walnut Creek. The Port Chicago gage is a continuously-operating gage with a tide record dating back to 1976. The tide range (MHHW – MLLW) at Port Chicago is 4.9 ft. In the summer of 2015 ESA installed two water level gages along Lower Walnut Creek. One gage was installed near the creek mouth and the second was installed at the BNSF Bridge. The water level measurements from these gages showed that tide conditions near the Project Area are comparable to those measured at the Port Chicago gage (ESA, 2015b). Likewise, the tidal datums calculated for the Port Chicago gage were found to be representative of conditions observed at the project site. **Table 3** lists tidal datums for the Port Chicago gage.

Creek water levels are tidally-influenced from the mouth of Walnut Creek upstream to a sewer pipe crossing located immediately downstream of Highway 4; up Pacheco Creek to Highway 680; and up Grayson Creek to Pacheco Blvd (SFEI – Eco Atlas, 2011-2015).

TABLE 3
TIDAL DATUMS AND COASTAL FLOOD ELEVATIONS

Datum	***Elevation (ft NAVD88)***
Highest Astronomical Tide	7.26
Mean Higher High Water (MHHW)	6.01
Mean High Water (MHW)	5.50
Mean Sea Level (MSL)	3.66
Mean Low Water (MLW)	1.84
Mean Lower Low Water (MLLW)	1.10
Lowest Astronomical Tide	0.08

Source: NOAA Tides and Current – Port Chicago, Station #941514944, September 15, 2015; FEMA FIS # 06013CV003B, 2015

Drainage

The Pacheco Creek and Walnut Creek channels are the primary drainage pathways through the project area, with Pacheco Creek flowing into Walnut Creek and Walnut Creek flowing into Suisun Bay. Walnut Creek has a drainage area of 147 square miles, while Pacheco Creek is much smaller, with a drainage area of 3.8 square miles (USGS/Stream Stats, 2015). A third large creek channel, Grayson Creek, converges with Walnut Creek 1 mile south of the project area. Figure 8 shows the key drainage pathways, berms and basins in the project area. Figure 9 shows a more detailed view of the drainage pathways near Waterfront Road.

Upstream of the Union Pacific Railroad (UPRR) Bridge, flows within the creek channels are constrained by flood control levees and/or high ground on both banks. The levees along the west bank of Walnut Creek and along Pacheco Creek are owned and maintained by the District. The elevation of these levees varies. Hydraulic modeling performed by the District indicates that levees to the west of Walnut Creek overtop in an approximately 1-in-40 annual chance exceedance flood event (CCCFCCD, 2010). Downstream of the Union Pacific railroad bridge there is a low dredged material placement berm (elevations from 9.5 to 11ft NAVD) on the west channel bank along the Pacheco Marsh Restoration site. The western berm is overtopped during high flow events allowing floodwaters to flow over Pacheco Marsh.

The east side of Walnut Creek is confined by high ground along the frontage of the Tesoro Refinery between Highway 4 and Waterfront Road with the exception of approximately 300 ft of lower ground located immediately upstream of the UPRR bridge (elevation 12 to 13ft NAVD). Downstream of Waterfront Road, the creek is separated from Tesoro's Tertiary Treatment Pond by a paved berm that is maintained by Tesoro (elevation varies from 13 to 15 ft NAVD).

In addition to the main creek channels, there are also several smaller drainages which pass through the project area:

- **Historic Walnut Creek Drainage -** a small channel that runs along the historic Walnut Creek alignment that provides local drainage from the Central Sanitary District parcel to Pacheco Creek;
- **Acme Drainage -** a swale between the Acme Landfill's East and North Parcels that flows from South to North, passes under the UPRR Bridge and then flows into a dead-end channel that runs parallel to Waterfront Road. During high water events this channel overtops Waterfront Road and drains into Pacheco Marsh; and
- **West Pacheco Tidal Slough** – a tidal or muted tidal channel system on the west side of Pacheco Marsh which drains through a culvert beneath the pier access road to a tidal slough that runs to the west and north of the Pacheco Marsh and Suisun Properties parcels.

The project area also includes several large basins with relatively poor drainage, which experience limited or no regular tidal inflow. Ponding commonly occurs in these basins following rain events. While some surface drainage occurs via gated culverts, depending on soil moisture and the intensity and duration of rainfall, ponded surface waters may persist for a few days to several weeks until the water evaporates or drains via sub-surface flow. These basins include:

- the diked marsh area on District-owned lands along Walnut Creek, between the BNSF railroad and the confluence with Pacheco Creek (South Reach), which drains to the Walnut Creek channel via a culvert with a tide gate (P. Detjens, pers. comm.);
- the diked Acme buffer area, which drains to Walnut Creek through a tide gate near the UPRR bridge. The managers of the Acme Landfill suspect that this tide gate does not close properly, possibly due to sediment accumulation (Nick Farros, Pers. Comm. July 2015). A second set of flap-gated culverts is located at the south end of the Acme buffer area. These gates were observed by ESA staff to be locked closed. The diked Acme buffer area becomes hydraulically connected to the bay during high tides which overtop Waterfront Road and flow through the UPRR bridge. Overtopping events can lead to extended ponding in the low area to the northeast of the Acme landfill; and
- several basins in Pacheco marsh that are separated from the tidal areas by berms and access roads. These berms and roads overtop during large floods.

Flooding

Lower Walnut Creek is exposed to elevated water levels from both tidal and fluvial sources. High tide waters in Suisun Bay can propagate upstream along the Walnut Creek Channel, while fluvial flooding occurs due to high flows conveyed by the Walnut Creek and Pacheco Creek channels. Nuisance ponding due to poor drainage of storm water runoff occurs in many low-lying areas during heavy rain events, particularly in areas separated from the creek channel by levees or berms. Interviews with local landowners during stakeholder outreach indicate that the landowners are aware of the existing flood risk in the low lying areas and have adapted their operations to be compatible with occasional flooding.

Tidal Flood Elevations

The current effective FEMA Flood Insurance Study (2015) lists extreme Bay high water levels for key flood events for locations along the coast of Contra Costa County, including the project area (located at transect #34). Coastal flood stillwater elevations for the mouth of Walnut Creek are 9.4 ft for the 1% annual exceedance chance event (100-year event) and 10.4 ft for the 0.2% annual exceedance chance event (500-year event).

The 2015 FEMA Flood Maps for the project area, FEMA Maps 06013C0087G and 06013C0089G, indicate that the mouth of Walnut Creek is Zone AE. This designation indicates that the area is subject to inundation by a 100-year flood event. The FEMA-identified base flood elevation (predicted 100-year flood elevation) at the creek mouth is 10ft NAVD.

Fluvial Flood Flows

In 2008, the US Army Corps of Engineers prepared a Hydrologic Study in support of the Lower Walnut Creek General Reevaluation Report. This study evaluated the expected recurrence interval of peak flow events at various locations in the Walnut Creek watershed. **Table 4** lists the peak flow rates for key recurrence intervals estimated at the confluence of Walnut Creek and Pacheco Creek.

TABLE 4
PEAK FLOW RATES AT MOUTH OF WALNUT CREEK

Annual Exceedance Chance	*50% (1 in 2)*	*20% (1 in 5)*	*10% (1 in 10)*	*4% (1 in 25)*	*2% (1 in 50)*	*1% (1 in 100)*	*0.5% (1 in 200)*	*0.2% (1 in 500)*
Flow Rate (cfs)	6,050	12,400	16,700	20,400	26,200	31,200	36,300	43,100

Source: Table 12A, USACE 2008.

Flood Extents

The Flood Control District continues to maintain levees along the Walnut Creek and Pacheco Creek Channels, with efforts targeted to protect the most sensitive infrastructure while minimizing impacts to existing habitats.

The current effective FEMA Flood Hazard Zones for the project area at the time of this study are shown in Figure 10. This flood hazard mapping was updated on September 29, 2015 and consolidates previous mapping as of that date. The mapping is based on modeling work conducted by the Corps in the 1977 and Tudor Engineering Company in 1982. Results in some of the project area may have been updated in 1997 (by Questa Engineering Corp.), 1999 (by Michael Baker Jr., Inc.), and in 2015 (as part of the San Francisco Bay Area Coastal Study). The entire project area from Walnut Creek westward is mapped within the 100-year flood plain.

The area east of the Walnut Creek channel downstream of Waterfront Road, including the Tesoro water treatment pond, is mapped within the 100-year floodplain. Most areas along the east bank of the creek between Waterfront Road and Highway 4 are mapped outside the 100-year floodplain.

Recent hydraulic analysis conducted by the Corps and the District suggests that the FEMA map likely overestimates the extent of flooding in several areas. In particular, given the high elevation of the ACME and IT Baker landfills, it is unlikely that those areas would be inundated during a 100-year flood event. In addition, the FEMA map does not appear to reflect recent improvements made to the flood control levees adjacent to the Central Sanitary District parcels (Paul Detjens, pers. coms. July 2015).

Preliminary fluvial flood analysis conducted by the Corps and District in support of the General Reevaluation Report showed a more limited extent of the 100-year flood plain (Figure 11), however this analysis was never advanced beyond draft level. This analysis also did not consider coastal/tidal flooding, and consequently underestimates the extent of inundation near the mouth of Walnut Creek. The FEMA map indicates that the coastal/tidal flood elevation may exceed the fluvial flood elevation for the region from Suisun Bay to approximately 1000ft upstream of Waterfront Road.

ESA has conducted additional hydraulic modeling to support the Lower Walnut Creek Project. This modeling has included an updated evaluation the 100-year flood plain extent based on current site conditions, and an evaluation of the potential future flood plain extent with sea-level

rise and estimated geomorphic change in the channel and adjacent marsh. Figure 12 shows the modeled inundation extents for the 100-year fluvial flood under existing conditions, and potential future conditions with +2ft of sea-level rise. See Attachment B for a description of the methods, assumptions and uncertainties for this analysis.

Surface Water Quality

This section discusses available data describing key surface water quality parameters at Lower Walnut Creek.

Salinity – The salinity in Suisun Bay ranges from 0-25ppt (MBH 2012). Salinities in Walnut Creek are generally lower than those observed in Suisun Bay due to the freshwater inflows from Walnut Creek and its tributaries. High salinity salt pannes and scalds can be found in the poorly drained basins near the IT Baker and Acme Landfill parcels, as well as at Pacheco Marsh.

Suspended Sediment – suspended sediment concentrations in Suisun Bay typically range from 10 to 300 mg/L, with peaks as high as 1000mg/L (MBH 2012). Suisun Bay experiences elevated suspended sediment concentrations during the spring when the prevailing winds re-suspend fine sediments from the muddy shallows.

Water Temperature – The water temperature measured at Port Chicago varies from the high 40s during the winter months to the low 70s during the late summer.

Contaminants – The Contra Costa Clean Water Program produces an annual Urban Creek Monitoring Report as a condition of the Municipal Regional Permit for urban stormwater issued by the Regional Water Quality Control Board. The most recent report, for water year 2014, indicates that toxicity tests conducted on wet weather samples collected at Grayson Creek approximately 1.5 miles upstream of the project site exceeded water and sediment toxicity parameters (CCCWP, 2015). Pyrethroid pesticides were identified as the likely cause of this toxicity.

Contra Costa County has defined TMDLs for mercury and PCBs, however neither of these contaminants are known to occur in elevated concentrations at the project site (Paul Detjens, pers. coms. June, 2015).

Groundwater Hydrology

Groundwater data are available for part of the project area, in the vicinity of the Acme Landfill. Acme Landfill produces a bi-annual water quality monitoring report describing surface and groundwater conditions on the Acme parcels to satisfy requirement specified by the Regional Water Quality Control Board (RWQCB). The most recent available report is for the Sumer and Fall of 2014, for the North and East landfills. According to the Summer-Fall 2014 Acme Water Quality Monitoring Report, groundwater in the underlying Young Bay Mud and Old Bay Mud layers exhibits lateral flow away from the centers of the North and East landfills. Deeper groundwater, within the Panoche Formation Bedrock, flows from the northwest to southeast, in the same general direction as surface flows.

Acme operates groundwater wells for leachate extraction. The Acme water quality monitoring report describes current leachate extraction operations as follows:

> "Leachate is currently being removed for the North Parcel and East Parcels, processed through the leachate treatment plan, and discharged to CCCSD under terms of a Special Discharge Permit."

Annual leachate extraction rates at the Acme Landfill vary, ranging from 3 million to 12+ million gallons per year. Leachate extraction rates at the IT Baker and Vine Hill parcels are not available to the project team at this time.

3.8 Biological Resources

This section describes the biological and ecological communities found within the project area. The project area is comprised of a fluvial, tidal, and non-tidal system that supports an array of wetland habitats. These habitats include brackish tidal marsh within the Lower Walnut Creek channel and non-tidal and muted tidal wetlands located behind flood control levees and on poorly-drained parts of Pacheco Marsh. Upland habitat occurs along levee embankments, along landfill margins, and within well-drained parts of Pacheco Marsh where dredged material has been placed.

Potential Jurisdictional Wetlands and Waters

The extent of wetlands within the project area, including "Jurisdictional Weltands" and "Waters of the United States" were mapped in January 2017 and are shown in Figure 13. Tidal waters in the project area include Walnut Creek, Pacheco Creek, and small tidal channels within the tidal marsh. Non-tidal wetlands, including scalds and seasonal ponds occur across large areas of the diked marsh areas on the South, Middle and North Reaches and in upland depressions on Pacheco Marsh.

Plant Communities and Wildlife Habitats

The project area contains coastal brackish marsh, considered a sensitive natural community by California Department of Fish and Wildlife (CDFW). Brackish tidal marsh and its associated habitats provide habitat for a wide variety of plant and wildlife species. **Table 5** shows the different habitat types and acreages within the project area (Jones & Stokes, 2005a). These habitat types are also described below.

TABLE 5
HABITAT TYPES AND ACREAGES WITHIN THE LOWER WALNUT CREEK PROJECT AREA

Habitat Types[1]	Acres[2]
Tidal Emergent Marsh (Low Marsh)	95
Tidal Alkali Wetland (Mid/High Marsh)	62
Pickleweed Marsh (Diked Marsh)	40
Pond (Diked Marsh)	< 0.1
Scald (Diked Marsh)	11
Seasonal Wetland (Diked Marsh)	7
Seasonal Wetland - Alkali Wetland Complex (Diked Marsh)	31
Stream Channel (Subtidal and Intertidal Mudflat)	66
Annual Grassland/Ruderal (Upland/Transition)	34

[1] Habitat types as mapped by Jones & Stokes (2005), with habitat types from the Suisun Marsh Plan (U.S. Bureau of Reclamation, 2013) shown in parentheses. Note that for this project we use the term "diked marsh" to better reflect site conditions, rather than "managed marsh" per the Suisun Marsh Plan.
[2] Includes only areas mapped by Jones & Stokes in 2005, not the entire Project Area

Brackish Tidal Marsh

The brackish tidal marsh within Lower Walnut Creek is typical of brackish tidal marsh in Suisun Bay and contains low, mid, and high marsh. A typical tidal brackish marsh profile is shown in Figure 14. Elevation and vegetation transect surveys were completed by ESA from upland to the edge of vegetation within low marsh at Lower Walnut Creek. The elevations where the most common vegetation was found along the elevation transects is represented in Figure 15.

Low marsh, or tidal emergent wetland, consists of the marsh directly adjacent to Lower Walnut Creek. Low marsh generally occurs between elevations 2.1 and 5.5 ft NAVD, or approximately MLLW +1 ft to MHW, according to typical vegetation elevation zones in Suisun Marsh (SMP 2013). Vegetation within Lower Walnut Creek is consistent with these typical zones according to elevation and vegetation transect surveys completed by ESA for the project.

Typical vegetation within the low marsh zone includes California bulrush (*Schoenoplectus californicus*), common bulrush (*S. acutus*), and broad-leaf cattail (*Typha latifolia*). These species occur more frequently and in higher density between 2.9 and 5.5 ft NAVD within the project area. Although these plants also occur below 2.9 ft NAVD, with isolated plants found as low as 2.0 ft NAVD, the plant cover at these low elevations is typically lower and more of the area is covered by mudflat.

Mid Marsh and high marsh, or tidal alkali wetland, is inland of the low marsh and occurs over a large area from the mouth of Walnut Creek to Waterfront Road. South of Waterfront Road only narrow bands of mid marsh and high marsh exist. Mid marsh generally occurs between 5.5 and 6.2 ft NAVD, or between MHW and MHHW. Two species that generally occur within the mid marsh, but also occur into low marsh include bulrush (*Bolboschoenus* spp.) and common reed (*Phragmites australis*).

Common reed has expanded over the years at the project site and tends to grow in circular clumps (Google Earth 2002-2015). The invasive form of common reed is assumed present in Suisun and the Delta, identified as a non-native genetic variant which is contributing to the rapid expansion observed in some marshes (Cal-IPC 2008). Common reed occurs within the mid and upper elevation range within the low marsh (3.5 – 5.8 ft NAVD) at the project site.

High marsh generally occurs between elevation 6.2 and 7.2 ft NAVD, or between MHHW and Extreme HHW. Vegetation within the high marsh zone at Lower Walnut Creek is dominated by native pickleweed (*Salicornia pacifica*) and invasive perennial pepperweed (*Lepidium latifolium*). These species also occur and can be dominant species within the mid marsh zone. Other species co-occur with these dominant species in the mid marsh zone including fat-hen (*Atriplex prostrata*). Many other species are found at the upper elevations of the high marsh and at the edge of the transition zone including salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and gumplant (*Grindelia stricta*).

Plant diversity is greater in the mid and high marsh than in the low marsh within the project area. Some other native species encountered intermittently within the mid or high marsh include western goldentop (*Euthamia occidentalis*), salt marsh baccharis (*Baccharis glutinosa*), and marsh fleabane (*Pluchea odorata*).

Although the high marsh has a diversity of native species, perennial pepperweed is a highly invasive plant within the low marsh, mid marsh, high marsh, and transition zones and is known to exclude native species. Perennial pepperweed has been shown to reduce cover of rare endemic plant species in other brackish tidal marshes where they co-occur (Fiedler et al. 2007). Perennial pepperweed is difficult and expensive to control and is best managed during initial invasion (Reynolds and Boyer 2010).

Tidal marshes support a diversity of wildlife species including special-status species. Common species seen on site during field surveys include: Suisun song sparrow (*Melospiza melodia maxillaris*), great egret (*Ardea alba*), marsh wren (*Cistothorus palustris*), barn swallow (*Hirundo rustica*), and red-winged blackbird (*Agelaius phoeniceus*). Other wildlife species that typically inhabit brackish tidal marshes include foraging waterfowl and shorebirds, as well as special status species such as salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), Ridgway's rail (*Rallus obsoletus*), California black rail (*Laterallus jamaicensis coturniculus*), and salt marsh harvest mouse (*Reithrodontomys raviventris*).

Non-Tidal Wetlands

Non-tidal wetlands occur throughout the project area and include the following habitat types: pickleweed marsh, seasonal wetland, seasonal wetland - alkali wetland complex, scald, and pond. These include areas of diked marsh where historic tidal wetlands have been disconnected from tides by the construction of berms or levees. Non-tidal wetlands can also occur in supra-tidal areas with suitable drainage and soil conditions.

Some of the non-tidal wetlands contain large barren areas devoid of vegetation while others contain dense, monotypic stands of common pickleweed. With a slight increase in elevation,

pickleweed intergrades into areas composed of an assortment of hydrophytic species including perennial pepperweed, saltgrass, alkali heath, fat-hen, brass buttons (*Cotula coronopifolia*), and rabbitfoot grass (*Polypogon monspeliensis*).

Non-tidal wetlands support a wide range of wildlife species. Species observed on site during field surveys include: norther harrier (*Circus cyaneus*), white-tailed kite (*Elanus leucurus*), and killdeer (*Charadrius vociferus*). Other common wildlife species that commonly occur within diked marsh include California vole (*Microtus californicus*), foraging great egret and great blue heron (*Ardea herodias*), and foraging shorebirds in the winter when standing water is present.

Upland/Transition

Upland, or annual grassland/ruderal habitat, occurs along levees throughout the project area and at some higher elevation areas within the marsh. The majority of the upland habitat is dominated by non-native herbaceous vegetation. Plant species that are common to this upland/transition habitat include annual non-native grasses, perennial pepperweed, black mustard (*Brassica nigra*), and wild radish (*Raphanus sativus*). Native coyote brush (*Baccharis pilularis*) is also scattered throughout the upland habitat and some patches of creeping wild rye (*Elymus triticoides*) exist. The upland areas contains many other invasive species including iceplant (*Carpobrotus edulis*), stinkwort (*Dittrichia graveolens*), bull thistle (*Cirsium vulgare*), and yellow star thistle (*Centaurea solstitalis*).

Transitional vegetation provides refuge habitat for wildlife during high tide events. Common upland wildlife species seen during field surveys include black-tailed jackrabbit (*Lepus californicus*) and mourning dove (*Zenaida macroura*). Other common wildlife species likely to occur within upland habitat include California vole, desert cottontail (*Sylvilagus auduboni*), western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), and western meadowlark (*Sturnella neglecta*).

Aquatic and Intertidal Mudflat

Subtidal habitat occurs in Suisun Bay and within the Lower Walnut Creek and Pacheco Creek channels. Subtidal channel habitats occur below the elevation of 1 ft NAVD (MLLW) where the substrate is continuously submerged. Intertidal mudflat includes intertidal areas where it is not continuously submerged and also has no vegetation. Intertidal mudflat occurs upslope of the subtidal areas and in numerous smaller tidal channels within the project area.

Tidal channels serve an important function of water conveyance and drainage onto and off of mudflat and marsh surfaces as well as the transfer of sediment and nutrients between the marsh and Lower Walnut Creek. Many of the small tidal channels onsite are naturally sinuous; however there are also numerous mosquito ditches (linear human-constructed channels).

Lower Walnut Creek and the other subtidal channels are used by a variety of bird species for foraging including diving and dabbling ducks and egrets and herons. Fish species likely to occur within the project area include Sacramento sucker (*Catostomus occidentalis*), inland silverside (*Menidia beryllina*), threespine stickleback (*Gasterosteus aculeatus*), and common carp

(*Cyprinus carpio*). Very little intertidal mudflat occurs within the project area. However, this area along channels provides important foraging areas for shorebirds, egrets, herons, and Ridgway's rail.

Special Status Species

For purposes of this assessment, "special status species" include plants and animals listed, proposed for listing, or candidates for listing as threatened or endangered under the Federal Endangered Species Act (FESA) or the California Endangered Species Act (CESA); animals listed as "fully protected" under the California Fish and Wildlife Code (Section 3511); animals designated as "species of special concern" by the California Department of Fish and Wildlife (CDFW); and plants ranked as rare or endangered by the California Native Plant Society (CNPS).

The potential for the site to support special-status plant and wildlife species is discussed below. A map of all CNDDB occurrences within 2 miles of the project area is shown in Figure 16. In addition to site reconnaissance surveys, background information was gathered to determine the potential for special-status species to occur on the project site. The information reviewed included the following:

- California Natural Diversity Database (CNDDB)
- Final Delineation of Waters of the United States, Including Wetlands, for the Lower Walnut Creek Channel Restoration Project, 2005 (Jones & Stokes, 2005a)
- Botanical Report for the Lower Walnut Creek Channel Restoration Project, (Jones & Stokes, 2005b)
- Pacheco Marsh Restoration Wetland Technical Assessment, (H.T. Harvey, 2003)
- Data Summary Report for Baseline Surveys of Anadromous Fish Habitat on Lower Walnut Creek, (Jones & Stokes, 2004)
- Data Summary Report for Chinook Salmon Spawning Escapement and Fry Emergence in Lower Walnut Creek, (Jones & Stokes, 2007)

Special Status Plants

On August 6, 2015, ESA ecologists Stephanie Bishop and David Rodriquez conducted a reconnaissance-level field survey for special status plant species and visited locations where special status plants were observed in 2005. Suisun marsh aster (*Symphyotrichum lentum*), delta tule pea (*Lathyrus jepsonii*), and Mason's lilaeopsis (*Lilaeopsis masonii*) were the three special status plant species observed in 2005 within the tidal marsh. Suisun marsh aster was the only special status plant observed during field surveys in 2015. It was observed in the same general locations where it was found in 2005 as well as an additional location. In most locations Suisun marsh aster co-occurred with pickleweed and perennial pepperweed. A full botanical survey was not performed so additional populations of Suisun marsh aster or other plant species may occur within the project area. Figure 16 shows all CNDDB rare plant occurrences within two miles of the project site.

Special Status Wildlife

On August 6 and September 15, 2015, ESA ecologists Stephanie Bishop and David Rodriguez conducted a reconnaissance-level field survey for special status wildlife species and their associated habitat on the project site. The survey method involved hiking, canoeing, and driving the project area.

Salt marsh harvest mouse habitat occurs where there is pickleweed, which includes the high marsh and diked marsh within the project area. California black rail and Ridgway's rail habitat occurs throughout the low marsh and high marsh within the project area. CNDDB occurrences have been recorded within the project area for six special status wildlife species listed in **Table 6**.

TABLE 6
SPECIAL-STATUS WILDLIFE SPECIES WITH CNDDB OCCURRENCES WITHIN THE PROJECT SITE.

Common Name	***Scientific Name***	***Federal Listing***	***State Listing***
salt marsh harvest mouse	*Reithrodontomys raviventris*	Endangered	Endangered
Ridgway's rail	*Rallus obsoletus*	Endangered	Endangered
California black rail	*Laterallus jamaicensis coturniculus*	None	Threatened
Suisun song sparrow	*Melospiza melodia maxillaris*	None	Species of Special Concern
saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*	None	Species of Special Concern
longfin smelt	*Spirinchus thaleichthys*	Candidate	Threatened

Source: CDFW, 2015.

Nesting white-tailed kite is a California Department of Fish and Wildlife (CDFW) fully protected species and nesting northern harrier is a CDFW species of special concern. Both species were observed foraging on site, but no nest surveys were completed. Suisun song sparrow was also observed on site during field surveys. No other special-status wildlife species were observed during field surveys. Figure 16 shows all CNDDB special status wildlife occurrences within 2 miles of the project site.

Several salmonid surveys and habitat suitability studies have been completed within Walnut Creek upstream of the project area in the non-tidal reaches. Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss irideus*), both federally threatened, have been observed upstream of the project site within Walnut Creek and Grayson Creek (Jones & Stokes 2004, 2007). The aquatic areas within the project site may provide habitat for longfin smelt and migration habitat for chinook salmon and steelhead. The project site is not known to provide spawning or rearing habitat for chinook salmon or steelhead (Jones & Stokes 2004, 2007).

3.9 Public Access

There is currently no public access through the project area except for Waterfront Road, however regional trail network plans have proposed several potential future trail connections passing through or near the project area.

Figure 17 shows trails within the vicinity of the project area. Regional trail plans identify potential future trail within the project area, including the extension of the existing Iron Horse Trail to the project site and a future trail connector from the project site to the Bay Trail. The Iron Horse Trail is managed and maintained by the EBRPD and the Bay Trail is managed by the Association of Bay Area Governments (ABAG). Both trails are multimodal, allowing for bicycle and pedestrian access. In addition, the Iron Horse Trail allows equestrian use. The San Francisco Bay Area Water Trail (Coastal Conservancy) includes a vision for small-craft boat launch or landing sites around the Bay. Walnut Creek is not included in the Water Trail vision map but is located between proposed launches into Suisun Bay, at Martinez and Bay Point Regional Shoreline. There are currently no landing or launch sites along Walnut Creek or Pacheco Creek.

3.10 Cultural Resources

In 2015 ESA performed background research to assess the expected sensitivity of the project site to prehistoric archaeological resources. This investigation was conducted to support compliance with the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

A search of historic records indicates no previous identified cultural resources within the project area. There are six recorded cultural resource sites within the vicinity of the project area. Additional information on these nearby cultural resources has been provided to the District in a confidential memorandum (Koenig). The geological context of the site, which is predominantly fill placed over bay mud, provides an unlikely setting for the discovery of pre-historic archaeological resources as these areas were either fully or periodically submerged during the per-historic period. These findings have not yet been confirmed by a field survey.

3.11 Future Conditions

In the future, conditions at the project area will be subject to rising sea levels and geomorphic change (sedimentation and erosion) in the Walnut Creek channel and adjacent marshes. This section address future changes generally, with additional discussion and analysis in Chapter 6 and Attachment C.

Sea-Level Rise

Tide elevations are anticipated to increase over time due to rising sea levels. The rate of future sea-level rise is uncertain; however projections by the National Resources Council suggest that 0.4 to 2.0 feet of sea-level rise may occur by 2050 and 1.4 to 5.4 feet by 2100 relative to 2000 sea levels (NRC 2012). Rising sea levels will increase the frequency of inundation in low-lying

coastal areas, and will alter the downstream tailwater elevation for coastal creeks, potentially increasing upstream water levels during large streamflow events.

Sediment Deposition and Marshplain Accretion

Lower Walnut Creek has experienced a high level of sediment deposition based on the combined sediment inputs from the creek watershed and estuarine deposition (SFEI 2016). Over time, subtidal and intertidal areas are expected to aggrade due to sediment deposition and, where vegetation exists, due to the accumulation of plant material. The rate of aggradation may keep pace with sea-level rise initially, but is expected to fall behind as sea-level rise accelerates over time (Stralberg, et al. 2011). Current research suggests that the San Francisco Bay may be transitioning to a period with lower over-all sediment supply as excess sediment that was introduced due to gold rush-era mining techniques are flushed out of the watershed.

Coastal Shoreline Erosion

A review of aerial photos shows that the edge of vegetated marsh along the Suisun Bay shoreline at the mouth of Walnut Creek eroded by approximately 50ft between 1987 and 2016 (after having migrated 500-800 feet into the bay between 1939 and 1987). This rate will tend to increase with accelerated sea-level rise and declining regional sediment supply. The northern limit of the project area is located approximately 1000 feet inland of the Suisun Bay shoreline, so is unlikely to be directly subject to coastal erosion for many decades.

Channel Scour

Since the construction of the Lower Walnut Creek flood control channel in 1962, the geometry of the creek channel has changed drastically as sediment accumulated and filled large sections of the creek channel. A review of historic cross sections collected along Walnut Creek indicates that the creek channel has evolved in a manner that is consistent with observed geomorphic relationships for tidal and fluvial channels (Williams et al. 2002; Colins & Leventhal, 2013). We assume that over time the depth and cross section area of the creek channel will tend towards the geomorphically stable dimensions predicted by either tidal or fluvial hydraulic geometry relationships (whichever is larger for a given reach). We expect that the channel evolution will be a punctuated equilibrium process, with the relatively steady tidal scour and deposition processes punctuated by infrequent episodes of intense erosion and deposition during large streamflow events.

CHAPTER 4
Alternatives Development

The project team – the District and ESA – began the alternatives development process by identifying project constraints, considerations and "measures." Measures are potential actions that can be implemented to help achieve the project goals and objectives. The initial list of measures was screened to remove those considered too costly or infeasible. The team then worked to identify desirable combinations of the remaining measures to form the project Alternatives (presented in Chapter 5).

4.1 Constraints and Considerations

Constraints are absolute restrictions on the performance of alternatives, such as the requirement to provide for appropriate flood protection, while considerations allow for some flexibility. Project planning constraints and considerations were developed based on site conditions (Chapter 3) and conversations with adjacent landowners and other stakeholders. Constraints and considerations are described below.

Infrastructure

The following existing infrastructure will need to be protected from construction-related impacts (and flood-related impacts, discussed separately below). This infrastructure is shown on Figure 2.

South Reach

- Contra Costa Water District "Shortcut Pipeline" – CCWD requires access to settlement monitoring locations (two on District Lands)
- BNSF railroad
- Overhead PG&E power lines
- Unmapped Chevron petroleum products pipeline located in easement coincident with or adjacent to PG&E utility easement

Middle Reach

- Groundwater quality monitoring and compliance wells at the Acme Landfill – to be protected and accessible for seasonal observations.
- UPRR railroad
- Storm water retention at Acme Landfill

- Acme Landfill perimeter access road
- Overhead PG&E power lines

North Reach

- Central Sanitary District Outfall and Access Road
- Plains Products Pier pipeline and road
- Waterfront Road pipelines

Note that additional unmapped subsurface utilities may exist in the project area. The project team continues to coordinate with local utilities and infrastructure operators to identify and document unmapped infrastructure within the project area.

Biological Resources

To protect existing biological resources, the project seeks to avoid or minimize impacts to existing wetlands and sensitive species, where possible.

Compatibility with Future Trail Projects

The District is coordinating with the EBRPD and the John Muir Land Trust to ensure consistency of the Project with proposed trails and public access, to the extent possible. The alignment of the proposed EBRPD trail through the project area was refined by EBRPD during the course of the restoration planning process and remains preliminary. The District seeks to the maintain flexibility to accommodate future trail alignments in those locations considered reasonably likely.

Collaboration with Potential Projects by Third Parties on Adjacent Parcels

Conco Inc. proposes the development of equipment storage and maintenance facilities on the parcels to the west of Walnut Creek in the South Reach. Conco proposes placement of fill to create access roads and flat work/parking areas. The District has been coordinating with Conco to understand the proposed project and explore opportunities for integrating the proposed Conco grading with the South Reach restoration alternatives. South Reach Alternative 3 was developed as a result of this coordination.

Flood Protection

The project must maintain an appropriate level of flood protection to adjacent and upstream properties. The District has met with adjacent landowners to understand existing flooding concerns and define appropriate levels of flood protection.

The levees along Walnut Creek and Pacheco Creek downstream of the BNSF Railroad Bridge are expected to overtop during major flood events. These levees are estimated to overtop during the ~25 year fluvial flood event, and overtopping at both the Conco and Acme levees was observed during the December 2006 Flood, an estimated 40-year flood event.

The levee overtopping into the disconnected basins on the South and Middle Reaches provides a critical flood protection function. When these levees over-top, a large volume of floodwater is diverted from Walnut Creek, resulting in a significant reduction in the peak water level along the Middle and North Reaches and upstream of the BNSF Railroad during large floods.

Land uses within the disconnected basins along the Middle and South Reaches are understood to have a low sensitivity to inundation during large flood events. Facilities at the Conco yard and Acme Landfill have been designed to be flood tolerant.

Similarly, we understand that the Tesoro facilities located within the FEMA floodplain on the Middle and North Reaches have been designed to tolerate infrequent inundation (pipelines and parking areas) or are protected by flood protection infrastructure that is maintained by Tesoro (wastewater pond).

The Central Contra Costa Sanitary District waste water treatment plant, including the retention pond facilities, are highly sensitive to flooding and must be protected in order to prevent the discharge of untreated wastewater into the Bay. We understand that the District has recently made improvements to the existing levees and berms which protect the treatment plant and ponds, and that the District and Sanitary District intend to make additional improvements to these berms and levees as needed to protect the treatment plant from flooding during severe storms.

Waterfront road currently becomes inundated and hazardous to drive along during king tide events. The road's owner, Contra Costa County, currently has no plans or funding to address the inundation of Waterfront Road.

District Maintenance Access

The District requires an access corridor along the Walnut Creek and Pacheco Creek channels to support ongoing operations and maintenance. Currently the District's maintenance access is along the existing flood control levees.

Acme Landfill Stormwater Retention

The Acme Landfill is required to prevent runoff from their landfills from flowing into tidal waterways. Currently the Acme Buffer Area, a low-lying basin located along the northern, eastern and southern boundary of Acme's east landfill, provides retention for runoff from the landfills. Any project alternatives which alter the Acme Buffer Area must continue to provide appropriate storm water diversion and retention facilities at the Acme Landfill.

4.2 Project Measures

The initial plan formulation process consisted of identifying a broad array of potential measures to address the planning objectives and conducting initial screening of those measures. The screening was based on technical, economic, and environmental considerations. As described above, a "measure" is a feature or an activity that addresses one or more planning objectives. Measures are the building blocks for the alternatives. **Table 7** lists the potential project measures

and identifies those recommended for consideration in the alternatives (screening results). Not all recommended measures were eventually included in the final alternatives.

The project team conducted a preliminary screening of the potential project measures to eliminate measures considered too costly or unlikely to be feasible. The remaining measures were considered in developing the final alternatives presented in Chapter 5. Note that not all measures remaining after screening were incorporated into the final alternatives.

TABLE 7
POTENTIAL PROJECT MEASURES

Potential Design Measures	Project Objectives: Restoration	Project Objectives: Appropriate Flood Protection	Project Objectives: Public Access & Recreation	Project Objectives: Sustainability	Recommended for consideration in alternatives?
Expansion of Project Area through acquisition of easements or fee-title via mutual agreement with landowner(s)	x		x	x	Yes
Re-introduce tides to disconnected basins by removing existing barriers to tidal action	x			x	Yes
Construct new tidal channels	x			x	Yes
Preserve and enhance existing uplands to create desirable ecotones	x			x	Yes
Targeted grading to create new tidal wetlands and/or transition zones	x			x	Yes. Target areas that best enhance habitat connectivity and/or complete ecotones.
Develop habitat plan that enhances regional ecological connections	x				Yes
Re-vegetate with native species	x			x	Yes
Invasive species management and/or removal	x				Yes
Long-term re-use of treated wastewater for irrigation and treatment (Central Contra Costa Sanitary District, CCCSD)	x				No. Preliminary feedback from CCCSD indicates that the they are not prepared to make major changes to the outfall pipe at this time. The District will continue to coordinate with CCCSD to explore potential future opportunities for beneficial re-use of treated wastewater. Short-term re-use of treated wastewater may be possible, i.e. for dust control and irrigation to support re-vegetation efforts.
Dredge Walnut Creek channel to increase flood conveyance		x			Large-scale dredging - No. Would require significant, unavoidable impacts to protected habitats, high cost, and only provides short-term benefits. Targeted dredging - Yes. Must be limited in scale/volume.
Levee setbacks to increase connectivity to floodplain	x	x			Yes

TABLE 7 (Continued)
POTENTIAL PROJECT MEASURES

Potential Design Measures	Project Objectives: Restoration	Project Objectives: Appropriate Flood Protection	Project Objectives: Public Access & Recreation	Project Objectives: Sustainability	Recommended for consideration in alternatives?
Promote flood-tolerant land uses within existing and future floodplain		x			Yes
Raise elevation of existing District flood protection levees in place		x			No. Does not achieve restoration goal. Note that increasing levee elevations through the project reach would reduce flows into off-channel storage basins (onsite), which would result in unacceptable increases in flood levels upstream.
Raise elevation of existing transportation infrastructure (Waterfront Road, rail roads)		x			No. Outside the scope of this project.
Maintain off-channel storage basins. Enhance diked wetlands with muted tidal flow or active water management		x			No. The District is not able to commit to the active maintenance obligations necessary to operate managed habitat ponds.
Set aside alignment for potential future expansion of public trails through project area			x		Yes
Identify opportunities for the integration of public access and education amenities including interpretative elements, staging/parking areas, restrooms, etc.			x		Yes

CHAPTER 5
Final Alternatives

This section presents the final alternatives identified through the collaborative planning process. The Project area was divided in to three reaches – the South Reach, Middle Reach and North Reach (Figure 1) – with alternatives developed for each reach. The final suite of alternatives consist of three alternatives for the South Reach, three for the Middle Reach and two for the North Reach. In addition, a Without Project Alternative was defined for each reach. All alternatives, With and Without-Project, are described for existing and future conditions.

Table 8 provides a summary of the primary project measures proposed for each alternative. The alternatives are shown graphically in Figure 18 through Figure 23. Additional descriptions for each of the proposed alternative are provided in the sections below.

For the South and Middle Reaches, the alternatives reflect different approaches to reintroducing the tides to existing diked (non-tidal) former baylands, constructing new setback levees for flood protection of adjacent industrial lands, and accommodating potential future public access. In the North Reach, part of the restorable area has been filled due to past use for aggregate handling and processing. Both North Reach alternatives including reintroduction of the tides to existing diked former baylands and mass grading of the previously-filled areas to restore appropriate elevations for tidal wetland establishment. The North Reach alternatives reflect different relative extents of restored tidal marsh, transitional habitat and upland area. Project alternatives were compared and evaluated based on their ecological benefits, flood protection performance, consistency with potential future trail locations, and overall ecological sustainability and consistency with ongoing natural processes.

Note that while the names of the alternatives are often spelled out in full (e.g., South Reach Alternative 1), we sometimes abbreviate them with a reach letter-alternative number code (e.g., Alternative S1).

TABLE 8
PROJECT ALTERNATIVES SUMMARY

Project Elements	South Reach			Middle Reach			North Reach	
	Alt S1	**Alt S2**	**Alt S3**	**Alt M1**	**Alt M2**	**Alt M3**	**Alt N1**	**Alt N2**
	Breach and maintain levee in place	Breach and setback levee on District property	Breach and setback levee to maximize restoration	Breach and maintain levee in place	Breach and setback levee with public access	Breach and setback levee with public access elsewhere	2004 Pacheco Marsh Plan	Revised Pacheco Marsh Plan
Re-connect diked areas to tidal inundation	●	●	●	●	●	●	●	●
Preserve existing levees, install new bridges or culverts	●			●				●
Lower existing berms/levees (all or part)		●	●		●	●	●	●
Mass grading to remove artificially-placed fill and restore tidal wetlands							●	●
Excavate new tidal channels	●	●	●	●	●	●	●	●
Construct new setback levee	●	●	●	●	●	●		
Revegetate (seeding, planting and irrigation) along transition and upland areas	●	●	●	●	●	●	●	●
Invasive plant management	●	●	●	●	●	●	●	●
Expand project area through easement or land Acquisition			●	●	●	●	●	●
Facilitate Public Access Amenities	●	●	●	●	●	See text	●	●
Potential Future Public Access Amenities (by Others)								
Trail Paving and Fencing	●	●	●	●	●	See text	●	●
Interpretive Signage	●	●	●	●	●	See text	●	●
Parking/Staging Area/Restrooms							●	●
Kayak Launch								●

● = Lower Walnut Creek Project Element

● = Potential Future Project Element (by Others)

5.1 Without-Project Alternative (All Reaches)

The Without-Project Alternative is included for comparison with the Project Alternatives in each reach. In the Without Project Alternative, there are no major improvements to the District levees. The District continues ongoing maintenance of the existing levees and drainage structures.

The Future Without Project Alternative assumes the existing flood protection infrastructure in the project area is maintained as-is. This is consistent with current District plans, as there are no plans to raise levees downstream of the BNSF railway in response to sea-level rise. The Future Without-Project alternative assumes that no significant dredging efforts occur.

In the Future Without-Project Alternative scenario, changes will occur as a result of ongoing natural processes. Sea-level rise will result in a steady increase in tide elevations. Lower Walnut Creek will continue to fill with sediment to some more geomorphically-stable configuration. Sediments will continue to accumulate in the tidal marshes and creek floodplains. According to our assessment, the combined effect of these changes will be an increase in flood elevations in the lower reaches of Walnut Creek over time. Over time the level of flood protection provided by existing berms and levees will decline, and vulnerable areas will be subject to more frequent inundation. See Attachment C for additional discussion of projected future conditions.

In the near term we anticipate that existing diked marsh areas will continue to function as degraded seasonal wetlands. In the medium to long-term, ponding in the diked marsh areas will increase in depth and frequency as groundwater levels rise and surface drainage becomes less effective due to increased water levels in the downstream tidal waterways. Unlike the marsh areas that are connected to the creek channel, the diked marshes will not accumulate sediment over time. These diked marsh areas will become more difficult to restore to tidal wetlands as sea-levels rise.

5.2 South Reach

The South Reach extends from the BNSF Railroad embankment to the confluence of Walnut Creek and Pacheco Creek. Along this reach the District owns a ~500 foot wide strip of land along the west bank of Walnut Creek, approximately 300 feet of which is behind the existing flood control levee. The District owns a narrower strip of land along lower Pacheco Creek. Between Walnut Creek and Pacheco Creek are several parcels owned by Conco Inc. which are planned to be used as a contractor's yard. Also to the west is a closed hazardous waste landfill (formerly the "IT Baker" landfill).

The South Reach alternatives reflect different approaches to reintroducing the tides to existing diked (non-tidal) former baylands, constructing new setback levees for flood protection of adjacent industrial lands, and accommodating potential future public access. The project team developed three alternatives for the South Reach, as shown in Figure 18 and Figure 19, and described in the sections below.

The following project elements are common to all three restoration alternatives on the South Reach:

- Re-connect the existing non-tidal wetlands located on the District's (and potentially Conco's) property to tidal inundation by breaching or lowering potions of the existing flood control levees along Walnut Creek and Pacheco Creek.
- Excavate new channels to enhance tidal connectivity to the reconnected tidal wetland areas.
- Establish transitional ecotone habitats in areas where ground elevations are above typical tides but subject to periodic inundation due to extreme tides and/or creek flows.
- Manage non-native invasive vegetation on uplands and in existing wetland areas.
- Preserve a corridor for District access for levee inspection and maintenance.
- Provide a corridor for the future construction of a recreational trail along the west side of Walnut Creek.

Alternative S1: Breach and maintain levee in place

Alternative S1 provides a tidal connection to the disconnected basins, providing habitat benefits while preserving the District's maintenance access along the existing flood control levee. This alternative was developed as a means of preserving District and public access as close to the creek channel as possible. It was also considered as a potentially lower cost option, as keeping the District and public access on the existing levee could allow for the construction of a narrower setback levee and would avoid the costs of de-constructing the existing levee.

Alternative 1 proposes to restore tidal connectivity to the disconnected basin on the District's parcel by installing several breaches or large culverts through the existing flood control levee. The existing access road would be preserved along the levee crest, which would provide operations and maintenance access for the district and could serve as a future public access corridor.

If breaches are used, rather than culverts, bridges would be included to maintain vehicle access along the levee. The construction of new bridges is anticipated to be more costly than culverts. However, bridges may require less maintenance than culverts (which are prone to sedimentation and blockage by debris) and would provide slightly better ecological and hydraulic connectivity. We assume the use of culverts for the alternatives evaluation in Chapter 6.

Alternative S2: Breach and setback levee on District property

Alternative S2 is formulated to maximize the area of restored habitat while keeping all construction on District-owned property. Alternative 2 proposes to restore tidal flows to the disconnected basin by breaching and partially lowering the existing flood control levee. Parts of the existing levee would be lowered to create new tidal wetlands and parts would be kept high to provide transitional and upland habitats. A new setback levee would be constructed along the west side of the District's parcel. An access road would be constructed along the new setback levee to serve as the District's future maintenance access. This roadway could also be improved to provide public access through this reach as part of a future project.

Alternative S3: Breach and setback levee to maximize restoration

The District is currently in negotiations with Conco Inc. to potentially expand the restoration project area to include a narrow strip of property (approximately 4.5 acres) owned by Conco along the border with the District property. If these negotiations are successful, the District could pursue Alternative S3, which would allow for a new setback levee to be constructed on the Conco property.

Alternative S3 is formulated to maximize the area of restored habitat by incorporating the new setback levee into the proposed grading on Conco's property. Like Alternative S2, Alternative S3 proposes to restore tidal flows to the disconnected basin by breaching and partially lowering the existing flood control levee. Parts of the existing levee would be lowered to create new tidal wetlands and parts would be kept high to provide transitional and upland habitats.

An access road would be constructed on the new setback levee to serve as the District's future maintenance access. This roadway could also be improved to provide public access through this reach as part of a future project. Conco's industrial access would be located along the inboard toe of the new levee.

Alternative S3 emerged as a variation on Alternative S2. After reviewing a preliminary mock-up of Alternative S2, Conco and the District concluded that additional habitat benefits could be realized at minimal additional expense if the new setback levee could be incorporated into the proposed grading on Conco's property. Figure 20 shows a review copy of Conco's proposed setback levee cross-section showing how the new setback levee and access road would be integrated with the Conco grading project.

5.3 Middle Reach

The Middle Reach extends from the confluence of Walnut Creek and Pacheco Creek to the Union Pacific Railroad embankment. The District maintains a flood control levee along the west banks of Pacheco Creek and Walnut Creek. Acme Landfill owns an approximately 300-ft wide strip of low-lying former tidal marsh (known as the "Acme buffer area") inboard of the flood control levee, which is currently disconnected from regular tidal action. The buffer area becomes tidally inundated during extreme high tides when tide waters overtop Waterfront Road and flow into the buffer area at a small bridge in the UPRR embankment approximately half a mile west of Walnut Creek. The buffer area provides storm water retention for runoff from the landfill as required by the landfill's operating permits.

The Middle Reach alternatives reflect different approaches to reintroducing the tides to existing diked (non-tidal) former baylands, constructing new setback levees for flood protection of adjacent industrial lands, and accommodating potential future public access. The project team developed three alternatives for the Middle reach, as shown in Figure 21 and Figure 22 and described in the sections below. The following project elements are common to all three restoration alternatives on the Middle Reach:

- Re-connect the existing non-tidal wetlands located on the District's and Acme Landfill's property to tidal inundation by breaching and/or lowering potions of the existing flood control levees along Walnut Creek and Pacheco Creek.
- Construct swales and other features to divert stormwater runoff from the landfill into non-tidal basins to the west and north of the restoration area.
- Excavate new tidal channels to enhance tidal connectivity to the reconnected wetland areas.
- Establish transitional ecotone habitats in areas where ground elevations are above typical tides but subject to periodic inundation due to extreme tides and/or creek flows.
- Manage non-native invasive vegetation on uplands and in existing wetland areas.
- Preserve a corridor for District access for levee inspection and maintenance.

Alternative M1: Breach and maintain levee in place

Alternative M1 provides a tidal connection to the Acme buffer lands, providing habitat benefits while preserving the District's access along the existing flood control levee. This alternative was developed as a means of locating public access close to the creek channel and farther away from active landfill operations.

Alternative M1 proposes to restore tidal connectivity to the Acme buffer area by installing large culverts or constructing several breaches through the existing flood control levee. Two new levee sections would be constructed at the northeast and southwest corners of the East Landfill to connect the landfill access road with the sections of the flood control levee that are to remain. The District would use these levees and the landfill's perimeter road for maintenance access. It may be necessary to improve the perimeter road by widening and raising the road surface in some locations. The existing levee would remain, with culverts or bridges crossing any breaches, to serve as a future public access corridor.

The construction of new bridges is anticipated to be more costly than culverts. However, bridges may require less maintenance than culverts (which are prone to sedimentation and blockage by debris) and would provide slightly better ecological and hydraulic connectivity. We assume the use of culverts for the alternatives evaluation in Chapter 6.

Alternative M2: Breach and setback levee with public access

Alternative M2 aims to maximize the area of restored habitat while providing for potential future public access. Alternative M2 proposes to restore tidal flows to the disconnected basin by breaching and partially lowering the existing flood control levee. Parts of the existing levee would be lowered to create new tidal wetlands and parts would be kept high to provide transitional and upland habitats. The existing private landfill perimeter access road would be improved to provide two separated access roads, one for industrial access to support landfill operations and a second for the District's maintenance access. This second (District access) alignment could be improved to provide potential future public access through the Middle Reach. District and public access would be physically separated from the landfill's access road.

Alternative M3: Breach and setback levee with public access elsewhere

Alternative 3 is a variation on Alternative 2 which emerged when it became evident that the EBRPD preliminary preferred trail alignment does not pass through the Middle Reach. This alternative is similar to Alternative M2 but does not provide public access along the Middle Reach, as such access is not necessary to accommodate the EBRPD preferred trail alignment.

Alternative M3 proposes to restore tidal flows to the disconnected basin by breaching and partially lowering the existing flood control levee. Parts of the existing levee would be lowered to create new tidal wetlands and parts would be kept high to provide transitional and upland habitats. The existing private landfill perimeter access road would be improved to provide industrial access to support landfill operations and this road would also support the District's maintenance access.

5.4 North Reach

The North Reach, also known as Pacheco Marsh, is located along the west bank of Walnut Creek between the Waterfront Road Bridge and the shore of Suisun Bay. The North Reach consists of 125 acres of land owned by the District and co-managed with the John Muir Land Trust, 92 acres of fringing marshes owned by the District, and 25 acres of adjacent property owned by the California State Lands Commission. The District would obtain a lease arrangement with the Commission to allow project actions on Commission property.

The north reach presents opportunities to re-connect existing non-tidal pickleweed wetlands to tidal inundation by lowering berms and excavating tidal channels; to enhancing transition zones and upland areas adjacent to existing marsh areas to create ecotones and provide sea-level rise accommodation; and to facilitate the creation of public access amenities, including the creation of a trail network and parking area.

The North Reach alternatives reflect different relative extents of restored tidal marsh, transitional habitat and upland area. The project team has identified two alternatives for the North reach which are shown in Figure 23 and described in the sections below. The following project elements are common to both restoration alternatives on the South Reach:

- Re-connect the existing non-tidal pickleweed wetlands located on Pacheco Marsh to tidal inundation by lowering potions of the perimeter dikes and berms.
- Excavate new tidal channels to enhance tidal connectivity to the reconnected wetland areas.
- Establish transitional ecotone habitats in areas where ground elevations are above typical tides but subject to periodic inundation due to extreme tides and/or creek flows.
- Grade targeted areas to remove artificially placed fill and create new tidal wetlands.
- Preserve and enhance existing non-tidal wetlands that are located at elevations above the existing tide range.
- Manage non-native invasive vegetation on uplands and in existing wetland areas.

- Preserve a corridor for future public trails, District access (for levee inspection and maintenance), and CCCSD maintenance access to their outfall pipe.
- Create public access amenities, potentially including a trail network, parking area, restrooms, wildlife viewing locations and water access.

Alternative N1: 2004 Pacheco Marsh Plan

Alternative 1 was developed as part of the 2004 Pacheco Marsh Plan (PWA, 2004), and includes new breaches in the existing perimeter berms and the construction of a network of new tidal channels to establish tidal connectivity to existing non-tidal wetland areas. Mass grading will be performed in some upland areas to remove fill material and return portions of the site to tidal wetland elevations. Excess fill material will be placed in existing upland areas. This alternative will preserve access along the CCCSD outfall maintenance road, and will provide opportunities for future public access trails and other amenities to be installed in partnership with the John Muir Land Trust.

Alternative N2: Revised Pacheco Marsh Plan

Alternative N2 revises the 2004 Pacheco Marsh Plan based on updated site conditions, more recent (higher) estimates for rates of future sea-level rise, and updated wetlandscience. As recommended by the Flood Control 2.0 Regional Science Advisory Team review (SFEI 2016), Alternative N2 proposes less excavation for near-term tidal wetland creation, creates more transitional habitat, and leaves more of the site as uplands compared to Alternative N1. These revisions increase the extent of refuge areas for terrestrial species during extreme high water events, and increase the sustainability of tidal wetlands with future sea-level rise by allowing room for wetland transgression. In addition Alternative N2 reduces impacts to existing seasonal wetlands compared to Alternative N1, based on updated wetlands mapping (ESA 2017 in progress).

In formulating Alternative N2, the District considered a range of grading options. On one end of the range, the District considered a greater level of grading in order to create more tidal wetlands in the near term. This additional earthwork would necessitate an increased amount of upland fill placement, reducing the quality and extents of upland transition zone habitats. On the other end of this range, the District considered a reduced level of grading in order to preserve and enhance existing upland transition zones which provide high water refuge for terrestrial species in the near term and will convert to tidal wetlands in the future. Alternative N2 is considered to provide a reasonable balance within this range. Alternative N2 minimizes impacts to existing seasonal wetlands located in upland areas (ESA 2017 in progress). The net result is a reduced area of restored tidal wetland habitat but a larger area of preserved seasonal wetlands compared to Alternative N1 and a greater potential for tidal wetland expansion as sea levels rise. Alternative N2 is subject to refinement based on future study.

5.5 Public Access – All Reaches

As noted in Section 2.2, while the District is not in a position to directly implement public access and recreational facilities, the District partners with other agencies, municipalities and organizations to provide public access on District land. For the Lower Walnut Creek Restoration Project the District has partnered with the EBRPD and the John Muir Land Trust to provide foundational infrastructure that can support future public access facilities through the project area. The District appreciates the close coordination of the EBRPD and John Muir Land Trust, whose input has helped guide the restoration planning work.

During planning for the Lower Walnut Creek Restoration Project, the EBRPD prepared a preliminary draft feasibility study for public access trail alignments through the project area (Attachment D). The proposed trail would connect the regional Iron Horse Trail and San Francisco Bay Trail. The District has endeavored to create project alternatives that are compatible with the EBRPD's preferred alignment to the extent feasible.

The EBRPD prepared a draft feasibility study evaluating potential trail alignments through the Lower Walnut Creek Area (S. Dougan, pers. coms. August 18, 2016). This study identified three potential trail alignments (Figure 24). All three trail alternatives enter the project site along the west bank of Walnut Creek via an elevated crossing structure over the BNSF railroad. All three require negotiation of an easement through the Acme Landfill property and other easements.

- EBRPD Alternative 1 proposes a trail along the new setback levee along the South Reach, across Pacheco Creek to the south of the Martinez Gun Club, west (up the hills) towards Central Avenue, and then north to Waterbird Regional Preserve.
- EBRPD Alternative 2 proposes a trail along the new setback levee along the South Reach and across Pacheco Creek approximately 1500 feet upstream of the confluence with Walnut Creek. The trail then crosses the Acme buffer and runs adjacent to the Acme access road around the perimeter of the Acme landfill before heading west to connect to Waterbird Regional Preserve.
- EBRPD Alternative 3 proposes a trail along the new setback levee along the South Reach and across Pacheco Creek approximately 1500 feet upstream of the confluence with Walnut Creek. The trail would be located on top of the existing District levee along the Middle Reach to Waterfront Road before heading west towards Pacheco Marsh. This alignment would require a large elevated crossing structure to cross over the UPRR embankment, Waterfront Road and the adjacent petroleum pipelines. EBRPD anticipates that this crossing structure would be prohibitively expensive.

EBRPD Alternative 1 was preliminarily identified as the preferred alignment for a trail connector through the project area. While Alternative 1 is the preferred alternative, Alternative 2 remains in consideration by EBRPD. The alternatives evaluation and preliminary selection has been reviewed by the Executive Committee of EBRPD's Board of Directors (S. Dougan, pers. comm.). To date, the selection of Alternative 1, with Alternative 2 remaining in consideration, represents the official position of the EBRPD based on currently available information.

We have assumed that EBRPD Alternative 1 is the most likely trail route through the project area. We understand that the preferred trail alignment has been developed only to a draft level, and will be subject to future revision. The District will continue to work with the EBRPD to refine plans for future public access through the Lower Walnut Creek Area. The greatest challenge facing both potential trail alignments (EBRPD Alternatives 1 and 2) appears to be identifying cost-effective ways to cross the BNSF railroad. The BNSF railroad crossing would likely be via an elevated pedestrian walkway. We anticipate that this structure will require an enlarged "landing" area where the new setback levee meets the BNSF embankment.

The EBRPD screened out Alternative 3 for the foreseeable future due to cost. A large overhead pedestrian walkway would also be needed to cross the UPRR tracks, Waterfront Road and the several petroleum pipelines north of Waterfront Road. The EBRPD report suggests that it may be cost prohibitive to include a crossing the UPRR tracks. At this time we assume that there will be no new pedestrian crossing over the UPRR tracks, however the District is open to exploring options for such a crossing at a future time.

The District is also partnering with the John Muir Land Trust to develop public access plans for the North Reach. Preliminary concepts for the public access on the North Reach include a parking/staging area with a restroom, a trail network with interpretive signage, and an overlook at the north end of the site. The Land Trust is also considering potential additional amenities, including a kayak launch, a covered pavilion and elevated overlook structures.

It is currently not clear if and when construction of the proposed future public access projects would occur, and the District has no control over when and whether such projects may proceed. The District encourages the EBRPD, JMLT and other interested partners to continue to participate in the Lower Walnut Creek Restoration planning process to ensure that the restoration project is compatible with anticipated future public access projects through the project area.

CHAPTER 6
Alternatives Evaluation and Selection

Project alternatives were compared and evaluated based on their ecological benefits, flood protection performance, consistency with potential future trail locations, and overall ecological sustainability and consistency with ongoing natural processes, and cost. These evaluation criteria reflect and tie directly to the project goals and objectives. The alternatives evaluation compares the Without-Project and Project alternatives, using the evaluation criteria at each reach. This section presents the alternatives evaluation methods, alternatives comparison, and the preferred alternative.

6.1 Evaluation Criteria and Methods

This section identifies the metrics used to evaluate and compare alternatives (e.g., habitat area, consistency with future public trails) and the methods used to quantify these metrics. Reach-specific results are presented in the Alternatives Comparison section below.

Habitat

Restoration performance is evaluated quantitatively by comparing the area of tidal wetland, non-tidal wetland, and remaining (non-wetland) habitat for each alternative. In general it is assumed that the greatest ecological benefits come from the restoration of tidal wetlands and preservation and creation of high-quality non-tidal wetlands. However ecological benefits are also provided by transitional and upland habitats when appropriately located on the landscape. This analysis also includes a qualitative assessment of benefits such as enhanced habitat connectivity and tidal connectivity.

Flood Protection

The level of flood protection performance provided by the with-project alternatives is evaluated using modeled flood water levels compared to without project conditions. Alternatives are compared based on the relative change in water levels and the change in extents of inundation. Evaluation focuses on the 1% (100-year) flood event, though more frequent large events such as the 10% (10-year) event are also considered.

Flood modeling uses the HEC-RAS 2D hydrodynamic model. The project team developed four test cases that provide representative results for likely combinations of alternatives at each reach. These test cases serve as bounding cases which allow us to infer the expected hydraulic conditions for the combinations of project alternatives that were not modeled directly.

Test cases modeled:

- Case 1: Without-Project (all reaches)
- Case 2: Alternative S3, Without Project Alternative in the Middle Reach (M0), Alternative N1
- Case 3: Alternatives S3, M3, and N1
- Case 4: Alternatives S1, M1, and N1

These cases were evaluated for flood events under existing conditions and anticipated future conditions, including sea-level rise. Small differences were observed between the without-project and with-project alternatives for the existing conditions flood scenarios, as discussed in the sections that follow. The differences in performance between the without project and with-project alternatives for the anticipated future conditions flood events were negligible. The hydraulic model setup and detailed discussion of the results of the hydraulic modeling are included in Attachment B.

Public Access

Public access performance is evaluated based on whether or not each alternative is consistent with the EBRPD's preliminary preferred trail alignment through the South and Middle Reaches. At the North Reach, public access performance is evaluated based on consistency of each alternative with the John Muir Land Trust's interest in constructing trails and other public access facilities. Initial planning for public access in the North Reach is in progress. A "consistent" ranking means that the Lower Walnut Creek Project alternative preserves an appropriate corridor that could be converted into a public trail at a future time. An "inconsistent" ranking means that the alternative does not set aside such a corridor, making it difficult/infeasible to construct a public trail through the project reach at a future time.

Sustainability

Sustainability was assessed for flood performance and habitat restoration for future conditions scenarios with +2 ft and +5 ft of sea-level rise. Flood protection sustainability is evaluated based on detailed analysis and modeling of future flood levels with sea-level rise and geomorphic change (Attachment B). Modeled water levels for the future With-Project Alternatives were nearly identical to those for the future Without-Project Alternative (negligible differences, $\leq$0.1 ft). Therefore, flood protection sustainability was not a differentiator between alternatives.

Habitat sustainability performance is evaluated based on the projected extents of wetland habitats with +2 ft and +5 ft of sea-level rise. Potential habitats are mapped based on land elevations relatives to the tides. For the near-term conditions analysis we use the following habitat-elevation bands based on preliminary habitat mapping and site surveys. This analysis is approximate and the results may not necessarily match those from a detailed habitat mapping.

- Subtidal: below 1' NAVD
- Mudflat: 1' to 3.5' NAVD

- Tidal Wetland: 3.5’ to 6.5’ NAVD
- Transition: 6.5’ to 9’ NAVD
- Upland: Above 9’ NAVD

Future habitats are estimated by shifting the habitat elevation bands upward to adjust for anticipated relative sea-level rise (sea-level rise adjusted for estimated sedimentation). We evaluated future habitats at two time horizons:

- LT2, reflecting conditions with +2’ of Sea-Level Rise
- LT5, reflecting conditions with +5’ of Sea Level Rise

Alternatives are compared based on the extents of tidal wetlands, transitional habitat, and adjacent uplands predicted to persist during the two future time horizons. Figure 25 illustrates an example of habitats mapped using these methods for a combination of Alternatives S3, M3, and N1.

Construction Cost

ESA evaluated the relative cost of each alternative based on the current conceptual level of design. These cost estimates allow for relative comparison of the various alternatives within a reach and between reaches. Relative costs are shown in increments (and half-increments) of dollar signs ($). The relative cost estimates consider the anticipated costs of mobilization, demolition, earthwork, hydraulic structures, access improvements and re-vegetation. The estimates do not include operations and maintenance costs; the alternatives are expected to require similar levels of operations and maintenance effort. The estimates do not include real-estate costs for acquisition of land or easements.

6.2 Alternatives Evaluation / Comparison

South Reach

Table 9 provides a summary of the results of the alternatives comparison for the South Reach. Based on this comparison we find that Alternative S3 best achieves the project goals and objectives and is recommended as the Preferred Alternative for the South Reach. The sections below provide additional discussion of the findings for each evaluation criteria.

TABLE 9
SOUTH REACH ALTERNATIVES COMPARISON SUMMARY

Evaluation Criteria	Without-Project	Alternative S1	Alternative S2	Alternative S3 (Preferred)
Habitat Tidal Wetland: Non-Tidal Wetland: Non-Wetland:	 8 ac 22 ac 12 ac	 20 ac 2 ac 19 ac	 24 ac* 2 ac 15 ac* * see text	 28 ac 2 ac 11 ac
Flood Protection	Baseline	Potential small, localized increase (see text)	Similar to Alternative S3	Potential very small, localized increase or improvement (see text)
Public Access	Compatible	Compatible	Compatible	Compatible
Habitat Sustainability	Low	Moderate / High	High	High
Flood Protection Sustainability	Baseline	Negligible change from future Without Project	Negligible change from future Without Project	Negligible change from future Without Project
Construction Cost	N/A	$	$$	$$
Other				Requires agreement with land owner.

Habitat

All With Project alternatives provide much greater habitat connectivity and greater extents of tidal marsh compared to the Without Project Alternative. The alternatives that include levee breaching and partial removal (Alternatives S2 and S3) provide greater habitat connectivity compared to Alternative S1.

Alternative S3 provides the largest total wetland (tidal and non-tidal) area. Although Alternative S2 shows a net loss of wetland habitat based on the numbers in Table 9, this alternative can be revised to avoid any loss by grading more of the existing levee to tidal wetland elevations (versus remaining high ground as assumed in Table 9). Alternative S1 results in an unavoidable net loss of wetland area compared to the Without Project alternative.

Flood Protection

As noted above, Alternatives for the South Reach were modeled in combination with alternatives for the other reaches. In the modeling cases, Alternative S1 is combined with M1 and N1 (Case 4) and Alternative S3 is combined with N1 (using Case 2). Flood performance results for Alternative S2 are expected to be similar to those for S3 (modeled).

Results for the relevant cases are presented below. “Negligible”effects are those where the change in water surface elevation (1% flood event) is ≤ 0.1 ft. “Very small” effects are those where the change in water surface elevation is ≤ 0.2 ft.

Results for Case 4 (Alts S1M1 N1) used to evaluate Alternative S1 (1% flood event)

- Upstream of project: negligible
- South Reach: very small increase
- Middle Reach: small increase of up to 0.3 ft
- North Reach: very small increase to negligible decrease

If Alternative S1 is pursued, additional analysis would be required to confirm feasibility. It would need to be determined whether or not a localized increase of up to 0.3 ft would impact neighboring properties, many of which will already be inundated by several feet of water. It may be possible to refine Alternative S1 (and M1) to reduce flood levels, such as by replacing culverts (modeled) with breaches to increase conveyance. Finally, the effects of Alternative S1 would need to be modeled in combination with the actual alternatives pursued for the Middle and North Reaches.

Results for Case 2 (Alts S3M0 N1) used to evaluate Alternative S3 (1% flood event)

- Upstream of project: Negligible
- South Reach: small decrease (-0.4 ft) to very small increase
- Middle Reach: very small increase.
- North Reach: very small increase to and negligible decrease

Alternative S3 has the potential to reduce flood levels within the South Reach, with localized very small increases elsewhere in the project area. Model results show that water levels *decrease* for the 10% (10-year) flood event for Alternatives S3.

Public Access

All of the project alternatives and also the Without-Project case are compatible with a potential future public access trail through the South Reach.

Sustainability

All With Project alternatives provide much greater habitat sustainability compared to the Without Project Alternative. Alternatives S2 and S3 provide somewhat increased habitat sustainability compared to Alternative S1, because of their greater hydraulic connectivity to estuarine and fluvial sediment sources in Walnut Creek.

For the Without Project Alternative, areas currently disconnected from the tides will be subject to higher groundwater and reduced surface drainage as sea-level rises, resulting in increased frequency and depth of ponding. The disconnected basin will “lose” elevation over time, as sea levels rise but the ground elevation in the basin remains constant. If the levees separating these areas from the tides fail in the future, returning the basin to tidal inundation, the resulting habitat

will be a more frequently inundated marsh or mudflat. This habitat is considered less desirable than a vegetated marsh higher in the intertidal range.

For the With Project alternatives, the breaches will allow estuarine and fluvial deposition, and later marsh vegetation, to raise ground elevations, reducing the relative rate of sea level rise. Appendix C describes modeling conducted by ESA to evaluate expected rates of future sediment accumulation in the wetland areas adjacent to Walnut Creek with anticipated future sea-level rise. This analysis was used to produce maps of expected tidal and transitional habitat extents for different amounts of sea level rise, shown in Figure 25 for the preferred alternative. In the near term, the restored site maps primarily as transitional habitat, however over time this transitional area is expect to convert to tidal wetlands with rising sea levels (Figure 25). Given the high local suspended sediment concentrations in Walnut Creek, we anticipate that these tidal wetlands will be persist through the 2050 planning horizon and beyond, though at lower intertidal elevations.

The South Reach appears to be a good candidate for sustainable tidal marsh restoration. The existing topography exhibits a gentle gradient rising ~5 feet from the north end to the south ends of the site. Consequently we expect this site to exhibit a mixture of wetland, tansition and upland habitats even with 5 feet of sea level rise.

As noted above, for flood protection sustainability, there were negligible differences between alternatives.

Cost

Alternative S1 is expected to be approximately 25% less expensive than Alternatives S2 and S3. The costs for Alternatives S2 and S3 are roughly equal. The cost for Alternative S3 is the theoretical cost if the District implements setback levee construction before or separate from Conco fill placement. The actual cost of Alternative S3 will be subject to phasing and agreement between Conco and the District.

Other Constraints

Conco owns the parcels to the west of the restoration site and plans to develop portions of the area for equipment storage and maintenance areas. This project would include the import of fill material to create level pads and to elevate the work areas above nuisance flood elevations. The District has approached Conco regarding opportunities to coordinate between the two projects, resulting in the development of Alternative S3, where the setback levee would be located on Conco's property and integrated with their proposed grading. Alternative S3 provides additional habitat and flood protection benefits, but is contingent on the timely construction of the proposed Conco project, and will require that the County obtain an access easement on Conco property. In addition, future construction of the proposed trail will require that EBRPD obtain an access easement from Conco.

Middle Reach Alternatives Comparison

Table 10 provides a summary of the results of the alternatives comparison for the Middle Reach. Based on this comparison we find that Alternative M3 best achieves the project goals and objectives and is recommended as the Preferred Alternative for the Middle Reach. The sections below provide additional discussion of the findings for each evaluation criteria.

TABLE 10
MIDDLE REACH ALTERNATIVES COMPARISON SUMMARY

Evaluation Criteria	Without-Project	Alternative M1	Alternative M2	Alternative M3 (Preferred)
Habitat				
Tidal Wetland:	28 ac	58 ac	66 ac	67 ac
Non-Tidal Wetland:	36 ac	0 ac	0 ac	0 ac
Non-Wetland:	14 ac	19 ac	12 ac	10 ac
Flood Protection	Baseline	Potential small, localized increase (see text)	Similar to Alternative M3	Potential very small, localized increase or improvement (see text)
Public Access	None	Compatible	Compatible	None (provided elsewhere)
Habitat Sustainability	Low	Moderate / High	High	High
Flood Protection Sustainability	Baseline	Negligible change from future Without Project	Negligible change from future Without Project	Negligible change from future Without Project
Construction Cost	N/A	$$	$$$	$$
Other			Requires agreement with land owner.	

Habitat

All With Project alternatives provide greater habitat connectivity and consistency with regional habitat goals (BEHGU 2015) compared to the Without Project Alternative. The alternatives that include levee breaching and partial removal (Alternatives M2 and M3) provide greater habitat connectivity compared to Alternative M1. Alternatives M2 and M3 provide the largest tidal wetland area and total wetland (tidal and non-tidal) area.

Flood Protection

As discussed above, Alternatives for the Middle Reach were modeled in combination with alternatives for the other reaches. In the modeling cases, Alternative M1 is combined with S1 and N1 (Case 4), Alternative M3 is combined with S3 and N1 (Case 3). Flood performance results for Alternative M2 (not modeled) are expected to be similar to those for M3 (modeled). See discussion for South Reach Alternatives comparison (above) for additional context.

Results for Case 4 (Alts S1M1 N1) used to evaluate Alternative M1 (1% flood event)

- Upstream of project: negligible
- South Reach: very small increase

- Middle Reach: small increase of up to 0.3 ft
- North Reach: very small increase to negligible decrease

As discussed above for evaluation of Alternative S1, if Alternative M1 is pursued, additional analysis would be required to confirm feasibility. It would need to be determined whether or not a localized increase of up to 0.3 ft would impact neighboring properties, many of which will already be inundated by several feet of water. It may be possible to refine Alternative M1 (and S1) to reduce flood levels, such as by replacing culverts (modeled) with breaches to increase conveyance. Finally, the effects of Alternative M1 would need to be modeled in combination with the actual alternatives pursued for the South and North Reaches.

Results for Case 3 (Alts S3M3 N1) used to evaluate Alternative M3 (1% flood event)

- Upstream of project: negligible change
- South Reach: small decrease (up to -0.4 ft)
- Middle Reach: negligible change
- North Reach: very small increase to negligible decrease

Alternative M3 has the potential to reduce flood levels within the South Reach, with negligible change or localized very small increases elsewhere in the project area. Model results show that water levels *decrease* for the 10% (10-year) flood event under Alternative M3.

Public Access

The preferred trail alignment identified in the draft trail feasibility study prepared by EBRPD is not reliant on a public trail through the Middle Reach. If the EBRPD pursues their preferred alignment (Public Access Alternative 1), there is no public access criterion for the Middle Reach. Based on the EBRPD findings, Alternative M2 is not recommended for implementation, at least in the near term, as it appears unlikely that a public trail would be constructed through this reach.

Sustainability

As described above for the South Reach, all With Project alternatives provide much greater habitat sustainability compared to the Without Project Alternative. Alternatives M2 and M3 provide somewhat increased habitat sustainability compared to Alternative M1, because of their greater hydraulic connectivity to estuarine and fluvial sediment sources in Walnut Creek.

The Middle Reach appears to be a good candidate for sustainable tidal marsh restoration, however the low existing grades and steep slopes at the toe of the landfill provide very little transitional and upland habitat. If excess fill material becomes availible it may be desirable to construct more gentle slopes along the landfill toe to create this valuable ecotone habitat, however such fill placement would likely impact existing non-tidal wetlands and may not be viable from a permitting standpoint.

As noted above, for flood protection sustainability, there were negligible differences between alternatives.

Cost

Alternative M2 is roughly 25% more expensive than Alternatives M1 and M3, largely due to the cost of creating two separate access corridors (one for private access and one for shared District and public access) along this reach, with associated costs for grading, paving and fencing. The costs for Alternatives M1 and M3 are approximately equal.

North Reach Alternatives Comparison

Table 11 summarizes the results of the alternatives comparison for the North Reach. Based on this comparison we find that Alternative N2 best achieves the project goals and objectives. The sections below provide additional discussion of the findings for each evaluation criteria.

TABLE 11
NORTH REACH ALTERNATIVES COMPARISON SUMMARY

Evaluation Criteria	Without-Project	Alternative N1	Alternative N2 (Preferred)
Habitat			
Tidal Wetland:	86 ac	155 ac	145 ac
Non-Tidal Wetland:	58 ac	4 ac	24 ac
Non-Wetland:	98 ac	83 ac	73 ac
Flood Protection	Acceptable	Acceptable	Acceptable
Public Access	None	Compatible	Compatible
Habitat Sustainability	Moderate	Moderate / High	High
Construction Cost	N/A	$$$$$	$$$$

Habitat

Both With Project alternatives provide greater wetland extent, habitat connectivity and consistency with regional habitat goals (BEHGU 2015) compared to the Without Project Alternative. Alternative N1 provides a slightly greater extent of tidal wetlands compared to Alternative N2. Alternative N2 provides the greatest extent of non-tidal wetlands and a slightly greater extent of total wetland acreage compared to Alternative N1.

Flood Protection

The configuration of the North Reach is not expected to affect flood performance. No modeling was completed to assess relative flood performance of the North Reach Alternatives.

Public Access

Both With Project alternatives are consistent with provision of future public access and recreation.

Sustainability

Future conditions habitat projections indicate that the Without Project at Pacheco Marsh is on a trajectory towards becoming tidal marsh as sea levels rise. Existing upland and transitional habitats are anticipated to convert to tidal wetlands with +2 and +5 ft of sea-level rise at this site without further action. However, habitat sustainability is limited by the lack of (or delay in) hydraulic connectivity to estuarine and fluvial sediment sources in Walnut Creek and by steeper transitional slopes.

Alternatives N1 and N2 both preserve large areas that will convert to tidal marsh with sea-level rise, while maintaining future adjacent transitional and upland habitat. As described in Section 5.4, Alternative N2 was developed as a refinement of Alternative N1 with the intent of providing more sustainable tidal wetlands with future sea-level rise, and outperforms Alternative N2 for sustainability. Alternative N2 provides more gentle upland slopes, allowing more room for transgression of tidal wetlands. Tidal wetlands at the Pacheco Marsh are expected to provide relatively greater ecological value in the future, as wetlands elsewhere in San Francisco Bay become more inundated and increasingly convert to mudflats. Alternative N2 will also sustain greater extents of valuable transitional and protected upland habitats along the tidal wetland perimeter compared to Alternative N1.

As noted above, for flood protection sustainability, there were negligible differences between alternatives.

Cost

Alternative N2 is anticipated to be less costly to construct compared to Alternative N1. Alternative N2 requires less excavation and has a smaller area of revegetation planting.

6.3 Preferred Alternative

Based on the evaluation of alternatives described in the previous sections, the project team identified a Preferred Alternative which consists of:

- South Reach Alternative S3: Breach and setback levee to maximize restoration
- Middle Reach Alternative M3: Breach and setback levee with public access elsewhere
- North Reach Alternative N2: Revised Pacheco Marsh Restoration Plan

Figure 3 shows a conceptual plan view of the Preferred Alternative. While there are benefits to implementing restoration in the three reaches in one coordinated effort (e.g., the North Reach is available as a soil disposal location for excess material excavated from the South and Middle Reaches), the Preferred Alternative can be implemented independently between reaches, as

needed. The reaches can be implemented separately or in any combination. The District may phase implementation of the Preferred Alternative depending on the timing of construction funding and property agreements.

The Preferred Alternative is contingent on the County successfully obtaining easements on privately-owned lands, and upon the availability of funding for project implementation. According to estimates of relative costs, the Preferred Alternative is cost effective compared to other alternatives considered.

In the event that the District is not able to reach a mutually-beneficial agreement with the private land owners at the South or Middle project reach, the District will pursue:

- South Reach: Alternative S2 Breach And Setback Levee On District Property.
- Middle Reach: Without-Project Alternative

The Preferred Alternative will be refined and described in more detail in subsequent planning, and documented in an upcoming Project Study Report.

This page intentionally left blank

CHAPTER 7
References and Report Preparation

7.1 References

AECOM , 2016. San Francisco Bay Tidal Datums and Extreme Tides Study. Prepared with funding from FEMA and SF BCDC. February.

BCDC (San Francisco Bay Conservation and Development Commission), 2012. San Francisco Bay Plan. Reprinted in 2012. Available online at www.bcdc.ca.gov/pdf/bayplan/bayplan.pdf

CDFW (California Department of Fish and Wildlife), 2015. California State Wildlife Action Plan: A Conservation Legacy for Californians – 2015 Update: Volume 1 Plan Update. Available online at https://www.wildlife.ca.gov/SWAP/Final

California Division of Mines and Geology. 1969. "Geologic and Engineering Aspects of San Francisco Bay Fill". Special Report 97.

California State Coastal Conservancy, 2011. Enhanced San Francisco Bay Area Water Trail Plan. December 2011. Available online at http://sfbaywatertrail.org/wp-content/uploads/2015/05/Enhanced-Water-Trail-Plan-Dec2011.pdf

California Natural Resources Agency, California Department of Food & Agriculture, and California Environmental Protection Agency, 2016. California Water Action Plan 2016. Available online at http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf

California Wetlands Monitoring Workgroup (CWMW). 2015. EcoAtlas. Accessed October1, 2015.http://www.ecoatlas.org.

Center for Collaborative Policy. 2015. Lower Walnut Creek Stakeholder Assessment Report. Report prepared for Contra Costa County.

Contra Costa Clear Water Program. 2015. "Transmittal of the Urban Creeks Monitoring Report in Accordance with Permit Provision C.8.g.ii". Report transmittal to California Regional Water Quality Control Board, 13 March, 2015.

Colins, L., and Leventhal, R.. "Regional Curves of Hydraulic Geometry for Wadeable Streams in Marin and Sonoma Counties, San Francsico Bay Area. Data Summary Report. May 10, 2013.

Contra Costa County Flood Control and Water Conservation District (CCCFCD 2007). Lower Walnut Creek Corrective Action Plan. Report prepared for the US Army Corps of Engineers, Sacramento District. June 28, 2007.

Contra Costa County Flood Control & Water Conservation District (CCCFCCD). 2010. Lower Walnut Creek Restoration 1% (100-year) Floodplain – Existing Conditions. Draft Poster, Dec 2010.

Contra Costa Public Works, Contra Costa County Flood Control and Water Conservation District, and Bay Development and Conservation District, 2016. Adapting to Rising Tides Contra Costa County Sea Level Rise Vulnerability Assessment Final Report.

Detjens, Paul. 2009. Summary of Sediment Issues in Lower Walnut Creek. Memorandum, 3 March, 2009.

EBRPD, 2013. Master Plan 2013. Available online at http://www.ebparks.org/Assets/_Nav_Categories/Park_Planning/Master+Plan/Master+Plan+2013+Final+-+Web.pdf

Engeo. 1994. Final Report: Results of Chemical, Physical and Bioassay Testing of Sediments from the Lower Walnut Creek Flood Control Channel. Report prepared for Contra Costa County Flood Control and Water Conservation District. April 20, 1994.

Environmental Science Associates (ESA, 2015a). 2015. Lower Walnut Creek Restoration Project – Cultural Resources Background Research. Confidential Memorandum. 29 September, 2015.

Environmental Science Associates (ESA, 2015b). 2015. Lower Walnut Creek Field Data Collection. Memorandum to Contra Costa County Flood Control and Water Conservation District. 5 October, 2015.

Fiedler, P., M. Keever, B. Grewell, and D. Partridge. 2007. Rare plants in the Golden Gate Estuary (California): the relationship between scale and understanding. Aust. J. Bot. 55:206-220.

Federal Emergency Management Agency. 2015. Flood Insurance Study – Contra Costa County, California and Incorporated Areas. FIS #s: 06013CV001B, 06013CV002B, 06013CV003B, 06013CV004B, 06013CV005B. 30 September, 2015.

Goals Project. 2015. The Baylands and Climate Change: What We Can Do. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

H.T. Harvey & Associates. 2003. Pacheco Marsh Restoration, Contra Costa County, California, Wetland Technical Assessment. Prepared for The Muir Heritage Land Trust, Contra Costa County, and The East Bay Regional Park District. 24 October, 2003.

H.T. Harvey and Associates. 2004. Re: Pacheco Slough Soil Contaminants Evaluation. Memorandum to Phillip Williams and Associates. 1 March, 2004.

Hultgren – Tillis Engineers. 2007. "Geotechnical Investigation, Lower Walnut Creek Channel, Martinez/Concord, California". Project No. 670.01, 27 July, 2007.

Hultgren – Tillis Engineers. 2009. "Geotechnical Field and Laboratory Data Collection, Lower Walnut Creek Channel, Contra Costa County, California". Project No. 670.02. 9 June, 2009.

Hultgren – Tillis Engineers. 2009. "Sediment Core Sampling, Lower Walnut Creek Channel, Contra Costa County, California". Project No. 670.01. 10 November, 2009.

Jonas and Associates, Inc. 2002. "Site Characterization Report". Report prepared for Contra Costa County Public Works Department. January 22, 2002.

Jones & Stokes. 2004. Data Summary Report for Baseline Surveys of Anadromous Fish Habitat in Lower Walnut Creek, Contra Costa County, California. July, 2004.

Jones & Stokes. 2005a. Final Delineation of Waters of the United States, Including Wetlands, for the Lower Walnut Creek Channel Restoration Project, Concord, California. January, 2005.

Jones & Stokes. 2005b. Botanical Report for the Lower Walnut Creek Channel Restoration Project, Concord, California. January, 2005.

Jones & Stokes. 2007. Final Data Summary Report for Chinook Salmon Spawning Escapement and Fry Emergence in Lower Walnut Creek, Contra Costa County, California. September, 2007.

Kennedy/Jenks Consultants, ESA, Kearns & West, and Zentraal, 2013. San Francisco Bay Integrated Regional Water Management Plan. Available at http://bairwmp.org/docs/2013-bairwm-plan-update/2013-final-plan/San%20Francisco%20Bay%20Area%20IRWMP%20Final_September%202013.pdf

Mobile Boundary Hydraulics. 2012 "Walnut Creek Sedimentation Study". Prepared for U.S. Army Corps of Engineers Sacramento District. January 10, 2012.

NOAA CO-OPS (National Oceanic and Atmospheric Administration Center for Operations Oceanographic Products and Services), 2010. URL: https://tidesandcurrents.noaa.gov/benchmarks/9415144.html. Accessed October 2017.

NRC (National Research Council), 2012. "Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future." National Academy Press: Washington, D. C.

Orr, M. and L. Sheehan, 2012. Memo to Rebecca Sloan, ICF. BDCP Tidal Habitat Evolution Assessment. August.

PWA (Philip Williams and Associates with HT Havey & Associates), 2004. "Pacheco Marsh Restoration Plan – Final Report". Prepared for the Muir Heritage Land Trust and Contra Costa County. April 18, 2004.

Reynolds, L. K. and Boyer K. E. 2010. Perennial pepperweed (Lepidium latifolium): Properties of invaded tidal marshes. Invasive Plant Science and Management 3:130-138.

San Francisco Bay Trail, 2016. San Francisco Bay Trail Design Guidelines and Toolkit. Prepared by 2M Associates, PlaceWorks, Questa Engineering Corporation, and Michelle DeRobertis. Funded by the California Coastal Conservancy.

SFEI (San Francisco Estuary Institute), 2016. Flood Control 2.0 Project Website. http://www.sfei.org/projects/flood-control-20 . Accessed March 2017.

SFEI (San Francisco Estuary Institute), 2016. Resilient Landscape Vision for Lower Walnut Creek: Baseline Information & Management Strategies. A SFEI-ASC Resilient Landscape Program report developed in cooperation with the Flood Control 2.0 Regional Science Advisors and Contra Costa County Flood Control and Water Conservation District, Publication #782. November 2017.

Stralberg, D., M. Brennan, J. Callaway, J. Wood, L. Schile, D. Jongsomjit, M. Kelly, V. T. Parker, and S. Crooks. 2011. Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay. PLoS ONE 6(11)

USBR (U.S. Bureau of Reclamation), U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, 2013. Suisun Marsh Habitat Management, Preservation and Restoration Plan. URL: https://www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=17283

U. S. Geological Survey. 2015. StreamStats Version 3 Beta: CA. Accessed September, 2015. http://streamstatsags.cr.usgs.gov/v3_beta/viewer.htm?stabbr=CA.

Williams and Orr. 2002. Physical Evolution of Restored Breached Levee Salt Marshes in the San Francisco Bay Estuary. Restoration Ecology Vol. 10 No. 3: 527-542.

Williams, P. B., Orr, M. K. and Garrity, N. J., 2002. Hydraulic Geometry: A Geomorphic Design Tool for Tidal Marsh Channel Evolution in Wetland Restoration Projects. Restoration Ecology, vol. 10, pp. 577–590.

U. S. Army Corps of Engineers. 1968. Operation and Maintenance Manual for Walnut Creek Project - Contra Costs Count, California – Part No. 1 – From Suisun Bay to Drop Structure No. 2 at Bancroft Road. June 1968.

U. S. Army Corps of Engineers. 2013. Hydrauic Modeling Documentation. Draft Report - 13 May, 2013.

USFWS (U.S. Fish and Wildlife Service), 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California.

7.2 Report Preparation

This report was developed under the direction of Paul R. Detjens, PE, Contra Costa Flood Control and Water Conservation District.

This report was prepared by the following ESA staff:

Michelle Orr, PE

Eddie Divita, PE

With contributions from:

Chris Rogers, ESA

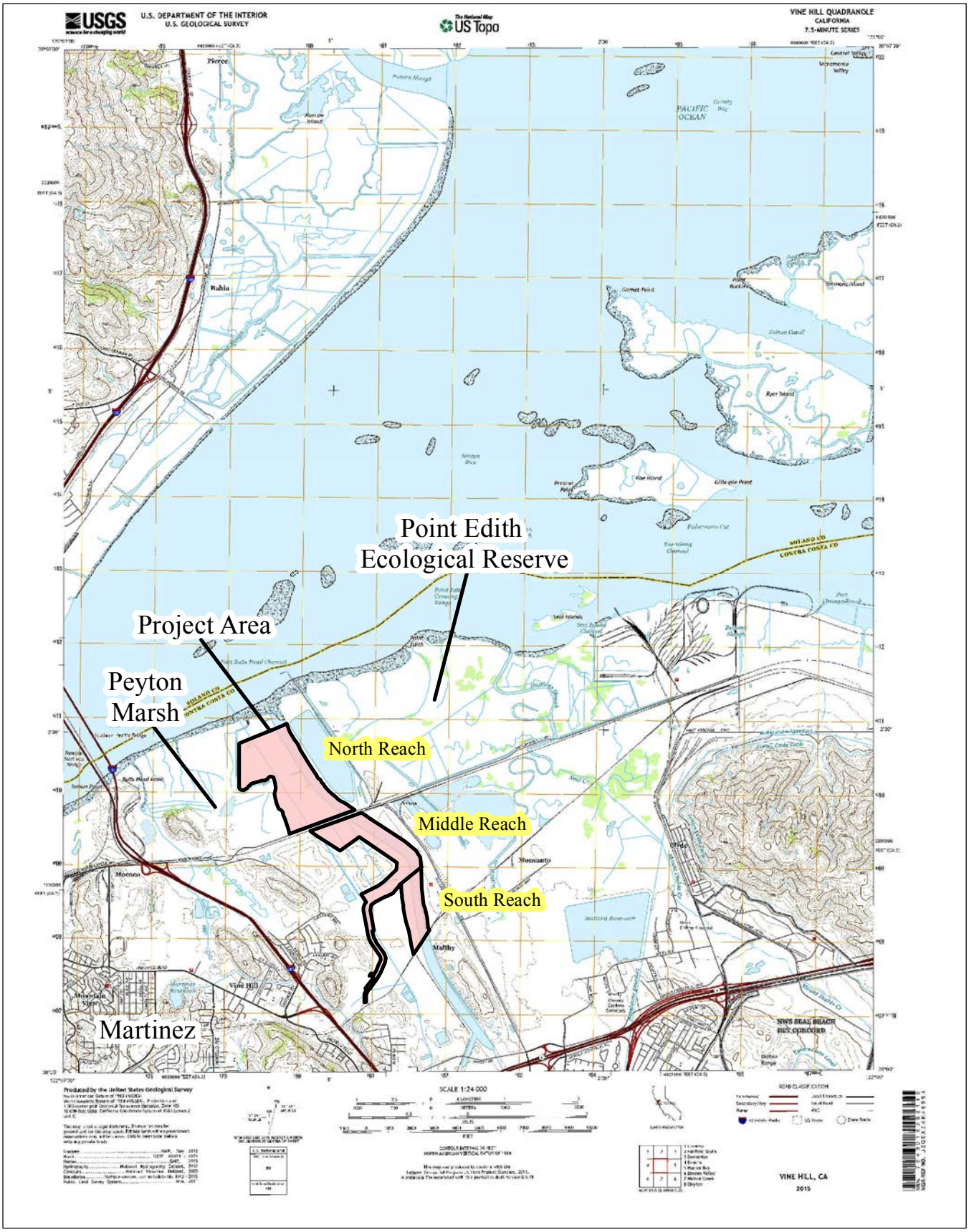
Stephanie Bishop, ESA

Heidi Koenig, RPA, ESA

Jerrold Hanson, PE, Hultgren-Tillis Engineers

Jessie Jones, PlaceWorks

Isabelle Minn, ASLA, PlaceWorks

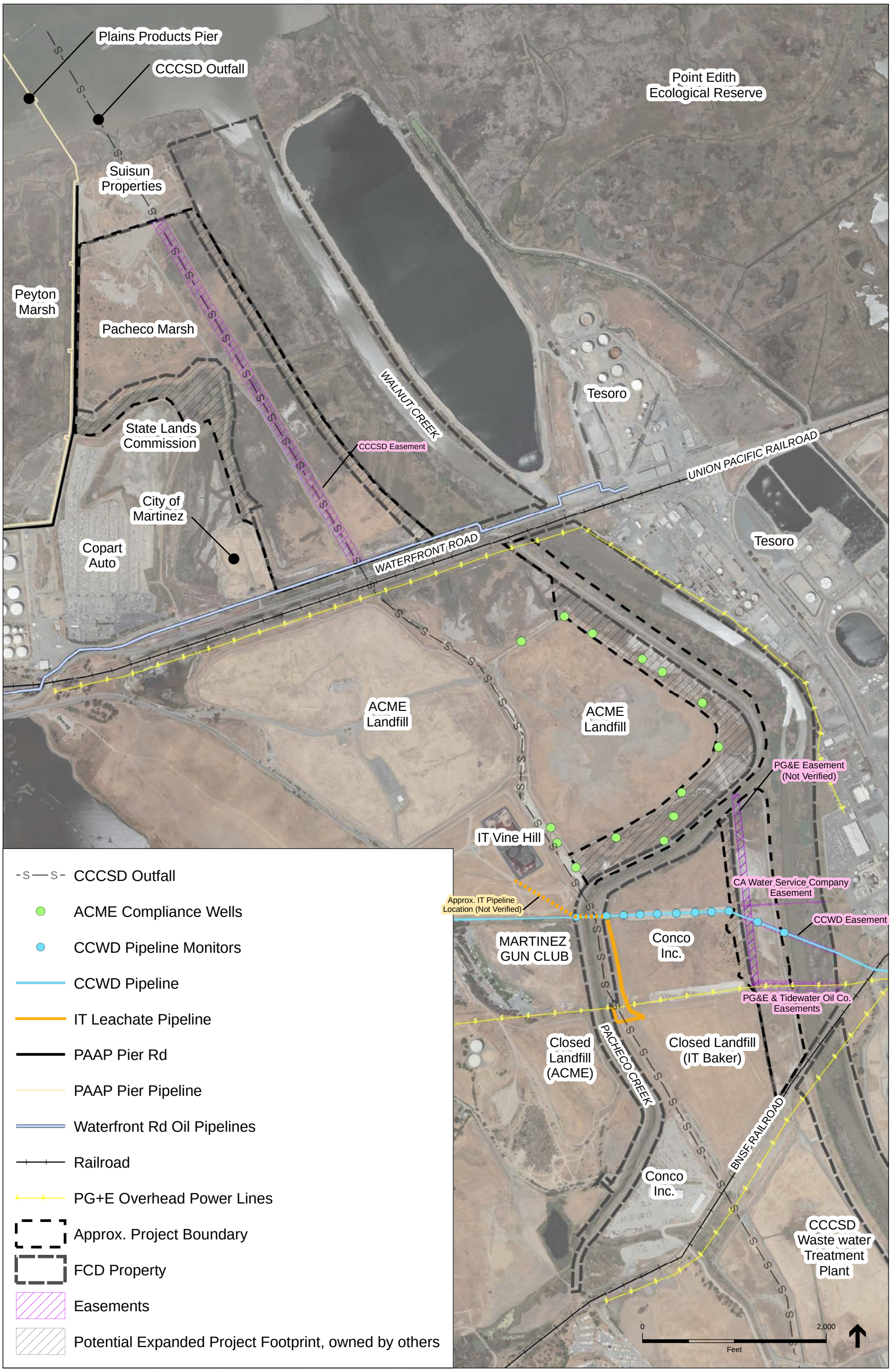


SOURCE: USGS, 2016

Lower Walnut Creek Restoration . D140703

Figure 1
Regional Map

ESA



Lower Walnut Creek Restoration . D140703.00

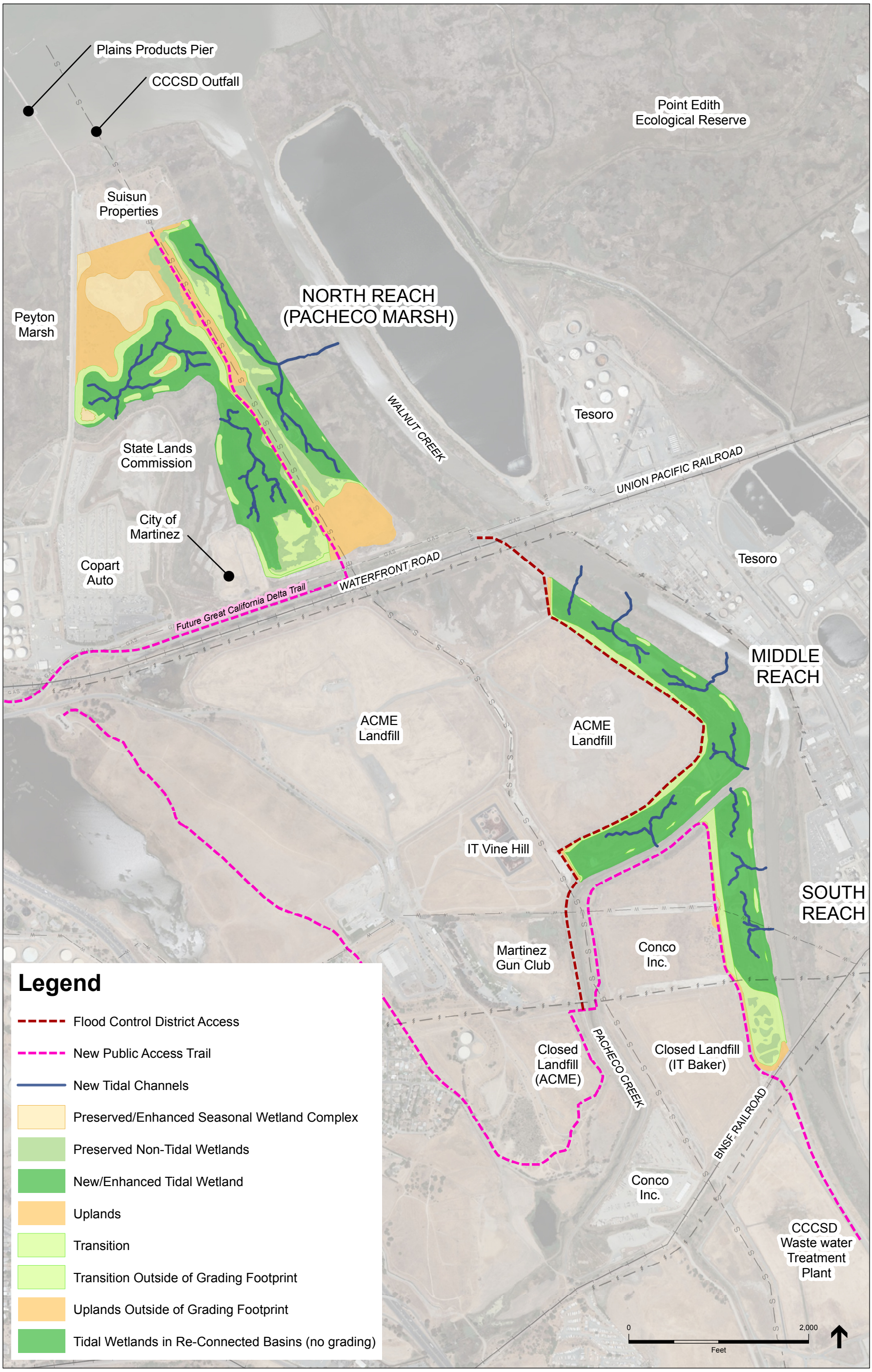
Figure 2

Existing Land Use, Utilities and Infrastructure

NOTES:
PAAP - Plains All American Pipeline

Additional pipelines, including a petroleum products pipeline owned by Chevron, pass through the utility easements on the South Reach. These pipelines are not shown as no map data for these pipelines has been made availible to the project team as of the time of publication.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User



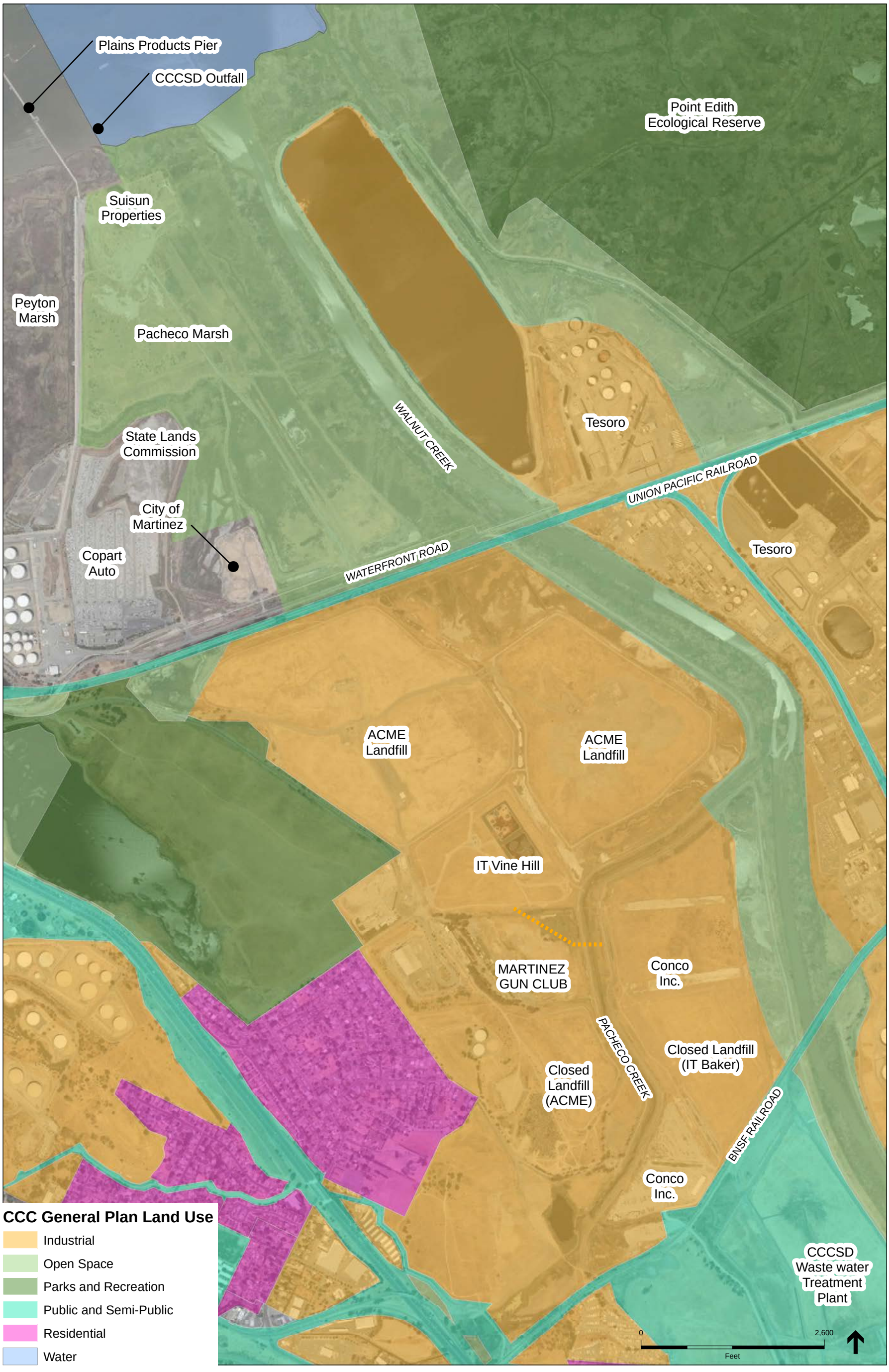
SOURCE:

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Potential USACE Jurisdiciton Area: H.T. Harvey & Assoc.

Lower Walnut Creek Restoration . D140703.00

Figure 3
Lower Walnut Creek Restoration
Preferred Alternative



SOURCE:

Pacels and Land Use Data from CCMAP

http://gismap.ccmap.us/imf/imf.jsp?site=ccmap, Accessed February 2015

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

Lower Walnut Creek Restoration Project. D140703

Figure 4

Land Use Zoning

Towill 2005 Photogrametry
Elevation (ft NAVD88)

- < -4
- -4 to -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16
- 16 to 17
- 17 to 18
- 18 to 19
- 19 to 20
- 20 to 21
- 21 to 22
- 22 to 23
- 23 to 24
- 24 to 25
- 25 to 26

N

0 2,000
Feet

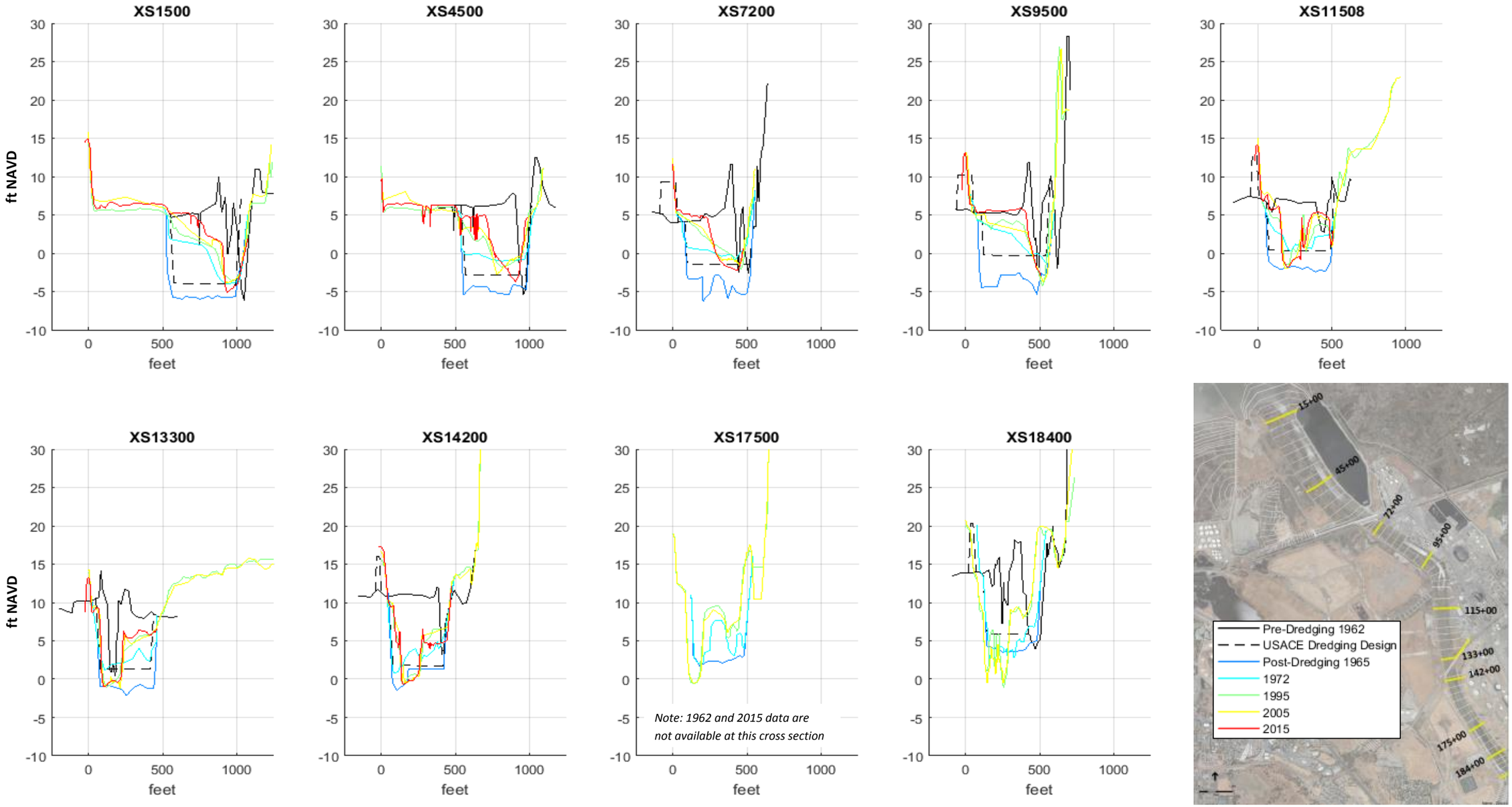
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

SOURCE: Towill Inc., 2005

Lower Walnut Creek Restoration . D140703

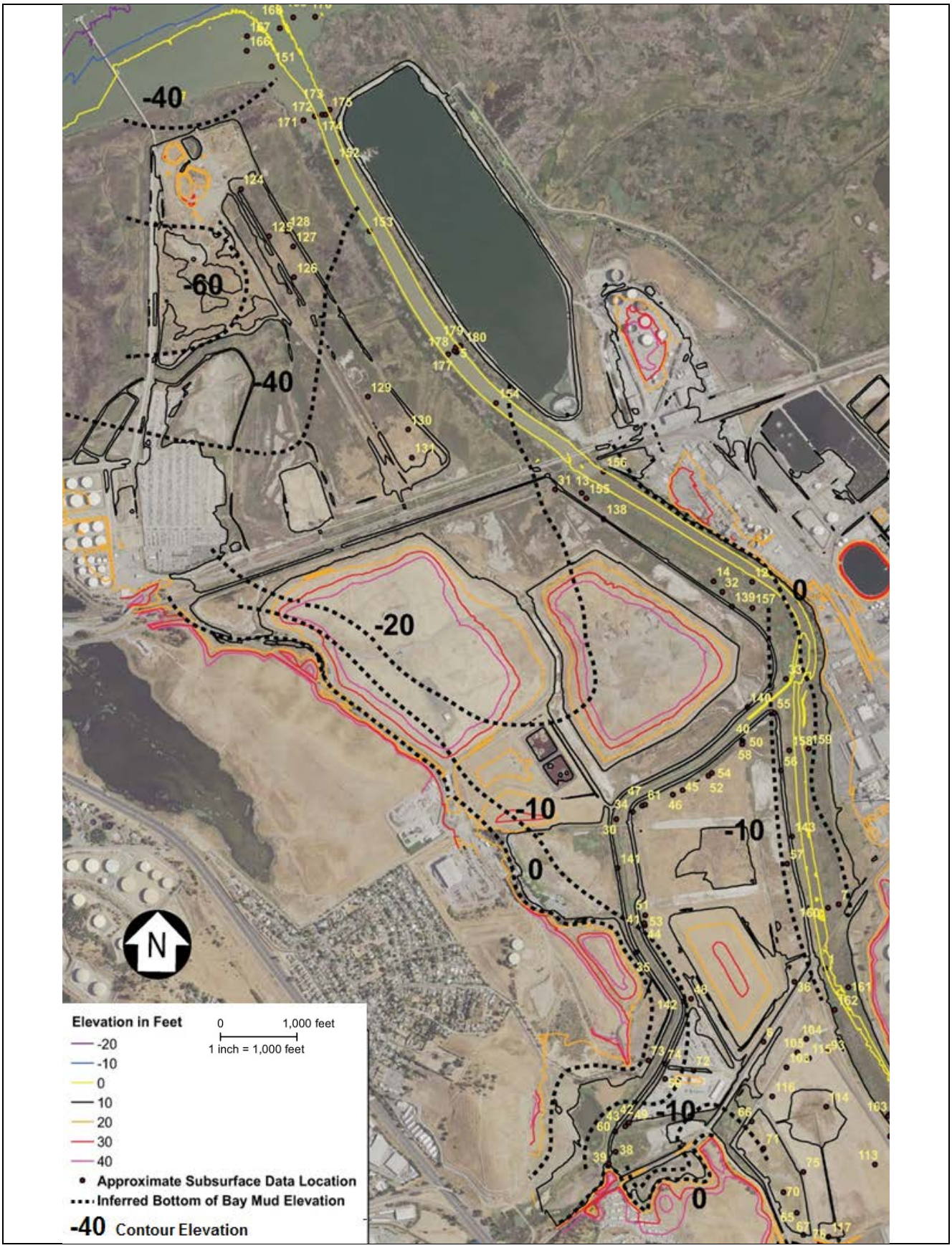
Figure 5
Topography
2005 LiDAR

ESA



SOURCES:
USACE, 1965
MBH, 2009
ESA, 2015

Figure 6
Lower Walnut Creek Channel Cross Sections



SOURCE:
Hultgren – Tillis Engineers

Lower Walnut Creek Restoration . D140703

Figure 7

Subsurface Data Locations

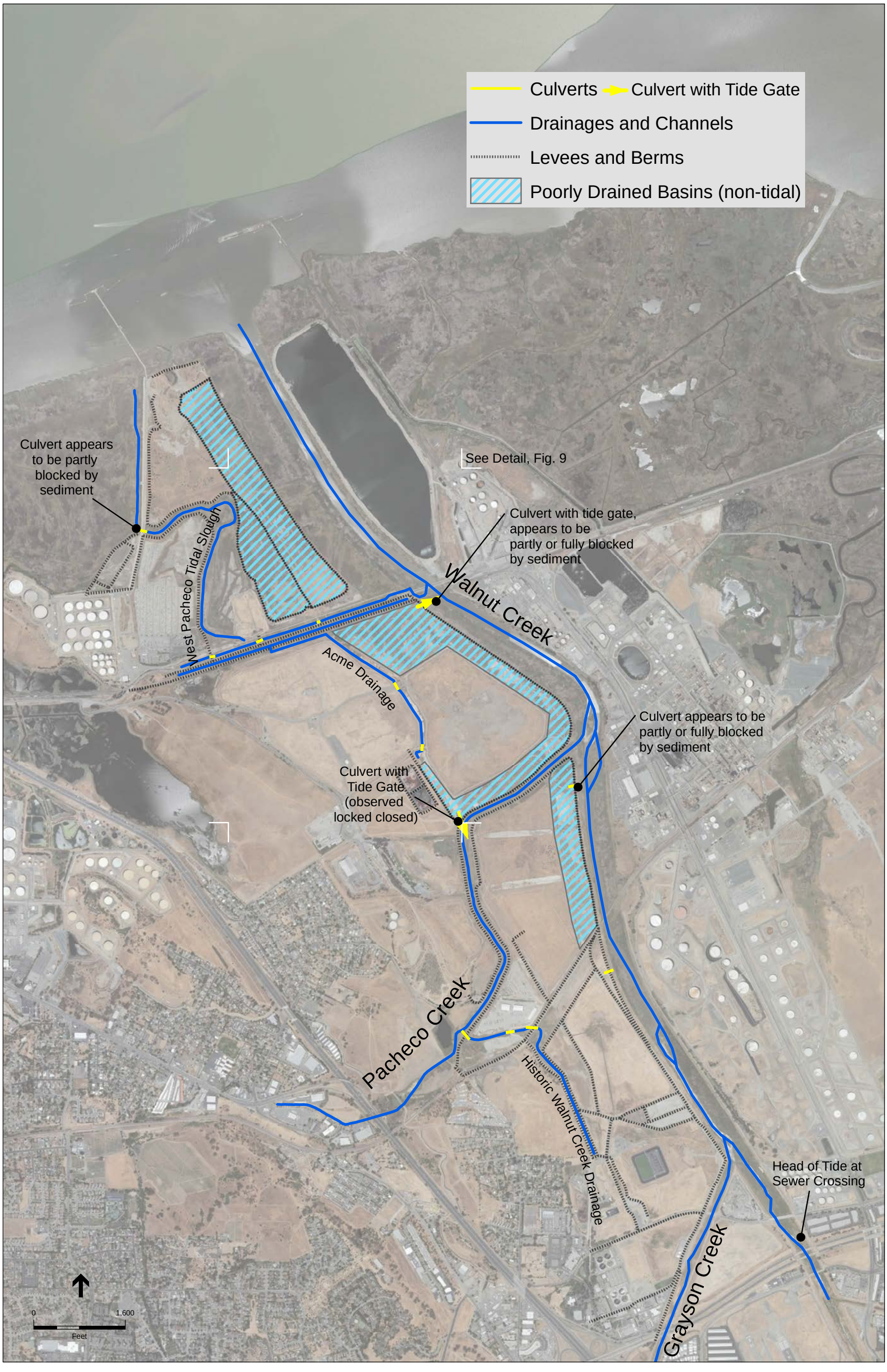
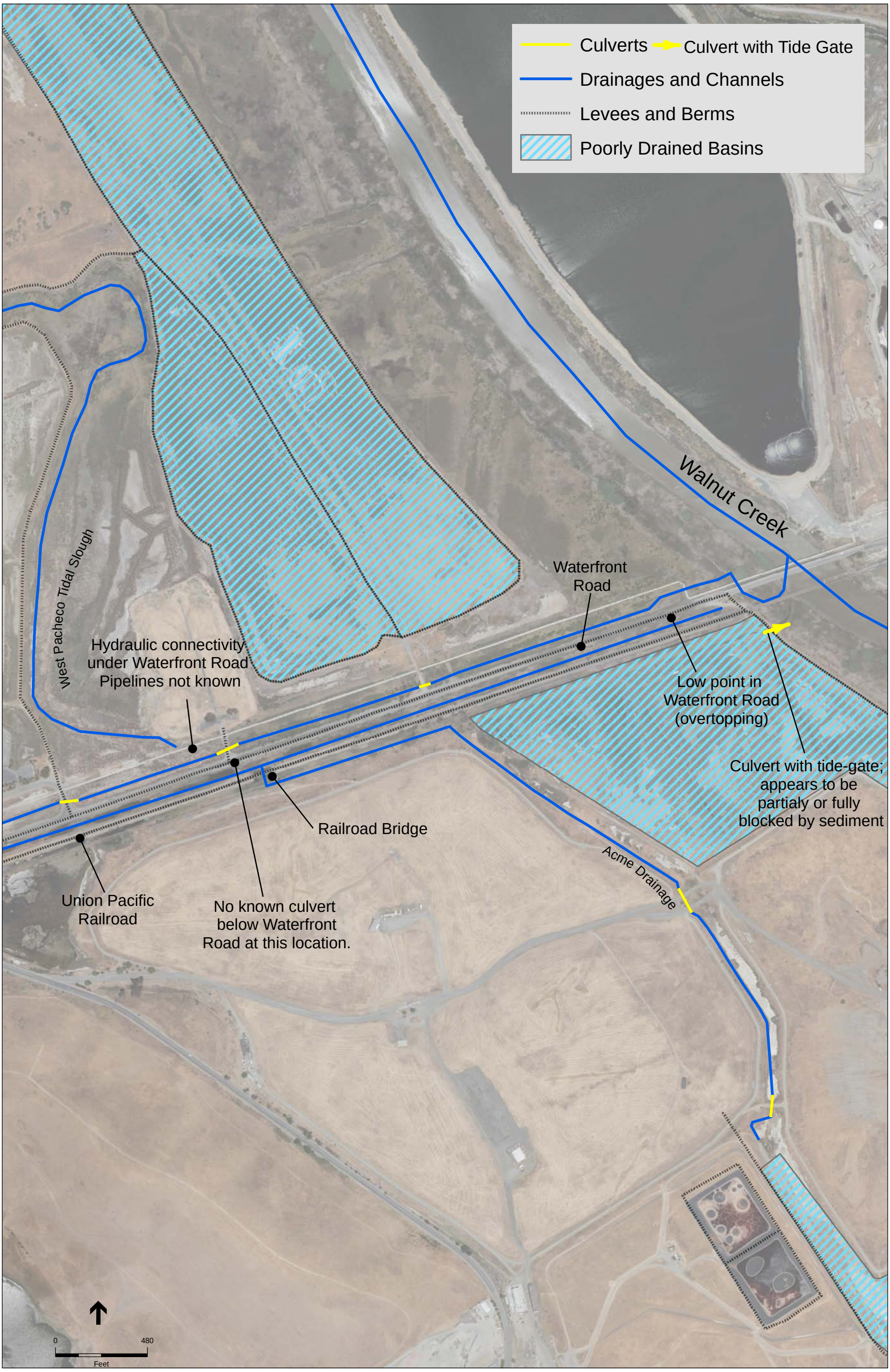


Figure 8
Local Drainage

SOURCE:

CCCFCWQCD (levees and berms)

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



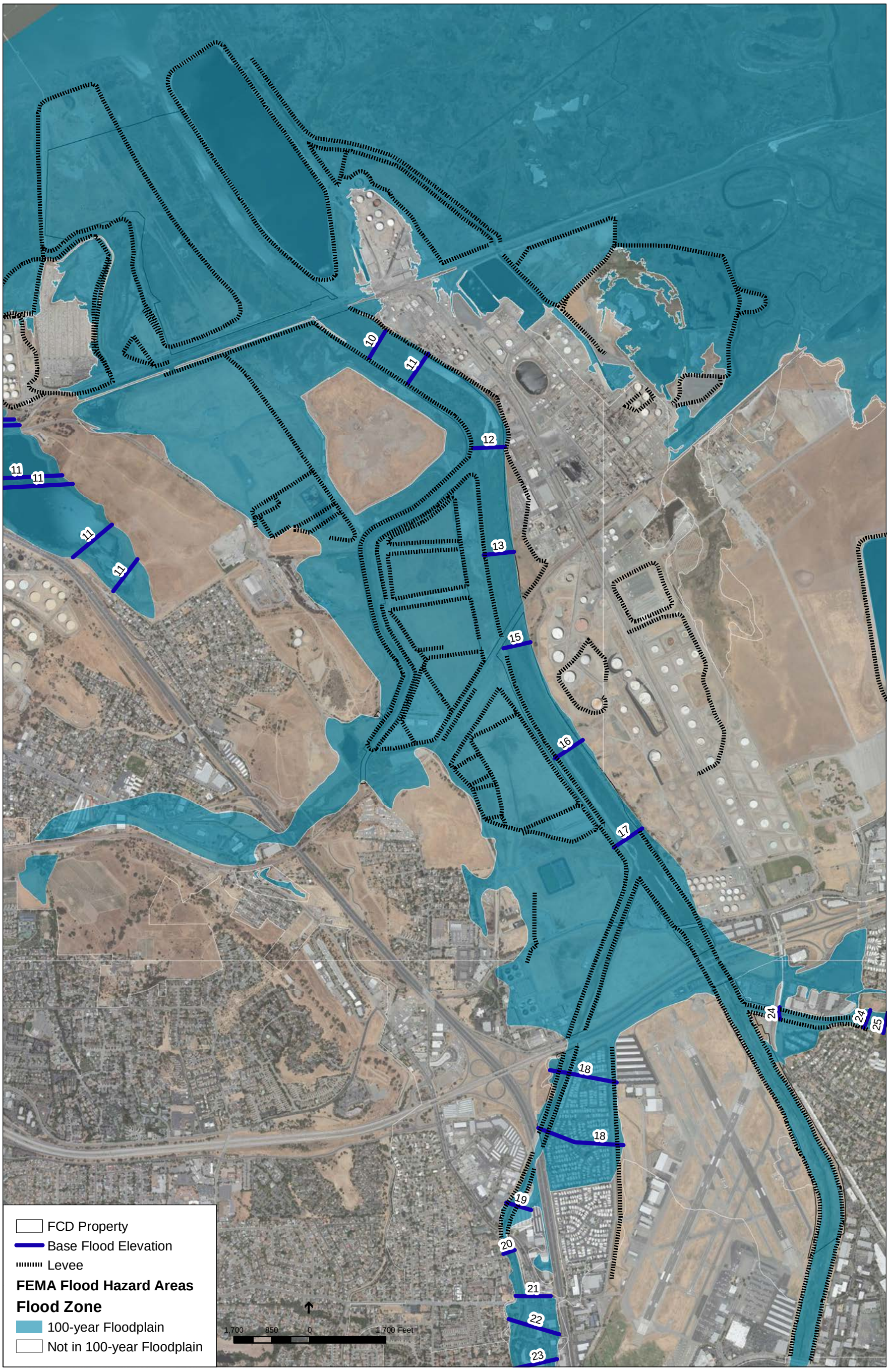
SOURCE:

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Lower Walnut Creek Restoration Project . D140703

Figure 9

Local Drainage Detail - Near Waterfront Road



Lower Walnut Creek Restoration. D140703.00

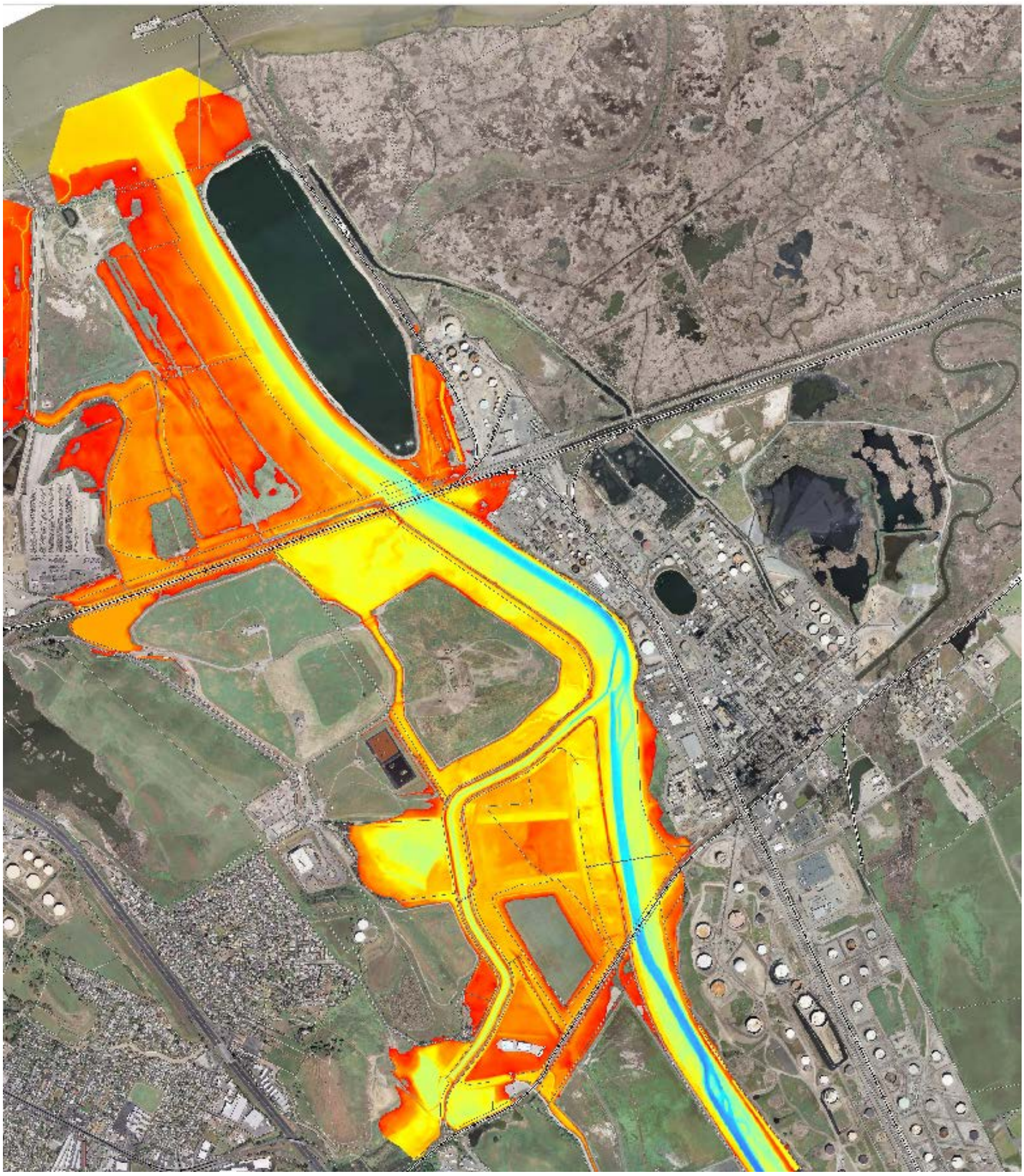
Figure 10

FEMA Flood Hazard Zones

SOURCE:

FEMA, 2015 - 100-year floodplain, BFEs and Levee Alignments

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Floodplain depth (feet)

V11b - 100 year

High : 21.8604

Low : 0

- DATA DISCLAIMER - USE AT YOUR OWN RISK -

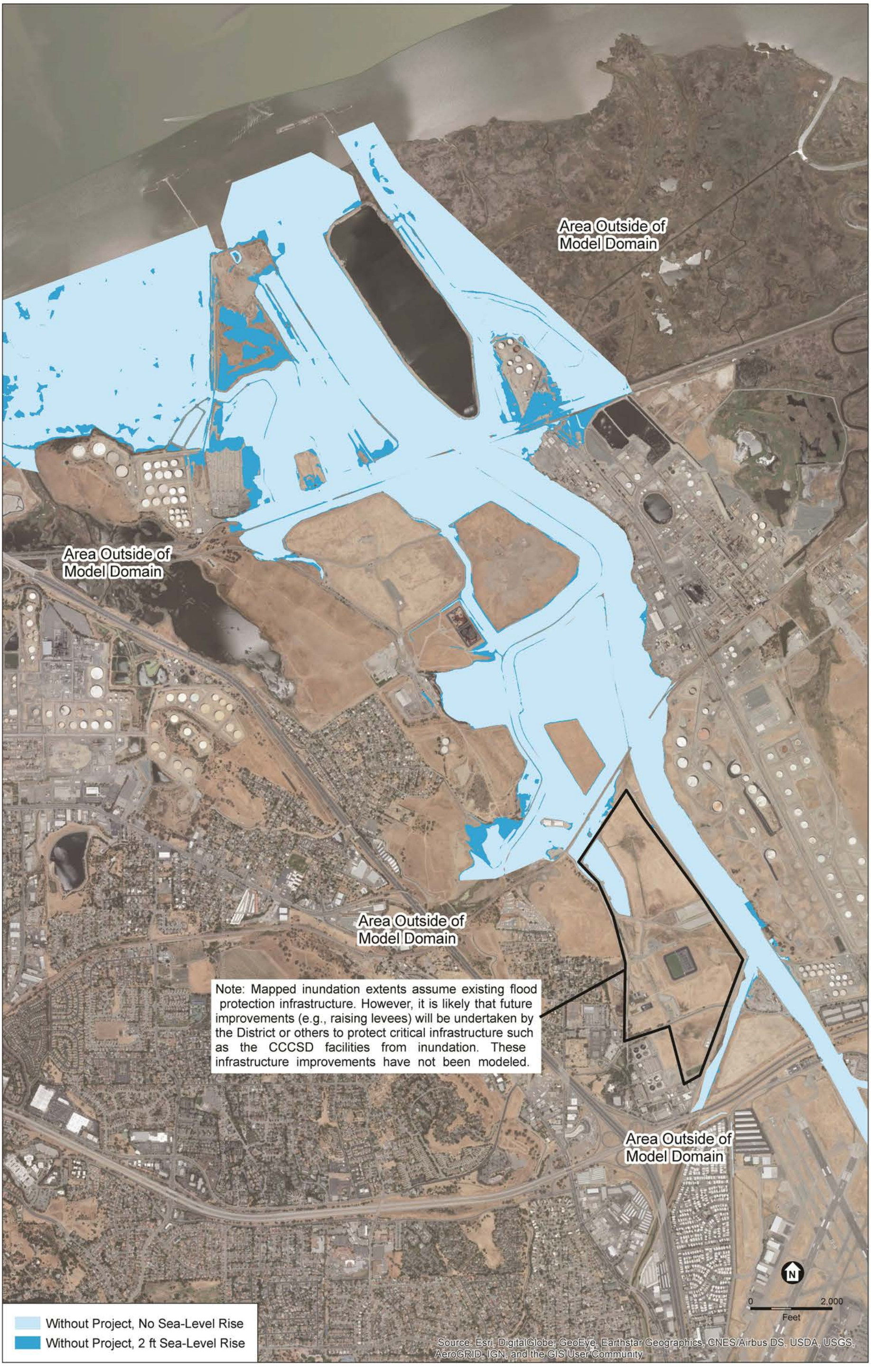
The authorized use of this data is limited to government and educational purposes only, and NOT for operational or commercial purposes. THIS DATA IS PROVIDED "AS IS" AND IN NO EVENT SHALL THE PROVIDERS BE LIABLE FOR ANY DAMAGES, INCLUDING, WITHOUT LIMITATION, DAMAGES RESULTING FROM LOST DATA OR LOST PROFITS OR REVENUE, THE COSTS OF RECOVERING SUCH DATA, THE COSTS OF SUBSTITUTE DATA, CLAIMS BY THIRD PARTIES OR FOR OTHER SIMILAR COSTS, OR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, ARISING OUT OF THE USE OF THE DATA.

The accuracy or reliability of the data is not guaranteed or warranted in any way and the Providers disclaim liability of any kind whatsoever, including, without limitation, liability for quality, performance, merchantability and fitness for a particular purpose arising out of the use, or inability to use the data. This data is NOT verified or certified for use in 911 or emergency response where lives, property, or health are at risk.

Contra Costa County and its agencies are and shall remain the sole and exclusive owner of all rights, title and interest in and to all lists, libraries, databases, maps, graphics, compilations, files and other data created and posted for inclusion in this system, including ownership of any trade secrets or copyright pertaining thereto, except as specifically noted.

SOURCE:
Contra Costa County Flood Control & Water Conservation District, 2010

Figure 11
1% (100-year) Floodplain
2010 CCCFCWCD Modeling



SOURCE: Topography from Towill Inc., 2005. Modeled flood levels from ESA 2017 (See Text).

Lower Walnut Creek Restoration . D140703

Figure 12
100-year Fluvial Flood
Potential Future Inundation Extents
with Sea-level Rise and Estimated Geomorphic Change

ESA

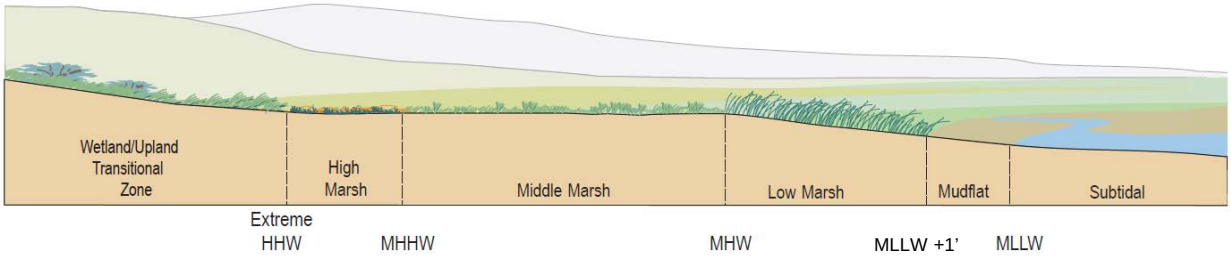
DRAFT FEBRUARY 2017

SOURCE: ESRI 2017, ESA 2017

Lower Walnut Creek Restoration Project . 140703.00

Figure 13

Potential Federal and State Wetlands and Waters

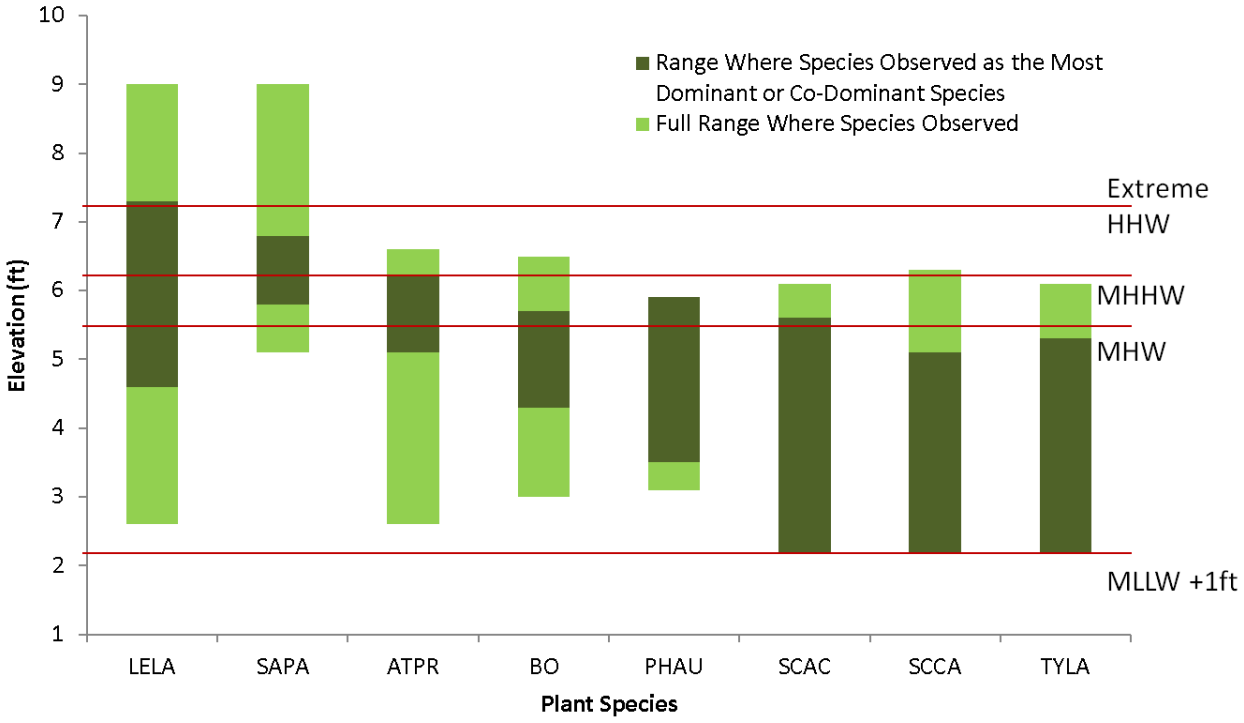


SOURCE:
ESA PWA 2012; USBOR, 2013

Lower Walnut Creek Restoration . D140703

Figure 14

Schematic Tidal Marsh Profile



LELA = *Lepidium latifolium*, perennial pepperweed

SAPA = *Salicornia pacifica*, pickeweed

ATPR = *Atriplex prostrata*, fat-hen

BO = *Bolboschoenus* species, bulrush

PHAU = *Phragmites australis*, common reed

SCAC = *Schoenoplectus acutus*, common bulrush

SCCA = *Schoenoplectus californicus*, California bulrush

TYLA = *Typha latifolia*, broad-leaf cattail

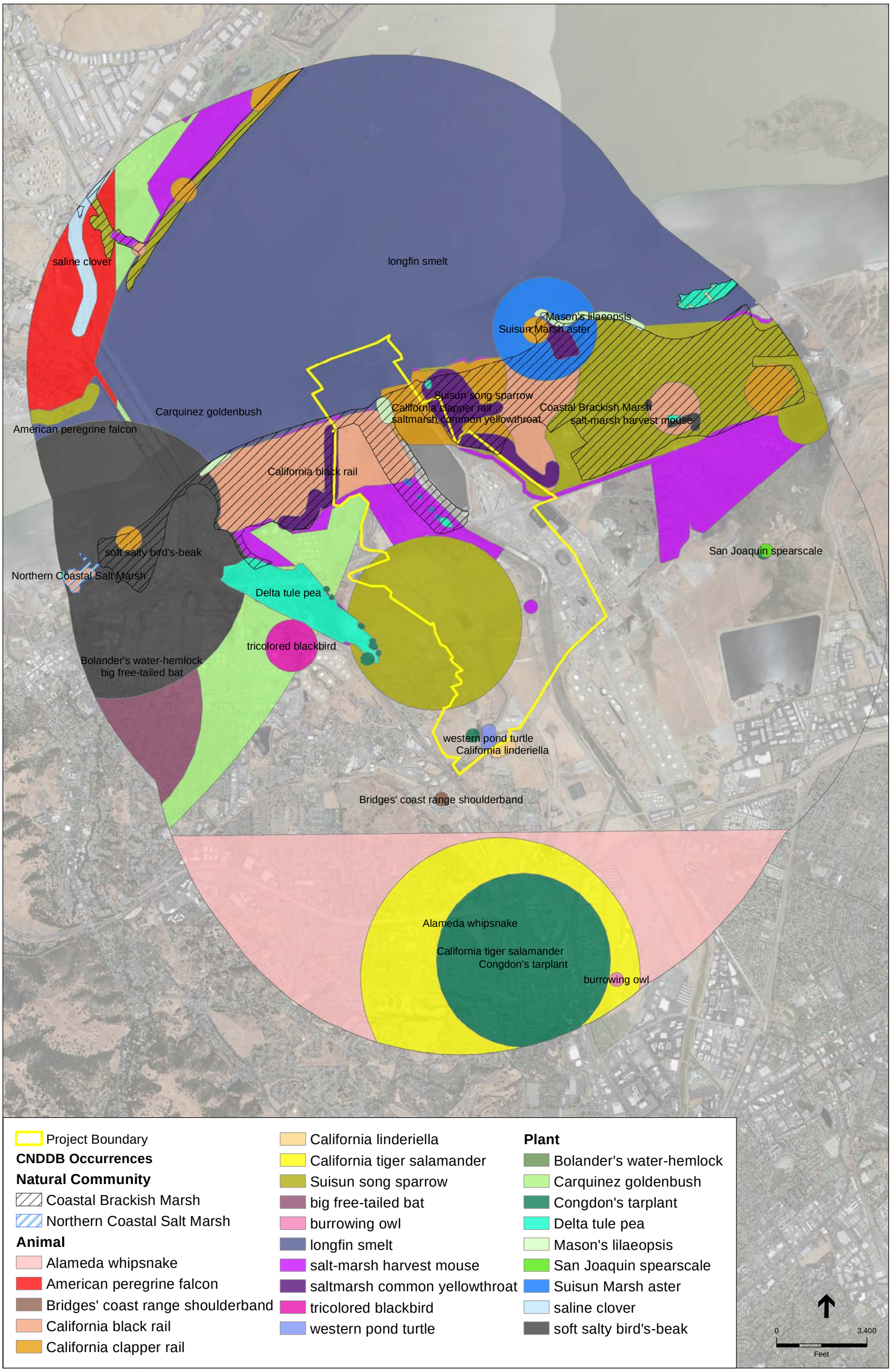
SOURCE:
ESA, 2015

Note: Along different transects or in different locations within the same transect different species occurred as dominant at different locations at the elevations represented. Although SCAC, SCCA, and TYLA have been measured as low as 2.0 ft NAVD, the plant cover is typically lower and surrounded mudflat.

Lower Walnut Creek Restoration . D140703

Figure 15

Common Tidal Marsh Plant Species And Elevation Ranges Observed At Lower Walnut Creek

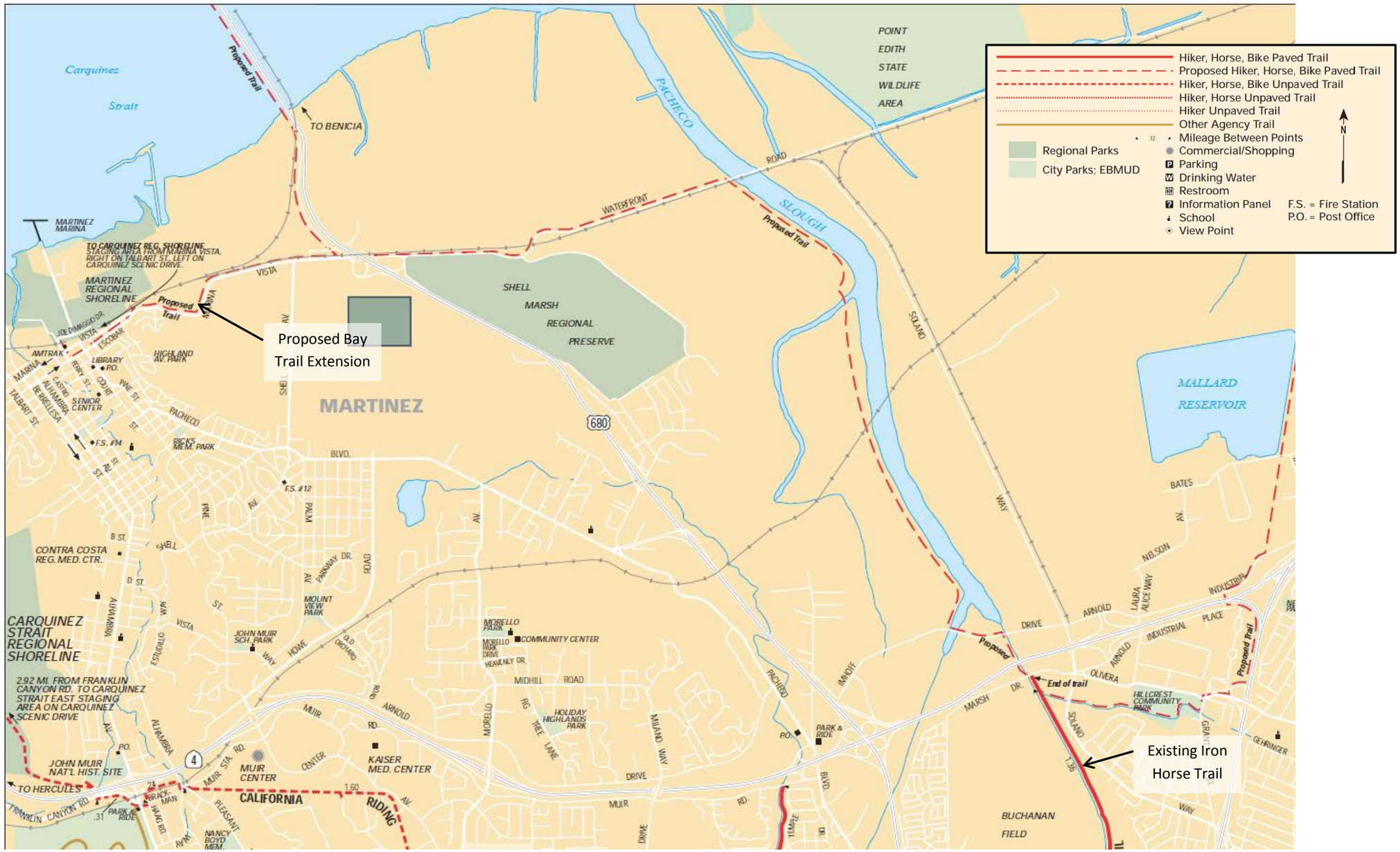


SOURCE: Aerial (ESRI); CNDDB Occuirences (CDFW 2015)

Lower Walnut Creek Restoration Project . 140703

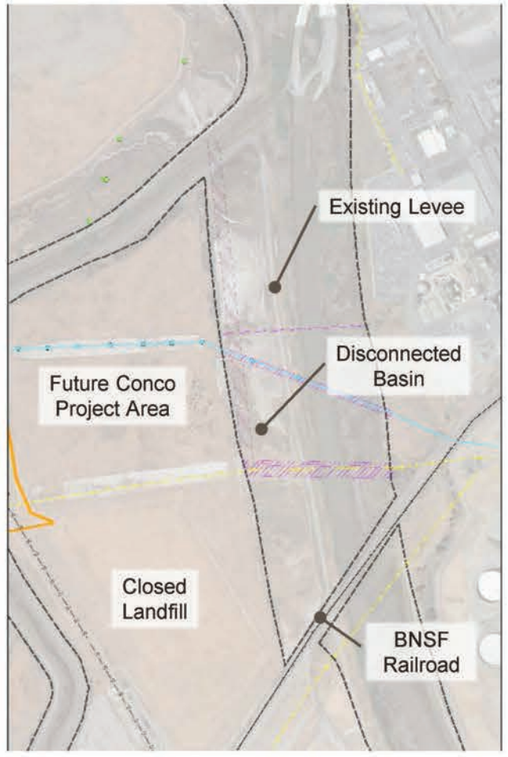
Figure 16

CNDDB Occurrences Within 2 Miles of the Project Area

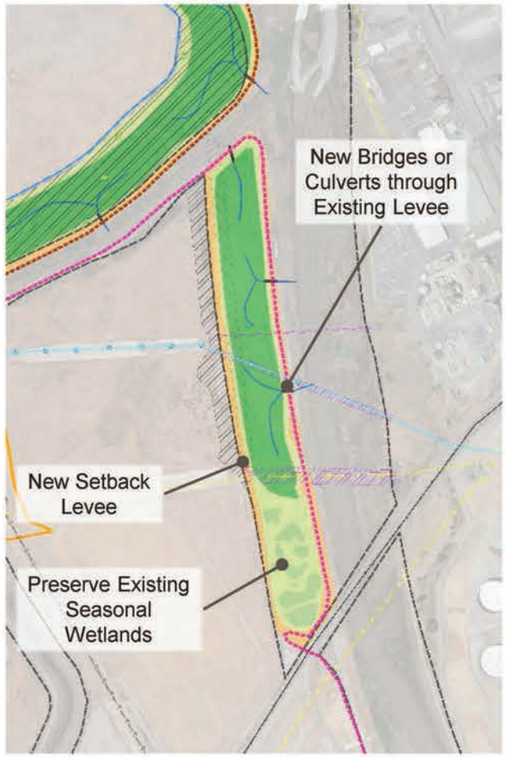


SOURCE:
East Bay Regional Parks District, Iron Horse Trail Map (North)
Available at http://www.ebparks.org/Assets/files/EBRPD_files/brochure/ihnorth.pdf, Accessed February, 2017

Figure 17
Regional Trails

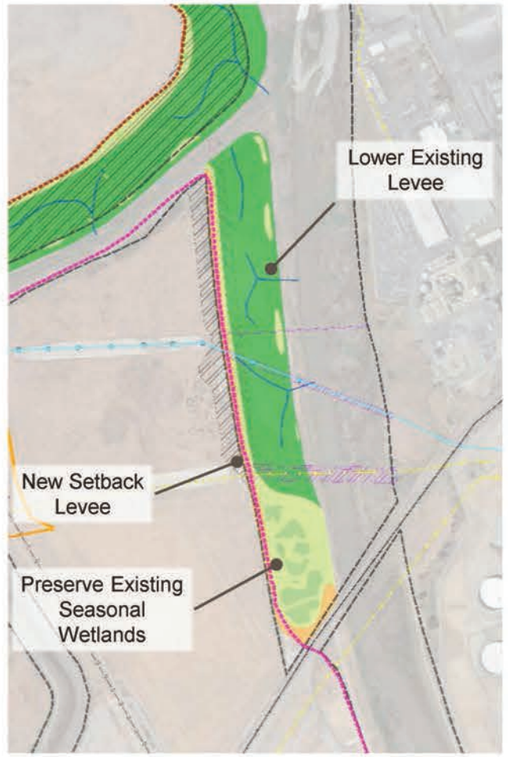


Without Project



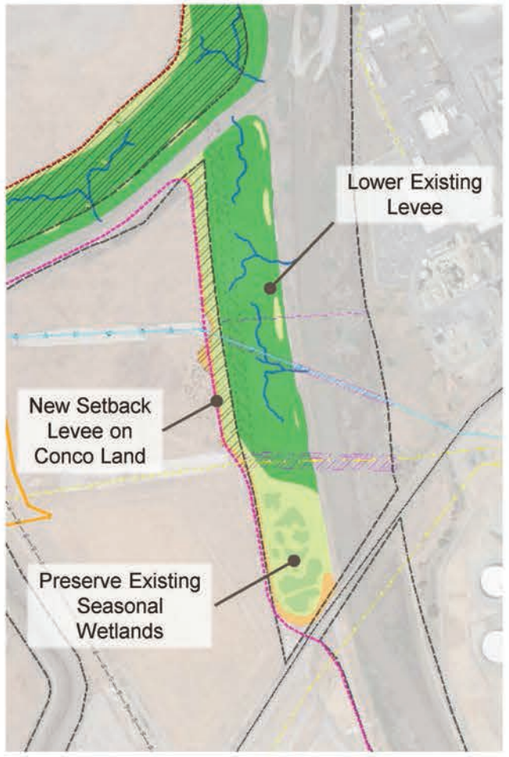
Alternative S1

Breach and Maintain Levee in Place



Alternative S2

Breach and Setback Levee on District Property



Alternative S3

Breach and Setback Levee to Maximize Restoration

- Preserved/Enhanced Seasonal Wetland Complex
- Preserved Non-Tidal Wetlands
- New/Enhanced Tidal Wetland
- Transition
- Uplands

See Figure 2 for Utilities Legend

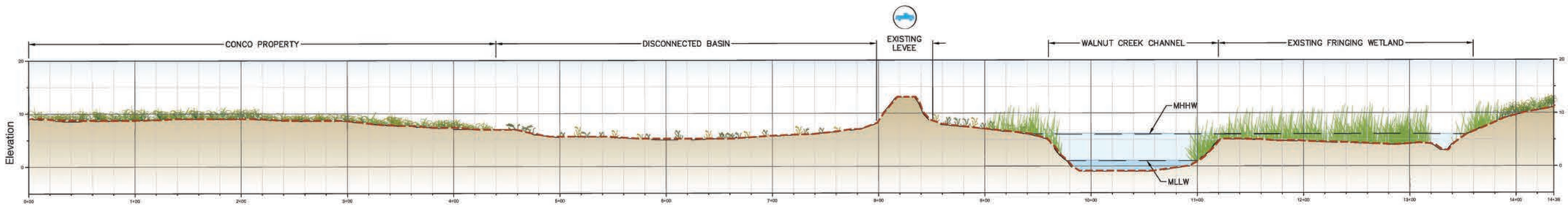
- Potential Expanded Project Footprint, owned by others
- Easements
- FCD
- CCCSD Access Road (Enhance/Re-align)
- FCD Property
- CCCSD Outfall

SOURCE:
ESA, 2017

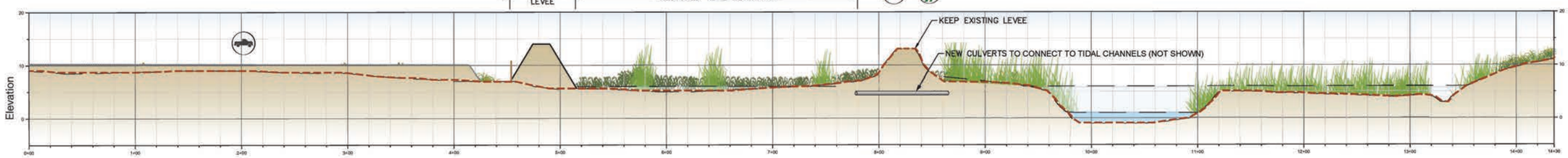
Lower Walnut Creek Restoration . D140703

Figure 18
South Reach Alternatives
Plan Views

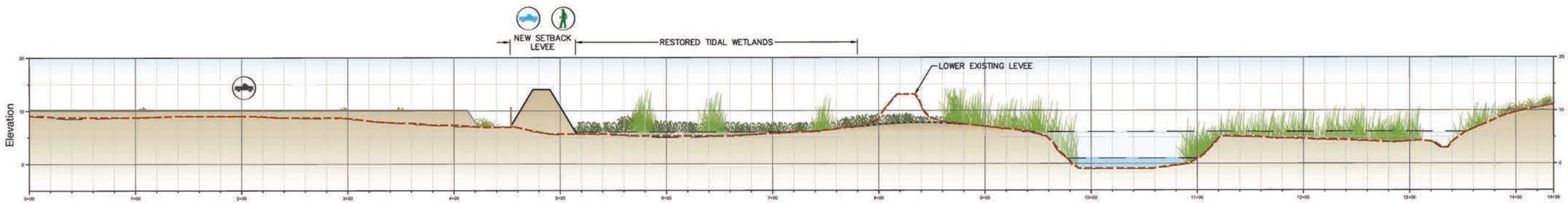
Without Project



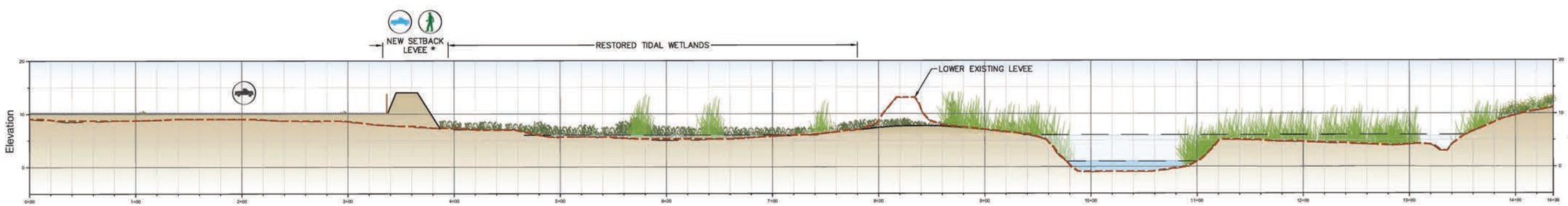
Alt S1
Breach and Maintain Levees in Place



Alt S2
Breach and Setback Levee on District Property



Alt S3
Breach and Setback Levee to Maximize Restoration



Vertical exaggeration: 5x

*See cross-section detail in Figure 20

SOURCE: ESA 2016

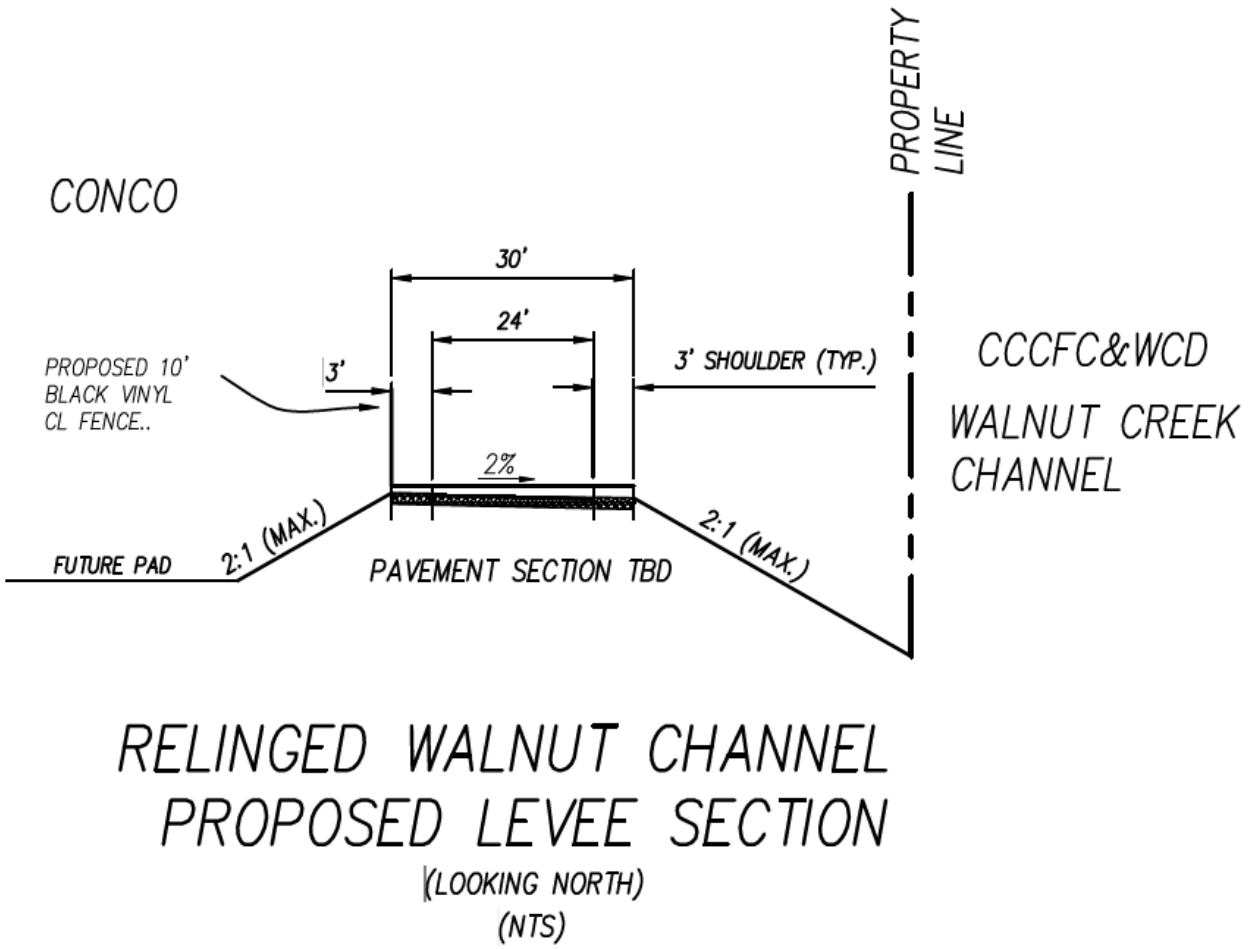
Private Access

District Access

Public Recreational Access

Lower Walnut Creek Restoration Project. 140703.00

Figure 19
South Reach Alternatives
Cross Section Views

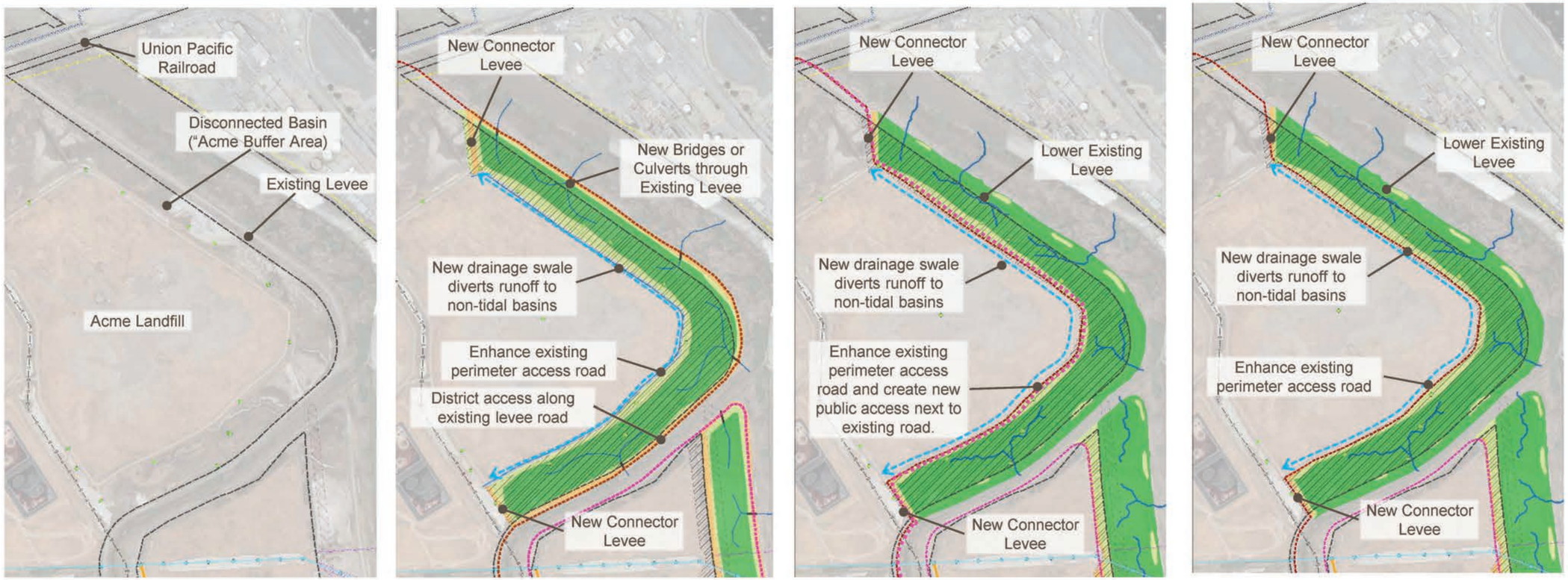


RELINGED WALNUT CHANNEL
PROPOSED LEVEE SECTION

(LOOKING NORTH)
(NTS)

SOURCE:
Milani and Associates, 2016 (Review Copy)

Figure 20
South Reach
Conco Re-Aligned Levee Section



Without Project

Alternative M1
Breach and Maintain Levee in Place

Alternative M2
Breach and Setback Levee with District and Public Access

Alternative M3
Breach and Setback Levee with Public Access Elsewhere

- Preserved/Enhanced Seasonal Wetland Complex
- Preserved Non-Tidal Wetlands
- New/Enhanced Tidal Wetland
- Transition
- Uplands

See Figure 2 for Utilities Legend

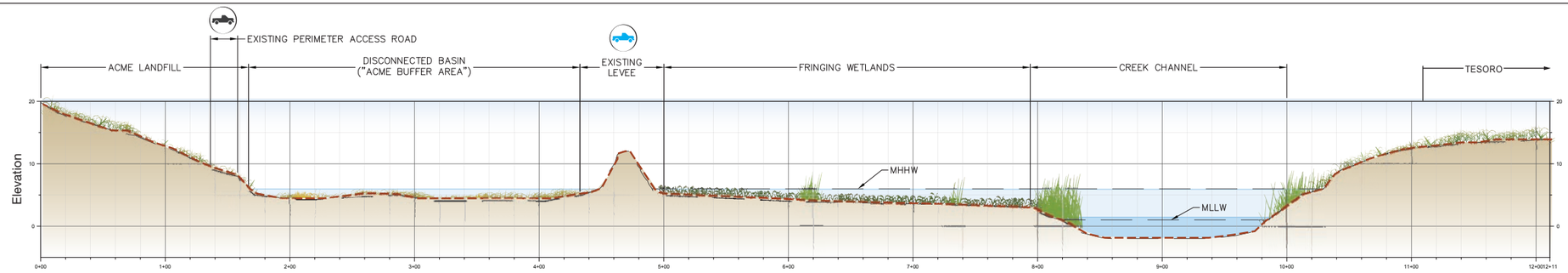
- Potential Expanded Project Footprint, owned by others
- Easements
- FCD
- CCCSD Access Road (Enhance/Re-align)
- FCD Property
- CCCSD Outfall

SOURCE:
ESA, 2017

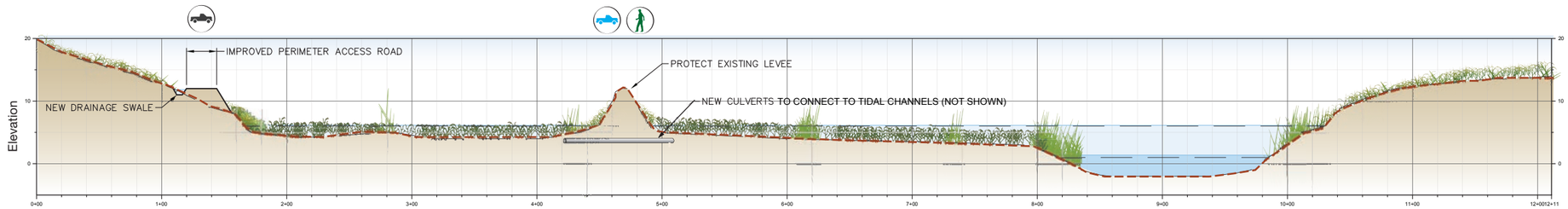
Lower Walnut Creek Restoration . D140703

Figure 21
Middle Reach Alternatives
Plan Views

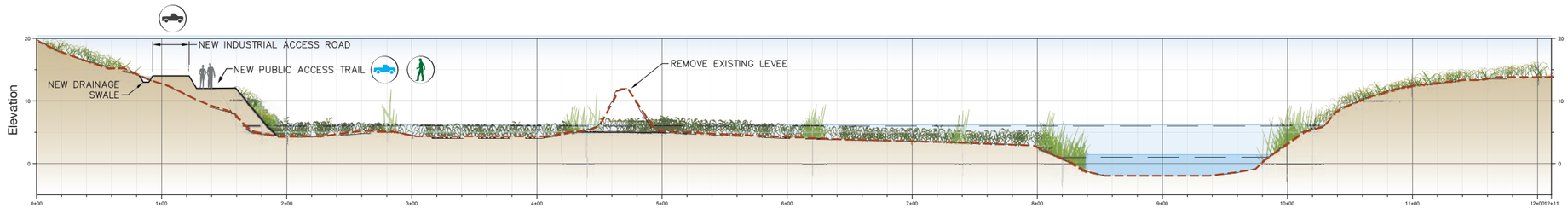
Without Project



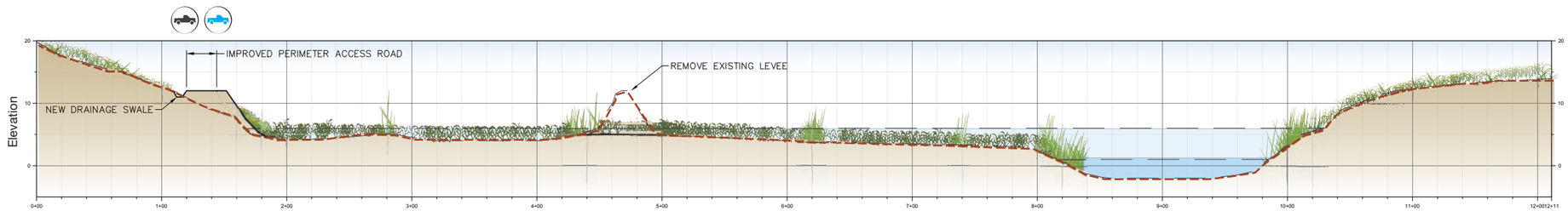
Alt M1
Breach and Maintain Levee in Place



Alt M2
Breach and Setback Levee with Public Access



Alt M3
Breach and Setback Levee with Public Access Elsewhere



Vertical exaggeration: 5x

SOURCE: ESA 2016

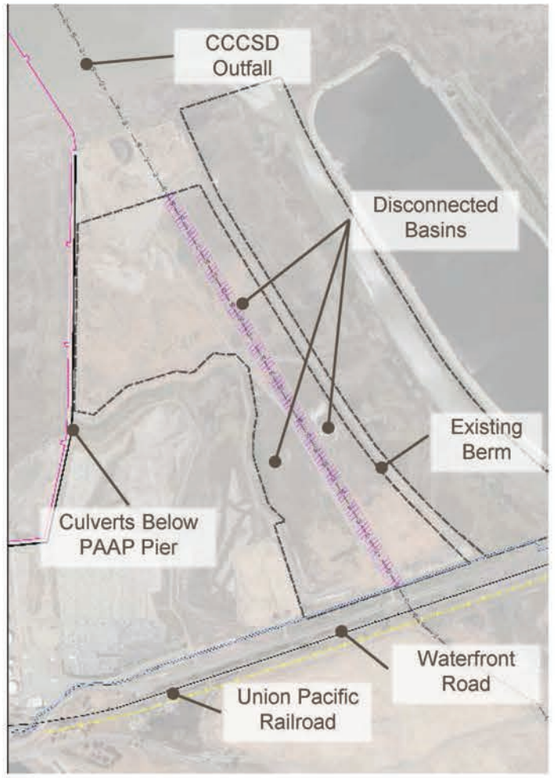
Private Access

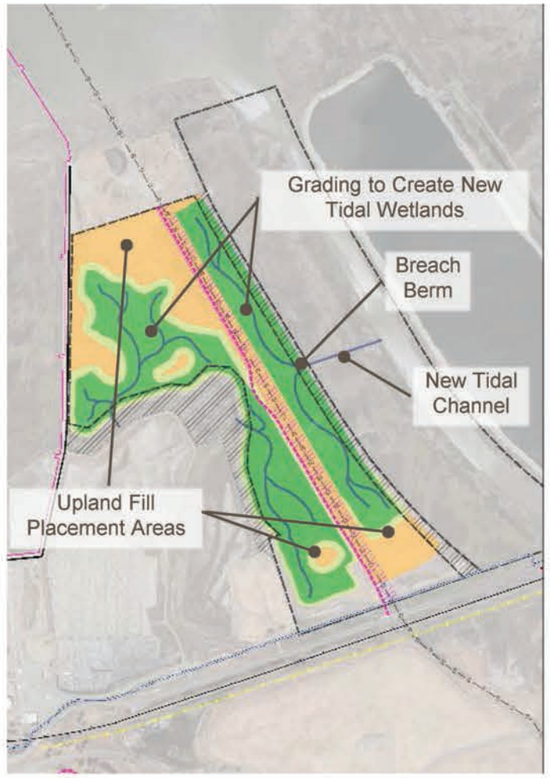
District Access

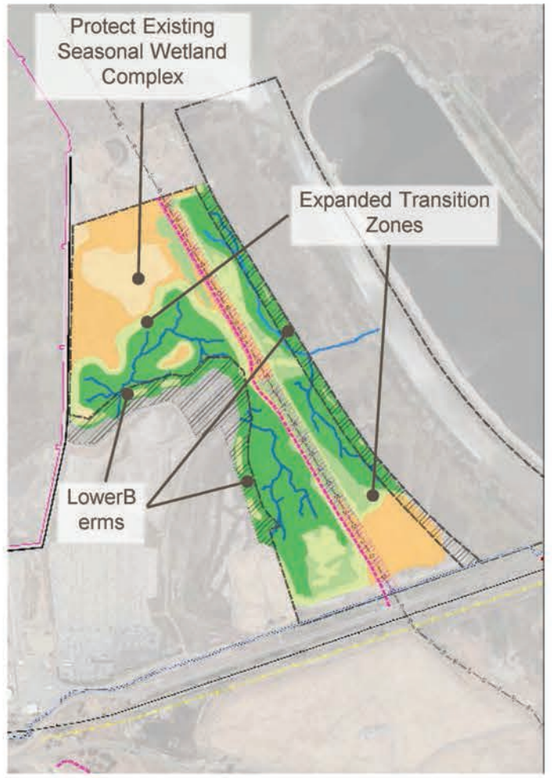
Public Recreational Access

Lower Walnut Creek Restoration Project. 140703.00

Figure 22
Middle Reach Alternatives
Cross Section Views







Without Project

Alternative N1
2004 Pacheco Marsh Restoration Plan

Alternative N2
Updated Pacheco Marsh Restoration Plan

Preserved/Enhanced Seasonal Wetland Complex
Preserved Non-Tidal Wetlands
New/Enhanced Tidal Wetland
Transition
Uplands
See Figure 2 for Utilities Legend

Potential Expanded Project Footprint, owned by others
Easements
FCD
CCCSD Access Road (Enhance/Re-align)
FCD Property
CCCSD Outfall

SOURCE:
ESA, 2017

Figure 23
North Reach Alternatives
Plan Views

Alternative 1

Alternative 2

Alternative 3

SOURCE: EBRPD

Lower Walnut Creek Restoration Project . D140703

Figure 24

East Bay Regional Parks District Trail Alternatives

Existing

+ 2 ft SLR

+ 5 ft SLR

SOURCE:
ESA 2017

Lower Walnut Creek Restoration Project . D140703

Figure 25
Habitat Sustainability with Sea-Level Rise
Preferred Alternative