LOS CERRITOS WETLANDS
FINAL CONCEPTUAL RESTORATION PLAN

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Executive Summary

This Los Cerritos Wetlands (LCW) Conceptual Restoration Plan (CRP) provides all information generated to date for the CRP effort carried out by the LCW Authority (LCWA). The LCWA is a Joint Powers Authority (JPA) consisting of the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy (RMC), State Coastal Conservancy, and Cities of Long Beach and Seal Beach. The CRP was funded through two grant funds, one each from the California Coastal Conservancy and the RMC, and the LCWA expresses gratitude for their respective contributions. The LCWA completed this effort by working with a Steering Committee (SC) and Technical Advisory Committee (TAC) to guide a consulting team through a course of investigations and analyses. The SC consists of staff from each member agency of the LCWA JPA. The TAC is composed of representatives of approximately 20 resource and permit agencies and research groups, covering federal, state, regional, and local jurisdictions. The public provided input to this investigation throughout its duration, with six workshops held over 28 months. Workshops were conducted to provide information and to solicit input, opinions, and experiences.

A series of technical deliverables were prepared and circulated to incrementally inform the process, and to enable development of restoration alternatives. Technical documents were reviewed and comments received and incorporated into final versions. This CRP utilizes all available previous technical documents, and analyzes the performance of three alternatives and a no action scenario from the present out into the future. The time period addressed by this CRP extends approximately 90 years into the future to account for future sea level rise (SLR). SLR projections are evolving, but have recently been provided as guidance by the State of California. This CRP considers the guidance and analyzes alternatives for a full range of the most recent SLR scenarios to the year 2100. The most recent SLR projections range from 1.5 feet to 5.5 feet at year 2100.

The early CRP effort consisted of generating information on the following components that are summarized herein:

- Existing site base data mapping and GIS database creation;
- Habitat assessment;
- Soil characteristics;
- Upstream activities impacting the wetlands;
- Hydrologic and hydraulic conditions;
- Opportunities and constraints (including oil operations and infrastructure); and
- Native American and cultural considerations.

Information is also compiled about regional wetland habitat needs, projected SLR, and opportunities and constraints for restoration of the LCW. The CRP effort included developing goals and objectives for restoration at the LCW. The LCWA then created a series of screening restoration alternatives for consideration by the agencies and public. Careful consideration led to a compilation of three restoration alternatives for full analyses. The alternatives were developed to provide the range of possible scenarios and an intermediate action. Alternatives include:

- Alternative 1 – Minimum Alteration – This alternative largely retains the existing site condition and character to the greatest extent, while expanding areas of tidal influence. Tides are introduced to the sites by improving existing tidal connections and providing new ones where needed. Oil infrastructure remains largely unchanged. Culverts are used nearly everywhere to convey tides, and only minimal topographic changes are made to enable water to penetrate into the sites as far as possible. Large areas of upland habitat remain. Existing Steam Shovel Slough is to remain unaffected.

- Alternative 2 – Moderate Alteration – This alternative largely reconfigures the sites with new channel networks on parcels north of the San Gabriel River, and retains existing channel networks on sites south of the San Gabriel River. Overall, this alternative emphasizes mid- and high marsh, and transitional habitat. Areas north of the San Gabriel River are lowered to provide low tidal wetland habitats, while areas south of the San Gabriel River remain relatively high with more mid- and high marsh, and supra-tidal habitats. Open channels convey tides everywhere except at the site referred to as the Isthmus Area in this report (see Figure 1-4). Oil operations are consolidated on all areas except the Isthmus Area. The majority of existing upland habitat areas remains unaltered. Existing Steam Shovel Slough is to remain unaffected.

- Alternative 3 – Maximum Alteration – This alternative reconfigures the sites with new channel networks at all areas. Overall, this alternative emphasizes subtidal, low, and mid-marsh. Smaller areas of transitional and upland habitat remain. Large portions of each area are lowered in elevation to provide low tidal wetland habitats, and the Orange County Los Alamitos (OC) Retarding Basin is converted to tidal wetlands, with removal of the pump station function as stormflows would be rerouted through the wetlands. Open channels convey tides everywhere except at the Isthmus Area. Oil production and exploration infrastructure is consolidated on all areas. Existing Steam Shovel Slough is to remain unaffected.

This CRP presents the preliminary designs and phasing of alternatives. Analyses were performed of their habitats, public accessibility, tidal hydrology, likely construction scenarios, maintenance requirements and construction costs. Analyses are summarized below by alternative. For public access, the LCW Stewardship Program (LCW SP) presently provides guided access to the site. Programming of public access by the LCW SP will continue and be developed as appropriate for each alternative.

As the LCW consists of multiple parcels, landowners, and colloquial names, a naming convention is provided below by major area to organize the discussion. Table 1-1 shows the current landowner names for the areas and the nomenclature used for this project. A figure is provided in the main body of the CRP showing these sites.

Table ES-0-1. LCW Parcel Naming Convention Used for the CRP

Landowner Site Name	CRP Parcel Name
LCW Partners Site (formerly), now Synergy, Loynes, Studebaker, Alamitos Bay Partners	Northern Area (North of E. 2nd Street)
LCWA Phase I, Marketplace Marsh, Bryant, Lyon	Central Area
LCWA Phase I, LADWP, Bryant	Isthmus
LCWA Phase II, Hellman, State Lands, OCFCD	Southeast Area (Southeast of HCC)

The alternatives and analyses in this CRP are not intended to serve as the basis for mitigation bank planning and design. Further design and analyses would be necessary before decisions about mitigation banking could be made from this work. However, designation of the site as a mitigation bank may be a viable future implementation mechanism that could serve as a valuable template or model for future projects.

Further concept design development of a hybrid alternative may occur at some point in the future to maximize benefits and minimize impacts of restoration. This work may include "mixing" and "matching" certain footprints of particular alternatives with those of different alternatives to create more alternatives that may provide more overall benefit than any of these individual conceptual alternatives.

Alternative 1 – Minimum Alteration

Habitat – Alternative 1 emphasizes diversity and resilience to SLR within the complex, largely at the expense of diversity and resilience within individual areas. Habitat is relatively diverse in the Northern Area for existing sea level, and is biased toward higher elevation habitats at the Central, Southeast, and Isthmus Areas. Areas above tidal influence (supra-tidal) predominate at all sites except the Northern Area. A SLR of 1.5 feet would result in habitat becoming more diverse at most sites with the least diversity at the Isthmus, while a SLR of 5.5 feet would result in habitat dominated by low elevation tidal wetland habitats (subtidal and mudflat).

Tidal Hydrology – Tides are muted in all areas except Steam Shovel Slough, where tides range fully under existing sea level. A SLR of 1.5 feet would result in tidal ranges expanding at all sites. A SLR of 5.5 feet would result in tidal ranges increasing farther, except at the Isthmus and Southeast Areas.

Public Access – In keeping with the minimal alteration theme, public access is generally limited to the peripheral areas and interior areas utilizing the existing access road network. This alternative provides the greatest number of low cost opportunities for trails to penetrate the site with additional interior access loops along existing compacted routes.

Construction Methods – Alternative 1 lends itself to construction in the dry using land-based equipment. Construction consists of installing culverts under roads and breaching certain levees. Work would likely require site dewatering and a moderate quantity of soil would require likely beneficial re-use and/or offsite disposal. Additional soil investigations are needed to identify if contamination exists on site that would require remediation and/or removal.

Maintenance Ramifications – Maintenance may be significant for Alternative 1 due to the number of culverts and isolated wetland cells. However, less trash removal will be required compared to other alternatives.

Construction Costs – Opinions of probable construction costs were determined based on the components included in each alternative. These estimates are comprehensive and include all hard costs and soft costs of construction. Hard costs are actual construction components (e.g., earthwork), and soft costs are process-related items such as permitting and environmental review. A range in costs was estimated, and this range in costs is provided on a per acre basis. Costs vary for each alternative depending on the level of complexity in the design, the anticipated amount of earth work, and probable material re-use and/or disposal options. The costs for Alternative 1 are the lowest of all scenarios, and its range of costs is between $106,000 and $159,000 per acre.

Alternative 2 – Moderate Alteration

Habitat – Alternative 2 is a relatively expensive approach that offers significant short-term functional gains in some areas with long-term resilience limited to the Southeastern Area. Habitat is relatively diverse at the Northern and Central Areas for existing sea level, and is biased toward higher elevation habitats at the Southeast Areas and Isthmus Area. Areas above tidal influence (supra-tidal) predominate at the Isthmus and Southeastern Areas. Habitat patterns remain similar for a SLR of 1.5 feet, but would become dominated by low elevation tidal wetland habitats for a SLR of 5.5 feet.

Tidal Hydrology – Areas north of the San Gabriel River are full tidal, and areas south of the San Gabriel River are muted tidal. A SLR of 1.5 feet would result in tidal ranges expanding at all sites. A SLR of 5.5 feet would result in tidal ranges increasing farther, except at Zedler Marsh in the Isthmus Area.

Public Access – Public access includes a primary trail system at the periphery. Since this alternative proposes more topographic alteration, there are fewer opportunities to follow existing developed access infrastructure. Therefore, additional opportunities to penetrate the site with access points and loops will require new alignments. In addition, this alternative provides opportunities for enhanced urban connectivity.

Construction Methods – Alternative 2 also lends itself to construction in the dry using land-based equipment. If desired, water-based dredging could occur in the Northern Area. Construction would likely consist of earthwork to install a new channel system and to consolidate oil operations on multiple sites. Land-based work would require significant dewatering, and a large quantity of soil would likely require beneficial re-use and/or offsite disposal. Additional soil investigations are needed to identify if contamination exists on site that would require remediation and/or removal.

Maintenance Ramifications – Larger-scale restoration over broad areas may generate more maintenance associated with wetlands restoration, such as erosion and sedimentation control. Trash removal will increase compared to Alternative 1. Oil is consolidated so less human-wetland interaction will occur and less human-use-related maintenance is required for Alternative 2.

Construction Costs – Opinions of probable construction costs for Alternative 2 are between those of the other two alternatives. The range of probable costs is between $158,000 and $260,000 per acre.

Alternative 3 - Maximum Alteration

Habitat – Alternative 3 yields significant intertidal habitat within each area, but has minimal resilience to SLR. Habitat is diverse at all areas for existing sea level. Habitat patterns remain similar for a SLR of 1.5 feet, but become dominated by low elevation tidal wetland habitats for a SLR of 5.5 feet.

Tidal Hydrology – All areas are full tidal, except the Isthmus Area, which is still muted tidal. A SLR of 1.5 feet would result in tidal ranges expanding at all sites. A SLR of 5.5 feet would result in tidal ranges increasing farther, except at the Isthmus Area due to culvert constraints.

Public Access – Public access includes a primary trail system at the periphery. Since this alternative proposes the most topographic alteration, there are the least number of opportunities to follow existing developed access infrastructure. Therefore, most opportunities to penetrate the site with access points and loops will require new alignments. In addition, this alternative provides opportunities for enhanced urban connectivity and shows three possible themes by which access could be developed: "perimeter," "loop," and "urban connectivity," in order of increasing access opportunity.

Construction Methods – Alternative 3 lends itself to both dredging and/or construction in the dry using land-based equipment. Water-based dredging could occur in all areas except the Isthmus Area. Construction would likely consist of earthwork to install new channels and to consolidate oil operations on all sites. Land-based work would require significant dewatering. A very large quantity of soil would likely require beneficial re-use and/or offsite disposal, even with proposed filling at the OC Retarding Basin. Additional soil investigations are needed to identify if contamination exists on site that would require remediation and/or removal.

Maintenance Ramifications – Large-scale restoration over broad areas may generate more maintenance associated with wetlands restoration, such as trash removal, and erosion and sediment control. Oil is consolidated so less human-wetland interaction will occur and less human-use-related maintenance is required for Alternative 3.

Construction Costs – Opinions of probable construction costs for Alternative 3 are higher than those of the other two alternatives. The range of probable costs is between $273,000 and $473,000 per acre.

No Project – Existing Conditions

Habitat – No Project preserves existing habitat, and the site would continue to be managed for non-habitat uses, so non-tidal habitats will continue to be low-functioning. Habitat is highly disturbed over large areas, with smaller high value sites. Supra-tidal areas dominate at all sites except Steam Shovel Slough. A SLR of 1.5 feet would result in relatively little change in habitat, while a SLR of 5.5 feet may result in higher groundwater and greater ponding.

Tidal Hydrology – Portions of three areas receive tides, while the Central Area possesses no functioning tidal connection. Tides are muted in all areas except Steam Shovel Slough, where tides range fully under existing sea level. A SLR of 1.5 feet would result in slightly increased tide ranges at existing sites subject to tidal action. A SLR of 5.5 feet would result in reduced tidal range at muted tidal areas.

Public Access – Public access is limited to the peripheral area on existing trails, without opportunities to penetrate the site except with a landowner or owner's representative.

Construction Methods – No construction would occur for the No Project Alternative.

Maintenance Ramifications – Maintenance would remain modest for the No Project Alternative, relying on the existing LCW SP.

Construction Costs – No construction costs would be incurred for No Project.

No particular alternative is proposed as the preferred alternative from this work. The preferred alternative will be identified in the environmental document after evaluation and public comment. One possible scenario that may result from preliminary engineering and environmental review is a “hybrid” alternative that mixes footprints of different alternatives over the various project areas. Certain footprints may be more suitable for particular project areas, rather than the overall treatment of a particular alternative driving what occurs at multiple sites. For example, the Alternative 3 Maximum Alteration Alternative in the Northern Area will preserve the existing estuary of Steam Shovel Slough, while the Alternative 2 footprint may be more suitable at the Southeast Area due to less impact to existing habitat and greater opportunity for higher habitats to increase resilience during SLR. These decisions of restoration refinements would come at a subsequent phase.

Other items presented in this report include implementation guidelines and next steps. Implementation guidelines consist of restoration recommendations and specifications. Next steps are a list of future actions, timelines, and budgets. The project will require additional funding, and may take up to five years to implement the first phase if work continues uninterrupted.

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List of Acronyms

BMP	Best Management Practices
CDFW	California Department of Fish & Wildlife
CDP	Coastal Development Permits
CEQA	California Environmental Quality Act
CLOMAR	Conditional Letter of Map Revision
CRAM	California Rapid Assessment Method
CRP	Conceptual Restoration Plan
CSCC	California State Coastal Conservancy
CSULB	California State University, Long Beach
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HCC	Haynes Cooling Channel
JPA	Joint Powers Authority
LAOH	Los Angeles Outer Harbor
LCW	Los Cerritos Wetlands
LCW SP	LCW Stewardship Program
LCWA	Los Cerritos Wetlands Authority
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MOA	Memorandum of Agreement
MSL	Mean Sea Level
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NERRS	National Estuarine Research Reserve System
NOAA	National Ocean and Atmosphere Administration
NPDES	National Pollutant Discharge Elimination System
OCFCD	Orange County Flood Control District
OTD	Offer to Dedicate
NWR	Naval Weapons Reserve
PAP	Public Access Plan
PCH	Pacific Coast Highway
RFP	Request for Proposal
RMC	Rivers and Mountains Conservancy
SC	Steering Committee
SELC	San Elijo Lagoon Conservancy
SGBT	San Gabriel Bicycle Trail
SLR	Sea Level Rise
TAC	Technical Advisory Committee
TEA	Tidal Epoch Analysis
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish & Wildlife Service
WRP	Wetland Recovery Project

1.0 Overview/Introduction

This Los Cerritos Wetlands (LCW) Conceptual Restoration Plan (CRP) consists of preparation of a set of feasibility-level studies addressing wetland restoration on the site that is 565 acres in area. This document is a restoration alternatives analyses report coupled with restoration planning directions. It presents results of all the work to quantify the performance of each alternative and elements of restoration planning needed for implementation. It goes beyond just an analyses document, as it also serves to guide the decision-making and future planning for project implementation. The terms "the plan" and the "CRP" are used interchangeably throughout this document.

The project area is located within both Los Angeles and Orange Counties and it straddles the San Gabriel River. While being former river floodplain, the site still possesses sensitive and degraded wetlands. Oil production also exists on the site, and perimeter development constrains site uses. Being in an urbanized area lends the opportunity to provide a valuable learning landscape for multiple types of user groups. The CRP is funded by the LCW Authority (LCWA), which is a joint powers authority (JPA) including the four following agencies:

- San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy (RMC);
- California State Coastal Conservancy (CSCC);
- City of Long Beach; and
- City of Seal Beach.

Staff representatives of the LCWA member agencies comprise the Steering Committee (SC) that directs the CRP. The LCWA commissioned preparation of schematic design documents of a multi-disciplinary type of project that meets the needs of the community and environment. The work is performed for both the base approximately 200-acre area currently in public ownership (170 acres owned by the LCWA, 34 acres owned by the City of Long Beach, and 5 acres owned by the California State Lands Commission), and the entire 565-acre area that is partially owned by others.

The LCW complex affords the opportunity to restore this complex of salt marsh, seasonal and other freshwater wetlands, open water, and transitional/upland habitat. The general location of the LCW Complex is shown in Figure 1-1.

Funding of this project is through grants from the RMC and CSCC.

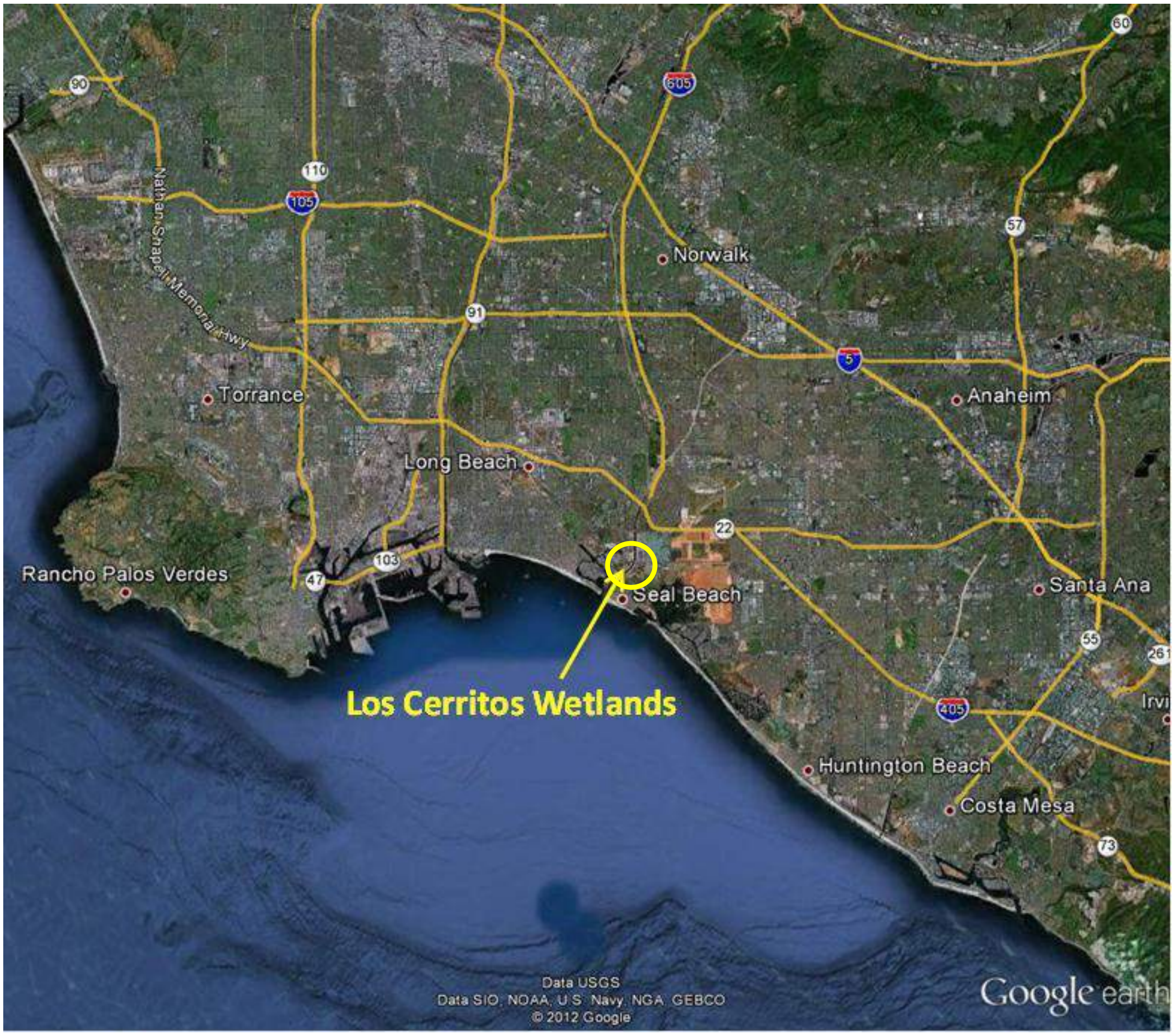


Figure 1-1. Vicinity Map

The LCW falls within both the City of Long Beach (Los Angeles County) and the City of Seal Beach (Orange County). It is generally bounded by commercial areas to the south, industry to the north, and residential and mixed use areas to the east and west. Several waterways, including the Los Cerritos Channel, the San Gabriel River, and Haynes Cooling Channel (HCC), run through or adjacent to the site.

Historically, as late as 1895, the LCW Complex covered approximately 2,400 acres and stretched approximately two miles inland. The extent of this vast LCW Complex can be seen in the overlay of Figure 1-2. Over the past century, the wetlands have been used for farming (cattle and beets in the 1800s and very early 1900s), oil production, landfills, burn dumps, and urban development. Today, only remnants of the historical wetlands occur in degraded patches.

Figure 1-2. Overlay of Historic Wetlands on Modern Day Aerial Photo

The CRP provides a roadmap for habitat enhancement and improved public access for the approximately 200 acres currently owned by the public (LCWA, City of Long Beach, and State) knows as the Base Project," and potentially the entire 565-acre complex that includes land currently owned by others (multiple private landowners, the City of Los Angeles, and the County of Orange). Figure 1-3 shows the boundaries of the entire LCW Complex. Figure 1-4 shows specific areas and the land ownership within the LCW Complex.

By necessity, site locations are referred to throughout this report. As the LCW consists of multiple parcels, landowners, and colloquial names, a naming convention is provided below by major area to organize the discussion. Table 1-1 shows the current landowner names for the areas and the nomenclature used for this project, and Figure 1-5 shows their locations. Channels exist outside of the parcels that are not included in the table, but comprise the San Gabriel River, Los Cerritos Channel, and the HCC.

Table 1-1. LCW Parcel Naming Convention Used for the CRP

Landowner Site Name	CRP Parcel Name
LCW Partners Site (formerly), now Synergy, Loynes, Studebaker, Alamitos Bay Partners	Northern Area (North of E. 2nd Street)
LCWA Phase I, Marketplace Marsh, Bryant, Lyon	Central Area
LCWA Phase I, LA DWP, Bryant	Isthmus
LCWA Phase II, Hellman, State Lands, OCFCD	Southeast Area (Southeast of HCC)

Figure 1-3. Map of Entire LCW Complex

Figure 1-4. Map of Specific Areas

Figure 1-5. CRP Parcel Nomenclature

1.1 Purpose of the Plan

The purpose of this plan is to present a cohesive conceptual level approach for restoration of tidal wetlands and associated habitats within the LCW Complex. This plan provides the LCWA and its partners with guidance in developing project-specific plans and, ultimately, the implementation of large-scale tidal wetland restoration conducted through a single project or multiple projects implemented in phases. This CRP is the result of a collaborative process. In developing this plan, the LCWA SC provided guidance, a Technical Advisory Committee (TAC) made up primarily of agency representatives contributed ideas, and local citizens provided input through multiple public workshops.

The early chapters of the CRP discuss the rationale that was used to develop conceptual level restoration strategies, including goals and objectives for the restoration project, an overview of the historical ecology of the site, a regional and local needs analysis, studies related to the baseline conditions of the site, analysis of the potential impacts of climate change (sea level rise [SLR]) on restored habitats, and identification of the various opportunities and constraints related to the site. Using this background information, six different screening alternatives were developed and presented to the TAC and the public for input. Preferred themes and approaches from each screening alternative were integrated into three conceptual-level designs. These were further analyzed to determine the general feasibility and rough costs of different approaches.

The conceptual designs and the rationale provided to support those designs are based on the best available science and input from the LCWA SC, the TAC, and the public. While there was not necessarily consensus on all aspects of this plan from these groups, six underlying principles emerged that had very wide support. First, restoration should emphasize tidal salt marsh and related habitats (including sub-tidal, wetland-upland transition, and uplands). Second, planning should occur on a complex-wide basis despite complicated land ownership in the area. Third, all restoration strategies should seek to be resilient in the face of sea level rise over the next 100 years. Fourth, restoration designs should not cater specifically to potential or known sources of mitigation funding since this might lead to designs that emphasize habitat for a limited suite of species (*e.g.,* sub-tidal habitat for fish). Fifth, all restoration strategies should emphasize the restoration of natural ecosystem processes in order to create self-sustaining habitats. And sixth, improving public access and educational opportunities should be part of the restoration process and plan.

The conceptual restoration designs presented in this plan do not include many of the details that will be an important part of subsequent plans. The basic designs presented are intended to illustrate three alternative restoration strategies and serve as a foundation for hydrologic modeling. Three strategies are presented to illustrate how different restoration approaches will vary in a wide number of ways, including implementation cost, permitting challenges, habitat diversity, and resilience to SLR. The hydrologic modeling was done to assess the relative effectiveness of different strategies for returning tidal flow to different areas and assess how habitats will change as sea level rises. Each alternative design offers tradeoffs that will need to be weighed as project-specific grading and implementation plans are developed in the future. Different strategies may be appropriate on different parcels and at different points in the future. Further concept design development of a hybrid alternative may occur at some point in the future to maximize benefits and minimize impacts of restoration. This work may include “mixing” and “matching” certain footprints of particular alternatives with those of different alternatives to create more alternatives that may provide more overall benefit than any of these individual conceptual alternatives.

Developing this CRP is the first major step toward the ultimate goal of implementing large-scale habitat restoration at the LCW. It is the first in what will ultimately be a set of tiered documents, with subsequent plans focusing on specific projects within the complex and containing more detailed designs and analyses. These subsequent plans will use the guiding principles and background information presented in this plan to assure all the restoration actions on the site are synergistic and contribute to the larger vision.

1.2 Development of the Plan

The CRP was developed to fulfill the need for restoration planning on the LCW site. As the LCW site is the subject of much public scrutiny and it represents an important natural resource, the public and the resource and permit agencies were consulted for input. The LCWA took this input and prepared the plan accordingly.

1.2.1 Public Involvement

Public involvement consisted of conducting six public meetings starting in November 2011 and ending in March 2014. The process of public involvement included the following tasks and subtasks:

1. Create Los Cerritos Conceptual Design Website:
    a. Introduce the project team;
    b. Communicate updates of the design;
    c. Communicate updates from general public meetings.

2. Develop and Maintain a Stakeholder Email Database:
    a. Collect emails throughout the process;
    b. Email announcements and other pertinent information at key milestones.
3. Prepare logistics for general public workshops:
    a. Prepare announcements, invitations, agendas, etc.;
    b. Identify potential meeting places (Aquarium of the Pacific, local libraries and meeting places, etc.);
    c. Organize materials (photos, projectors, education materials, hand-outs, easels, sign-in sheets, name-tags, etc.);
    d. Organize talking points and discussion goals;
    e. Establish meeting dates.
4. Facilitate up to six workshops:
    a. Workshop #1 - Spirit: Initial general public meeting at the project start-up;
    b. Workshop #2- Earth: Report results on information gathered in baseline studies;
    c. Workshop #3 - Water: Identify opportunities and constraints of the wetlands and urban landscape, and input toward alternatives;
    d. Workshop #4 - Air: Introduce screening alternatives and solicit input;
    e. Workshop #5 - Fire: Present drafts of the three restoration alternatives and get input while moving toward consensus;
    f. Workshop #6 - Present Restoration Plan: build consensus and wrap-up the project while pointing toward the next steps.

The project team created the LCW Conceptual Design Website that posts the project scope, schedule, performance goals, pertinent educational materials, and relevant source information. The website also announces community workshops. Notes from the workshops are included in Appendix A to this report. The website created for the LCW Conceptual Design will continue to exist and be managed by the LCWA. Two addresses can be used to access the information, consisting of intoloscerritoswetlands.org and lcwetlands.org.

1.2.2 TAC Involvement

The TAC was also a critical advisory and review tool. TAC members included the following agencies:

- NOAA's National Marine Fisheries Service (NMFS)
- U.S. Fish & Wildlife Service (USFWS)
- CA Department of Fish & Wildlife (CDFW)
- L.A. Regional Water Quality Control Board (RWQCB)
- S.A. Regional Water Quality Control Board
- U.S. Army Corps of Engineers (USACE)
- CA Coastal Commission (CCC)
- CA State Lands Commission (SLC)
- Port of Long Beach (POLB)
- County of Orange Engineering/PM Section
- County of Orange, Public Works

- County of LA, Watershed Management Division
- So. Cal. Water Resources Research Project (SCWRRP)
- Cal. State University, Long Beach (CSULB)
- Santa Monica Bay Restoration Commission
- CSCC
- City of Long Beach
- City of Seal Beach
- RMC

The LCWA conducted eight meetings with the TAC, approximately quarterly, throughout the project period. The work included scheduling, providing agendas, making progress presentations, taking notes, and providing minutes. The LCWA reported progress to the group and solicited their input, then took suggested requests or direction away from the meeting for work to be done before the next meeting. Minutes with action items from each meeting were prepared and disseminated back to the TAC and SC after each meeting.

The TAC served to oversee progress and provide advice to avoid pitfalls that could render the project unable to be permitted or approved for implementation. Summaries of the TAC meetings are provided in Appendix B to this report.

1.3 Format of the Plan

The CRP is structured to include background information, analyses of alternatives for future decision-making, and then recommendations for implementation. The actual analyses of alternatives consist of the information below:

- **Descriptions:** A description of each final alternative including infrastructure changes, hydrology, benefits, impacts, and a table specifying pre- and post-project habitat types by acre.
- **Preliminary Designs:** Preliminary designs (schematic design document) for each restoration alternative including grading plans, cross-sections, habitat elevation bands, and structures.
- **Hydrodynamic Modeling:** Hydrodynamic modeling to estimate the size of channels and types of connections or control structures required to achieve the targeted tide range and inundation frequency of the wetlands, and to maintain the current level of flood protection.
- **Maintenance:** Long-term maintenance needs including sediment removal to maintain water control structure functions, channel network functions, habitat areas, and water quality swales. Maintenance cost estimates will be prepared to facilitate comparison between restoration alternatives as part of the alternative evaluation process.
- **Public Access:** Public access plan (PAP) component describing how the public will access and experience the property, as well as how the public access and interpretation concepts are integrated into each restoration alternative.
- **Construction Methods:** Construction methods are identified and assessed to provide information relative to constructability and to provide input to the development of construction cost estimates.

- **Cost Estimates:** Cost estimates for all phases of project implementation including preliminary engineering, environmental review, final engineering, permitting, construction, construction management, construction monitoring, monitoring, and management.
- **Summary Matrix:** A matrix that summarizes the pros and cons for each restoration alternative. The summary matrix shows the advantages and disadvantages of each alternative.

2.0 Goals and Objectives

The CRP goals and objectives were developed with the LCWA SC and TAC and then were vetted through the public. The final set of restoration goals and objectives is listed below, with reference to directions provided by the LCWA in their Request for Proposal (RFP) in blue font. These goals and objectives were the principles guiding site studies and development and analyses of restoration alternatives. This document refers to this list in subsequent sections.

- Restore tidal wetland processes and functions to the maximum extent possible. *(RFP: Restore wetland processes and functions.)*

  Objectives:

  - Increase estuarine habitat with a mix of tidal channels, mudflat, salt marsh, and brackish/freshwater marsh and ponds.
  - Provide adequate area for wetland-upland ecotone and upland habitat to support wetlands.
  - Restore and maintain habitat that supports important life history phases for species of special concern (*e.g.*, federal and state listed species), essential fish habitat, and migratory birds as appropriate.

- Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance. *(RFP: Maximize contiguous wetland areas and minimize the edge between wetlands and sources of disturbance.)*

  Objectives:

  - Maximize wildlife corridors within the LCW Complex and between the LCW Complex and adjacent natural areas within the region. *(RFP: Restore the complex as habitat for resident bird species and migratory birds along the Pacific Flyway.)*
  - Incorporate native upland vegetation buffers between habitat areas and human development to mitigate urban impacts (*e.g.*, noise, light, unauthorized human encroachment, domestic animals, wastewater runoff) and reduce invasion by non-native organisms. *(RFP: Ensure the long-term viability and sustainability of the project in the face of such threats as urbanization, SLR and other impacts of climate change* (latter items addressed by goal #5 below).*)*
  - Design the edges of the LCW Complex to be respectful and compatible with current neighboring land uses.

- Create a public access and interpretive program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience. *(RFP: Create a public access and interpretive program that is practical and economically feasible and will ensure a memorable visitor experience.)*

  Objectives:

  - Build upon existing beneficial uses.
  - Minimize public impacts on habitat/wildlife use of the LCW Complex.

    - Design interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community.
    - Solicit and address feedback from members of the surrounding community and other interested parties.

- Incorporate phasing of implementation to accommodate existing and future potential changes in land ownership and usage, and as funding becomes available.

  Objectives:

    - Include projects that can be implemented as industrial operations are phased out and other properties are acquired over the near-, mid- and long-term (next 5-25-100 years).
    - Investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings.
    - Remove/realign/consolidate existing infrastructure (roads, pipelines, etc.) and accommodate future potential changes in infrastructure, to the maximum extent feasible.

- Strive for long-term restoration success.

  Objectives:

    - Implement an adaptive management framework that is sustainable.
    - Restore habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife.
    - Design habitats that will accommodate climate changes, *e.g.*, incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels. *(RFP: Ensure the long-term viability and sustainability of the project in the face of such threats as urbanization* (addressed by goal #2 above)*, SLR and other impacts of climate change.)*
    - Provide economic benefit to the region.

- Integrate experimental actions and research into the project, where appropriate, to inform restoration and management actions for this project.

  Objectives:

    - Include opportunities for potential experiments and pilot projects to address gaps in information (*e.g.*, effect of warm river water on salt marsh ecosystem) that are protective of sensitive habitat and wildlife and that can be used to adaptively manage the restoration project.
    - Include areas on the site, where appropriate, that prioritize research opportunities (such as those for adaptive management) over habitat sensitivities.

3.0 Biological Framework for Restoration Planning

Ecological restoration is a process through which degraded landscapes are manipulated to improve the ecological integrity and sustainability of natural habitats. One of the major goals of the restoration planning process is to determine which habitats should be restored. Ideally, ecological restoration seeks to restore the habitat or habitats that were present on a site before some, usually human-caused, disturbance altered or degraded them. While most projects start from the assumption that returning a site to some historical condition is preferred, this is an oversimplified view of the role of restoration and, in reality, is only rarely the case.

Most projects run into two general problems. First, humans have been altering the natural ecosystems in California in different ways for thousands of years. The obvious question becomes, which point in history do you choose as your target? Pre-human arrival? Pre-European arrival? Consistent with the earliest maps and historical descriptions? There is no universally agreed upon answer to this question. In fact, any one of these targets may be valid for a given site.

Second, even if one can satisfactorily decide on an historical target, it may be impossible to restore the important processes that are necessary for sustaining that habitat given current constraints. This is especially true in urban areas where issues like flood control, transportation and existing economically important uses often trump restorative actions like removing levees to restore hydrology, moving roads to restore ecological connectivity or removing infrastructure to increase the amount of area available for restoration. There is increasing consensus that, with changing climates and the increasing influence of non-native species, many biological communities and habitats are moving toward “no analog” conditions. With even the least altered sites shifting away from historical conditions as hydrology, nutrient and sediment dynamics change, native species ranges shift, and invasive species colonize, the need to maintain resilient ecosystems capable of supporting California’s natural heritage is as important as ever.

A more realistic goal for most restoration projects it to identify the extent to which important processes can be restored and, in turn, how those restored processes can support ecological communities with higher ecological functioning than current communities provide. In most cases, the target biological communities for a site will be closely related to what was historically present on the site. In other cases though, a site may be so constrained by large-scale alterations within the landscape that returning the site to what is believed was the historical condition is no longer possible.

Since it is not sufficient to simply define the goals of an ecological restoration project by what types of habitat were present in the past, every project needs a plausible framework for making decisions about what types of habitats are appropriate. There are multiple frameworks available for making such decisions. One of the most common is a regulatory (mitigation) framework, where a target habitat is determined through a permitting process and then an appropriate site must be found where that habitat can be created, restored or enhanced. In contrast to that approach, this plan is using a biological framework.

Using a biological framework for determining appropriate restoration targets requires analysis of five primary factors. First, the historical ecology of the project site and surrounding area is analyzed. Depending on the amount of information available, this process should provide insight into the types of habitat the site supported in the past, which is typically a good starting point for determining the types of habitat it could support today. Second, the degree to which important ecosystem processes are intact or altered should be analyzed. The extent to which certain degraded processes can or cannot be restored will determine which, if any, of the historical habitats can be restored. Third, an analysis of local and regional needs can help fine-tune biological targets. Some of the needs might be biological, such as supporting locally or regionally rare and extirpated habitats and species, or socioeconomic, such as education, passive recreation or water quality. Fourth, an analysis should occur of the resilience of restored habitats under future conditions. This can include somewhat predictable factors such as SLR as well as stochastic events that are difficult to predict and may be natural or man-made. Finally, an analysis of the existing conditions of the site can identify areas where different types of actions might be more or less appropriate.

The remainder of this chapter will provide a preliminary analysis of these five primary factors that have guided the approach to developing a CRP for the LCW. While these factors are the most important in this conceptual planning phase, additional factors will need to be considered as more detailed restoration plans are developed in the future. These more detailed plans will rely on additional information about the sites, which may need to be gathered (*e.g.*, soil analyses) or may come from elsewhere over time (*e.g.*, updated guidance on SLR, changes in land ownership, etc.). This additional information will inform the extent to which different designs vary in terms of: 1) cost, 2) balancing short-term functional gains against longer-term resilience, 3) assessing the relative risk associated with attaining project goals, and 4) relative difficulty in attaining regulatory permits, among other factors.

3.1 Historical Ecology

Historical ecology is a study of how natural landscapes change over time. The field tends to focus primarily on how humans drive changes in natural systems, but it is important to remember that not all changes are directly related to humans. Atmospheric, geological and climatological processes, for instance, drive ecological change free of human influence (until recent times at least). Nevertheless, once humans are part of a landscape, they almost invariably have profound effects on how ecosystems function.

A basic tenant of historical ecology is that different societies alter ecological landscapes in different ways. Societies in turn adapt their practices to the altered landscapes and, over time, societies and landscapes evolve together. In Southern California, there are generally three major shifts in human uses of the landscape: 1) early human arrival, 2) the Spanish and Mexican years, and 3) the population boom.

Humans probably arrived in Southern California about 13,000 years ago, during the last major period of glaciation. Over the ensuing millennia, the climate warmed and human societies interacted with the natural landscapes in many ways. During the early part of this period, the diverse megafauna that characterized much of California went extinct. The loss of these huge grazers probably had a significant impact on plant communities. These human societies manipulated landscapes with fire (intentionally or otherwise), moved species around (intentionally or otherwise), and employed various forms of agriculture. All in all, it is safe to assume that by the time the first Europeans arrived in California, the landscape looked very different than it did when humans first arrived.

The Portola Expedition of 1769 was among the first overland explorations of Southern California. Journals from this expedition provide some tantalizing accounts of what the landscapes looked like and how the Native Americans lived and managed the land. The Spanish colonists, though, soon brought an end to most of the traditional hunting, gathering, and agricultural practices of the Native American societies in the region. The natural landscapes of Southern California would undergo huge changes again. The Spanish introduced many plants (intentionally and unintentionally) and livestock to California. Agriculture expanded using Native American slave labor and ranching became the backbone of the new economy. The first Spanish Ranchos were established in 1784 in what are now Los Angeles and Orange Counties. The 167,000-acre Rancho Los Nietos (granted in 1784) stretched along the coast from the Santa Ana River to the Los Angeles River, and included present-day Long Beach and Seal Beach. Cattle ranged throughout the landscape and had devastating impacts on natural communities. During droughts, cattle would eat almost anything that was green; leaving vast tracks of land totally unvegetated. In the winter of 1861-62, a 43-day-long storm battered California, causing catastrophic flooding and severe erosion (Dettinger and Ingram 2012, Ingram 2013). Significant amounts of the eroded soil surely wound up in our coastal wetlands.

A well-documented example of how our coastal wetlands were altered during these times is found at Goleta Slough near Santa Barbara. Early explorers in the 1600s sailed large ships into what was then an open bay. Cattle and sheep denuded the surrounding hillsides throughout the 1800s and, by the time the area was mapped in the 1870s, the bay had almost completely filled in with sediment and had been converted to an intertidal marsh. This example is probably an extreme case compared to most other coastal wetlands in Southern California, however it is important to remember that by the time the first detailed maps were made of our coast in 1873, there had been over 100 years of major modifications to the landscapes of Southern California by European colonists.

It is also important to remember that Southern California's landscapes have never been static. They respond in dramatic ways to droughts, floods, geologic shifts (uplift or subsidence), tsunamis, and large wave events, among other natural forces. This is especially true along the coast from Pt. Fermin to Newport Bay, an area commonly referred to as the San Pedro Bay (Wiegel 2009). This stretch of coast is a vast delta formed by the Los Angeles, San Gabriel, and Santa Ana Rivers (Wiegel 2009). We know these rivers repeatedly shifted course over the last several hundred years in response to these forces (Wiegel 2009, Stein, et. al. 2007). River-mouth estuaries formed on the sediment deposited by these rivers wherever their mouths happened to be over many hundreds or thousands of years (Wiegel 2009). The result was a vast complex of coastal wetlands that were intermittently connected to rivers.

Individual wetland systems probably functioned differently during periods when they were connected to riverine inputs compared to periods when river mouths shifted elsewhere. For instance, for some period prior to the 1860s, Alamitos Bay was not the location of the mouth of the San Gabriel River. It was in response to the great floods of the 1860s that the San Gabriel River changed course and established (re-established?) its mouth at Alamitos Bay. Prior to this, it was a tributary of the Los Angeles River (Stein, et. al. 2007) for an unknown number of years. Historical accounts even indicate that during large floods in the early 1900s, the Santa Ana River shifted course and joined the San Gabriel River to flow out through Alamitos Bay (Wiegel 2009).

There is also evidence to suggest that during prolonged dry periods, these rivers probably didn't even have defined channels all the way to the estuaries, but rather ended as distributaries on the vast coastal plain (Wiegel 2009). All of this serves to remind us that choosing a point in time to define a restoration target, no matter how carefully researched, ultimately yields an arbitrary result. The lesson of the historical ecology of the area is that one should seek to restore dynamic natural processes in order to create resilient natural ecosystems. Unfortunately, most of the dynamic nature that characterized the San Gabriel River and the estuary at Alamitos Bay has been irrevocably lost over the last hundred years or so due to urbanization, flood control infrastructure, and water supply infrastructure.

By 1900, the population of Los Angeles was over 100,000 people. In 1921, oil was discovered in the Long Beach Oil Field and soon after in the Seal Beach Oil Field. During the first decades of the 20^{th} Century, parts of the Alamitos Bay Wetlands were being filled for development or dredged to create marinas and harbors. The channelization of the lower San Gabriel River started in about 1932 and was completed by 1941 (Wiegel 2009). The earliest aerial photos of the region, which date to the late 1920s, show significant loss and fragmentation of coastal wetlands. This trend continued through the ensuing decades.

Currently, most of the vast wetland complex that existed at Alamitos Bay has been irrevocably converted to other uses (mostly development and sub-tidal habitat). The focus of this plan is to identify restoration opportunities where they remain, namely within the LCW. Uncovering the historical ecology of the region and the actual project site are key pieces of this planning process. The preponderance of the historical evidence suggests that this region supported a large intertidal wetland complex, probably for millennia. The earliest maps of the area suggest the project site itself was intertidal wetland in the 1870s.

Natural landscapes in California have been evolving along with changing human uses for over 10,000 years, and they will continue to do so. At the LCW, some of these changes will undoubtedly be good for the ecology of the site (*e.g.*, oil operations may be consolidated and will probably be removed at some point). Some changes, such as SLR, will cause significant changes, not necessarily positive or negative, over the next 100 years or more. There will also, undoubtedly, be threats to the ecological integrity of the site in the future that cannot be imagined today.

To the extent feasible, the CRP will seek to bring back many of the lost ecological functions that the wetland complex once supported. Restoring ecological functioning will require working within the opportunities and constraints of the site. The CRP will not necessarily try to replace historical features, like tidal channels, in the exact location where they appear in historical maps or photos. Rather, the goal of this restoration project is to restore important biological and physical processes in order to create self-sustaining ecological communities that are resilient to changing conditions.

3.2 Ecosystem Processes

A unique suite of ecosystem processes structures each native plant and animal community in Southern California. Trying to restore communities in areas where important ecosystem processes are missing will lead to failure. Through the process of ecological restoration, one may substitute man-made manipulations for some natural processes (*e.g.*, removal of invasive plant species, irrigation, controlled burns, etc.). These tools can be used successfully to help establish and maintain native plant communities. To be successful, ecological restoration must take into account the restoration of all the ecosystem processes that are important for the long-term persistence of the target community.

Ecosystem processes are a result of the interaction of physical and biological factors. How these processes interact to structure vegetation communities is fairly well understood in Southern California, but often ignored when planning ecological restoration projects. When the proper suite of ecosystem processes is restored on a site, the result must be the eventual establishment of the target community. The goal of ecological restoration is to speed up the establishment through restorative actions. Understanding the ecosystem processes at a site also allows the restoration team to use these processes to make the restoration projects economical, successful, and self-sustaining.

Successful restoration of coastal salt marsh in Southern California requires especially close attention to several physical and biological processes. Important physical processes include those related to hydrology, landform, sedimentation and erosion, and soil biogeochemistry. The most important biological processes are related to vegetation composition and structure, and food web dynamics. The physical processes control, to a large extent, the biological processes, so most of the planning emphasis should be placed on getting physical processes restored correctly.

There is no “correct” way to restore these processes for most projects. For example, at the LCW, there are several potential hydrological regimes that could be restored, any of which might lead to higher functioning of the site. Usually, there is a trade-off though: higher functioning (*e.g.*, fully tidal areas) typically means more cost and complexity. Simpler and less expensive options often lead to lower functioning habitats (*e.g.*, freshwater dominated or muted tidal). The crux of the restoration planning process is to determine the most cost-effective way to restore important ecosystem processes within the opportunities and constraints of the site while still achieving self-sustaining target habitats.

3.2.1 Hydrology and Hydraulics

The most obvious and crucial physical process that needs to be restored at the LCW is hydrology. The combination of levees, raised roads, fill placement, and tide gates have severely restricted or eliminated tides from the majority of the complex. Since a primary goal of this project is to restore tidal salt marsh habitat, restoration will require re-introduction of tides to large areas of land. There are three main approaches for reconnecting tides through levees and raised roads:

1. Culverts are relatively inexpensive to install but often restrict flows during extreme tides or runoff events. Restriction of tides (tidal muting) leads to narrower vegetation zones and generally lowers ecological functioning. Appropriately sized (large) or multiple culverts can avoid this problem, but this may raise the cost considerably. Culverts with control structures can be used to lessen the risk of flooding of infrastructure, though such mechanisms are costly, may not always operate predictably, and require periodic maintenance. Culverts may also require regular maintenance to keep them free of sediment and debris if they do not sufficiently self-scour, adding to long-term costs. If culverts are not maintained and they cannot self-scour, they may eventually fill with sediment or debris and fail to convey water at all, leading to a return to non-tidal conditions (however, this has not yet occurred at several local wetlands relying on culverts to connect marshes to seawater sources such as Inner Bolsa Bay). If a culvert or flood control structure were to fail while the marsh is full of salt

water, the system can become hypersaline in a short period of time, leading to floral and faunal die-off.

2. Open connections can be made through notches in levees or raised roads. Notches are preferable to culverts in most cases since they are typically inexpensive, have less of a tendency to mute tidal flows, and require little or no maintenance (though they can become clogged where there is high sediment transport). The freer flow of water through notches allows for higher ecological functioning, but more care must be taken to protect infrastructure from flooding during extreme events. Conveying extreme tidal and flood events into and out of a salt marsh is a benefit to the ecological functioning of the salt marsh. A drawback of open connections is the need to bridge the channel with any transportation route that crosses the channel. Bridges are typically expensive and also require maintenance. Culverts are often installed to prevent the need for bridges. At channel locations away from transportation routes, open channels are often the preferred type of hydraulic connection.

3. Setting back of levees or removal of raised roads can lead to the most natural hydrological functioning. This can come at great expense, though in many cases the ecological benefits make it justifiable. Removal of levees, such as those along HCC or the San Gabriel River, would allow for a much more dynamic hydrograph for the restored wetlands. This leads to several benefits for the ecosystem. For example: 1) seasonal freshwater and saltwater mixing in the marsh during rain events helps create low salinity gaps in the high marsh, which help *Lasthenia glabrata* ssp. *coulteri* and *Cordylanthus maritimus* ssp. *maritimus* and other rare annual salt marsh species germinate; 2) extreme high tides and flood events are also important for sustaining the salt marsh-upland ecotone as a unique community; and 3) fine sediments brought in during flood events can help the marsh accrete slowly to keep pace with SLR. A drawback of removing levees, such as those along the San Gabriel River, is that the perimeter of the project site may need to be "flood-proofed" to prevent high water levels during storm flows from flowing into neighboring areas. Flood-proofing the project boundary may trigger more extensive flood studies, erection of new floodwalls and/or dikes, and remapping of the floodplain.

Any proposed Project Alternative that includes modifications to flood control infrastructure shall include hydrological and hydraulics analysis to determine if the modifications could result in flooding. Appropriate designs to maintain the existing level of flood conveyance without causing additional flooding must be done for any options including connections to flood control channels and rivers.

In general, the greatest ecological benefits come from restoring hydrologic connections that yield the most dynamic interactions between land and water. While it may not be feasible from a cost or regulatory perspective to set back major levees at the LCW, it is important to study the benefits of such actions. Where culverts and notches are the only feasible approach, perhaps they can be designed in such a way as to allow hydrologic functioning that mimics levee-free designs most closely. This typically means that the water conveyance device would have to possess the same cross-sectional area, shape, and invert elevation as an open channel at the site. This is more difficult to achieve for relatively larger devices and more readily achieved for smaller devices.

3.2.2 Landform Conditions

Intertidal salt marshes are typically characterized by broad, nearly flat marsh plains dissected by dendritic tidal creek networks. Features, such as mudflats and salt flats, may be found in poorly drained or depressional areas. These geomorphic features of salt marshes are in dynamic equilibrium, controlled by erosion and accretion due to tidal flux and freshwater floods. In certain cases, tectonic uplift or subsidence can play a role as well. The complex landforms seen in reference wetlands have typically developed over many thousands of years. It can be extremely difficult or impossible to accurately design and construct these features in restored marshes. A more realistic goal is to get the elevations and drainage close enough to "natural" so that the marsh can evolve toward its own dynamic equilibrium as conditions change over decades and centuries.

Elevation relative to tidal inundation is the most important factor and one that can be planned for with reasonable accuracy. The elevation ranges of most salt marsh plants are fairly well known for fully tidal systems. In muted tidal systems, it may be more difficult to predict the elevation zones for different species or communities. Accurate modeling of tidal inundation frequency is essential to developing accurate grading plans.

For restored marshes to flood and drain naturally, the marsh plain needs to have very subtle slopes toward tidal creeks. Steeper slopes will limit the width of different vegetation zones and hasten soil drainage. Flat areas will not drain and may become too wet or too saline for salt marsh vegetation to establish (it may be desirable to have some flat or depressional areas to support salt flats and tidal ponds, both of which naturally occur in marshes).

Tidal creek networks provide valuable habitat for fish, birds, and invertebrates and play an important role in the hydrologic functioning of a salt marsh. Natural creek networks are typically dendritic in nature. Small low-order creeks (higher in the marsh) are typically intertidal and may have shallow cross sections. Larger high-order creeks (closer to the mouth) often have steep banks and are always at least partially flooded. In natural systems, tidal creeks develop and evolve in response to topography and hydrology through erosion and sedimentation. These same processes can lead to the development of natural tidal creek networks on restoration sites without having to design and construct all the channels.

Transition zones between the high marsh and uplands come in many different forms. The marsh may transition abruptly to upland at the base of bluffs or sand dunes or very gradually in flatter areas. There are very few examples left of natural salt marsh-upland transitions left in Southern California, primarily due to development and most salt marsh restoration projects have ignored this important habitat. Gradual transitions provide important habitat, increase the functioning of the marsh, and provide an area for up-slope migration of the marsh as sea level rises. For these reasons, it is preferable to include transition zone habitat as part of the overall plan for wetland restoration.

3.2.3 Sedimentation and Erosion

Coastal salt marshes in Southern California are generally formed where sediment deposition and erosion are in equilibrium. Coastal salt marshes can receive sediment from the ocean via littoral processes and/or from upland areas via fluvial processes. Tidal and freshwater flows suspend sediments and can redistribute them within a marsh or carry them to the ocean. When sedimentation and erosion are out of balance, salt marsh habitats can be altered and degraded.

Some coastal salt marshes in Southern California are probably sediment-starved due to dams and debris basins that capture sediment from upper watersheds before they can reach the marsh. The alteration of natural upland habitats adjacent to marshes (by filling and development) has removed another natural source of sediment for most of our marshes. Over time, sediment-starved systems may be subject to increased inundation of salt marsh zones, causing a shift in habitat distributions. The tidal prism of these systems will begin to increase as well and the resulting higher velocity flows, especially on ebbing tides, could lead to higher rates of erosion, resulting in a sort of positive feedback loop that can alter habitats severely over time.

In cases where landscapes have been denuded of natural vegetation, by agriculture for instance, sediment rates can be much higher than natural. This can lead to decreased inundation of salt marsh zones and conversion of wetland to upland in extreme cases. The resulting decrease in tidal prism could potentially lead to more accretion, channel and mouth closures, and large-scale changes in vegetation and wildlife composition in another feedback loop.

Before development, natural fluvial processes interacted with littoral processes at the mouths of Southern California estuaries in patterns that varied with tides, precipitation, and waves. The interactions among flows generated by runoff and the tidal prism within the estuarine basins tend to maintain inlet channels, while littoral processes tend to build barriers across inlets. Generally, estuaries experience more regular tidal influence when littoral sediment is scoured from the inlet not only by tidal flows, but seasonally by winter and spring runoff. In estuaries that are connected to littoral processes during the dry season, wave energy along the shoreline becomes relatively stronger, building beach berms, pushing sand across inlets, and enhancing the formation of flood tide deltas within the estuary inlets. The inlets of smaller estuaries are more likely to be completely closed than larger systems.

Because of the setting of the LCW, very low rates of sediment delivery are expected under any of the restoration scenarios. The sites are isolated from littoral processes by extensive infrastructure and distance. The wetland complex is largely removed from the riverine processes of the San Gabriel River by levees in its current configuration. The upper watershed is subject to considerable management by flood control and water supply infrastructure. However, there may be some opportunities for accretion of suspended sediments during detention of water from runoff events.

3.2.4 Soil Biogeochemical Processes

Soils form the foundation of biological communities. Most plant communities are adapted to certain soil conditions. The most important aspects of soil include texture (grain size distribution), structure (compaction, porosity), and chemistry (nutrients, salinity, and redox potential). All these factors are closely interrelated with one another and can be difficult to restore on highly disturbed sites.

There is some variability in natural salt marsh soils within and between different coastal marsh systems. Some marsh habitats, primarily those dominated by littoral sedimentation processes, have coarse-grain (sandy) soils with relatively low levels of organic matter. However, the majority of salt marsh soils in Southern California are comprised of fine-grains (silt and clay) with relatively high levels of organic matter and low redox potentials. Failure to restore proper soils usually leads to problems establishing desired levels of diversity and productivity in vegetation communities. Inadequately restored soil is a common reason that restoration projects fail.

Soil texture is a description of the relative proportions of sand, silt, and clay in soil. Salt marshes are generally depositional areas with low water velocities. This favors the deposition of very fine particles, silt, and especially clay. The high proportion of clay in salt marsh soils is important for nutrient cycling. High clay content reduces drainage and makes soils more anaerobic than well-drained (*i.e.*, sandy) soils. This slows the breakdown rate of organic matter, leading to its accumulation in the soil. As the organic matter is broken down very slowly under anaerobic conditions, a continual low level of nutrients is available to plants. Clay soils also slow the leaching of nutrients out of the soil, again, making them more available to plants. Many salt marshes have been restored or created on dredge spoils, which tend to be sandy and lack clay (Zedler 2000). The result is often poor plant growth (Boyer and Zedler 2000), which leads to poor wetland functioning. The limited productivity of these marshes will probably persist for many years (Boyer, et. al. 2000). Preliminary analyses of the soils within the Phase 1 and Phase 2 areas of the LCW properties (see Figure 1-4) suggests that much of the soil is dredge spoils and may be too sandy for salt marsh restoration. In-depth analysis of soil texture will need to be done in the next steps of planning to determine whether soil amendments may be necessary in some areas.

Soil structure describes the way in which the mineral and organic constituents of soil aggregate together and form voids or pores within the soil profile. In natural soils, structure develops over centuries or even millennia. In restoration sites, it is difficult, if not impossible, to restore natural soil structure in the short-term. The most important aspect to consider in most restoration sites, including salt marshes, is compaction. Compacted soil that inhibits root growth and drainage generally has an adverse effect on plant growth. During salt marsh restoration, heavy equipment used to grade sites can cause severe compaction, which is known to effect vegetation establishment (Zedler 2000). To minimize compaction, grading should be done on dry soils whenever possible. Ripping or disking can improve growing conditions in compacted soils. Working in wetlands “in the dry” may require dewatering that can be difficult in wetlands and may not be effective or economical under some conditions.

Several aspects of soil chemistry are especially important in salt marshes. In addition to nutrient cycling (outlined above), soil salinity and pH also play an important role in vegetation growth and diversity. High soil salinities are a prerequisite for salt marsh vegetation. Freshwater inputs can result in salt marsh vegetation being replaced by brackish or freshwater species. Seasonal drops in soil salinity associated with rainfall are natural in Southern California salt marshes. However, year-round freshwater inputs (augmented stream flows or point-source inputs) are detrimental to salt marsh habitats. Elevations regularly inundated by tides tend to have soil salinities very close to seawater (~34 ppt). Less frequently inundated areas, specifically high marsh habitats, are much more dynamic. Evaporation after tidal inundation can lead to very high soil salinities (>100 ppt), which inhibit establishment and growth of even native high-marsh species. Heavy rainfall can drop soil salinities to near zero, allowing invasion by annual non-native weeds. It is important to avoid very high salinity levels during plant establishment on restoration sites. This can be done with soil augmentations and/or irrigation (Zedler 2000). Natural salt marsh soils are generally neutral to slightly acidic. Restoration sites on dredge spoils have been known to become overly acidic due to the conversion of sulfates to sulfuric acid (Zedler 2000). In some cases, tidal flushing can ameliorate the problems; however, in some cases, soil amendments such as lime may be needed to raise soil pH.

3.2.5 Processes Related to Vegetation Composition and Structure

The native vegetation communities within coastal salt marshes provide, directly and indirectly, most of the ecosystem functions and values associated with these systems. Wetland plants (including vascular plants and algae) provide a matrix that supports wildlife and microbial communities (Zedler 2000) and they play an important role in nutrient cycling and soil chemistry (Mitsch and Gosselink 2007). Establishing self-sustaining vegetation communities quickly is, therefore, a primary goal of virtually all restoration projects.

Setting targets for vegetation communities is best done by selecting reference sites that have desirable levels of diversity, productivity, stature, and functioning. Steam Shovel Slough provides one obvious reference site for restoration at the LCW. Other nearby marshes, including Anaheim Bay, Upper Newport Bay, and Mugu Lagoon, are good choices that contain more habitat diversity than Steam Shovel Slough alone (*e.g.*, eelgrass beds, tall *Spartina* and salt flats). The specific site characteristics of restored habitats (soil, hydrology, slope, etc.) should be matched to similar abiotic conditions at reference sites.

There are several characteristics of reference sites that will be desirable to try to replicate on restoration sites. First, there should be no invasive species on the site. Invasive species are almost never a concern in low- and mid-marsh elevations (though *Spartina alterniflora* is an exception). High marsh habitats are prone to invasion by annual weeds following winter rains. Of more concern though are perennial invaders such as *Limonium ramosissimum*, which occurs at Steam Shovel Slough currently. Managing topsoil contaminated by non-native propagules and conducting grow-kills early in projects can limit problems with invasive species on restoration sites. Over-irrigating can promote non-natives, so this should be controlled as well.

Second, reference sites tend to have high species diversity and measures should be taken to assure that a diverse assemblage of native salt marsh plants becomes established at restoration sites. Higher species diversity is correlated with a broad range of important ecosystem functions (Zedler 2000). Assuring high diversity in salt marsh restoration projects typically means: 1) limiting the amount of perennial pickleweed (*Salicornia pacifica*) at the site in the short-term; and 2) introducing a large diversity of plants from seed and nursery stock. Perennial pickleweed is easy to propagate and establish on most salt marsh restoration sites; however, it can quickly dominate large areas and decrease overall plant diversity (Lindig-Cisneros and Zedler 2002. This is generally undesirable. While Southern California salt marshes are relatively species-poor compared to many other plant communities, there is good evidence to suggest that each species may play an important role in overall functioning. For example, arrow grass (*Triglochin concinna*) is a somewhat inconspicuous mid-marsh species that is often overlooked in restoration plantings. Nevertheless, it has been shown to have important effects on nitrogen pooling and may decrease the dominance of perennial pickleweed and favor other species, especially annuals (Zedler, et. al. 2001). Similarly, the parasitic plant salt marsh dodder (*Cuscuta salina*), which is rarely included in restoration projects, can subdue perennial pickleweed and allow colonization by other species (Callaway and Pennings 1998). Re-vegetation techniques are fairly well established for a wide diversity of species (Zedler 2000), though we still recommend pilot and experimental plantings in most cases and limiting or avoiding introducing perennial pickleweed since it often establishes on its own from seed.

Third, the structure (*e.g.*, height, stem density, and canopy architecture) of the vegetation community is important to certain functions. For instance, the federally and state endangered light-footed clapper rail successfully nests primarily in pacific cordgrass (*Spartina foliosa*), which must be tall enough to support the birds floating nest on the highest tides (Massey, et. al.1984). On restoration sites, achieving cordgrass of sufficient height to support clapper rail nesting has been difficult where soil and nutrient conditions are not adequate (Boyer, et. al. 2000). Vegetation structure is probably also important for Belding's savannah sparrow nesting (*see* Keer and Zedler 2002). Vegetation structure is primarily a function of productivity and species diversity. The best way to achieve desirable structure is to assure soil processes (especially nutrient cycling) are restored and by introducing a variety of plant species by seed and/or nursery plants.

3.2.6 Processes Related to Invertebrates, Fish, and Salt Marsh Food Webs

Salt marsh food webs include many trophic levels, inputs from terrestrial, marine and freshwater sources, and are necessarily complex. Invertebrates are an integral part of salt marsh food webs and are an especially important food source for birds and fish. Invertebrates serve other important ecosystem functions as well. Benthic invertebrates have strong influences on soil properties such as compaction, water content, and texture.

Fish function as an important vehicle for nutrient cycling and energy transfer within salt marsh food webs (Allen 1982, Kwak and Zedler 1997). Different species of fish use virtually all areas of estuaries at different tides, from deep sub-tidal areas and eelgrass beds to high marsh habitats during high tides. The wide variety of resident fishes in salt marshes provides food for birds, including endangered least tern and light-footed clapper rail. Some fish that spend at least parts of their lives in salt marshes are commercially important in Southern California and provide energy transfers between terrestrial, wetland, and near-shore systems.

Some recent large-scale estuarine restoration projects in Southern California have been funded primarily by mitigation for destruction and disturbance of sub-tidal habitat. These projects placed considerable emphasis on sub-tidal habitat, perhaps as a trade-off for other types of habitat, and potentially at the possible expense of overall wetland functioning (as argued by some). To this end, it is important to remember that fish are part of complex food webs that involve algae, microbes, vascular plants, terrestrial and estuarine invertebrates, and a host of birds and other vertebrates. It follows that in order to restore high-quality fish habitat in salt marshes, a holistic view, which places emphasis on a wider range of estuarine habitat types, must be taken.

In restoration projects, the plant part of the food web is often addressed with re-introductions, while the fish and invertebrate components are often expected to take care of themselves through colonization (Zedler 2000). This may be a reasonable approach for some species; however, given the importance of these groups to the food web and to overall wetland functioning, development of re-introduction protocols for some species may be warranted.

3.3 Regional and Local Considerations for Restoration Planning at LCW

After considering the range of habitats that occurred on the site historically and analyzing the extent to which important ecosystem processes are either intact or could be restored, some practical decision making must be used to focus the goals of the restoration project. These decisions should be made using the most current understanding of how different restoration scenarios can address both regional and local biological and socioeconomic needs. Regional needs address issues with necessarily broad geographic scales (in this case, Southern California) such as endangered species recovery, loss of certain types of wetlands and near-shore fisheries. A regional needs assessment is being completed by the Southern California Wetland Recovery Project (WRP) and managed by the CSCC. Please see the WRP website for more information at http://scwrp.org/. Local needs include issues that affect the site itself and the communities immediately adjacent to the site (in this case, the Long Beach and Seal Beach areas) such as locally extirpated species, public access, and education/interpretation.

The goal of this section of the CRP is to identify the most important regional and local needs that may be addressed by restoration of the LCW Complex. In many cases, these needs may seem to be, or may actually be, in conflict with each other, and this is by no means unique to the LCW Complex (*see* Needles, et. al. 2013). Nevertheless, acknowledging these issues and weighing the importance of different needs is an important step toward developing a restoration project that provides a wide variety of both biological and socioeconomic functions and values.

There has long been a need for an in-depth analysis of regional estuarine restoration needs. This document provides an outline of important needs as they relate to restoration at the LCW. Many of the regional and local needs that have been identified here have been broadly outlined by Zedler (2000), and this section of the plan borrows heavily from that text. Additionally, the TAC and the SC identified many of these needs during a series of eight quarterly meetings. A series of six public meetings led to identification of many of the local socioeconomic needs as well. There was not always consensus on which needs are of greater importance than others and none have been explicitly ranked here. Rather, the LCWA developed, with TAC and public input, three alternative restoration designs that implicitly differentially weight all these different needs.

3.3.1 Regional Biological Needs

The LCW Complex sits approximately midway along the Southern California bight, which runs more or less from Point Conception in the north to the international border in the south. Coastal wetlands within this region, and farther south into Mexico as far as Bahia de San Quintin, share broad biological similarities. All these wetlands have a subset of the distinct plant and animal communities that characterize the region’s estuarine habitats. Many salt marsh plant and animal species reach their southern and/or northern range limits within this region. Though there are exceptions, these wetlands tend to share similar physical characteristics as well, including climate, water temperature, substrate, and age. All the coastal wetlands in Southern California have been adversely impacted by land use changes since the first European visitors arrived in the area and by development in the last hundred or so years. In fact, about 90% of the historical coastal wetlands in the region have been lost due to filling (generally for development) or dredging (for harbors). What is left today is a patchwork of remnant systems, many of which have drastically altered hydrology (generally a loss of fully tidal areas) and have suffered a severe loss of biodiversity.

The cumulative effect of this region-wide loss of habitat and ecosystem functions and values can be addressed where there are opportunities to conduct large-scale salt marsh restoration. Some of the most important regional biological needs that can be addressed include: 1) restoration of high intertidal and associated upland habitats, which are especially rare throughout the region; 2) expand populations of special status species; 3) mitigate the effects of SLR on long-term conversion of habitat types within the region; 4) restoration of dynamic natural processes that facilitate spatial and temporal heterogeneity within the wetland; 5) connectivity to other wetlands and open space; and 6) facilitated migration of species that are threatened by climate change and habitat fragmentation. Each need is discussed in more detail below.

1. Considering the severe loss of coastal wetlands in Southern California, it is obvious that all the habitat types associated with these systems are in need of restoration. However, with the limited opportunities for restoration, it may be appropriate to prioritize some habitat types that have been most severely impacted and/or received less attention in past restoration projects.

   Generally, priority should be given to restoring fully tidal systems as opposed to periodically tidal systems (Zedler 1982). Fully tidal systems support greater diversity of plants and animals. Most of the special status estuarine species that are threatened with extinction occur only in tidal systems. Belding's savannah sparrow and Coulter's goldfields do occur in non-tidal salt marsh remnants, but generally have healthier populations in tidal systems. Restoring periodically tidal habitats in smaller estuaries with unstable inlets that cannot support fully tidal conditions, such as Malibu Lagoon, is desirable and will benefit other listed species such as tidewater goby and southern steelhead. Excepting these smaller systems, it is always desirable to restore fully tidal salt marsh whenever feasible (Zedler 1982). LCW does not possess a direct ocean channel connection, so it is not under the threat of seasonal closure by sand bars, as occurs at relatively small coastal lagoons. Therefore, comparisons with sites and conditions at seasonally closed/open coastal lagoons may not be as applicable for this site as they may be for other sites.

   High marsh (including salt panne) and upland transition habitats are extremely limited in most of our remaining wetlands compared to their historical extent. This is primarily due to the fact that small amounts of fill could be added to the driest/highest portions of marshes in order to make areas suitable for development. The majority of coastal wetland restoration projects have given little or no attention to restoration of the highest areas of tidal influence (steep slopes and very narrow habitat bands were the norm, primarily due to mitigation needs and in some cases space limitation). Nevertheless, these areas support high biodiversity, including unique species (James and Zedler 2000), support higher functioning of low and mid marsh habitats (Parsons and Zedler 1997, Zedler 2000), provide high-tide refuge for salt marsh wildlife (Zedler 2000) and will serve a critical role in adaptation to SLR.

   Brackish marshes were probably once fairly common along the upper edges of salt marshes located on the large alluvial plains where groundwater reached the surface and mixed with tidewater. Historically, this included many of the marshes from Long Beach south to Newport Beach (Wiegel 2009). Extraction of groundwater for agricultural and municipal uses, along with channelization of streams and rivers, has lowered the water table and probably limited the opportunity to restore natural hydrology. Urban runoff into salt marsh habitat can support areas of brackish marsh, though pollutants in this runoff may make this approach undesirable. Brackish marshes support many unique plant species including the rare spiny rush (*Juncus acutus*) and areas of bulrushes can support nesting for light-footed clapper rail.

Eelgrass (*Zostera marina*) beds occur primarily in shallow sub-tidal areas within embayments and other areas protected from wave action or scouring. Eelgrass beds provide important habitat for a large range of fish, invertebrate and vertebrate species. In California, the most significant patches of this habitat type occur in our larger embayments (Humboldt, San Francisco, Morro, Newport and San Diego bays). A total of perhaps 200 acres of this habitat remains in small but ecologically important patches near the LCW complex (within the Ports of Long Beach and Los Angeles, San Pedro Bay, Alamitos Bay, Anaheim Bay, Huntington Harbour, Seal Beach Naval Weapons Reserve (NWR), and Bolsa Chica). Ongoing studies in San Diego Bay suggest that future SLR will greatly reduce the area of eelgrass in that system (by as much as 90%). Many other areas that support eelgrass currently may be at even greater risk due the limited opportunities to migrate upslope (especially in marinas and harbors). Elevations that support salt marsh at current sea level (be they natural marshes or restored marshes) may come to support much of the eelgrass habitat in Southern California in the future.

Estuaries provide important habitat for many species of fish. Southern California's estuarine-dependent fish have been severely impacted by numerous types of activities in coastal wetlands, including filling, continual dredging, water quality impairments, loss of wetland and eelgrass habitat, and invasive species. Restoration of estuarine habitat in Southern California can benefit recreationally and commercially important species, endangered species, and certain fish species that occur mostly or only in estuarine habitats. Estuaries are important nursery grounds for some commercially and recreationally important fisheries species such California halibut and other flatfish. Endangered tidewater goby and southern steelhead are generally more closely associated with periodically tidal lagoons; however, they can and do occur in tidal systems where conditions are appropriate. Estuarine specialists such as longjaw mudsucker, California killifish, and topsmelt rely on tidal salt marshes. Fish play an important role in estuarine food webs, especially in moving energy between different habitats and trophic levels (Zedler, et. al. 2001). Fish rely on sub-tidal habitat within estuaries during low tides and, therefore, sub-tidal areas should be included in restored systems. However, intertidal areas provide important refuge for smaller fish and provide habitat for invertebrate prey species. Therefore, designs that include some balance between lower and higher salt marsh habitats should provide the most functional diversity and support the widest variety of species (Zedler, et. al 2001).

It is probably not desirable to make any of these habitats the sole focus of any coastal restoration project. However, inclusion of these habitats in the design of large-scale salt marsh restoration projects, where feasible, will lead to higher overall functioning of the ecosystem. This will, in most cases, mean less total area of mid- and low-marsh habitats, which are often seen as the most desirable habitats to restore. Importantly though, restoring topographically higher habitats will provide areas for salt marsh to establish in the future as sea level rises.

2. Coastal wetlands in Southern California are home to several rare, threatened and endangered plant and animal species. The total list of special status plants and animals that could occur in salt marsh and adjacent upland habitat is truly impressive (see Appendix C). Restoration and mitigation projects have focused at least some efforts on several of these species, including plants found in high marsh habitats: salt marsh bird's beak (*Chloropyron maritimum* ssp. *maritimum*), Coulter's goldfields (*Lasthenia glabrata* ssp. *coulteri*) and estuary seablite (*Suaeda esteroa*) and salt marsh-upland transition habitats; California boxthorn (*Lycium californicum*), wooly seablite (*Suaeda taxifolia*) and Ventura marsh milk vetch (*Astragalus pycnostachyus* var. *lanosissimus*). Many special status birds benefit from restoration projects, and two endangered resident species, light-footed clapper rail and Belding's savannah sparrow, which rely on healthy stands of cordgrass and pickleweed respectively, have received much attention in the past. This is likely due to the fact that the Belding's savannah sparrow is listed as an endangered species by the State, and the light-footed clapper rail is listed as endangered by both the State and Federal governments. Nesting areas for California least tern have been included in many coastal wetland restoration projects as well.

   The long-term recovery of these species will depend on healthy populations within multiple wetland systems. Introducing special status species to new systems, such as a restored LCW, can aid in species recovery and protect them from future extinction. If special status species will be introduced on site, then all reintroductions will be consistent with the appropriate approved recovery plans. For example, light-footed clapper rails were introduced into San Elijo Lagoon in San Diego County with success. It is highly desirable to restore habitat that can support healthy, self-sustaining populations of these target species. Caution should be exercised, however, when setting expectations for any specific species at a restoration site. For instance, the degree to which a population can be expected to be self-sustaining should be carefully assessed. Least tern nesting habitat (large unvegetated areas) has been created in the past, but these areas often require continual maintenance to keep them free of vegetation. Without regular maintenance, these areas will become weed patches that have very little habitat value to any native species, let alone least terns. Other lessons have been learned while trying to restore new light-footed clapper rail nesting habitat where predator assemblages are not in balance. Essentially, in systems without high-level predators (coyote, bobcat, etc.), mesopredators (red fox, raccoon, skunk, etc.) can reach high densities. These mid-level predators tend to prey on clapper rail nests and young birds, and can severely limit breeding success. Mesopredator control has been used successfully, but again this is a long-term maintenance issue that may need to continue in perpetuity in order to support a stable population. Restoring special status plants can be somewhat more straightforward as long as appropriate growing conditions are present. It should be remembered though that the populations of annual species will fluctuate greatly between years so careful setting of goals is essential.

   With the limited area available for restoration at the LCW, there will be a tradeoff between restoring different types of habitats that might support different special status species. For instance, large areas of cordgrass could be restored in hopes of supporting light-footed clapper rails. But this would almost certainly come at the cost of less pickleweed habitat that might support Belding's savannah sparrow. Given the rather specific habitat requirements for almost all the special status species that occur in coastal wetlands, attempting to restore areas for each one in the short-term, at one site, might lead to areas of appropriate habitat that are too small to support self-sustaining populations of any of the species. Therefore, a careful analysis should be done to determine which species might not do well at the site, even if appropriate habitat was restored. At the LCW, this might include species that are especially sensitive to anthropomorphic disturbances or predation by mesopredators for instance.

There is also an important temporal aspect to restoring special status species habitat. As has been described elsewhere in this plan, SLR will drive conversion of intertidal habitats. As areas are inundated more frequently and vegetation communities migrate up-slope (where possible), the available area of appropriate habitat for target species will change. This should be considered during fine-tuning of grading designs. Further, a region-wide analysis of how current populations of special status species will be affected by SLR would help set longer-term priorities for restoration projects.

Restoration of coastal wetlands can be of great benefit to migratory birds, especially waterfowl and shorebirds. Though not necessarily classified as special status species, these groups of migratory birds can benefit especially from restoration of mudflats and open water areas. Birds will invariably find and use appropriate habitat for resting during migration and overwintering as long as there is food (invertebrates, fish or plants, depending on the species and habitat).

3. As sea level rises over the next century, Southern California's salt marshes will undergo dramatic changes. The inundation frequency of a given elevation will increase, causing elevations that currently support, for instance, mid-marsh, to convert to low-marsh, mudflat and eventually sub-tidal habitat (depending on the amount of SLR). This will lead to a net loss of marsh habitat and an increase in mudflat and sub-tidal habitat. High-marsh and transition zone habitats, which typically abut developed areas, will, in many systems, be squeezed virtually out of existence.

   There has not been a systematic analysis of how the distribution of estuarine habitats will shift with SLR on a regional scale. In systems with appropriate rates of sedimentation, accretion may keep pace with SLR, allowing habitats to remain more or less stable over time. However, sedimentation rates are anything but natural in almost all our coastal watersheds. They are too low where sediment is impounded behind dams. Conversely, where land uses leave large areas of bare soil, they can be unnaturally high. Without watershed level studies of each system, it remains unclear how our estuaries might or might not stay in equilibrium with SLR. In a few systems, adjacent uplands will provide areas where habitats can transgress upwards. The general trend will be toward more sub-tidal habitat and less mid-marsh, high-marsh, and transitional habitats.

   Without some scheme for adding sediment to marshes being developed and permitted in the future, the region will have proportionally more low-intertidal and sub-tidal habitat and, it may be desirable to include less of these areas in coastal wetland restoration projects. Similarly, since proportionally less high-intertidal and adjacent upland habitats may occur in the future, it is desirable to include areas that can support these types of habitats even in the face of SLR. At the LCW, natural sedimentation rates may be too low to keep pace with

SLR. Therefore, the best alternative at this site may be to leave upland areas fairly high in the short-term and allow them to convert to intertidal habitats as sea level rises.

4. The plants and animals that live within Southern California's estuaries have evolved over many thousands of years to tolerate, and even take advantage of, small and large scale disturbance events. Natural disturbances are important for creating both spatial and temporal heterogeneity within salt marshes. Heterogeneity is associated with higher levels of diversity of plants, birds, fish, and invertebrates (Zedler 2000).

   A common type of disturbance is burial of plants by sedimentation. This can happen on large scales during floods and dune over-wash events or on very fine scales by burrowing mammals. In any case, the result is bare soil where opportunistic species that are not common in stable marshes can become established (Zedler 2000). Sedimentation rates are generally out of balance in Southern California. Too much sedimentation (usually due to poor soil management in the watershed) ultimately leads to conversion of tidal habitats to non-tidal habitats. Lack of sediment deposition (usually due to damming and/or channelization of rivers) can lead to overly stable marshes with lower plant and animal diversity. Region-wide, the loss of the natural dynamic nature of some ecosystem processes has undoubtedly led to estuaries with lower diversity than they might otherwise support and a general scarcity of species specifically adapted to these types of disturbance.

   Where natural disturbance regimes cannot feasibly be restored, it is desirable to build large amounts of heterogeneity into restoration sites. Heterogeneity is desirable at multiple scales. Creating habitat diversity within a system means including subtidal, mudflat, low marsh, mid marsh, high marsh, and transition habitat. At smaller scales, restoration projects should seek to include substantial numbers of tidal creeks and small depressions and mounds. This type of diversity will increase the chances that at least some areas within the restoration site will be suitable for a wide variety of species.

5. Southern California's remaining coastal wetlands are more isolated from each other than they were historically. This is especially true in the San Pedro Bay where estuarine habitats backed dunes and sandy beaches almost continually from Long Beach to Newport Beach. Today, these wetlands have been fragmented by development and are much less biologically connected to each other than in the past. This has important implications for populations of many species and on colonization rates for restored habitat.

   In general, a population of a given species is prone to extirpation in proportion to its size and isolation from other populations. Many species that are limited to estuarine habitats have had their size reduced due to loss of habitat and are more isolated than ever from other populations due to fragmentation. This puts them at much greater risk of experiencing local extinctions. Indeed, many smaller marsh systems support fewer species of salt marsh plants and animals than the larger systems (Zedler 2000). One way to help bolster the health of existing small populations and encourage establishment of new populations is to increase connectivity between estuarine systems. Existing populations will benefit from increased gene flow with other populations. A group of geographically separated populations that are tenuously connected (a metapopulation) is less prone to extinction over time. Even if one population disappears due to stochastic events, other populations can support re-colonization of that habitat.

Connectivity to other natural habitats is especially important for restoration sites. While many species of plants, and, in some cases, a few animals, are reintroduced to sites through the restoration process, most species are expected to arrive via natural colonization. In estuarine restoration sites, this is much more likely to happen where there are good aquatic and terrestrial connections to existing estuarine habitats. The connections can be to high-functioning areas within a complex (*e.g.*, Steam Shovel Slough) or to other nearby systems (*e.g.*, Anaheim Bay).

"Connectivity" will mean different things to different suites of species. Fish and many invertebrates need aquatic connections. Mammals and herpofauna need terrestrial connections, preferably wild lands without road crossings. Plants use many different strategies, though generally, shorter distances are easier to travel for seeds and pollen.

6. As explained above, local coastal wetlands are not as connected to each other as they once were. This will pose a challenge to plants and animals as they attempt to adapt to a changing climate and habitat conversion due to SLR. As habitats convert in one system, appropriate habitat for a given species may be reduced or lost all together. Appropriate habitats for that species may become available within other systems where they do not currently occur. Ideally, species will move between systems on their own; however, this may be difficult or impossible for some species given the distances between systems and the lack of migration corridors. This could lead to local extirpations or even extinction of some species.

   The idea of facilitated migration in the face of climate change is a relatively new one (McLachlan, et. al. 2007). The idea is somewhat controversial because it encourages introduction of species beyond what is understood as their historical range (generally toward higher latitudes and/or elevations in the face of warmer conditions). There are legitimate concerns about species becoming invasive in new areas and having detrimental effects on indigenous species. In many cases, these risks are probably outweighed by the threat of a species going extinct where there is little or no opportunity for it to migrate on its own. Until the science is better understood, the current focus should be on rare species that are most at risk. In these cases, introduction of certain species to areas that were not known to support them in the past may not only be appropriate, but encouraged.

3.3.2 Regional Socioeconomic Needs

There is a wide array of socioeconomic values associated with wetlands and wetland restoration in Southern California. The majority of socioeconomic values are mostly of benefit to the local communities where the wetlands occur. There are some regional socioeconomic needs that can be addressed through estuarine restoration at the LCW.

First, estuarine wetlands are well known as rearing grounds for several species of fish that are important to near-shore commercial and/or sport fisheries. Expansion of tidal and sub-tidal habitats at the LCW will benefit these fisheries region-wide. Having sub-tidal habitat is necessary to provide fish a low tide refuge. Deeper waters are important for larger fish and shallow waters provide refuge for juveniles. At the LCW, there is already considerable, mostly deep, sub-tidal habitat in channels and in the adjacent marinas. While these areas surely support some commercial and sport fish, the diversity and number of fish could probably be increased by expanding the area of adjacent salt marsh habitat (*see* Kneib 1997). Salt marshes provide habitat for a distinct assemblage of smaller fish that can become prey for larger more economically important species. Allen, et. al. (2006) and Zedler (2000), among others, have argued that tidal salt marsh and tidal creeks should be included adjacent to sub-tidal habitats in mitigation and restoration projects seeking to benefit bay-estuarine fishes.

The history of salt marsh restoration in Southern California includes a broad mix of successful and unsuccessful projects. Much has been learned over the years about how to design and implement better projects by including hypothesis-driven research and monitoring at both natural marshes and as part of the restoration process elsewhere. The volumes of work done in the field over the last several decades have led to great advances in the state-of-the-art in coastal wetland restoration and, today, successes seem to be outnumbering failures. Nevertheless, there is still a lot that is not known about how restoration sites function and how to design projects to function better. It is, therefore, important to include opportunities for research and monitoring in all estuarine restoration projects. This will not only benefit scientists throughout the region who specialize in this type of research, but the knowledge gained will benefit future restoration projects as well.

In Southern California, there is a more or less continual need for sites where estuarine mitigation can be conducted. This is driven in large part by dredging and filling at ports and harbors, though other agencies, including the California Department of Transportation, are expected to need mitigation credits in the future. Sites for estuarine restoration in the region are limited and the LCW is probably one of the best opportunities for large-scale restoration that could be funded by mitigation. The U.S. Army Corps of Engineers (USACE), who is primarily responsible for requiring mitigation in marine areas, has a preference for mitigation banking in lieu of fee mitigation programs. Such programs could be set up at the LCW and used to fund restoration. This might benefit the landowners as well as those who need to earn mitigation credits. Section 4.0 of this report provides additional information of economic benefits nationwide.

3.3.3 Local Biological Needs

The LCW Complex includes 565 acres of open space within what was once a ~2,400-acre tidal estuary. As with most degraded coastal estuaries, only a limited picture exists of what the biological resources of the site were before human disturbance. Major hydrologic changes to the system and residential, commercial and industrial development around, and in some cases within, the complex, has certainly reduced the functioning of the site for plants and animals that use estuarine habitat. Restoration of salt marsh and associated habitats has the potential to address several important local biological needs associated with returning more natural functioning to the site.

The current native biodiversity of the LCW Complex, while impressive, is surely only a fraction of what it once was. Restoration of estuarine habitats will provide opportunities to re-introduce species that have been extirpated and expand populations that have been reduced from historical levels. This includes many of the special status species identified in Appendix C of this report as well as many other plant and animal species that rely on tidal estuarine ecosystems. As restoration planning moves forward, an essential step will be to identify opportunities for restoring the local diversity of plants and animals.

Virtually all the remaining open space within the LCW Complex was once tidal salt marsh. Most of this has been converted to other habitat types by alterations to hydrology and topography. Most of the tidal area that remains is highly degraded. However, there are certain areas that have: 1) retained high salt marsh functioning; and 2) converted to non-salt marsh habitat types that are nevertheless providing ecological function and value. It is desirable to protect high-functioning areas and assess opportunities to preserve ecosystem functions of non-salt marsh habitats within the system.

Steam Shovel Slough is a fairly pristine remnant of the tidal salt marsh once known as Alamitos Bay. This remnant has a broad mix of estuarine habitats and high plant diversity. It is connected to full tidal conditions through the Los Cerritos Channel. The primary threat to the area is from water-born trash that enters the marsh with the tides. Other than protecting the area from trash, it is probably desirable to limit restoration activities that could impact the habitats and hydrology of this area. There are other small muted tidal habitats scattered around the complex that have limited salt marsh functioning. It is probably desirable to minimize grading in these areas, but they could all benefit from improved hydrology. Any new or altered hydrologic connections between Steam Shovel Slough and restored areas should be carefully studied to assure impacts to intact habitat are avoided or minimized and that there is no increased risk of contaminated water entering the site from nearby oil operations.

Non-salt marsh wetlands have developed on large areas of the LCW Complex that are no longer tidal. The current habitats fall in to two general categories, brackish marsh and seasonal ponds. Brackish marsh habitat has developed (most notably at Marketplace Marsh) where urban freshwater runoff is directed via storm drains onto the salty soils of formerly tidal areas. The historical Alamitos Bay ecosystem probably supported brackish marshes fed by stream flow and ground water. All or most of the historical brackish areas have been lost due to development or converted to other habitats due to loss of hydrology. This habitat currently only occurs where urban runoff provides the necessary hydrology. Brackish marsh is a productive and rare habitat in Southern California and worthy of restoration where conditions allow. However, urban runoff can deliver nutrients and other pollutants into the ecosystem, making it a generally undesirable source of water where habitat is the primary focus. It is probably better to develop bioswales or other storm water treatment wetlands off-site that do not have a habitat focus or develop a mechanism that allows urban runoff to enter the restored marsh after contaminants have been reduced, ideally in a way that mimics the frequency and magnitude of storm events.

Shallow basins (some bermed in by oil roads) retain rainwater and can pond for several months in wet years. When ponded, these areas are used by waterfowl and shore birds. Reintroduction of tides will cause these habitats to convert and/or be reduced in area. While these ponds are currently providing occasional ecosystem functions, it is probably not desirable to protect these habitats from conversion to tidal salt marsh in place. There may be opportunities to recreate some of the lost functions in different areas of the complex.

The remaining open spaces within the LCW Complex are highly fragmented by roads, berms, and levees. The overall ecological functioning of the complex could be improved by restoring connectivity between different areas. These connections should be both hydrological and terrestrial to the extent feasible. For instance, restored salt marsh habitat would benefit from a hydrological connection to Steam Shovel Slough. This would allow invertebrates and plant propagules to move into restored areas and colonize the new habitat. Connections to the San Gabriel River would allow periodic pulses of freshwater to more easily enter the salt marsh. These flood pulses are important for marsh functioning and may encourage growth of some marsh species such as cordgrass (*Spartina foliosa*). Terrestrial connections such as wildlife bridges could encourage larger predators (*e.g.*, coyotes) to use the site more often. These higher-level predators will help suppress mesopredators, which are especially detrimental to several nesting bird species in salt marshes.

Of special local biological interest is the population of Pacific green sea turtles that have recently become resident in the lower San Gabriel River channel. Genetic studies indicate these turtles are probably most closely related to eastern Pacific/Mexican breeding populations. Ongoing telemetry and tag/recapture studies being conducted by Cal State Long Beach and NMFS indicate that the turtles are visiting other local estuaries seasonally (Anaheim Bay, Seal Beach NWR and Alamitos Bay) but suggest the warm water in the river channel (caused by power plant cooling water discharges) is the primary reason for the presence of this generally tropical species (Jirik and Lowe.2009). There have been Pacific green sea turtles present in San Diego Bay for at least a couple decades. These turtles were known to spend considerable time in warm-water affluent from a power plant and feed in nearby eelgrass beds. The warm water discharges ended there in 2010 and their long-term presence is in question, though so far, the turtles do not seem to have abandoned the bay. Warm water discharges from the power plants on the San Gabriel River are expected to cease in the somewhat near future, meaning the long-term presence of this species is in question here as well. Therefore caution is recommended in emphasizing restoration of habitats (*e.g*., eelgrass beds) with the explicit goal of supporting this species. There is a risk of setting up expectations that restoration will be sufficient to sustain the presence of this species, and, given the turtles popularity with the general public, this could lead to criticism of or disappointment with restoration efforts should the lack of warm water lead to the turtles leaving the area. Nevertheless, restoration of eelgrass beds and sub-tidal habitat within the LCW complex would benefit this species (and others) and, therefore, may be desirable.

3.3.4 Local Socioeconomic Needs

Many of the local benefits of a restoration project, such as that proposed for the LCW Complex, are socioeconomic. Direct and indirect economic benefits of restoration projects (*e.g.*, jobs created, increase in visitors and economic activity, increases in adjacent property value, etc.) are difficult to calculate and, doing so, is well beyond the scope of this plan. However, there are important benefits to the local community that are clear even if monetizing them is difficult.

Restoration projects that include trails, viewpoints and other types of access provide opportunities for passive recreation. This can include bird watching, walking, running, biking, painting, dog walking, kayaking, etc. While some of these activities may be disruptive for some wildlife species, creating passive recreational opportunities, especially in urban areas, can be a major amenity to the community. It is usually possible to balance human uses with concerns about wildlife disturbance.

Trails through restored areas can also provide people with new foot and bike connections between their homes and retail or work areas. Traveling on dedicated trails through natural spaces is generally more enticing than traveling along busy roads. New connections may encourage less car travel and better health, both benefits to the local communities.

Along with public access to restored habitats, there is an opportunity to provide educational opportunities for visitors. There are many ways to provide interpretive and educational material, including signage along trails, visitor centers (preferably not located within restorable areas), interactive exhibits, and so forth. These can be used by visitors on their own, via docent led tours, or by organized tours for school groups and the like. These types of amenities not only bring visitors to the area (an economic benefit to area businesses), but also increase the level of appreciation and awareness of natural habitats in the general public. This hopefully leads to increased public support for other conservation and restoration activities in the future.

Restoration in urban areas often takes place on degraded lands that the public is using for various types of recreation. Conflicts can arise when habitats are restored and recreation patterns are expected to change. In the case of the LCW, there has been very limited public access to the vast majority of the site for many years. Therefore, the probability of such conflicts is expected to be low. Most of the current public access to the site is via the LCW SP, which leads wildlife viewing walks and involves volunteers and school groups in small-scale restoration activities. The El Dorado Audubon also leads regular bird walks within the area. Continuing these uses will be important as restoration projects are implemented and finished since those involved undoubtedly feel some ownership of the LCW.

A "sense of place" is a term that refers to "the complex interactions people have with the environments they encounter" (Soini, et. al. 2012). Many types of environments that people in Southern California encounter are "placeless," that is, they could be anywhere and have no relevance to Southern California. Examples include shopping malls, parks with lawn and playgrounds, and chain stores and restaurants. By this definition, much of the area immediately adjacent to the LCW is rather placeless. Allowing people to access restored natural habitats within urban areas is an ideal way to encourage a sense of place. Many studies have shown the value of an increased sense of place to communities and individuals. People become more likely to interact with neighbors and create new social bonds (Sullivan, et. al. 2004) and are more likely to actively seek protection of other natural areas (Adamic 2012). Natural open spaces are important spiritually as well, and are known to instill increased senses of wonder, action, and freedom, especially in children (Brook 2010). Southern California's habitats, our estuaries in particular, are unique. To experience these natural areas is a quintessential part of what it means to live here.

Restored coastal wetlands can provide other benefits to people even if they are not engaged in visiting the site. Coastal wetlands can effectively take up nutrients in plant material and trap other pollutants in anoxic soils, leading to improved water quality in adjacent channels, marinas, and beaches. Coastal wetlands can also act as a buffer that protects developed areas from storm surges, flooding, and SLR. It is not yet clear the extent to which restored estuarine habitat at the LCW can serve these functions, though different designs could optimize these types of benefits.

3.4 Ecological Resilience and Restoration

Ideally, restored habitats should be resilient to short-term disturbances and changing conditions over time. In the ecological sense, resilience is a measure by which an ecosystem retains or quickly recovers its ecological functioning and biodiversity after some stochastic event, which may be natural (fire, flood, drought, etc.), human caused (oil spill, invasive species introduction, etc.) or some combination of the two (algal blooms). When systems are not resilient enough, such events will lead to major shifts in the ecological functioning and biodiversity of an area. This is commonly referred to as "regime shift," where the habitat types, species assemblages, and other measures of ecological functioning change, more or less permanently. If restoration sites are to meet their habitat targets over the long run, restored systems must be resilient or else the intended habitats will usually convert to less desirable ones.

Building resilience into restoration projects is often difficult, especially in urban settings where many natural processes are compromised, edge effects tend to be stronger, and biodiversity is limited compared to completely natural systems. These challenges are compounded in coastal areas where SLR will have dramatic effects on natural and developed areas over the next 100 years. Therefore, on the coast, one must seek to restore habitats that are resilient to short-term disturbances and long-term changes. In light of these challenges, it is important to design, build, and manage restoration projects in such a way that they will be sustainable over time. In order to do this, one must plan on stochastic events occurring and recognize the effects of predicted long-term changes.

Southern California's estuaries are adapted to many types of natural disturbance, including periodic mouth closures, fluvial floods, invasive species, sedimentation events, and drought. These natural disturbances can severely affect certain species and alter ecosystems in many ways. However, natural systems have been shown to be surprisingly resilient to these types of events and, in fact, they are probably important for maintaining biodiversity within estuarine systems (Zedler 2000). Systems without natural functioning or low biodiversity are probably less resilient in the face of these types of events.

SLR of at least a couple feet over the next century is considered likely (NRC 2010, 2012). The development that commonly surrounds our remaining estuaries means that there will be very limited opportunities for these systems to migrate inland. The massive alterations to coastal watersheds have disrupted natural sediment supply in most systems as well, meaning accretion will probably not keep up with rising sea levels. It is still unclear how resilient estuaries will be to SLR. In some systems, sedimentation rates may keep up with rising water levels. Systems that receive very little or no sediment from their watersheds will probably not be resilient and habitat conversion and biodiversity declines are likely. There will likely be considerable loss of certain types of estuarine habitat over the coming decades.

Coastal wetland restoration projects should seek ways to maximize the resilience of restored habitats to natural and human caused stochastic events. There is no consensus on how to accomplish this for most natural habitats, and there is a lack of studies addressing this issue for Southern California salt marshes (Callaway 2011). General ecological theory suggests that increased diversity leads to increased resilience (Elmqvist, et. al. 2003). Building many types of diversity into restoration projects is probably the best way to maximize resilience. This should include many different types of diversity. For coastal salt marshes in Southern California, restoration projects should look to provide a wide range of diversity in at least native species (plant and animal), functional groups, habitats, and elevations.

Resilience of salt marsh restoration sites to SLR may be even more difficult to deal with. Since substantial SLR has yet to occur (8 inches since 1927) (Moffatt & Nichol 2013), most hypotheses about how salt marsh habitats will respond have been based on areas where the land is subsiding (and, therefore, effectively sea level is rising). Some evidence suggests that, given sufficient sediment supply, marshes will naturally accrete with SLR. When tidal flows were restored to subsided salt ponds that were once salt marsh habitat along the margins of San Francisco Bay, rapid natural accretion raised the soil surfaces to elevations appropriate for supporting vegetated salt marsh again (Callaway, et. al. 2009, Williams and Orr 2002). The wave climate within the bay probably has a lot to do with the rapid sedimentation rates and it is not clear if this same result might be expected in Southern California systems. Another possible answer to long-term resilience in the face of SLR may be to add sediment to systems in some controlled way. Sediment additions have been shown to increase resilience of subsiding coastal marshlands on the Gulf Coast (Stagg and Mendelssohn 2011).

While the best ways to restore resilient estuarine systems in Southern California may not yet be known, there are certain practices that are generally detrimental to the process. First, many restoration and mitigation projects are designed to achieve certain results in a very short amount of time (often five years or less), leading to shortsighted decision making, such as planting a site with a few species of "super plants" that will grow quickly and reach cover targets by a certain year, but often at the cost of biodiversity. Second, restoration sites with fine-scale topographic diversity support more diverse plant and animal assemblages in salt marsh habitats (Zedler 2000), though they are often not included on construction drawings due to the practical challenges of building them in the field. Third, habitat diversity is often compromised by either a desire to maximize wetland area (at the cost of transition and upland habitats for instance) or meet some rigid mitigation criteria for certain types of habitat. Fourth, some project designs are driven by budgetary limitations rather than biological concerns, leading to projects that cut corners on things like planting diversity, fine-scale grading, and long-term monitoring and maintenance. Finally, many of our regulatory structures, especially permit conditions, have simplified performance criteria that do not encourage designs that are diverse and resilient.

Many of these pitfalls can be avoided. Structural reforms to how mitigation projects are designed and regulated would obviously be helpful. Building different types of diversity into restoration designs from the earliest stages of planning will help in developing realistic budgets. Of course, restoration planners and practitioners need to acknowledge that resilience is an important ecosystem attribute, especially in light of climate change and SLR. In developing the conceptual restoration alternatives detailed in the plan, the LCWA has carefully considered what it will take to restore an ecosystem that will truly be resilient over the next 100 years or more.

3.5 Current Conditions

Careful assessment of the current conditions of the restoration site is crucial to the planning process. In general, this type of assessment provides baseline data that helps guide conceptual restoration designs and will be critical as more detailed plans are drawn and environmental review takes place in anticipation of implementing projects. These analyses also serve as a primary basis for identifying many of the opportunities and constraints at the site (see Section 5.0 of this report).

Different aspects of the current site conditions are organized here in seven subsections. The first section outlines the current land management practices and ownership structure within the complex. Current land management practices on some parcels are not compatible with restoration, but there are opportunities to work with landowners on these issues. The second section is a detailed assessment of existing habitats on the site, including an analysis of special status species. This habitat assessment report (Appendix C) is based on extensive field surveys carried out in 2011 and 2012. The third section shows the results of soil cores from the LCWA Phase 1 property. More extensive soil analyses will be needed in the next phase of planning. The fourth section assesses the how various activities within the San Gabriel River watershed effect the functioning of the current wetlands. Restored wetlands will be impacted by these activities as well. The fifth section is a detailed assessment of the current hydrologic and hydraulic conditions of the LCW Complex. The area is complex and includes interesting patterns related to pumping of cooling water by several nearby power plants. The sixth section includes a summary of the current oil operations and infrastructure within the complex. With oil prices at their current level, pumping in this area is economically feasible and expected to continue indefinitely. Finally, the seventh section includes an overview of Native American and other cultural considerations at the site.

3.5.1 Historic and Current Land Management

Since the early part of the 20th Century the majority of the land within the project area was managed as oil fields and for other industrial uses. This management focus shifted slightly in 2006 when the LCWA purchased the first 66-acre portion of the LCW for the purpose of wetlands conservation and restoration. Currently, the LCWA manages approximately 175 acres of land for this purpose. The LCWA's main land management objectives are to protect existing sensitive habitat and associated species, provide safe and controlled public access, and maintain safe working conditions for mineral rights owners to access and operate their equipment. The LCWA has an agreement with the current oil lease operators on their property that allows them to remove vegetation from around their mineral extraction equipment as required by the Fire Department and the Department of Oil, Gas and Geothermal Resources. The oil operator compensates for this impact by providing the LCWA with an annual endowment fee to be used for wetlands habitat restoration. Neighboring land owners manage their properties for a variety of different purposes including mineral extraction, flood management, power plant cooling systems, and as potential sites for commercial or residential developments.

One of the main ways that the LCWA meets its objectives for land management is through the LCW SP. The LCW SP was founded in 2007 and began community-based programming in September 2009. The Mission of this program is to promote community involvement with environmental education, maintenance, restoration, and monitoring of the wetland areas owned by the LCWA. The LCW SP puts forth guidelines to ensure volunteers, visitors, partners, easement holders, and other guests use the LCWA properties appropriately and perform safe and lawful services. Currently, four non-profit partners have Memorandums of Agreement with the LCWA to be a part of this program and perform management, restoration, and educational services on the LCWA's properties. This program is coordinated by consultants in cooperation with LCWA staff. The majority of the LCW SP's actions have been focused on a 10-acre restoration project at Zedler Marsh on the Isthmus. The Zedler Marsh restoration project has attracted over 4,000 participants since May 2010, who have provided over 7,000 hours of service worth over $200,000 of in-kind volunteer services according to the independent sector. This work was funded by nearly $100,000 in competitive grant funding that paid for the installation of nearly 5,000 native plants, and removal of over 50,000 pounds of trash and debris.

The CRP required a number of baseline environmental studies to characterize existing conditions. The conclusions of these studies are provided in subsections below, as taken from their conclusions sections. Additional work that is not summarized here include investigations of available topographic/ bathymetric data, oil infrastructure, historic site aerial photographs, marsh conditions, easements, and property lines as part of the CRP

3.5.2 Habitat Assessment

Twelve coastal habitat types were identified within the 537.71 acres of the LCW studied. Of those, six plant communities were identified: southern coastal salt marsh, southern coastal brackish marsh, southern willow scrub, mule fat scrub, alkali meadow, and eelgrass beds. The other habitat types identified are: intertidal mudflats, salt flats, rip-rap, subtidal marine water (tidal channels and basins), ruderal wetlands, and ruderal uplands. Additionally, vegetation free zones (levees, dirt roadways, perimeters around pumps and pipes, exclusive oil lease easements) and developments (asphalt roadways, abandoned concrete foundations, and active mineral extraction facilities) exist on the site. These vegetation free zones and developments were not considered as habitat types, but are indicated in the habitat maps (Figure 3-1 and Figure 3-2).

In many instances, the filled southern coastal salt marsh habitats never recover to form a distinct native plant community but are identifiable as wetlands versus uplands. In this case, the areas are either non-vegetated (due to harsh conditions) or vegetated by over 75% of non-native vegetation with no more than one native plant species present. In the LCW, invasive plants are widespread and few areas exist where the native plant communities have relatively high species richness and biodiversity without invasive non-native plant species.

Literature reviews and observations during vegetation mapping identified 64 native plant species, 43 non-native plant species, 27 species of invertebrates, 7 species of fish, 1 species of amphibian, 6 species of reptile, 123 species of bird, and 11 species of mammals within the LCW Complex.

The LCW Complex is not well known for supporting large populations of sensitive species. This is understandable considering the system's fragmented condition and isolation from tidal exchange. That, combined with various degrees of historic degradation, has likely resulted in the local extirpation of many sensitive species typically associated with Southern California's coastal wetlands.

Few studies at the LCW have documented special status species. Moreover, privately commissioned studies made claim that special status species were absent from areas where they currently are present, notably the California least tern and Belding's savannah sparrow, as well as Coulter's goldfields (Natural Resource Consultants 1995, Michael Brandman Associates 1996).

The literature review of databases resulted in a list of 20 sensitive plant species that have records of occurrence on or within the same quads as the project site. Four of the 20 special status plant species, salt marsh bird's-beak, Ventura River milk-vetch, Gambel's watercress, and California Orcutt grass, are federal- and/or state-listed as endangered, threatened, or candidate species. However, none of these species were documented on site during visits or were previously documented in the LCW Complex. The most widespread sensitive plant species is by far the southern tarplant. This species thrives in disturbed conditions like those found throughout the LCW. Populations of Coulter's goldfields appear to be the most precarious; as they are only located in Seal Beach and their locations are not consistent from year to year (Glenn Lukos Associates 2010).

The California Natural Diversity Data Base literature review resulted in a list of 26 sensitive animal species that have records of occurrence on or within the same quads as the project site and were reasonable to be analyzed for their potential to occur. A total of 11 animals that are Federal- or State-listed have a potential to occur on the site. Of these, only the Belding’s savannah sparrow, California least tern, and Pacific green sea turtle have been documented to be present within the study area. Belding’s savannah sparrow is the most prevalent of this listed species within the study area. This resident bird species has been observed nesting in salt marsh vegetation throughout the LCW Complex. Regular statewide counts by Dick Zembal have found populations as high as 33 breeding pairs at Steam Shovel Slough (Zembal and Hoffman 2010).

Figure 3-1. Exiting Habitat Types with Study Site North of 2nd Street

Figure 3-2. Existing Habitat Types South of 2nd Street

The extensive disturbed habitat at the LCW offers an enormous potential for restoration of coastal habitats. Ruderal wetlands (15.8%) and ruderal uplands (22.0%) make up 37.8% of the land cover within the study site. Vegetation frees zones (14.6%) and developments (2.9%) cover another 17.5% of the study site. This means that 55.3% of the study site currently supports areas that have little to no habitat value. Furthermore, another 12.5% of the study site is composed of marine habitats.

About one-third (32.2%) of the study site is composed of discernable wetland habitats, and of that acreage, 11.7% are tidal wetlands. This is a dramatic shift from 1873 when an estimated 88.5% of the land encompassed by the study site boundaries was tidal wetland habitat (see Appendix C).

Observations of the existing habitats have led to the determination that a successional process is occurring for non-tidal wetland habitat types as plant communities recover from historic disturbances. The existing non-tidal habitat types appear to be in transition as freshwater has diluted the salt content of the soil, creating current conditions that invite less salt-tolerant hydrophytes to invade the landscape.

If left in its current environmental condition, much of the LCW Complex will become dominated by a mixture of freshwater wetland types bordered by ruderal uplands. However, the successional pattern observed is not apparent at Steam Shovel Slough. This full tidal salt marsh appears to have changed little over the decades and is a model climax coastal salt marsh plant community. It is likely that this stability is due to its full tidal conditions and lack of major landform alteration. Therefore, the reintroduction of tidal influence to non-tidal wetland areas will allow for the LCW to become a self-sustaining urban wetland.

3.5.3 Soil Characteristics

Grain Size – Base Project Area

Kinnetic Laboratories, Inc. (2012 and 2013 in Appendices D and E, respectively) presented all known information understood to be available at the time of their study regarding grain size characteristics and the types of contaminants present in the soils, the horizontal and vertical distribution of these contaminants, and the ranges of contaminant concentrations in soils from this region. A large proportion of the full 565 acres has been impacted by use as landfill for disposal of clean construction materials, disposal of dredged material associated with excavation of the cooling water intake channel for the Haynes Power Plant and the San Gabriel River Channel, and waste products from drilling operations were stored in sumps located throughout the property. Very little of the historic surface of the wetlands is exposed at the surface. Records suggest that the entire area has been subjected to some degree of fill. Core logs associated with sampling conducted in the Hellman Ranch parcel indicate that soils are predominantly silts and silty-clays with some layers of clay at depth and some sands near the surface.

Additional grain size data for the base project area were obtained by conducting a reconnaissance survey at five different sites within the LCWA Phase 1 (Bryant) parcel. Soil texture was assessed for the upper 10 feet at each location. Although many strata were identified at each site, grain size composition consisted primarily of silts, sandy-silts, and clayey-silts. Clays were present in thin layers at most sites. Odors of hydrocarbons were recorded in three of the five soil cores. The three cores with oil odors were all located along the western edge of the parcel. Previous soil cores taken in the LCWA Phase 1 (Bryant) parcel and the LCWA Phase 2 (Hellman Ranch) parcel were found to have similar grain size characteristics.

As concluded by CSULB (2009), soils at the LCWA Phase I property are highly layered and were comprised primarily of clays, clay loam, and loam. As expected, soils along each core profile were relatively low in organic carbon and had slightly elevated levels of zinc near the surface. Although zinc concentrations were higher in the surface of the cores, concentrations were well below National Ocean and Atmospheric Administration (NOAA) Effects Range Low and would not be considered to be of concern.

Grain Size – Outside of the Base Project Area

Information on soil contamination and physical characteristics in the additional parcels beyond the base project is extremely sparse. Limited information on soil texture and characteristic is available from wetland delineation work conducted within the Bryant parcel by Huffman and Associates (2000) and Huffman-Broadway Group (2008). The 2008 report indicated that the study area was filled with dredged material that was dewatered and graded for use as a pad for an oil and gas facility during the late 1920s. Excavation revealed the presence of soils above 20 inches have textures ranging from silt to silt loam to silty sandy to fine sand loam to sandy loam. The majority of the study area was also remediated in the past using an on-site land farming approach to treat for identified areas containing petroleum hydrocarbons resulting from oil field activities.

Construction of the (OC) Retarding Basin required a geotechnical study that also provided information on soil texture with depth. Four borings were taken to depths of roughly -94.0 feet MSL. From the surface of the basin perimeter road (approximately +6 feet) to an elevation of about -34.0 feet, soils were reported as predominantly gray, dark gray, or black silt and clay with varying amounts of sand. This layer appeared to contain many relatively thin lenses of silty sand and sand interlayered within the silt and clay similar to those encountered in cores from the LCW Phase I property on the west side of the San Gabriel River (Kinnetic Laboratories, Inc. 2012). Since groundwater was encountered within this layer, soils were observed to vary from moist to wet with depth. This entire layer was classified as ML (silts) based upon the Unified Soil Classification System. More information is provided Appendices D and E to this document.

Chemistry – Base Project Area

The LCW Complex has been used for oil exploration and recovery for the past 90 years. In addition, certain areas were used as landfill for disposal of clean construction materials. Other areas, such as Area 18 in the LCWA Phase 2 (Hellman Ranch) parcel, were used for disposal of dredged material associated with excavation of the cooling water intake channel for the Haynes Power Plant and the San Gabriel River. Oil sludge presumed to be from a nearby tank farm was also disposed at Area 18. Sumps are located throughout the property. The sumps were used for waste products associated with drilling operations.

A large number of investigations have been conducted in the LCW over the past 25 years. The most extensive of these studies were performed on the LCWA Phase 2 (Hellman Ranch) property (Anchor 2004a; 2004b), the LCWA Phase 1 (former Texaco/Bryant) property (CDM 1991), and the LCWA Phase 1 (OTD/Edison) parcel (CH2MHILL 2004). In contrast, at the time of the Kinnetic's study as part of this project, no studies were found that assessed potential soil contamination in the City of

Long Beach (Marketplace Marsh) property. Subsequent to their work, information was made available by the City of Long Beach (U.S. EPA 2009; Ecology and Environment 2010) that pertains to portions of the Central Area. The data are not integrated yet into this CRP but may be developed into a subsequent soils investigation to be used for future analyses, permitting and designs.

All early studies (pre-1990) focused on contaminants associated with sumps or tank farms. TPH concentrations are highest in sumps and in the vicinity of historic tank farms, but are also widespread throughout all parcels where these contaminants have been measured. Average concentrations in most areas ranged from 10,000-20,000 mg/kg, but this reflects a bias towards more measurements being taken in sumps.

Metals have not been emphasized in any of the studies conducted to identify contaminants in LCWA properties. Studies that incorporated analysis of metals indicated that metal concentrations are mostly within the range of typical background concentrations found in California soils. A few metals such as such as arsenic, vanadium, barium and chromium also tend to be elevated in the sumps and are associated with some drilling muds. Anchor (2004b) found that high concentrations of lead, in particular, were strongly correlated with high concentrations of TPH in sumps. One of the earlier studies (BCL 1987) reported elevated levels (~2 to 9 mg/kg) of mercury at sites near the Area 18 landfill on the LCWA Phase 2 (Hellman Ranch) parcel.

In most cases, extremely elevated concentrations of one or two metals were reported at a limited number of sites. Sampling densities were not sufficient to identify distinct patterns of association with any particular feature or location. CH2MHILL (2004) reported single instances of lead, nickel and vanadium on the OTD/Edison parcel that were 100 times the average concentrations at other sites. Although these could have been clerical or laboratory errors, they did occur at sites that had other issues, such as elevated pesticides.

Chlordane compounds, DDT compounds and their derivatives and dieldrin were the most common pesticides found in this region. Although large numbers of analyses have not been conducted, these compounds tended to be most common in surface soil samples. In the LCWA Phase 2 (Hellman Ranch) parcel, these compounds tended to occur along an access road and were not frequently encountered in the sumps. Very high concentrations of DDE, DDT, chlordane and dieldrin were present in surface soils at two sampling points on the OTD/Edison parcel. The associated report suggests that the sampling points were saturated with water at the time of the survey. This may indicate that the sampling points were low spots on the property where water would pond after small rain events. The analytical detection limits used for organochlorine pesticides at the OTD/Edison parcel were quite elevated compared to detection limits used for other analytes of concern. In all cases, the reporting limits for organochlorine compounds were well above the NOAA Effects Range Low values. In the case of chlordane, reporting limits were nearly 10 times the NOAA Effects Range Median.

Chemistry – Outside of the Base Project Area

As mentioned above, at the time of the soils analysis for this CRP, no data were available on contaminants on the City of Long Beach (Marketplace Marsh) property or any of the additional 300 acres of property of potential future acquisition. However, after completion of the soils analysis for the CRP data were provided by the City of Long Beach about certain issues existing at the Northern Area (U.S. EPA 2009; Ecology and Environment 2010). As the soils analysis for the CRP had already been completed, results of these data and their pertinence to restoration actions have not yet been integrated into the CRP, but will be completed in a subsequent project phase and carried forward in the planning process from there.

Table 3-1 identifies the major studies conducted in both the Base Project Area as well as any new information from the full extent of the future wetland footprint. The table identifies major studies conducted within each parcel and identifies whether the reports contain data from others or present new data.

Table 3-1. Summary of Information on Soil Contamination within the LCW

◆ (red) Indicates reports that summarize other data sets
◆ (green) Indicates reports with original data sets

PARCEL/STUDY OR DATA SOURCE	TPH/Oil&Grease	BTEX	Metals	PAHs	Organochlorine Pesticides/PCBs	Grain Size	Other Information
BASE PROJECT PARCELS							
LCWA Phase 1 (Previously Bryant) Parcel							
Kinnetic Laboratories, Inc. 2012. Soil Contamination and Grain Size Report. REVIEW and new grain size data	◆ (red)	◆ (red)	◆ (red)	◆ (red)	◆ (red)	◆ (green)	
Anchor Environmental LLC (2006) REVIEW	◆ (red)	◆ (red)	◆ (red)	◆ (red)	◆ (red)	◆ (red)	
NRCS, 2009. Soil Characteristics at three sites, December 2009.						◆ (green)	
CSULB, 2009. Soil composition in degraded marsh			◆ (green)			◆ (green)	
Geomatrix, 1996. Letter reviewing comments on the 1995 Texaco Draft Remedial Action Plan for the Bryant Lease (REVIEW)	◆ (red)	◆ (red)	◆ (red)	◆ (red)			
CH2MHill 1991 Phase II ESA and the TEPI 1996, Soil Remediation Plan	◆ (green)	◆ (green)					
CDM, 1991a. Final Phase II ESA, Texaco – Bryant Lease	◆ (green)	◆ (green)	◆ (green)	◆ (green)			
CDM, 1991b. Environmental Audit, Texaco- Bryant Lease	◆ (red)	◆ (red)	◆ (red)	◆ (red)			
Engineering Enterprises, Inc. 1989. Report of Preliminary Subsurface EA, Bryant Property	◆ (green)	◆ (green)	◆ (green)	◆ (green)			
International Technology Corporation, 1988. Phase I ESA Results and Proposal to perform Phase II ESA of Bryant Property	◆ (green)	◆ (green)	◆ (green)				
Earth Technology Corporation. 1988. Hydrologic investigation at the Texaco Bryant Lease Facility	◆ (green)	◆ (green)					
LCWA Phase 1 Separate Parcel (OTD/Edison Parcel)							
Tidal Influence. 2010. OTD Feasibility Study	◆ (red)	◆ (red)	◆ (red)	◆ (red)	◆ (red)		
CH2MHILL, 2004. Phase II ESA for Edison Pipeline and Terminal Company Alamitos Parcel 3-4	◆ (green)	◆ (green)	◆ (green)	◆ (green)	◆ (green)		

PARCEL/STUDY OR DATA SOURCE	TPH/Oil&Grease	BTEX	Metals	PAHs	Organochlorine Pesticides/PCBs	Grain Size	Other Information
CH2MHill 2000. ESA Phase I Edison Pipeline/Terminal							Paper study/visual field survey
City of Long Beach (Marketplace Marsh) Parcel							
AECOM Technical Services, Inc., 2011. Jurisdictional Delineation Report for Waters of the U.S. and State of California, Marketplace Marsh, Long Beach						◆	
LCWA Phase 2 (Previously Hellman Ranch) Property							
Moffatt & Nichol and Anchor Environmental LLC 2007. Hellman Ranch Wetlands Conceptual Feasibility Study	◆	◆	◆	◆	◆		
Anchor Environmental LLC. 2004b. Hellman Ranch Supplemental Environmental Site Investigation, Prepared for State Coastal Conservancy and Hellman Properties LLC, April	◆	◆	◆	◆	◆		
Anchor Environmental LLC. 2004a. Hellman Ranch Supplemental Environmental Site Investigation, Prepared for State Coastal Conservancy and Hellman Properties LLC, January	◆	◆	◆	◆	◆		
Everest International Consultants and Anchor Environmental, CA, L.P. 2003. Review of Environmental Site Investigation Reports and Recommendations for Future Evaluations, Hellman Ranch Property	◆	◆	◆	◆	◆		
Geomatrix 2001. Environmental Site Investigation	◆	◆	◆	◆	◆		Focus on landfill areas
BCL Associates, June 1987. Environmental Site Audit and Field Investigation.	◆	◆	◆	◆	◆		
City of Seal Beach, 1975. Letter to Coastal Commission							Landfill identification
ADDITIONAL PARCELS							
Bryant							
Huffman and Associates, Inc. 2000. Investigation of extent of wetland habitat, waters of U.S.						◆	
Huffman-Broadway Group, Inc. 2008. Wetland investigation						◆	
Hellman, LLC							
(no available data)							
State Lands Commission							
(no available data)							
Orange County (Los Alamitos Retaining Basin)							
Earth Mechanics, Inc. 2005. Geotechnical Investigation Report Proposed Los Alamitos Pump Station						◆	
Loynes LLC							
(no available data)							
LCW Partners							
(no available data)							
Alamitos Bay Partners							

PARCEL/STUDY OR DATA SOURCE	TPH/Oil&Grease	BTEX	Metals	PAHs	Organochlorine Pesticides/PCBs	Grain Size	Other Information
(no available data)							
Lyons Communities							
(no available data)							
City of Los Angeles, DPW							
(no available data)							
Studebaker LLC							
(no available data)							

In addition, a potential future task could be to establish a geospatial database for the entire wetlands that will provide a long-term management tool. Data from the larger studies conducted over the past 10 years should be available in Electronic Data Files. If these files could be recovered from previous consultants and placed into a common format, they would provide a starting point for better tracking and identification of problem areas. In the current form, information is extremely difficult to glean out of the hard copy reports and appendices. With data in a basic geospatial database, queries could be used to quickly assess the current status of contaminants in a variety of matrices, determine what analyses have been performed, and screen the data to examine horizontal and vertical distributions and concentrations of contaminants. A geospatial database could also provide a system to store photographic records before, after, and during modifications. A geospatial database was developed when the Bolsa Chica wetlands were first being examined to determine the extent of contamination and the effects of different cleanup criteria on soil reuse or disposal.

3.5.4 Upstream Activities Impacting the Wetlands

Watershed activities that may affect the LCW were evaluated as a component in assessing the feasibility of restoring the wetlands. Existing watershed discharges (*i.e.*, runoff) may affect the hydrologic processes within the wetlands, which include contributing sources of fresh water and pollutants to the wetlands. Watershed impacts were identified to characterize upstream activities impacting the wetlands, as well as identifying existing or future activities that may affect or impede the restoration of the LCW Complex (Everest International Consultants 2012). The technical report of this work is included as Appendix H to this report.

The restoration area is comprised of ten parcels situated along the Los Cerritos Channel, Alamitos Bay, and San Gabriel River Estuary that have been identified for inclusion in the restoration plan. General watershed descriptions for each wetland parcel, including drainage area, potential storm water sources, and other characteristics including major hydrologic features, land uses, and jurisdictions were summarized. A summary of the watersheds draining into each of the wetland parcels is provided in Table 3-2.

Table 3-2. Summary of Wetland Parcel Watersheds

Wetland Parcel	Watershed Description	Approximate Drainage Area (mi^2)
LCWA Phase 1 – Main	San Gabriel River Watershed including Coyote Creek and San Gabriel River Estuary	689
LCWA Phase 1 – Separate	None	0.0
LCWA Phase 2	Receives runoff from Gum Grove Park and hydraulically connected to San Gabriel River	--
OC Retarding Basin	Los Alamitos Channel	5.6
Gum Grove Park	Low density residential area in the northern portion of the Marina Hill	0.036
State Lands Commission	None	0.0
LADWP	None	0.0
Hellman	None	0.0
Bryant Properties	None	0.0
City of Long Beach	Marketplace Shopping Center	0.028
LCW Partners	Los Cerritos Channel	30

Watershed impacts were identified to characterize upstream activities that may impact the wetlands restoration. Available information for each wetland parcel watershed was reviewed to determine water quality conditions of runoff from each watershed. Potential watershed impacts were assessed based on watershed activities, pollutant source assessments, and water quality improvement projects.

Watershed activities in each watershed are discussed in Appendix H as pertaining to existing or on-going pollutant sources, water quality monitoring, or watershed management plans. Information on watershed activities were obtained from National Pollutant Discharge Elimination System (NPDES) permits, Total Maximum Daily Load (TMDL) activities, storm water monitoring programs, regional water quality monitoring programs, watershed management plans, watershed studies, and other related activities that may affect the hydrologic or water quality conditions of watershed discharges to the wetlands. A summary of the watershed activities for each wetland parcels is provided in Table 3-3.

Table 3-3. Summary of Watershed Activities

WETLAND PARCEL	WATERSHED ACTIVITIES
LCWA Phase 1 – Main	• TMDLs • 1,408 NPDES permits including 5 Publicly-owned treatment works and 2 power generation stations • 3 regional monitoring programs • 4 joint powers authorities • 13 watershed plans
LCWA Phase 1 – Separate	None
LCWA Phase 2	• Same as Gum Grove Park and San Gabriel River
OC Retarding Basin	• Urban land uses • Increase capacity of Los Alamitos pump station
Gum Grove Park	• Low density residential activities
State Lands Commission	None
LADWP	None
Hellman	None
Bryant Properties	None
City of Long Beach	• Commercial activities
LCW Partners	• TMDLs • 79 NPDES permits • Surface Water Ambient Monitoring Program • City of Long Beach storm water monitoring

Information from prior water quality and pollutant source assessments was reviewed to identify general water quality conditions of watershed discharges and potential pollutant sources to the planned wetland parcels. Water quality assessments included regional monitoring programs and watershed studies. Pollutant source assessments include TMDL source assessments and pollutant loading studies (measured or modeled). Table 3-4 summarizes the results for the pollutant source assessments for each wetland parcel.

Table 3-4. Summary of Pollutant Source Assessments

WETLAND PARCEL	POLLUTANT SOURCE ASSESSMENTS
LCWA Phase 1 – Main	• Major NPDES metal loadings • Monitored wet weather metal loadings • Modeled load duration curves • Trash assessment
LCWA Phase 1 – Separate	None
LCWA Phase 2	• Same as Gum Grove Park and San Gabriel River
OC Retarding Basin	None
Gum Grove Park	None
State Lands Commission	None
LADWP	None
Hellman	None
Bryant Properties	None
City of Long Beach	None
LCW Partners	• NPDES water quality assessment • San Gabriel River Regional Monitoring Program • TMDL metal loadings, measured and modeled from Los Cerritos Channel fresh water • Trash assessment

Planned water quality improvement projects in each watershed are summarized in Table 3-5. Future watershed activities or projects that may affect watershed hydrologic conditions or pollutant sources were identified for each watershed. These projects may have long-term impacts on hydraulic or water quality conditions within the wetlands. Certain projects exist that are not included in the Table because they came on-line after Appendix H (the Watershed Technical Report) was prepared. Two TMDLs have been adopted or established that are not reflected in this Plan. A Regional Board regulatory action for copper in El Dorado Lakes serves the purpose of a TMDL, and the U.S. Environmental Protection Agency (USEPA) established TMDLs for multiple pollutants in L.A. area lakes in a single action which includes the rest of the El Dorado Lakes impairments. More on these can be found at http://www.waterboards.ca.gov/losangeles/water_issues/programs/tmdl/.

Table 3-5. Summary of Water Quality Improvement Projects

WETLAND PARCEL	WATER QUALITY IMPROVEMENT PROJECTS
LCWA Phase 1 – Main	• Greater Los Angeles County Integrated Regional Water Management Plan • LA Gateway Region IRWMP JPA • Confluence to Coast Project • Clean Water Act Section 316(b) compliance
LCWA Phase 1 – Separate	None
LCWA Phase 2	• Same as Gum Grove Park and San Gabriel River
OC Retarding Basin	• Increase capacity of Los Alamitos pump station
Gum Grove Park	None
State Lands Commission	None
LADWP	None
Hellman	None
Bryant Properties	None
City of Long Beach	None
LCW Partners	• City of Long trash control programs including catch basin Best Management Practices (BMP) • CWA Section 316(b) compliance

Watershed impacts were identified to characterize upstream activities affecting the wetlands and existing or future activities that have the potential to affect the restoration of the LCW Complex. Water quality concerns and watershed impacts to the wetland parcels are summarized in Table 3-6. The watershed impacts were determined based on existing watershed areas. Future restoration activities may increase tidal exchange with San Gabriel River Estuary, Los Cerritos Channel, or Alamitos Bay, thereby altering the watershed area of the wetlands area. However, due to watershed activities within the major watersheds (San Gabriel River and Estuary and Los Cerritos Channel), long-term water quality improvements in watershed runoff are anticipated from watershed management plans and TMDL compliance. In addition, the CWA Section 316(b) compliance will significantly reduce or eliminate power generating station intake and discharge into the San Gabriel River estuary. There is potential for long-term changes to hydraulic and hydrologic conditions within the LCW Complex.

Table 3-6. Summary of Watershed Impacts

Wetland Parcel	Water Quality Concerns	Watershed Impacts
LCWA Phase 1 – Main	• Metals • Bacteria • Ammonia • Toxicity • Diazinon • Dioxin • Trash	• Overall water quality from San Gabriel River watershed expected to be improved due to significant resources being dedicated for watershed management plan and water quality improvement projects • Long-term improvement in water quality expected due to TMDL development and compliance • CWA Section 316(b) compliance will significantly reduce or eliminate power generating station intake and discharge into the San Gabriel River estuary, thus improving water quality.
LCWA Phase 1 – Separate	None	None
LCWA Phase 2	• Same as Gum Grove Park and San Gabriel River	• Same as Gum Grove Park and San Gabriel River
OC Retarding Basin	• Urban runoff	• Increase capacity of Los Alamitos pump station will reduce flooding in watershed and may increase discharge to San Gabriel River; water may experience longer "filtering" by on-site wetlands thus improving water quality.
Gum Grove Park	• Urban runoff	• No anticipated changes
State Lands Commission	None	None
LADWP	None	None
Hellman	None	None
Bryant Properties	None	None
City of Long Beach	• Urban runoff	• No anticipated changes
LCW Partners	• Ammonia • DEHP • Chlordane • Bacteria • Metals • Trash	• Reduction in trash anticipated due to planned City of Long Beach catch basin BMPs • Long-term improvement in water quality expected due to TMDL development and compliance • CWA Section 316(b) compliance will significantly reduce or eliminate power generating station intake from Los Cerritos Channel

3.5.5 Hydrologic and Hydraulic Conditions

A hydrology study was done to quantify tidal circulation throughout the hydraulic system at Los Cerritos (Moffatt & Nichol 2011). Hydraulic and hydrologic conditions of the LCW area vary tremendously over the site because the hydraulic system is complex. It varies from fully tidal systems to muted tidal systems and non-tidal systems.

The main components of the hydraulic system are water bodies on or adjacent to the LCW Complex and connections from water bodies to the site. Adjacent water bodies include Alamitos Bay, the San Gabriel River, and the Haynes and Los Cerritos Channels, all connected to the nearshore ocean. On-site waters include Steam Shovel Slough, the Hellman Channel, Zedler Marsh, and runoff and perched groundwater on-site in other areas.

Conditions are complicated by effects of the San Gabriel River on water levels from flood routing and from effects of pumping associated with power plants. Pumping by upstream power plants affects flow directions and dictates that some channels (Los Cerritos and Haynes Channels) flow only upstream, while constant effluent released to the San Gabriel River causes it to flow constantly downstream. Also, certain connections (Haynes Channel and Alamitos Retarding Station outlets) are siphons under existing channels that further complicate the flow pattern.

To represent this complexity, a hydrodynamic finite element model of the existing system was developed and calibrated using measured field data. This model represents the significant hydraulic features of the LCW Complex, (*i.e.* the San Gabriel River, Alamitos Bay, Marine Stadium, Colorado Lagoon, Los Cerritos Channel, Haynes Channel, Hellman Channel, the nearshore ocean, as well as other culvert connections to/from the existing LCW areas). The model is capable of simulating tidal conditions, various power plant pump operating scenarios, storm events, and SLR. It is a powerful tool capable of fully representing future conditions for analyses of restoration alternatives. Each alternative will be assessed for tidal range, tidal inundation frequency, and SLR.

General hydrology conditions are characterized as full tidal areas, muted tidal areas, and non-tidal areas. Full tide ranges exist in the Alamitos Bay, San Gabriel River, Haynes Channel, and Steam Shovel Slough. These water bodies would likely be water sources for this restoration project and, therefore, full tidal restoration of certain areas may be possible. The Isthmus and the LCWA Phase 2 properties receive muted tidal circulation via the Hellman Channel and Zedler Marsh culvert connections, respectively, to/from the San Gabriel River. Restoration may be constrained if existing culverts are used for tidal connections. No tidal action occurs at the Marketplace Marsh and northern portion of the LCWA Phase 1 properties. These sites are typified by high ground water and impounded surface runoff or rainwater.

The dominant existing circulation pattern is generally that water flows upstream (north) along both the Haynes and Los Cerritos Channels and then downstream to the ocean via the San Gabriel River as tides. However, this circulation pattern is expected to change upon the AES and Haynes Generating Stations repowering that will implement alternative approaches to once through cooling water technology.

3.5.6 Oil Operations and Infrastructure

This project is located within the Seal Beach Oil Field. A total of four oil leases are operated within the project area. Listed from west to east, these operations are owned and/or managed by, the Termo Company, Synergy Oil and Gas, LLC, Signal Hill Petroleum Inc., and Hellman Properties, LLC (Figure 3-3). The Seal Beach Natural Gas Processing Venture operates a natural gas pipeline that connects several points-of-sale throughout the project area and transports the gas to a processing plant located in the Seal Beach Naval Weapons Station (Figure 3-4).

According to the State of California Department of Oil, Gas and Geothermal Resources interactive map online mapping systems, an estimated 168 wells (active, inactive, plugged or buried) exist within the project area (Figure 3-5). Of those, 97 appear to currently be active, with the reminder either being plugged or idle. No wells within the project area are listed as buried or new. Both crude oil and natural gas are pumped from active wells, and these resources are transferred through thousands of feet of pipeline to points-of-sale or tank farms. A system of raised dirt roads provides access to each well site and other infrastructure. Some of the pipelines run along existing roadways, while others traverse wetlands habitat. The width of roads ranges between 10 and 30 feet. Power poles exist throughout each lease that connects electric lines to each pump and other electrical equipment. Oil operation regulations dictate a vegetation clearance of at least 50 feet in diameter around well sites, a 20-foot perimeter around pipelines, and a 6-foot diameter around power poles.

Certain well sites are impacted by flooding from large winter rainfall events. Many of the well sites and other equipment are protected from tidal water flood events by levee or dike systems.

Figure 3-3. Oil Leases

Figure 3-4. Alamitos Gas Line Map

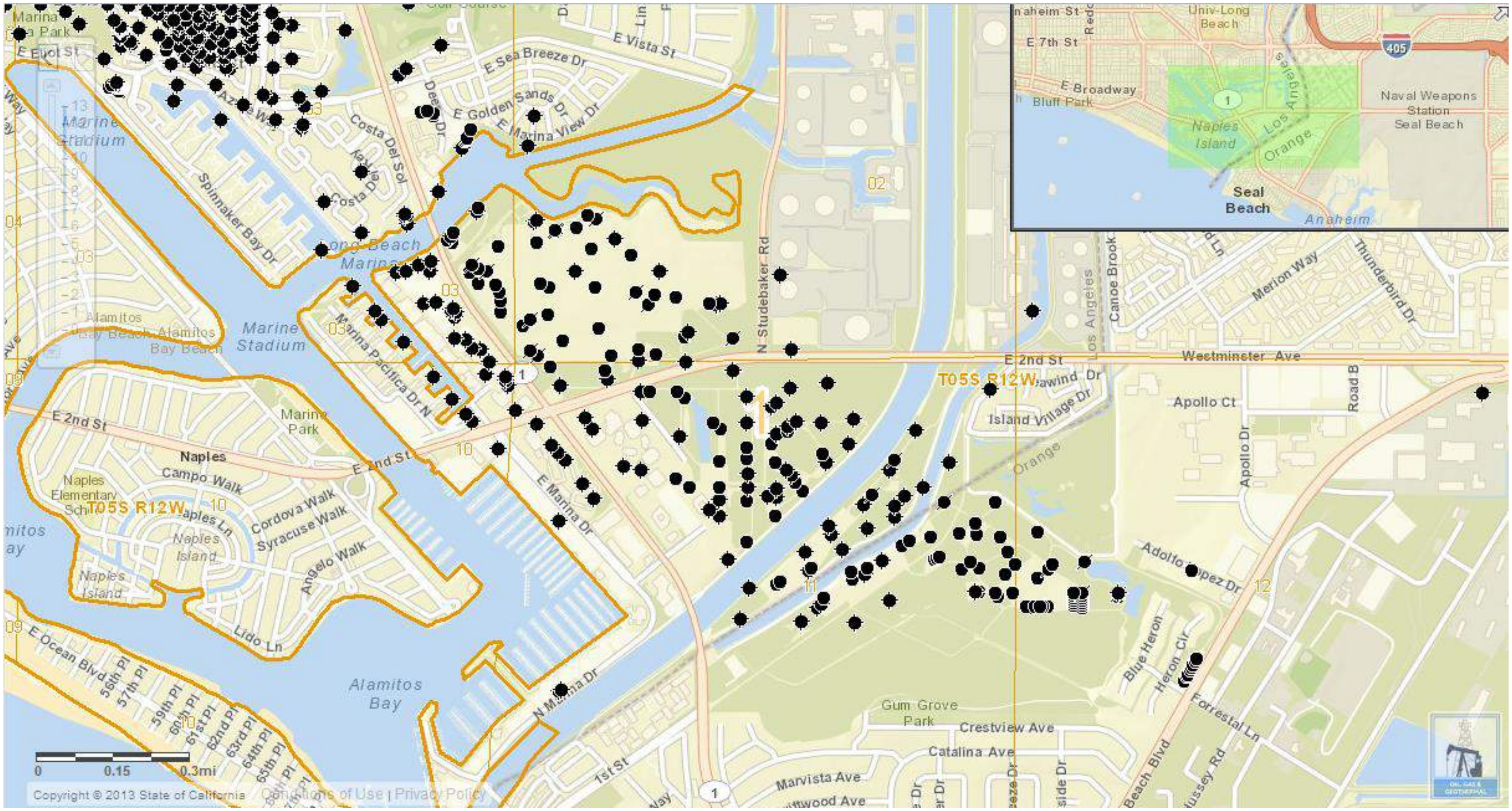


Figure 3-5. Seal Beach Oil Field Well Sites

Source: California Division of Oil, Gas, and Geothermal Resources website

3.5.7 Native American/Cultural Considerations

This section of the Report discusses design process considerations and implications in two parts: 1) the approach taken to date; and 2) recommendations for ongoing interaction with interested Native American stakeholders to achieve maximize participation in the conceptualizing and design of the ecological restoration, interpretive educational, and public access elements of the LCW Complex.

Part One: Approach to Date

The team, and the design alternatives generated in this initial conceptual design phase of the restoration, recognize and address the importance of the project site within the context of Gabrileno - Tongva culture. Not only does the project site contain archaeological resources (identified in separate documents to protect these resources), but remains the focus of important cultural activity in the present day. The project area figures prominently in the creation story of the Tongva people, and is adjacent to the currently identified Puuvugna site on the campus of Cal State Long Beach. Given the proximity of the wetlands to this site and the oral histories of the Tongva locating the birthplace of the people at the mouth of the San Gabriel River system, the entire LCW Complex is a cultural site and is of great significance within the larger homeland of the Tongva. The LCWA recognizes that they are working at the place of origin; literally the mother-land of the Tongva nation.

The LCWA charged its consultants with doing all that is ethically, legally, and professionally proper to protect Native American interests in the project process and CRP. The LCWA's recognition of the cultural significance of the site has led to two tracks in the design process. First, at the legal and regulatory level, all applicable federal and state laws are acknowledged and addressed. At the federal level (Nation to Nation), the Native American Graves Protection and Repatriation Act (NAGPRA) covers federal lands specifically; at the state level, Senate Bill 18 is its companion legislation guiding work at the site in both the design and construction phases.

Within this legal framework, the ongoing work at the site will require the development of a Discovery Plan, which is particularly important for the discovery of ancestral human remains, but also for cultural artifacts of any kind, and a Monitoring Plan, to ensure that Native Americans qualified to identify such remains and artifacts are fully and effectively engaged in all phases of the site preparation and restoration construction process. While the project is not at the stage where these Plans can be developed, the conceptual work recognizes that these Plans will be developed at the appropriate time.

Beyond these legal considerations, the process to date has proactively engaged the public, with particular invitations extended to state-identified representatives of the Gabrileno -Tongva community. In addition to the extensive public input process, an individual meeting was held with Julia Bogany of the Gabrileno -Tongva San Gabriel Band of Mission Indians, who came recommended to us by the Los Angeles City/County Native American Commission. The Bureau of Indian Affairs (BIA) also recognizes the Gabrileno -Tongva San Gabriel Band of Mission Indians as the historical group, which according to the Commission, has a water right on the San Gabriel confirmed by the BIA and Metropolitan Water District This group was also involved at the direction of the BIA in the set-aside of lands at Puvunga.

Julia Bogany is a Tongva language expert and has advised on other cultural resource issues on behalf of her Tongva group. Regarding historical conditions at the wetlands Julia noted that records indicate that the Tongva likely had a "salt works" in the region, and that salt was a primary trade item for them, and was once produced in the tidal flats area. The Tongva would have modified the wetlands to create salt panne, a habitat type that should be considered as a potential part of the "teaching wetland" at the Isthmus or near Marketplace Marsh, at the upper end of the tidal zone nearest the proposed interpretive center site, or perhaps elsewhere if conditions are appropriate and ecological function is enhanced. Salt panne brings brine flies and some specialist birds, and small sections of the Malibu Lagoon Restoration included this unique habitat type in the design, as a precedent. Future phases of wetland and interpretive design might consider this landscape type as more substantial part of an interpretive program, perhaps even including actual "harvest" of the salt as a cultural and educational activity. *Lo'I* (taro paddies), for instance, and aquaculture (fish ponds) are a significant part of native Hawaiian cultural interpretation and recovery and so such managed elements of the wetlands could be considered in design development phases of the wetlands.

Ms. Bogany suggested that in future phases, all of the various Tongva “family” groups, could be invited in the physical and interpretive design so long as it is made clear that inter-tribal politics will not be discussed or allowed as a condition of participation. At the recommendation of Ms. Bogany, the LCWA also made contact with Cindi Alvitre at Cal State University, Long Beach, who was involved with the set aside of campus land for Puvunga, in order to identify how activities, access and interpretation at the wetlands should be integrated with the Puvunga site.

Part Two: Ongoing Considerations

Given the particular importance of the traditional and specific knowledge of the Gabrileno -Tongva peoples in relation to the LCW Complex and its association with Puvunga, the development of a process for an on-going and personal stakeholder coordination process is recommended for future phases. Future phases of the design work should endeavor to engage this component of the local community, specifically with sensitivity toward identification of potential archaeological sites and traditional knowledge that requires a level of privacy. This process should allow for a sufficient number and sequence of meetings and workshops, so that the Gabrileno -Tongva representatives can share in the authorship of the restoration, its public access and, in particular, its interpretive educational development to determine an appropriate level of sharing of traditional knowledge and stories.

4.0 Economic Benefits of Restoration

Multiple references cite economic benefits of wetlands (*e.g.*, Restore America's Estuaries 2011 and 2008; EPA 2006; NOAA undated). These benefits are both local and regional. Economic benefits come from fisheries production, recreation and tourism, flood control, better water quality, property value, and local jobs. Per NOAA (from NSCEC 1998), estuaries are the "economic centers of coastal communities," providing habitat for more than 75% of the U.S. commercial fish catch and an even greater percentage of recreational fish catch. While fishing would not occur in the LCW proper and only at the downstream end of the HCC, it would provide habitat area for fish. It is estimated that two-thirds of all fish consumed worldwide are dependent on coastal wetlands at some stage in their life (EPA 2006).

As cited in EPA (2006), it is difficult to calculate the economic value provided by a single wetland, but it is possible to evaluate the range of services provided by all wetlands and assign a dollar value. NOAA quotes a number of $4.3 billion a year benefit to the U.S. economy and the EPA cites $14.9 trillion worldwide. Some specific project examples (from Restore America's Estuaries 2011) are:

- Restoration of the Everglades, initial investment of $11.5 billion, is expected to provide a 4:1 return on investment ($46 billion) including benefits from park visitation and increased property values, and additional long-term jobs;
- 280 direct jobs and 400 indirect and induced jobs for a marsh restoration project in New Orleans; and
- $427 million in economic output and 3,200 jobs from restoration efforts in Chesapeake Bay, Great Lakes, and Everglades during 2010.

It is expected that the LCW restoration project would provide economic benefit by generating local jobs during construction as well as tourism, recreation, increased property values, fisheries habitat after construction, and oil revenue if oil operations are maintained.

5.0 Opportunities and Constraints

An opportunities and constraints report was prepared by Moffatt & Nichol (2012) identifying such considerations for restoration. Opportunities and constraints are based on previous CRP tasks, including existing site data collection, discussions with the SC and TAC, and previous LCW studies.

The opportunities and constraints were categorized and discussed under these general topics:

- Topography / Landforms / Soils
- Tidal Exchange / Local Watersheds / Hydrology
- Ecology
- Climate Change
- Infrastructure
- Human Interaction
- Regulatory / Implementation

Opportunities for Restoration

Numerous opportunities can be capitalized upon to increase the success and effectiveness of the project and minimize impacts and costs. These opportunities include topography and landforms supportive of wetlands habitat, proximity to potential tidal connections, already existing habitat areas (e.g., Zedler Marsh and Steam Shovel Slough), utilization of future SLR, proximity to wildlife corridors, and future watershed improvements. Other opportunities include collaboration with efforts of government agencies (such as the Los Angeles County sensitive habitat areas map and database), local universities, enthusiastic stakeholders, and the potential acquisition of additional land for restoration. The latter is a significant opportunity (and constraint) to enable the restoration of the entire LCW Complex. Opportunities have been identified as consisting of the items listed below.

Topography / Landforms / Soils

- Existing ground elevations suitable for coastal wetlands
- Existing landforms can be used to control water
- Existing roads can provide high tide refugia
- Soils suitable for wetlands and uplands habitat cover
- Site location provides opportunities for nearby soil disposal
- Site size provides opportunities for onsite remediation
- Presence of earthquake fault through site may be deterrent to other development

Tidal Exchange / Local Watersheds / Hydrology

- Site location provides tidal exchange enhancement opportunities
- Site location provides freshwater enhancement opportunities
- Altered geomorphology minimizes sedimentation-related maintenance
- Watershed activities will provide improved water quality

Ecology

- Already existing ecologically-valuable areas (*e.g.*, those on the LA County sensitive habitat areas map)
- Habitat potential for degraded land areas
- Already existing special status species
- Potential for freshwater habitat
- Conversion of upland areas to wetlands habitat areas
- Adjacency to wildlife corridors and connectedness

Climate Change

- Utilization of SLR for tidal exchange
- Existing Hellman site topography provides for habitat adjustment
- Potential to restore "natural" sedimentation
- Potential to accommodate upslope transgression of habitats
- Potential to increase flood protection

Infrastructure

- Lease agreements include reconfiguration of oil infrastructure
- LCWA-owned property includes the San Gabriel River levees

Human Interaction

- Public access to large open space area
- Synergy with the LCW SP
- Active local stakeholders
- Cooperative efforts with local universities
- Adjacent existing public use areas
- Limited visibility from housing developments
- Already existing infrastructure for public interpretation

Regulatory / Implementation

- Potential for additional land acquisition
- Potential funding opportunities
- Potential for agency coordination

Constraints to Restoration

As is typical in most projects, there are also many constraints to restoration. The constraints to restoration also need to be considered and either avoided, remediated, or otherwise factored into the planning and design effort. The degree of constraint imposed by each factor varies. Some constraints will be difficult to avoid and thus must be incorporated into the CRP (*e.g.,* surrounding power plants, roads and neighborhoods, an earthquake fault through the site), some may be able to be modified to remediate the constraint (*e.g.*, reconfiguration of onsite oil infrastructure, construction of bridges along surrounding roadways, habitat transition zones for SLR, soil contamination and remediation).

Existing and future contamination associated with oil operations could be one of the largest drivers in the type of restoration that is feasible. Once the gaps in data concerning existing contamination within the entire complex are filled, the conceptual restoration designs could significantly change. Limited project funding is another obvious constraint that must be considered for any alternative. None of the identified constraints make restoration infeasible. Constraints have been identified as the items in the list below.

Topography / Landforms / Soils

- Historical and current land uses have altered natural topography
- Landform changes limit natural processes
- Existing soil quality limits restoration success
- Earthquake fault may constrain oil infrastructure reconfiguration and/or cause damage to the wetlands

Tidal Exchange / Local Watersheds / Hydrology

- Human disturbance has altered tidal exchange
- Human disturbance has altered freshwater hydrologic functioning
- Human disturbance has altered geomorphology
- Poor water quality can impair restoration success

Ecology

- Protection of existing sensitive habitat resources (see the LA County sensitive habitat areas map)
- Simplified food webs

Climate Change

- Modification of habitat proportions with climate change
- Limited areas for upslope transgression of habitats as sea level rises
- Steep perimeters support only narrow habitat bands as sea level rises
- Limited natural sediment supply
- Flood protection with SLR

Infrastructure

- Incorporation of existing and future-remaining oil infrastructure
- Fragmentation and encroachment by roadways
- Protection of existing flood control systems
- Fragmentation and encroachment by utilities

Human Interaction

- Habitat sensitivity to urban surroundings
- Habitat sensitivity to public access
- Onsite homeless encampments
- Maintaining positive public perception

- Potential impacts to surrounding neighborhoods
- Archaeological resource protection

Regulatory / Implementation

- Land ownership by other entities
- Easements by other entities
- Limited funding
- Compensatory mitigation restrictions
- Permitting and environmental reviews
- Compliance with the City of Long Beach Local Coastal Program and General Plan

In conclusion, no fatal flaws to restoration exist, and there are abundant options to optimize habitat restoration, public enjoyment, and other project goals and objectives. This CRP is, in itself, a major opportunity to restore a significant wetlands complex.

6.0 Alternatives Development

The goal of the alternative development process was to develop a range of restoration alternatives for subsequent analysis, as presented in Chapter 7. Given the overall management objectives of the project, the range of restoration alternatives needed to be limited enough to allow analysis of the alternatives to be conducted within the timeframe and budget allocated to this task. On the other hand, the range of alternatives needed to capture the restoration goals and objectives in consideration of the opportunities and constraints. In addition, public input obtained through the stakeholder outreach program needed to be incorporated into alternative development as well. Consequently, an alternative development process was needed to develop a reasonable range of restoration alternatives in consideration of project goals and objectives, opportunities and constraints, and public input that could be analyzed within the project schedule and budget.

A six step approach was developed and implemented to achieve the successful completion of the alternative development process. The six steps are listed below.

1. Review goals and objectives;
2. Consider opportunities and constraints;
3. Incorporate public input;
4. Identify thematic guidance;
5. Develop screening alternatives; and
6. Develop three “final” alternatives.

These six steps are summarized in the sections below.

6.1 Review Goals and Objectives

The restoration goals and objectives developed during the first phase of the project (Chapter 2) were reviewed to provide initial guidance for restoration alternative development. At the top level, the major project goals were to:

1. Restore tidal wetland processes and functions to the maximum extent possible.
2. Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance.
3. Create a public access and interpretative program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience.
4. Incorporate phasing of implementation to accommodate existing and future potential changes in land ownership and usage, and as funding becomes available.
5. Strive for long-term restoration success.
6. Integrate experimental actions and research into the project, where appropriate, to inform restoration and management actions for this project.

Looking over this list of goals, it becomes clear that it might not be possible to achieve all the goals, or at least to maximize all the goals, with one restoration alternative. For example, meeting Goal 1 by restoring tidal wetland processes and functions to the maximum extent possible could be achieved through restoration of these processes and functions right up to the project boundary.

However, this would impact the ability of meeting Goal 2, which involves maximizing contiguous habitat areas and maximizing the buffer between habitat and sources of human disturbance. Consequently, some tradeoffs would be needed across these and other goals as well as the objectives associated with each goal. The need to consider tradeoffs among and across goals and objectives was carried forward through the alternative development process as discussed further below.

Chapter 2 of this plan includes the Goals and Objectives that were developed in close coordination with the SC and the TAC. They were used to help guide the development of the conceptual restoration designs and should continue to be used to guide refinement of those designs in the future. Site-specific objectives and considerations for restoration are much narrower in focus and will primarily be useful for refining and adding details to the conceptual plans as the planning process continues.

Site-specific objectives and considerations for restoration are organized geographically by major areas on the site, more or less by parcel within the major areas. The purpose of this section is to document many of the important objectives that were discussed and identified during the conceptual planning process for each area. In order to not bog the conceptual alternatives down in details, many of these site-specific objectives and considerations were not explicitly included in the conceptual drawings. The intent here is to provide guidance to subsequent rounds of planning where these more nuanced objectives can be addressed.

This is not a complete list and it should be updated regularly as site conditions change and new opportunities and constraints arise. Therefore, it should be considered a "living document." Objectives and considerations are numbered under each geographic area, but are not necessarily ranked by importance or any other factor. Finally, no restoration design can, or necessarily should, try to address each and every objective for a given site. Indeed, as with the project goals, some objectives and considerations may be in direct conflict with each other. Rather, these should be considered along with other important factors (*e.g.*, available budget) when developing more detailed restoration plans.

6.1.1 Northern Area Objectives and Considerations for Restoration

Synergy Gas and Oil Operations

1. Consider strategies for preserving brackish marsh habitats or restoring similar habitats elsewhere within the LCW Complex.
2. Consolidate oil operations and protect them from flooding.
3. Eliminate un-needed roads and infrastructure.
4. Provide tidal connections, could come directly from Los Cerritos Channel or from Steam Shovel Slough.
5. Enhance tidal exchange with a tidal channel under 2nd St. to connect Phase 1 and Marketplace parcels to tides.
6. Emphasize mid- and low-marsh habitats to minimize grading volume.
7. Enhance hydrologic, terrestrial and human connectivity to other parcels across 2nd St.

Steam Shovel Slough

1. Leave intertidal areas un-impacted by restoration activities.

2. Enhance buffer habitats and transition zone.
3. Avoid degradation of existing high-quality habitat within Steam Shovel Slough when connecting the LCWP Oil Operations area to tides through the Slough to minimize physical and biological disturbances.

Old Landfill along Studebaker Rd.

1. Cleanup debris (*e.g.*, concrete slabs), but avoid exposing any capped landfill areas or creating erosion issues.
2. Enhance vegetative buffer along Studebaker Rd.
3. Transition to the tidal and non-tidal wetlands at Steam Shovel Slough and the rest of the LCW property are very steep and do not allow for transgression of habitats up-slope with SLR.
4. Maintain as a natural place for trails that have views into the wetlands.
5. Upland habitats and storm water treatment wetlands should be restored in this area.

LCWA Phase 1 (OTD Parcel)

1. Parcel has little potential for tidal wetland restoration.
2. Continue to use the site to create revenue for the LCWA.
3. Potential site for development as income-generating interpretive center or could be swapped for wetland habitat elsewhere in the LCW Complex.
4. Could be connected to wetland areas using bridges across Studebaker Rd. and 2nd St. if used as an interpretive center.

Loynes Property

1. Currently the site of a coastal sage scrub mitigation project.
2. Probably limited potential for tidal wetland restoration.

6.1.2 Central Area Objectives and Considerations for Restoration

LCWA Phase 1 (Bryant)

1. Seek transfer of privately owned property along 2nd St. to the LCWA.
2. Protect adjacent areas from increased flooding risk when tides are re-introduced to the parcel.
3. Expand salt marsh habitat by improving tidal connections and grading.
4. Tidal connections could come from the San Gabriel River or under 2nd St. from the Synergy Oil and Gas property.
5. Emphasize high-marsh habitats to minimize grading volume.
6. Design restoration on this parcel and the Marketplace Marsh parcel together.
7. Consolidate oil operations and protect them from flooding.
8. Eliminate un-needed roads and infrastructure.
9. Seek to replace the seasonally ponded habitats that currently occur on the parcel elsewhere within the LCW Complex (*e.g.*, the Orange County Flood Control Basin).
10. Enhance hydrologic, terrestrial, and human connectivity to other parcels across the San Gabriel River.

Marketplace Marsh (City of Long Beach)

1. Consider strategies for preserving brackish marsh habitats or restoring similar habitats elsewhere within the LCW Complex.
2. Consolidate oil operations and protect them from flooding.
3. Eliminate un-needed roads and infrastructure.
4. Tidal connections could come from the San Gabriel River or under 2nd St. from the Synergy Oil and Gas property.
5. Emphasize high-marsh habitats to minimize grading volume.
6. Design restoration on this parcel and the LCWA Phase 1 parcel together.
7. Enhance hydrologic, terrestrial, and human connectivity to other parcels across the San Gabriel River and 2nd St.

Bryant Parcel (along 2nd Street)

1. LCWA should seek to purchase this property.
2. Restore wetland, transition, and upland habitat once acquired.

6.1.3 The Isthmus Objectives and Considerations for Restoration

1. Improve functioning of existing salt marsh habitats (*e.g.*, Zedler and Callaway Marshes).
2. Seek transfer of ownership to the LCWA.
3. Expand salt marsh habitat by improving tidal connections and grading.
4. Encourage consolidation of on-site oil infrastructure.
5. Use the areas already dedicated to oil operations as a consolidation location for some operations currently located across the river on the LCWA Phase 1 parcel.
6. Continue to use the site for the LCWA SP.
7. Enhance hydrologic, terrestrial, and human connectivity to other parcels across the San Gabriel River and HCC.

6.1.4 Southeast Area Objectives and Considerations for Restoration

Orange County Flood Control Basin

1. Continue developing freshwater habitats in the basin using urban runoff.
2. Maintain existing mitigation sites.
3. Assure any constructed habitats are compatible with flood retention.
4. Study feasibility of filling in basin, restoring salt marsh, and retaining flood control benefits by spreading flood waters over a larger area.

Hellman Retained

1. Seek acquisition of surface rights for this parcel.
2. Work with current owners on land management strategies that could benefit certain species that occur there (*e.g.*, burrowing owl, Coulter's goldfields).
3. Raise roads or create berms to protect infrastructure from flooding using dirt excavated during restoration activities on other parcels.

4. Identify alternative access roads that could eliminate the need for the current road through the LCWA Phase 2 property.
5. Study the feasibility of consolidating oil operations, cleanup of contaminated soils, and creation of tidal salt marsh through connections to the HCC or the LCWA Phase 2 parcel.

LCWA Phase 2 (Hellman)

1. Expand salt marsh habitat by improving tidal connections and grading with tidal connection to HCC being preferable.
2. Design salt marsh restoration for the area that leaves room for habitats to transgress upwards with SLR.
3. Provide Coastal Commission-mandated raptor foraging habitat.
4. Use upland areas as an access connection between Gum Grove trails and other trail systems (*e.g.* California Coastal Trail and San Gabriel River Bike Trail).
5. Clean up contaminated soils or avoid grading contaminated areas.
6. Enhance hydrologic, terrestrial, and human connectivity to other parcels across the San Gabriel River and HCC.

State Lands Parcel

1. Integrate restoration of this parcel with the larger Phase 2 parcel and consider approaches that help buffer habitats from urban edges.
2. Seek transfer of ownership to the LCWA or negotiate with the State Lands Commission to allow for restoration.
3. Prioritize the area for restoration of habitats as opposed to other uses (*e.g.*, interpretive center or demonstration garden).

Gum Grove Park

1. Maintain and improve public access.
2. Preserve eucalyptus trees.
3. Use the area as a key entry point for visitors and connect to other trail systems (*e.g.*, California Coastal Trail and San Gabriel River Bike Trail).

6.1.5 Channel Areas Objectives and Considerations for Restoration

San Gabriel River

1. The lower river through the project site is almost fully tidal (very slight muting) and the connection to the ocean is essentially constant.
2. Water in the river is heated due to effluent from upstream power plants and it is not known what effects, if any, this might have on salt marsh habitats that might use the river as a source of water.
3. Green sea turtles that inhabit the river should be preserved.
4. Restore connectivity of the river to adjacent salt marsh habitat.
5. Maintain existing eelgrass beds and consider adding eelgrass.

Haynes Cooling Channel

1. Fully tidal via a siphon connection under the San Gabriel River to Alamitos Bay.
2. Past talks with the channel operators indicate that they would not be open to connecting to restored tidal habitat at Hellman until the plan no longer uses the channel for cooling.
3. Opportunities may arise for using this as a source of tidal flows once power plants stop using once-through cooling.
4. Maintain existing eelgrass beds and consider adding eelgrass.

Los Cerritos Channel

1. Fully tidal in the project area.
2. Trash floating down the channel is a major concern.
3. Maintain existing eelgrass beds and consider adding eelgrass.

6.2 Consider Opportunities and Constraints

The opportunities and constraints identified during the early phase of the project (Chapter 5) were reviewed to provide guidance for restoration alternative development. At the top level, the primary opportunities and constraints were grouped into categories to facilitate use in the alternative development process. The categories are listed below.

- Topography / Landforms / Soils
- Tidal Exchange / Local Watersheds / Hydrology
- Ecology
- Climate Change
- Infrastructure
- Human Interaction
- Regulatory / Implementation

An example of opportunities and constraints used in alternative development is illustrated in Figure 6-1 for topography/landforms/soils. This figure depicts the road network within and surrounding the site as well as the berms and levees. These features represent obvious constraints regarding hydrology impacts and topographic impacts to habitats, as well as impairments related to wildlife connectivity. However, these features also provide opportunities related to ongoing oil operations and hydrology (*e.g.*, rainwater ponding). Another example is provided in Figure 6-2, which shows the theoretical habitat distribution under existing and future mean sea level (MSL) conditions if the hydromodifications (*e.g.*, levees and berms) across the project site were removed, thus allowing tidal saltwater to flow freely across the entire area. If tidal exchange is provided across the site, then the existing elevations provide opportunities to enhance and restore tidal wetland processes and functions without significant levels of earthwork (*i.e.*, cut and fill). However, the existing elevations also represent a constraint to the creation of large areas of marsh plain and subtidal habitat under existing sea levels since such habitats require lower elevations. In reviewing this information, it is clear that it might not be possible to accommodate all the opportunities and constraints within one restoration alternative. As with the goals and objectives, some type of tradeoff approach will be required to accommodate the opportunities and constraints in a spatial and/or temporal manner. This is discussed in more detail later in this chapter.

Image Source: Google Earth Pro

Figure 6-1. Opportunities and Constraints Example – Topography/Landforms/Soils

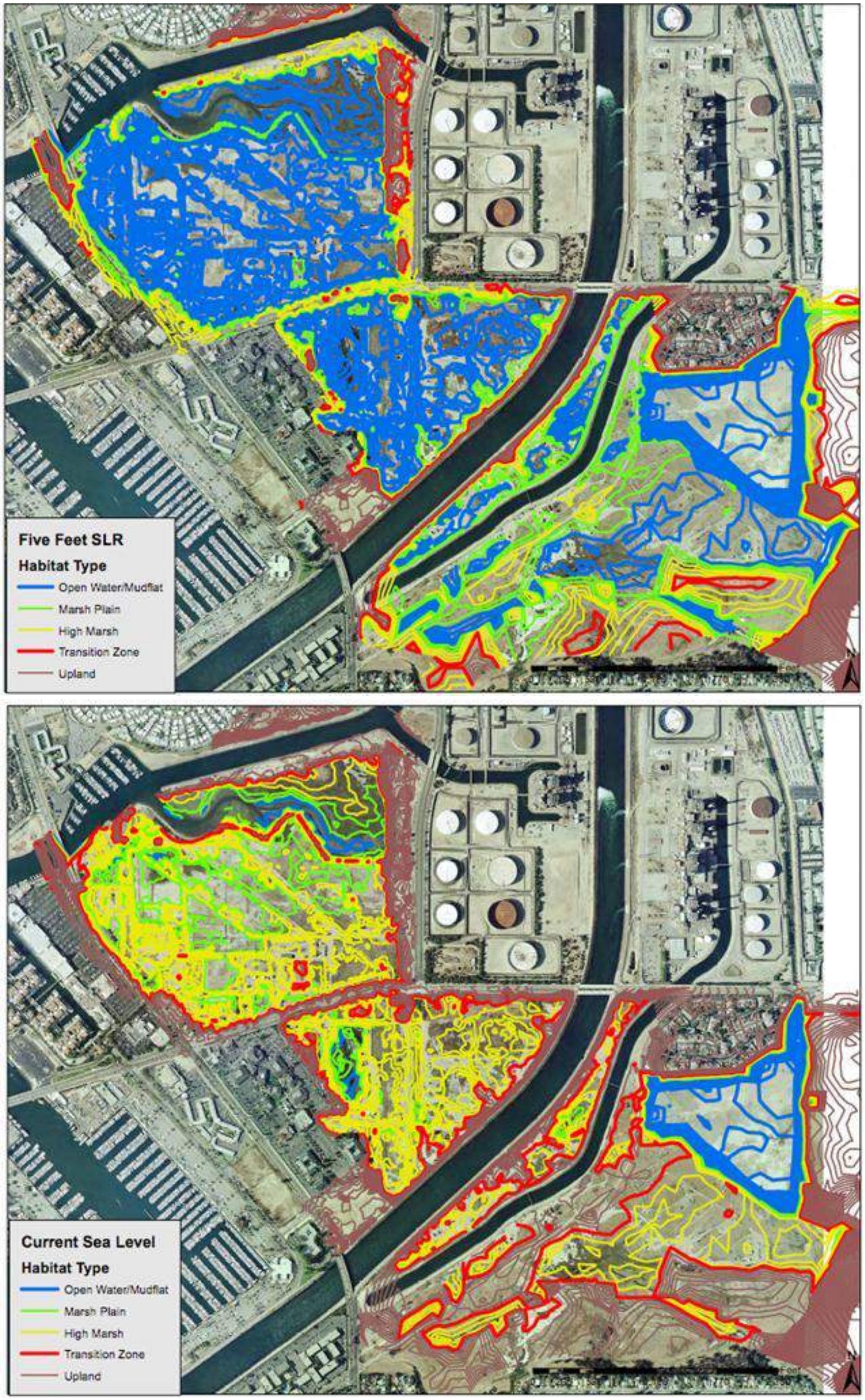


Figure 6-2. Opportunities and Constraints Example – Theoretical Habitat Distribution under Different MSLs

6.3 Incorporate Public Input

Input obtained from the public through the public outreach process (Appendix A) was summarized in graphic and tabular format to provide guidance for restoration alternative development. An example graphic taken from the public involvement process is presented in Figure 6-3. Approximately 25 such graphics were provided by interested members of the public. The input provided through this process ranged from somewhat detailed input for a specific site to overarching broad-based guidance applicable to an entire area or the entire project. There was guidance provided on what to do and what not to do at a certain location or throughout the entire project. This information was reviewed and distilled down to general input categories that were used in developing the restoration alternatives. Upon the development of actual restoration alternatives, the alternatives were cross checked with the public input to make sure most of the public input was adequately captured in the range of restoration alternatives. Results of these analyses were also conveyed to the public in a final CRP meeting.

Figure 6-3. Example of Public Input

6.4 Identify Thematic Guidance

Upon completion of the first three steps in the alternative development process, there was a lot of useful information, but much of that information was in potential conflict or lacked enough clarity to be useful in developing restoration measures (activities) that met the overall goals. What was needed was a unifying approach that allowed integration of the goals and objectives given the project opportunities and constraints, along with incorporation of input received from the public. After extensive brainstorming and consideration, it was noted that the existing ground elevations would support tidal wetlands under existing and future MSLs so it seemed logical to develop restoration measures around SLR adaptation. As this concept became clear in terms of specific restoration measures (*e.g.*, dike removal), it was realized that the theme of SLR adaptation made sense for a restoration measure. Using this theme as guidance, it was possible to identify restoration measures that meet various goals and objectives to certain levels while taking into account the various opportunities and constraints as well as public input. Once the SLR adaptation theme was identified, it became clear that this concept could be extended through the development of additional themes to provide guidance for restoration measures and, ultimately, alternative development. After extensive deliberation, two additional themes were developed for a total of three themes, as listed below.

- SLR Adaptation Theme;
- Habitat Connectivity Theme; and
- Habitat Diversity Theme.

As work progressed in identifying restoration measures, how to address the scale of such measures became an issue. It was relatively easy to identify a restoration measure (*e.g.,* excavation), but the scale of such a measure could drive the degree to which that measure met or failed to meet a goal or objective. On the other hand, it was not desirable to scale back a given measure just because it did not meet one goal or objective since such a measure might meet others. A tool was needed that could be used to capture the range of restoration measures and the associated levels of scale in a manner that would allow for subsequent use in winnowing down measures to develop screening alternatives. The tool that was developed to address this issue was to bracket the range of various restoration measures through the identification of minimum and maximum alteration restoration measures. Minimum alteration restoration measures represented activities that could be implemented with little effort and associated impact (*e.g.,* small levels of grading or placement of small pipes), while maximum alteration restoration measures represented activities that could be implemented with significant effort and associated impact (*e.g.,* large levels of grading or construction of open channels). By combining the minimum alteration and maximum alteration tool concept with the themes, it was possible to identify a range of restoration measures that adequately captured the goals and objectives within the opportunities and constraints.

Several meetings were held to formulate restoration measures using the themes and scale tool as guidance. The outcome of this task was the development of schematic graphics for the project site that showed various restoration measures that could be considered within a given theme and scale. Six schematic diagrams were developed, as listed below. The graphic depictions are presented in Figure 6-4 through Figure 6-9.

- SLR Adaptation Theme (Minimum Alteration);
- SLR Adaptation Theme (Maximum Alteration);
- Habitat Diversity Theme (Minimum Alteration);
- Habitat Diversity Theme (Maximum Alteration);
- Habitat Connectivity Theme (Minimum Alteration); and
- Habitat Connectivity Theme (Maximum Alteration).

The six diagrams include text boxes with descriptions of the various restoration measures. A color scheme was developed to facilitate identification of areas and measures. The color green was used to identify primary restoration measures while yellow was used to identify potential restoration measures. The color red was used to identify areas for which no restoration measures were identified, while the color blue was used to identify areas and/or restoration measures not within or a part of the Conceptual Plan development project. The identification of areas and/or restoration measures not within or a part of the Conceptual Plan development project was necessary to capture ideas that could substantially impact the future success of the Conceptual Plan.

The schematic diagrams of restoration measures contain a lot of information, some of which was not advanced in future phases of the process. It was the intent of these diagrams to capture as much information as possible for each theme and associated scale. In this sense, these graphics were developed as intermediate tools to get to the next step, which was the formulation of screening restoration alternatives. These graphics were reviewed by the SC, TAC, and public primarily to make sure no restoration measures were omitted from the alternative development process. The secondary purpose of the review was to make sure there were no restoration measures that represented some type of “red flag” to the restoration alternative development process.

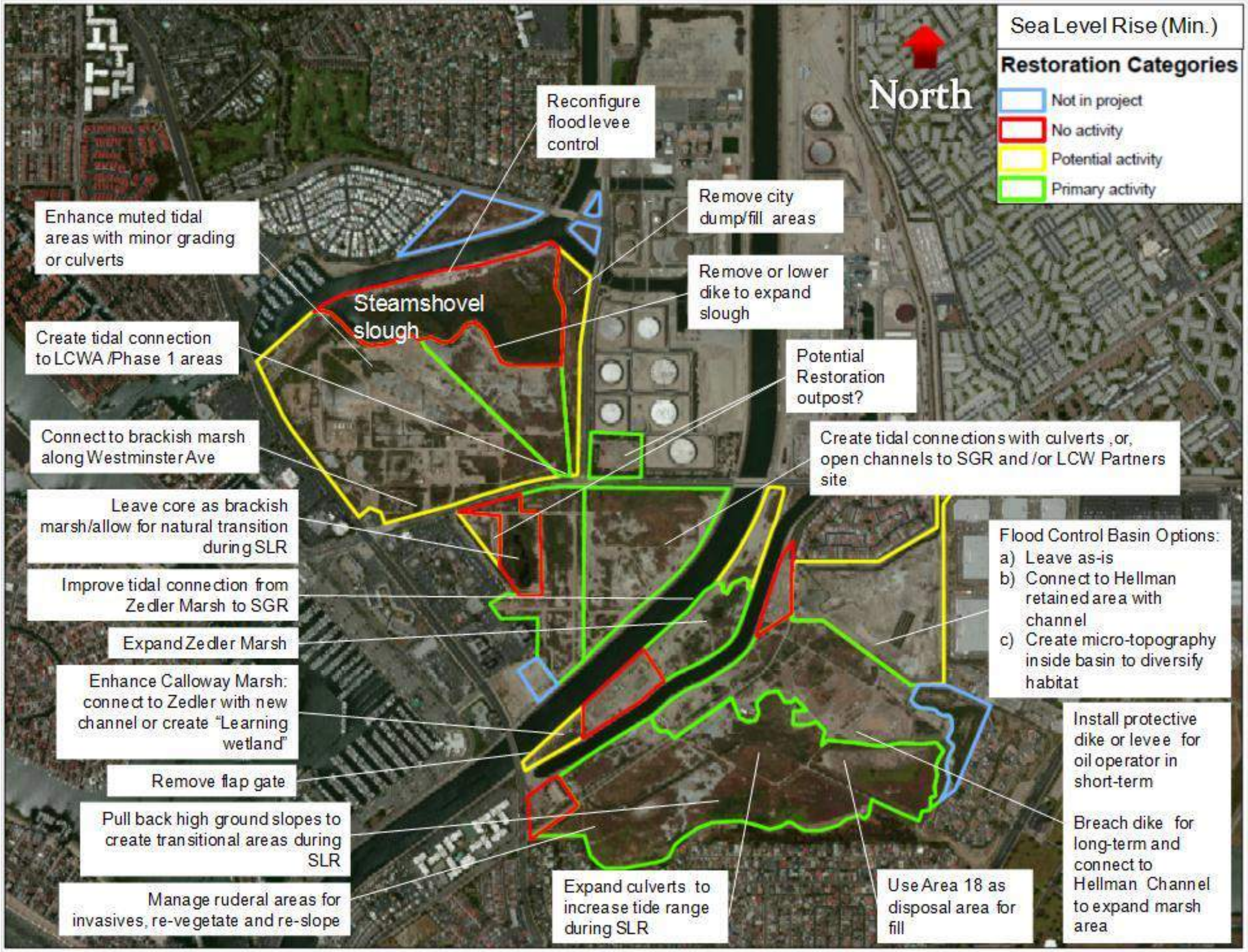


Figure 6-4. SLR Adaptation Theme (Minimum Alteration)

Figure 6-5. SLR Adaptation Theme (Maximum Alteration)

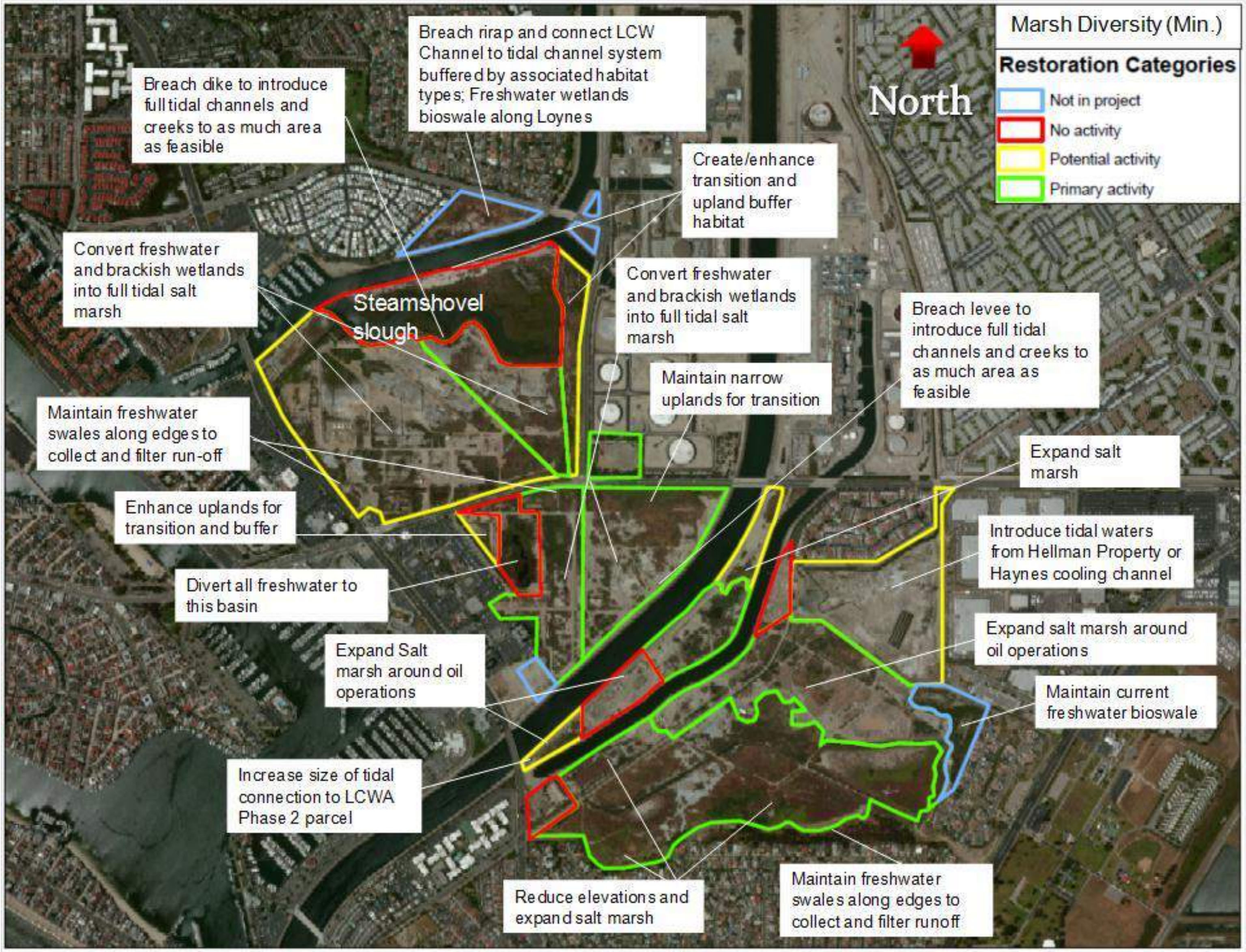


Figure 6-6. Habitat Diversity Theme (Minimum Alteration)

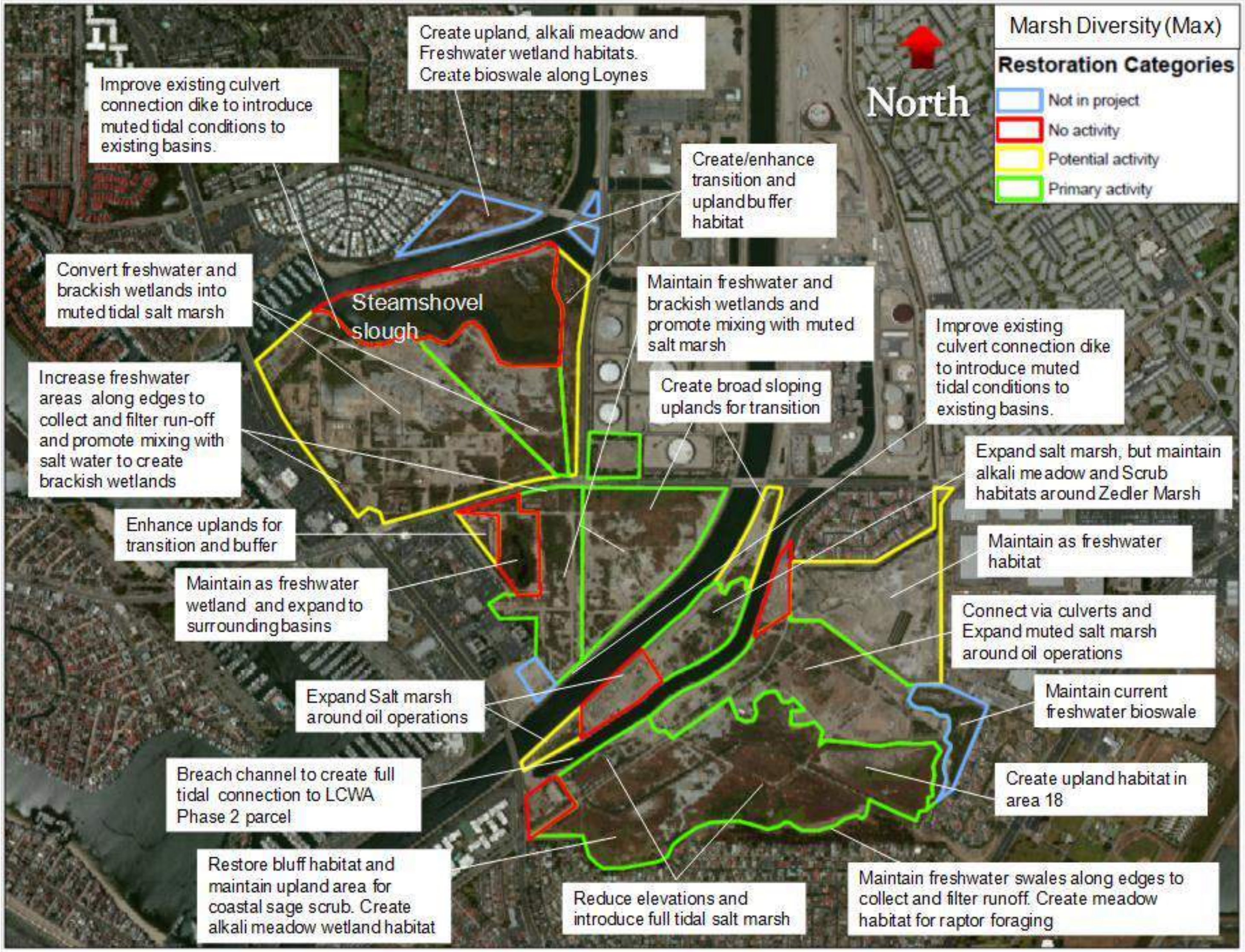


Figure 6-7. Habitat Diversity Theme (Maximum Alteration)

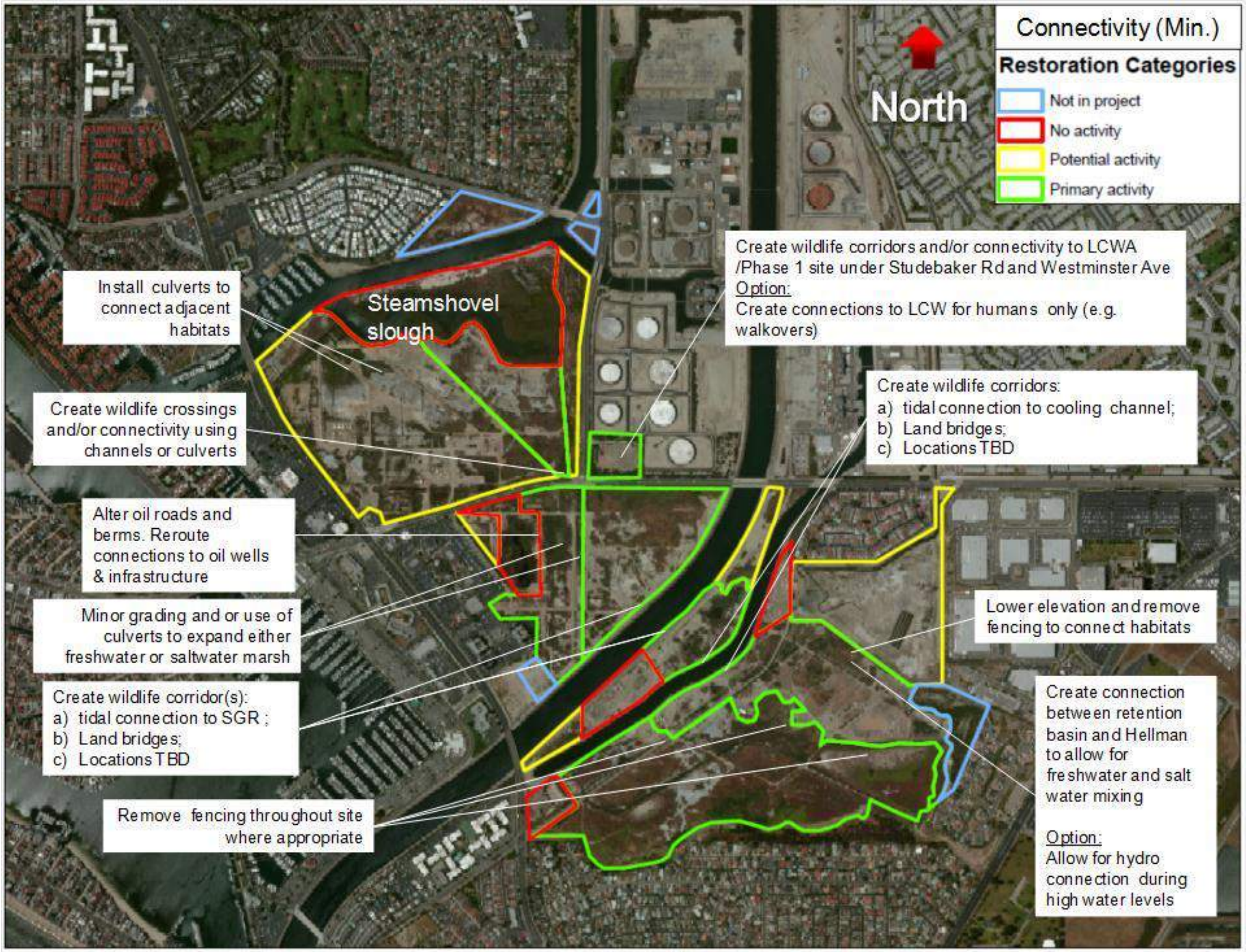


Figure 6-8. Habitat Connectivity Theme (Minimum Alteration)

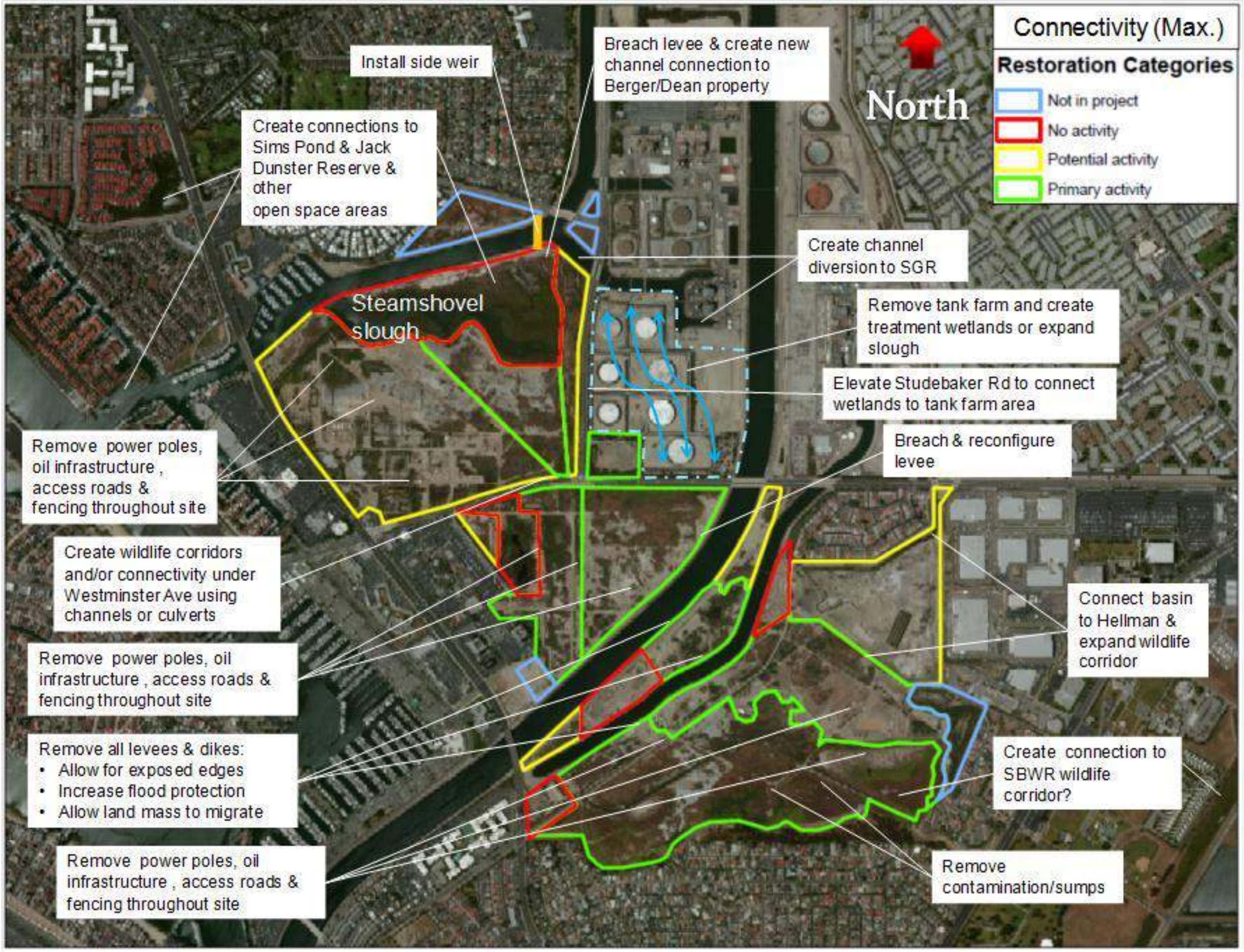


Figure 6-9. Habitat Connectivity Theme (Maximum Alteration)

Although some of the information contained in these diagrams did not end up in the final restoration alternatives, it still provided useful information for the development of the Conceptual Plan. A good example can be found on Figure 6-9, which shows the Habitat Connectivity theme under the maximum alteration scale. One of the restoration measures identified in this figure is the complete removal of the levees along the San Gabriel River and HCC. This restoration measure did not make it into the final restoration alternatives; however, it was identified in the Conceptual Plan as something that could be pursued in future restoration project development. Removal of portions of certain levees along the San Gabriel River and HCC were included in the Maximum Alteration Alternative, however.

6.5 Develop Screening Alternatives

After development of the six schematic diagrams, the next step in the alternative development process was to prepare preliminary screening alternatives. This step was necessary to produce visual representations of the outcome of the various restoration measures selected for each theme and scale. Through several workshops, an optimal mix of restoration measures from each schematic diagram was selected to prepare each screening alternative. Draft versions of these graphics were prepared and reviewed with the SC, TAC, and public to obtain input on any information that might be missing, as well as to identify any "red flags" that would hinder development of the three final restoration alternatives. The six screening alternatives are listed below followed by brief summaries.

- Screening Alternative 1: SLR Adaptation Theme (Minimum Alteration);
- Screening Alternative 2: SLR Adaptation Theme (Maximum Alteration);
- Screening Alternative 3: Habitat Connectivity Theme (Minimum Alteration);
- Screening Alternative 4: Habitat Connectivity Theme (Maximum Alteration);
- Screening Alternative 5: Habitat Diversity Theme (Minimum Alteration); and
- Screening Alternative 6: Habitat Diversity Theme (Maximum Alteration).

6.5.1 Screening Alternative 1: SLR Adaptation Theme (Minimum Alteration)

Screening Alternative 1 is shown in Figure 6-10. The overall vision for this alternative would be to restore tides using small pipes, culverts, and/or channels. Existing ground elevations would be utilized as much as possible to provide coastal salt marsh habitat and minimize earthwork. The oil infrastructure would be maintained throughout the site with minor adjustments. From a temporal standpoint, this alternative would seek to provide a wide range of wetland and associated upland habitats in the near-term with a wide range of habitats remaining in the future based on current projections of MSL rise.

This alternative would involve the development of an intertidal channel network throughout the entire project site. In the Northern Area, two low intertidal channels would be created off Steam Shovel Slough to provide tidal exchange to the low lying areas. Relatively low levels of grading would be conducted throughout this area to provide elevations suitable for coastal salt marsh. This would include lowering oil service dikes where appropriate and connecting cells between those dikes that remain. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. Redundant roads would be removed within the Central (LCWA Phase I) Area and basins would be interconnected with newly excavated tidal channels, where needed. These tidal channels would be connected to the San Gabriel River via a new tidal connection consisting of a small to medium sized pipe within the existing levee. Existing freshwater inputs would be used to support brackish habitats in the Central Area. Within the Isthmus Area, Zedler Marsh and Callaway Marsh would be connected and the tidal connections to the San Gabriel River would be enhanced. Within the Southeast (LCWA Phase 2 and Hellman retained) Area, the tidal channel connection to the HCC would be improved and selective grading would be conducted to provide enhanced tidal exchange throughout the area. Upland areas would be restored to native grassland and shrublands, while avoiding extensive work within the eastern areas that contain high levels of contaminated soil. In addition, the OC Retarding Basin would receive selective grading to enhance freshwater wetlands habitat.

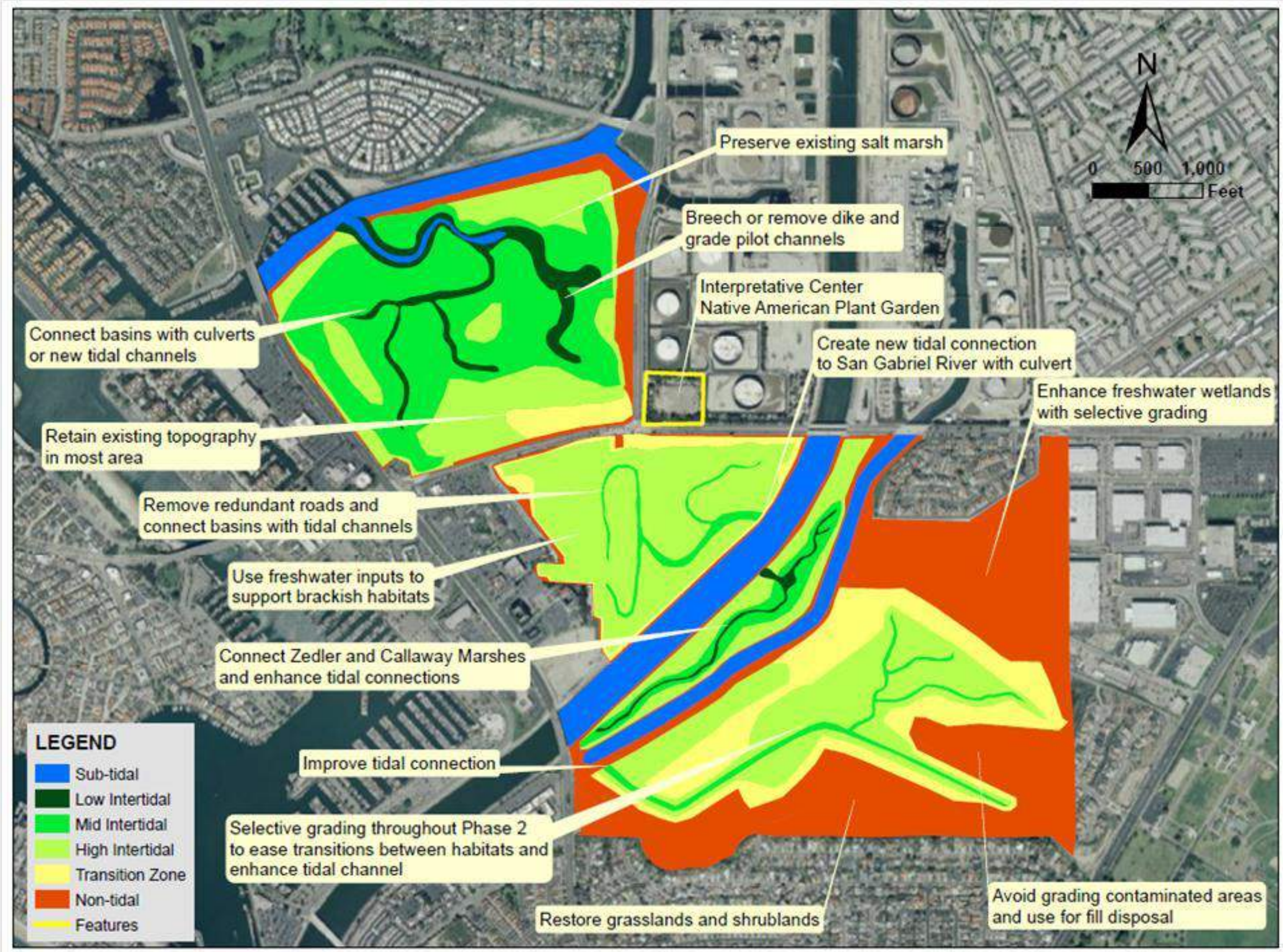


Figure 6-10. Screening Alternative 1: SLR Adaptation Theme (Minimum Alteration)

6.5.2 Screening Alternative 2: SLR Adaptation Theme (Maximum Alteration)

Screening Alternative 2 is shown in Figure 6-11. The overall vision for this alternative would be to restore tides using large pipes, culverts, and/or channels. Existing ground elevations would be graded to improve hydrology and topography. The oil infrastructure would be consolidated throughout the site to provide as much area for restoration as possible in the near-term. From a temporal standpoint, this alternative would seek to maximize coastal salt marsh in the near-term under current MSL; however, this coastal salt marsh would likely be inundated in the future based on current projections of MSL rise.

This alternative would involve the development of a subtidal channel network throughout the entire project site. In the Northern Area, an extensive subtidal channel network would be created off Steam Shovel Slough to provide tidal exchange throughout the areas. Extensive grading would be conducted throughout this area to provide elevations suitable for coastal salt marsh. This would include removing oil service dikes and reconfiguring the flood control levee. A tidal connection would also be provided under Westminster Avenue to hydraulically connect this area to the Central Area. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. Significant grading would be conducted within the Central Area to remove fill and create tidal channels. These tidal channels would be connected to the San Gabriel River via a new tidal connection consisting of an open channel built through the existing levee. Within the Isthmus Area, Zedler Marsh and Callaway Marsh would be graded to enhance marsh hydrology and the eastern levee along the San Gabriel River would be removed to provide tidal exchange. Within the Southeast Area, two new tidal channels would be constructed to connect the HCC with the restored wetlands and the HCC levees would be removed as well. Extensive grading would be conducted across this area to remove fill and restore coastal salt marsh. Upland areas would be restored to native grassland and shrublands. The highly contaminated soils in the eastern area would be removed, capped, or treated to acceptable levels. The OC Retarding Basin would receive fill from the adjacent excavated areas and it would be connected hydraulically to the wetlands to the south, thereby maintaining flood control while expanding wetlands habitat.

For perspective, the effect of future projections of SLR of 2.0 feet and 5.0 feet are illustrated in Figure 6-12 and Figure 6-13, respectively. As these figures show, the low intertidal, mid-intertidal, and high intertidal marsh habitats are progressively inundated with increasing sea level. These two figures illustrate the importance of theme selection and restoration work scale (minimum alteration and maximum alteration). Although not shown herein, a similar sequence for Screening Alternative 1 would reveal less change in wetlands habitat from mid- and high intertidal marsh to subtidal and low intertidal marsh compared to Screening Alternative 2. By this metric, Alternative 1 would be better in terms of adaptation to SLR. However, Screening Alternative 2 provides more subtidal and lower elevation salt marsh habitat in the near-term. The two scale representation brackets the range of restoration measures within the SLR adaptation theme.

Figure 6-11. Screening Alternative 2: SLR Adaptation Theme (Maximum Alteration) at Current MSL

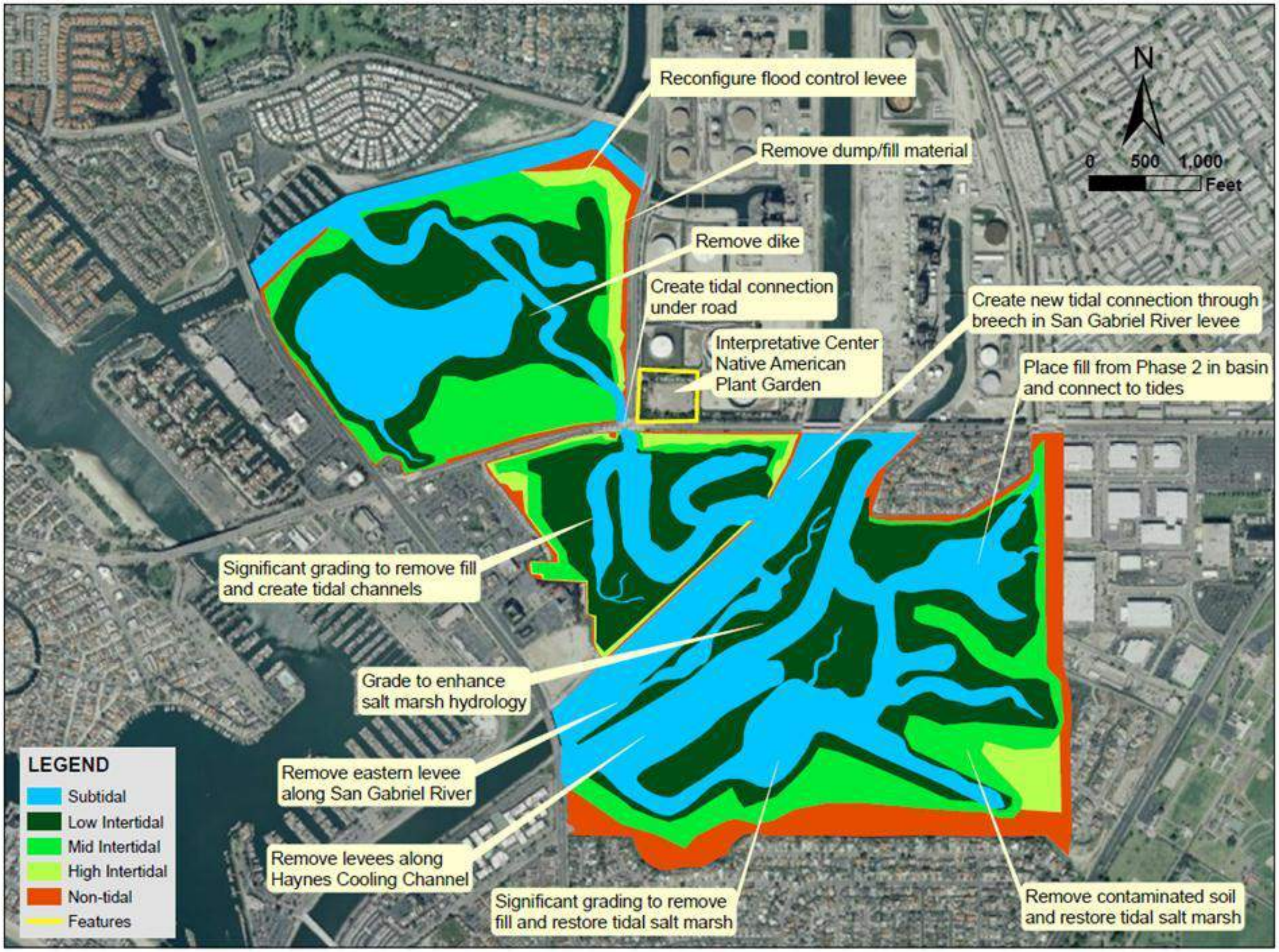


Figure 6-12. Screening Alternative 2: SLR Adaptation Theme (Maximum Alteration) with 2 Feet of MSL Rise

Figure 6-13. Screening Alternative 2: SLR Adaptation Theme (Maximum Alteration) with 5 Feet of MSL Rise

6.5.3 Screening Alternative 3: Habitat Connectivity Theme (Minimum Alteration)

Screening Alternative 3 is shown in Figure 6-14. The overall vision for this alternative would be to provide water connectivity through the addition of culverts and land connectivity via tunnels and bridges. Existing ground elevations would be utilized as much as possible to provide coastal salt marsh habitat and minimize earthwork. The oil infrastructure would be maintained throughout the site with restoration work planned around the existing infrastructure. Fences and other barriers to wildlife connectivity would be removed. From a temporal standpoint, this alternative would seek to provide a wide range of wetland and associated upland habitats in the near-term with a wide range of habitats remaining in the future based on current projections of MSL rise.

This alternative would involve connecting basins throughout the entire project site via small pipes placed within the existing oil dikes as well as through small channels, where appropriate. In the Northern Area, existing pipes and channels connecting Steam Shovel Slough to the isolated, degraded wetland areas (basins) would be improved and pipes would be installed in the oil dikes to provide increased tidal exchange to the low lying areas. Spot grading would be conducted throughout the area to provide elevations suitable for coastal salt marsh and to provide the needed hydraulic connectivity, which could include lowering the elevation of the existing oil service road off Westminster Avenue. A tunnel or large culvert would be installed under Westminster Avenue to facilitate land connectivity for terrestrial wildlife between the Central Area and the Northern Area. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via new pipes and/or improvements to the existing pipes currently located within the existing levee. Existing freshwater inputs would maintain the existing brackish habitats in the Central Area. Within the Isthmus Area, the Zedler Marsh and Callaway Marsh would remain unchanged relative to existing conditions. In general, the same type of work performed in the Northern Area would be performed in the Southeast Area under this alternative. Land bridges would be constructed across the San Gabriel River and HCC to provide land connectivity for terrestrial wildlife. Enhanced public access would be provided in the western area located off Pacific Coast Highway (PCH) in Seal Beach. Upland areas would be restored to native grassland and coastal sage scrub, while avoiding extensive work within the eastern areas that contain high levels of contaminated soil. The fence along the OC Retarding Basin would be removed to facilitate improved land connectivity.

6.5.4 Screening Alternative 4: Habitat Connectivity Theme (Maximum)

Screening Alternative 4 is shown in Figure 6-15. The overall vision for this alternative would be to provide water connectivity through levee breeching and channel construction and land connectivity via roadway elevation. Large-scale extensive grading would be conducted to improve hydrology and topography. The oil infrastructure would be consolidated throughout the site and flood protection would be provided where needed. Transitional habitats would be provided to enhance terrestrial wildlife connectivity. From a temporal standpoint, this alternative would seek to maximize subtidal and low coastal salt marsh in the near-term under current MSL.

This alternative would involve hydraulically connecting the project site via large open channels constructed under roadways and through levees. Westminster Avenue would be elevated from Studebaker Road to Shopkeeper Road to enhance connectivity for aquatic and terrestrial wildlife between the Central Area and the Northern Area. In the Northern Area, a new tidal channel would be constructed under the elevated Westminster Avenue to provide tidal exchange from the San Gabriel River via the Central Area. The Los Cerritos Channel would be redirected through the site and out to the San Gabriel River via the Central Area with an optional side weir used to regulate flows through the Los Cerritos Channel out to Alamitos Bay. The areas outside the channel would be graded to provide a mosaic of salt marsh habitats under current MSL. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via an open channel constructed through the existing levee. The entire Isthmus Area would be re-graded to provide a mosaic of salt marsh habitats under current MSL. In general, the same type of work performed in the Northern Area would be performed in the Southeast Area under this alternative. Upland areas would be restored to transitional zones. The fence along the OC Retarding Basin would be removed to facilitate improved land connectivity and the area would be converted to a freshwater mixing zone with non-tidal habitats and transition zones. The entire perimeter would be checked to verify that flood protection is maintained or improved under this alternative.

Figure 6-14. Screening Alternative 3: Habitat Connectivity Theme (Minimum Alteration)

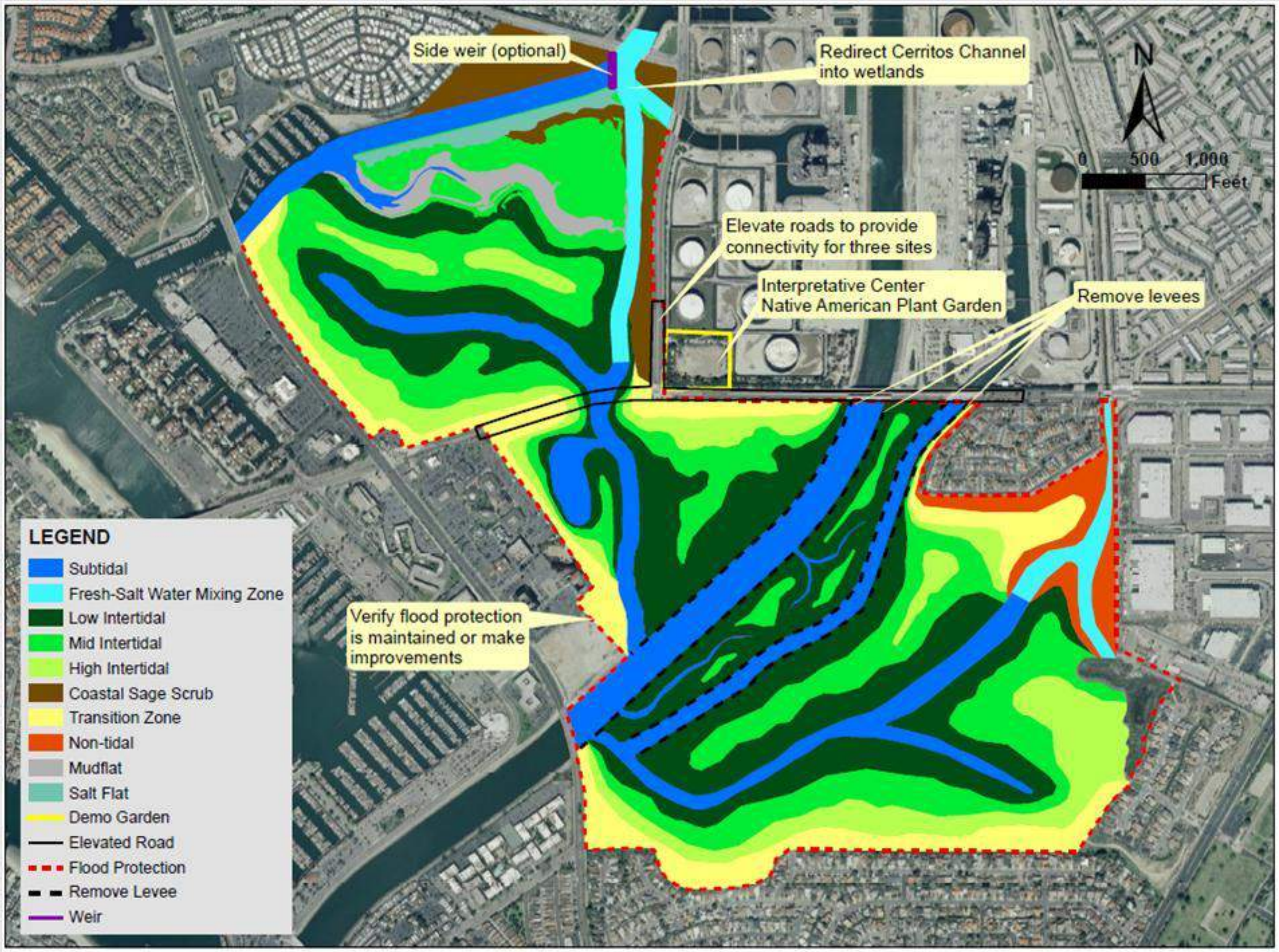


Figure 6-15. Screening Alternative 4: Habitat Connectivity Theme (Maximum Alteration)

6.5.5 Screening Alternative 5: Habitat Diversity Theme (Minimum Alteration)

Screening Alternative 5 is shown in Figure 6-16. The overall vision for this alternative would be to enhance habitat diversity through the preservation of existing wetlands habitats and the conversion of upland and unvegetated areas to wetlands and wetlands-associated habitats. Existing ground elevations would be utilized as much as possible to maintain existing wetlands habitats and expand coastal salt marsh habitat. The oil infrastructure would be maintained throughout the site with restoration work planned around the existing infrastructure. From a temporal standpoint, this alternative would seek to provide a wide range of wetland and associated upland habitats in the near-term with a wide, but decreased range of habitats remaining in the future based on current projections of MSL rise. This alternative would achieve habitat diversity through the preservation of existing wetlands habitats and the restoration of degraded area to other wetlands habitats and wetlands associated upland habitats.

This alternative would involve connecting basins throughout the entire project site via small pipes placed within the existing oil dikes as well as through small channels, where appropriate. In the Northern Area, existing pipes and channels connecting Steam Shovel Slough to the isolated, degraded wetland areas (basins) would be improved and pipes would be installed in the oil dikes to provide increased tidal exchange to the low lying areas. Spot grading would be conducted throughout the area to provide elevations suitable for coastal salt marsh and to provide the needed hydraulic connectivity. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via new pipes and/or improvements to the existing pipes currently located within the existing levee. Existing freshwater inputs would maintain the existing brackish habitats in the Central Area. Within the Isthmus Area, the Zedler Marsh would remain unchanged relative to existing conditions. Callaway Marsh would be converted to a micro marsh used for applied scientific research (a learning wetland). In general, the same type of work performed in the Northern Area would be performed in the Southeast Area under this alternative except that more extensive grading would be conducted to lower some elevations to support coastal salt marsh habitat. Tidal exchange would be provided from the HCC via the existing culvert with improvements, if needed. Enhanced public access would be provided in the western area located off PCH in Seal Beach. Upland areas would be restored to coastal sage scrub, while avoiding extensive work within the eastern areas that contain high levels of contaminated soil. The fence along the OC Retarding Basin would be removed and the area would be converted to a mosaic of habitats consisting of freshwater marsh, southern coastal brackish marsh, mulefat scrub, and southern willow scrub.

6.5.6 Screening Alternative 6: Habitat Diversity Theme (Maximum)

Screening Alternative 6 is shown in Figure 6-17. The overall vision for this alternative would be to enhance wetland habitat diversity through widespread conversion to coastal salt marsh habitat, thereby replicating the historical mix of wetland habitats found on the site in the late 1800s. Extensive grading would be conducted to maximize the areal coverage of coastal salt marsh habitats. The oil infrastructure would be consolidated throughout the site, and flood protection would be maintained at existing levels throughout the site. From a temporal standpoint, this alternative would seek to provide a limited range of wetland and associated upland habitats in the near-term with a decreased range of habitats (conversion of high- and mid-marsh habitats to low marsh, mudflat, and subtidal habitats) remaining in the future based on current projections of MSL rise. This alternative would achieve habitat diversity through creation of a large estuarine ecosystem similar to the historical wetlands habitat distributions.

This alternative would involve hydraulically connecting the project site via large open channels constructed under roadways and through levees. In the Northern Area, existing pipes and channels connecting Steam Shovel Slough to the isolated, degraded wetland areas (basins) would be replaced with a large-scale subtidal channel providing tidal exchange from the Los Cerritos Channel. Extensive grading would be conducted throughout the area to provide elevations suitable for coastal salt marsh and to provide the needed hydraulic connectivity. Coastal sage scrub habitat would be restored along the eastern and northern boundaries of this area. An Interpretive Center and Native American plant garden would be established at the corner of Studebaker Avenue and Westminster Avenue. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via a large-scale subtidal channel constructed through the existing levee. The Isthmus Area would be graded to elevations to support coastal salt marsh habitats under current sea level and the levees would be lowered to provide the necessary tidal exchange. In general, the same type of work performed in the Northern Area would be performed in the Southeast Area. Tidal exchange would be provided from the HCC via the construction of a large-scale tidal channel near PCH in Seal Beach. Almost all the existing upland areas would be restored to coastal salt marsh habitats with extensive work conducted in the eastern areas to remove, cap, or treat highly contaminated soils. The fence along the OC Retarding Basin would be removed and the area would be converted to coastal salt marsh.

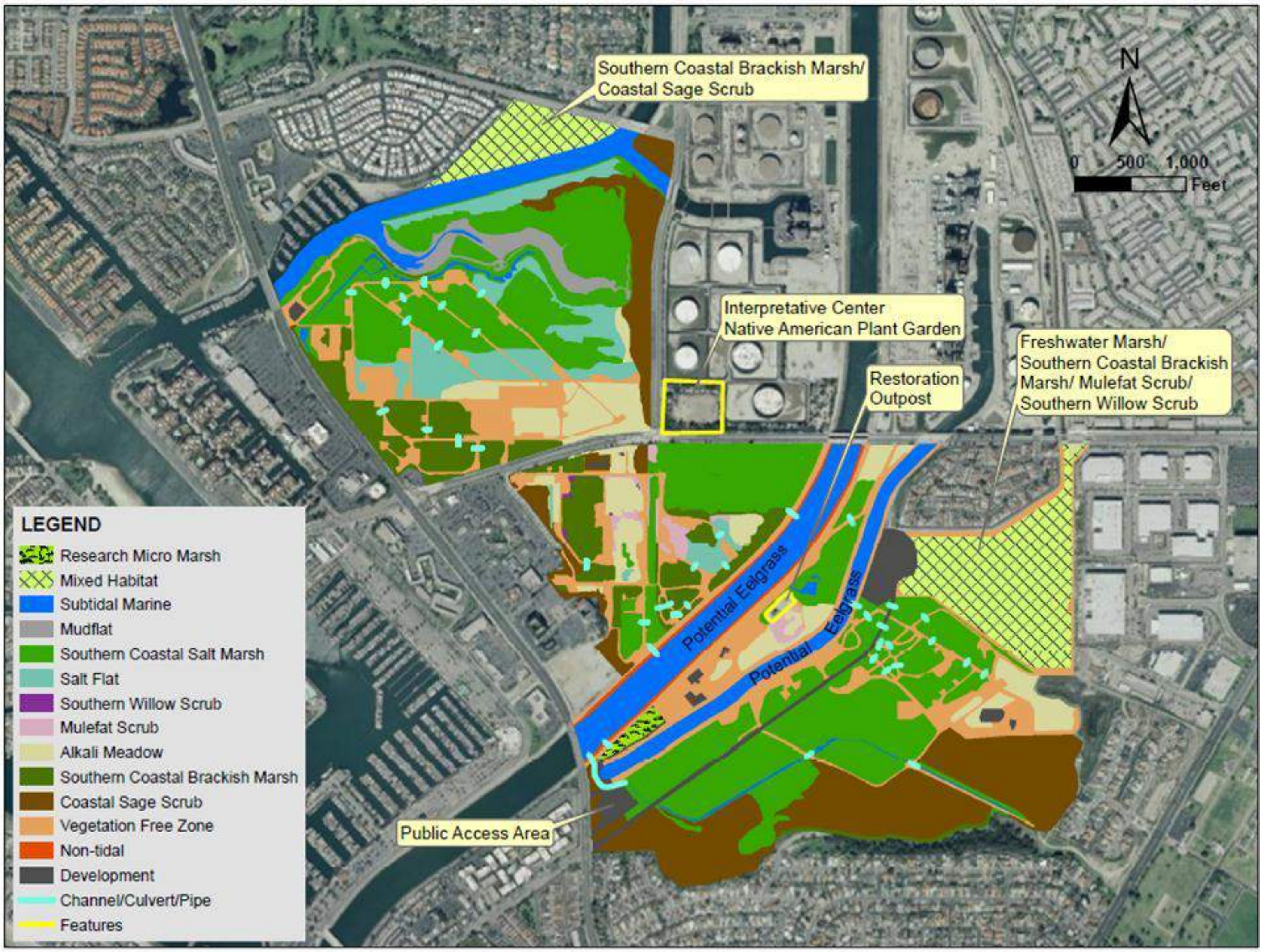


Figure 6-16. Screening Alternative 5: Habitat Diversity Theme (Minimum Alteration)

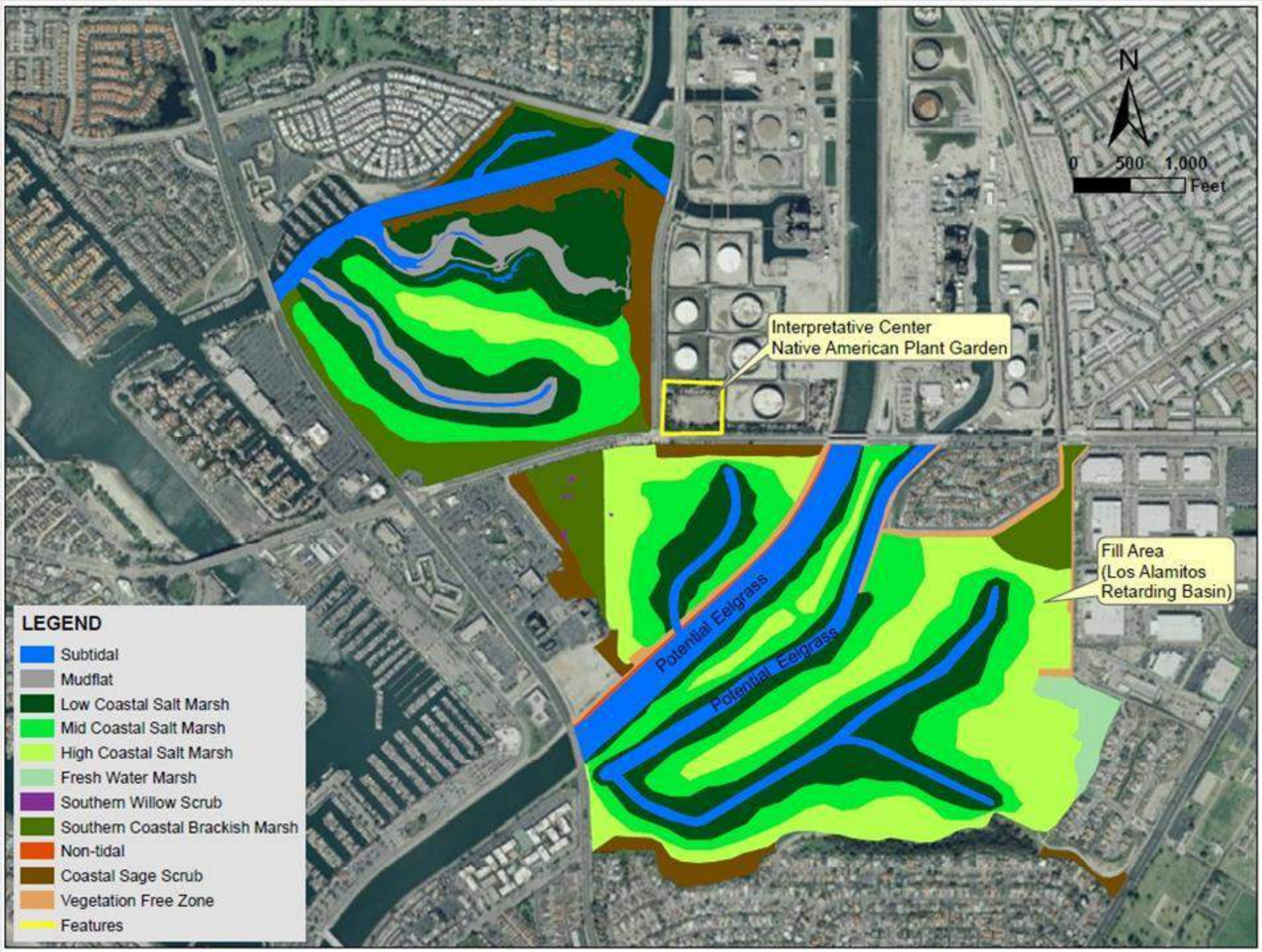


Figure 6-17. Screening Alternative 6: Habitat Diversity Theme (Maximum Alteration)

6.5.7 Oil Infrastructure Consolidation

The descriptions of Screening Alternatives 2, 4, and 6 above mention the consolidation of oil infrastructure throughout the site to allow more widespread restoration of wetlands habitats and wetlands associated upland habitats. Several areas throughout the site were identified as potential areas for oil infrastructure consolidation to illustrate the potential scale of such restoration activities. There were a total of nine areas identified throughout the vicinity of the project with seven located within the project site. These nine areas are shown in Figure 6-18 with Screening Restoration Alternative 6 shown as the backdrop. Of course, each restoration configuration would need to be modified to accommodate the actual oil consolidation areas once such locations have been determined through additional analyses and discussions with representatives from the oil operation companies.

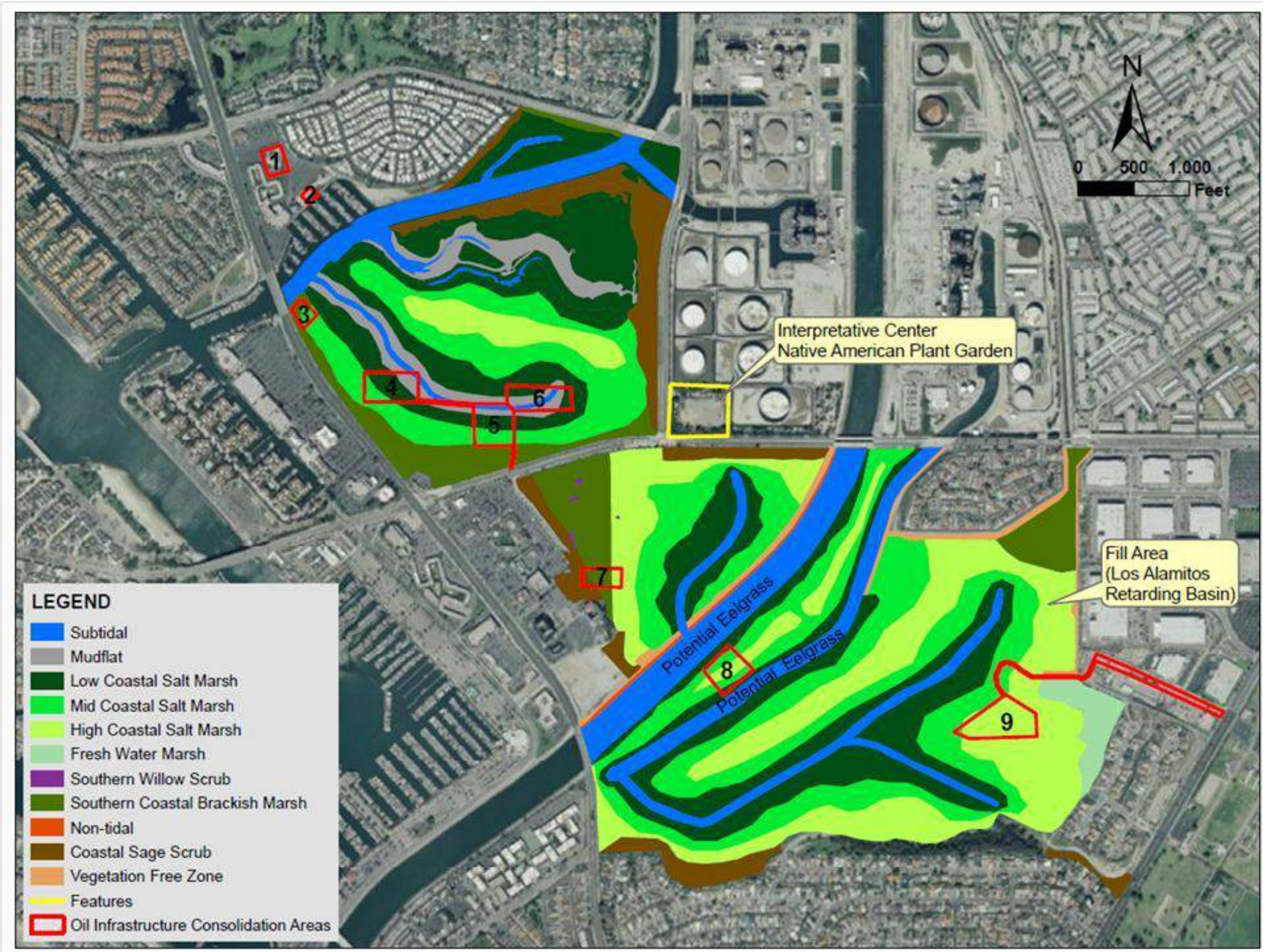


Figure 6-18. Potential Oil Infrastructure Consolidation Schematic

6.6 Develop Three "Final" Alternatives

The final step in the alternative development process was to utilize the screening alternatives to develop three final restoration alternatives that would be suitable for detailed analysis, as summarized in Chapter 7. To achieve this goal, the proposed restoration configurations in each of the four major areas (Northern Area, Central Area, Isthmus Area, and Southeast Area) for each screening alternative were extracted, thus yielding 24 separable elements. The separable elements were then grouped to create two restoration alternatives with one representing a minimum alteration approach and the other representing a maximum alteration approach. The focus at this point in the process was switched from the guidance theme to the restoration measure scale, as it was determined that scale was more important in helping to capture the full range of restoration measure possibilities developed through the process. A third alternative was developed to represent a level of scale somewhere between the minimum alteration and the maximum alteration approach; hence the moderate alteration alternative was developed as the third alternative. These three alternatives were presented to the SC and TAC to obtain input on any information that might be missing as well as to identify any "red flags" that would suggest a certain restoration measure/feature should not be included in the three final restoration alternatives. The three alternatives listed below represent the final restoration alternatives that were selected for detailed analysis, as presented in Chapter 7. It should be noted that even though the nomenclature related to the themes was dropped as the focal point for the restoration alternatives, the three final restoration alternatives still capture the full thematic range of SLR adaptation, habitat connectivity, and habitat diversity across the site. The alternatives are the:

- Final Alternative 1 (Minimum Alteration);
- Final Alternative 2 (Moderate Alteration); and
- Final Alternative 3 (Maximum Alteration).

Brief summaries for each of these three alternatives are provided below, along with associated graphics. Each alternative consists of multiple components to create a high-quality, functioning wetland complex. While not yet explicitly called out in the descriptions of alternatives, perimeter flood protection is assumed to be included in each alternative. Also, each alternative specifically retains the 10-acre deed restricted area for raptor foraging habitat and grassland, cultural resources, and parking lot for coastal access at Gum Grove Park in Seal Beach adjacent to the south perimeter of the Southeast Area. The graphics of the alternatives designate the area as Upland Habitat, with the intent of leaving existing upland conditions at Gum Grove Park unchanged for all alternatives. All alternatives are intended to support the raptor population. Parking lot areas are also not specifically called out in the concept graphics for alternatives, but it is assumed that existing parking is to remain unchanged and additional parking may be provided at sites shown as "Development," "Upland," or "Vegetation-Free" zones on the concepts.

None of the alternatives presented herein are intended for use in mitigation bank planning due to their conceptual nature and preliminary level of design.

Also, each alternative will require hydrology and hydraulics analysis to determine the flood impact on the surrounding properties and required level of flood protection. Flood protection mitigation measures must be incorporated as part each alternative.

6.6.1 Final Alternative 1 (Minimum Alteration)

Alternative 1 is shown in Figure 6-19. This graphic is a conceptual draft figure created using Geographic Information Systems, or GIS. Each alternative is represented by a conceptual GIS graphic. The overall vision for Final Alternative 1 would be to enhance habitat diversity through the preservation of existing wetlands habitats and the conversion of upland and unvegetated areas to wetlands and wetlands-associated habitats. Existing ground elevations would be utilized as much as possible to maintain existing wetlands habitats and expand coastal salt marsh habitat. Tidal exchange would be improved, but this would be done through the enhancement of existing channels/pipes and the addition of small channels and pipes where needed to provide hydraulic connectivity. For the most part, oil infrastructure would be maintained throughout the site with restoration work planned around the existing infrastructure. From a temporal standpoint, this alternative would seek to provide a wide range of wetland and associated upland habitats in the near-term with a decreased range of habitats remaining in the future based on current projections of MSL rise. Transitional and upland habitats would be provided along the perimeters. Potential interpretive sites would be provided on the parcel at the northeast corner of Westminster Avenue and Studebaker Road (also known as the Offer to Dedicate parcel, or OTD) and/or the State Lands Commission parcel.

This alternative would involve connecting basins throughout the entire project site via small pipes placed within the existing oil dikes as well as through small channels, where appropriate. In the Northern Area, existing pipes and channels connecting Steam Shovel Slough to the isolated, degraded wetland areas (basins) would be improved and pipes would be installed in the oil dikes to provide increased tidal exchange to the low lying areas. Steam Shovel Slough would be protected and unaffected to the greatest possible extent to preserve its existing function. Spot grading would be conducted throughout the area to provide elevations suitable for coastal salt marsh and to provide the needed hydraulic connectivity. An extensive public access system involving a trail network would be provided around and within the restored habitats. More information regarding the PAP for this alternative can be found in Section 7.2.4. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via new pipes and/or improvements to the existing pipes currently located within the existing levee. Existing freshwater inputs would maintain the existing brackish habitats in the Central Area. Within the Isthmus Area, the Zedler Marsh would remain unchanged relative to existing conditions. Callaway Marsh would be restored to more functional coastal salt marsh habitat and tidal exchange would be improved through a new pipe connecting the site to the San Gabriel River.

In general, the same type of work performed in the Northern Area would be performed in the Southeast Area under this alternative except that more extensive grading would be conducted to lower some elevations to support coastal salt marsh habitat. Tidal exchange would be provided from the San Gabriel River in the near-term, and potentially from the HCC via the existing culvert with improvements, if needed, in the long-term (after oil operation ceases on the Hellman-retained parcel). Enhanced public access would be provided in the western area located off PCH in Seal Beach. Upland areas would be restored to coastal sage scrub, while avoiding extensive work within the eastern areas that contain high levels of contaminated soil and transitional habitat would be provided between the coastal salt marsh and coastal sage scrub habitats. The OC Retarding Basin and its function would remain unchanged; however, the fence along its perimeter would be removed and the area could represent a mix of freshwater habitats. Alternative 1 preserves existing freshwater habitats through non-native control and new vegetation/hydro management practices.

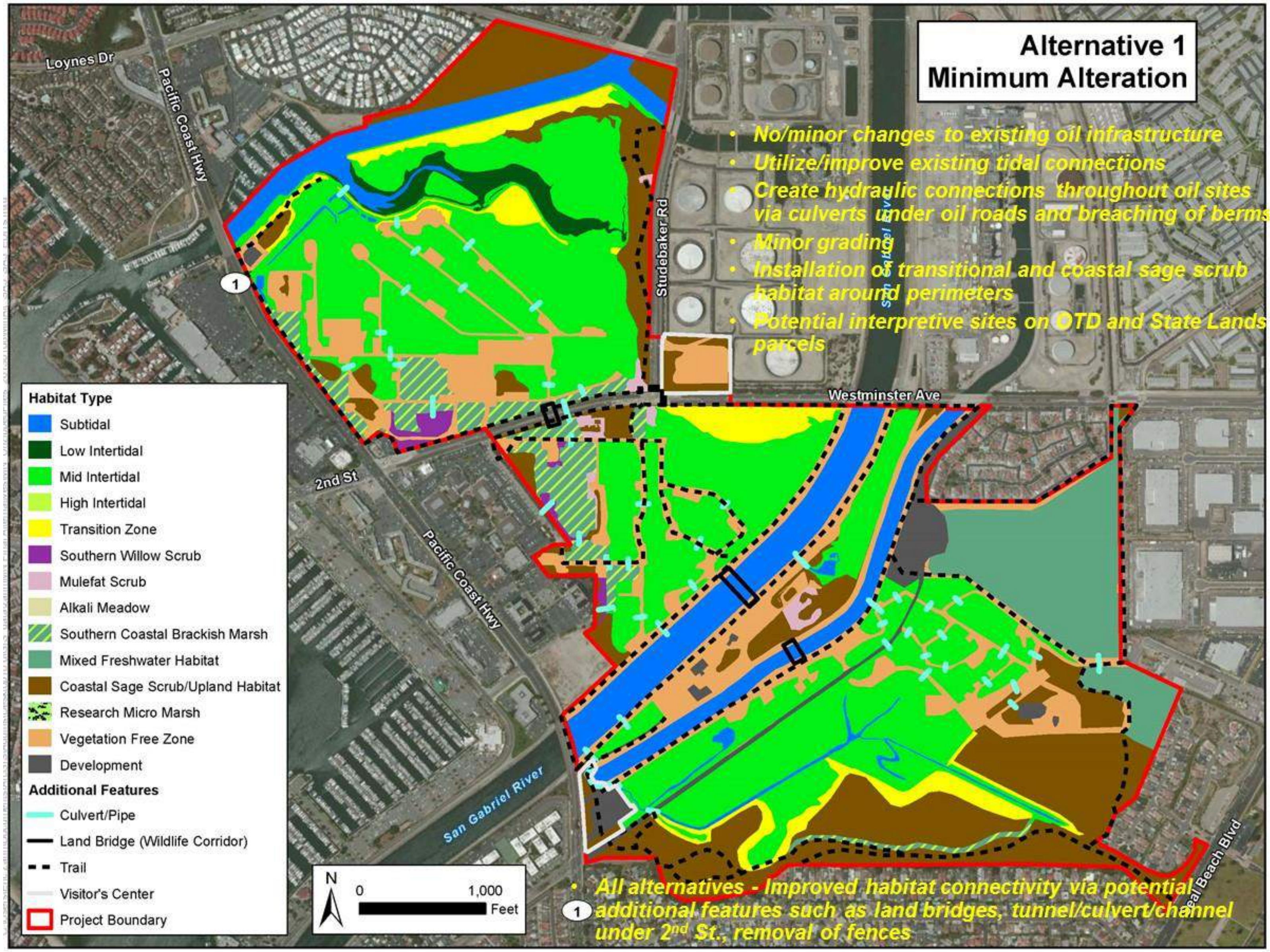


Figure 6-19. Final Alternative 1 – Minimum Alteration

6.6.2 Final Alternative 2 (Moderate Alteration)

Final Alternative 2 is shown in Figure 6-20. The overall vision for Final Alternative 2 would be to enhance habitat diversity through the preservation of existing wetlands habitats and the conversion of upland and unvegetated areas to wetlands and wetlands-associated habitats. Existing ground elevations would be utilized to maintain a large amount of the existing wetlands habitats and to expand coastal salt marsh habitat, but moderate levels of earthwork would also be conducted to expand coastal salt marsh under current MSL. Tidal exchange would be improved primarily through the construction of small to moderate subtidal channels. The oil infrastructure would be consolidated throughout the site to allow more extensive areal restoration of coastal salt marsh. From a temporal standpoint, this alternative would seek to provide a limited range of wetland (coastal salt marsh) and associated upland habitats in the near-term with a decreased range of wetlands habitats (converting to low intertidal, mudflat, and subtidal) remaining in the future based on current projections of MSL rise. Transitional and upland habitats would be provided along the perimeters. Potential interpretive sites would be provided on the OTD and/or the State Lands Commission parcels.

This alternative would involve constructing subtidal channels throughout the entire project site except for the Isthmus Area. In the Northern Area, a subtidal channel would be constructed to connect Steam Shovel Slough to the newly restored coastal salt marsh throughout the area. A public access system involving a perimeter trail network would be provided around the restored habitats. More information regarding the PAP for this alternative can be found in Section 7.3.4. In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via a new subtidal channel constructed through the existing levee. A tunnel or large culvert under Westminster Avenue would provide land connectivity for terrestrial wildlife. Within the Isthmus Area, the Zedler Marsh would remain unchanged relative to existing conditions except for spot grading to improve hydrologic functioning. Callaway Marsh would be converted to a micro marsh used for applied scientific research. Land bridges would be constructed on both sides of the Isthmus Area to provide land connectivity for terrestrial wildlife.

In general, the same type of work performed in the Northern Area would be performed in the Southeast Area under this alternative except that the results would be higher elevation habitats (high intertidal and transition zone) due to the higher ground elevations that currently exist in the area. Tidal exchange would be provided from the HCC through the construction of a mid-intertidal channel. Upland areas would be restored to coastal sage scrub while avoiding extensive work within the eastern areas that contain high levels of contaminated soil, and transitional habitat would be provided between the coastal salt marsh and coastal sage scrub habitats. The fence along the OC Retarding Basin would be removed, the Basin’s function would remain unchanged, and the area would remain a mix of freshwater habitats. Alternative 2 enhances existing freshwater habitat with relatively little earthwork (small improvements to existing drainages with the majority of the site staying at existing grade) complimented by the installation of "low" maintenance vegetation.

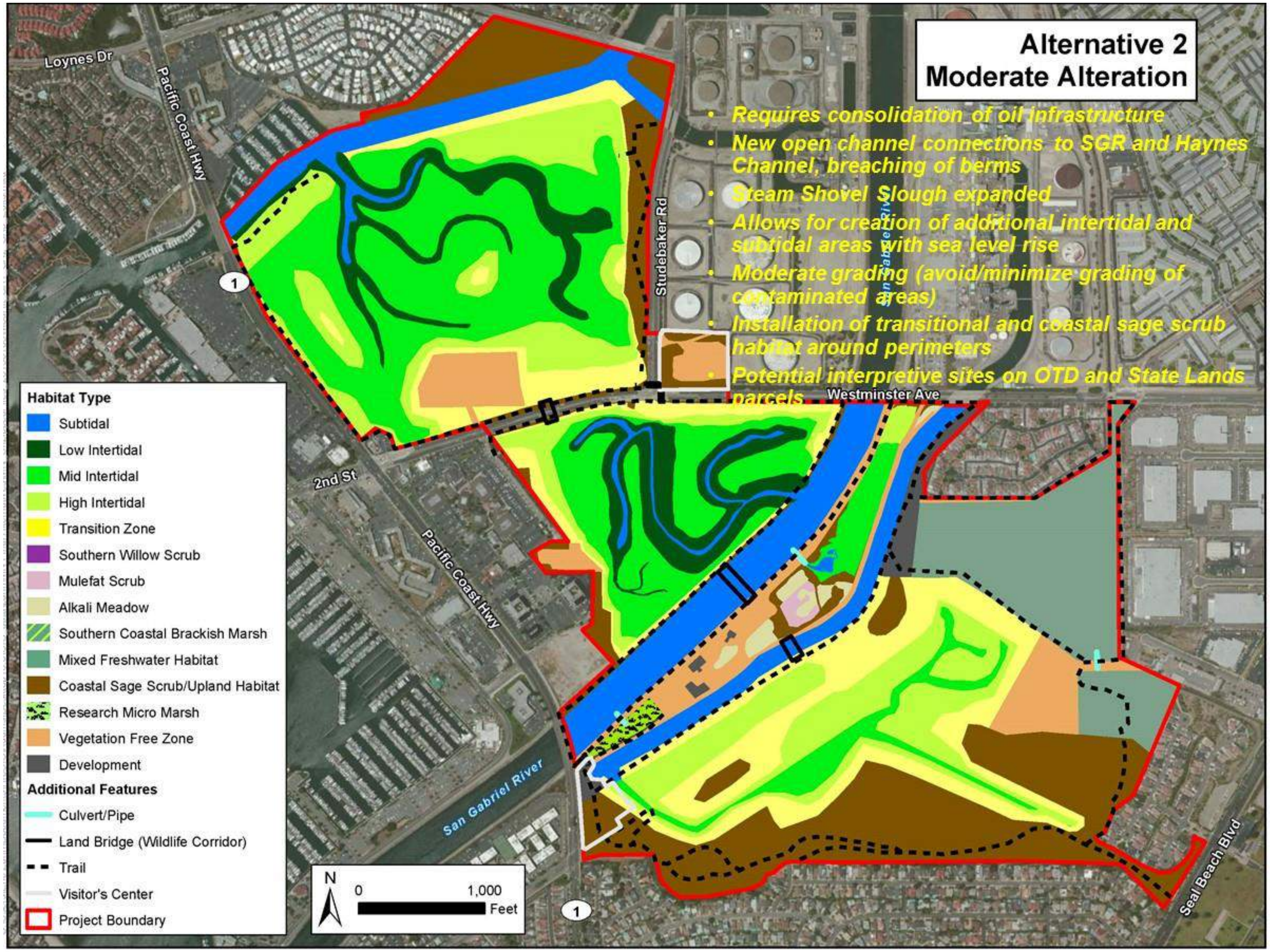


Figure 6-20. Final Alternative 2 – Moderate Alteration

6.6.3 Final Alternative 3 (Maximum Alteration)

Final Alternative 3 is shown in Figure 6-21. The overall vision for this alternative would be to enhance wetland habitat diversity through widespread conversion to coastal salt marsh habitat under current MSL, thereby replicating the historical mix of wetland habitats found on the site in the late 1800s. Extensive grading would be conducted to maximize the areal coverage of coastal salt marsh habitats. Tidal exchange would be improved through the construction of moderate to large subtidal channels. The oil infrastructure would be consolidated throughout the site and flood protection would be maintained at existing levels throughout the site. From a temporal standpoint, this alternative would seek to provide a limited range of wetland (coastal salt marsh) and associated upland habitats in the near-term with a decreased range of habitats (conversion of high and mid-marsh habitats to low marsh, mudflat, and subtidal habitats) remaining in the future based on current projections of MSL rise. Transitional and upland habitats would be provided along some of the perimeter areas. A potential interpretive site would be provided on the OTD parcel.

This concept is termed the Maximum Alteration Alternative relative to its degree of change in site conditions in comparison with the other two alternatives. It does not include components of a truly "Maximum Action" type of alternative on site that could consist of removal of all flood levees and barriers to hydrology and habitat connections. Alternative 3 is intended to include relatively feasible actions to a large extent as an example of a relative upper limit of site modification, rather than any and all possible actions to remove constraints imposed by man.

This alternative would involve hydraulically connecting the project site via moderate and large subtidal channels constructed through levees. In the Northern Area, existing pipes and channels connecting Steam Shovel Slough to the isolated, degraded wetland areas (basins) would be replaced with a large subtidal channel providing tidal exchange from the Los Cerritos Channel. Steam Shovel Slough would be protected and unaffected to the greatest possible extent to preserve its existing function. Extensive grading would be conducted throughout the area to provide elevations suitable for coastal salt marsh and to provide the needed hydraulic connectivity. Coastal sage scrub habitat would be restored along the eastern and northern boundaries of this area. Southern coastal brackish marsh habitat would be expanded along the western and southern boundaries. A fringe transition zone would be provided between the coastal salt marsh and coastal sage scrub as well as between the coastal salt marsh and southern coastal brackish marsh habitats. A public access system involving a perimeter trail network would be provided around the restored habitats. More information regarding the PAP for this alternative can be found in Section 7.4.4.

In general, the same type of work performed in the Northern Area would be performed in the Central Area under this alternative. Tidal exchange would come from the San Gabriel River via a large subtidal channel constructed through the existing levee. Southern coastal brackish marsh would remain along the western boundary. The Isthmus Area would be graded to elevations to support coastal salt marsh habitats under current sea level, and tidal exchange would be provided via construction of two pipes placed within the San Gabriel River levee. In general, the same type of work performed in Northern Area would be performed in the Southeast Area. Tidal exchange would be provided from the HCC via the construction of a large tidal channel near PCH in Seal Beach. In addition, the southern levee of the HCC would be lowered to increase hydrologic connectivity. Most of the existing upland areas would be restored to coastal salt marsh habitats with extensive work conducted in the eastern areas to remove, cap, or treat highly contaminated soils. The southern boundary would be restored to coastal sage scrub and transition habitats would be provided along the western boundary. The fence along the OC Retarding Basin would be removed and the area would be filled with sediment and converted to coastal salt marsh. The function of the Basin would be modified and flood retention would be accomplished throughout the entire southeast wetland area. Alternative 3 restores tidal salt marsh habitat with measurable earthwork.

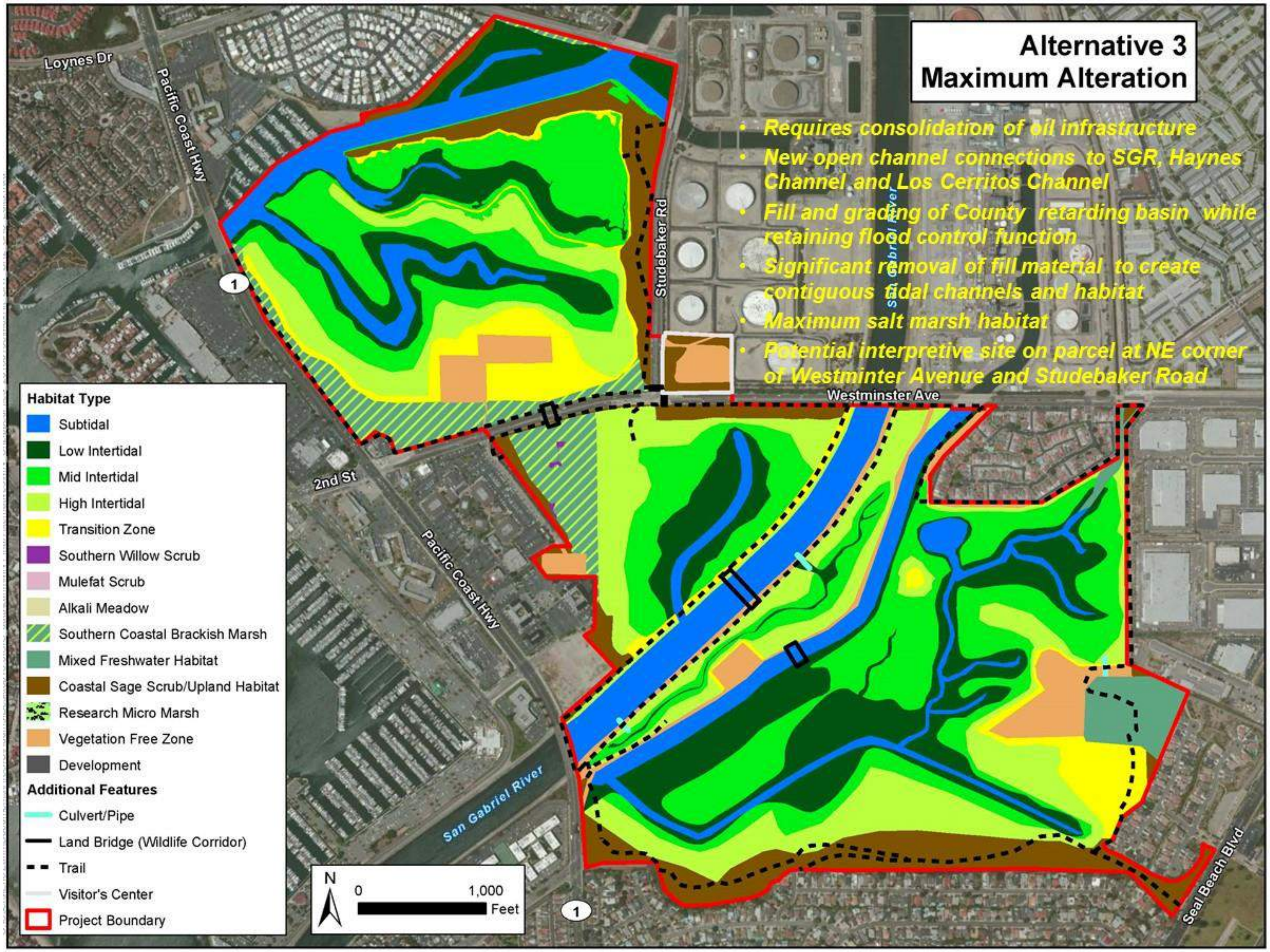


Figure 6-21. Final Alternative 3 – Maximum Alteration

7.0 Alternatives Analysis

Each alternative is analyzed in detail in this section of the report for each component pertinent to its function. An overview is provided below along with a methodology of analysis for each focus of study.

7.1 Overview

Alternatives were analyzed for their function relative to design, habitat, access, tidal hydrology, maintenance needs, and costs. Perimeter flood protection is assumed to be included in each alternative, and analysis for flood protection is deferred to a subsequent project phase. Designs, analyses, and results are provided below. Each area of analysis is introduced in detail below under Alternative 1, which is the first place in the document that it appears. Analyses of remaining alternatives are also provided, but the discussions are less extensive because they do not include the background of the item being analyzed.

7.1.1 Habitat Analyses Methodology

All three of the restoration alternatives presented in the plan offer plausible approaches for restoring significant areas of tidal salt marsh and associated habitats. Each alternative differs rather significantly from the others in the relative area of different habitat types that would be restored. In order to better understand these differences, rough estimates of area were calculated for nine general habitat types for each alternative based on the conceptual grading plans (Figure 7-20 through Figure 7-23). The goal of this section is to present the results of this analysis and summarize how the three alternatives meet different habitat-related goals.

Two general approaches are provided. The first approach is to simply assess the degree to which different alternatives provide habitat for target species. These may be individual special status species (*e.g.,* Belding's savannah sparrow or salt marsh birds beak) or guilds of species that are characteristic of salt marsh ecosystems (*e.g.,* shorebirds or estuarine fishes). Comparing the habitat requirements for each species or guild (Table 7-1) to the relative areas of different habitats in different alternatives allows one to determine which alternative might provide the most habitat for that target. A separate analysis for each species or guild is not provided due to the almost endless number of comparisons that would be needed. In developing these alternatives, the LCWA avoided prioritizing specific species or guilds since this often leads to designs that do not provide a desirably wide range of functions. If it is assumed that many such species and guilds are of equal value, the importance of habitat diversity becomes apparent (Table 7-1).

Any restoration design needs to consult the raptor foraging management plan for Gum Grove Park. Gum Grove Park is fully preserved by the restoration alternatives, as is the Heron Pointe (HP) treatment wetland.

Table 7-1. Habitat Requirements for Each Species or Guild

	Sub-tidal	Eelgrass	Mudflat	Low Marsh	Mid Marsh	High Marsh	Transition Zone	Upland	Brackish Marsh	Freshwater Wetlands
WILDLIFE										
Estuarine Fishes	B/F	F	F	HF	HF	HF			B/F	
Other Fisheries Guilds	B/F	B/F	F	HF	HF					
Wading Birds	F	F	F/R	F/R	F/R	F	F	F	F/R	F/R
Migratory Water Fowl	F/R	F	F	F	F	F			F/R	F/R
Migratory Shorebirds		F	F/R	F	F	F	HR			F/R
Ridgeway's Rail	F		F	B/F	F	HR	HR		OB	OB
Belding's Savannah Sparrow			F	F	B/F	B/F	F	F		
Least Tern	F	F	F hi tide					B		
Green Sea Turtle	F	F	F	F						
Salt Marsh Wandering Skipper						B	F		F	F
PLANTS										
Salt Marsh Birds Beak						P		X		
Coulter's Goldfields						P				OP
Estuary Seablite					P	P				
California Boxthorn							P	OP		
Spiny Rush						OP			P	OP
Woolly Seablite						OP	P	P		
Ventura Marsh Milk-vetch							P	P		

B=Breeding habitat; **OB**=Occasional breeding habitat **F**=Foraging habitat; **R**=Resting habitat **HF**=High-tide foraging habitat; **HR**=High-tide refuge; **P**=Preferred or required habitat; **OP**=Other potential habitat; **X**=Habitat for obligate pollinators

The second approach is a more holistic one. The focus is on some of the traits of estuarine ecosystems that can be manipulated during the restoration process. Specifically, the interest is in how the three alternatives differ in the degree to which they support: 1) habitat diversity; 2) habitat connectivity; 3) resilience to SLR; and 4) overall functional lift.

In general, it is desirable to include a wide diversity of habitats within estuarine restoration projects. Greater diversity of habitats can be expected to support greater biodiversity and increase resilience and overall ecological functioning. On small projects, greater habitat diversity can be counterproductive because patch sizes for each habitat become too small to support proper functioning. However, the LCW Complex is large enough to support a wide range of salt marsh and associated habitats with meaningful patch sizes. Analyses of diversity for this study are fairly crude at this stage and do not take fine-scale diversity such as microtopography, channel networks, or different plant assemblages into account; all of which are important aspects of restoration design that will need to be addressed in more detailed future plans. Instead, the focus is on the number of different habitats and their relative areas within each sub-area and the complex as a whole for each alternative. There have not been any *a priori* assumptions made related to what pattern of habitat diversity is superior to another. Every pattern has strengths and weaknesses that are identified in this analysis. For greater clarity, the diversity of salt marsh habitats and overall habitat diversity (which includes other wetland types) are analyzed separately.

This analysis makes use of the term “habitat connectivity” to compare the spatial distribution of different habitats and the degree to which the transitions or ecotones between adjacent habitats are more or less natural. Ecotones are important for ecological functioning and they support increased biodiversity. Salt marshes in our region contain many ecotones, which may be very easy to see (*e.g.,* the Spartina-mudflat transition) or rather subtle (*e.g.,* many mid-marsh/high-marsh transitions). In most cases though, they are defined primarily by small elevation differences over fairly broad areas. Many salt marsh restoration projects in Southern California have been designed and built with relatively narrow and abrupt ecotones. This may have occurred inadvertently, or may be a function of practical limitations of earthwork in wet environments and possibly to maximize the area of some target habitat (often mid-marsh or sub-tidal) within some confined area or with a minimum amount of soil excavation. This is a less desirable approach compared to creating more natural and broad transitions between each habitat type. This approach leads to better connectivity between habitats and higher ecological functioning.

As discussed elsewhere in this plan, even a relatively minor amount of SLR will have important consequences for habitats within tidal salt marsh ecosystems. Habitats will probably migrate upslope to the extent possible given topographic constraints. The primary results of this process in most coastal marsh systems will be conversion of vegetated marsh to mudflat and sub-tidal habitat and loss of high-marsh and transitional habitats where they are squeezed up against developed areas. Sedimentation could counter some of the effects of SLR; however, there is virtually no natural sediment source for the LCW from the San Gabriel River or other local watersheds and the current regulatory framework that protects wetlands makes it difficult or impossible to purposely add sediment to marshes. While these constraints may change in the coming decades, for the purposes of this analysis, the LCWA chose to leave the marsh elevations static and assess how habitats will convert under two SLR scenarios, +1.5 feet and + 5.5 feet. Designs are deemed more resilient based on the extent to which they continue to support a broad range of habitats with rising sea level. Given these assumptions, it is obvious that designs that include more intertidal marsh habitat under current conditions will be less resilient than designs that include more transition areas and low-lying uplands. While resilience is generally seen as a positive trait for restored ecosystems, in this case there is an obvious trade-off in terms of short-term tidal habitat area versus long-term habitat diversity. Again, the LCWA has not designated one or the other approach superior to the other; rather they seek to highlight the relative strengths and weaknesses of different approaches.

One of the primary goals of most ecological restoration projects is to improve the ecological functioning of a site. Ecological functioning of wetlands can be quantified by estimating certain landscape, hydrologic, geomorphic and biological parameters for a site. Accurate measurement of wetland functioning requires careful long-term monitoring and, in many cases, experimentation once projects are built. Conditions at the restored site can then be compared to reference sites that are considered "high functioning." When planning restoration projects and comparing different designs, it is useful to try to predict how different designs might function before they are built. By analyzing current conditions and estimating future conditions after restorative actions are taken, the degree of "functional lift" (increase in ecological functionality) can often be very roughly estimated for a given restoration design. Rapid assessment methodologies are sometimes used to roughly quantify how different restoration designs might change wetland functioning versus current conditions and to compare different designs. The California Rapid Assessment Method (CRAM) is currently the most popular such method in this region. This approach is increasingly popular in mitigation planning; however, results of analyses should be used with caution.

The conceptual designs in this plan have not been developed with enough detail to attempt any estimation of functional lift using CRAM. For the CRP, the LCWA chose a purely qualitative approach and assumed that designs that result in systems that are expected to function like most natural remaining estuaries, Anaheim Bay at Seal Beach Naval Weapons Station, Tijuana Slough and Mugu Lagoon for instance, are providing the most functional lift. This analysis compares the different alternatives to each other to assess the relative amount of functional lift each approach might be expected to attain.

7.1.2 Public Access Analyses Methodology

A list of beneficial uses was generated, and brought to the community for evaluation and conceptual placement within the restoration concepts described in a series of workshops. The workshops results and feedback, along with SC and TAC input were used to establish consensus for a program of recreational and educational uses and access/interpretive concepts for each of the restoration alternatives.

The designs were derived from analysis of the site's relationship to the surrounding community, as well as the complex context, entry, and edge conditions of the site and implications for access and potential types and intensities of use. Elements of that site and urban context analysis are described below.

SITE AND URBAN CONTEXT ANALYSIS

OPPORTUNITIES AND CONSTRAINTS

The CRP Opportunities and Constraints Report (M&N 2012) identified numerous opportunities to increase the success and effectiveness of the project and minimize impacts and costs. The various constraints to restoration were factored into the planning of public access components. Abundant options exist to optimize public access and interpretive design within the project goals and objectives.

OPPORTUNITIES ADDRESSED BY PUBLIC ACCESS PLAN ALTERNATIVES

Multiple public access opportunities are discussed below.

Access Opportunity #1 - Public Access to Large Open Space Area

Open space is limited throughout the local area and LCW offers a superb opportunity for the development of public use areas and educational programming. Currently, due to private land holdings and current land uses, this site is largely inaccessible to the public except at the site's peripheries. Even the 200 acres of current public land still are not accessible without escort because of existing oil operations. After the restoration is complete, the site has high potential for greater public access for a variety of beneficial uses. Parts of the site are already used for cycling, hiking, birding, and fishing, and the PAP alternatives expand upon these active beneficial uses.

The popular San Gabriel River Bike Path bisects the LCW, following the levee of the river, and is currently the most heavily used public area in the LCW. This Class A bike trail bisects the LCW and extends along the San Gabriel River for over 25 miles from Azusa to Seal Beach, CA. Figure 7-1 shows existing bike and pedestrian paths. And, while in its current form the bike trail feels isolated at the northern edge of the southern wetland restoration area, with new tidal connections and strategic viewing nodes, perhaps combined with partial lowering or removal of the northern levee to provide view corridors, this existing elevated alignment becomes the central "spine" of the public access system and interpretive program. A number of "ribs" of pedestrian overlook areas and teaching nodes are possible to provide resting areas with views to the heart of the wetland complex. The LCW SP nursery and operations center located between the San Gabriel River and HCC are proposed to remain as a docent-led hub for local stakeholder activities.

Figure 7-1. Existing Bike and Pedestrian Paths in the Vicinity of the LCW

The current mix of pedestrian and higher speed cyclists is dangerous, particularly at intersections and "on-ramps." The PAP alternatives, therefore, establish adjacent pedestrian access paths - meandering periodically down slope toward the wetland areas - to allow for safe mixing of cyclists and pedestrians without directly impacting restored core habitat areas. Fences should be relocated to the down slope border of the San Gabriel River multi-use trail zone to combine protection of sensitive resource areas with security for and protection of the public from the remaining oil operations. Figure 7-2 shows the existing San Gabriel River bike trail and a duplicate circulation route parallel to the trail.

Figure 7-2. Existing San Gabriel Bike Trail and Duplicate Circulation Route

The history of extractive and infrastructural land use in the complex provides a ready template of potential access ways. A key component in the restoration concepts is removal of all unnecessary access infrastructure and associated fencing. The PAP alternatives propose cooperative access and management agreements to allow for these access roads to be restored to habitat and in some cases a combination of habitat and public access trails. Many potential existing access routes are proposed for redevelopment as part of the public trail network.

Access Opportunity #2 - Synergy with Stewardship and Educational Groups

The PAP alternatives establish a gradient of access so that guided stewardship and study groups can gain access to more sensitive and interior areas of the wetland complex. Presently, access to the site is only allowed through the LCW SP. The LCW SP was developed in 2007 by the LCWA and fully implemented in 2009. Community-based restoration, revegetation, and education activities have been relegated to small areas of the public land holdings and are limited in scope. The large-scale restoration project benefits by having a well-informed public, and by the opportunity to involve this access program in appropriate aspects of the restoration's implementation, management and maintenance. Public access and interpretive design alternatives account for this "host" function and work with existing and new locations of the LCW SP staging.

Access Opportunity #3 - Adjacent Existing Public Use Areas

There are several existing public access areas interfacing the site that provide an opportunity for a comprehensive interpretive trail system. The PAP alternatives connect to and complement these presently established areas and improve upon their beneficial uses and educational potential. The comprehensive trail system proposes to optimize connectivity with presently identified public use points while protecting the critical habitats established by the restoration. The through routes and primary loops of the PAP alternatives will provide the bulk of the interpretive displays in order to educate those who engage the site recreationally, and to enhance public awareness of the LCW. Figure 7-3 shows existing and potential visitor and public access nodes.

Figure 7-3. LCW Southeast Area Lowlands Overlook and Access at HP

Gum Grove Park is an established public use area with a trail that meanders through a 100-year old eucalyptus grove. Gum Grove Park is utilized regularly by dog-walkers, BMX-bikers, and local families, and connects to the HP Cultural Center that contains interpretive signage below to the HP residential community. These two residential areas are connected to the San Gabriel River Bike Trail in the PAP alternatives. The alignments shown extend from the HP Cultural Center along the edge of the treatment wetlands and OC Retarding Basin, and show proposed upgrades to existing footbridges to provide public access to the San Gabriel River bike trail as well as the LCW SP nursery and headquarters. Existing footbridges are shown in Figure 7-4.

Figure 7-4. Existing Footbridge over Haynes Channel

Kayakers in Alamitos Bay regularly access Steam Shovel Slough by going over the debris boom extending across the mouth, which is a low impact way to recreate in coastal wetlands. The expanded tidal creek networks of the restoration plan create additional water trails large enough for kayaking. The popular fishing hole that exists at the south end of the HCC is proposed to be maintained and enhanced by the restoration project, as it presents an opportunity to focus fishing activities and diminish impacts to other sensitive habitat areas. Figure 7-5 shows the fishing area at HCC.

Figure 7-5. Existing Fishing Area at HCC

Access Opportunity #4 - Active Local Stakeholders

Several non-profit groups have LCW restoration as part of their mission. With ongoing outreach, these groups will become major supporters of the restoration project. They also offer the opportunity to gather information about the site's historical beneficial uses, including access and interpretive program elements. Currently identified interest groups, limited here to community groups and homeowner associations, include the following: LCW Land Trust, LCW Stewards, Friends of Colorado Lagoon, Save Our Beach, EcoLink, Green Long Beach, Aquarium of the Pacific, El Dorado Chapter of Audubon, Los Angeles and San Gabriel Rivers Watershed Council, Alamitos Heights Improvement Association, Bay Harbour HOA, Belmont Shores Mobile Estates, Bixby Village HOA, University Park Estates Neighborhood Association, Island Village HOA, Pacific

Villas HOA, Naples Improvement Association, Spinnaker Bay HOA, and HP HOA. Other groups exist that are larger and also interested in the planning process (*e.g.* Surfrider Foundation, Long Beach Chapter and the Port of Long Beach).

Access Opportunity #5 - Cooperative Efforts with the Local University

California State University, Long Beach (CSULB) is within a 1/2 mile of the site, making LCW an attractive location for use as an outdoor classroom and a field research site. Ecological monitoring and other research projects can be accomplished by student researchers that will provide professional level data to aid in the management of the restoration and to quantify the project's success. This would be similar to the relationships between San Diego State University and the Tijuana Estuary, or U.C, Santa Barbara and Carpinteria Marsh and Devereaux Slough.

Access Opportunity #6 - Existing Infrastructure with Potential for Public Interpretation

As an alternative to development of new interpretive facilities, the LCW contains several existing structures and foundations that might be more easily converted into public interpretation areas. An intriguing oil operation foundation at Marketplace Marsh is proposed as an activity node. The State Lands Commission parcel has a large enough existing foundation to house an interpretive trail head and a parking lot or even a constructed interpretive center. The old Bixby Ranch Land building and Bryant Lease office offer potential sites for future offices or education facilities, and a small building exists at the edge of Marketplace Marsh (Figure 7-6), on the City of Long Beach parcel, that could be proposed to be adapted for docent staging and equipment storage.

Figure 7-6. Existing Foundation at Marketplace Marsh and Potential "Teaching Wetland" at the Southeast Lowlands Area

Constraints Addressed by Public Access Plan Alternatives

Access Constraint #1 -Habitat Sensitivity to Urban Surroundings

The LCW is fragmented with many edges exposed to urban impacts. Light, noise and intrusions from outside are to be buffered, which constrains restoration potential. Invasive exotic species are more likely to reach restored habitats along urban interfaces. New and existing public access trails and nodes are to be buffered by fences and/or upland areas in order to limit the impacts of unwanted introductions. An existing land use map is shown below that provides a sense of urban surroundings to the LCW.

Figure 7-7. Existing Land Use Surrounding the LCW

Access Constraint #2 - Onsite Homeless Encampments

This site is attractive to vagrancy and homeless encampments. Encampments are quick to be established in areas with thick vegetation that are hidden from public view. While the PAP alternatives have limited control over this social condition, reduction of access ways near tall upland vegetation, location of appropriate barriers, and maintaining visual access to potential encampment areas will minimize establishment of encampments and the public safety hazard they pose.

Access Constraint #3 - Maintaining Positive Public Perception

Maintaining a positive public perception of the restoration project is critical to its success. Consistent and effective outreach throughout the planning and implementation process can mitigate this constraint, as can sufficient public access. The desire to protect restored habitats has been balanced against the positive aspects of public interaction in the PAP alternatives.

Access Constraint #4 - Urban Amenity/Identity

The extent to which the wetlands complex may be integrated with adjacent land uses was a key consideration in public access design. These adjacencies include both residential and commercial elements that vary opportunities for appropriate integration into the wetland access design. The site's longstanding relative isolation within the urban fabric has left its ultimate definition open for consideration, and public access design integration will, to a large extent, determine the identity of the LCW as an urban figure and character. A study of well-known urban spaces was brought to the discussion to help determine the LCW role as local urban amenity as well as coastal habitat of regional and national importance. Figure 7-8 shows various well-known open space areas in the urban setting as compared to the scale of LCW. While LCW is large, it is still relatively small compared to certain other well-known open space areas, yet its importance to the local community cannot be over-stated.

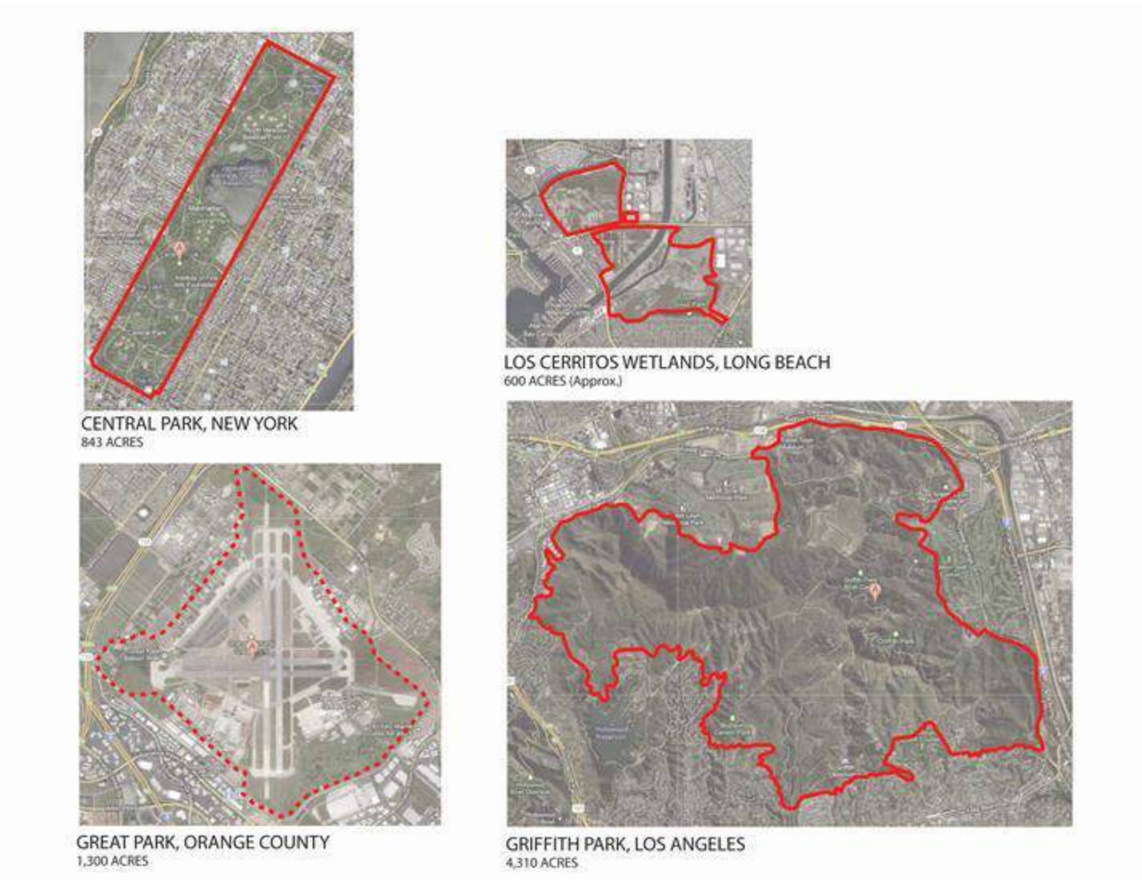


Figure 7-8. Comparison of Various Near-Urban Open Space Areas

While the rarity of coastal wetland restoration opportunities must keep ecological considerations foremost, the definition of the urban edge varies in the PAP alternatives. PAP alternatives could have edges that are more porous or less porous, depending on site-specific conditions. In addition, public access trails range in intensity of use and purpose of access, from quiet loop paths focused on passive recreation, to foot- and pedal-powered urban connectors as part of a walk-able city strategy. The PAP alternatives present a range of access options and corresponding spatial identities. Figure 7-9 shows examples of site edge analysis options.

Figure 7-9. Examples of Site Edge Analysis

Integrating the project site with adjacent urban land uses is critical to success. An example of such integration is a primary urban design opportunity to re-connect the marina waterfront with the Central Area adjacent the Marketplace Shopping Center. The western portion of the Central Area is the nearest cell that could lend itself to restoration as a less-sensitive wetland type with both stormwater treatment and more intensive access elements to function as a kind of Marsh Park, while limiting impacts to potential tidally-influenced wetlands beyond. Although technically outside of the restoration area, the Marketplace parking lot and access road were studied in the PAP alternatives (New West Land 2012) as an opportunity to expand the wetland treatment concept into bioswales and permeable parking within the parking zones. This would "blur" the edges of the wetland/access road/parking lot through repaving and transforming a car-dominated space into a multi-use urban plaza as a "Piazza" concept. Figure 7-10 shows the idea as an adjacency study, and Figure 7-11 shows a portion of the existing high impact area of the Marketplace Marsh site where wetlands are severely degraded, fragmented, and fully impacted.

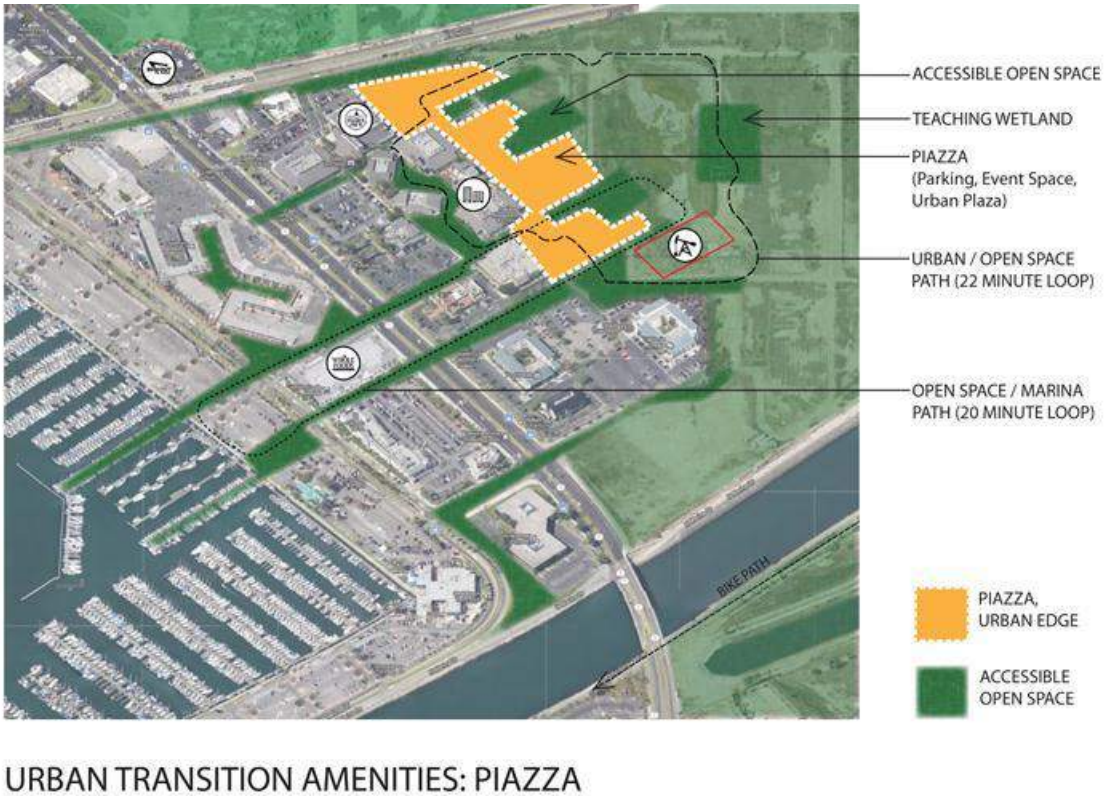


Figure 7-10. Adjacency Study

Figure 7-11. Marketplace Marsh Higher Impact Zone

Access Constraint #5 - Archaeological Resource Protection

The location of potential archaeological/cultural resources limits the areas where certain restoration activities can occur without instituting proper mitigation measures. Cultural resources in a wetlands context may include Native American dune habitations, hunting blinds, buried shoreline sites that have become exposed over time, or sunken boats, wharfs, or other historic waters-edge cultural resources. Excavation has the potential to disturb these resources. Such resources are most likely to occur in areas that were historically upland (like Landing Hill). These upland areas are limited throughout the project area, which reduces the influence of this constraint on restoration. Of note though, a prehistoric village/burial site associated with the wetlands was discovered and investigated in 2005-2006. The site yielded complete human remains from 35 individuals as well as cremated remains with associated funerary artifacts such as ground stone and shell beads. Middens and utilitarian objects were also in occurrence. All of the resources were recovered and reinterred in an undisclosed location.

A records search was conducted to identify specific locations where cultural resources have been found in the project area (M&N 2012). PAP alternatives avoid these areas, but connect to the existing Tongva Heritage Trail. The existing interpretive trail is a cul-de-sac, and the alternatives propose connecting to it as part of a loop to increase use and visibility.

In addition to physical resource protection, interpretive and access elements should be equally sensitive to cultural resources. Discussions should take place with representatives of the indigenous communities that resided here in the past regarding the extent to which alternatives identify and explain the site's cultural history. The current PAP alternatives utilize the current interpretive displays but do not propose additional zones of cultural interpretation. Given that the site is part of the former native resource area surrounding *Puvunga*, the "navel" of the Tongva cosmology, some of these loop trails and access areas may be appropriate for cultural interpretation in future design phases, but this will need to be driven by the representatives of the Tongva community.

Goals and Objectives

To direct the site and urban context analysis, and ultimately the public access and interpretive program design, relevant goals and objectives have been established.

Goal #3 of The LCW CRP establishes the focus of the plan:

- Goal #3: Create a public access and interpretive program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience... *(RFP: Create a public access and interpretive program that is practical and economically feasible and will ensure a memorable visitor experience.)*

  Objectives:

  3a. Build upon existing beneficial uses.
  3b. Minimize public impacts on habitat/wildlife use of the LCW Complex.
  3c. Design interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community.
  3d. Solicit and address feedback from members of the surrounding community and other interested parties.

Existing access points and recreational activities already provide some measure of access and, where appropriate, have been maintained or enhanced. Figure 7-3 above identifies such existing access and activity nodes. Integration of additional educational and interpretive spaces, routes, and signage will promote stewardship and link the urban and ecological environments in a beneficial and reciprocal fashion. To initiate that sense of community authorship in this restoration and its ongoing care, careful solicitation and incorporation of community input was critical. Building an "identity" for these wetlands in particular began with the public component of the conceptual design process.

In addition, other goals and objectives influenced the public access design, including:

- Goal #1: Restore tidal wetland processes and functions to the maximum extent possible. *(RFP: Restore wetland processes and functions.)*

  Objectives:

  1a. Increase estuarine habitat with a mix of tidal channels, mudflat, salt marsh, and brackish/ freshwater marsh and ponds.
  1b. Provide adequate area for wetland-upland ecotone and upland habitat to support wetlands.
  1c. Restore and maintain habitat that supports important life history phases for species of special concern (*e.g.*, federal and state listed species), essential fish habitat, and migratory birds as appropriate.

Given that restoration of tidal wetland habitat is the primary goal of the CRP, ecological functionality is the primary concern. However, as related to Objective 3b. above, some access to marginal or more isolated tidal wetland edges provides for a teaching/learning opportunity with the benefit of promoting stewardship and expansion of these rare coastal ecosystems. Such learning landscapes have been proposed in places where there is diminishing rate of ecological return on "pure" and protected tidal wetland habitat due to size, proportions, connectivity and/or adjacency challenges from a restoration perspective, but where those same characteristics provide significant urban design and interpretive program benefits.

- Goal #2: Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance. *(RFP: Maximize contiguous wetland areas and minimize the edge between wetlands and sources of disturbance.)*

  Objectives:

  2a. Maximize wildlife corridors within the LCW Complex and between the LCW Complex and adjacent natural areas within the region. *(RFP: Restore the complex as habitat for resident bird species and migratory birds along the Pacific Flyway.)*
  2b. Incorporate native upland vegetation buffers between habitat areas and human development to mitigate urban impacts (*e.g.*, noise, light, unauthorized human encroachment, domestic animals, wastewater runoff) and reduce invasion by non-native organisms. *(RFP: Ensure the long-term viability and sustainability of the project in the face of such threats as urbanization, SLR and other impacts of climate change* (latter items addressed by goal #5 below).*)*
  2c. Design the edges of the LCW Complex to be respectful and compatible with current neighboring land uses.

Connectivity with both urban and habitat adjacencies has been carefully composed to ensure that the whole of the LCW complex, as well as the larger coastal habitat complex identified in Figure 7-12, San Pedro Open Space Network. Given the density of the urban context surrounding these open spaces (of 10 acres or more), the diagram represents the scale of the opportunity for enhanced recreational and ecological connectivity alike. The PAP alternatives provide for varying levels of connectivity at the conceptual level. Figure 7-13 shows detail of how the LCW site could be connected to adjacent greenways of the Open Space Network.

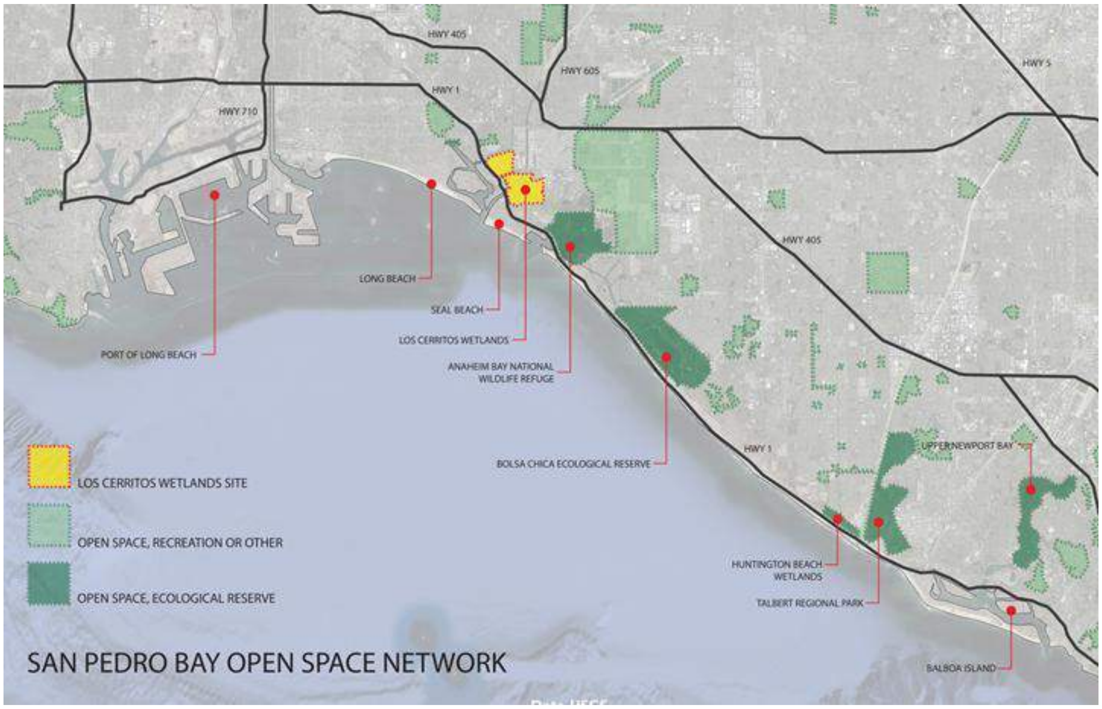


Figure 7-12. San Pedro Bay Open Space Network

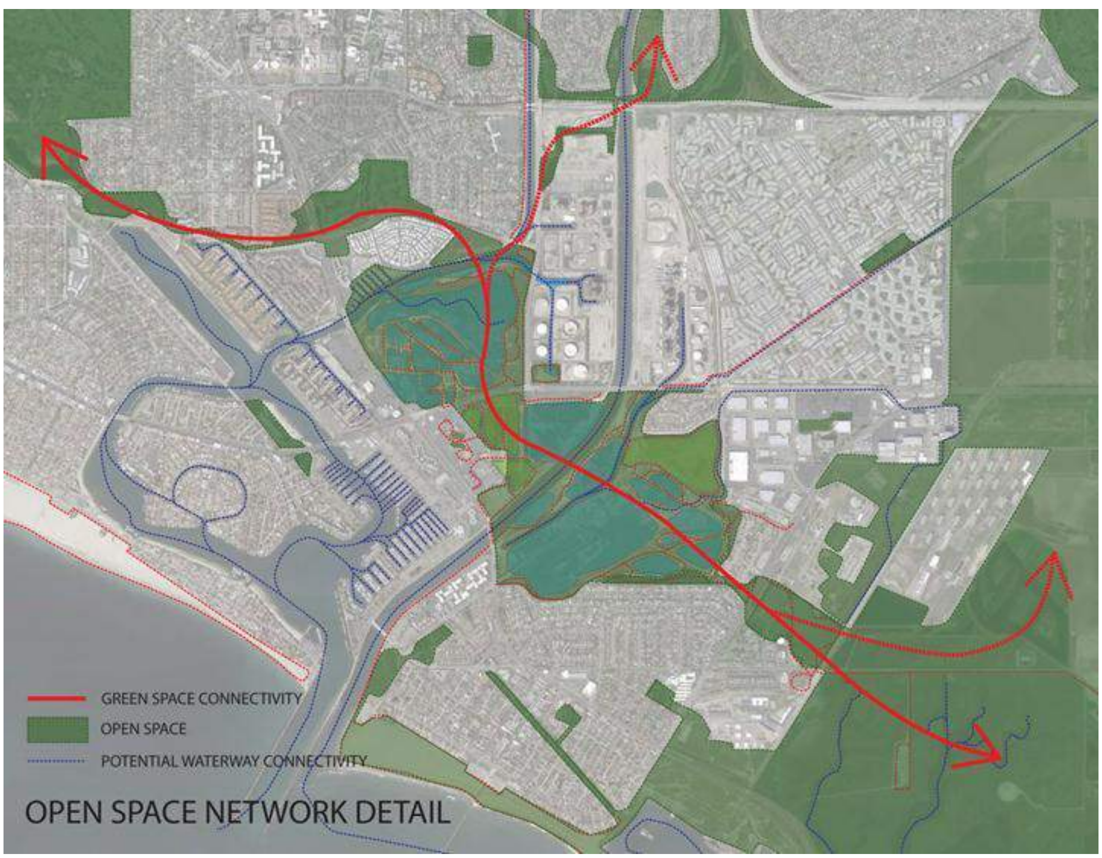


Figure 7-13. Open Space Network Detail

The PAP alternatives that follow include not only the three restoration plan alternatives, but for Alternative 3- Maximum Alteration, we also show a range of access planning concepts that can be taken as stand-alone approaches, or in some cases as potential phasing plans for a single restoration alternative. While shown only for Alternative 3, similar approaches could be applied to the other alternatives. The three PAP guiding design concepts are Perimeter, Loop, and Urban Connectivity.

Perimeter PAP trails and interpretive elements are located as suggested near the perimeter of the major wetland cells. In most cases some buffer area is provided separating these trail alignments from urban development and roads to minimize intrusion into restored habitats. Partial immersion of users can be provided into natural open space with limited exposure to urban development. In some cases, the perimeter of the wetland buffers existing habitat and provides a natural context on both sides of the buffer. These trails, for the most part, are proposed alignments in upland or transitional habitat zones that are less vulnerable to SLR and that allow for least costly on-grade construction approaches.

Loop PAP concept trails provide for additional access into and through various wetland cells. The purpose and opportunity of this range of access ways is that they will support educational and stewardship activities. They will also provide at least periodic access to some of the more sensitive habitat areas, which are often the most dramatic and educationally significant zones. Access may be tailored depending on location, expected species use, and degree of sensitivity. Access may be accomplished with open access trails or by developing exclusion approaches and gates to control access to docent-led, seasonal, or otherwise periodic access. This more restrictive approach would be designed to optimize proprietary interest of the community while maintaining high levels of ecological functionality.

Any exclusion elements (*i.e.*, blinds, gates) incorporated into access should be as limited as practicable to discourage unwanted access while avoiding unnecessary fragmentation of habitats. For instance, approach paths to sensitive areas and their entrance gates may be paralleled by fences for distances sufficient to discourage “desire paths,” and potentially with flared sections of fencing reaching to tidal zones on either side of the path. Most of the loop trail zones shown enter into tidal marsh areas on narrow bands of transitional habitat. Therefore, with slight manipulation, the grading design could create periodically inundated “moats” making unauthorized access less attractive.

Another approach, which may be necessary for some of the proposed alignments, is to utilize elevated boardwalks with guardrails. Although the wetland “standard” is to keep these elements as low as possible, guardrails are required for heights over 18” from grade in any case. For a particular foundation and span design, elevating the boardwalk would allow for better viewing of the marshes and a grade separation that would make unauthorized access unattractive.

Urban Connectivity PAP trails are major through routes designed to facilitate a “walkable cities” approach. The inclusion of these trails is intended to promote mixed-use pedestrian activity by providing more pedestrian friendly connections between residential areas. These areas might include Seal Beach/Gum Grove, HP, even Leisure World retirement living neighborhoods - and the commercial areas of Marketplace Marsh, and a potential interpretive site at 2nd St. and Studebaker. This access concept moves the urban identity of the wetlands in the direction of a “park.” Such trails are likely to increase use of the wetlands along with associated impacts such as disturbance and moderate fragmentation. They can also have benefits of education, promotion of awareness and stewardship, and "eyes on the land" benefits for discouraging vandalism in the wetlands area.

Given the fluid nature of property acquisition and restoration funding, some of these wetland cells may come on-line at different future dates. The smaller Loop alternatives may, therefore, have advantages over the Perimeter approaches in some phasing scenarios. It is also possible that some of these approaches will be more appropriate for the minimum, moderate, or maximum alteration restoration approaches or for particular locations. The LCWA and TAC members have noted, for instance, that higher functioning wetland restoration (maximum alteration) could sustain greater access impacts, while others suggested that the opposite approach was more appropriate. Therefore, this report does not identify a "preferred alternative" per se, and so these access concepts and associated details are provided as a menu of approaches that can be further evaluated in design development phases of the projects. Nevertheless, of the alternatives presented, a single vision based upon most recent TAC and LCWA feedback is provided as the "Optimized" PAP, in addition to the Perimeter, Loop, and Urban Connectivity PAP overlays on the restoration alternatives described herein.

7.1.3 Tidal Hydrodynamics Analyses Methodology

Tidal hydrology dictates the establishment of tidal wetland habitats to a large extent. Assuming other factors such as soils are adequate for habitat, the frequency that tidal wetlands are inundated by tides, called tidal inundation frequency, determines the type of habitat that colonizes a particular location. Tidal hydrology will vary throughout a site depending on tidal conveyance, seawater supply, and site topography/bathymetry. Site topography is above-water elevation, while bathymetry is below-water elevation. Determining tidal hydrology at the LCW requires use of numerical models to calculate tidal elevations and timing due to the site's complexity and dynamics of tides.

Each alternative will also require hydrology and hydraulics analysis to determine impacts on the surrounding properties and required level of flood protection. Flood protection mitigation measures must be incorporated as part each alternative. Flood protection analyses are deferred to a subsequent project phase.

Numerical Modeling

A tidal hydrology modeling study was completed for this project to set-up a method to quantify existing conditions (M&N 2011). That document presents the methods for modeling used in this analysis. Each area of the LCW was modeled separately due to their hydraulic isolation from one another, and their varying conditions as compared to each other. Also, each alternative dictated a different modeling approach due to varying connections and internal concepts. Table 7-2 shows the models used for the various alternatives and restoration areas.

Table 7-2. Summary of Models Used for the CRP

Alternative	Northern Area	Central Area	Isthmus	Southeast Area
Maximum	RMA2	RMA2	Link-Node	RMA2
Moderate	RMA2	RMA2	Link-Node	Link-Node
Minimum	Link-Node	Link-Node	Link-Node	Link-Node
Existing	RMA2	N/A	Link-Node	N/A

Note: N/A-no modeling performed

Model Boundary Conditions

All complete presentation of the LCW system model for existing conditions is provided in M&N 2011. The boundary conditions are the inputs to the LCW system model. These include the tides, power plant pumping (intake and discharged/released water), and storm event runoff. Dry season runoff is negligible in comparison to tidal and storm inputs to the wetlands and is thus not included in this modeling study. Groundwater within the LCW Complex is high, has been found to be saline, and is strongly influenced by tidal movement (AECOM 2011); however it is not a relevant factor for hydraulic modeling of restoration alternatives. Groundwater will be an important factor for wetlands function and for developing construction cost estimates. Sensitivity analyses were performed to assess impacts of power plant pumping to the tidal inundation frequency in wetlands. The results indicate that impacts are negligible; therefore, pumping is not included in the wetland hydraulic modeling.

Tides

There are no official tide stations within the LCW area or Alamitos Bay. As such, the nearest tide station administered by the NOAA at Los Angeles Outer Harbor (LAOH) was assumed to represent the ocean boundary tidal condition, as shown in Table 7-3. The diurnal mean tide range is approximately 5.49 feet from Mean Lower Low Water (MLLW) to Mean Higher High Water (MHHW) and MSL is at +2.82 feet relative to MLLW. Elevations for this project are presented and analyzed in NGVD29.

Table 7-3. Recorded Water Levels at LAOH (1983-2001 Tidal Epoch) (NOAA 2013)

Description	Elevation (feet, MLLW)	Elevation (feet, NGVD29)
Extreme High Water (1/27/83)	+7.82	+5.18
Mean Higher High Water (MHHW)	+5.49	+2.85
Mean High Water (MHW)	+4.75	+2.11
Mean Tidal Level (MTL)	+2.85	0.21
Mean Sea Level (MSL)	+2.82	0.18
National Geodetic Vertical Datum 1929 (NGVD29)	+2.64	0.00
Mean Low Water (MLW)	+0.94	-1.70
Mean Lower Low Water (MLLW)	0.00	-2.64
Extreme Low Water (12/17/33)	-2.73	-5.37

Modeling Tidal Series

The tide series used for modeling was a representative period from November 1-15, 2006. Modeling long-term hydrologic conditions is typically done using a synthetic (artificially-created) tide series that represents average spring tide conditions over the most recent 19-year tidal epoch, referred to as a Tidal Epoch Analysis (TEA) tide series. The benefit of using a statistical tide is that the long-term condition can be modeled over a shorter time period with less computation time. However, significant effort (beyond the scope of this study) is required to prepare a new TEA tide for this site. Therefore, a real tide series was used that matched average spring tide data available from the NOAA (2013).

Not using a statistical TEA tide for modeling is not a serious information gap. To address this potential shortcoming, the modeler evaluated existing tide data from NOAA for Los Angeles at the LAOH station (NOAA 2013). NOAA began publishing spring high and spring low tidal elevations of all tidal cycles in March 1994. The modeler averaged the spring high and spring low tidal elevations of all tidal cycles from March 1994 through March 2013 (19-years), then examined the existing data to identify a real two-week tidal cycle that matched them. Tides during the period of June 1 through June 15, 2006 reached nearly the exact same average spring high and spring low tidal elevations of NOAA's longer 19-year record. Also, the average tidal elevation of that June 1 through June 16, 2006 period compared with the average tidal elevation of the 19-year tidal epoch and was within 0.01 foot. Therefore, the modeler concluded that tides during the period of June 1 through June 16, 2006 sufficiently matched long-term tides at the site and use of this record poses no implications on habitat designs and analyses. The modeling tide includes both spring and neap tidal ranges as shown in Figure 7-14. Figures 7-15 through 7-17 show the locations of all nodes in modeling.

Tidal Connections

A series of tidal connections were assumed as part of concept design. Tidal connections assumed for Alternative 1 are shown in Table 7-4 below. Tidal connections for Alternative 1 consist mainly of culverts (pipes), with only two open channels over the entire complex.

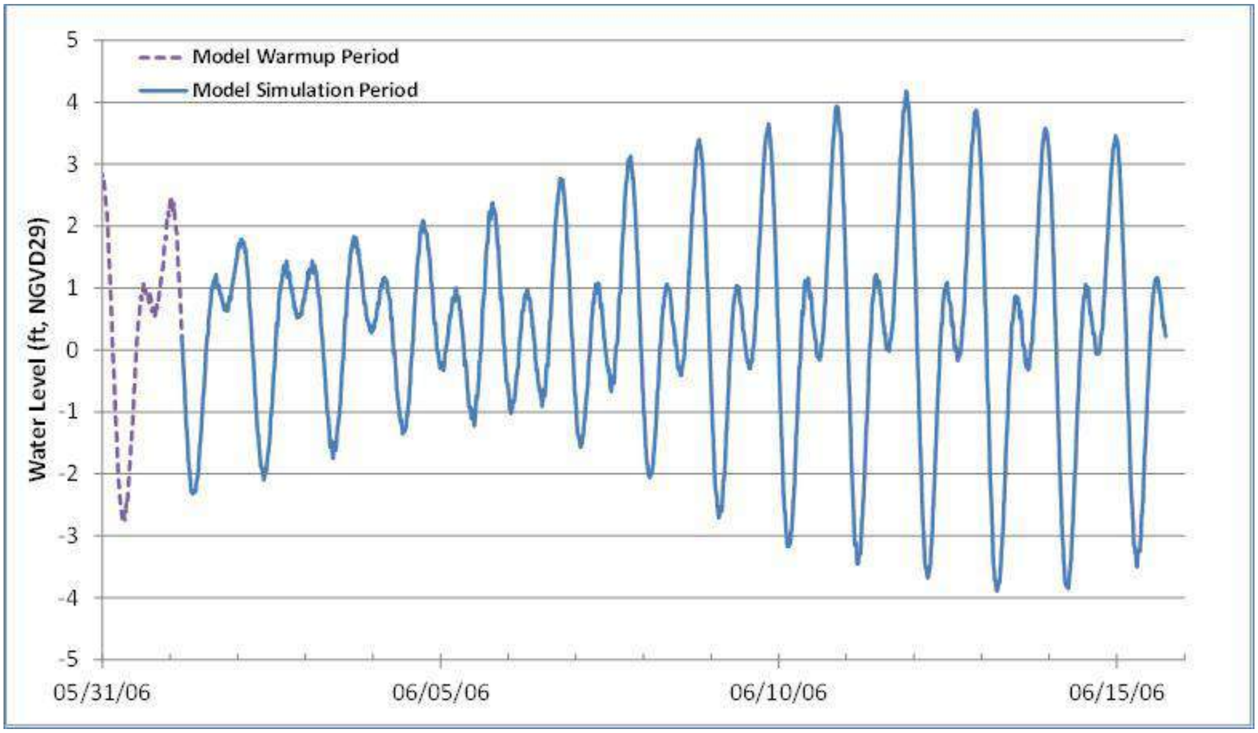


Figure 7-14. Modeling Tidal Series

Table 7-4. Assumed Tidal Connections for Alternative 1

Area	Site	Type of Connection	Location	Diameter (ft)	Invert (ft, NGVD)	No. of Culverts
Northern	Remaining Oil Field	Culverts	Node 0 (Steam Shovel Slough) to Node 1	6	-1	2
			Node 6 to Node 7 Node 7 to Node 8	4	1	2
			Node 2 to Node 3 Node 3 to Node 4 Node 3 to Node 6 Node 1 to Node 7	4	1	1
			Node 4 to Node 5 Node 9 to Node 10	3	1.5	1
	Steam Shovel Slough	Open Channel	Los Cerritos Channel mouth	Not Applicable		
Central	LCWA	Culverts	Node 0 (San Gabriel River) to Node 1	4	1	2
			Nodes 1 to 5	4	2	4
Isthmus	Callaway	Culvert	Callaway to San Gabriel River	2.5	1	1
	Zedler	Culvert	Zedler to San Gabriel River	2.5	0.5	1
Southeast	LCWA Phase II	Culverts	Node 0 (San Gabriel River) to Node 1	4	-1	3
	LCWA Phase II		Node 0 (San Gabriel River) to Node 5	6	-3	1
	Hellman Retained		Haynes Channel to Node 6	6	-3	1
			Node 6 to Node 7	4	-2	2
			Node 6 to Node 8 Node 6 to Node 9 Node 7 to Node 11 Node 7 to Node 12 Node 7 to Node 10 Node 7 to Node 13 Node 10 to Node 11 Node 10 to Node 14 Node 13 to Node 14	4	-2	1
			Node 13 to 16 Node 12 to 15	4	3	1
		Channel	Node 4 to Node 6	Not Applicable		

Figure 7-15. Modeling Nodes at the Northern Area for Alternative 1

Figure 7-16. Modeling Nodes at the Central Area for Alternative 1

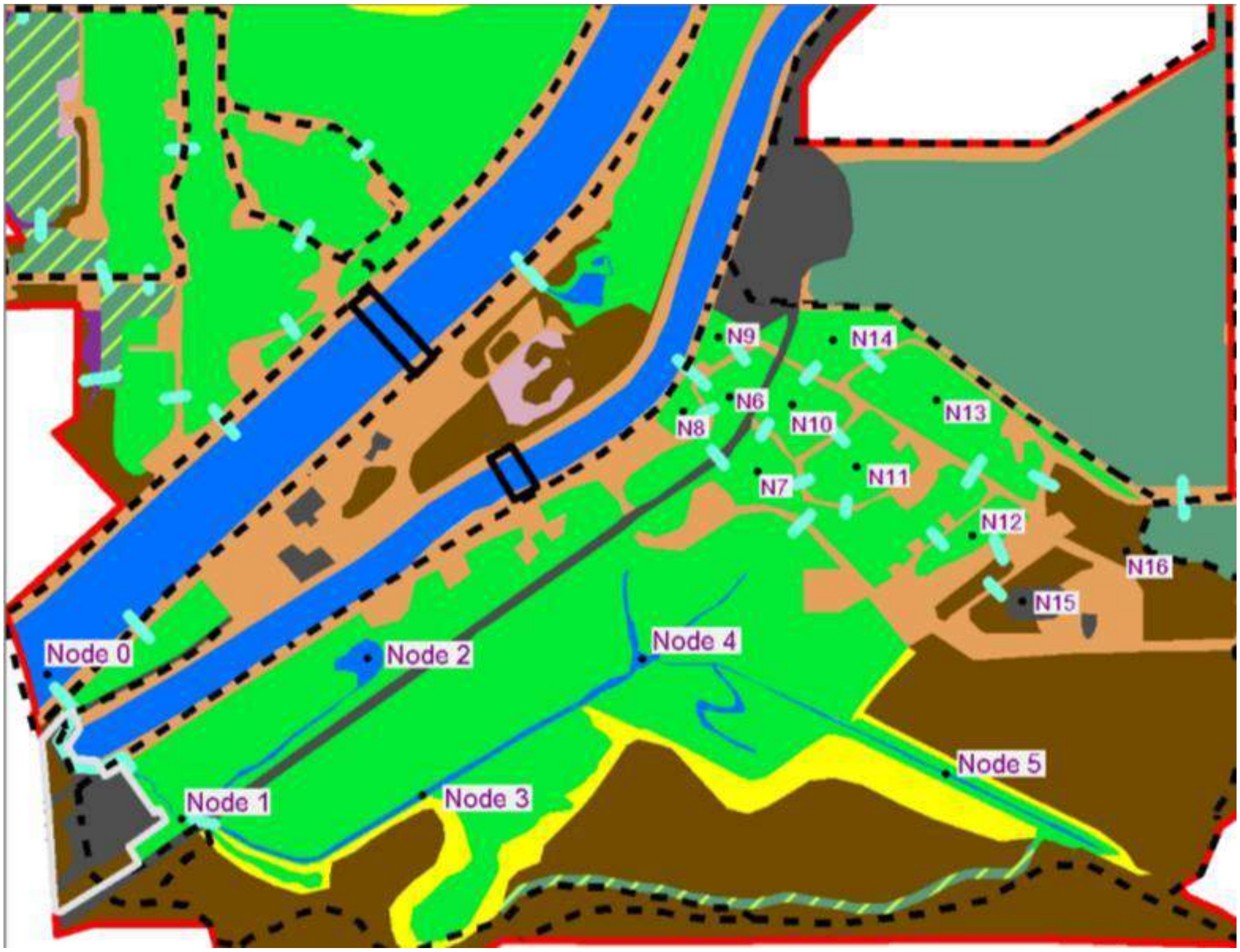


Figure 7-17. Modeling Nodes at the Isthmus and Southeast Area for Alternative 1

7.2 Alternative 1

Alternative 1 is the Minimum Alteration scenario. Analyses of Alternative 1 are presented below.

7.2.1 General Description

As more fully described in Section 6.6, the Minimum Alteration Alternative envisions the least degree of changes and earthwork compared to any other alternative. It will require the consolidation of certain pipelines, roadways, power poles, and non-operating equipment. All existing oil well site locations will be preserved, although some well sites, pipelines, and roadways would need to be elevated to avoid flooding. All tank farm locations would be preserved and remain unchanged. Hydrology will follow the existing drainage network within each area, and tides will be limited to conditions controlled primarily by existing culverts and/or channels. As a target, the greatest benefits assumed in the conceptualization to come from this alternative include:

- Relatively low costs compared to other alternatives from minimal changes to the site; and
- Greatest degree of compatibility with existing on-site uses from working around them.

The greatest disadvantages of this alternative assumed in the conceptualization consist of:

- Generally lower quality habitats resulting from restoration than what could be achieved with greater improvement to tidal hydrology;
- Implementation of the Minimum Alteration Alternative would require more maintenance (e.g., culvert cleaning, erosion repair);
- Habitat would be more fragmented for the Minimum Alteration Alternative than the other alternatives; and
- An emphasis on resilience and diversity within the entire complex at the expense of resilience and diversity within individual areas.

Phasing of implementation is required for each alternative due to the variety of land owners and status of ownership. As only portions of three areas are presently in LCWA ownership, restoration could occur there first, with restoration on parcels that are presently in private ownership to occur at a later date. Figure 7-18 and Figure 7-19 show a conceptual phasing plan for Alternative 1. The first graphic shows areas in Phase 1 that are in LCWA (or member) ownership at this time, and all other properties not in Phase 1 that are in LCWA member ownership. The second figure shows all properties in Phase 1 and all remaining properties that are in Phase 2 and beyond (referred to as Phase 2+). Precise phasing after the initial phase is not possible to determine with the information that presently exists.

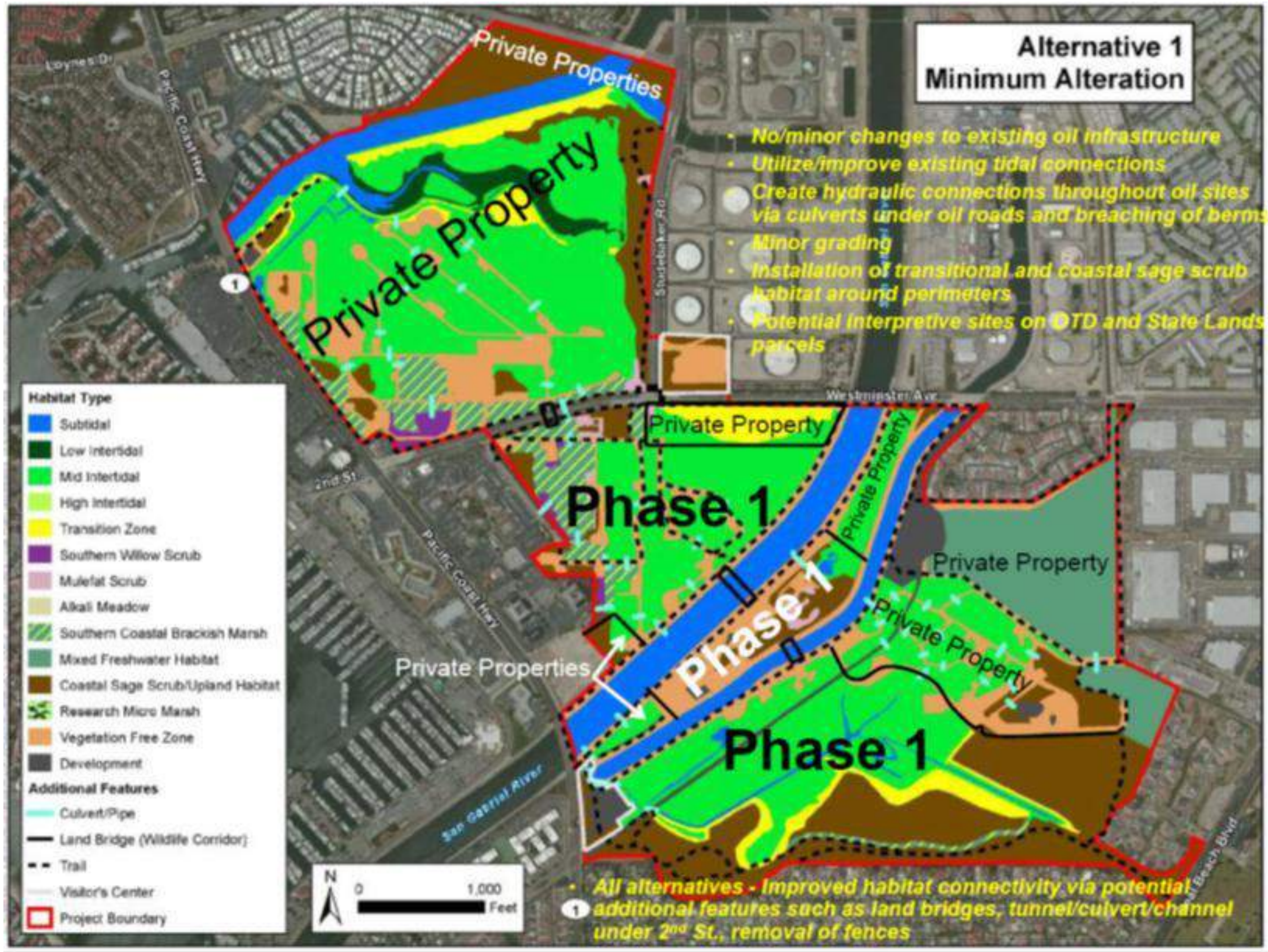


Figure 7-18. Phase 1 of Minimum Alteration

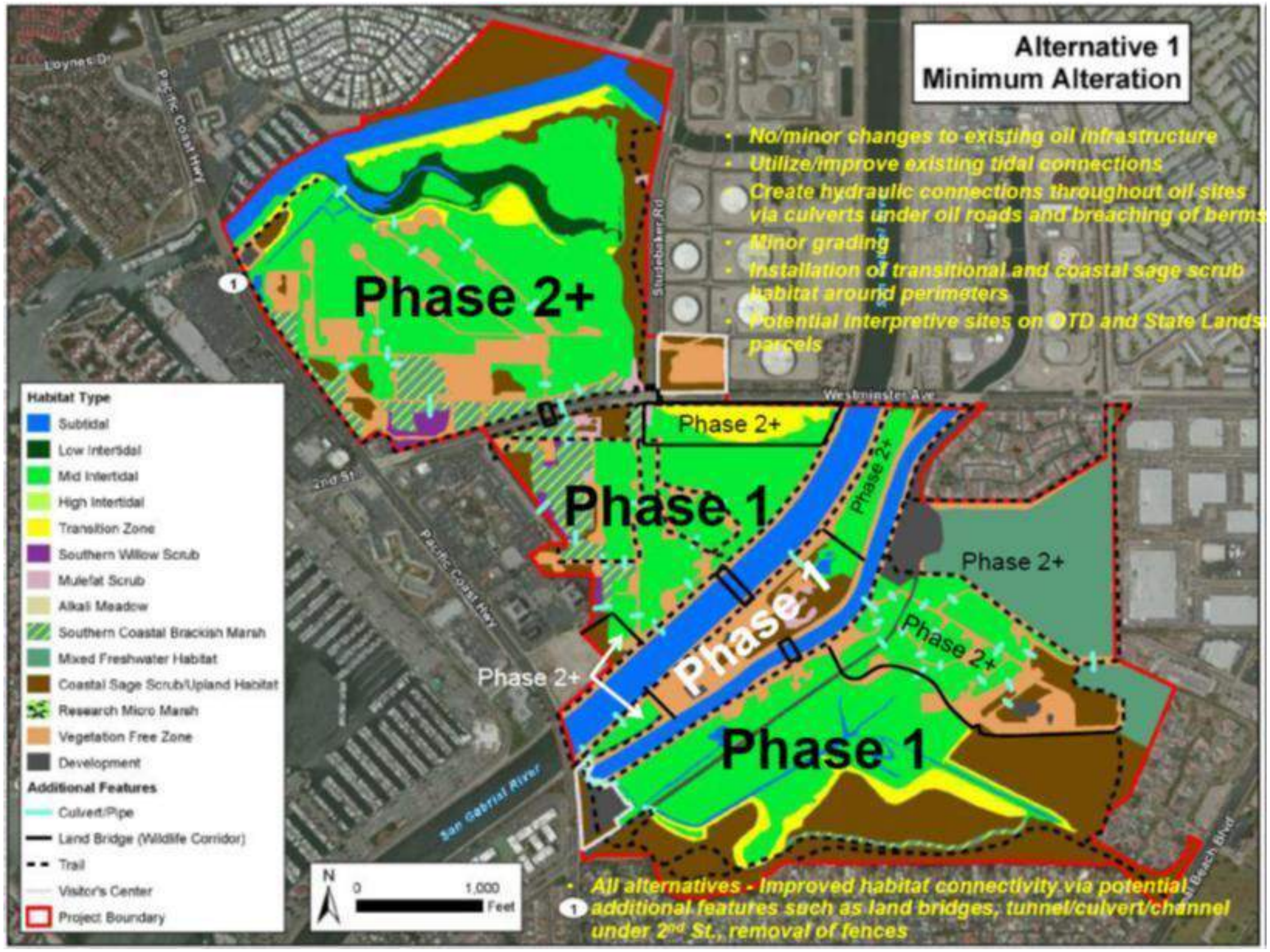


Figure 7-19. Phases 1 and 2+ of Minimum Alteration

7.2.2 Preliminary Design

The preliminary design of Alternative 1 is shown in the conceptual grading plan and cross-sections that show channels and structures. Figure 7-20 through Figure 7-23 show grading on each area (Northern, Central, Isthmus, and Southeast, respectively). The Minimum Alteration Alternative shows very little grading on the Northern, Central, and Isthmus areas. Some degree of minimal earthwork is needed to provide target habitats shown on the conceptual GIS graphic on Figure 6-19. The minor adjustments consist of:

- installing culvert through oil roads (on all sites);
- removing unneeded oil roads (on all sites except the Isthmus);
- raising needed oil roads (on all sites);
- creating transitional habitat areas (on the Northern Area);
- creating mid-marsh (on the Southeast Area); and
- breaching an existing dike (on the Northern Area).

The flat-topped features on each site are oil roads raised up to +10 feet NGVD to be clear of inundation if sea level rises by 5.5 feet in the future. More grading will need to be done on the Southeast Area in order to achieve target mid-marsh habitat, given hydrology resulting from using culvert connections to the San Gabriel River. Cross-sections of proposed grading were created to show the difference between existing topography/bathymetry and the proposed surface of this alternative. The location of the cross-sections is shown in Figure 7-24. The locations of cross-sections shown on this graphic are the same for every alternative. Cross-sections of the grading anticipated at each area are shown in Figure 7-25 through Figure 7-28.

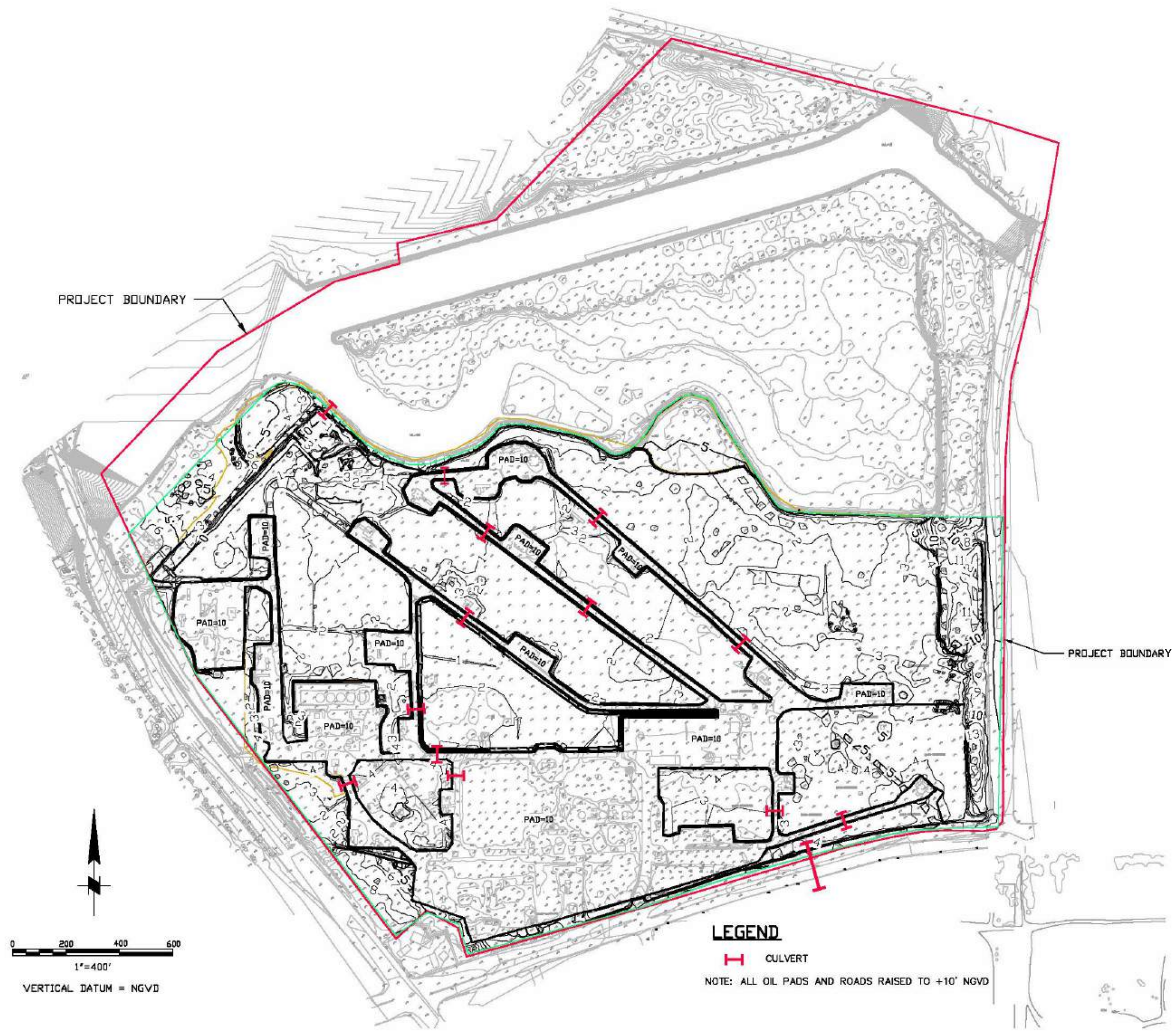


Figure 7-20. Conceptual Grading, Minimum Alteration, Northern Area

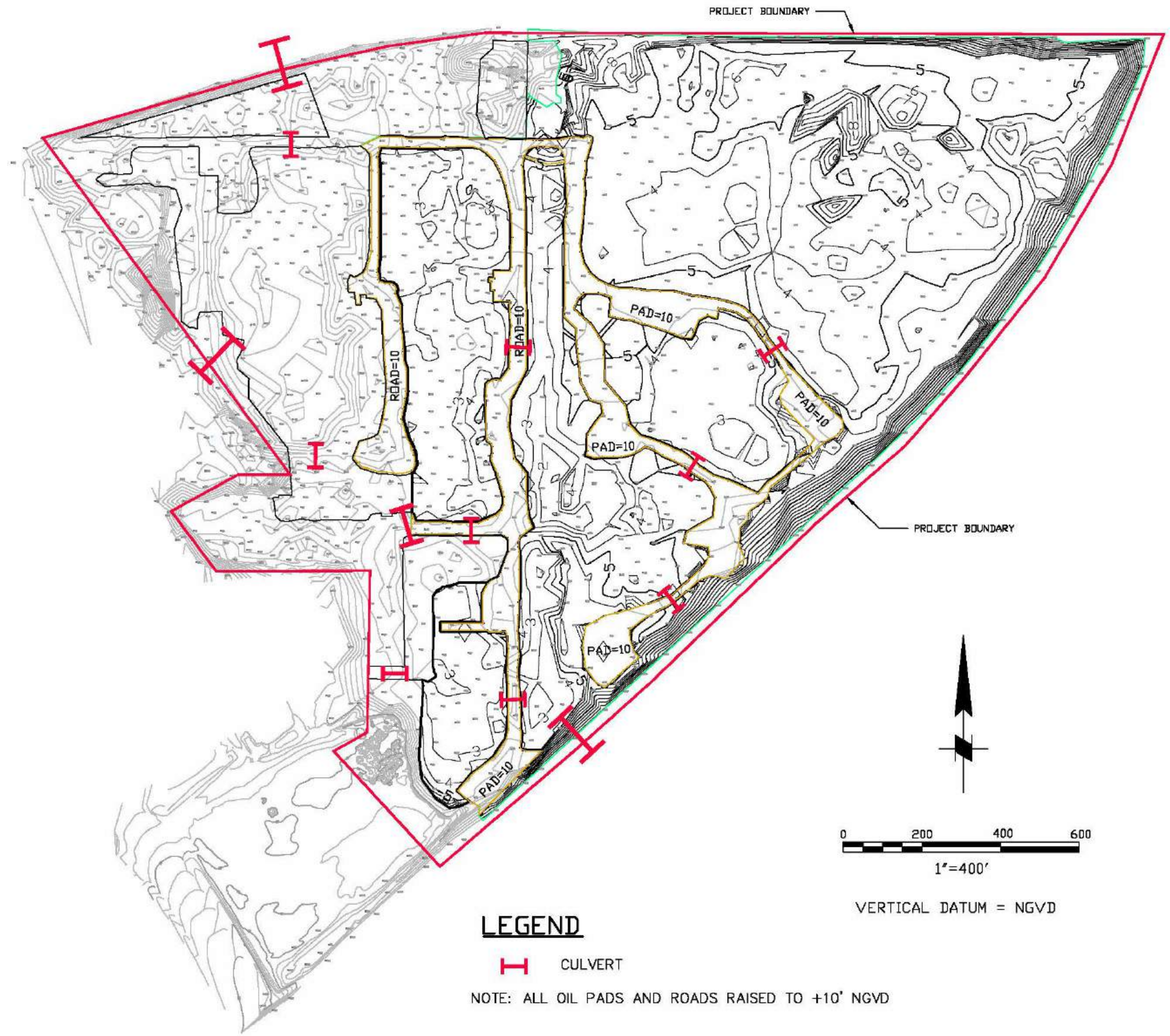


Figure 7-21. Conceptual Grading, Minimum Alteration, Central Area

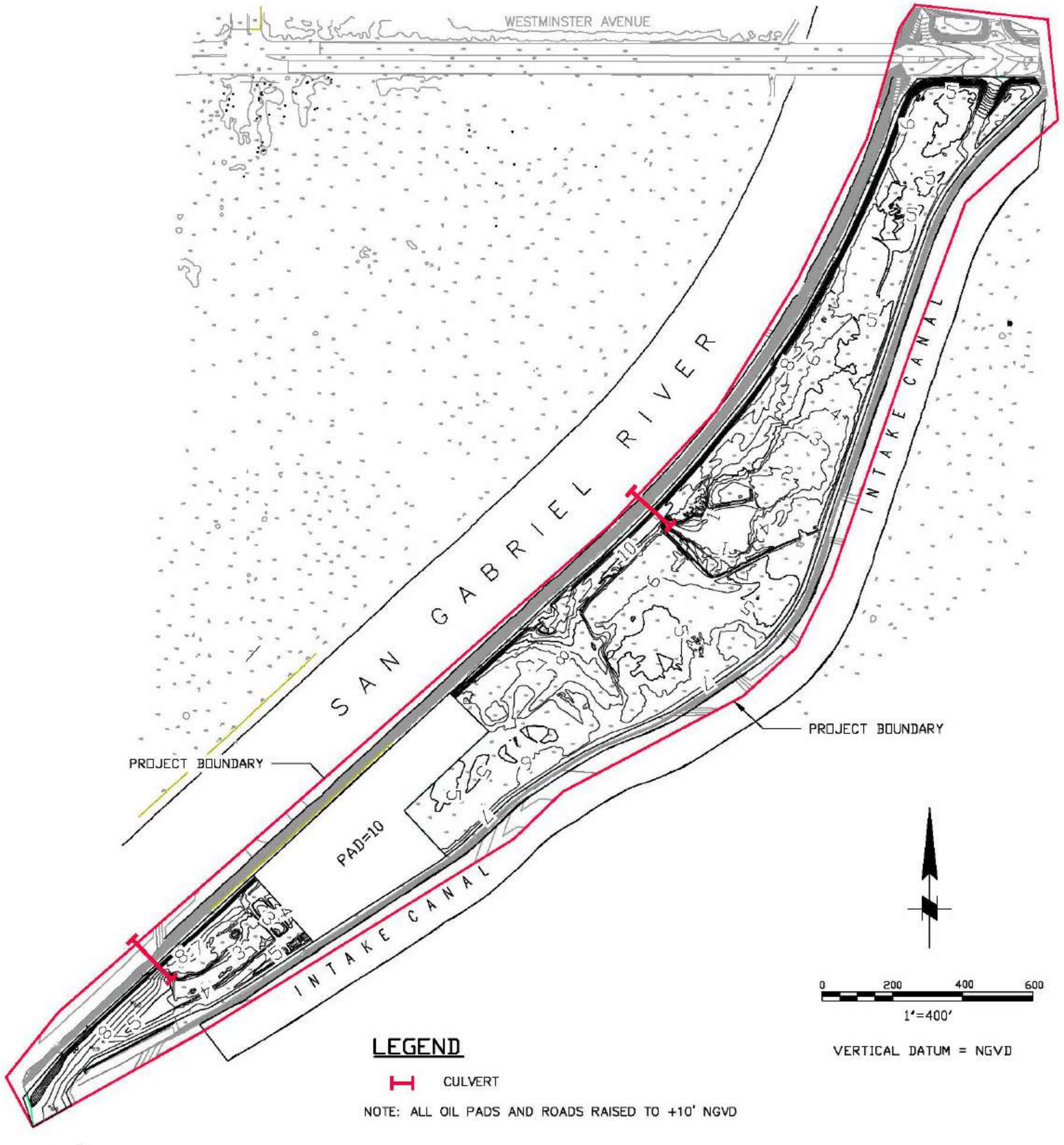


Figure 7-22. Conceptual Grading, Minimum Alteration, Isthmus

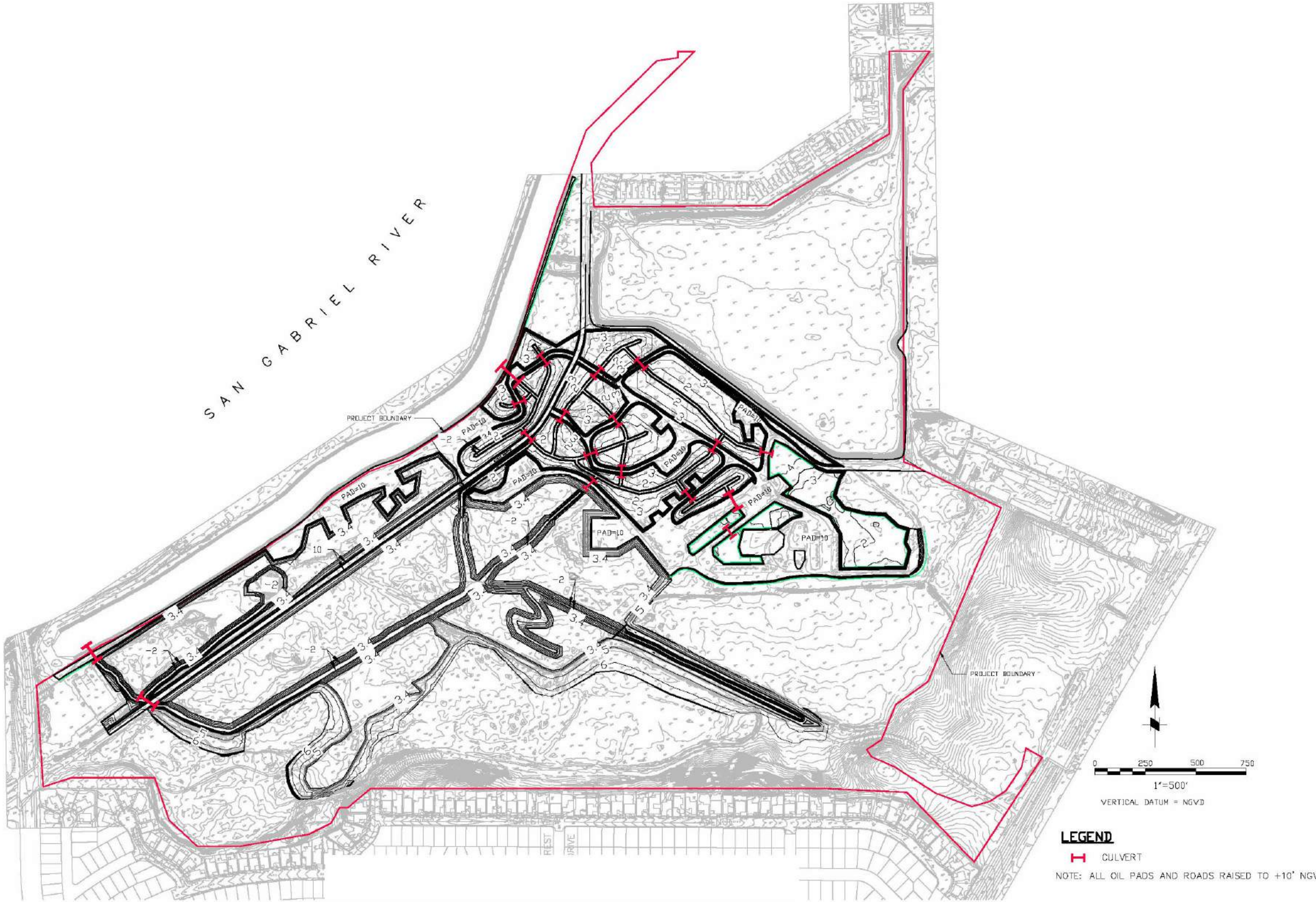


Figure 7-23. Conceptual Grading, Minimum Alteration, Southeast Area

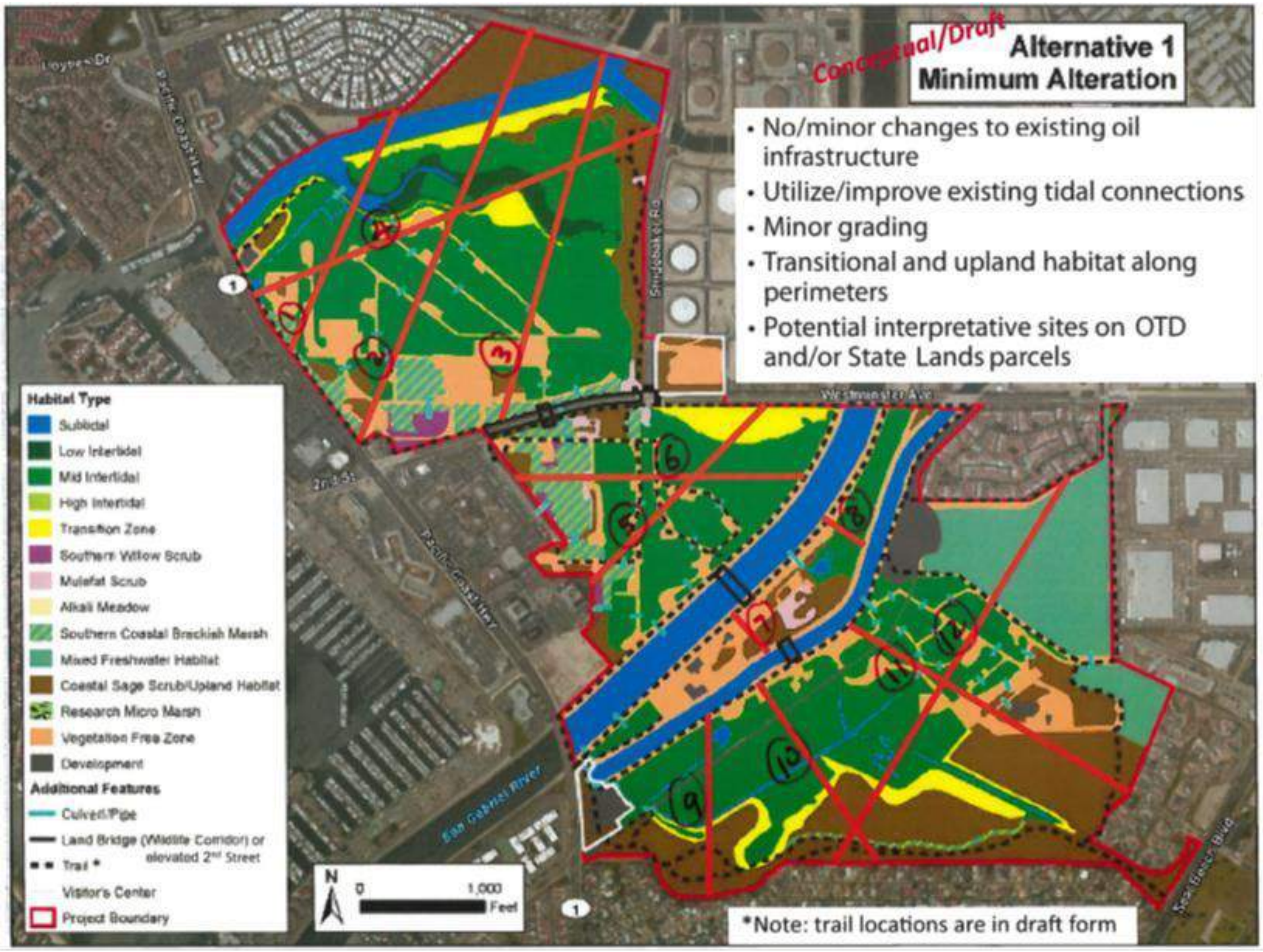
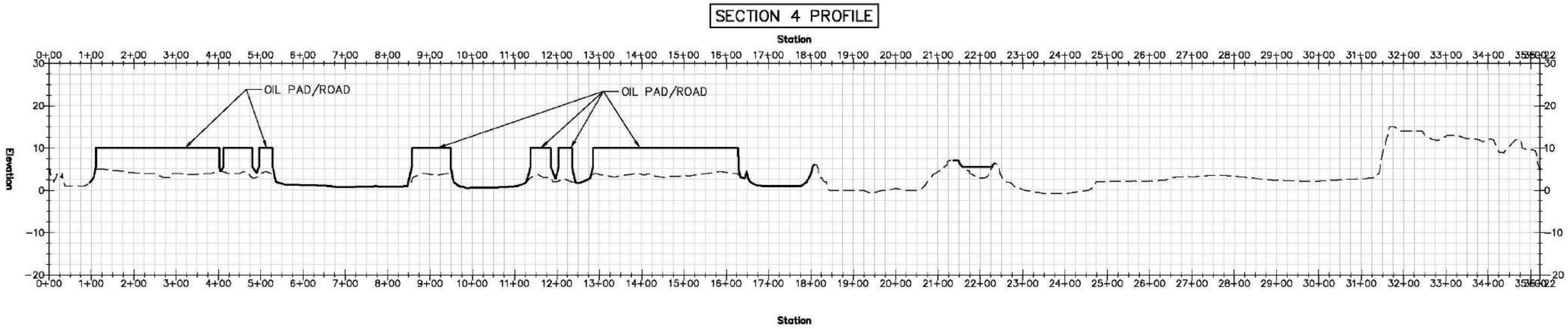


Figure 7-24. **Locations of Grading Cross-Sections**



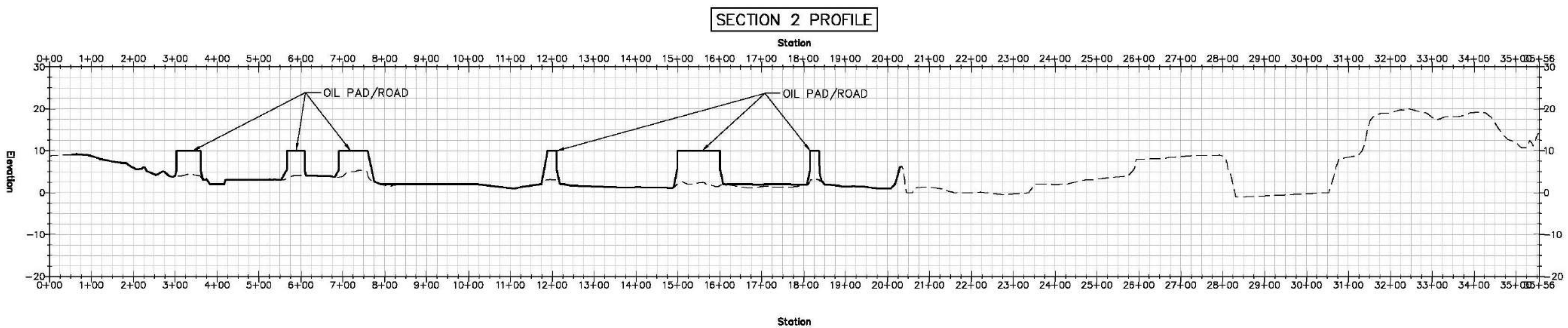
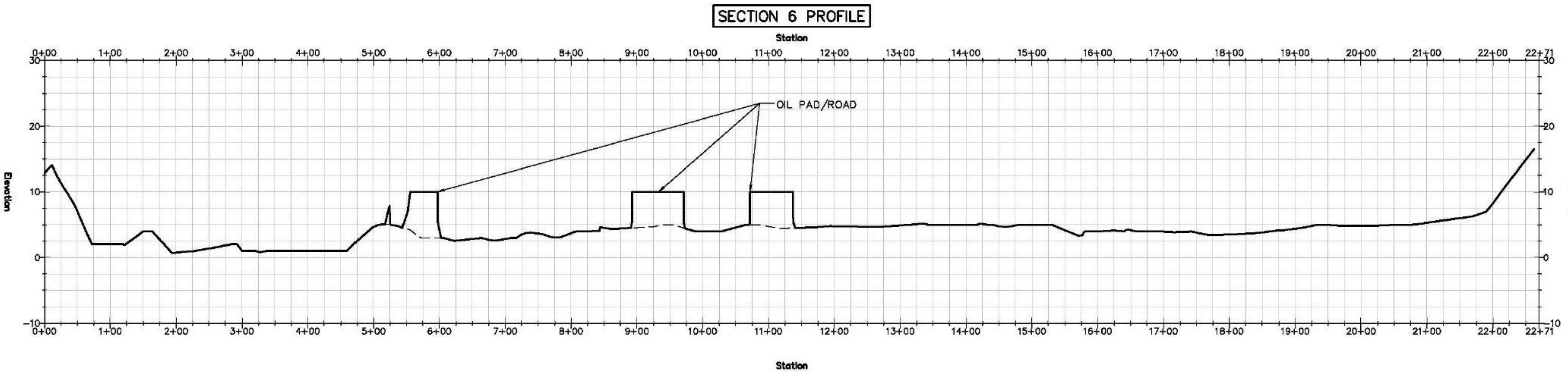


Figure 7-25. Conceptual Grading Cross-Sections, Minimum Alteration, Northern Area



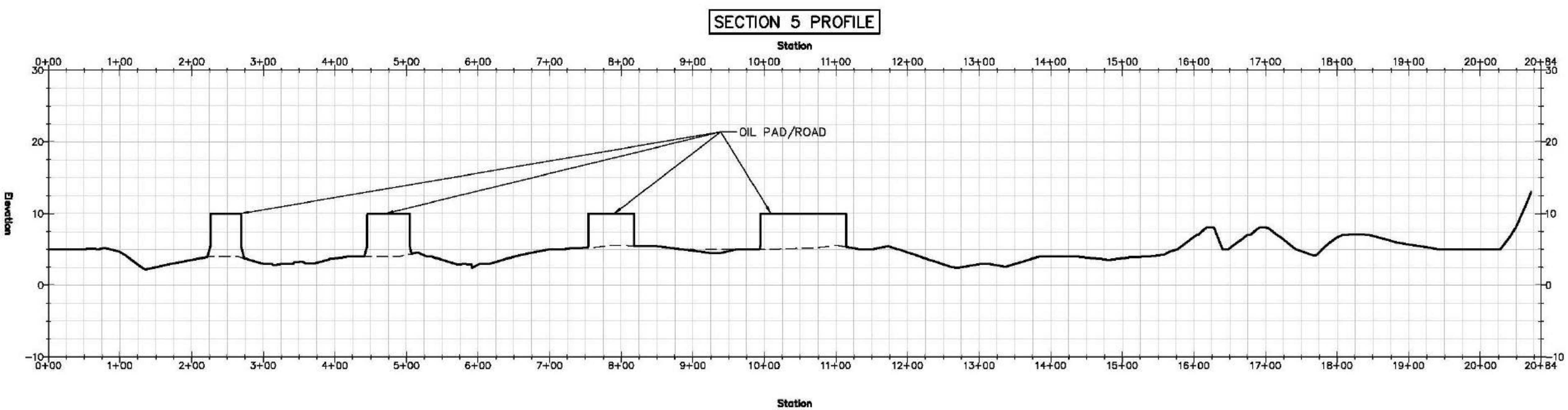
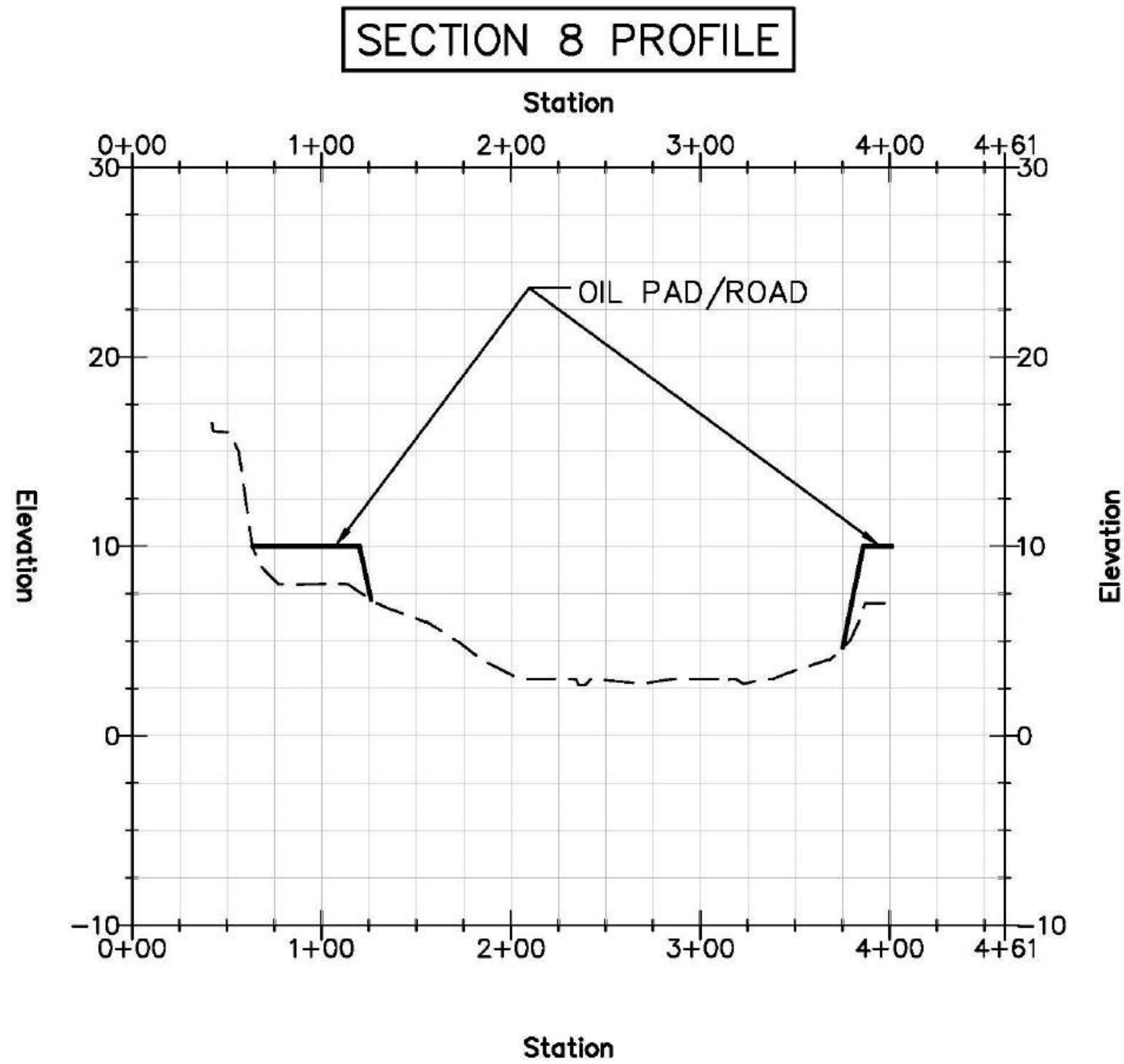


Figure 7-26. Conceptual Grading Cross-Sections, Minimum Alteration, Central Area



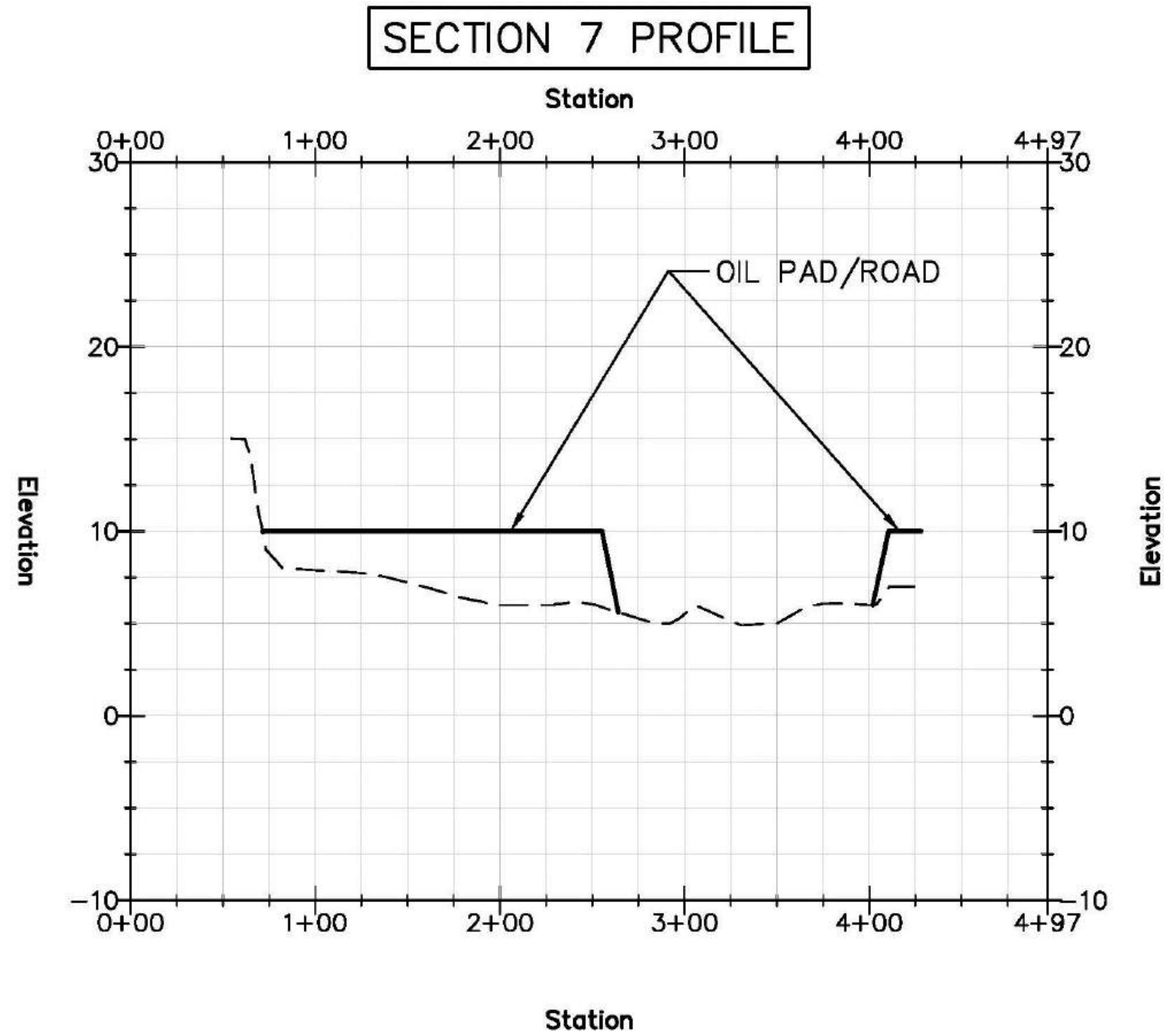


Figure 7-27. Conceptual Grading Cross-Sections, Minimum Alteration, Isthmus

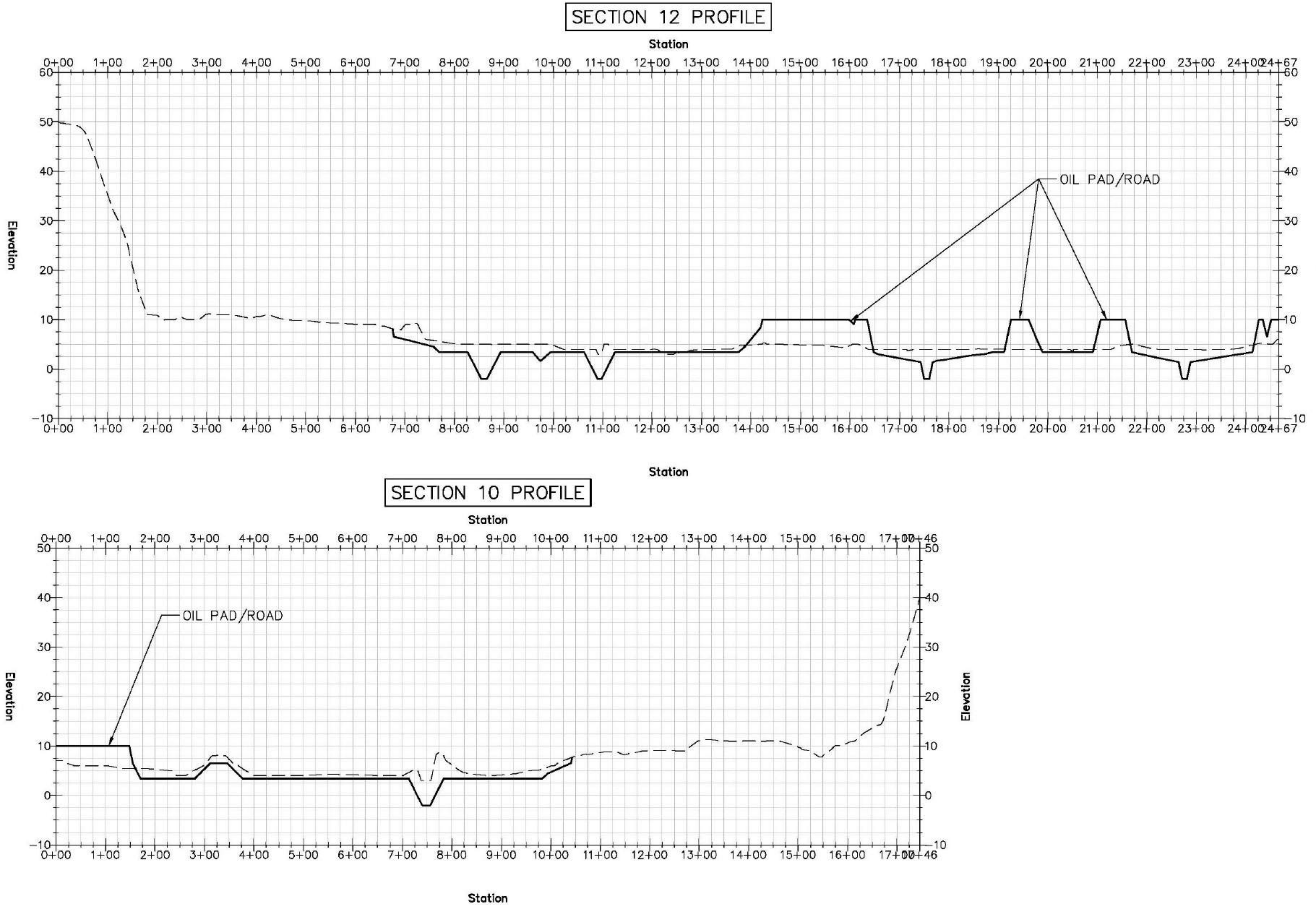


Figure 7-28. **Conceptual Grading Cross-Sections, Minimum Alteration, Southeast Area**

7.2.3 Habitat

The analyses are summarized in matrices in each alternative in its respective subsection for habitat. Within these matrices, the most important points are highlighted while remaining as concise as possible. For the most part, the analysis is purely qualitative. In a few cases, an area-alternative combination is called out as clearly superior or inferior to the others for a given trait. For the most part though, such decisions are left up to the reader and their personal biases.

Table 7-5 presents the habitat analysis for the Minimum Alteration Alternative. This alternative is much less resilient to SLR than anticipated. This is primarily due to the fragmented nature of the design and the myriad culverts and their negative effect on natural tidal exchange, which in some cases are exacerbated with SLR. Figure 7-29 through Figure 7-31 show the habitat areas at each site for Alternative 1, under various sea level scenarios.

Table 7-5. Habitat Analyses for Alternative 1, Minimal Alteration

Minimum Alternative	Northern Area	Central Area	Isthmus	Southeastern Area	Entire LCW Complex
Diversity of Salt Marsh Habitats	• Broad distribution of intertidal habitats skewed towards mid-intertidal • Some tidal muting in basins with culverts • Limited opportunities for tidal channel networks due to roads and berms • Limited transition habitats	• Almost complete lack of lower intertidal and sub-tidal habitat with emphasis on transition habitat • No opportunities for tidal channel networks due to higher elevations, roads and berms	• Very small areas under regular tidal influence • Lots of transitional habitat • Severe tidal muting (<40% tide range) due to perched culvert	• Broad distribution of intertidal habitats with an emphasis on high intertidal habitats • Significant tidal muting with proposed culverts (<60% tide range) • Habitats around the oil area are constrained by basins with steep transitions • Southern area provides opportunity for a fairly large contiguous wetland	• Full diversity of marsh habitats within the complex • Individual areas do not support such a high diversity of salt marsh habitats • Culverts result in muted tides in most areas; poor circulation could lead to hypoxic conditions
Overall Habitat Diversity	• Emphasizes intertidal salt marsh • Some storm-water-fed brackish habitat at current sea level • Steep transitions between tidal areas and most uplands	• Emphasizes intertidal salt marsh • Some storm-water-fed brackish habitat at current sea level • Limited adjacent upland habitat	• Uplands are primarily berms with limited habitat value	• Skewed towards non-salt marsh habitats in near term • Significant area of freshwater wetlands and some brackish habitat • Considerable upland habitat	• Significant non-tidal wetlands • Brackish marshes will be impossible to maintain with SLR • Significant upland habitats but mostly in Southeastern Area
Habitat Connectivity	• Habitats highly fragmented by roads and berms • Multiple culverts may limit connectivity for some aquatic species • Steep transitions between marsh habitats and uplands	• Habitats highly fragmented by roads and berms • Multiple culverts may limit connectivity for some aquatic species • Basins have steep transitions around edges	• Transition zone has reduced value when not adjacent to salt marsh • Entire site isolated by berms • Culverts may limit connectivity for some aquatic species	• Wetland habitats fragmented by roads and berms • Multiple culverts may limit connectivity for some aquatic species • Low-lying basins have steep transitions • Many wetland-upland transitions are steep	• Few examples where a full suite of salt marsh habitats are adjacent and well connected • Lots of fragmentation due to oil roads and levees • Different areas are isolated by major roads, berms and development
Resilience to Sea Level Rise (SLR)	• Majority of the vegetated marsh lost with moderate SLR • Almost no vegetated marsh left with significant SLR • Loss of brackish habitats • Least resilient to moderate SLR of the three alternatives	• Significant lower intertidal habitats will develop with moderate SLR • Tides becomes muted due to small culverts with significant SLR; vegetation zones are narrowed resulting in almost total loss of vegetated marsh • Uplands lost with moderate SLR	• Tidal habitats will expand with moderate SLR • Tides becomes muted due to small culverts with significant SLR; vegetation zones are narrowed resulting in almost total loss of vegetated marsh	• Significant lower intertidal habitats will develop and high intertidal habitats are lost with moderate SLR; little transgression of marsh habitats in to uplands; tide range improves • Significant loss of vegetated marsh; significant transgression of marsh habitats into uplands; tide range decreases	• Full range of habitats maintained with moderate SLR complex-wide • Vegetated marsh severely reduced with significant SLR • Raising oil roads and well pads may lead to wetland loss as footprints need to get bigger
Functional Lift	• Little or no change in Steam Shovel Slough • Return of tidal influence will provide moderate lift elsewhere • Fragmentation and culverts limit overall functioning • Functioning will decrease with SLR	• Return of tidal influence will halt conversion to freshwater wetlands providing moderate functional lift • High elevations, fragmentation and culverts limit overall functioning in near-term • Functioning will increase sharply with moderate SLR; decrease sharply with significant SLR	• Minor functional lift due to limited increase in tidally influenced area • Functioning will increase with moderate SLR; decrease with significant SLR	• Significant functional lift at current sea level; increases slightly with moderate SLR • Functioning decreases sharply with significant SLR • Freshwater wetlands in the retarding basin provide high-functioning non-tidal wetlands	• Moderate functional lift that is sustainable with moderate SLR • Alterations to current culvert specifications could allow greater tidal ranges and somewhat higher functioning • Artificial filling would be needed to maintain functioning with significant SLR
Take Home Message	• Relatively inexpensive and compatible with existing oil operations but resulting marsh habitat is highly constrained and not resilient to SLR	• Relatively inexpensive and compatible with existing oil operations but tidal exchange is limited and intertidal marsh area increases only with moderate SLR	• Relatively inexpensive and compatible with existing oil operations but functional gains are moderate and dependent on SLR	• Relatively inexpensive and compatible with existing oil operations with significant functional lift in the near term and with moderate SLR	• An oil-friendly and relatively inexpensive approach that emphasizes diversity and resilience within the complex largely at the expense of diversity and resilience within individual areas

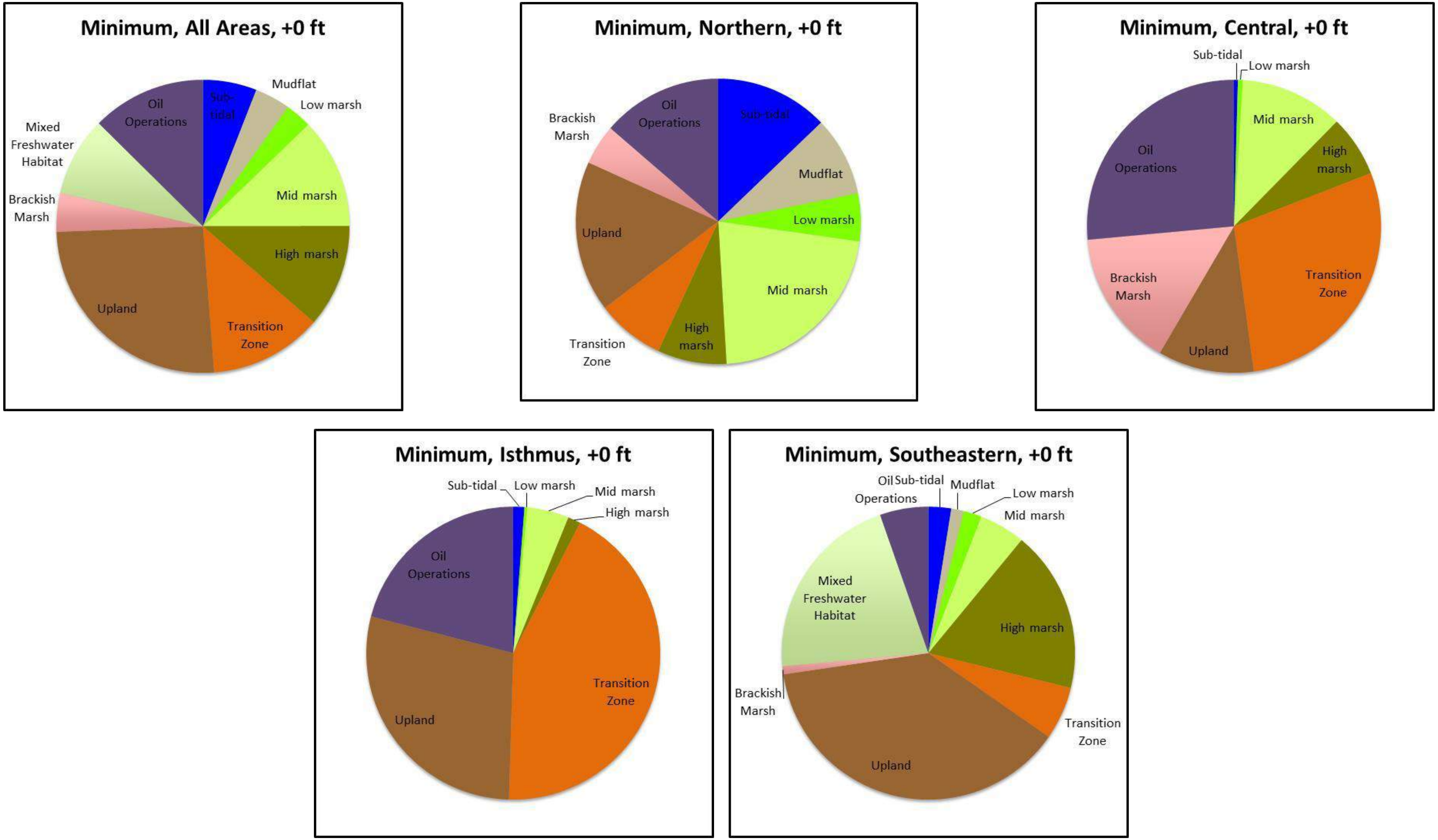


Figure 7-29. Habitat Acreage Alternative 1, Minimal Alteration SLR of +0 ft

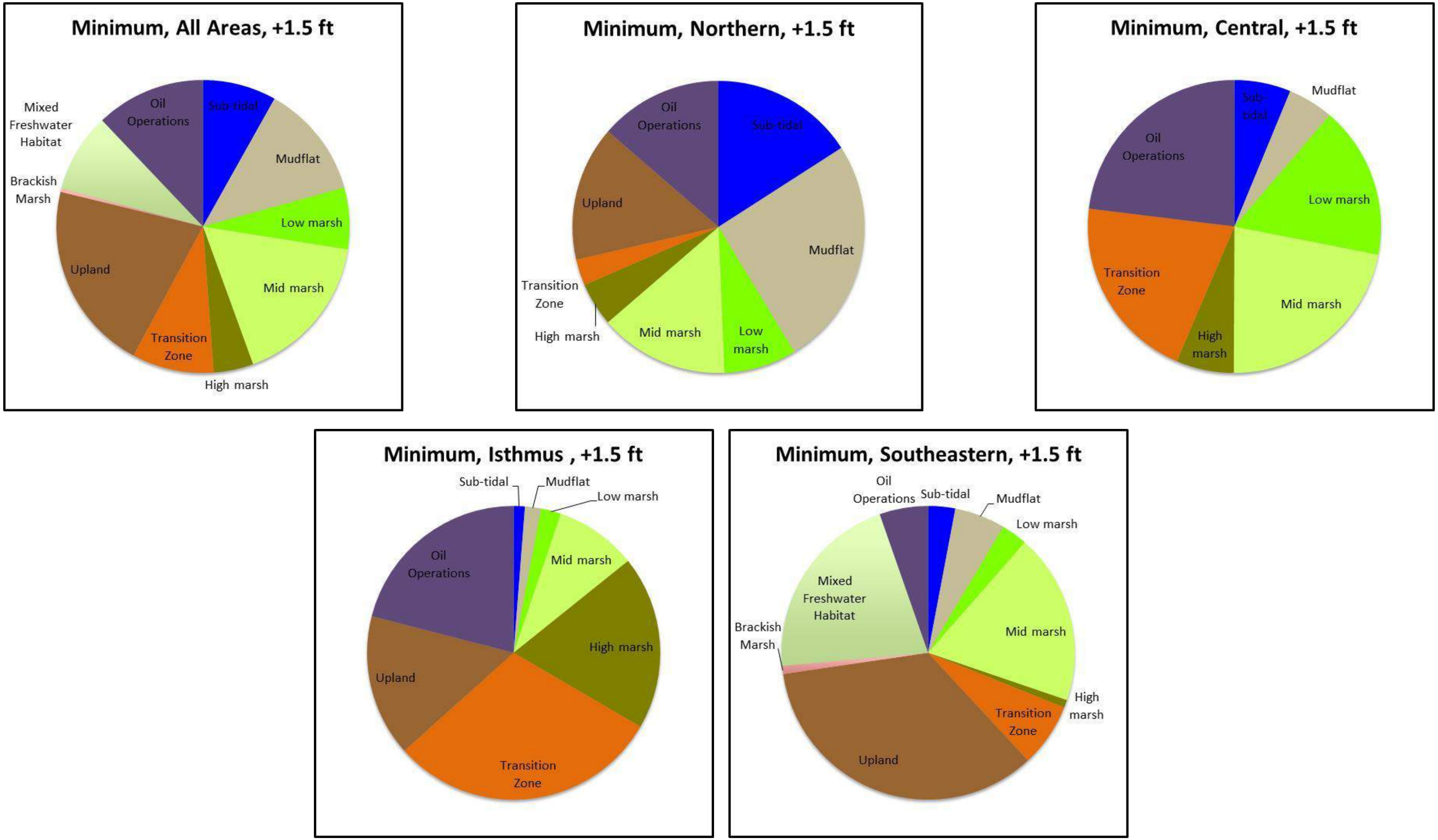


Figure 7-30. Habitat Acreage Alternative 1, Minimal Alteration SLR of +1.5 ft

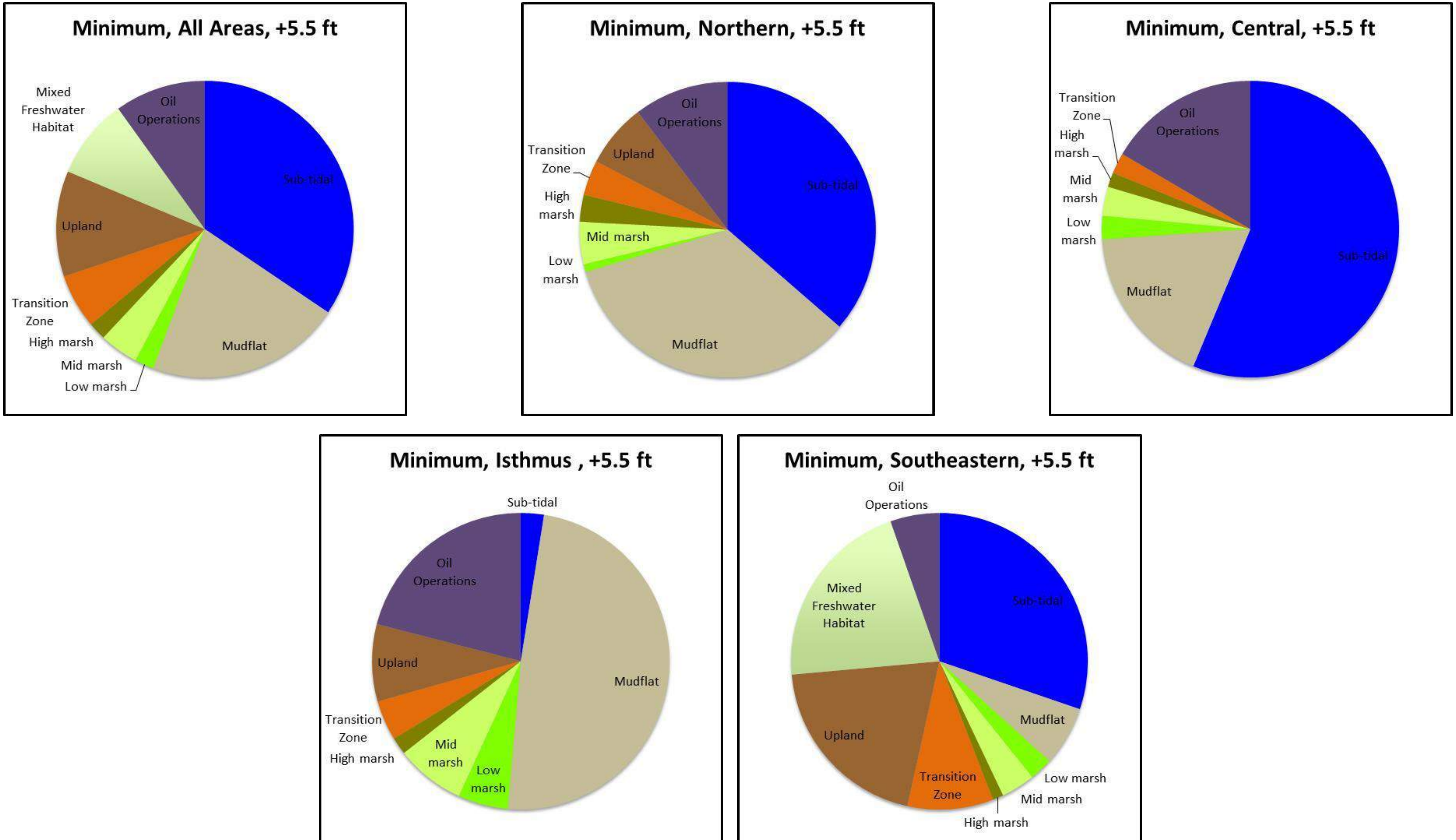


Figure 7-31. Habitat Acreage Alternative 1, Minimal Alteration SLR of +5.5 ft

Wildlife Corridor Analysis

Large contiguous tracts of natural open space generally support greater biodiversity and better ecosystem functioning than smaller isolated areas. Throughout Southern California, urbanization and transportation corridors have fragmented habitats into smaller and more isolated pieces. The negative effects of fragmentation on biodiversity are wide-ranging. Fragmented areas may simply not be large enough to support viable populations of some wildlife species, especially large predators. Isolated areas may support small populations of some species, but they are prone to local extinction due to stochastic events (*e.g.*, wildfires) and genetic bottlenecks (*e.g.*, allee effects and inbreeding depression). The loss of high-level predators typically has myriad trickle-down effects on fragmented ecosystems. The change in trophic dynamics may lead to an increase in the density of mesopredators. This is especially problematic in coastal salt marshes in Southern California, where increases in mesopredators often leads to increased predation on rare and endangered salt marsh birds.

Wildlife corridors are connections between otherwise isolated patches of habitat. They typically come in two varieties. They may be strips of habitat that connect larger intact natural areas or culverts or underpasses through transportation corridors that bisect large tracts of habitat. Wildlife corridors are beneficial in three primary ways: 1) individual animals can move between different areas, increasing the effective patch size available for hunting and foraging; 2) corridors allow for gene flow between otherwise isolated populations, which will decrease the chance of genetic bottlenecks; and 3) individuals can re-colonize patches where local extinctions have occurred due to stochastic events. There has been considerable research on how to design effective wildlife corridors but there is little consensus on what types work best. In general, large species seem to require larger corridors with less human disturbance (underpasses and culverts) or better habitat (strips).

Figure 7-12 and Figure 7-13 in the previous report section show Los Cerritos in the context of the region and its connectivity to adjacent habitat areas. Re-connecting restored wetlands at the LCW to adjacent natural areas and open space will be an important long-term goal for the complex. Since these connections are largely outside of the physical boundaries of this conceptual plan area, they are not implicitly part of the alternative design and analysis process. Within the LCW Complex roads, levees and fences all contribute to increasing the effective isolation of the different areas from one another for wildlife. With no project, wildlife connectivity will remain the same. However, the three alternative CRPs provide differing levels of increased connectivity. There are opportunities to increase the connectivity within the complex in three primary ways: 1) removal of existing barriers; 2) creation of wildlife bridges over barriers; and 3) creation of underpasses through barriers.

In the moderate alteration and maximum alteration alternatives, consolidation of oil operations could lead to the removal of many of the chain link fences that limit some wildlife movement between the different areas. Oil operation areas would still need to be fenced off, but only non-habitat areas would be isolated. Some modification of fences in the minimum alternative could improve wildlife movement between areas, but the larger footprint of oil operations would mean narrower gaps in fences and, therefore, narrower corridors. None of the alternatives call for removal or relocation of major roads or large levees. Removal of major levees along the San Gabriel River and the HCC were considered in several of the screening alternatives. Only one levee was proposed for removal in the final three alternatives (Maximum Alteration Alternative, Southeastern Area). Even in this case, the levee protecting the Isthmus Area opposite the Southeastern Area was left intact, which would considerably limit connectivity between these two areas regardless. The choice to not remove any major levees was based on other important considerations (flood control).

Since most of the major barriers between the areas remain intact in the three alternatives, opportunities to connect the areas are limited to bridges and underpasses. Wildlife bridges, discussed in Section 7.2.4 can be effective design elements for moving people and wildlife between different areas. The scale of the proposed bridges means they might be effective for small herbivores (*e.g.*, rabbits, ground squirrels and mice) and small to medium sized predators that are tolerant of humans (*e.g.*, raccoons, skunk and coyotes). The maximum alteration alternative has the best within-complex connectivity due to wildlife bridges between all four of the areas (Figure 7-113 through Figure 7-115). The moderate alteration and minimum alteration alternatives each have similar wildlife bridges (Figure 7-75, Figure 7-76, Figure 7-32, and Figure 7-35, respectively) and would result in some increase in connectivity.

Wildlife underpasses are only feasible under roads, such as 2nd Street, which separates the Northern and Central Areas. The minimum alteration alternative includes a culvert under the road, which could be designed to facilitate some degree of both aquatic and wildlife connectivity. All three alternatives include the optional raising of 2nd Street on to a causeway. This would greatly increase wildlife connectivity between these two areas. Again, the original screening alternatives did include other options for increasing wildlife connectivity under 2nd Street, but these options did not all appear in the final three alternatives.

Increasing wildlife connectivity within the LCW Complex will be challenging. The three conceptual restoration alternatives improve this ecosystem attribute from existing conditions while balancing competing needs. If it is determined that wildlife connectivity is of greater importance than other competing needs in the future, special attention to this issue will be needed to refine these conceptual plans in later planning stages.

The Pacific Flyway

The Pacific Flyway is one of four principle migration routes in North America. Flyways are major migration routes between bird breeding areas and bird wintering habitats. Millions of birds of more than 350 species follow at least parts of the Pacific Flyway. The entire route stretches from the Bering Strait to Tierra del Fuego at the southern tip of South America. Birds travel along this migration route twice a year: to the south in the boreal autumn, and back to the north in the spring.

Migration and Wintering

Birds migrate south as early as July and migrate north as early as March. The fall migration usually consists of more individuals because it includes the newest generation hatched in the spring and summer. Fall migration is also spread over a longer time period with waves of adult and juvenile birds coming through separately for some species.

Migration staging areas are thought to be vitally important to many bird species because migration is very costly in terms of energy and birds must be in very good condition before starting long distance flights. Birds must also arrive in good condition so they may set up and defend territories, build nests, produce eggs and raise chicks. Large areas of healthy habitat with good food resources are necessary to provide large flocks of birds with the fuel they need for successful migration.

Many birds stop along the Pacific Flyway and spend the winter in California. Productive habitat is necessary to support these populations during the short, cool days of the winter months.

Bird Conservation and the Pacific Flyway

Successful conservation of bird species requires healthy habitat in both breeding and wintering ranges as well as adequate migration corridors. Some species also rely on good staging areas. Urbanization along the coast and the loss of 90% of coastal wetlands in Southern California has likely put pressure on a number of species using the coastal portion of the Pacific Flyway.

From the perspective of numbers of birds, Southern California's coastal wetlands are probably most important for supporting migrations of shorebirds (sandpipers, plovers and related species) and waterfowl (ducks and geese), although large numbers of grebes, loons, gulls and terns also move along the coast. While in estuaries, shorebirds feed primarily by probing in mudflats and picking invertebrates off the surface. Waterfowl feed on plants, algae, and invertebrates in and out of the water. Many ducks and geese spend most of their time feeding in the water, although a higher diversity of habitats increases the value of sites for birds and upland roosting and foraging areas in particular are valuable for ducks and geese. Some species have narrow food preferences *e.g.* Brandt's cormorants consume eelgrass exposed on very low tides, diving ducks feed on invertebrates (Surf Scoters) or fish (Red-breasted Mergansers).

Alternatives and SLR Scenarios Analysis

Generally, the alternatives that produce larger acreages of shallow sub-tidal habitat and mudflat adjacent to vegetated marsh will support the greatest numbers of waterfowl and shorebirds, and total support for Pacific Flyway bird species. The shallow sub-tidal habitats will also support a wide variety of grebes, loons, cormorants, pelicans, gulls, and terns. Mudflats will also support herons, egrets and provide resting sites for a number of the species that use sub-tidal habitats.

There are trade-offs for other types of habitat in alternatives with large amounts of low intertidal and shallow sub-tidal habitat. Functioning high intertidal habitats are limited regionally and support rare species including endemic Belding's Savannah Sparrows (local breeders and non-migratory).

Sea Level Rise

All of the alternatives will produce very large areas (55 to 81% of site) of sub-tidal and mudflat habitat at 5.5 feet of SLR. Substantial areas of these habitats (21 to 42% of site) will be produced at 1.5 feet of SLR under each of the alternatives. At current sea level, the differences between the three alternatives for habitat supporting shorebird and waterfowl use of the site would exceed a 2:1 ratio. At current sea level, the differences between the Maximum Alteration Alternative (22%) would produce more than twice as much habitat for shorebirds and for birds that use low intertidal and sub-tidal areas than the Minimum Alteration (10%) or Moderate Alteration Alternatives (10%).

Pacific Flyway Analysis Summary

All alternatives would increase habitat use for bird species that utilize the Pacific Flyway; however, some alternatives under different sea level conditions would yield greater usage. Those scenarios are: 1) the Maximum Alteration Alternative under current sea level conditions; or 2) any alternative under any other sea level condition.

7.2.4 Public Access Plan

The following PAP alternatives have been developed according to goals and objectives, the biological framework for restoration planning, and opportunities and constraints described in detail in various sections above in this plan. However, highlighted and additional considerations leading to the final PAP alternatives are described below, and are applicable to all that follow.

Public Access Plan for Alternative 1- Minimum Alteration

The minimum alteration restoration alternative leaves a significant amount of oil infrastructure in place and proposes minimal consolidation of oil operations, leaving many of the original access roads in place. As a result, this alternative provides the greatest number of ready-made pathways through the wetlands of all of the alternatives, particularly in the Northern Area.

Figure 7-32. Northern Area PAP

Northern Area

This PAP marries significant loop trail opportunities with a less aggressive wetland reconfiguration. The fragmentation of the wetland into cells, therefore, would occur regardless of pedestrian access, but of course adds potential human disturbance impacts with the addition of these trails. Due to the unique status of Steam Shovel Slough as the one remaining historical remnant of the entire LCW area, it is both a critical interpretive element and a most sensitive site area. Therefore, no provision has been made for a complete perimeter loop trail, which would require a crossing of the Slough at its mouth - a feature deemed to have unacceptable impacts. Nevertheless, access is available to the neighborhood areas to the north, via proposed upland habitat areas that will provide exceptional elevated views from the east along Studebaker.

For this alternative, the trails were limited to upland areas and primarily along existing roads. An additional interior loop trail connecting the NW and NE neighborhoods is possible if the small levee at transitional marsh level is followed. This would require a new trail construction and so is somewhat beyond the minimal alteration parameters of this alternative.

Primary public access points occur at:

- the NW near PCH just south of the existing oil operations office
- Westminster just east of PCH intersection and the In-n-Out, which can be accessed from the Marketplace Shopping Center parking area via crosswalk; and
- via crosswalk or elevated "green bridge" (as shown in Figure 7-33 below) from the proposed Interpretive Center at the NE corner of Studebaker and 2nd Streets.

Figure 7-33. "Green Bridge" From Northern to Central Areas

A potential Interpretive Center is considered for this site due to its small size, its distance from wetlands, and lack of tidal hydrology and habitat. It also offers the best vantage point from which to view the entire expanse of the LCW. Elevating the Interpretive Center on a one- or two-story plinth would provide an exceptional view of the wetlands, ocean, and San Gabriel Mountains on clear days. This view would allow interpretation and visualization of elements of the entire San Gabriel Watershed from this single location. In addition, the elevated location would allow for pedestrian access over the street level between the Northern and Central Areas. The sketch shows a version of vegetated overpass that could also act as a nighttime wildlife crossing while literally bringing the open space to the Interpretive Center. Finally, the one or two-story plinth would not only support the Interpretive Center physically, but also financially if the lower space was leased as commercial space on this highly visible corner. This hybrid building type would then address the typical challenge of funding Interpretive Center construction and operating budgets, as shown in this early analysis of the site, in which a typical funding "sink" can be offset by a funding source. Figure 7-34 shows potential funding sources for wetlands access and interpretive elements.

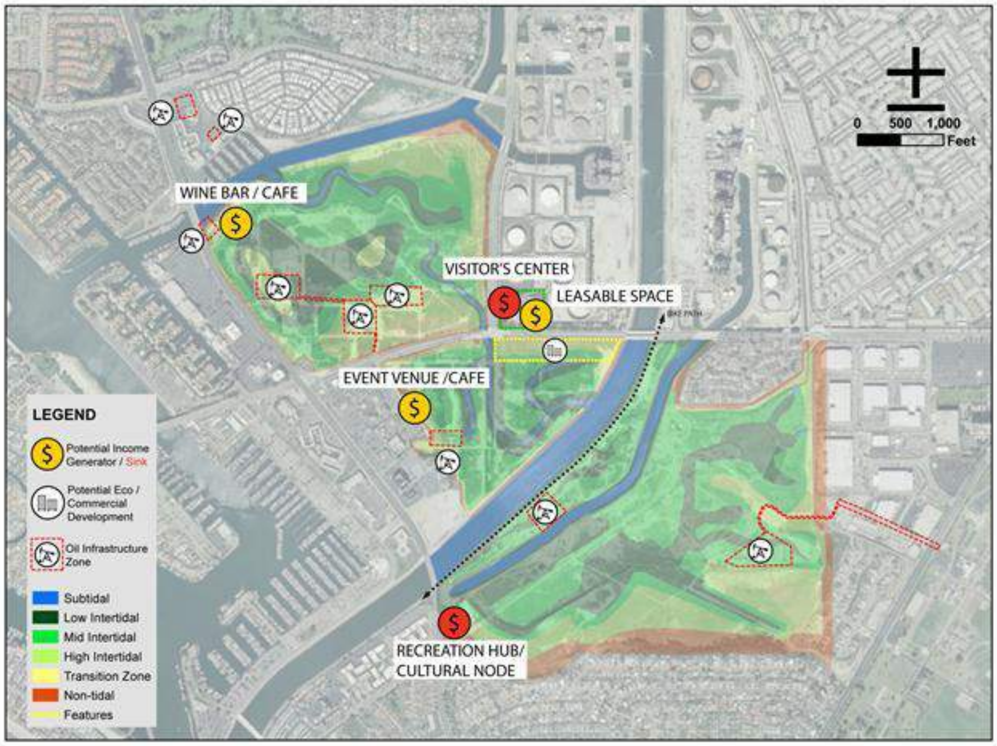


Figure 7-34. Potential Funding Sources for Wetland Access and Interpretive Elements

The Central Area, Isthmus, and Southeast Area

The primary access feature of the minimal alteration PAP in the southern LCW area is a loop trail surrounding the Central Area, the Isthmus, and the Southeast Area that runs 3.3 roundtrip miles with an average walk time of 90 minutes. The primary trail connects a number of interpretive areas, recreation sites, and ecotones. Beginning from a primary access point and Marketplace shopping center, a number of existing developed roads and high ground routes move through the brackish marsh of the Central Area. These intersect the primary loop trail, themselves providing a number of shorter length loops in close proximity to future docent staging areas at the storage building on LCWA property accessed from the Marketplace parking lot. Figure 7-35 shows this plan. The CRP shows various trail approaches (loop, connectivity, perimeter); none are specifically proposed, but simply presented for informational purposes. Any of these trails could be deleted from the future plan and not carried forward, as directed by the LCWA.

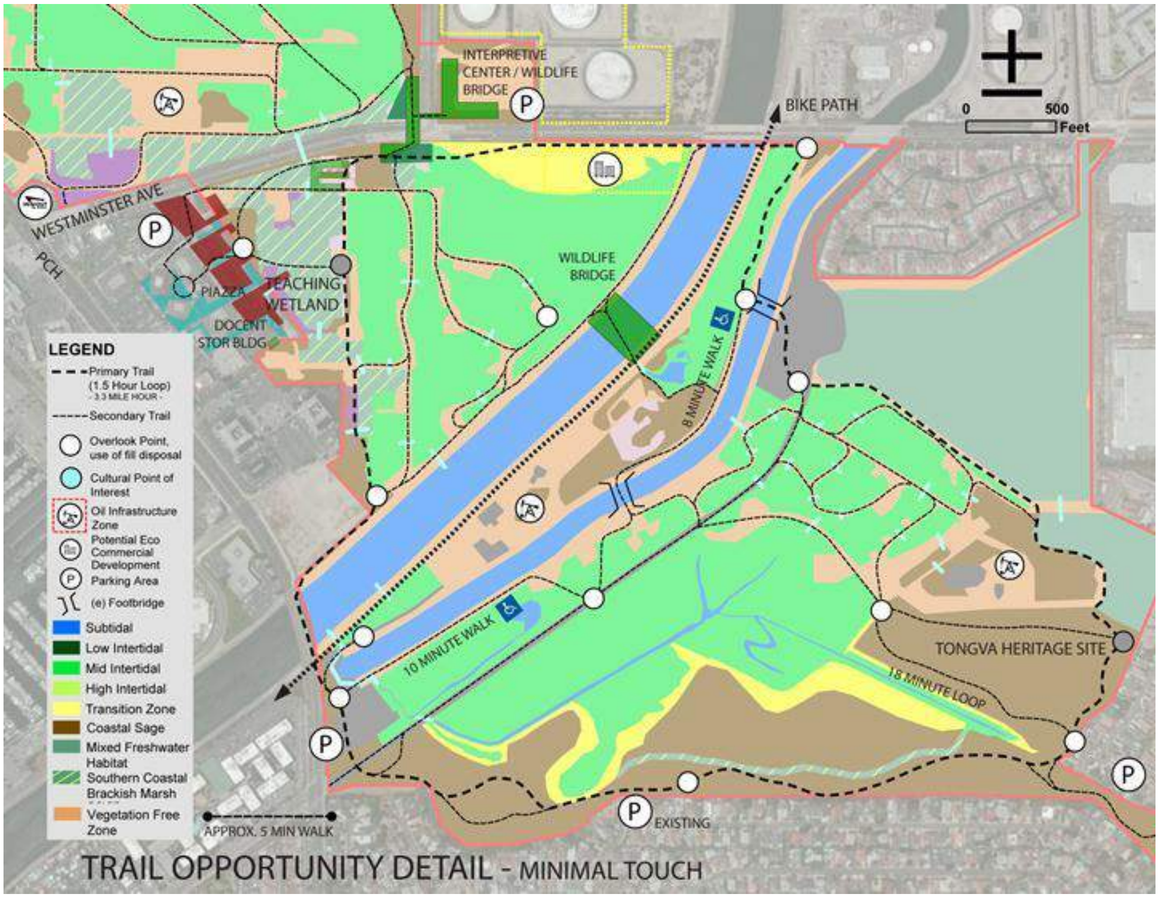


Figure 7-35. Access Plan for Central Area, Isthmus Area, and Southeast Area

The figure shows the potential reworking of the Marketplace parking lot and planter areas, expanding them through filtering bioswales, and providing overlooks linked to the parking areas. It also shows extension into the high ground of the "teaching wetland" created in this area of intensive use and, therefore, significant interpretive and educational value. The Primary Loop Trail occupies an existing oil infrastructure road at this location that divides the high intertidal area from the brackish marsh area. Secondary trails and loops are possible within the Central Area intertidal area, provided by existing oil access roads. This strategy would require enclosures around the oil wells themselves, and given the greater sensitivity of this habitat type might be accessed via gates on docent-led tours only. A major secondary trail would follow the north levee, the elevated position of which lends itself toward overlooks where educational panels would describe the key features of the San Gabriel River on the south side and the restored tidal wetlands on the north. This is a good location to illustrate the functionality and scale of the entire San Gabriel River watershed and the importance of its coastal wetlands. This path might also provide a pedestrian-only alternative to the popular San Gabriel River bike trail on the opposite levee, making for a safer situation by eliminating the current mix of bicycles and pedestrians.

The diagram also shows potential wildlife overpass connecting the large intertidal wetland of the Central Area with that of the Isthmus where the LCW SP is currently located at Zedler Marsh. The overland connection, while not strictly a restoration item, is provided in response to the existing fragmentation of coastal wetland areas. Habitat connectivity was considered of critical importance in the development of the alternatives, and the terrestrial connection will not only provide resilience to two otherwise isolated wetland cells, but will also provide an exceptional interpretive and educational overlook site. Design precedents exist for vegetated overpasses of similar span that combine wildlife and pedestrian trails, as in the proposal for Vail Pass over I-70 in Colorado, shown in Figure 7-36 below.

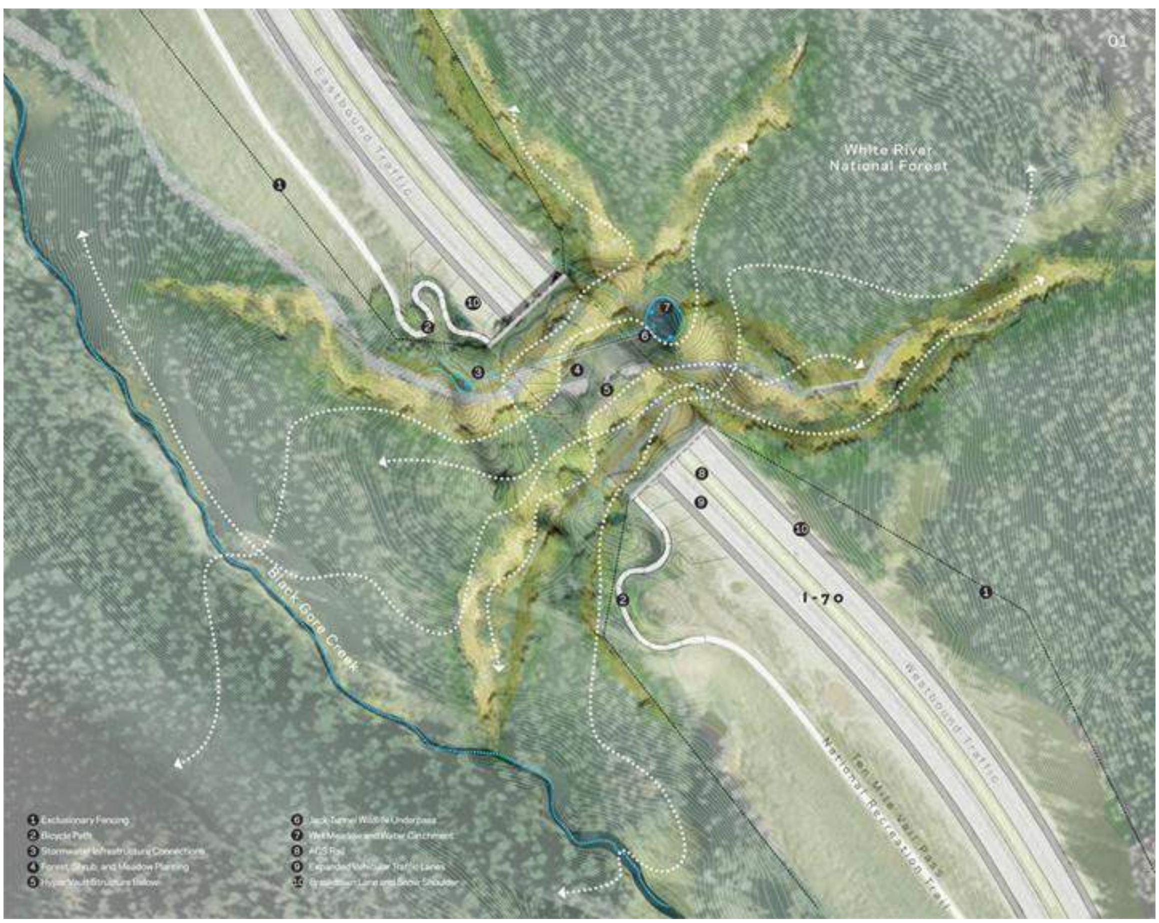


Figure 7-36. Wildlife Overcrossing Concept for the Rocky Mountains

The Primary Loop Trail reaches the Isthmus Area via a proposed upgrade of the existing HCC bridge, shown in Figure 7-36 on the previous page. The bridge alignment faces the center of the proposed high intertidal area to the north, and to the south connects the Primary Loop trail to the north portion of the Southeast Area, following the levee of the retention basin, past the HP treatment wetland area, ultimately connecting to the Tongva Heritage trail. As in the north, the oil operations roads offer numerous smaller loop trails and interior access opportunities, including a second existing footbridge provided that exclusionary fencing is limited to well sites and critical infrastructure. This would be the lowest cost approach to providing public access.

From the Tongva Heritage trail, access to and from HP neighborhood and associated public parking is available. Continuing along the Primary Loop Trail clockwise from here along the southern boundary of the Southeast Area, the major neighborhood access at Gum Grove Park is connected. In this potentially high traffic area, the Primary Loop Trail has been routed primarily through uplands to minimize impact to restored tidal wetland areas, but does provide some points of contact and overlook at the southwestern tidal lobes in this design. Continuing clockwise, the Primary Loop Trail intersects an upland parcel where major parking/trailhead and secondary interpretive center location is possible, then follows PCH bridge to the northern levee of the San Gabriel River, which it follows east before turning north to complete the loop at the Marketplace shopping center.

In conclusion, the Minimum Alteration Alternative PAP provides the most options for low first-cost access trails, provided coordination with oil operations will allow for safe use. Unlike the other two alternatives, in spite of these many trail opportunities, this restoration alternative does not offer the direct connectivity of commercial and residential area.

7.2.5 Hydrology

The important hydrologic parameters for the marsh are tidal elevations over time, ranges, and inundation frequencies. Modeling results yield the tidal elevations over time used to calculate the other important parameters. Each alternative will also require hydrology and hydraulics analysis to determine the potential flood impact on the surrounding properties and required level of flood protection. Flood protection mitigation measures must be incorporated as part each alternative.

Tidal Elevations and Ranges

Tidal elevations are the basic data of water levels over time and space that control tidal hydrology at a site. Quantifying tidal elevations allows assessment of the hydraulic efficiency of tidal connections and specific tidal ranges and tidal inundation frequency.

Existing Conditions

Existing tidal elevations were determined by both measuring tides (at LCWA Phase II, Zedler Marsh, and Steam Shovel Slough) and obtaining data from others (HCC). Existing tides are shown in Table 7-6. Note that several sites within the complex do not possess daily tidal fluctuations at this time because they are not adequately connected to sources of seawater.

Only the Northern Area possesses a full tide range and that occurs at Steam Shovel Slough. All other sites within the LCW possess either no effective tidal connection or a muted tidal range. The two sites with muted tides are Zedler Marsh at the Isthmus and the LCWA Phase II site (former Hellman) at the Southeast Area.

Table 7-6. Existing Spring Tidal Elevations and Ranges at the LCW Complex

Site Within the LCW	Specific Location on the Site	Existing Sea Level (No Rise)			1.5' Sea Level Rise			5.5' Sea Level Rise		
		High	Low	Range	High	Low	Range	High	Low	Range
Northern	Steam Shovel Slough	4.3	-3.9	8.2	5.8	-2.5	8.3	9.8	1.5	8.3
	LCWP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Central	LCWA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Isthmus	Zedler Marsh	4.1	0.7	3.5	5.2	0.8	4.4	7.6	3.8	3.8
	Callaway*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Southeast	Phase II	3.4	-0.4	3.8	4.3	0.1	4.2	7.4	4.3	3.1
	Phase II Future	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* Callaway Marsh is not effectively tidally-connected at this time, but it does receive some backwater during spring tides.

N/A refers to "not applicable" due to the respective sites not possessing any effective tidal influence at this time.

Alternative 1 – Minimum Alteration, Existing Sea Level

Tides simulated for Alternative 1 are shown in Table 7-7. All sites within the complex would possess daily tidal fluctuations as they would be adequately connected to sources of seawater. Similar to the existing condition, only the Northern Area possesses a full tide range and that occurs at Steam Shovel Slough. All other sites within the LCW possess a muted tidal range. Muted tidal conditions result from culvert connections serving as the means for tidal conveyance. Although a significant effort was made to maximize tidal ranges at each site, limitations of culverts and existing constraints of ground surface elevations and oil operations limited resulting tides for this alternative. One design assumption for Alternative 1 is to minimize site changes, including earthwork. Therefore, only a limited tidal range can exist on-site under this condition.

Table 7-7. Alternative 1 Spring Tidal Elevations and Ranges

Site Within the LCW	Specific Location on the Site	Existing Sea Level (No Rise)			1.5' Sea Level Rise			5.5' Sea Level Rise		
		High	Low	Range	High	Low	Range	High	Low	Range
Northern	Steam Shovel Slough	4.3	-3.9	8.2	5.8	-2.5	8.3	9.8	1.5	8.3
	Remaining Oil Field	4.1	1.3	2.8	5.7	1.5	4.2	9.7	2.1	7.6
Central	LCWA Phase I	3.8	2.0	1.8	4.8	2.0	2.8	8.1	4.8	3.3
Isthmus	Zedler Marsh	4.1	0.7	3.5	5.2	0.8	4.4	7.6	3.8	3.8
	Callaway Marsh	4.2	1.0	3.2	5.5	1.0	4.5	8.1	2.0	6.1
Southeast	LCWA Phase II	3.4	-0.4	3.8	4.3	0.1	4.2	7.4	4.3	3.1
	Phase II Future	3.5	-1.0	4.5	4.5	-0.4	4.9	7.9	4.1	3.8

Alternative 1 – Minimum Alteration, SLR

Tide ranges and elevations increase at every site with SLR of 1.5 feet. This result indicates that culverts are sufficient in size to convey the increased volume of seawater between tide cycles.

Further SLR of 5.5 feet results in mixed conditions of some sites experiencing increased tidal ranges and other sites experiencing reduced tidal ranges compared to existing sea level conditions. The entire Southeast Area, and Zedler Marsh at the Isthmus experience reduced tidal ranges for SLR of 5.5 feet as compared to SLR of 1.5 feet. Only the Southeast Area experiences a reduced tidal range with 5.5 feet of SLR compare to existing conditions. This mixed result is due to increase tidal volumes at each site having to pass through fixed culvert cross-sections. Therefore, under SLR of 5.5 feet the tidal conveyance of culverts at Zedler Marsh and the Southeast Area limits the volume of seawater exchange to and from each area and the tidal range becomes compressed.

Appropriate measures to consider for achieving increased tidal ranges in the future at these sites for this alternative are to: 1) increase the number of culverts to existing seawater sources; 2) increase the sizes of culverts to existing seawater sources; 3) change the invert elevation of the culverts, and/or 4) a combination of both approaches. Zedler Marsh is proposed to be connected to the San Gabriel River with the existing culvert, and it could either be replaced with a larger one or it could be supplemented with an additional culvert. The LCWA Phase II site at the Southeast Area is proposed to be connected to the San Gabriel River with three culverts. Alternatively, this site could be connected to the HCC with an open channel to provide unconstrained tidal conveyance in the future.

Tidal Inundation Frequency

Tidal inundation frequency analyses were performed with tidal hydraulic modeling results. Inundation frequency is the percentage of time that the tidal elevation exceeds a certain elevation. It is an important factor for habitat design and distribution because the plants become established at particular inundation frequencies. The first set of plots addresses the Northern Area at Steam Shovel Slough for Alternatives 1, 2 and 3 under existing sea level, and under future SLR of 1.5 feet and 5.5 feet. The existing hydrology of Steam Shovel Slough will not be modified by dredging or grading for any alternative, so the condition discussed below pertains to all alternatives. These data show the best possible case of tidal inundation frequency of a full tidal system at the LCW. Other areas will not achieve this ideal condition, but it is provided here for reference in analyzing other sites. Remaining plots show all other areas under the same sea level conditions for Alternative 1. Each scenario is described for each area below.

Northern Area, Steam Shovel Slough, Existing Sea Level

Figure 7-37 shows the tidal inundation frequency curve for Steam Shovel Slough in comparison to other full tidal systems nearby at Alamitos Bay and the lower San Gabriel River. The curves lie nearly on top of one another, which indicates that the different habitat types shown on the graph lie at approximately the same elevations at each area. Therefore, habitat areas at Steam Shovel Slough have become established at appropriate elevations relative to the tides. The range of elevations for salt marsh habitat is relatively unrestricted. At this location, the elevation range of wetland habitat is from +4.2 feet to -4.0 feet NGVD. This elevation range is subdivided into the following increments for habitat:

- Subtidal habitat – below -4.0 feet NGVD;
- Unvegetated intertidal habitat (mudflat) – Between -4.0 feet and +0.8 feet NGVD;
- Vegetated low intertidal habitat (cordgrass) – Between +0.8 feet and +1.4 feet NGVD;
- Vegetated mid-intertidal habitat (pickleweed) – Between +1.4 feet and +3.4 feet NGVD;
- Vegetated high-intertidal habitat (pickleweed) – Between +3.4 feet and +4.2 feet NGVD; and.

- Supra-tidal habitat – Above +4.2 feet NGVD.

All elevations above +4.2 feet are occupied by habitat that is broadly classified as either transitional or upland in this study. The distinction between transitional and upland habitats is that the elevation range for transitional is 2 feet above the highest high tide, or in this instance from +4.2 feet to +6.2 feet NGVD. All habitat above transitional, or above +6.2 feet NGVD, is classified as upland in this study.

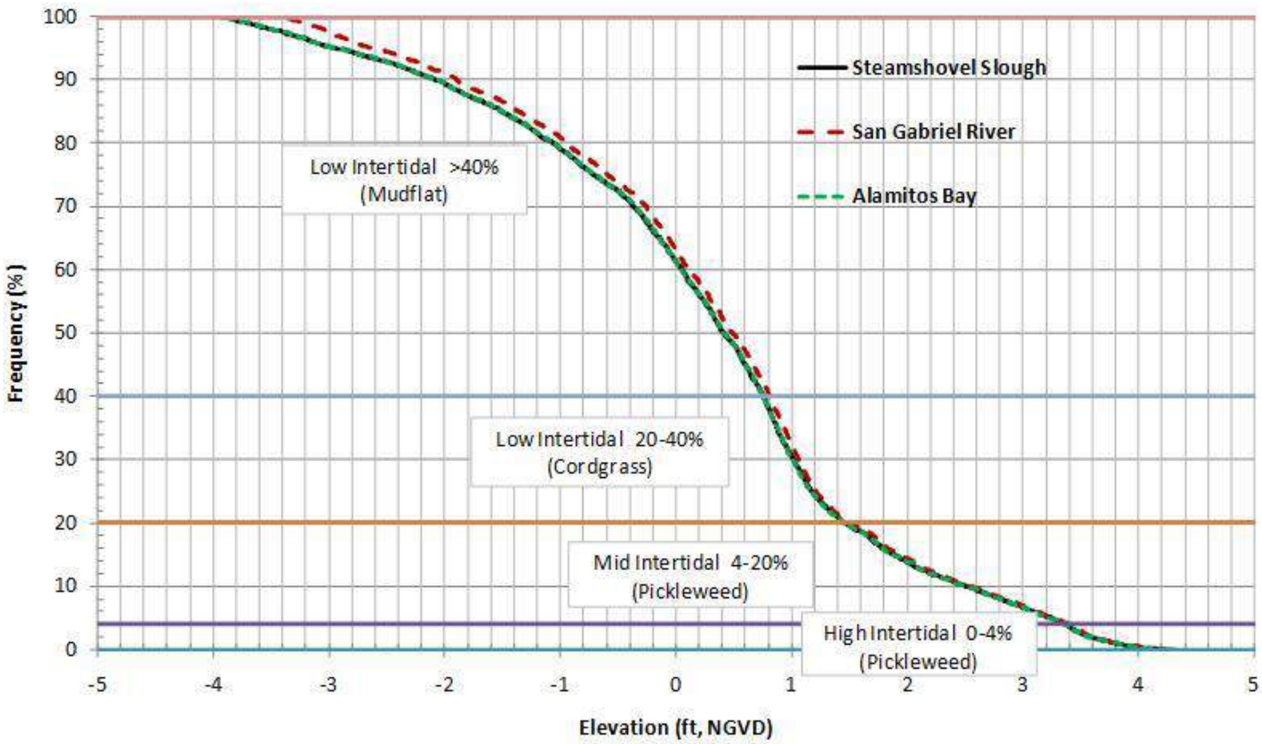


Figure 7-37. Tidal Inundation Frequency at the Northern Area, Steam Shovel for All Alternatives, Existing Sea Level

Figure 7-38 and Figure 7-39 show the same data at Steam Shovel Slough but SLR scenarios of 1.5 feet and 5.5 feet above existing sea level. The curves are similar in that they retain the same shape, but shift upward with sea level. The relative condition of full tidal habitats is conserved, but their elevations increase as water levels increase.

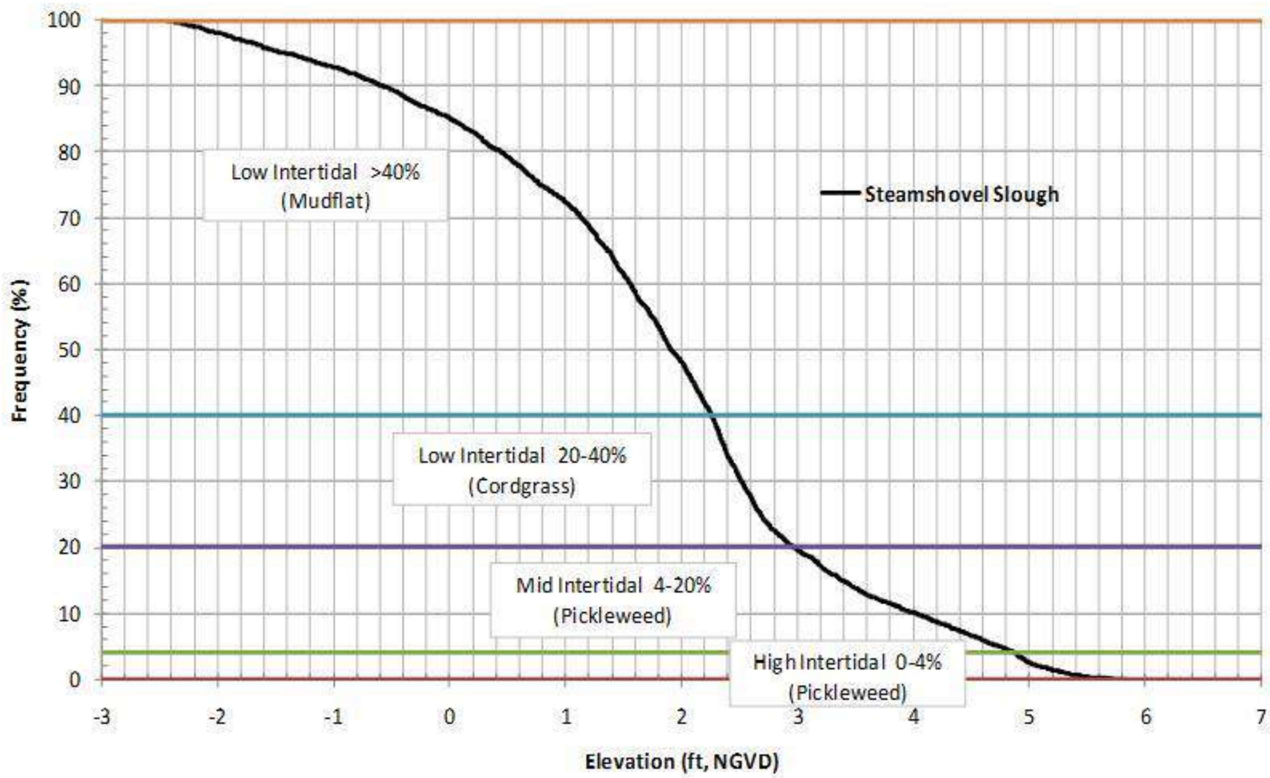


Figure 7-38. Tidal Inundation Frequency at the Northern Area, Steam Shovel for All Alternatives, SLR of 1.5 Feet

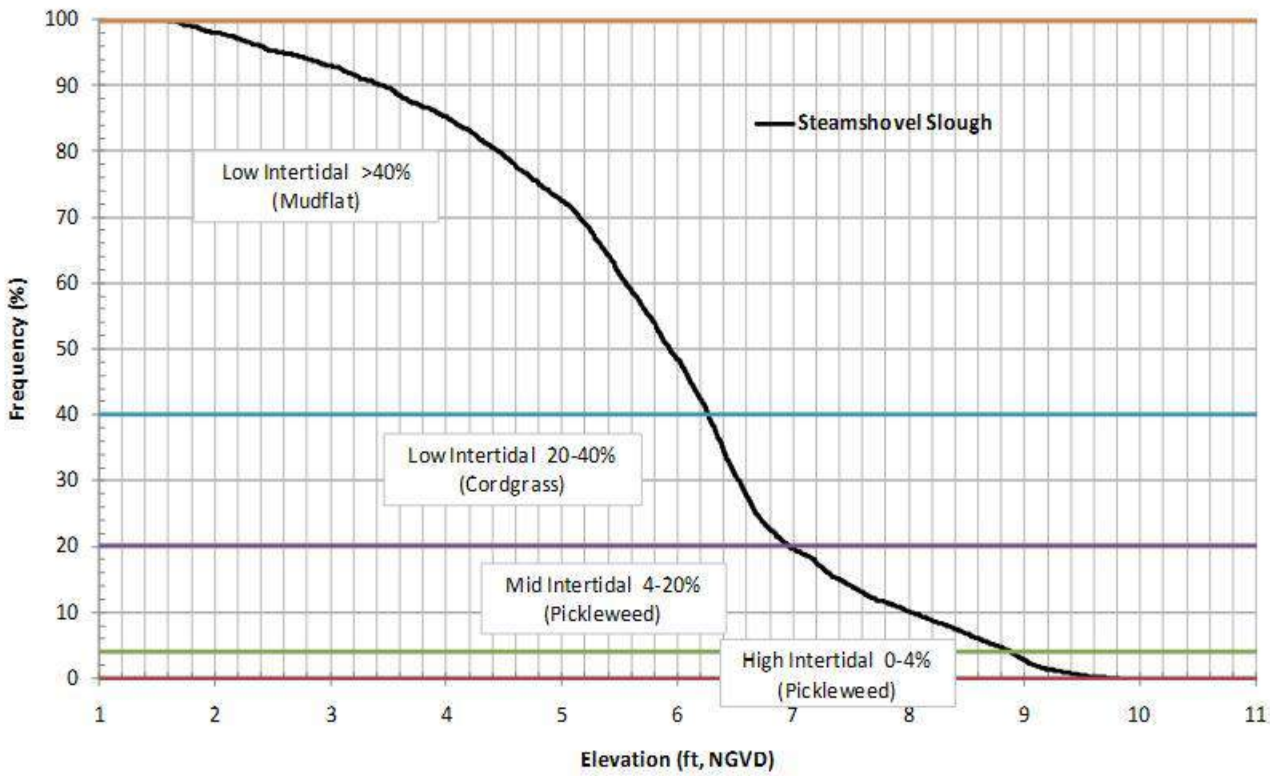


Figure 7-39. Tidal Inundation Frequency at the Northern Area, Steam Shovel for All Alternatives, SLR of 5.5 Feet

Northern Area, Remaining Oil Field, Alternative 1, Existing Sea Level

Figure 7-40 shows the tidal inundation frequency curve for existing sea level conditions at the remaining oil field in the Northern Area. The range of elevations for salt marsh habitat is severely limited in all areas, except in the most northwestern corner nearest to the connection with Steam Shovel Slough. At that location, the range is from +4.2 feet to -1.8 feet NGVD. In the center of the oil field site, the marsh ranges from +4.2 feet to between approximately +1 and +1.5 feet. In the most distant portions of the site, the marsh ranges from +4.2 feet to +3.0 feet.

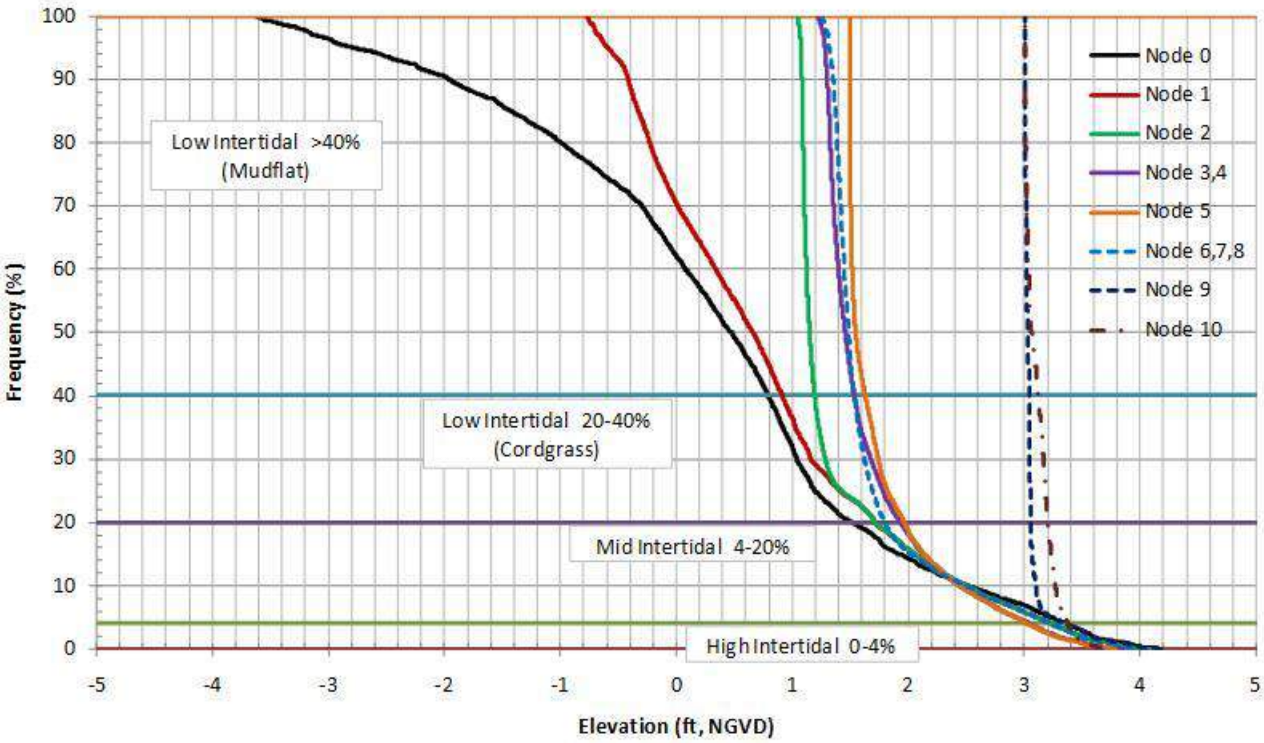


Figure 7-40. Tidal Inundation Frequency at the Northern Area, Remaining Oil Field for Alternative 1, Existing Sea Level

Northern Area, Remaining Oil Field, Alternative 1, Sea Level Rise of 1.5 Feet and 5.5 Feet

Figure 7-41 shows conditions under SLR of 1.5 feet. The range of elevations for salt marsh habitat is still limited in all areas, with less limitation in the most northwestern corner nearest to the connection with Steam Shovel Slough. At that location, the range is from +5.7 feet to -0.1 feet NGVD. In the center of the oil field site, the marsh ranges from +5.6 feet to between approximately +1.2 and +2.0 feet. In the most distant portions of the site, the marsh ranges from +5.6 feet to +3.1 feet. Most areas have a broader vertical range of habitats for this condition than for existing sea level, which would normally be beneficial. However, the ground elevations at this site are limited to a narrow vertical range (the site is broad, flat, and low), so expanding the vertical range of habitats does not provide associated benefits. Benefits would be incurred if the site possessed an area of transitional habitat at a higher elevation than the existing habitat.

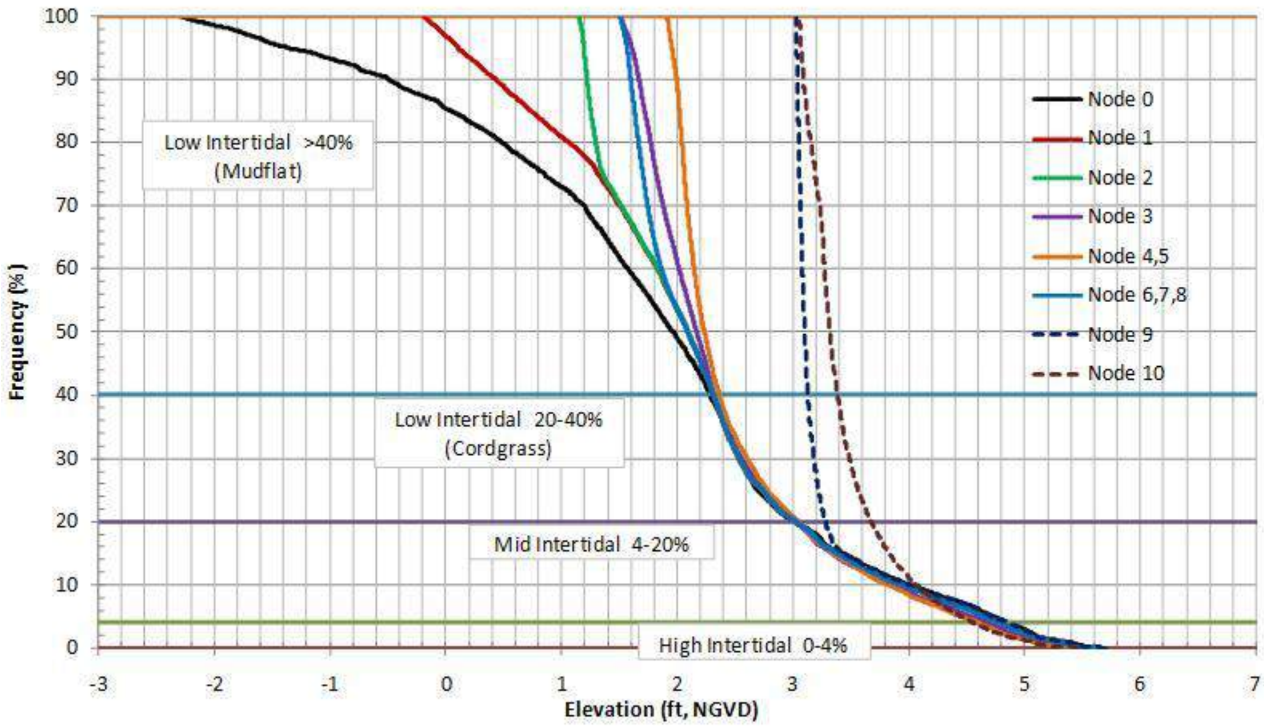


Figure 7-41. Tidal Inundation Frequency at the Northern Area, Remaining Oil Field for Alternative 1, SLR of 1.5 Feet

Figure 7-42 shows conditions under SLR of 5.5 feet. The range of elevations for salt marsh habitat changes significantly and most of the site possesses a similar range of habitat elevations. All areas have a broader vertical range of habitats for this condition than for existing sea level. The exception is the most distant reach of the site that has a compressed vertical habitat range by 2 feet from the rest of the site. Over the majority of the site the range is from +9.6 feet to between +2.0 and +3.3 feet NGVD. At the most distant portions of the site, the marsh ranges from +9.6 feet to +3.8 feet. As the ground elevations at this site are limited to a narrow vertical range (the site is broad, flat, and low), expanding the vertical range of habitats does not provide associated benefits. Benefits would be incurred if the site possessed an area of transitional habitat at a higher elevation than the existing habitat.

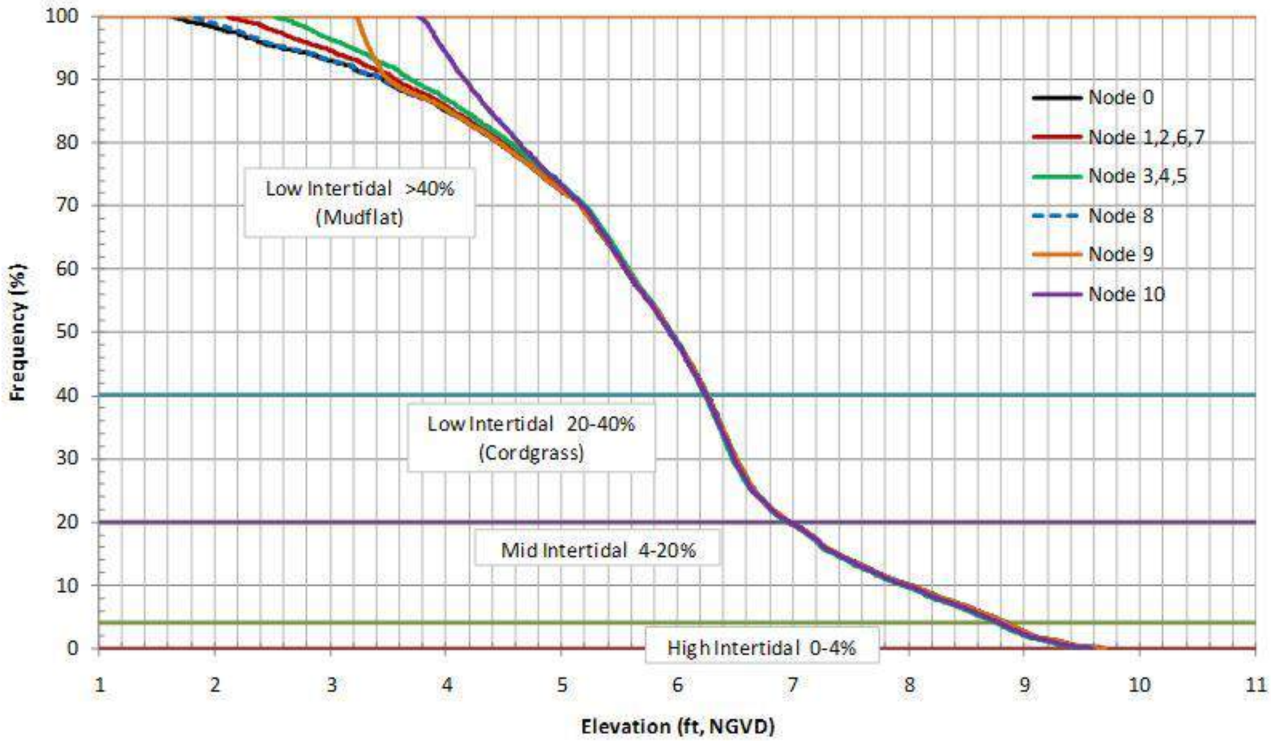


Figure 7-42. Tidal Inundation Frequency at the Northern Area, Remaining Oil Field for Alternative 1, SLR of 5.5 Feet

Central Area, Alternative 1, Existing Sea Level

Figure 7-43 shows the tidal inundation frequency curve for existing sea level conditions at the Central Area. Node 0 represents the San Gabriel River as the source of seawater. The range of elevations for salt marsh habitat is severely limited in all areas. The marsh ranges in elevation from +3.8 feet to +1.0 feet NGVD (the culvert invert to the San Gabriel River is at +1.0 feet NGVD and dictates the lowest habitat elevation at the site). In the most distant portions of the site, the marsh ranges from +3.6 feet to +2.9 feet. The limited vertical range of habitats is due to the limitations of the culvert connection to the San Gabriel River, and to the site's relatively high elevation and relatively flat surface. Alternative 1 proposes minimal surface modification, so no channel network would exist to provide lower habitat elevations. This alternative simply envisions connecting existing wetland cells with culverts under existing roads. Habitat elevation ranges could be increased with more or larger culverts, placed at lower elevations to accompany on-site creation of a channel network.

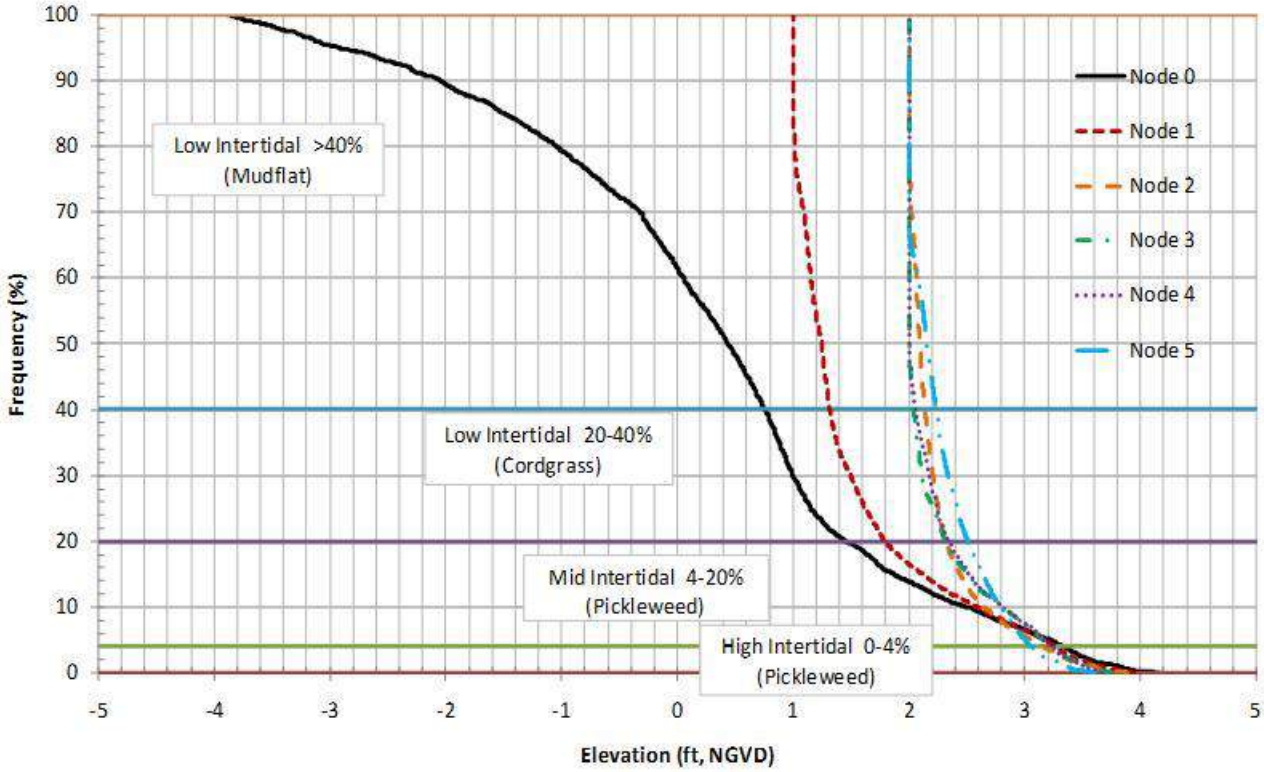


Figure 7-43. Tidal Inundation Frequency at the Central Area for Alternative 1, Existing Sea Level

Central Area, Alternative 1, SLR of 1.5 Feet and 5.5 Feet

Figure 7-44 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Central Area. The range of elevations for salt marsh habitat is still limited in all areas, but to a lesser extent than existing sea level conditions. The marsh ranges in elevation from +5.2 feet to +1.3 feet NGVD. In the most distant portions of the site, the marsh ranges from +5.0 feet to +2.2 feet. The same limitations and potential remedies apply for this situation as compared to existing conditions.

Figure 7-45 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Central Area. The range of elevations for salt marsh habitat remains limited in all areas, but to a lesser extent than both existing sea level conditions and with SLR of 1.5 feet. The marsh ranges in elevation from +8.8 feet to +4.0 feet NGVD. In the most distant portions of the site, the marsh ranges from +7.9 feet to +5.0 feet. The same limitations and potential remedies apply for this situation as compared to existing conditions and with SLR of 1.5 feet.

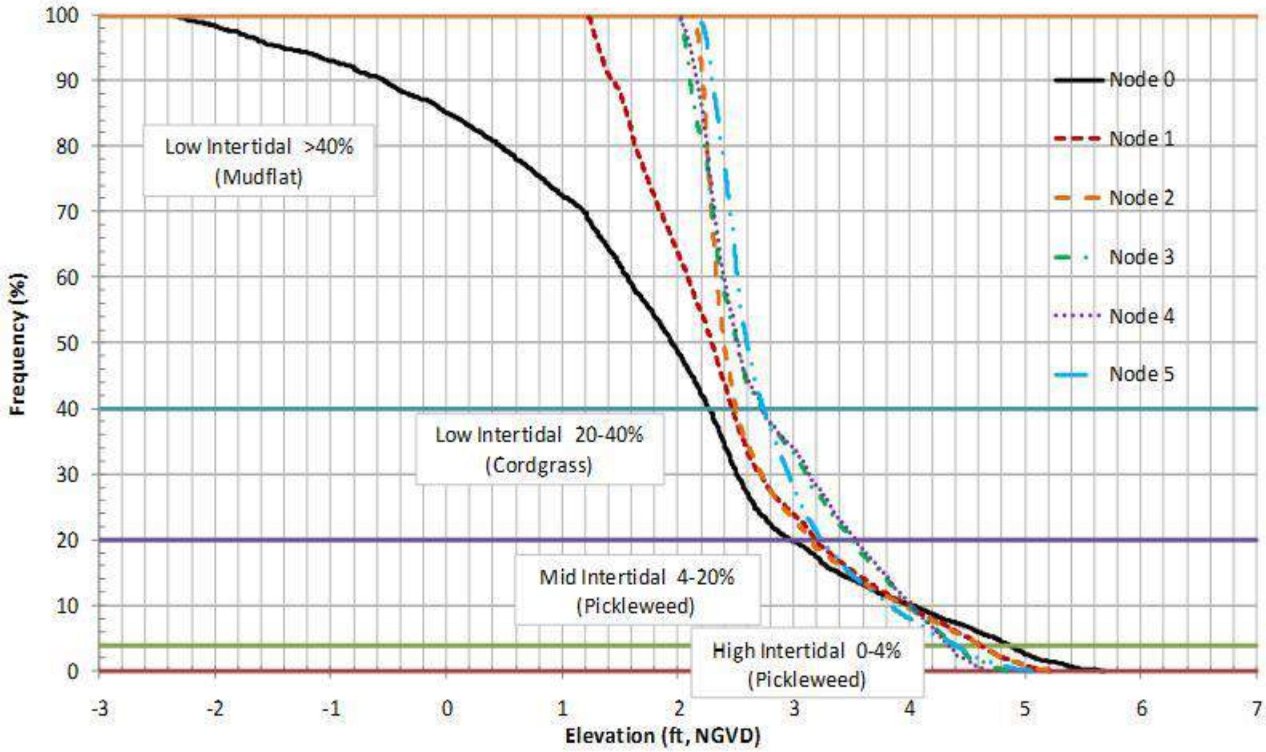


Figure 7-44. Tidal Inundation Frequency at the Central Area for Alternative 1, SLR of 1.5 Feet

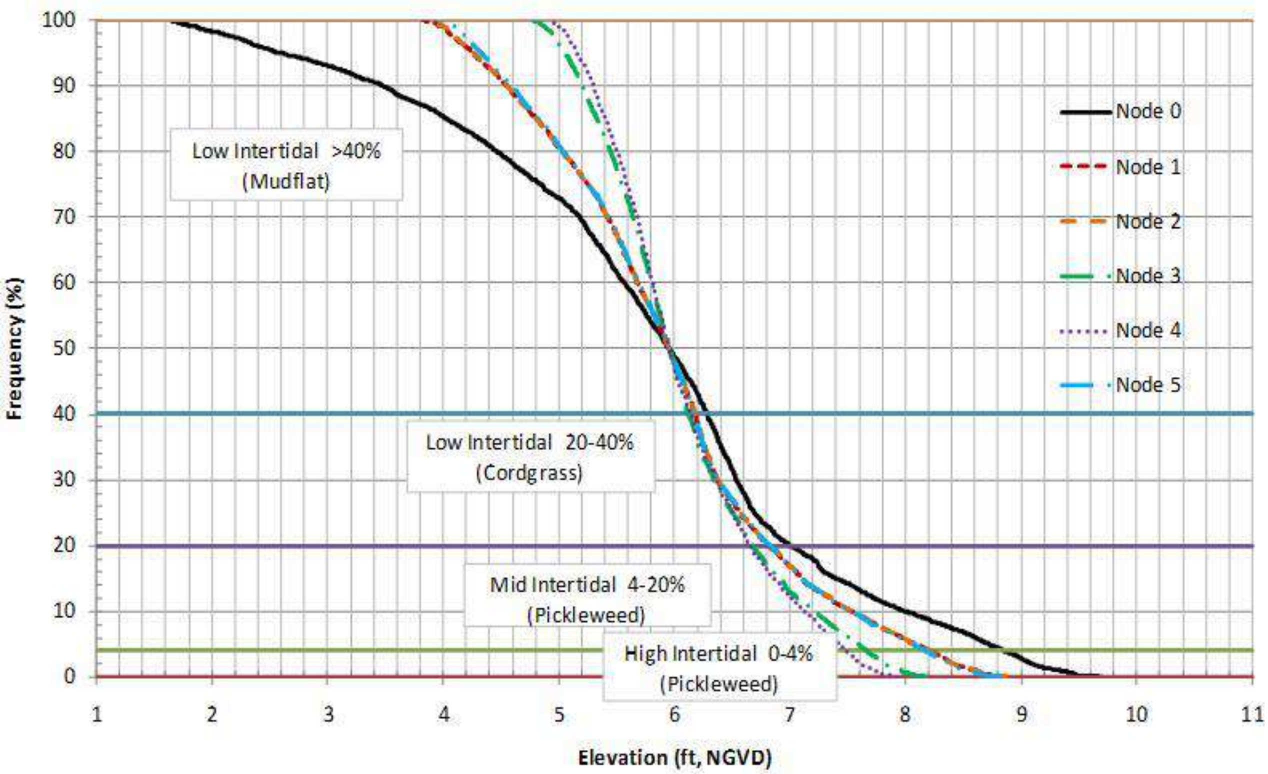


Figure 7-45. Tidal Inundation Frequency at the Central Area for Alternative 1, SLR of 5.5 Feet

Isthmus (Zedler and Callaway Marshes), Alternative 1, Existing Sea Level

Figure 7-46 shows the tidal inundation frequency curve for existing sea level conditions at Zedler and Callaway Marshes on the Isthmus. The San Gabriel River is the source of seawater. The ranges of elevations for salt marsh habitat are limited to +3.8 feet to +1.0 feet NGVD at both marshes, with slightly lower mudflat at Zedler Marsh as compared to Callaway Marsh due to a slightly lower culvert. The limited vertical ranges of habitats are due to the limitation of the culvert connections to the San Gabriel River, with the invert at Callaway Marsh being at +1.0 feet NGVD and the culvert at Zedler Marsh being at +0.5 feet NGVD. Habitat elevation ranges could be increased with lower and possibly larger culverts at each site, respectively.

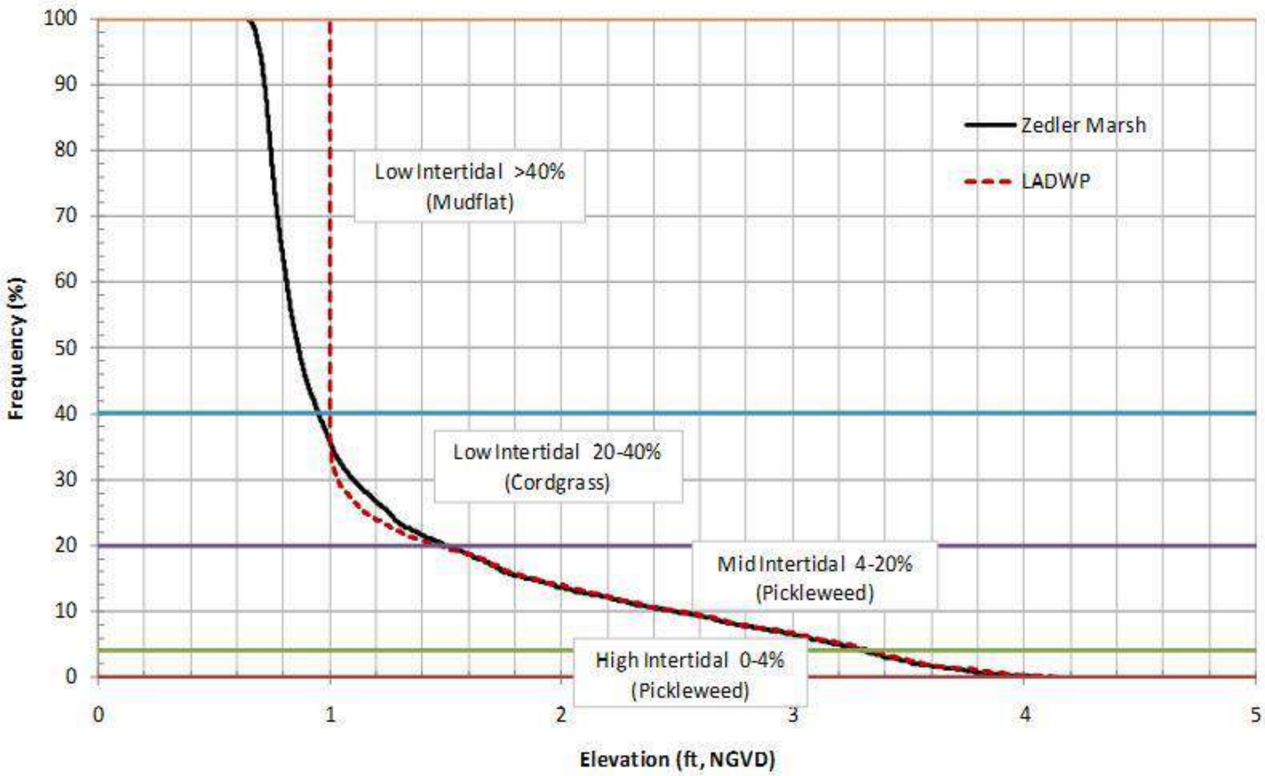


Figure 7-46. Tidal Inundation Frequency at the Central Area for Alternative 1, Existing Sea Level

Isthmus (Zedler and Callaway Marshes), Alternative 1, SLR of 1.5 Feet and 5.5 Feet

Figure 7-47 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at Zedler and Callaway Marshes on the Isthmus. The range of elevations for salt marsh habitat is still limited, but to a lesser extent than for existing sea level conditions. The marsh ranges in elevation from +5.2 feet to +0.8 feet NGVD. The same limitations and potential remedies apply for this situation as compared to existing conditions.

Figure 7-48 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at Zedler and Callaway Marshes on the Isthmus. The range of elevations for salt marsh habitat remains limited in all areas, but to a lesser extent than both existing sea level conditions and with SLR of 1.5 feet. The marsh ranges in elevation from +7.6 feet to +4.0 feet NGVD at Zedler. Tides range a bit more at Callaway Marsh because of its smaller area and tidal prism compared to Zedler. The reduced seawater volume at Callaway is able to pass through the culvert efficiently during a spring tidal cycle. The same limitations and potential remedies apply for this situation as compared to existing conditions and with SLR of 1.5 feet, with the possible addition of a larger culvert to Zedler Marsh to convey the increased tidal prism possessed at the site as compared to Callaway Marsh.

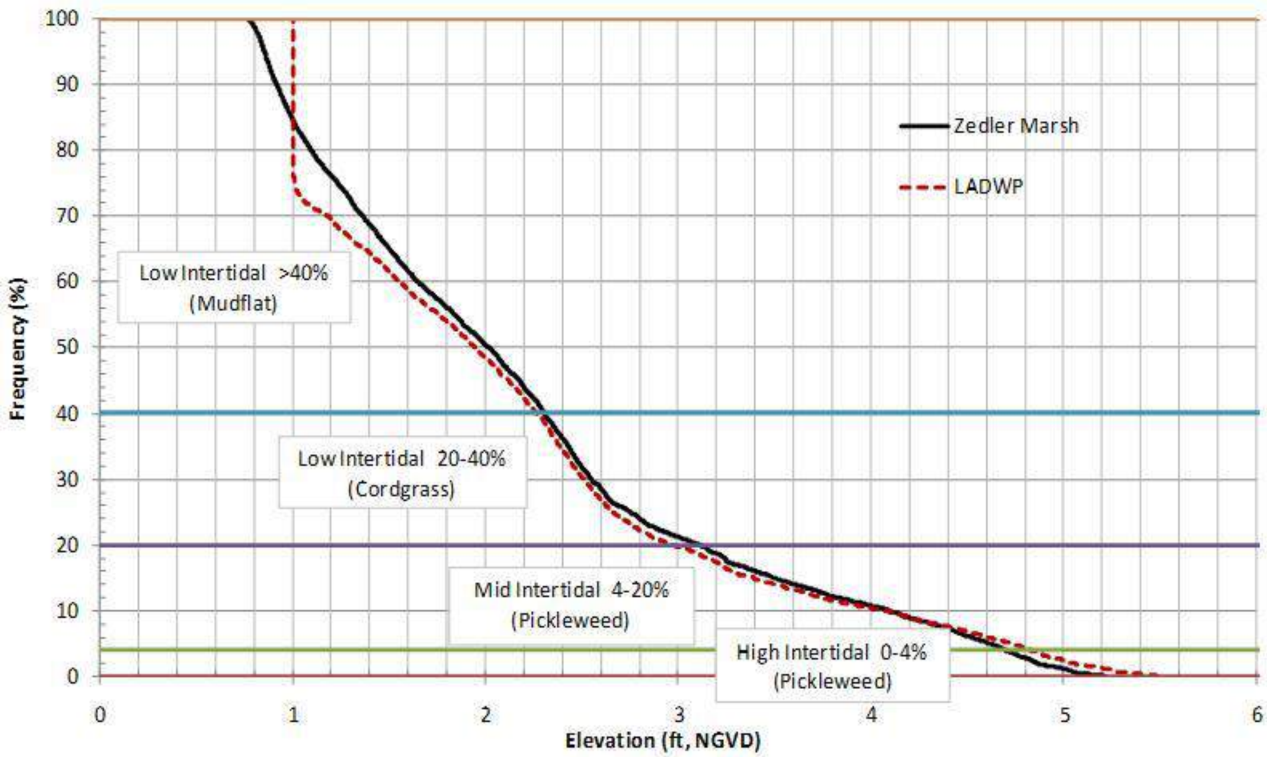


Figure 7-47. Tidal Inundation Frequency at the Isthmus for Alternative 1, SLR of 1.5 Feet

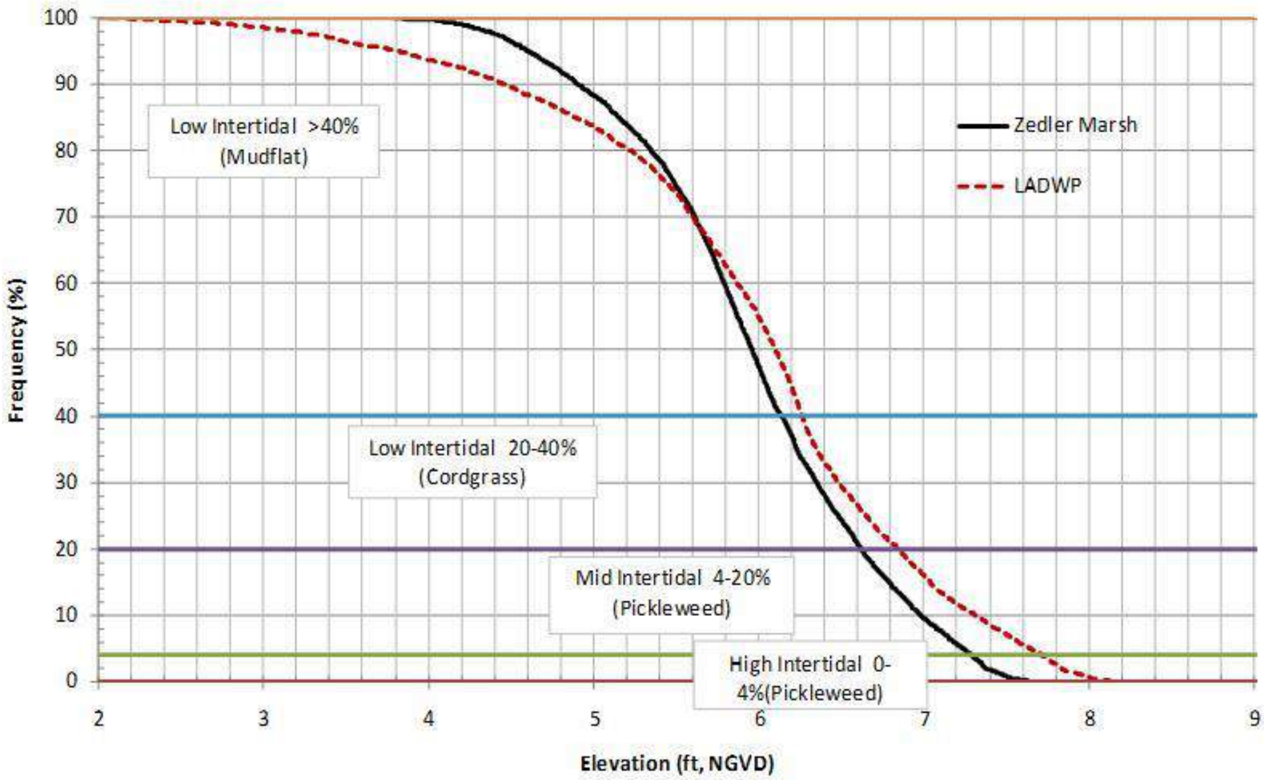


Figure 7-48. Tidal Inundation Frequency at the Isthmus for Alternative 1, SLR of 5.5 Feet

Southeast Area, Alternative 1, Existing Sea Level

Figure 7-49 shows the tidal inundation frequency curve for existing sea level conditions at the Southeast Area. Node 0 represents the San Gabriel River as the source of seawater. The range of elevations for salt marsh habitat is limited in all areas. The marsh ranges in elevation from +3.5 to -0.9 feet NGVD over the majority of the site, and from +3.9 feet to -1.7 feet NGVD at the area closest to the HCC connection. The limited vertical range of habitats is due to the limitations of the culvert connection to the San Gabriel River, and to the site’s relatively high elevation and relatively flat surface. The culvert invert to the HCC is at -3.0 feet NGVD while the culvert to the San Gabriel River is at -1.0 feet NGVD, and these dictate the lowest habitat elevation at the site. Alternative 1 proposes minimal surface modification, but the designer had to assume some measure of minor grading to lower the site sufficiently in the Phase II area to provide the desired mid-marsh habitat on-site. Habitat elevation ranges could be increased with more or larger culverts.

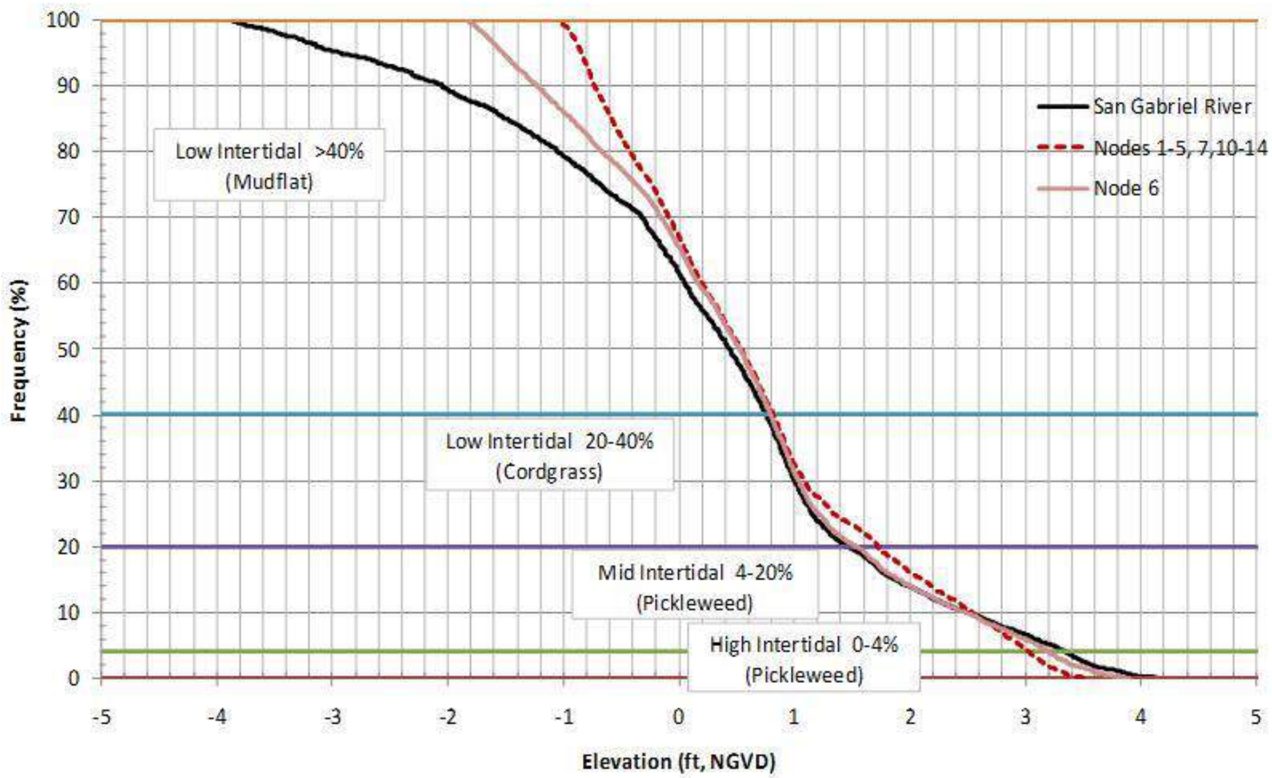


Figure 7-49. Tidal Inundation Frequency at the Southeastern Area for Alternative 1, Existing Sea Level

Southeast Area, Alternative 1, SLR of 1.5 Feet and 5.5 Feet

Figure 7-50 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Southeast Area. The range of elevations for salt marsh habitat is still limited in all areas, but to a lesser extent than existing sea level conditions. The majority of marsh ranges in elevation from +4.5 feet to -0.2 feet NGVD. Nearest the HCC, the marsh ranges in elevation from +5.3 to -0.9. The shape of the curves is more similar to an unrestricted tidal curve. The same limitations and potential remedies apply for this situation as compared to existing conditions.

Figure 7-51 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Southeast Area. The range of elevations for salt marsh habitat remains limited in all areas to a lesser extent than existing sea level conditions, but to a greater extent than with SLR of 1.5 feet. The marsh ranges in elevation from +7.7 feet to +4.3 feet NGVD. In the most distant portions of the site, the marsh ranges from +8.9 feet to +2.7 feet. The same limitations and potential remedies apply for this situation as compared to existing conditions and with SLR of 1.5 feet. The reason that SLR of 5.5 feet causes tidal ranges to compress compared to the 1.5 foot SLR scenario is that more water volume is being forced through relatively small culverts to the Phase II area. If the culvert to the San Gabriel River were enlarged, then tidal ranges would expand the range of habitats vertically.

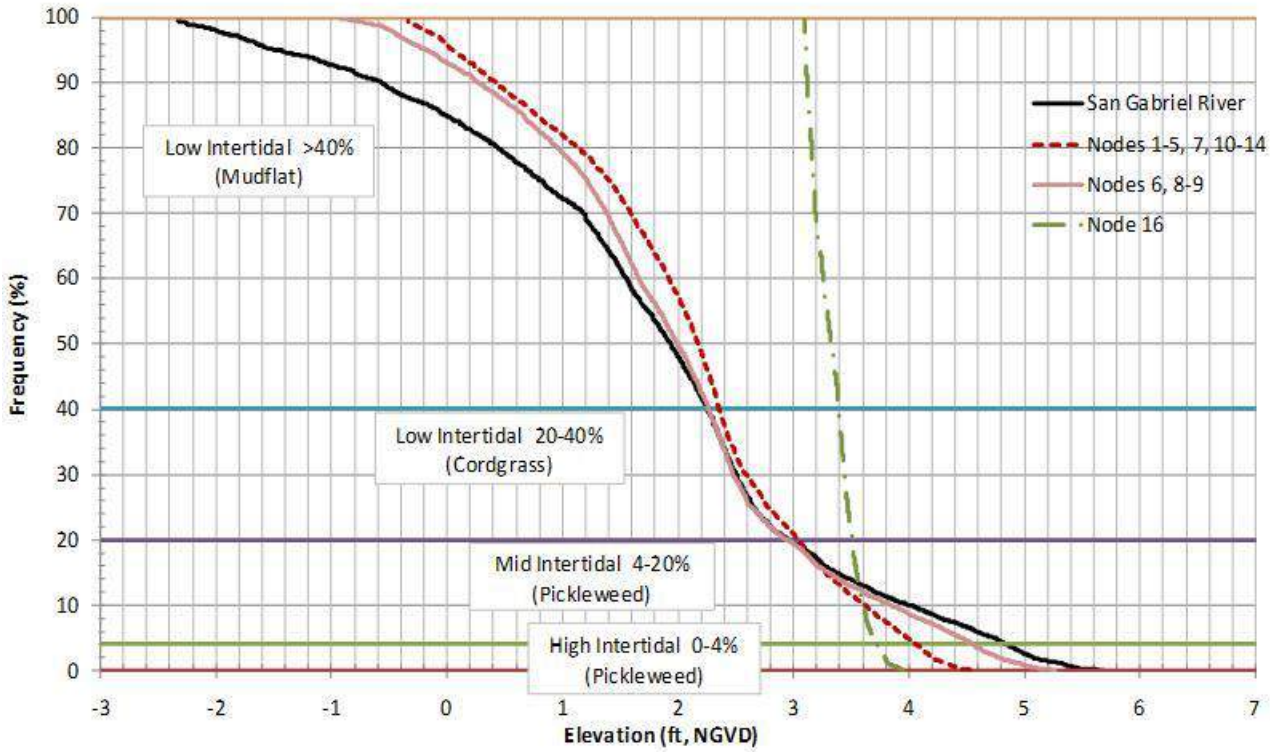


Figure 7-50. Tidal Inundation Frequency at the Central Area for Alternative 1, SLR of 1.5 Feet

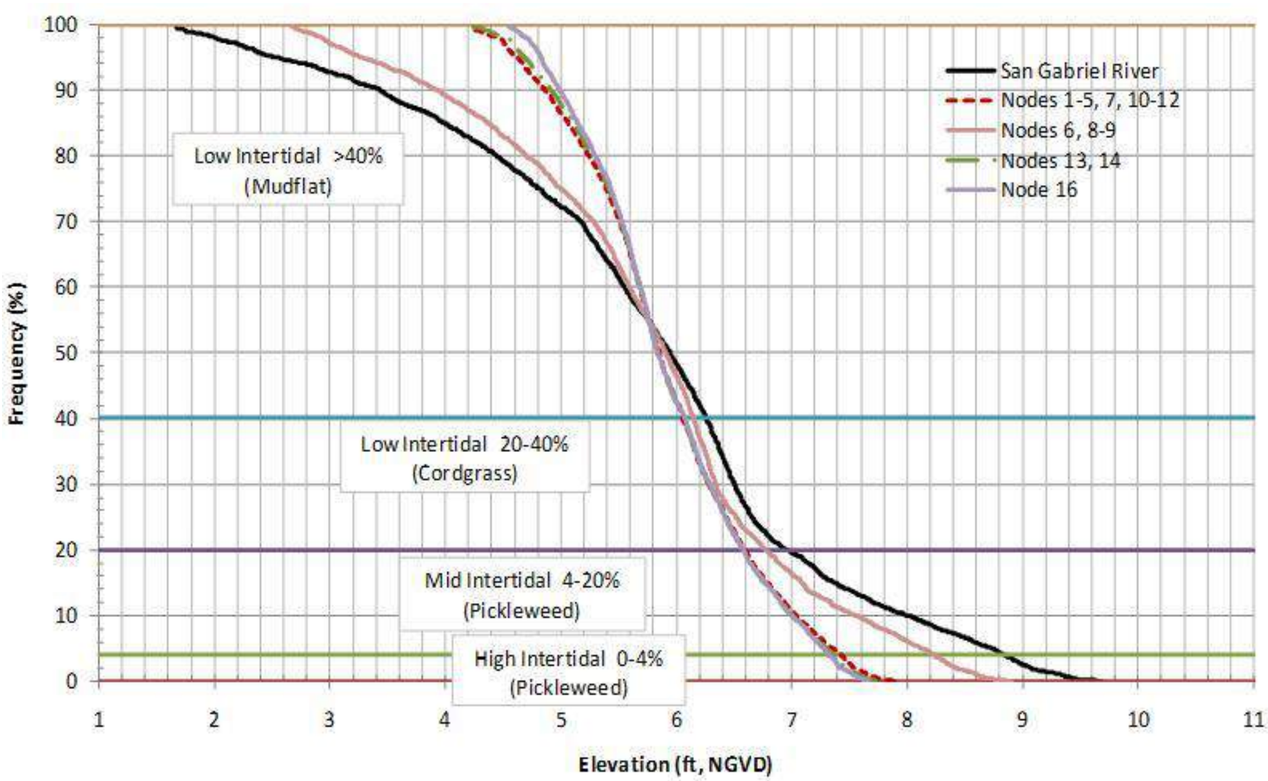


Figure 7-51. Tidal Inundation Frequency at the Central Area for Alternative 1, SLR of 5.5 Feet

The results of the tidal inundation frequency analyses are predicted habitat elevation bands for the alternatives. The analyses indicate the elevation ranges where habitat should occur, and these are shown on the grading plans that set elevations. Figure 7-52 through Figure 7-63 show the areas to be occupied by each habitat category under the three water level conditions of existing sea level, and SLR of 1.5 feet and 5.5 feet, respectively.

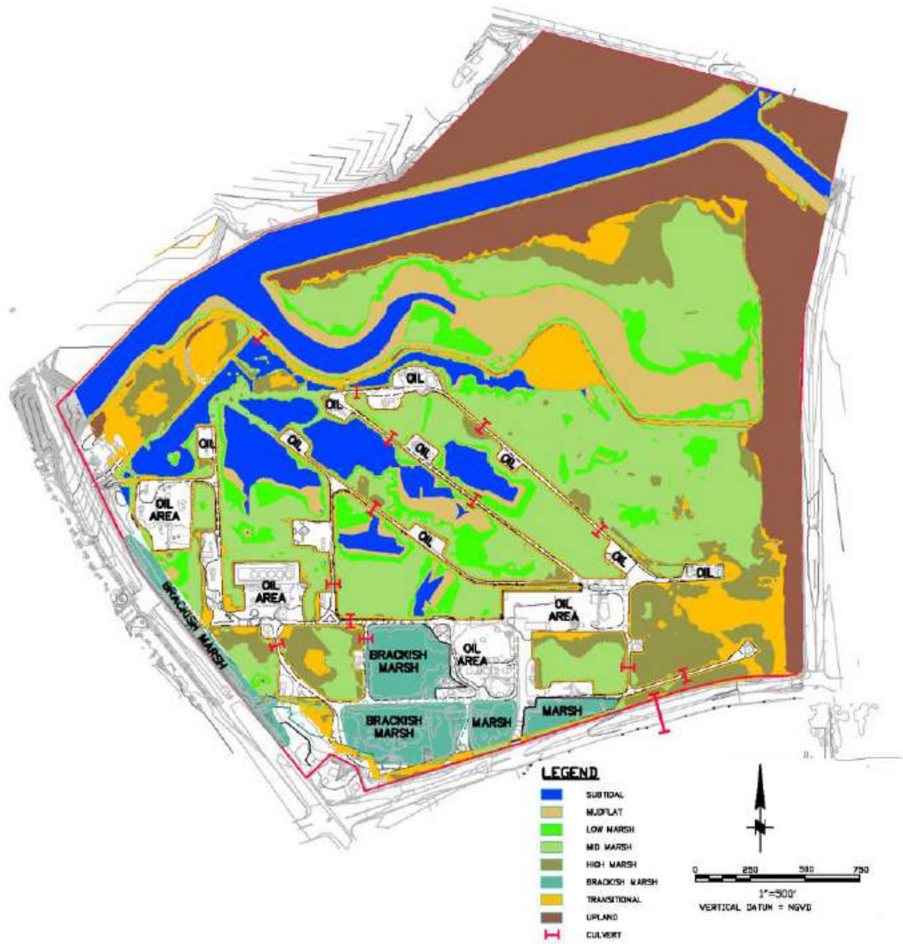


Figure 7-52. Habitat Elevation Bands, Minimum Alteration, Northern Area – Existing Sea Level
Note: Blank areas are non-tidal.

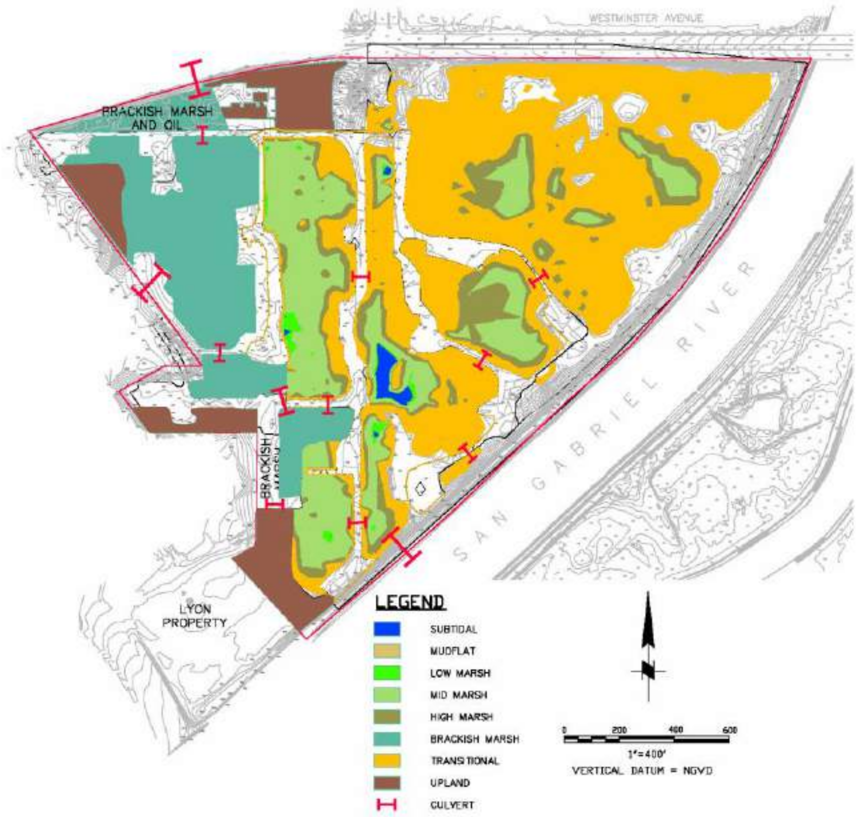


Figure 7-53. Habitat Elevation Bands, Minimum Alteration, Central Area – Existing Sea Level
Note: Blank areas are non-tidal.

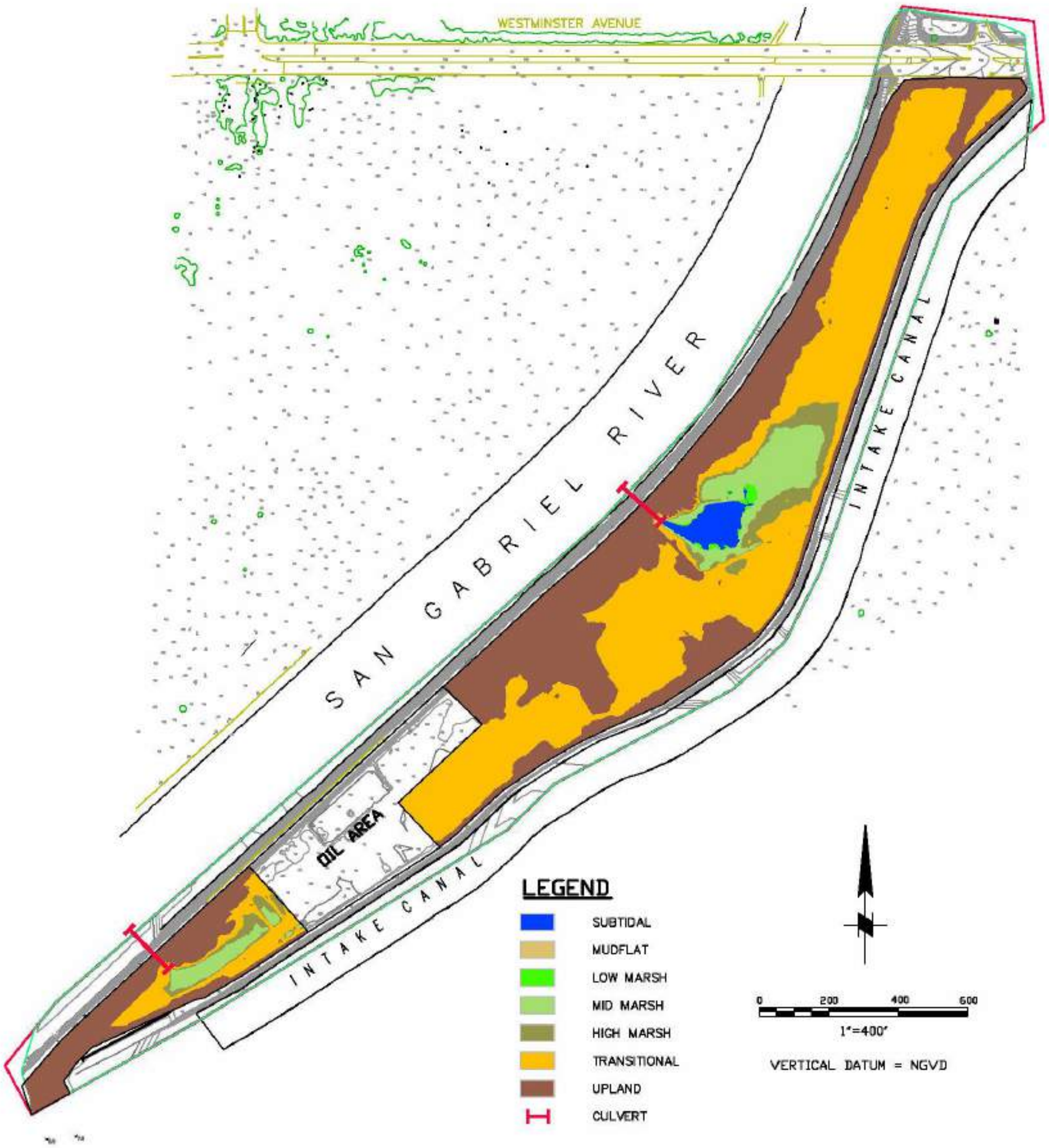


Figure 7-54. Habitat Elevation Bands, Minimum Alteration, Isthmus – Existing Sea Level
Note: Blank areas are non-tidal.

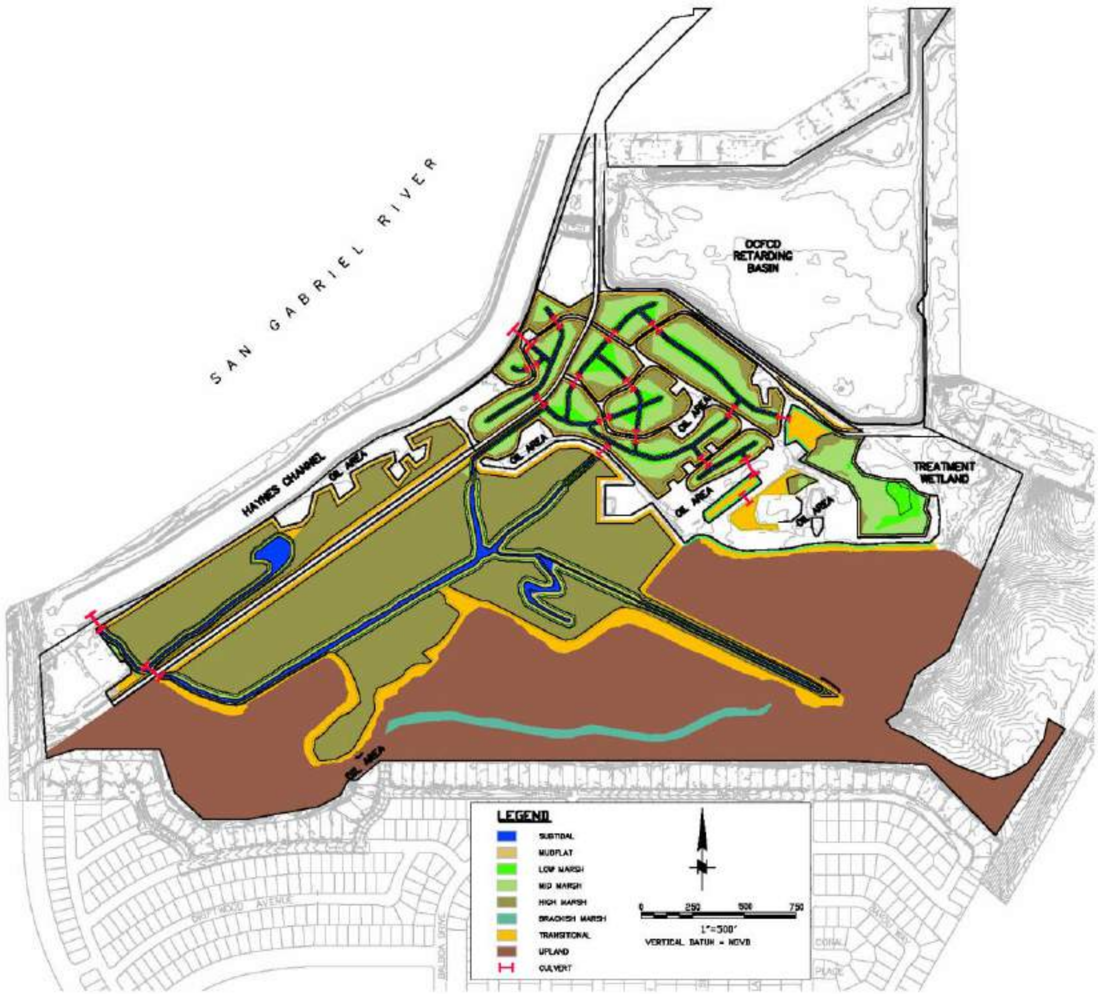


Figure 7-55. Habitat Elevation Bands, Minimum Alteration, Southeast Area – Existing Sea Level
Note: Blank areas are non-tidal.

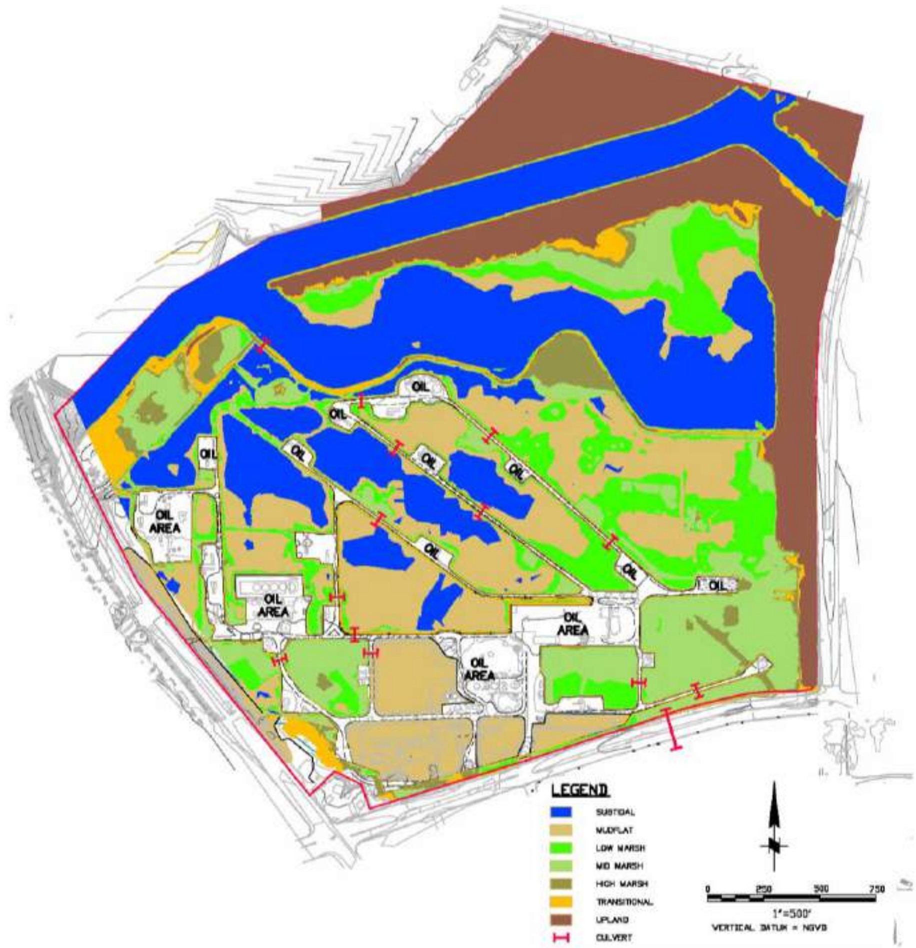


Figure 7-56. Habitat Elevation Bands, Minimum Alteration, Northern Area – Sea Level +1.5 ft
Note: Blank areas are non-tidal.

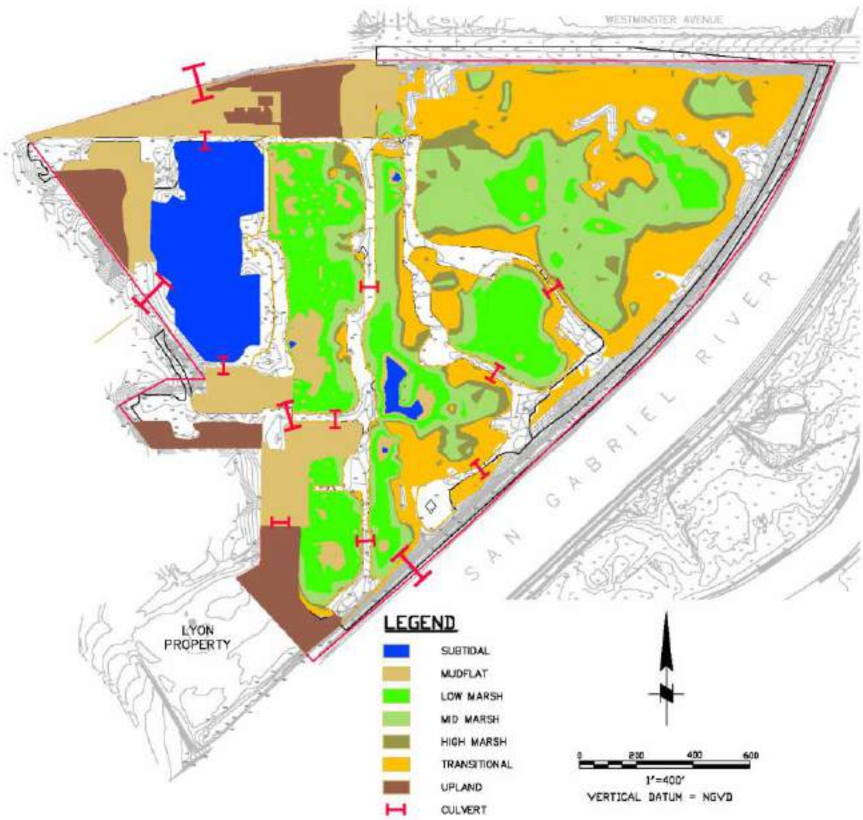


Figure 7-57. Habitat Elevation Bands, Minimum Alteration, Central Area – Sea Level +1.5 ft

Note: Blank areas are non-tidal.

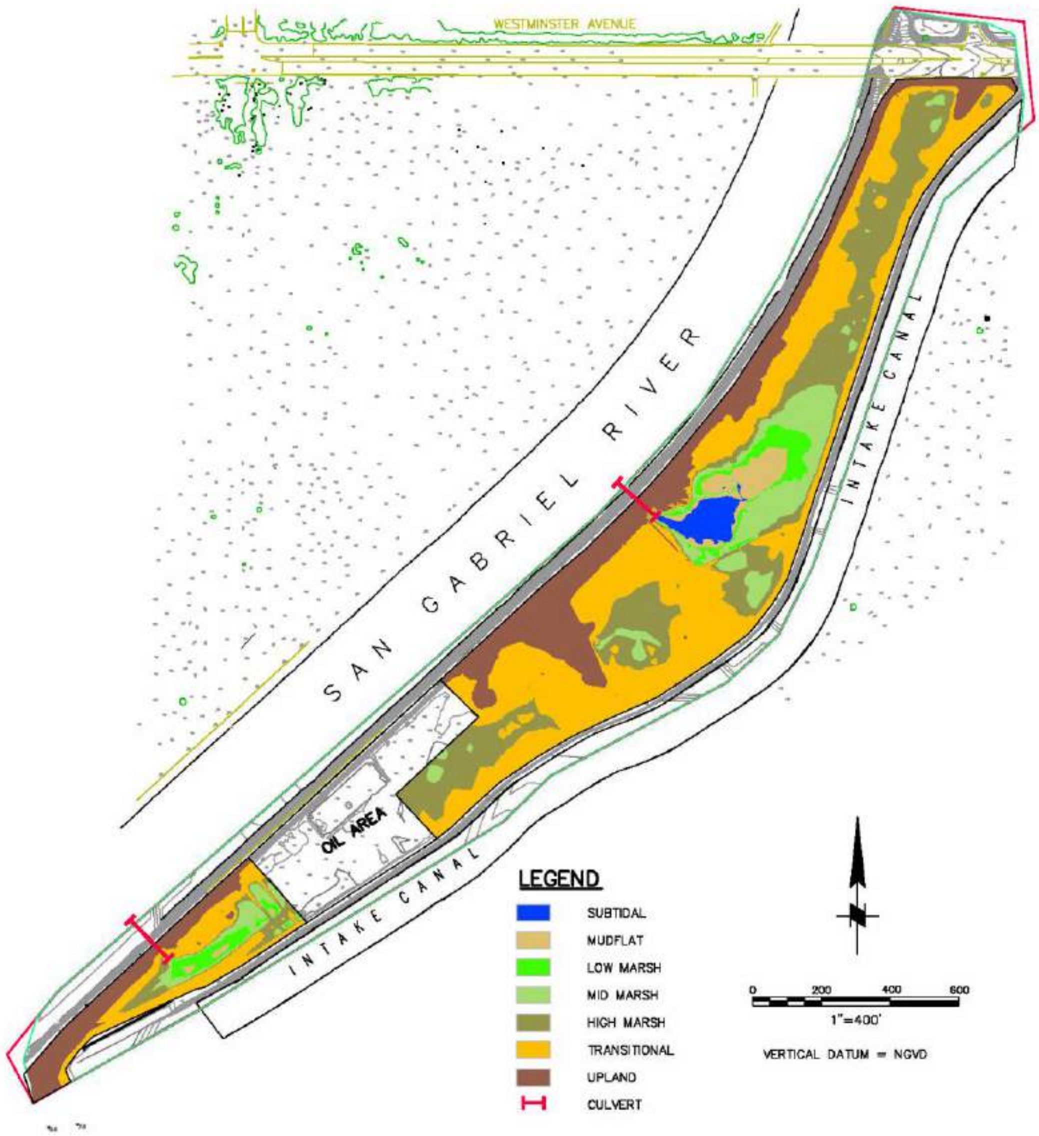


Figure 7-58. Habitat Elevation Bands, Minimum Alteration, Isthmus – Sea Level +1.5 ft
Note: Blank areas are non-tidal.

Figure 7-59. Habitat Elevation Bands, Minimum Alteration, Southeast Area – Sea Level +1.5 ft

Figure 7-60. Habitat Elevation Bands, Minimum Alteration, Northern Area – Sea Level +5.5 ft

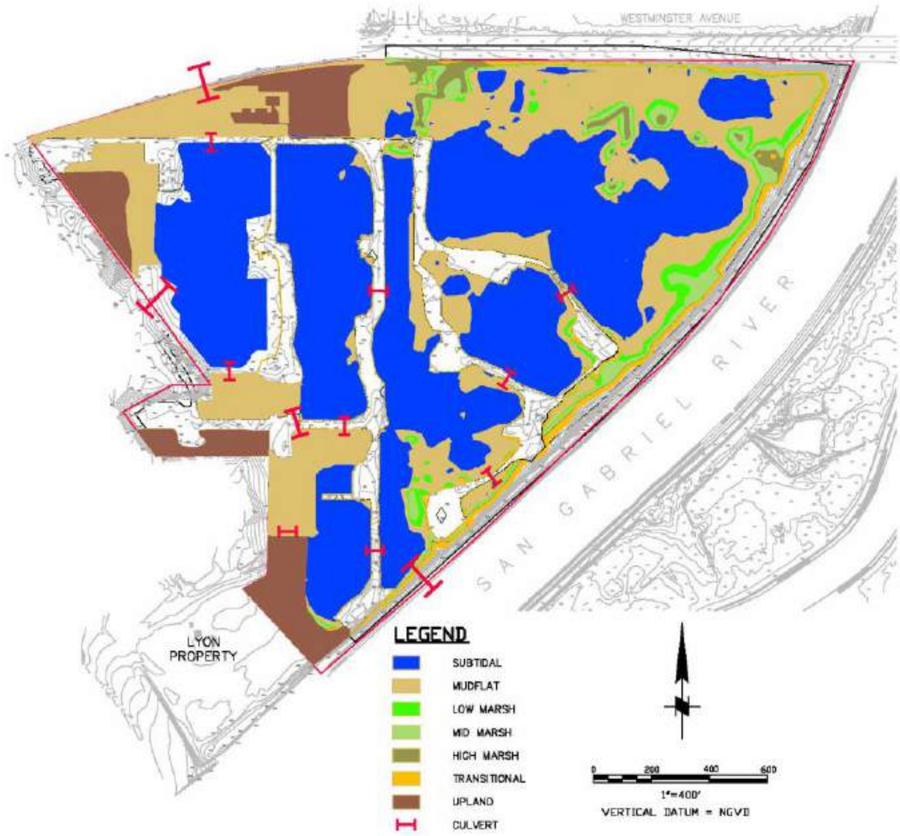


Figure 7-61. Habitat Elevation Bands, Minimum Alteration, Central Area – Sea Level +5.5 ft

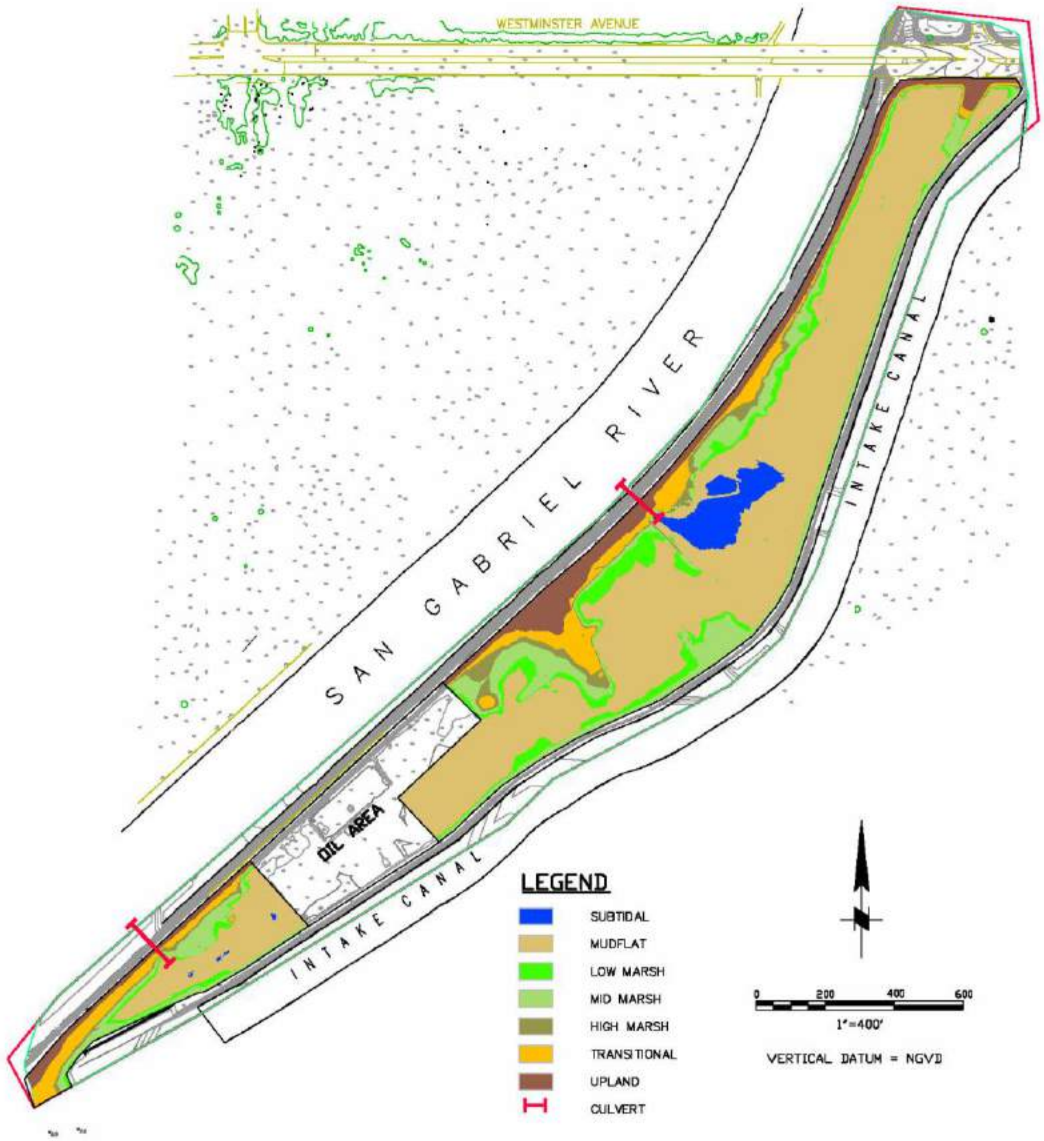


Figure 7-62. Habitat Elevation Bands, Minimum Alteration, Isthmus – Sea Level +5.5 ft

Figure 7-63. Habitat Elevation Bands, Minimum Alteration, Southeast Area – Sea Level +5.5 ft

7.2.6 Construction Methods

Construction methods for project construction and maintenance are provided below. These descriptions are intended to be suitable for use in developing construction and maintenance cost estimates.

Construction of wetland restoration projects often involves removing sediment from areas of the site to lower them sufficiently to form wetland. This sediment is either re-used elsewhere on site to "balance" cut and fill, or is removed from the site and disposed of or re-used off site. Two basic approaches exist to constructing a wetland project and each is described below.

One basic construction approach consists of construction "in the dry," which means work is done from land using land-based equipment. Land-based equipment includes backhoes, excavators, earthmovers, scrapers, bulldozers, front-end loaders, dump trucks, and other land-based equipment. Typically, the equipment operates above water in dry conditions, and reaches into wetter areas to remove earth material and recontour the site. At this stage of this project and with the LCWA's current level of understanding, construction in the dry appears to be the most likely approach to be taken at the LCW. Depending on the alternative selected, it can, however, be augmented by the other approach presented below.

The other basic construction approach is construction "in the wet." Wet construction involves working over water using water-born equipment. Water-born equipment includes a dredge or barge-mounted backhoe, boats, barges, scows, tugs, pumps and discharge lines, booster pumps, and possibly other items. Wet construction involves removing material below water by dredging.

Alternative 1 consists of minimal alteration to the site to accomplish restoration. This criterion calls for using equipment that will minimally disturb the site, yet accomplish restoration objectives. As such, construction in the dry will be the most suitable approach for Alternative 1. Construction on the existing site presents the advantages of a network of oil and access roads, and oil well pads and staging areas at each site that provide working platforms for equipment.

One possible construction scenario is summarized below. This scenario is hypothetical and is just one of possibly multiple scenarios that a contractor could devise. As such, it should not be considered the only approach to take, nor should it be the required approach when restoration commences. It is provided to demonstrate actions to be expected on site to build the project for purposes of decision-making.

Alternative 1 could be constructed by using the existing oil and access road network at each area as the basis for construction equipment access. Construction equipment would enter the site and work from the existing roads to excavate earth material, as needed, to provide tidal connections between basins. The work may only consist of installing breaches, removing segments of roads, and/or installing culverts at certain locations. This approach appears to be appropriate at the Northern Area retained in oil production, the Central Area, and the Isthmus. The Southeast Area actually requires more earthwork than other sites to achieve the restoration concept due to hydraulic limitations of the culvert(s) and the site elevation. Restoring the Southeast Area necessitates lowering of the LCWA Phase II area and the oil retained area by several feet. Greater disturbance will occur to the Southeast

Area as compared to other areas for restoration. There is no net surplus of soil material to be disposed of or re-used beneficially for Alternative 1.

Performing earthwork in the dry season is preferred over working in the wet season. Dry season work will require some measure of dewatering to excavate breaches/install culverts at roads. However, the amount of dewatering required during the dry season is much reduced compared to any dewatering needed during the wet season. Working during the wet season may require extensive dewatering, depending on the amount of rain at the site. Dewatering requires pumps to pull water from the marsh and store it in temporary "Baker" tanks for testing. Depending on its condition, the stored water is then either released into a different portion of the marsh or a nearby flood channel, or disposed of offsite. Moderate dewatering adds costs to construction, while extensive dewatering adds high costs to construction.

The timing of construction may also be affected by the patterns of nesting and breeding birds. Typically the nesting season window is mid-February through mid-September, which coincides with a large portion of the dry season. The LCWA may need to work during the majority of the wet season to avoid nesting birds, and/or attempt to negotiate some type of exception to avoidance of the bird nesting season for construction.

Construction of alternatives that connect existing Steam Shovel Slough to new wetland areas may cause impacts to the Slough and should be designed and analyzed carefully to minimize or avoid impacts.

7.2.7 Maintenance Regime

Maintenance of the restoration project will be required for any alternative. This section focuses on long-term maintenance of the site rather than short-term maintenance. Long-term maintenance consists of items such as fencing, trails, culverts, etc., while short-term maintenance consists of weeding, irrigation, replanting, etc. Short-term maintenance is required of all restoration projects, is typically included in the construction budget and is often performed by the contractor, and may be very similar between alternatives. Long-term maintenance is critical to site function and will vary between alternatives. Long-term maintenance actions tend to group into the two classes of: 1) ongoing maintenance; and 2) reactionary maintenance. Maintenance actions for Alternative 1 are itemized and briefly described below. Partnerships between the LCWA and other site owners and managers should be maintained and encouraged to minimize requirements on any one group. Examples of partners are oil operators at their surface lease sites, Los Angeles County Department of Public Works, and the Orange County Flood Control District (CFCD). The LCW SP should also be utilized where applicable to maximize cost effectiveness of maintenance.

On-Going Maintenance

- Vegetation management - This category covers: 1) non-native weed control, 2) dry brush control for fire, and 3) clearance of vegetation from around oil operations. Items 1 and 2 would be required of the LCWA (possibly through the LCW SP), while item 3 would be done by the oil operators. Alternative 1 likely requires the greatest degree of vegetation management due to its high level of disturbance and fragmentation.
- Culvert cleaning and repair – Culverts connecting the sites to seawater sources may need to be periodically cleaned or cleared of marine growth and/or obstructions, and repaired of any

damage (*e.g.*, leaks, breaks). If the culverts function adequately without being cleaned, this action could be deferred. If, however, tidal conveyance is compromised in the future by constrictions caused by marine growth (referred to as biofouling), then culvert cleaning should occur. Few culvert cleaning efforts have occurred at restored wetlands. Most sites function with culverts partially constricted. Biofouling occurs to an extent and then ceases, so the constriction effect is limited. Culverts do not typically completely close with marine growth because flows scour the inner surfaces. More culverts exist with Alternative 1, so a greater degree of culvert cleaning and repair may be required.

- Graffiti –Graffiti removal should be an ongoing concern for regular implementation. It occurs on opaque fencing, buildings, the State Lands Commission parcel foundation, interpretive signs, and at other sites. Active oil operations will be maintained by the lease-holder. The Cities of Long Beach and Seal Beach both have graffiti removal programs that may also be needed for removal. Alternative 1 provides the greatest opportunity for graffiti to occur without oil consolidation, so this action may be similar to existing conditions of the No Project Alternative.
- Removal of trash – Significant volumes of trash reach the sites through the Los Cerritos Channel and San Gabriel River, and from adjacent streets. Trash removal will be an ongoing activity into perpetuity. Alternative 1 would require the least amount of trash removal than other alternatives due to less open channel connections to sources of trash (*e.g.*, Los Cerritos Channel and the San Gabriel River). This action is a good opportunity to use the LCW SP.
- Vector Control – Vector control will be implemented by the Vector Control Districts of both Orange and Los Angeles Counties. Site access for these groups is imperative for them to perform their function, and periodic vegetation removal may be required to reduce stagnation in certain areas. Increased tidal circulation should reduce vectors; therefore, restoration should reduce the need for vector control over time. A greater degree of vector control would likely be required for Alternative 1 than other alternatives due to the poorer degree of tidal circulation expected on site.
- Fence and gate repair – Fences and gates bound the sites and may need to be erected in other areas for restoration. They typically require repair on a periodic basis after being damaged, vandalized, and/or weathered. The on-site oil operators will actively maintain their fences and gates, but fences and gates outside of the oil areas will require attention of the LCWA. A greater degree of fence and gate maintenance would be required for Alternative 1 than other alternatives due to the larger and more dispersed areas of oil operations.
- Access way (path) repair – Access pathways will need periodic repair and maintenance. Access path repair may be similar to all alternatives.
- Facilities maintenance – Certain project-related facilities such as parking lots, buildings, interpretive elements, storage areas, bike paths, and possibly other items need period inspection and repair. Any such elements that are installed as part of the project would require attention of the LCWA. Alternative 1 includes potential interpretive opportunities at the OTD and State Lands parcels that would likely include several, if not all, of these items.

Reactionary Maintenance by Contractors

- Possible erosion protection (unanticipated bank erosion) – Internal erosion of wetland shores may experience erosion on a variety of time and space scales, and local flood control levees are observed to be gradually eroding. Prediction of future sites of erosion is imperfect and, therefore, there may be the need to install additional small rock or articulated block mats at sites of erosion, possibly near culvert headwalls. Alternative 1 may require more erosion protection than other alternatives because it includes the greatest degree of interaction with man-made elements and infrastructure.

- Internal road repair and accompanying culvert repairs – Roads within wetlands can experience localized subsidence or failure near culverts if water reaches the road around the culvert. Periodic road repair may be needed in various wetland areas over time if they become affected. This is typically a small-scale effort and may require sealing the culvert or installing culvert headwalls to prevent water from reaching the road along the culvert alignment. Alternative 1 would require a greater level of internal road repair and associated culvert repairs due to the larger number of culverts in the system than other alternatives.
- Sediment removal from unwanted locations – Sediment may deposit, or accrete, in areas that are not desired for sedimentation. Removal of sediment may be required at certain channel areas. Alternative 1 anticipates less tidal circulation and lower flow velocities, so it may require less sediment removal compared to other alternatives.
- Levee repair – Any existing levees or new levees installed for the project may also need repair. No modifications to levees are included in Alternative 1 so this action should not be necessary for this alternative.
- Bridge/boardwalk inspections and repairs – Any bridges or boardwalks for wildlife and public access need regular inspection for repairs. Such activities should occur every few years or as needed based on structural conditions, structure age, and any impacting natural events (*e.g.*, earthquakes). Alternative 1 assumes the least amount of bridge/boardwalk components of other alternatives so less inspection and repair should be necessary.

7.2.8 Cost Estimates

Opinions of probable construction costs for all phases of project implementation were determined based on the components included in each alternative. Costs were estimated for items including preliminary engineering, environmental review (CEQA/NEPA), final engineering, permitting, construction, construction management, and construction monitoring. A range in costs was estimated, and this range in costs is provided on a per acre basis. Costs vary for each alternative depending on the level of complexity in the design, the anticipated amount of earth work, and probable material re-use and/or disposal options. The costs for Alternative 1 are the lowest of all scenarios, and its range of costs is between $106,000 and $159,000 per acre.

7.3 Alternative 2

The Alternative 2 (Moderate Alteration) analyses are presented below.

7.3.1 General Description

The Moderate Alteration Alternative envisions significant infrastructure changes compared to existing conditions and Alternative 1. This alternative will require extensive consolidation of pipelines, roadways, power poles, non-operating equipment and well sites to areas around existing tank farm locations. The Termo Company lease tank farm would require relocation outside of the project area, Synergy Oil and Gases three tank farms would be consolidated to one tank farm near their offices, Signal Hill Petroleum's tank farm would be preserved, and Hellman Properties' old tank farm would be removed while their new active tank farm would be preserved. A majority of wells will be re-drilled in consolidation zones. Certain consolidation zones may need to be elevated or diked to avoid flooding from tidal waters.

Hydrology will consist of a combination of using existing drainage channels within each area, and new drainage networks installed at certain sites. The Northern Area of oil retained land will possess an entirely new drainage network, as will the Central Area, and the Hellman oil retained portion of the Southeastern Area. Existing channel networks that are preserved include Steam Shovel Slough (Northern Area), Zedler and Callaway Marshes (Isthmus), and the LCWA Phase II site (Southeast Area).

As a target, the greatest benefits assumed in the conceptualization to come from this alternative include:

- Improved wetland functions and values with less fragmentation;
- Less cost compared to Alternative 3 due to less earthwork;
- Alternative 2 requires less maintenance than Alternative 1; and
- Greater resilience for future SLR conditions than other alternatives in the form of maintained habitat diversity.

The greatest disadvantages of this alternative assumed in the conceptualization consist of:

- Higher costs than Alternative 1 due to more earthwork;
- Greater impacts to the existing sites that will have new channel networks;
- Impacts to on-site oil and gas extraction activities due to consolidation;
- Reliance on connection to the HCC for the Southeast Area and uncertainty in timing associated with this feature.

The phasing of each alternative is the same, and is explained for Alternative 1 in the previous section of this report. As only portions of three areas are presently in LCWA ownership, restoration could occur there first, with restoration on parcels that are presently in private ownership to occur at a later date. Figure 7-18 and Figure 7-19 show the conceptual phasing plans. Phasing after the initial phase is not possible to determine with the information that presently exists.

7.3.2 Preliminary Design

The preliminary design of Alternative 2 is shown in the conceptual grading plan and cross-sections that show channels and structures. Figure 7-64 through Figure 7-67 show grading on each area. The Moderate Alteration Alternative shows extensive grading on the Northern, Central, and Southeast Areas. The Isthmus Area remains relatively unchanged. Some degree of minimal earthwork is needed to provide target habitats shown on the conceptual GIS graphic on Figure 6-19 through Figure 6-21. The site changes consist of:

- Removing oil roads and well pads (at all areas);
- Consolidating oil operations at each site;
- Creating transitional habitat at all areas;
- Creating high-marsh at all areas; and

- Converting existing brackish marsh in the Central Area to salt marsh.

Less grading will need to be done on the Southeast Area as compared to other alternatives to achieve target transitional, high-, and mid-marsh habitat, given new hydrology resulting from using an open channel connection to the HCC. Cross-sections of proposed grading show the difference between existing topography/bathymetry and the proposed surface of this alternative. The location of the cross-sections is shown in Figure 7-24. Cross-sections of the grading anticipated at each area are shown in Figure 7-68 through Figure 7-71.

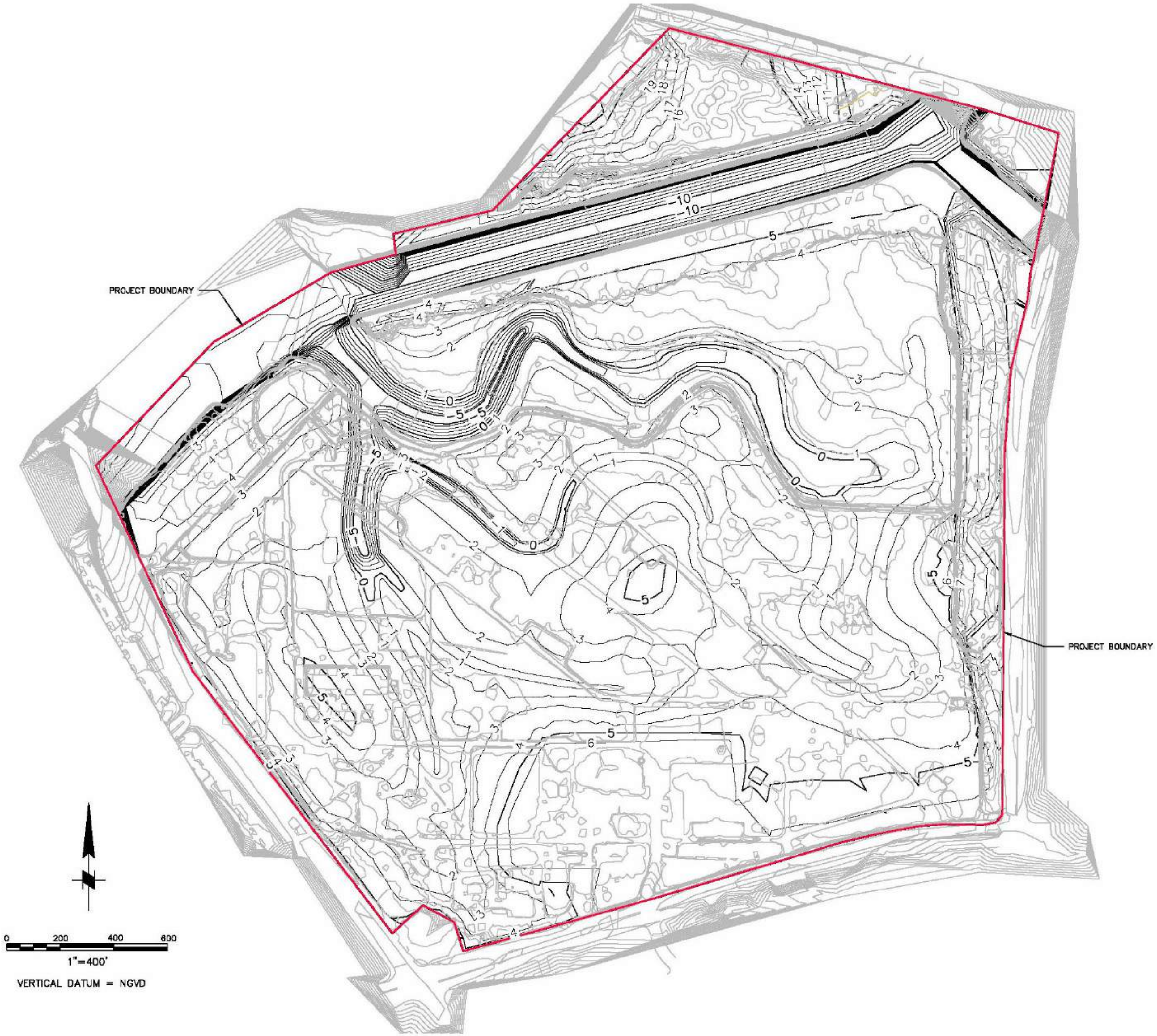


Figure 7-64. Conceptual Grading, Moderate Alteration, Northern Area

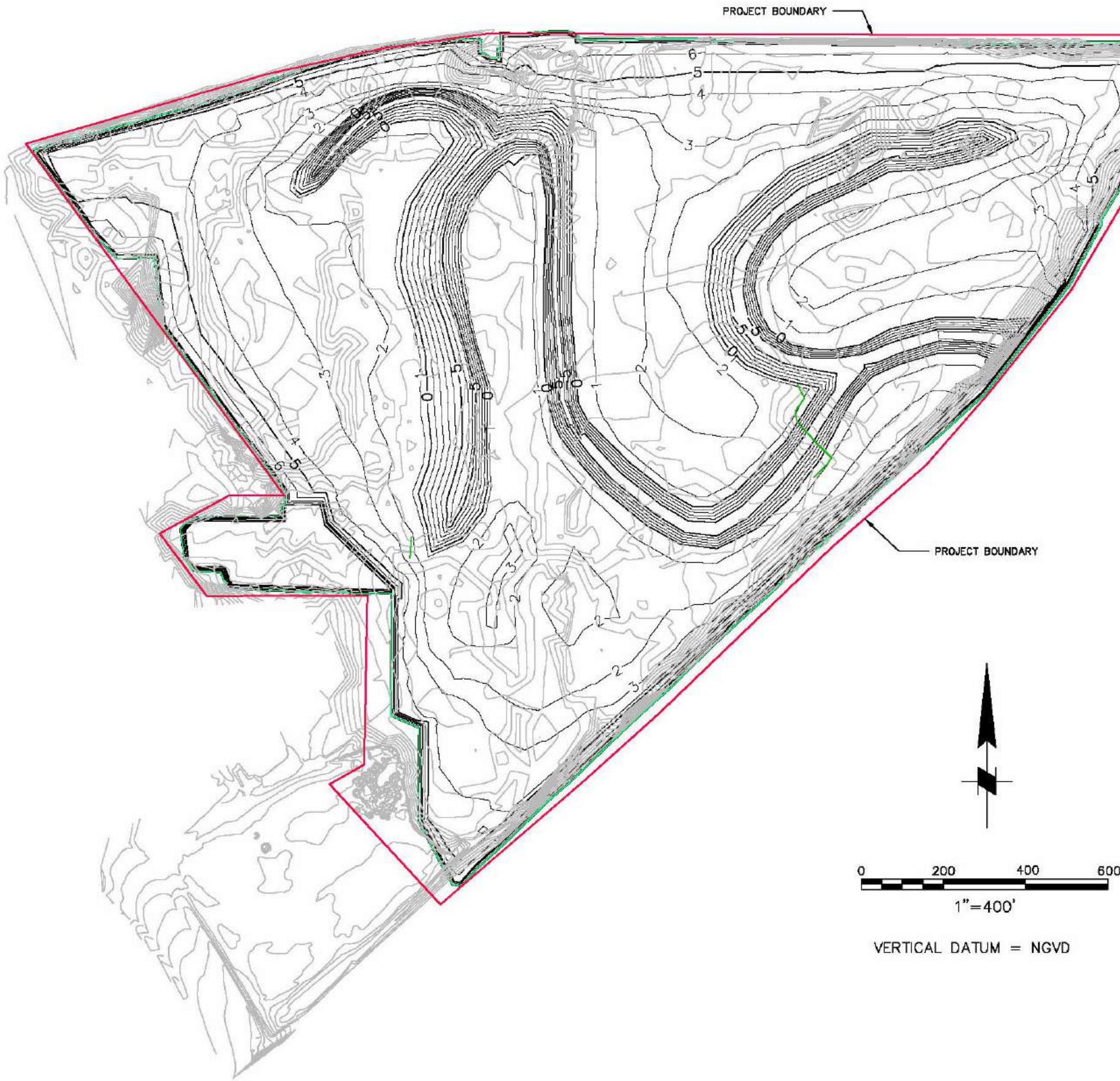


Figure 7-65. Conceptual Grading, Moderate Alteration, Central Area

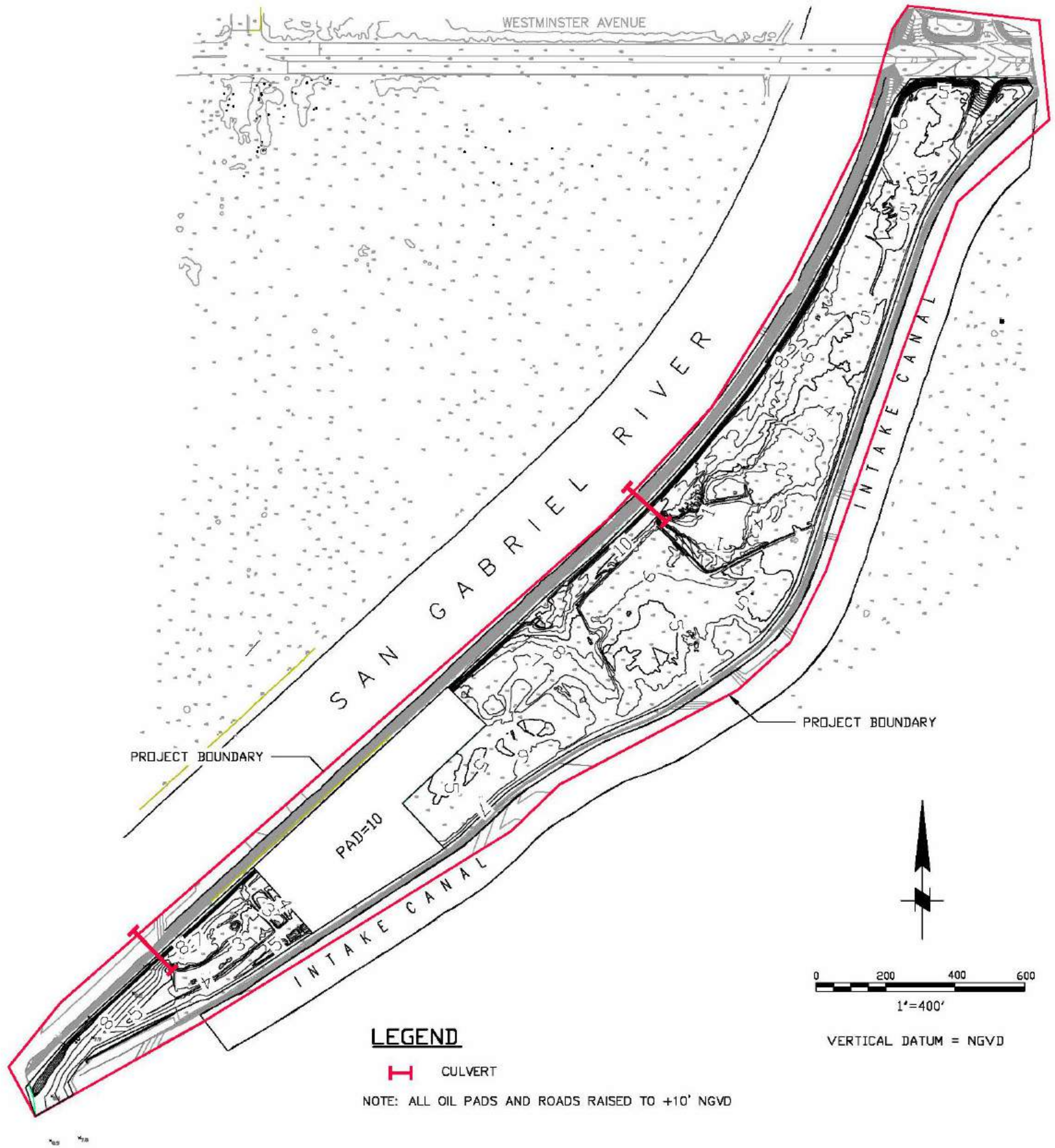


Figure 7-66. Conceptual Grading, Moderate Alteration, Isthmus

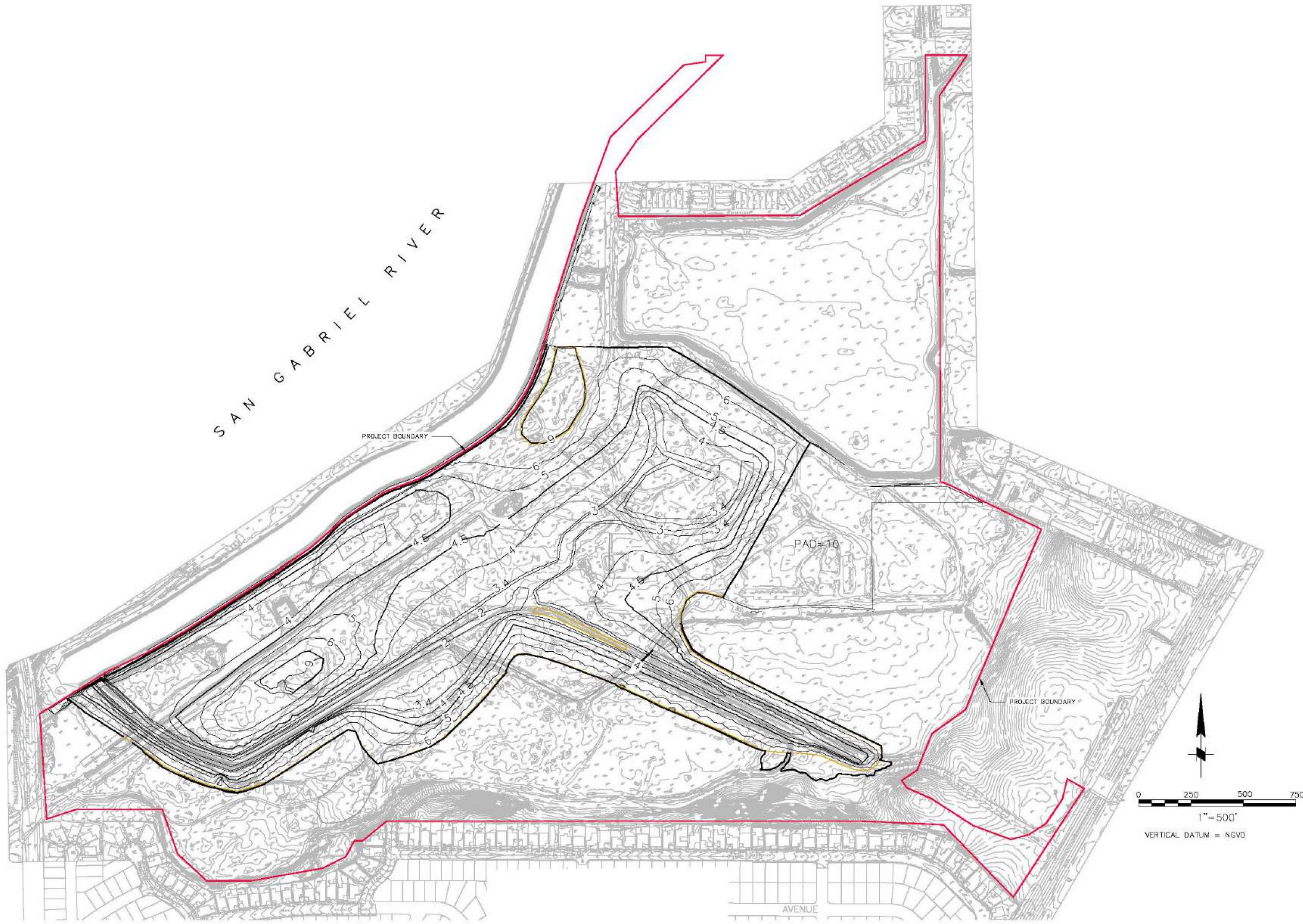
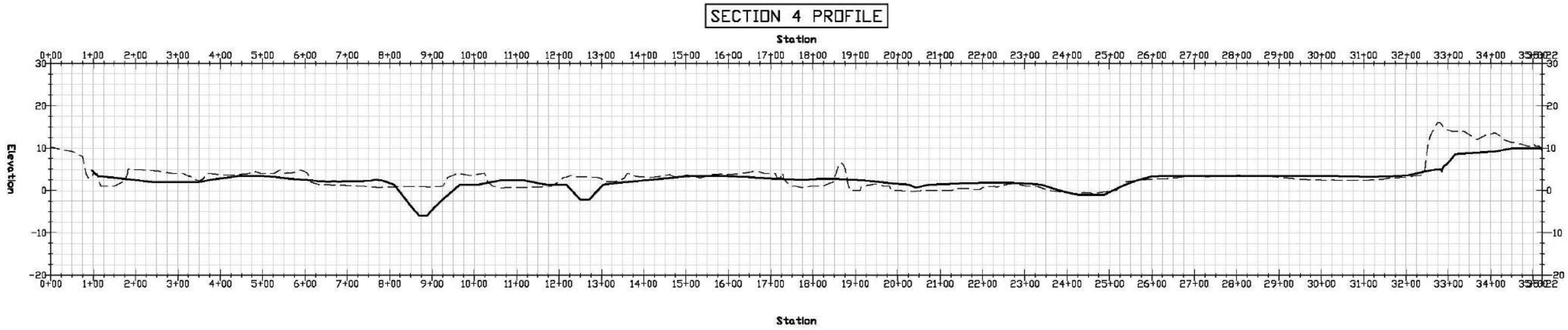


Figure 7-67. Conceptual Grading, Moderate Alteration, Southeast Area



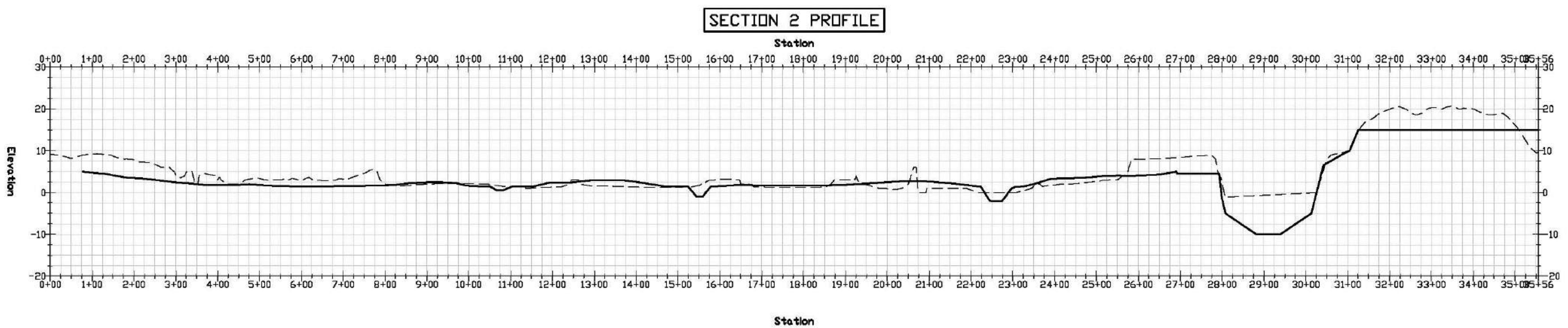


Figure 7-68. Conceptual Grading Cross-Sections, Moderate Alteration, Northern Area

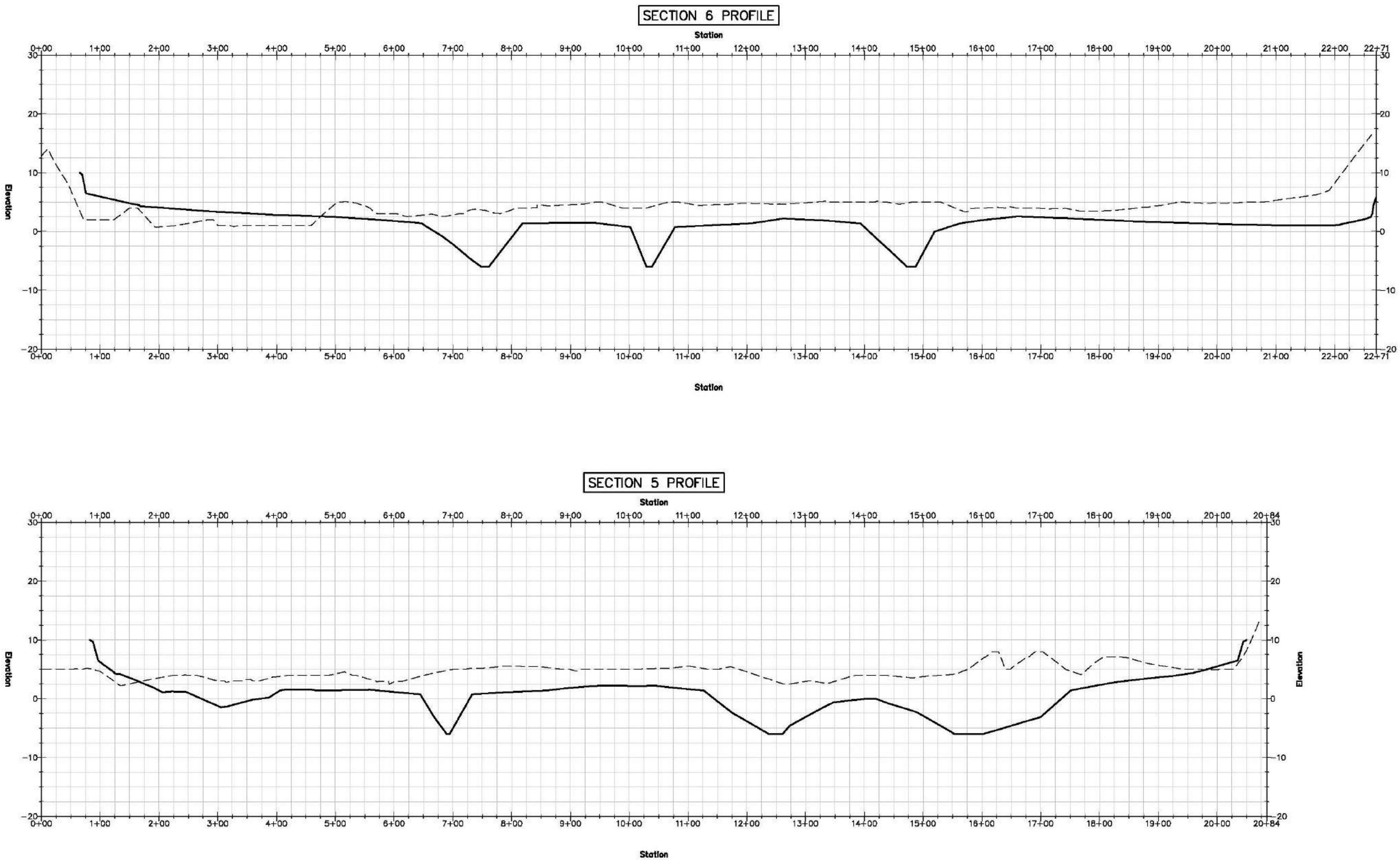
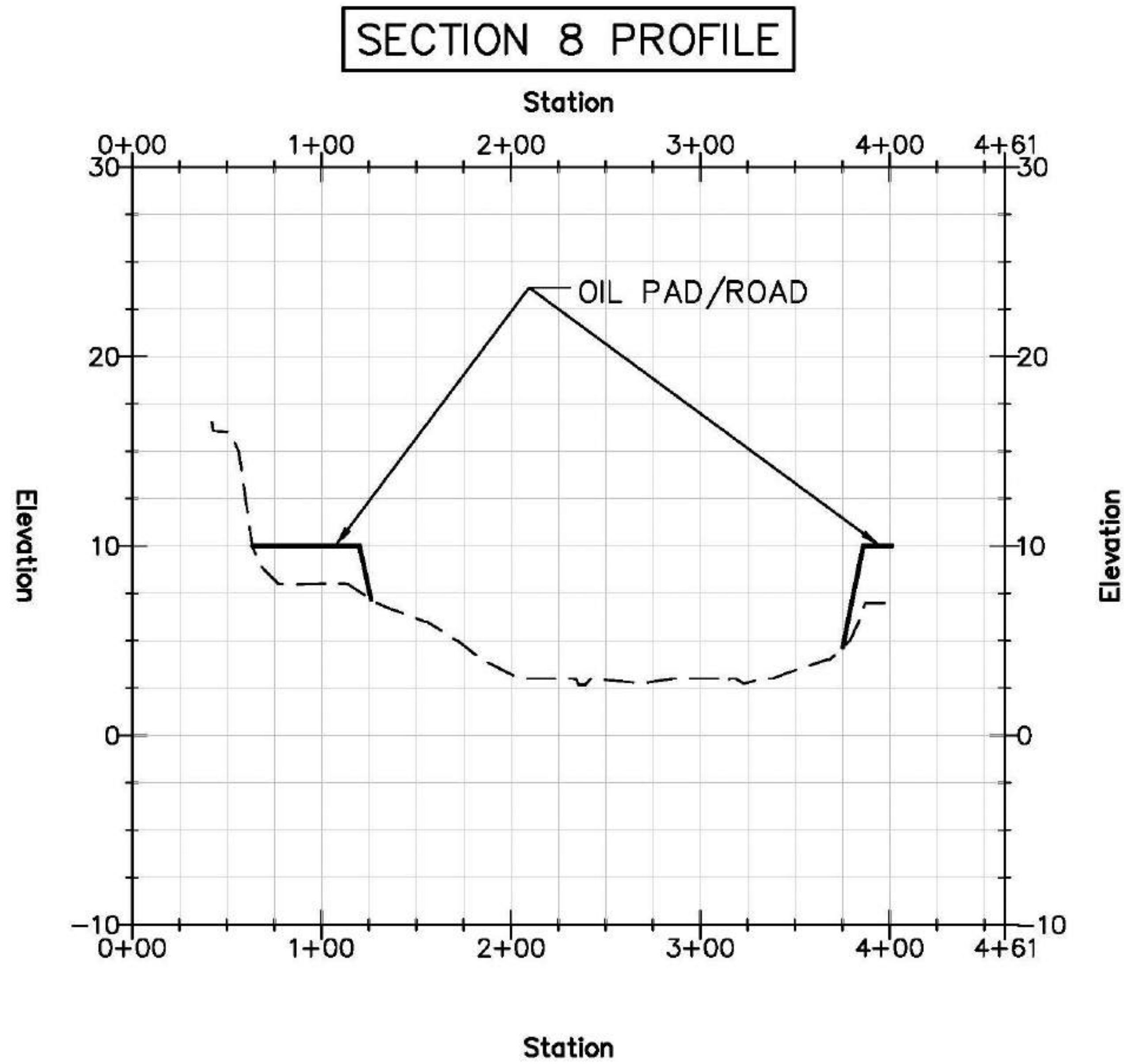


Figure 7-69. **Conceptual Grading Cross-Sections, Moderate Alteration, Central Area**



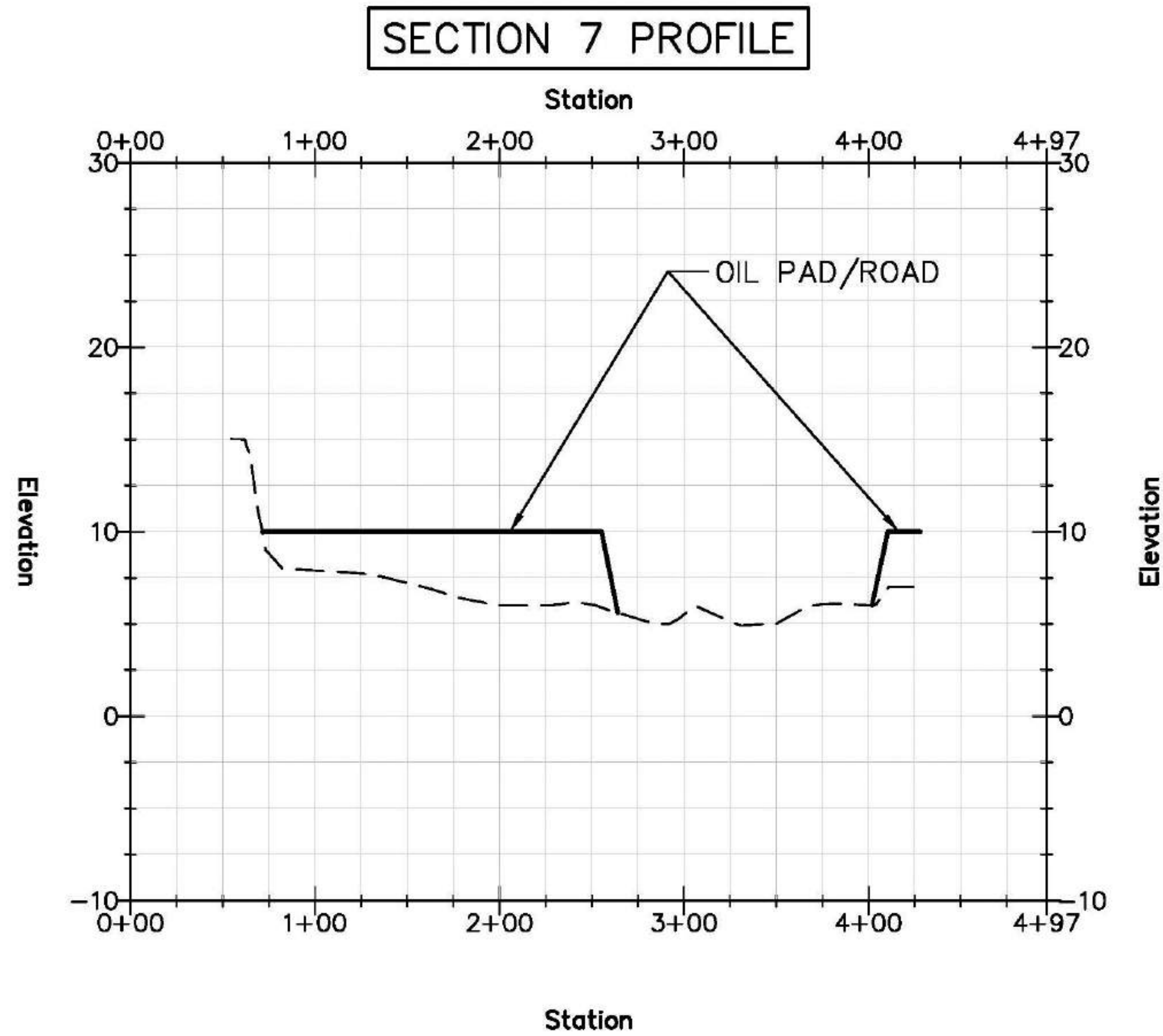
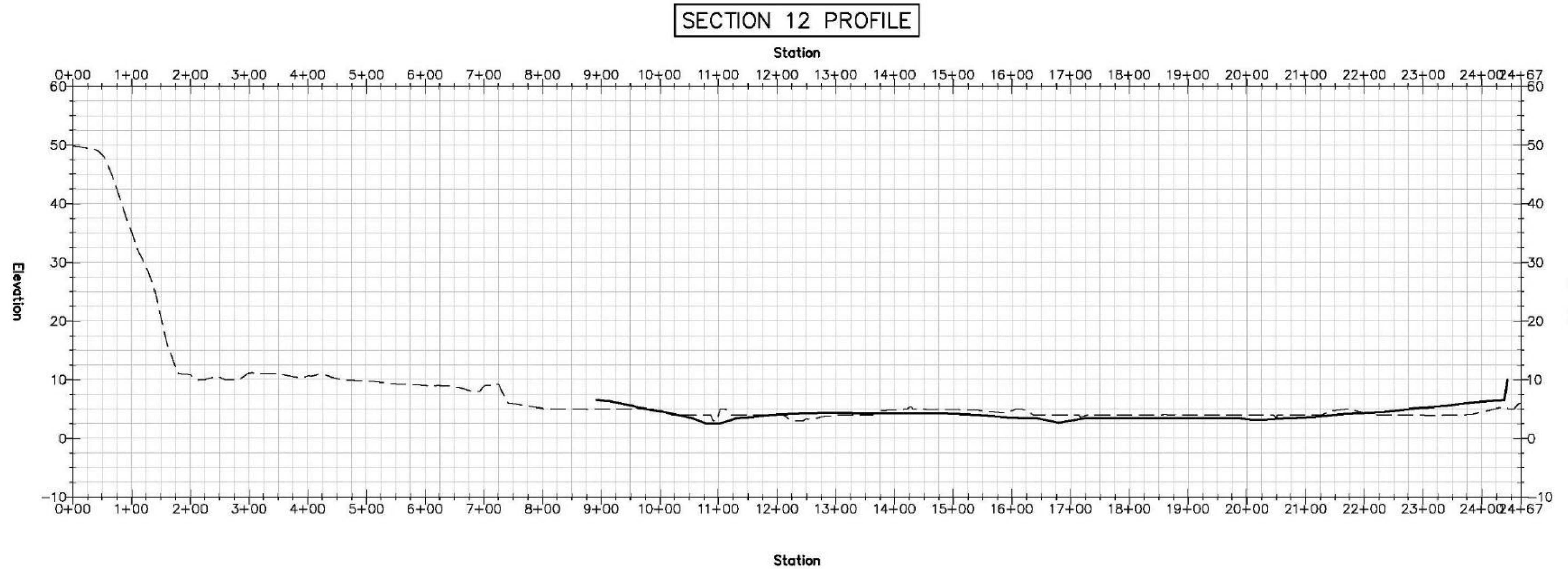


Figure 7-70. Conceptual Grading Cross-Sections, Moderate Alteration, Isthmus



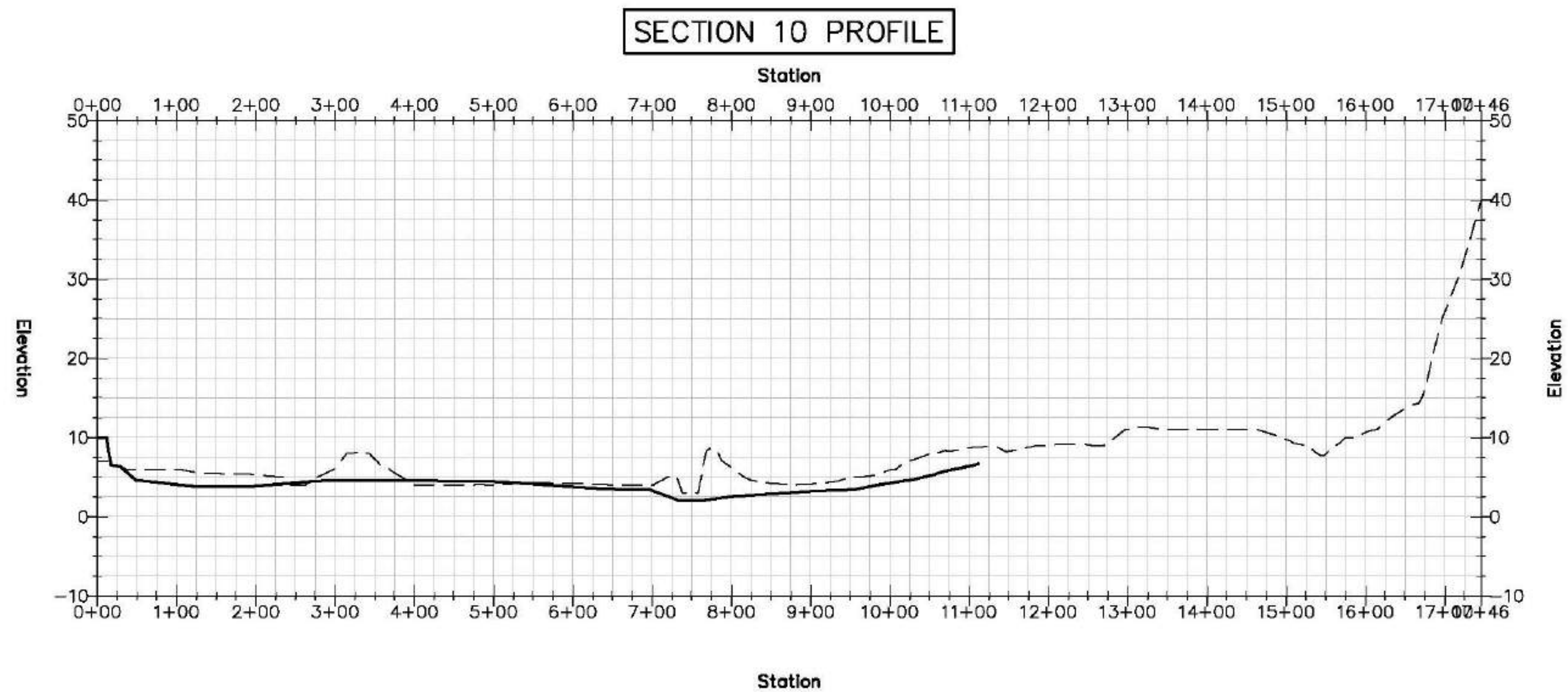


Figure 7-71. Conceptual Grading Cross-Sections, Moderate Alteration, Southeast

7.3.3 Habitat

The Moderate Alternative turned out to be the most resilient to SLR, primarily because the Southeastern Area is kept very high. This limits the areas functioning in the near-term though. Table 7-8 shows the habitat analysis of Alternative 2. Figure 7-72 through Figure 7-74 show the habitat areas calculated for each area under Alternative 2, for all three level scenarios.

Table 7-8. Habitat Analyses Matrix for Alternative 2

Moderate Alternative	Northern Area	Central Area	Isthmus	Southeastern Area	Entire LCW Complex
Diversity of Salt Marsh Habitats	• Broad distribution of intertidal habitats skewed towards mid intertidal • Opportunities for intricate tidal channel networks with full tidal range	• Broad distribution of intertidal habitats skewed towards mid intertidal • Opportunities for intricate tidal channel networks with full tidal range	• Very small areas under regular tidal influence • Severe tidal muting (<40% tide range)	• Small area of higher intertidal habitats • Almost no mid and lower intertidal or sub-tidal habitats • Very little salt marsh at current sea level	• Full diversity of marsh habitats within the complex • Different areas support a diversity of salt marsh habitats at different sea levels
Overall Habitat Diversity	• Strong emphasis on intertidal salt marsh • Narrow uplands along road edges • Limited sub-tidal and other wetland types	• Strong emphasis on intertidal salt marsh • Transition and upland habitats are narrow and confined to road edges and berms	• Uplands are berms with limited habitat value	• Emphasizes non-salt marsh habitats in near-term • Significant area of freshwater wetlands • Considerable upland habitat	• Significant non-tidal wetlands • Significant upland habitats but almost only in Southeastern Area
Habitat Connectivity	• Removal of roads and berms creates a large contiguous marsh • Good connection to existing salt marsh at Steam Shovel Slough • Steep transitions between marsh habitats and uplands	• Removal of roads and berms creates a large contiguous marsh • Filling of existing wetland basins needed to create natural ecotones and high intertidal and transition habitats • Open channel to the San Gabriel River allows good aquatic connectivity	• Transition zone has reduced value when not adjacent to salt marsh • Entire site isolated by berms • Culverts may limit connectivity for some aquatic species	• Removal of roads and berms creates a large contiguous area • Open tidal connection to HCC allows good aquatic connectivity with SLR • Significant adjacent uplands but many wetland-upland transitions are somewhat steep	• Full suite of salt marsh habitats are adjacent and well-connected in some areas at some sea levels • Different areas are isolated by major roads, berms and development
Resilience to Sea Level Rise (SLR)	• Decrease in high marsh and transition habitats, increase in most lower habitats with moderate SLR • Almost no vegetated marsh left with significant SLR • Some conversion of upland to wetland	• Majority of the vegetated marsh lost with moderate SLR • Vegetated marsh virtually eliminated with significant SLR • Very little opportunity for conversion of upland to wetland	• Tidal habitats will expand with moderate SLR • Almost total loss of vegetated marsh with significant SLR • Tides remain muted even with significant SLR	• Significant mid intertidal habitats will develop and high intertidal habitats are preserved with moderate SLR; some transgression of marsh habitats in to former uplands • Diversity of salt marsh somewhat maintained with significant SLR; significant transgression of marsh habitats in to former uplands	• Full range of habitats maintained with moderate SLR complex-wide • Some vegetated marsh remains even with significant SLR • Adjacent uplands in Southeastern Area allow for natural transgression of habitats with SLR • This alternative is the most resilient to SLR
Functional Lift	• Slight lift at Steam Shovel Slough due to connections to newly restored adjacent salt marsh • Moderately high lift elsewhere with removal of berms and roads and increased tidal influence • High functioning maintained with moderate SLR; will decrease with significant SLR	• Moderately high lift throughout the area with removal of berms and roads and increased tidal influence • Functioning will decrease with moderate SLR and decrease sharply with significant SLR	• Minor functional lift due to limited increase in tidally influenced area • Functioning will increase with moderate SLR; decrease with significant SLR	• Significant functional lift at current sea level and with moderate SLR • Moderately high functioning maintained with significant SLR • Freshwater wetlands in the retarding basin provide high-functioning non-tidal wetlands	• Substantial functional lift that is sustainable with moderate SLR • Functioning drops with significant SLR • This alternative maintains the highest functioning with significant SLR
Take Home Message	• Relatively minor grading and expensive oil operation consolidation yields significantly expanded tidal salt marsh habitat that is resilient to moderate SLR	• Extensive grading and expensive oil operation consolidation yields significantly expanded tidal salt marsh habitat that it is not resilient to SLR	• Relatively inexpensive and compatible with existing oil operations but functional gains are moderate and dependent on SLR • Design is the same as the Minimum Alternative	• Extensive grading and expensive oil operation consolidation yields significantly expanded tidal salt marsh habitat that is somewhat resilient to even significant SLR	• A relatively expensive approach that offers significant short-term functional gains in some areas with long-term resilience limited to the Southeastern Area

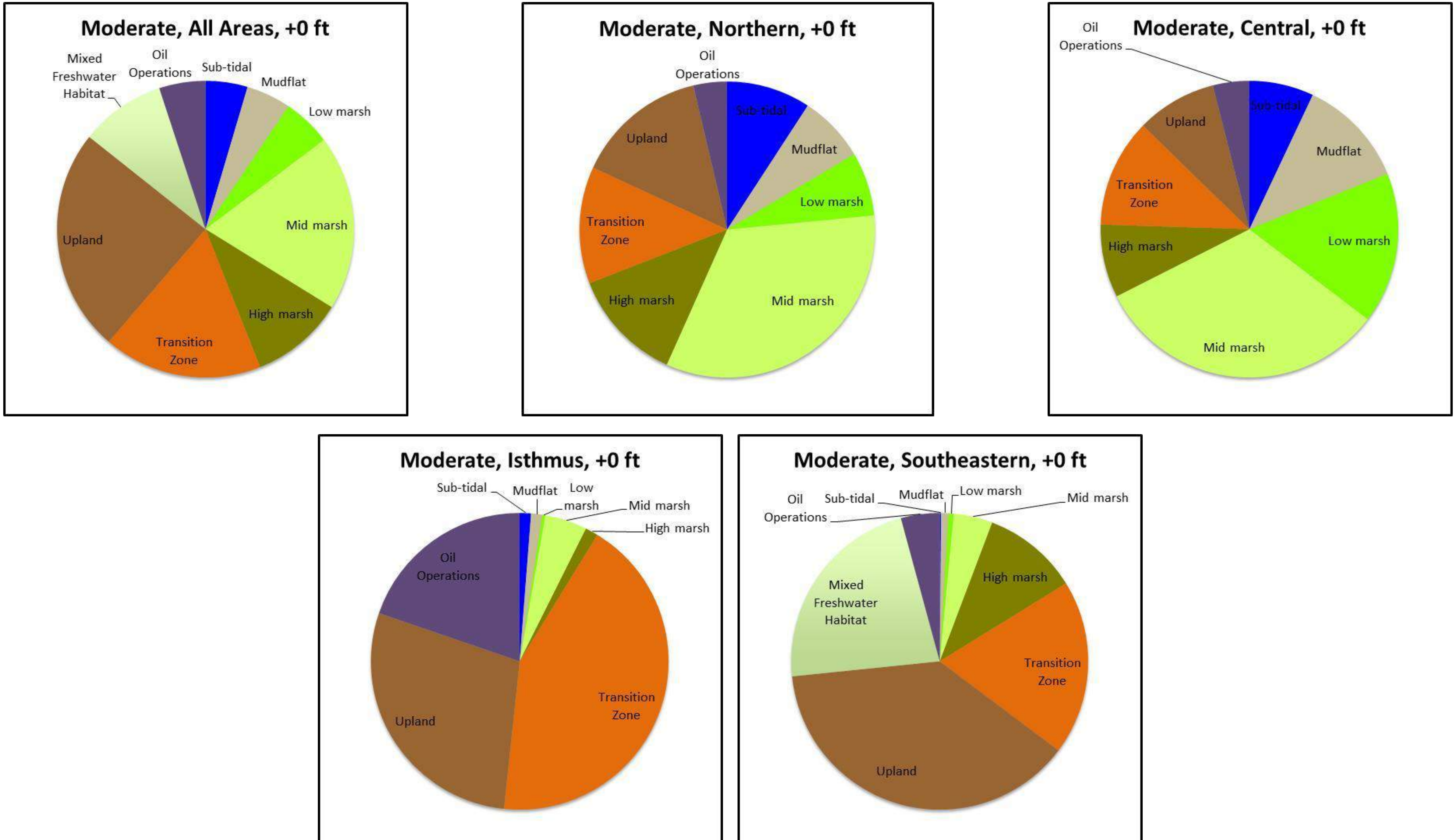


Figure 7-72. Habitat Acreage Moderate Alteration SLR of +0 ft

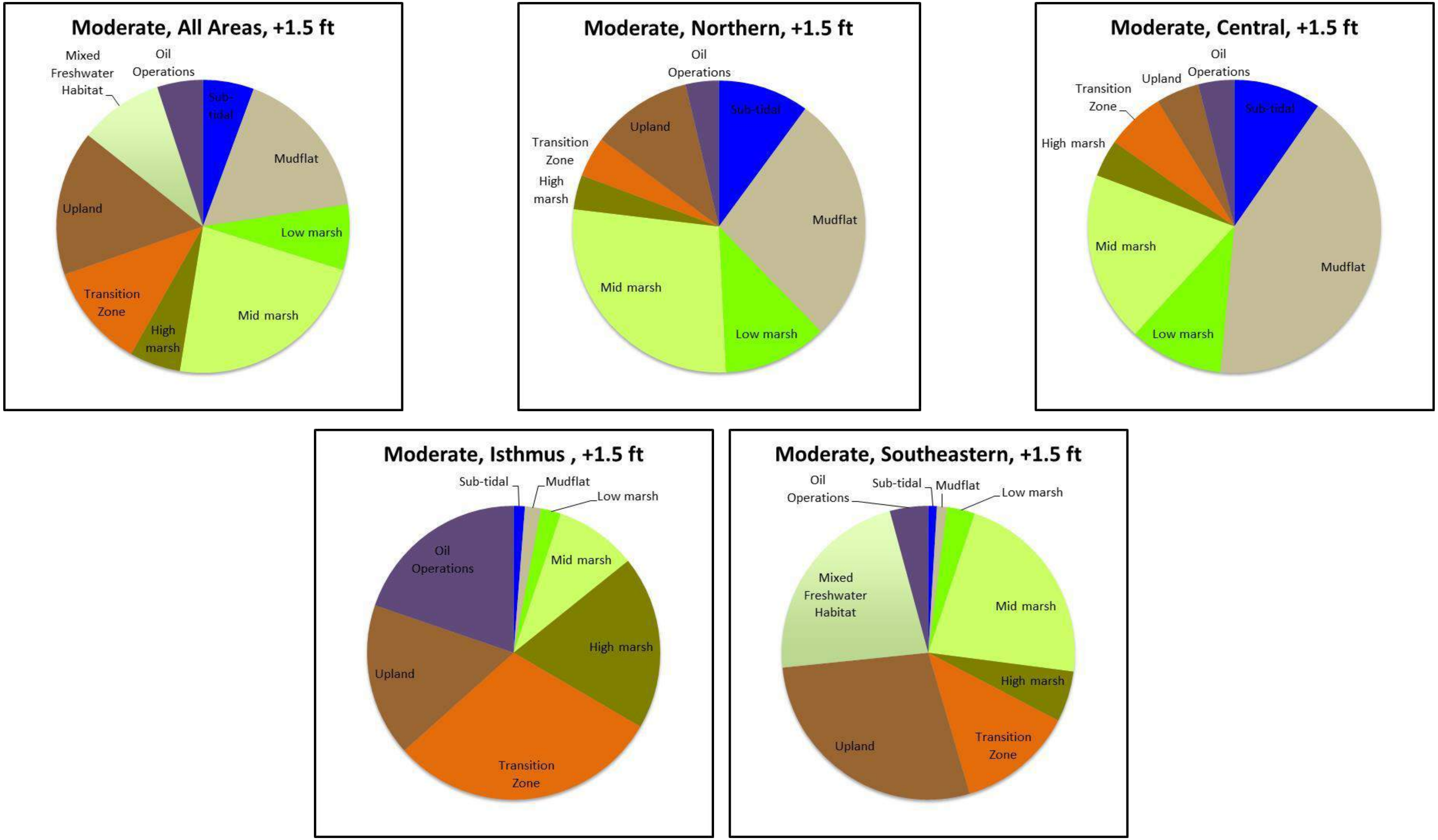


Figure 7-73. Habitat Acreage Moderate Alteration SLR of +1.5 ft

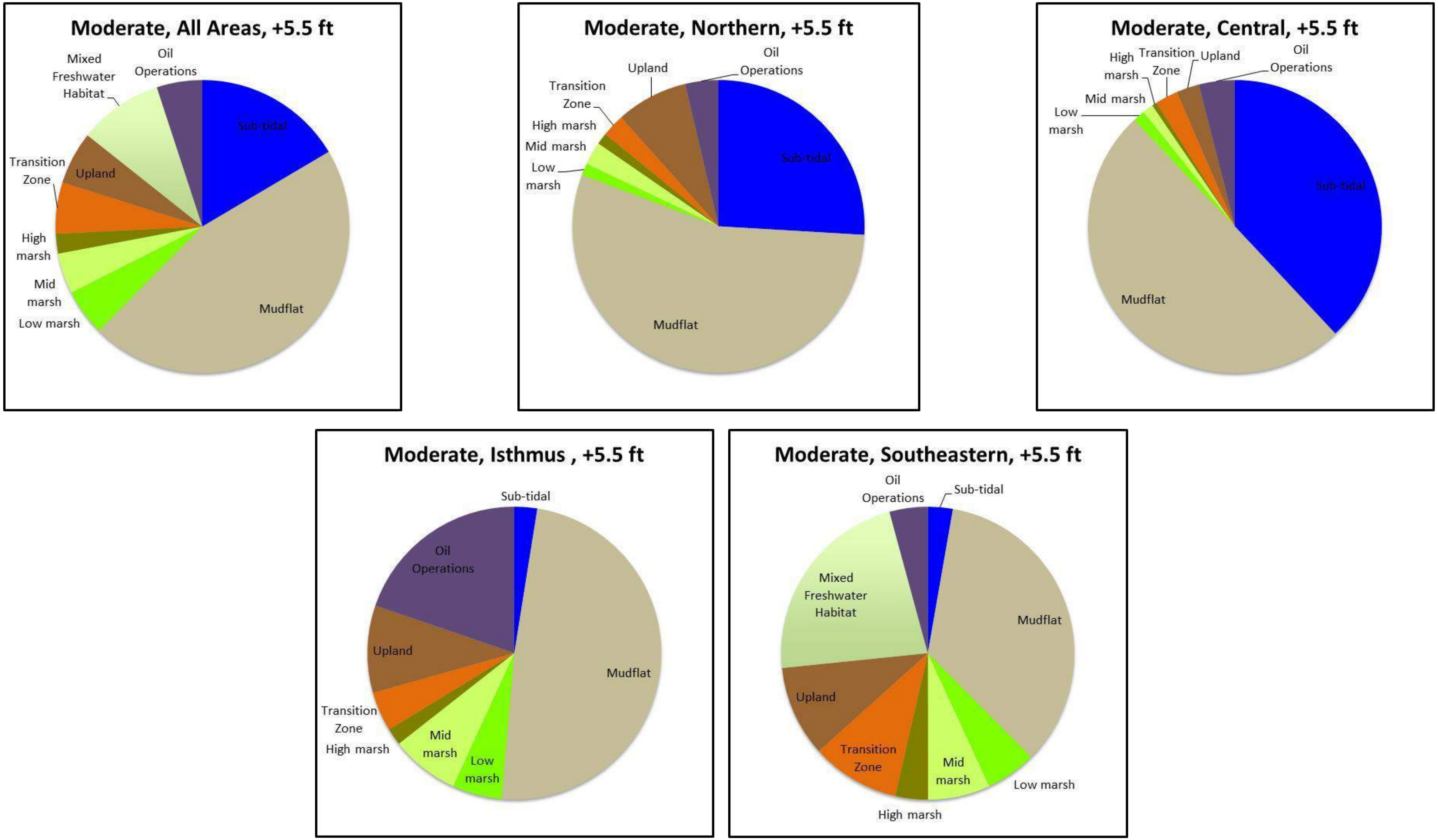


Figure 7-74. Habitat Acreage Moderate Alteration SLR of +5.5 ft

7.3.4 Public Access Plan

The Moderate Alteration Alternative proposes a significantly greater range of intertidal habitat areas and, therefore, removes a significant amount of the existing road infrastructure, particularly in the Steam Shovel Slough and Associated Uplands area. As such, the trail opportunities are considerably reduced unless new alignments are created. In this Moderate Alteration PAP, we elected to show a perimeter trail option, although additional loop trails and through routes would be possible in a similar manner as that proposed for the Maximum Alteration PAP schemes. Nevertheless, even with the "moderate alteration" approach, trails in this north area would have sections requiring elevating above the tidal range, either as elevated boardwalks or as raised causeways - the latter having potential hydraulic implications that would require modeling in later phases of the restoration design. The extent of these elevated trails is indicated by the sections of trail that cross areas of green in the diagram, representing the intertidal zones. Yellow and brown shaded areas are above the tidal range; the brown shaded areas remain above the intertidal in the SLR scenarios as well.

Figure 7-75. Trail Opportunity Detail – Moderate Alteration, Northern Half

Trails in the southern cells of LCW in the Moderate Alteration PAP are also somewhat reduced from that of the Minimal Alteration PAP. However, this alternative includes an expanded alignment for the Primary Loop Trail that allows access to and from the Leisure World retirement community. The proposal also includes a lengthy section of boardwalk or causeway trail at the highest line within the Central Area cell intertidal area, between the main and side channels of the new tidal creek connection, which could be reduced if a narrow area of transitional elevation could be added at the trail itself. This alignment takes advantage of the potential vegetated wildlife overcrossing discussed above, providing a direct route from the proposed Interpretive Center to the Isthmus Area and Southeast Area.

The Isthmus Area access plan is similar to that of the Minimal Alteration PAP, but here we have shown a teaching wetland area - consisting of micro habitats showing the full range of conditions found throughout the LCW Complex, but concentrated near the available access from PCH at the HCC inlet and San Gabriel Bike Trail. This teaching micro-wetland would allow for shorter duration docent events, and concentrate learning activities in an easily accessed location. From here, opportunities to explore the rest of the LCW Complex would be described.

The Southeast Area on the Moderate Alteration PAP are shown here with two secondary loops, the Gum Grove Cutoff, and the Tongva Loop Path, both of which follow transitional zone areas with short sections crossing intertidal areas and so requiring elevated boardwalks (at green areas on the diagram below).

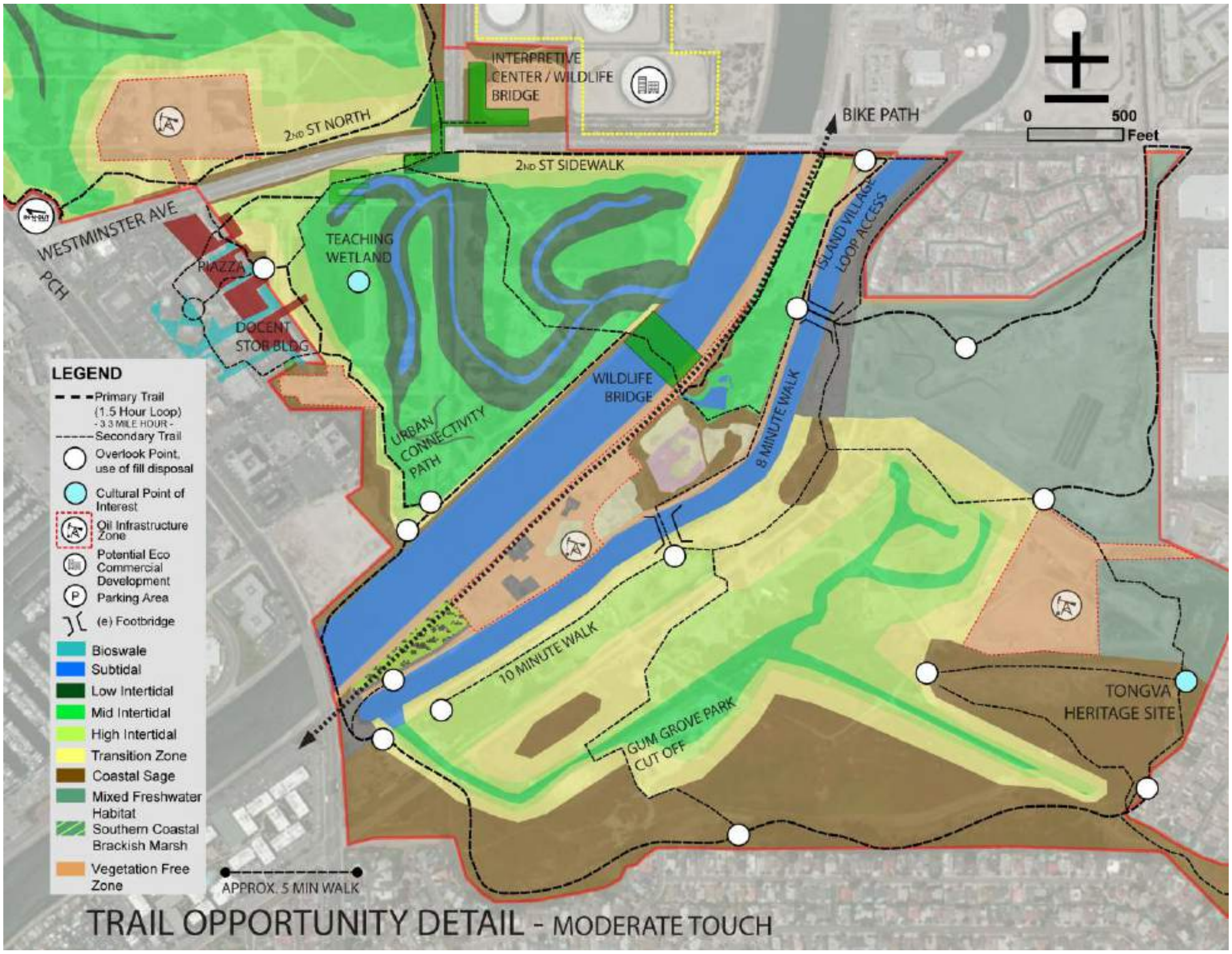


Figure 7-76. Trail Opportunity Detail – Moderate Alteration, Southern Half

Due to the relatively higher elevations, the trails of the Southeast Area would require shorter elevated sections than the Maximum Alteration Alternative below and, therefore, be less costly for similar alignments.

7.3.5 Tidal Hydrodynamics

Alternative 2 – Moderate Alteration, Existing Sea Level

Tides simulated for Alternative 2 are shown in Table 7-9. All sites except the Isthmus Area are connected to seawater sources with open channels, and internally they are composed of open channel networks. The exception is the Isthmus Area that is connected to the San Gabriel River by culverts. As a result, the Northern and Central Areas will possess a nearly full tide range, while the Isthmus Area will possess muted tidal ranges. The Southeast Area experiences a limited tide too due to the grading plan required to achieve the concept plan. The site is envisioned to be relatively high and, therefore, does not experience low tides of a full tidal system under existing sea levels. This situation will become less constraining as sea level rises.

Table 7-9. Alternative 2 Spring Tidal Elevations and Ranges

Site Within the LCW	Specific Location on the Site	Existing Sea Level			1.5' Sea Level Rise			5.5' Sea Level Rise		
		High	Low	Range	High	Low	Range	High	Low	Range
Northern	Synergy Retained	4.2	-3.9	8.1	5.8	-2.5	8.3	9.8	1.5	8.3
Central	LCWA Phase I	4.2	-3.6	7.8	5.7	-2.3	8.0	9.7	1.6	8.1
Isthmus	Zedler Marsh	4.1	0.7	3.4	5.2	0.8	4.4	7.6	3.8	3.8
	Callaway Marsh	4.2	1.0	3.2	5.5	1.0	4.5	8.1	2.0	6.1
Southeast	LCWA Phase II and Hellman Retained	4.1	2.0	2.1	7.7	2.1	5.6	9.7	2.8	6.9

Alternative 2 – Moderate Alteration, SLR

As with Alternative 1, tide ranges and elevations increase at every site with SLR of 1.5 feet. This result indicates that culverts are sufficient in size to convey the increased volume of seawater between tide cycles. Further SLR of 5.5 feet results in a similar trend, with the exception of Zedler Marsh that experiences a reduced tidal range compared to a SLR of 1.5 feet. Under SLR of 5.5 feet the tidal conveyance of the culvert at Zedler Marsh limits the volume of seawater exchange to and from the San Gabriel River and the tidal range becomes compressed. If necessary, the culvert to Zedler can be re-evaluated in the future to provide a larger tidal range in the future.

Tidal Inundation Frequency

Tidal inundation frequency analyses were also performed on Alternative 2 with tidal hydraulic modeling results. Tidal inundation frequency affects ultimate habitat distribution. Plots show all areas under various sea level conditions for Alternative 2 and analyses are provided.

Northern Area, Alternative 2, Existing Sea Level

Alternative 2 is a system of open channel connections throughout the Northern Area and tidal conveyance is optimal. Figure 7-77 shows the tidal inundation frequency curve for existing sea level conditions at the Northern Area. The range of elevations for salt marsh habitat is broad and reflects a full tidal system. The habitat range is from +4.2 feet to -3.8 feet NGVD, which is very similar to that existing at Steam Shovel Slough at this time. The elevation range is slightly compressed on the low end due to the increased volume of seawater leaving the site through the existing entrance channel. If necessary, that channel could be deepened to improve its hydraulic conveyance. Habitat is dominated by high marsh.

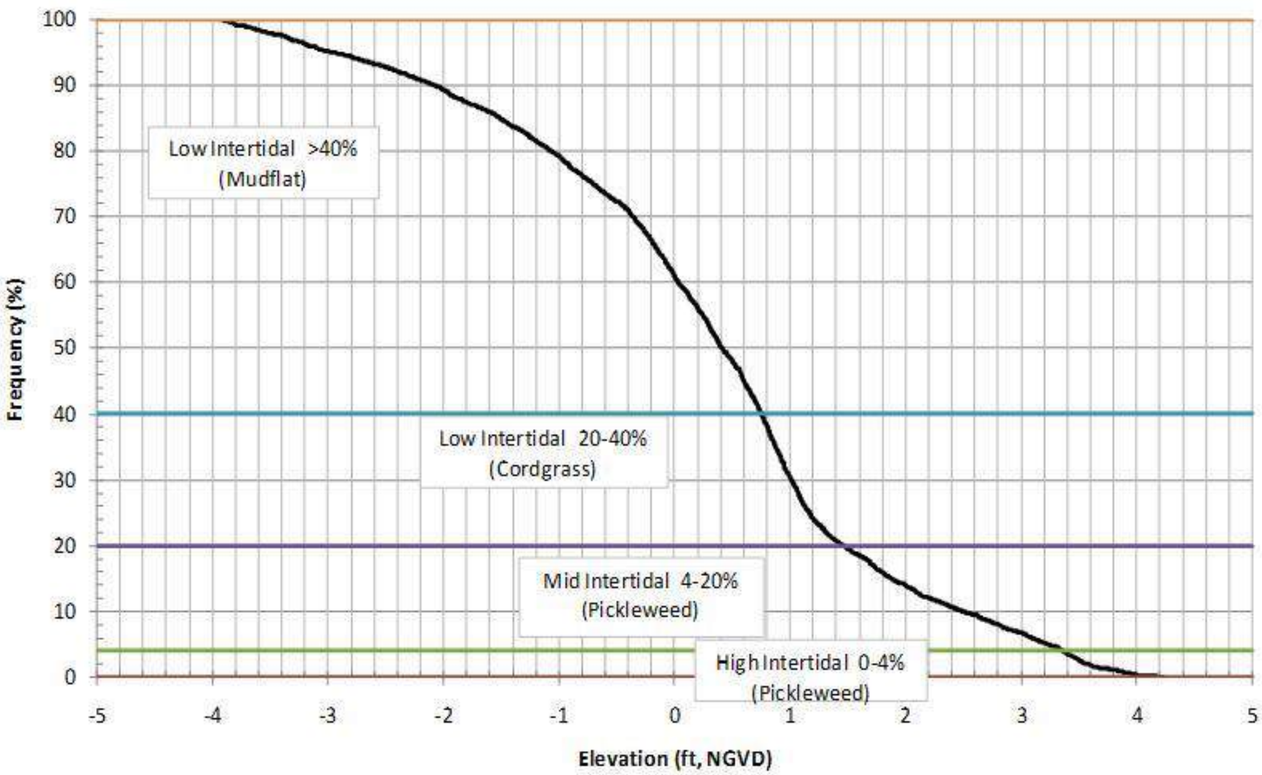


Figure 7-77. Tidal Inundation Frequency at the Northern Area for Alternative 2, Existing Sea Level

Northern Area, Alternative 2, SLR of 1.5 Feet and 5.5 Feet

Figure 7-78 shows conditions under SLR of 1.5 feet. The range of elevations for salt marsh habitat reflects the full tidal condition with a range from +5.7 feet to -2.4 feet NGVD. The inundation frequency curve simply moves upward in elevation with SLR while retaining the same shape as the full tidal conditions. Habitat proportions change from primarily high marsh, to more equal components of mudflat and mid-marsh.

Figure 7-79 shows conditions under SLR of 5.5 feet. The elevations for salt marsh habitat range from +9.7 feet to 1.6 feet NGVD. The existing elevation of the site results in formation of a preponderance of mudflat and subtidal habitats under this scenario, with much less salt marsh than lower water conditions.

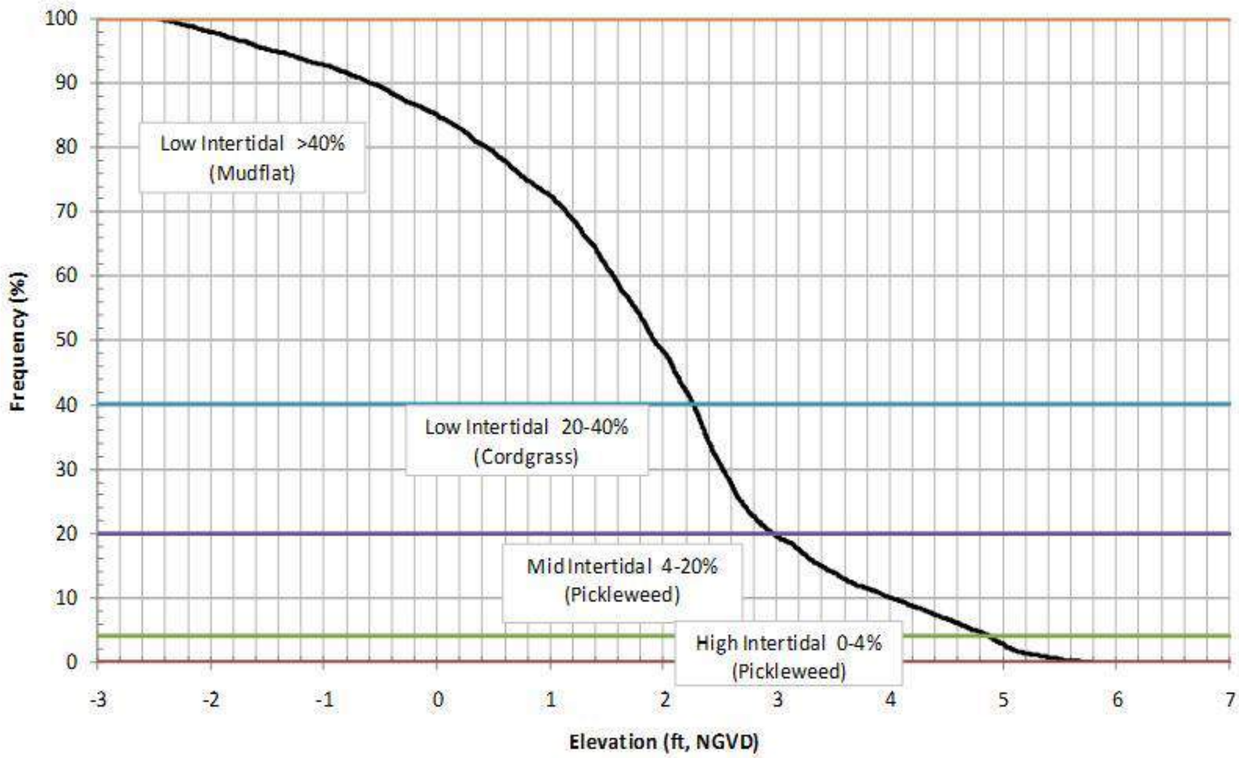


Figure 7-78. Tidal Inundation Frequency at the Northern Area for Alternative 2, SLR of 1.5 Feet

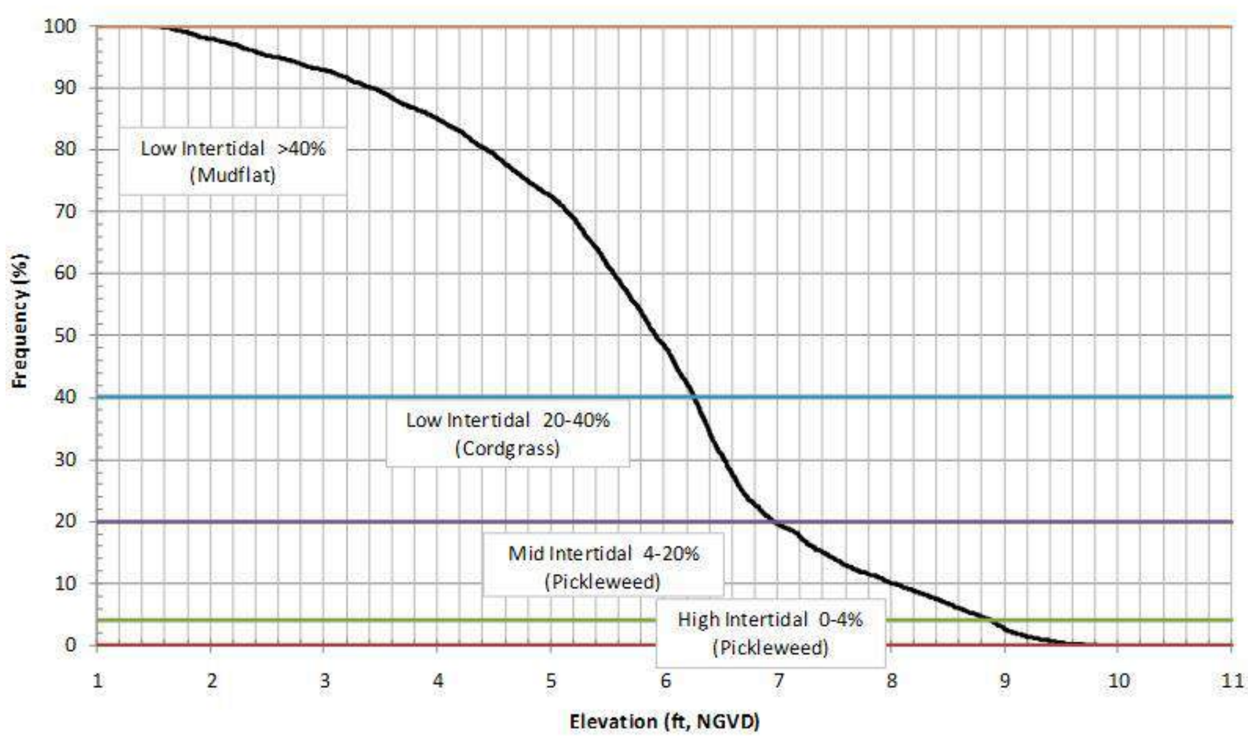


Figure 7-79. Tidal Inundation Frequency at the Northern Area for Alternative 2, SLR of 5.5 Feet

Central Area, Alternative 2, Existing Sea Level

Figure 7-80 shows the tidal inundation frequency curve for existing sea level conditions at the Central Area for Alternative 2. The wetland is connected to the San Gabriel River as the source of seawater. The range of elevations for salt marsh habitat is representative of full tidal conditions in all areas. The marsh ranges in elevation from +4.2 feet to -3.6 feet NGVD. Virtually no restrictions exist to tidal elevations other than the tide range of the San Gabriel River. Alternative 2 proposes creation of channel network to provide the full range of habitat elevations, and an abundance of salt marsh habitat will exist under this scenario.

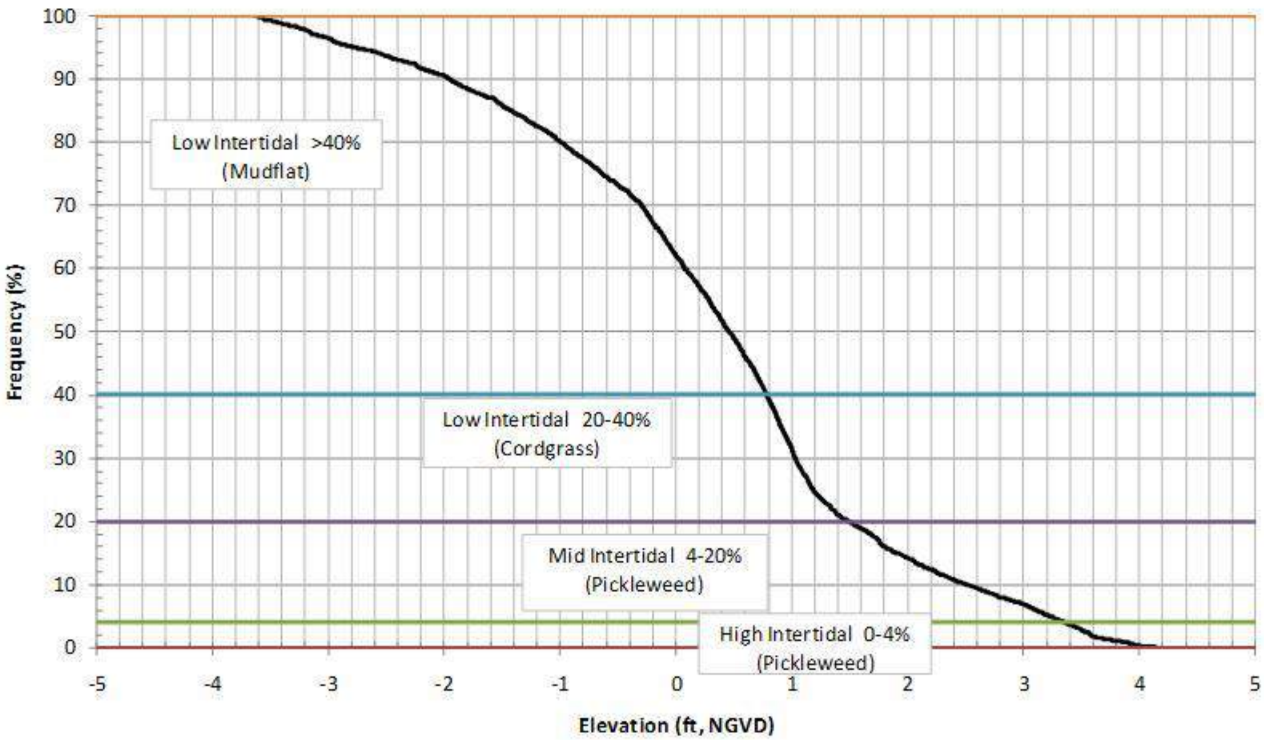


Figure 7-80. Tidal Inundation Frequency at the Central Area for Alternative 2, Existing Sea Level

Central Area, Alternative 2, SLR of 1.5 Feet and 5.5 Feet

Figure 7-81 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Central Area for Alternative 2. The range of elevations for salt marsh habitat still reflects full tidal conditions, as would be expected from an open channel connection. The marsh ranges in elevation from +5.7 feet to -2.3 feet NGVD. The elevation of the site is mainly within the range of mudflat and marsh habitats, and less supra-tidal habitat area remains under this SLR scenario.

Figure 7-82 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Central Area. The range of elevations for salt marsh habitat remains full tidal, and the marsh ranges in elevation from +9.7 feet to +1.7 feet NGVD. No restrictions exist to tidal elevations reached in the marsh. However, with the elevation of the site being largely within the range of subtidal and mudflat habitats, very little marsh area remains under this SLR scenario.

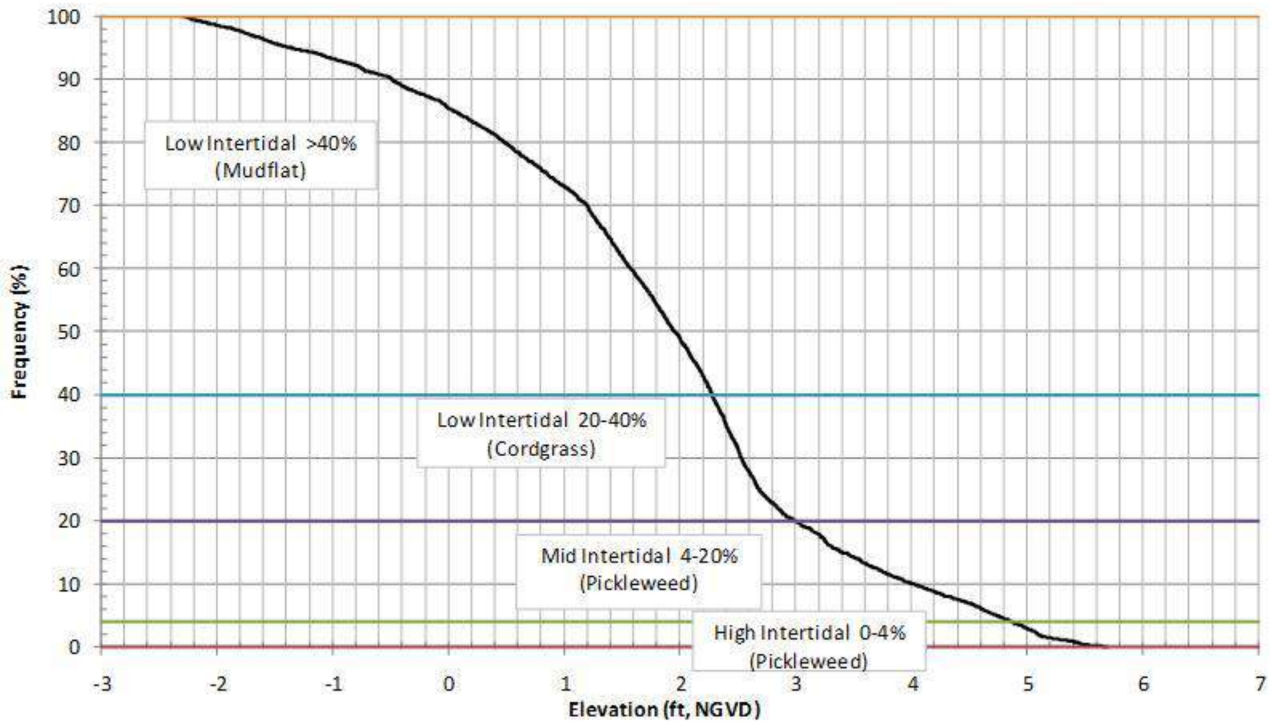


Figure 7-81. Tidal Inundation Frequency at the Central Area for Alternative 2, SLR of 1.5 Feet

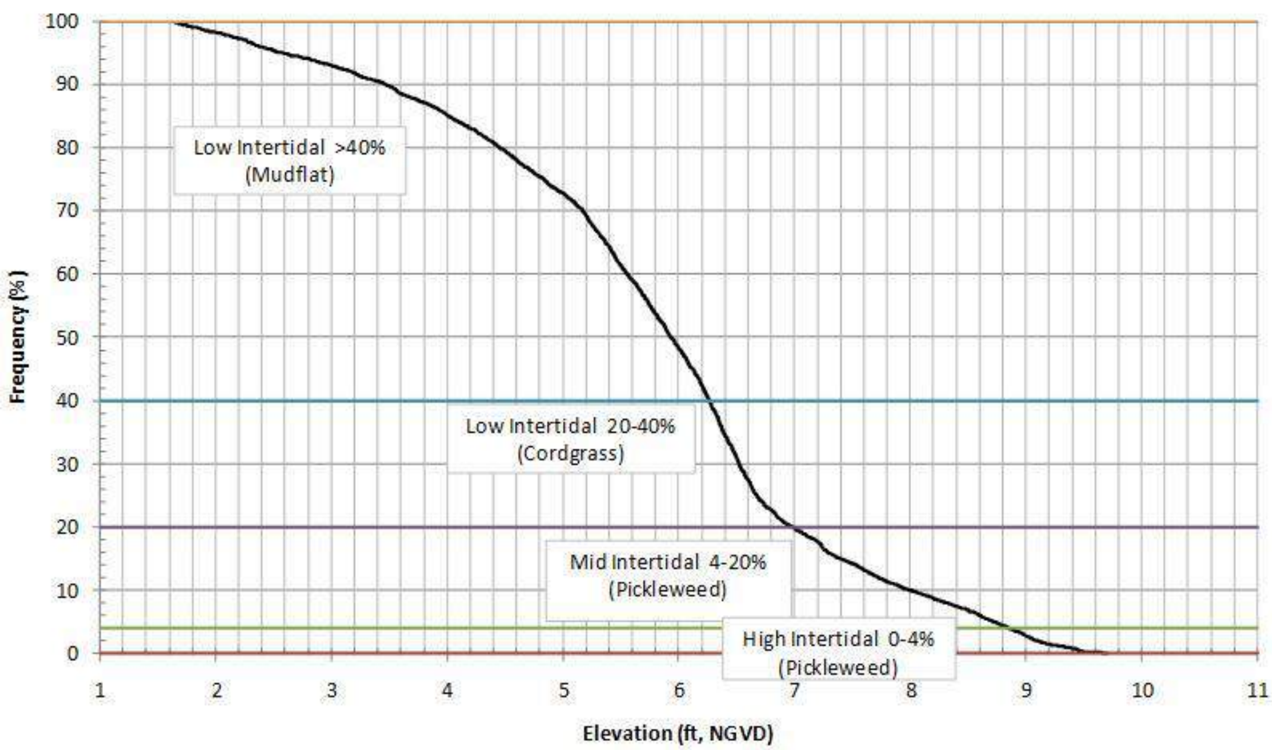


Figure 7-82. Tidal Inundation Frequency at the Central Area for Alternative 2, SLR of 5.5 Feet

Isthmus (Zedler and Callaway Marshes), Alternative 2, Existing Sea Level

Alternative 2 at the Isthmus Area is the same as Alternative 1, so all tidal conditions are the same. Figure 7-83 shows the tidal inundation frequency curve for existing sea level conditions at Zedler and Callaway Marshes on the Isthmus. The San Gabriel River is the source of seawater. The ranges of elevations for salt marsh habitat are limited to +3.8 feet to +1.0 feet NGVD at both marshes, with slightly lower mudflat at Zedler Marsh as compared to Callaway Marsh due to a slightly lower culvert. The limited vertical ranges of habitats are due to the limitation of the culvert connections to the San Gabriel River, with the invert at Callaway Marsh being at +1.0 feet NGVD and the culvert at Zedler Marsh being at +0.5 feet NGVD. Habitat elevation ranges could be increased with lower and possibly larger culverts at each site, respectively. Habitats are dominated by supra-tidal areas for this scenario.

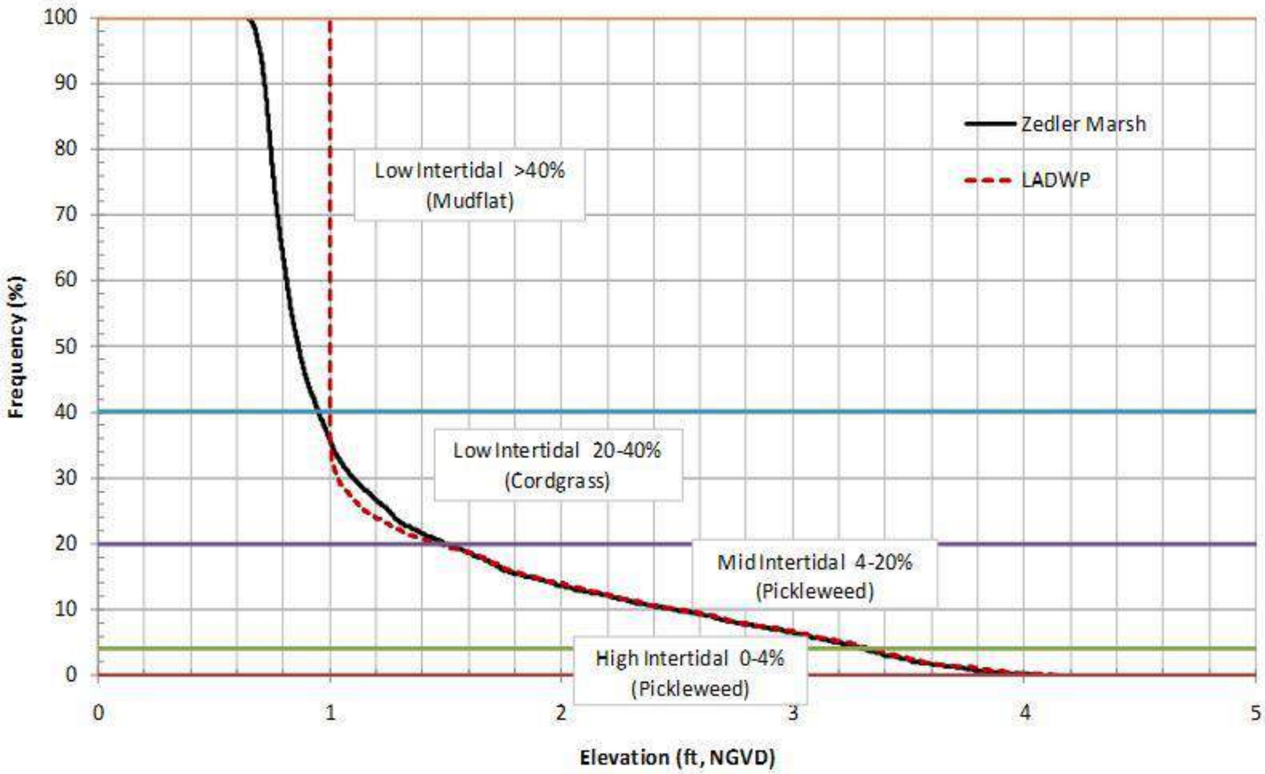


Figure 7-83. Tidal Inundation Frequency at the Isthmus for Alternative 1, Existing Sea Level

Isthmus (Zedler and Callaway Marshes), Alternative 2, SLR of 1.5 Feet and 5.5 Feet

Figure 7-84 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at Zedler and Callaway Marshes on the Isthmus for Alternative 2. The range of elevations for salt marsh habitat is still limited, but to a lesser extent than for existing sea level conditions. The marsh ranges in elevation from +5.2 feet to +0.8 feet NGVD. The same limitations and potential remedies apply for this situation as compared to existing conditions. Habitats are still dominated by supra-tidal areas, with increasing high and mid-marsh.

Figure 7-85 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at Zedler and Callaway Marshes on the Isthmus Area. The range of elevations for salt marsh habitat remains limited in all areas, but to a lesser extent than both existing sea level conditions and with SLR of 1.5 feet. The marsh ranges in elevation from +7.6 feet to +4.0 feet NGVD at Zedler. Tides range a bit more at Callaway Marsh because of its smaller area and tidal prism compared to Zedler. The reduced seawater volume at Callaway is able to pass through the culvert efficiently during a spring tidal cycle. The same limitations and potential remedies apply for this situation as compared to existing conditions and with SLR of 1.5 feet, with the possible addition of a larger culvert to Zedler Marsh to convey the increased tidal prism possessed at the site as compared to Callaway Marsh. Habitat is dominated by mudflat under this scenario.

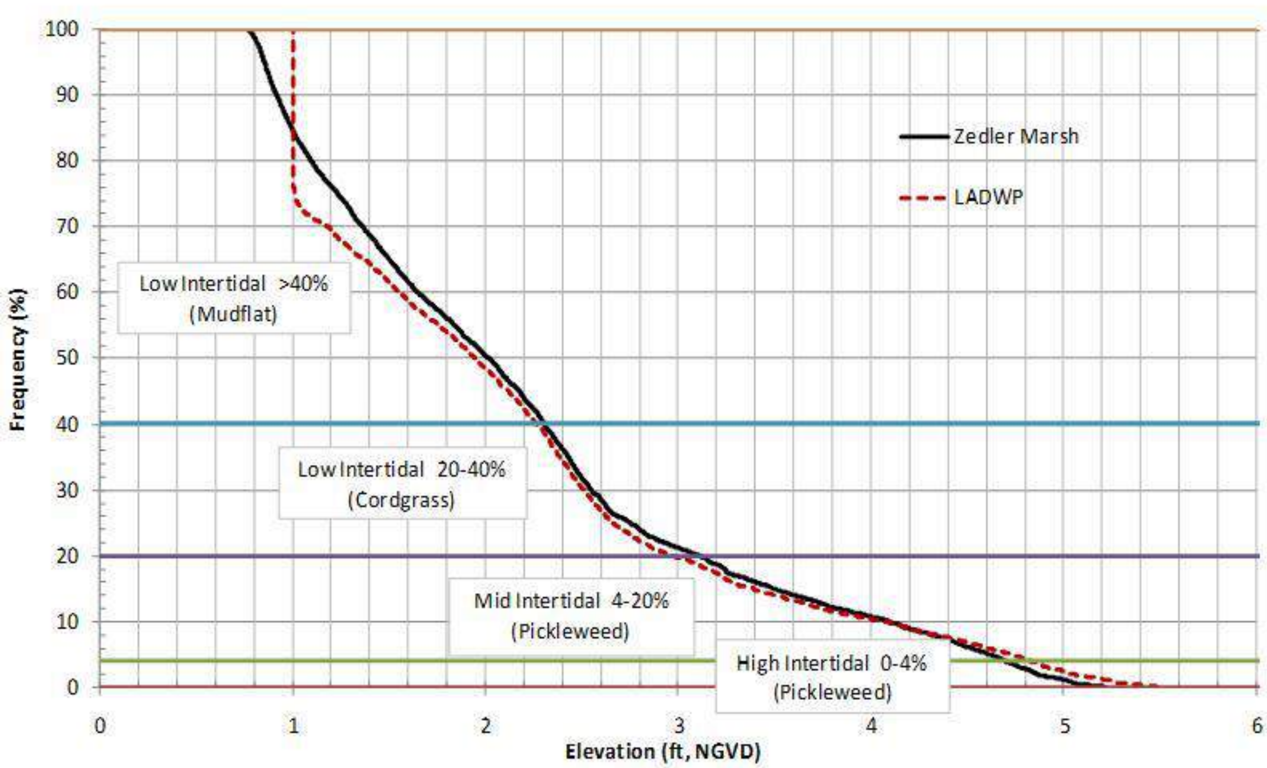


Figure 7-84. Tidal Inundation Frequency at the Isthmus for Alternative 2, SLR of 1.5 Feet

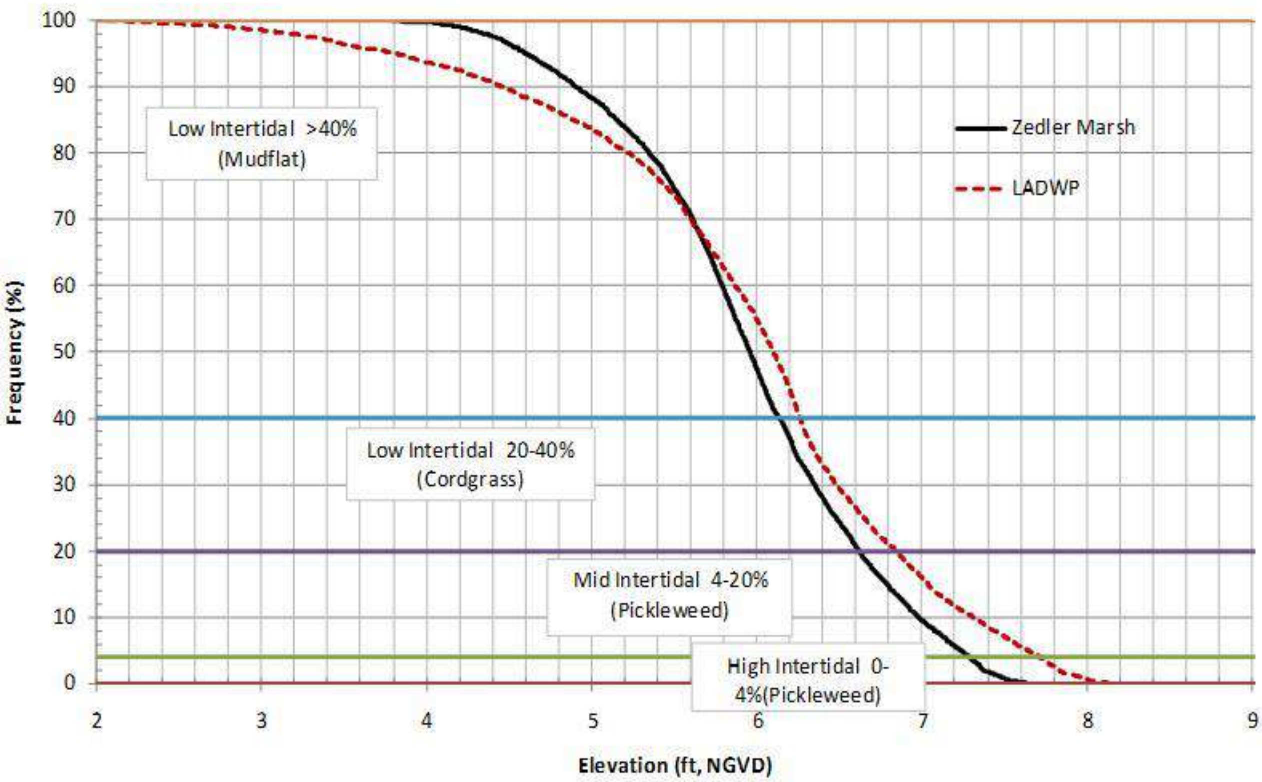


Figure 7-85. Tidal Inundation Frequency at the Isthmus for Alternative 2, SLR of 5.5 Feet

Southeast Area, Alternative 2, Existing Sea Level

Figure 7-86 shows the tidal inundation frequency curve for existing sea level conditions at the Southeast Area for Alternative 2. The HCC is the source of seawater and the site is connected with an open channel. The range of elevations for salt marsh habitat represents full tidal conditions in all areas. The marsh ranges in elevation from +4.2 to -3.6 feet NGVD over the entire site. Although tidal ranges are broad, the elevation of the site results in habitats being dominated by high marsh and supra-tidal habitats.

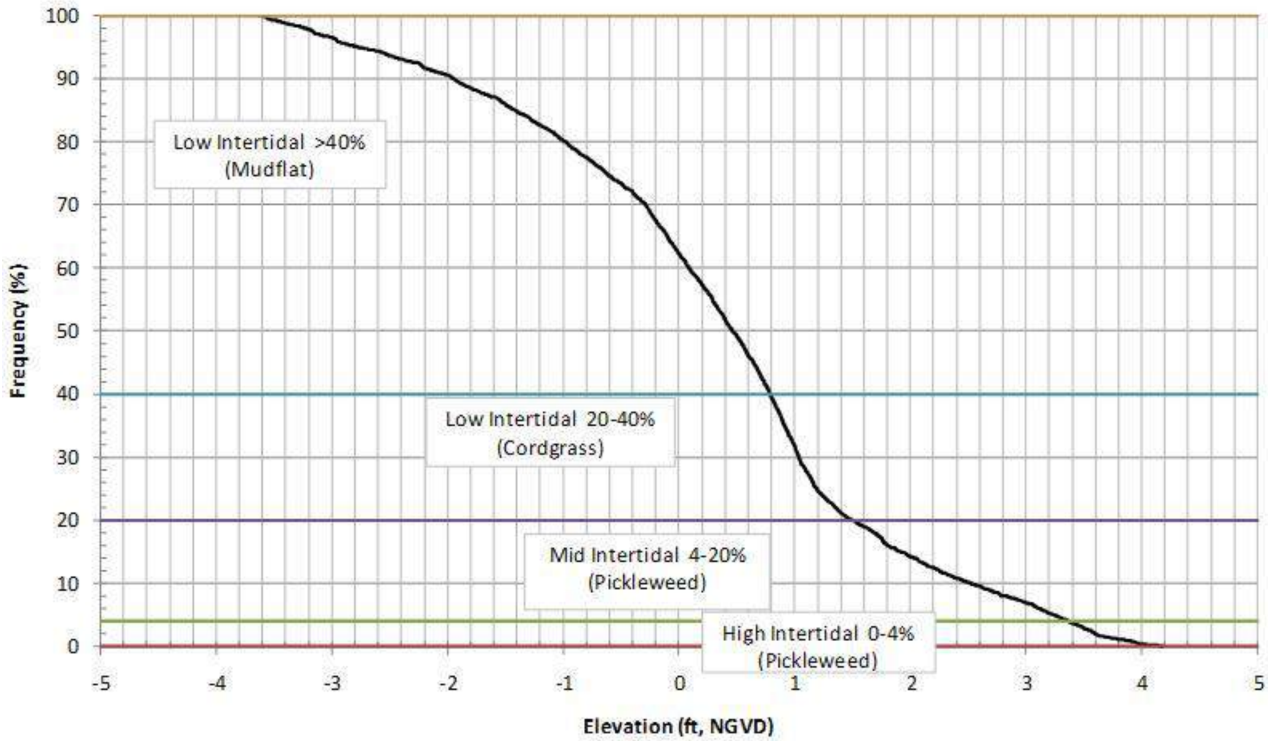


Figure 7-86. Tidal Inundation Frequency at the Southeastern Area for Alternative 2, Existing Sea Level

Southeast Area, Alternative 2, SLR of 1.5 Feet and 5.5 Feet

Figure 7-87 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Southeast Area for Alternative 2. The range of elevations for salt marsh habitat is still represented of full tidal conditions and habitats range in elevation from +5.6 feet to -2.2 feet NGVD. Due to the high elevation of the site the habitats are still dominated by supra-tidal and high marsh habitats.

Figure 7-88 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Southeast Area for Alternative 2. The range of elevations for salt marsh habitat remains full tidal and the marsh ranges in elevation from +9.7 feet to +2.3 feet NGVD. Site elevations result in habitat being dominated by mudflat, marsh, and supra-tidal habitats. This site presents the most balanced range of habitats than any site under this SLR scenario.

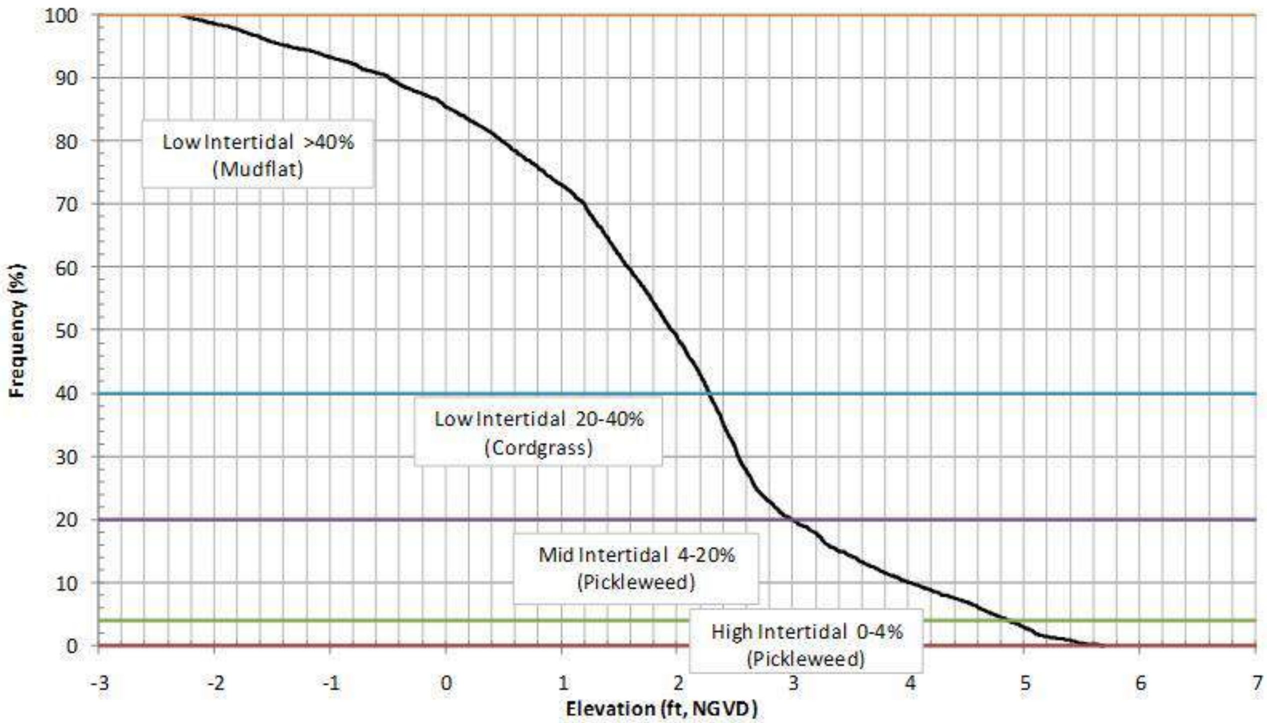


Figure 7-87. Tidal Inundation Frequency at the Southeast Area for Alternative 2, SLR of 1.5 Feet

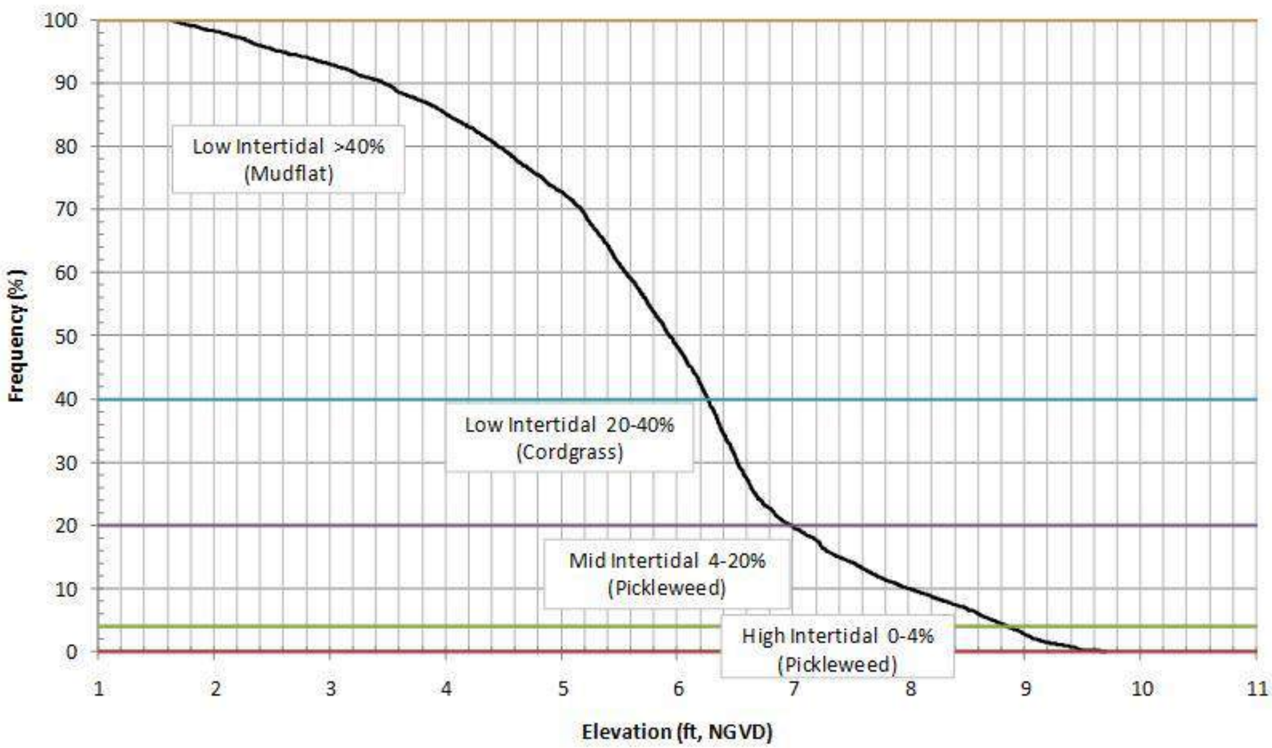


Figure 7-88. Tidal Inundation Frequency at the Southeast Area for Alternative 2, SLR of 5.5 Feet

The results of the tidal inundation frequency analyses are predicted habitat elevation bands for the alternatives. The analyses indicate the elevation ranges where habitat should occur, and these are shown on the grading plans that set elevations. Figure 7-89 through Figure 7-100 show the areas to be occupied by each habitat category under the three water level conditions of existing sea level, and SLR of 1.5 feet and 5.5 feet, respectively.

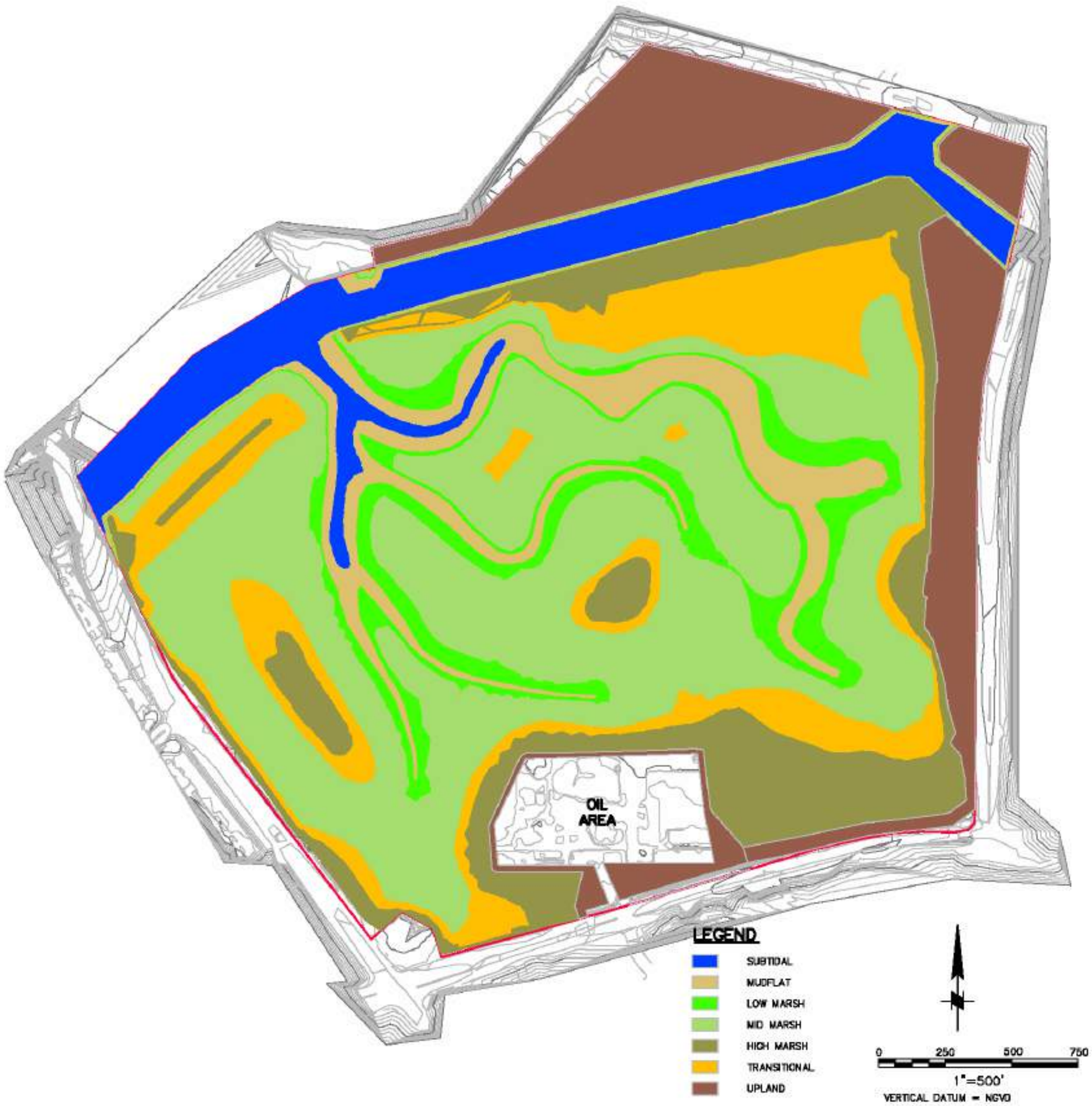


Figure 7-89. Habitat Elevation Bands, Moderate Alteration, Northern Area – Existing Sea Level

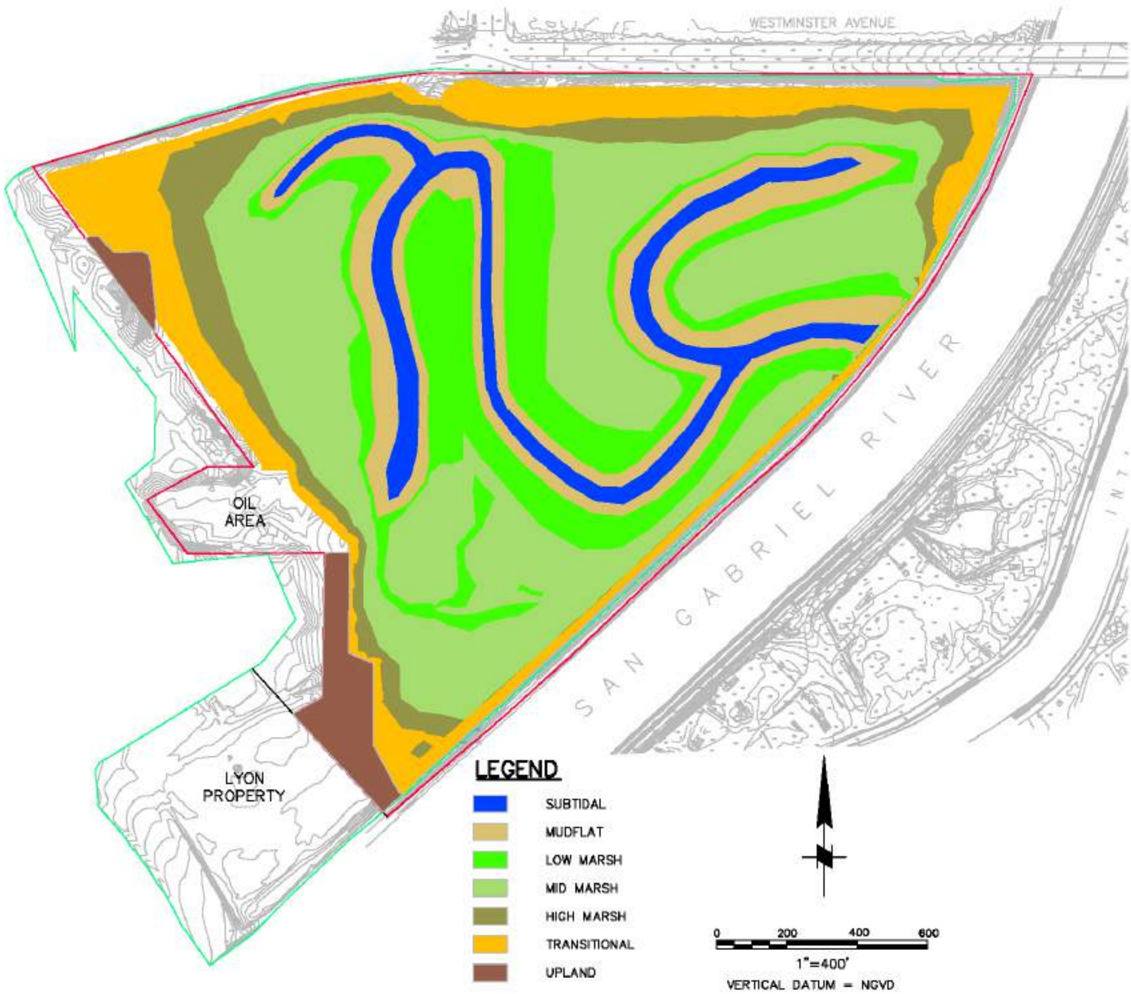


Figure 7-90. Habitat Elevation Bands, Moderate Alteration, Central Area – Existing Sea Level

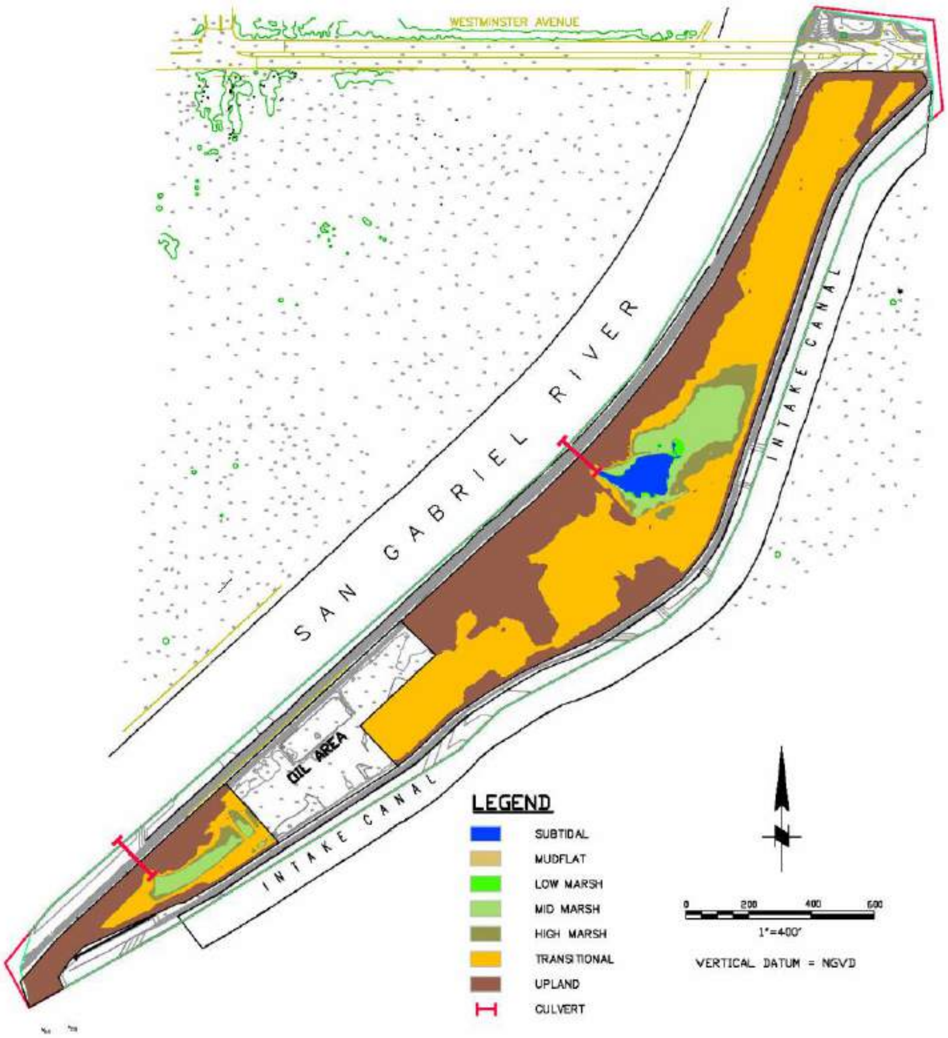


Figure 7-91. Habitat Elevation Bands, Moderate Alteration, Isthmus – Existing Sea Level

Figure 7-92. Habitat Elevation Bands, Moderate Alteration, Southeast Area – Existing Sea Level

Figure 7-93. Habitat Elevation Bands, Moderate Alteration, Northern Area – Sea Level +1.5 ft

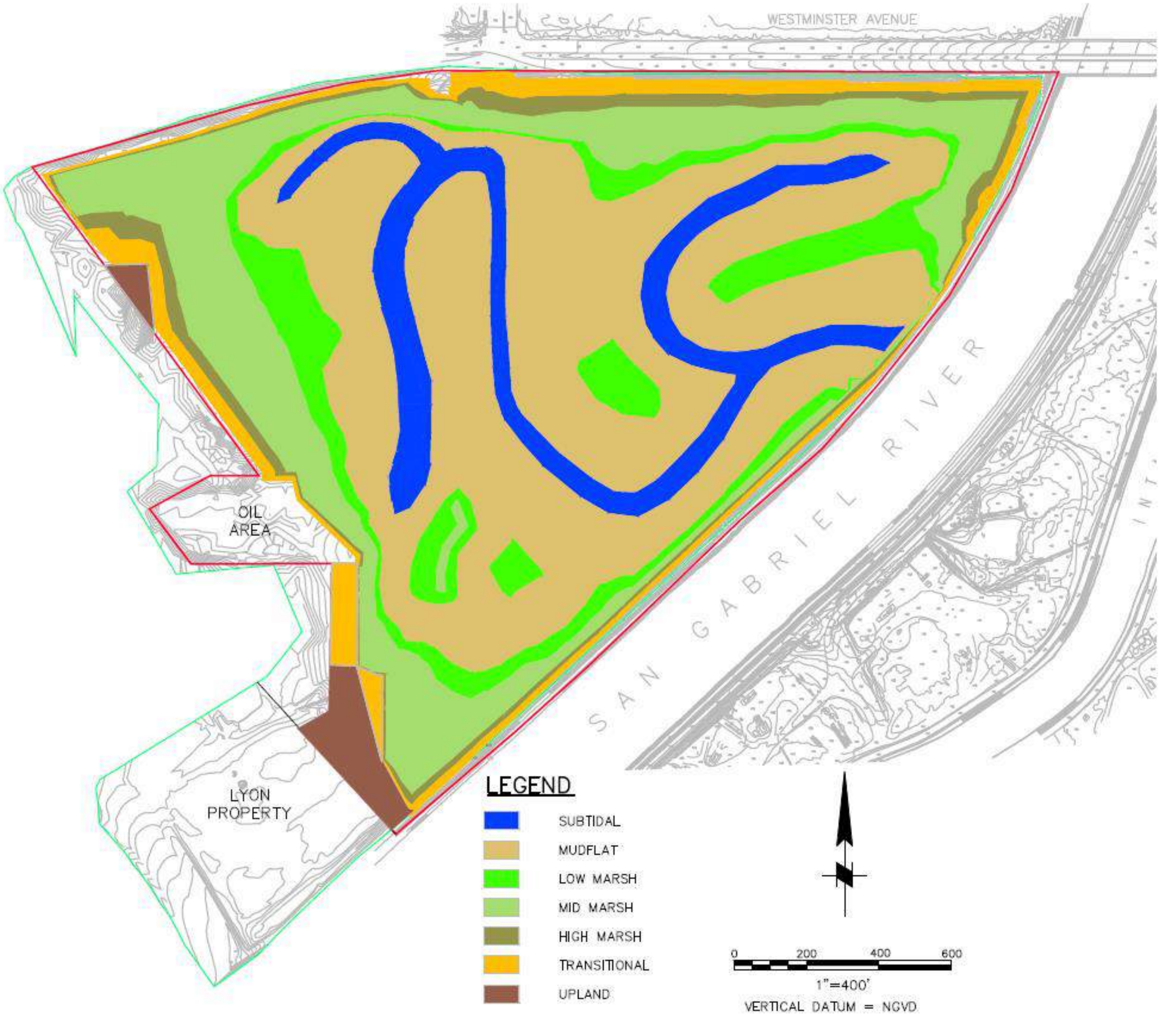


Figure 7-94. Habitat Elevation Bands, Moderate Alteration, Central Area – Sea Level +1.5 ft

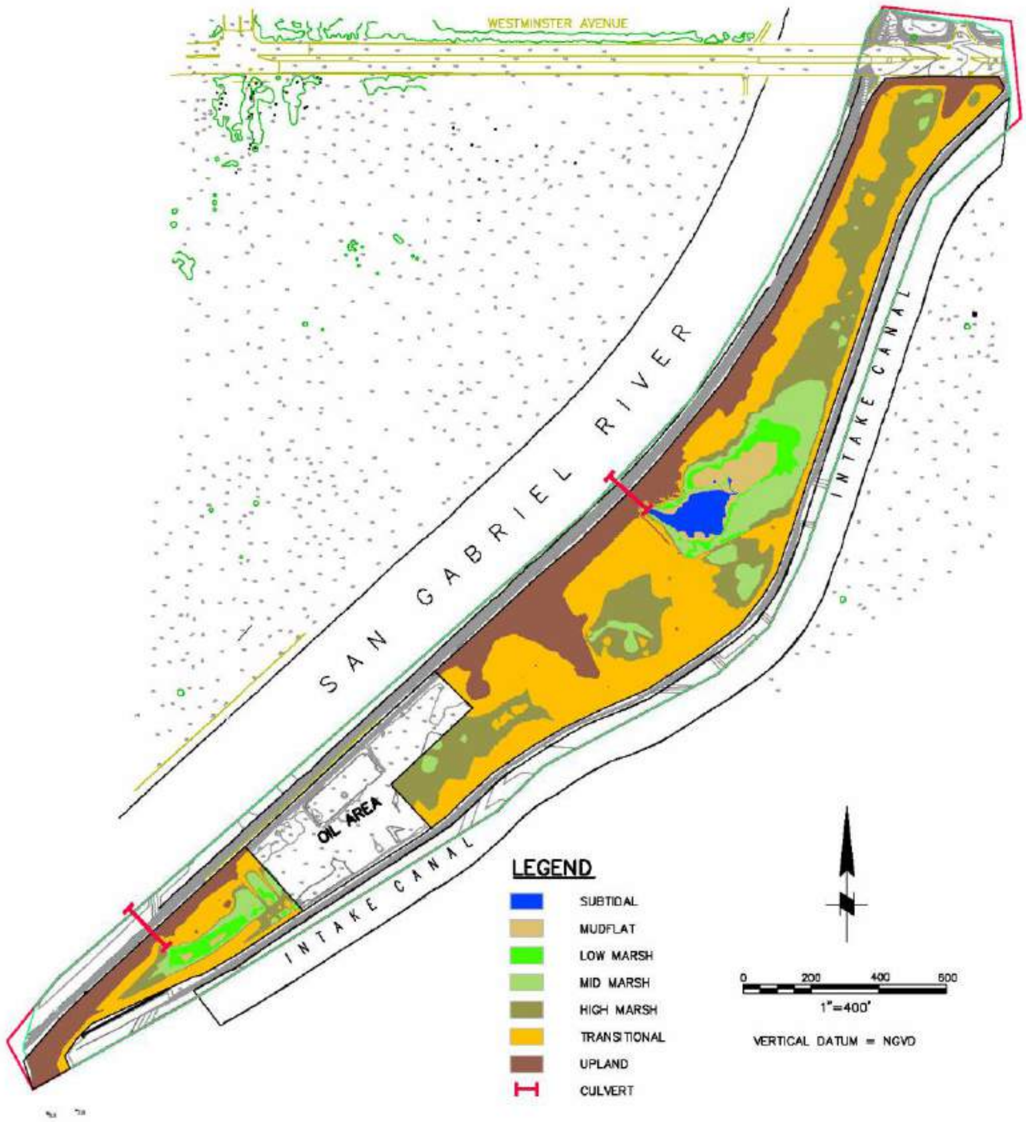


Figure 7-95. Habitat Elevation Bands, Moderate Alteration, Isthmus – Sea Level +1.5 ft

Figure 7-96. Habitat Elevation Bands, Moderate Alteration, Southeast Area – Sea Level +1.5 ft

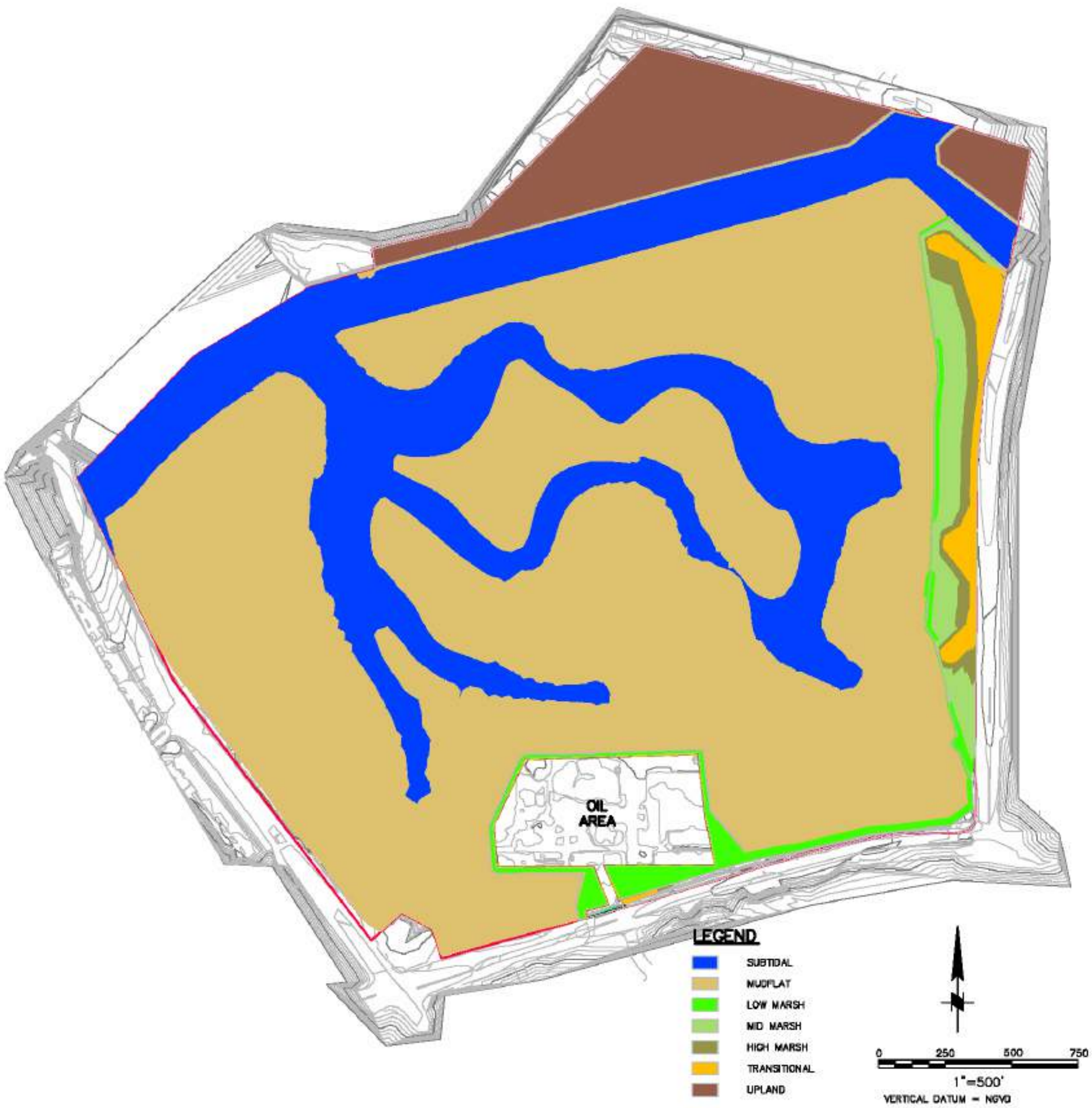


Figure 7-97. Habitat Elevation Bands, Moderate Alteration, Northern Area – Sea Level +5.5 ft

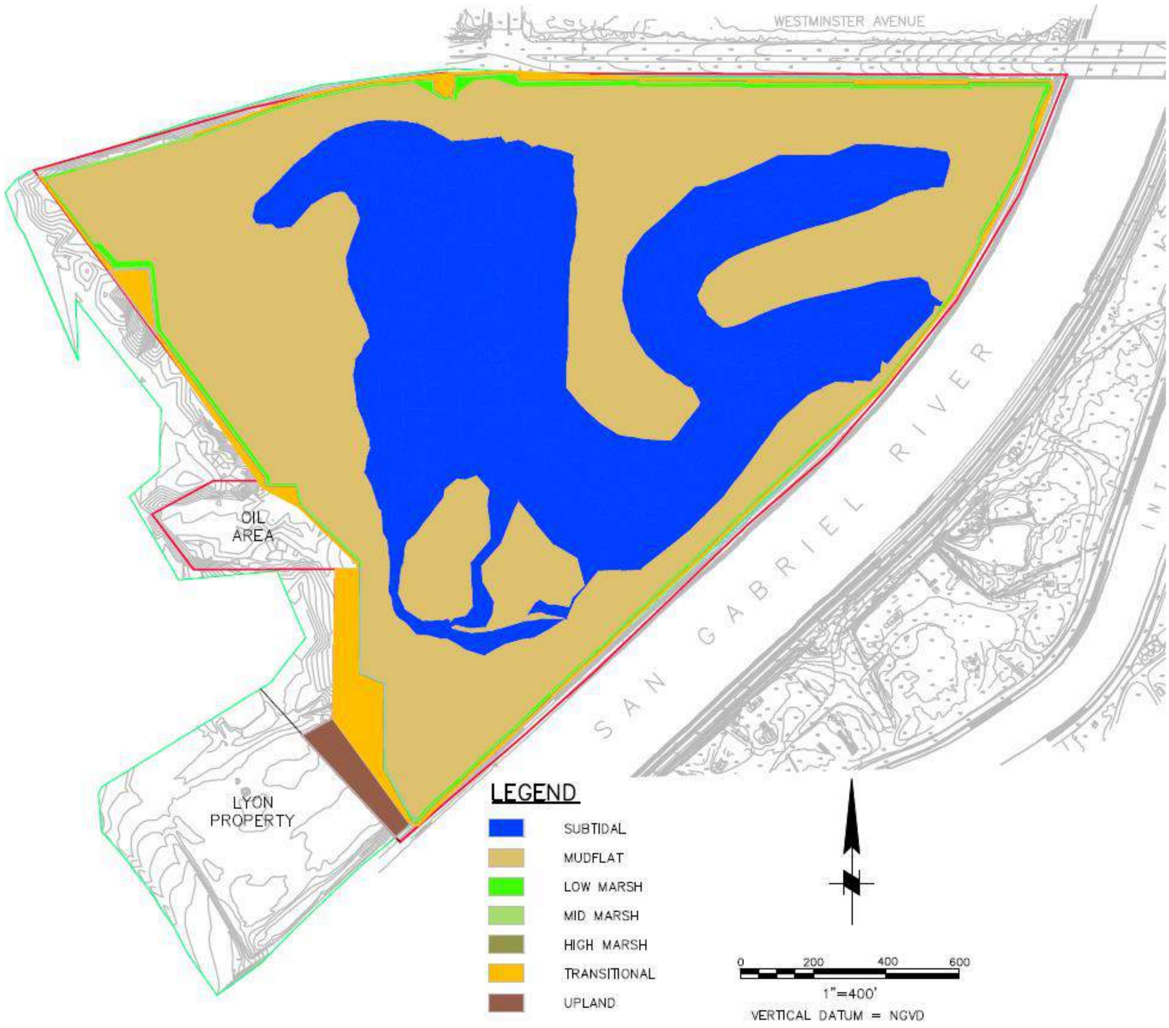


Figure 7-98. Habitat Elevation Bands, Moderate Alteration, Central Area – Sea Level +5.5 ft

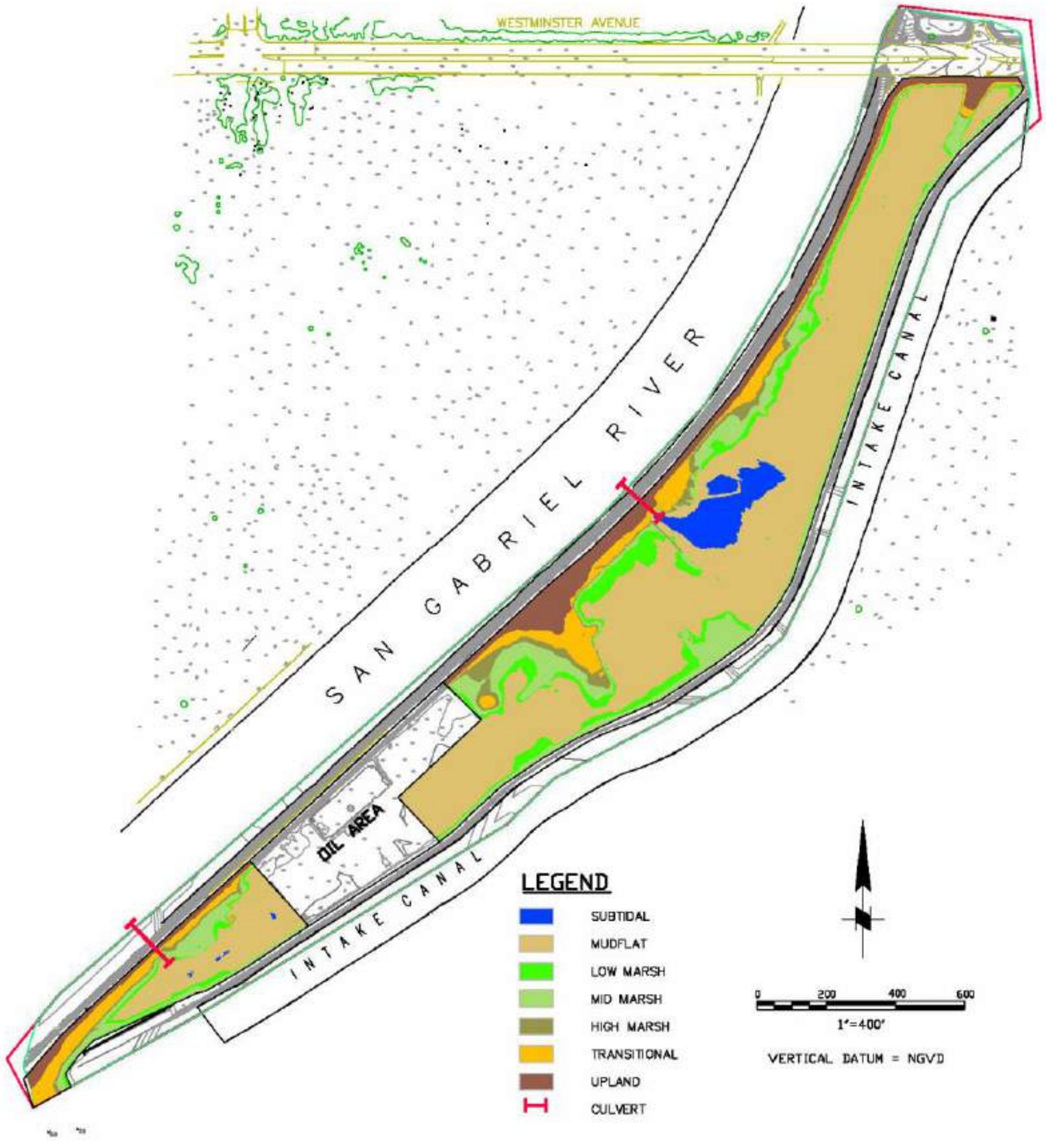


Figure 7-99. Habitat Elevation Bands, Moderate Alteration, Isthmus – Sea Level +5.5 ft

Figure 7-100. Habitat Elevation Bands, Moderate Alteration, Southeast Area – Sea Level +5.5 ft

7.3.6 Construction Methods

Alternative 2, Moderate Alteration, lends itself to consideration of both “wet” (dredging) and “dry” (earthwork) construction. Dredging becomes more viable when certain conditions exist at a site such as it already being under water or extremely saturated, connected to a water channel, and planned for subtidal habitat as to render the operation cost-effective. Water-born equipment includes a dredge or barge-mounted backhoe, boats, barges, scows, tugs, pumps and discharge lines, booster pumps, and possibly other items. Wet construction involves removing material below water by dredging.

Two of the sites (the Northern and Central Areas) would be full tidal with subtidal habitat, and connected to major channels. The remaining two areas are less suited for dredging and more suited for construction in the dry. The Isthmus Area is to be left relatively unchanged with little or no material to be removed, and the Southeast Area is relatively high in elevation and will not be converted to subtidal habitat. Although dredging is an option for the Northern and Central Areas, it still may be less cost-effective for the contractor due to added complications of: 1) requiring water level control to constantly float the dredge; 2) disposal of the dredge slurry; and 3) multiple mobilizations of the dredge at separate areas. Each item is elaborated upon below.

The water level at the dredge site needs to remain high enough to constantly float the dredge through all tide cycles. To accomplish this, sites are typically diked-off to the tides and continually flooded with seawater while the dredge pumps its slurry out of the site. Steam Shovel Slough would likely have to be diked off while construction occurs. The duration of dredging could extend over 170 working days if the total volume of material to be removed (341,442 cubic yards [cy]) is divided by the daily dredge production rate for a small dredge (approximately 2,000 cy per day). This time period may be too long for the site to be flooded due to habitat impacts.

The dredge slurry needs to be disposed of or re-used at an appropriate site. Dredge slurry could be barged offshore to a designated disposal site such as LA-2 off San Pedro and/or LA-3 off Newport Beach, or possibly re-used at the Port of Long Beach. Re-using of the material on site is challenging because the dredge slurry is 80% water and 20% solids, so it requires dewatering prior to re-use. Therefore, a sufficient area for dewatering is required, and a beneficial use needs to be identified. Dredged material disposal and/or re-use adds cost to the project. There are no large-scale fill areas on site as part of this alternative, so beneficial re-use may have to occur offsite, requiring hauling of the material to another site by truck with associated impacts and costs. The total surplus volume for disposal/re-use is 580,000 cy from the LCW for this scenario.

If some of the material were composed primarily of sand (80% or more), with the remaining portion being silts and clays, then it may be feasible to place some of it at the beach or nearshore coastal ocean off Long Beach as beneficial re-use. Another potential re-use option for sandy material would be creation of a nesting site within the project area. This alternative does not include such a feature at this time, but it could potentially be considered in the future.

Finally, the dredge could be mobilized and floated into Steam Shovel Slough for construction at the Northern Area. However, if that dredge were also to work at the other subtidal site at LCW (the Central Area), then it would have to be demobilized from the Northern Area and remobilized to the Central Area; thereby increasing costs. The other option of mobilizing the dredge from the Northern Area to the Central Area would be to float it through Alamitos Bay to the ocean, and then from the ocean upstream on the San Gabriel River to the entrance channel to the Central Area. This is potentially hazardous however, as the San Gabriel River is characterized by shallow shoals and high tidal flow velocities. Additionally the entrance channel to the Central Area is anticipated to be relatively small in cross-section and may not be sufficient for passage of a dredge.

One possible construction scenario is summarized below for Alternative 2. As is the case for Alternative 1, this scenario is hypothetical and is just one of possibly multiple scenarios that a contractor could devise. As such, it should not be considered the only approach to take, nor should it be the required approach when restoration commences. It is provided to demonstrate actions to be expected on-site to build the project for purposes of decision-making.

Alternative 2 could be constructed entirely in the dry from land using backhoes, excavators, earthmovers, scrapers, bulldozers, front-end loaders, dump trucks, and other land-based equipment. As previously mentioned, the equipment operates above water in dry conditions, and reaches into wetter areas to remove earth material and recontour the site. Construction equipment would enter the site and work from the existing oil and access roads to excavate earth material, as needed, to implement the grading plan. The work would consist of more extensive grading than Alternative 1 on every site except the Isthmus Area (which is left nearly the same for Alternatives 1 and 2). Large-scale channel networks would be installed in the Northern and Central Areas, and a smaller channel network would be installed in the Southeast Area. Installing these channels could require the contractor to install a temporary construction road network to increase the access to all site areas. In addition, specialized construction equipment that runs on tracks rather than on rubber tires may be needed to access extremely wet soil areas (*e.g.*, trucks, bulldozers, earthmovers, backhoes, etc.). Such equipment was necessary to successfully construct a network of channels under similar conditions at Huntington Beach Wetlands in 2009-2010.

It is assumed that the overall approach for earthmoving could be to work “backward” from the most seaward portion of the site that is closest to the channel and designed to be the lowest point in elevation, back toward the higher portions of the site closer to the construction access location. Dewatering of all land-based construction sites would be required on an ongoing basis. The contractor may incrementally create a system of cells over the site using oil roads and dikes to dewater smaller portions off the site and excavate the desired channel pattern. Once the work in one cell is complete, the contractor may move on to a new area and erect a new dike to create another working sub-area, and then remove the former dike. Alternatively, the contractor may leave cells diked off until excavation is complete and then remove all dikes from downstream to upstream (channel to upland) in one coordinated operation. This could potentially provide a benefit of reduced dewatering during excavation.

Performing earthwork in the dry season is preferred over working in the wet season to reduce dewatering and weather-related interruption to construction. As with all other alternatives, the timing of construction may also be affected by the patterns of nesting and breeding birds. The nesting season window can extend from mid-February through mid-September, which coincides with a large portion of the dry season. As is the case for the previous alternative, the LCWA may need to work during the majority of the wet season to avoid nesting birds, and/or attempt to negotiate some type of exception to avoidance of the bird nesting season for construction.

7.3.7 Maintenance Regime

Alternative 2 will require long-term maintenance. Items such as fencing, trails, culverts, etc., require periodic attention to prevent replacement. Maintenance actions for Alternative 2 are itemized and briefly described below. Partnerships between the LCWA and other site owners and managers (*e.g.*, oil operators at their surface lease sites, Los Angeles County Department of Public Works, and the OCFCD) should be maintained and encouraged. The LCW SP should also be utilized where applicable to maximize cost effectiveness of maintenance.

On-Going Maintenance

- Vegetation management - This category covers: 1) non-native weed control, 2) dry brush control for fire and 3) clearance of vegetation from around oil operations. Items 1 and 2 would be required of the LCWA (with the LCW SP), while Item 3 would be done by the oil operators. Alternative 2 likely requires less vegetation management than Alternative 1 due to proposed consolidation of oil facilities and associated reduced level of disturbance and fragmentation.
- Culvert cleaning and repair – Culverts connecting the sites to seawater sources may need to be periodically cleaned or cleared of marine growth and/or obstructions, and repaired of any damage (*e.g.,* leaks, breaks). If the culverts function adequately without being cleaned, this action could be deferred. If, however, tidal conveyance is compromised in the future by constrictions caused by marine growth (referred to as biofouling), then culvert cleaning should occur. Few culvert cleaning efforts have occurred at restored wetlands. Most sites function with culverts partially constricted. Biofouling occurs to an extent and then ceases, so the constriction effect is limited. Culverts do not typically completely close with marine growth because flows scour the inner surfaces. Fewer culverts exist with Alternative 2 compared to Alternative 1, so a reduced degree of culvert cleaning and repair may be required.
- Graffiti –Graffiti removal should be an ongoing concern for regular implementation. Alternative 2 should require less graffiti removal than Alternative 1 because oil consolidation will occur, offering fewer places to vandalize.
- Removal of trash – Significant volumes of trash reach the sites through the Los Cerritos Channel and San Gabriel River, and from adjacent streets. Trash removal will be an ongoing activity into perpetuity. Alternative 2 would require greater trash removal than Alternative 1 because it includes more open channel connections to sources of trash (*i.e.*, Los Cerritos Channel and the San Gabriel River). This work is well-suited to be performed by the LCW SP.
- Vector Control – Vector control will be implemented by the Vector Control Districts of both Orange and Los Angeles Counties. Site access to these groups is imperative for them to perform their function, and periodic vegetation removal may be required to reduce stagnation in certain areas. Increased tidal circulation should reduce vectors; therefore, restoration should reduce the need for vector control over time. A reduced degree of vector control would likely be required for Alternative 2 compared to Alternative 1 due to the improved tidal circulation expected on site.
- Fence and gate repair – Fences and gates bound the sites and may need to be erected in other areas for restoration. They typically require repair on a periodic basis after being damaged,

vandalized, and/or weathered. The on-site oil operators will actively maintain their fences and gates, but fences and gates outside of the oil areas will require attention of the LCWA. A reduced degree of fence and gate maintenance would be required for Alternative 2 compared to Alternative 1 due to consolidated oil operations.

- Access way (path) repair – Access pathways will need periodic repair and maintenance. Access path repair may be similar to all alternatives.
- Facilities maintenance – Certain project-related facilities such as parking lots, buildings, interpretive elements, storage areas, bike paths, and possibly other items need period inspection and repair. Any such elements that are installed as part of the project would require attention of the LCWA. Alternative 2 includes potential interpretive opportunities at the OTD and State Lands parcels that would likely include several, if not all, of these items.

Reactionary Maintenance by Contractors

- Possible erosion protection (unanticipated bank erosion) – Internal erosion of wetland shores may experience erosion on a variety of time and space scales, and local flood control levees are observed to be gradually eroding. There may be the need to install additional small rock or articulated block mats at sites of erosion, possibly near culvert headwalls. Alternative 2 may require reduced erosion protection than Alternative 1 because it assumes reduced interaction with man-made elements and infrastructure, and tidal flow in its channels is less than that of Alternative 3.
- Internal road repair and accompanying culvert repairs – Roads within wetlands can experience localized subsidence or failure near culverts if water reaches the road around the culvert. Periodic road repair may be needed in various wetland areas over time if they become affected. This is typically a small-scale effort and may require sealing the culvert or installing culvert headwalls to prevent water from reaching the road along the culvert alignment. Alternative 2 would require no internal road repair and associated culvert repairs because no culverts exist under roads in the system.
- Sediment removal from unwanted locations – Sediment may deposit, or accrete, in areas that are not desired for sedimentation. Predictions of hydraulics and sedimentation are imperfect and the site may experience some degree of evolution over time and space. Minor removal of sediment may be required at certain channel areas. Alternative 2 anticipates greater tidal circulation and higher flow velocities than Alternative 1, so it may require more sediment removal compared to other alternatives.
- Levee repair – Any levees installed may also need repair. Alternative 2 includes a breach to the San Gabriel River levee for the Central Area, so certain repairs to that levee may be needed.
- Bridge/boardwalk inspections and repairs – Any bridges or boardwalks for wildlife and public access need regular inspection for repairs. Such activities should occur every few years or as needed based on structural conditions, structure age, and any impacting natural events (earthquakes). Alternative 2 assumes a greater amount of bridge/boardwalk components compared to Alternative 1 so more inspection and repair could be necessary.

7.3.8 Cost Estimates

Opinions of probable construction costs were determined for Alternative 2 based its components. As with the other alternatives, comprehensive cost estimates were estimated for all phases of project implementation including preliminary engineering, environmental review (CEQA/NEPA), final engineering, permitting, construction, construction management, construction monitoring. A range in costs is provided here on a per acre basis. The costs for Alternative 2 are between those of the other two alternatives at between $158,000 and $260,000 per acre.

7.4 Alternative 3

7.4.1 General Description

The Maximum Alteration Alternative envisions significant infrastructure changes compared to existing conditions and Alternatives 1 and 2. This alternative includes the greatest amount of consolidation of pipelines, roadways, power poles, non-operating equipment and well sites to areas around existing tank farm locations. The Termo Company lease tank farm would require relocation outside of the project area. Synergy Oil and Gases' three tank farms would be consolidated to one tank farm near their offices in the same footprint as the existing southern site. Signal Hill Petroleum's tank farm would be preserved, and Hellman Properties' old tank farm would be removed while their new active tank farm would be preserved. This alternative has the smallest consolidation zones; therefore, the majority of wells will be re-drilled in consolidation zones, while others may not be replaceable with the space provided. Certain consolidation zones may need to be elevated or diked to avoid flooding from tidal waters.

Hydrology will be significantly re-worked to provide efficient hydrology. The channel network will consist of a combination of existing drainage channels within each area and new drainage channels installed at certain sites. The Northern Area of oil retained land will possess a new separate drainage network, as will the Central Area. The Southeast Area will possess a new channel network utilizing the existing channel and extending north into the Hellman oil retained area and the OC Retarding Basin site. The Isthmus will be reconfigured to possess one long channel fed by two culverts to the San Gabriel River. Only Steam Shovel Slough (Northern Area) will be preserved unaltered.

As a target, the greatest benefits assumed in the conceptualization to come from this alternative include:

- Immediate short-term realization of improved wetland functions and values;
- Minimal fragmentation;
- Greatest tidal prism and tidal exchange for optimal tidally-influenced habitat and water quality;
- Optimal hydraulic connections to sources of seawater;
- Increased tidally-influenced area with inclusion of the OC Retarding Basin and Loynes Properties; and
- Greatest opportunity for interpretive boardwalks due to more extensive channel patterns.

The greatest disadvantages of this alternative assumed in the conceptualization consist of:

- Potentially less resilience for future SLR conditions than other alternatives in the form of maintained habitat diversity.
- Higher costs than Alternatives 1 and 2 due to more earthwork and material disposal quantity;
- Greater impacts to all existing sites;
- Greatest impacts to on-site oil and gas extraction activities due to consolidation;
- Reliance on connection to the HCC for the Southeast Area and uncertainty in timing associated with this feature; and
- Least amount of transition and upland habitat for future wetland transgression during SLR.

The phasing of this alternative is the same as for other alternatives, and is explained for Alternative 1 in a previous section of this report. As only portions of three areas are presently in LCWA ownership, restoration could occur there first, with restoration on parcels that are presently in private ownership to occur at a later date. Figure 7-18 and Figure 7-19 show the conceptual phasing plans. Phasing after the initial phase is not possible to determine with the information that presently exists.

7.4.2 Preliminary Design

The preliminary design of Alternative 3 is shown in the conceptual grading plan and cross-sections. Figure 7-101 through Figure 7-104 show grading on each area. The Maximum Alteration Alternative shows extensive grading in every area. The site changes consist of:

- Complete consolidation of oil operations at each site;
- Removing all oil roads and well pads and relocation to consolidation areas;
- More wetland habitat than any alternative;
- Maximizing subtidal habitat at all areas except the Isthmus;
- Creating low, mid- and high marsh at all areas;
- Creating transitional habitat at the Northern and Southeast Areas, with minimal transitional habitat elsewhere;
- Less upland habitat everywhere; and
- Creating new brackish marsh in the Northern Area and preserving it in the Central Area.

More grading will be done everywhere as compared to other alternatives to achieve target habitats. All sites, except the Isthmus Area, will have large open-channel connections to seawater sources. Cross-sections of proposed grading show the difference between existing topography/bathymetry and the proposed surface of this alternative. The location of the cross-sections is shown in Figure 7-24. Cross-sections of the grading anticipated at each area are shown in Figure 7-105 through Figure 7-108.

Figure 7-101. Conceptual Grading, Maximum Alteration, Northern Area

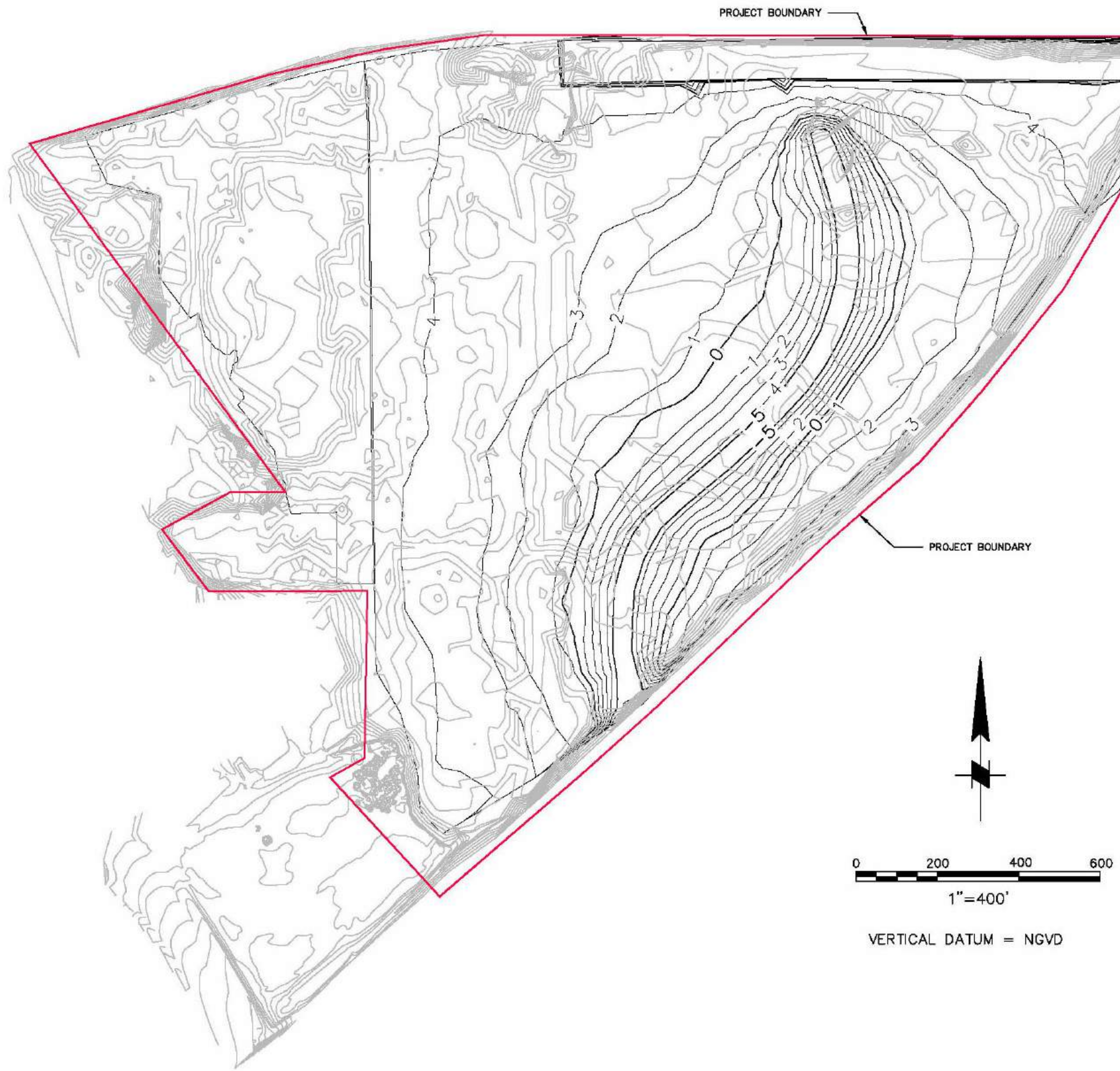


Figure 7-102. Conceptual Grading, Maximum Alteration, Central Area

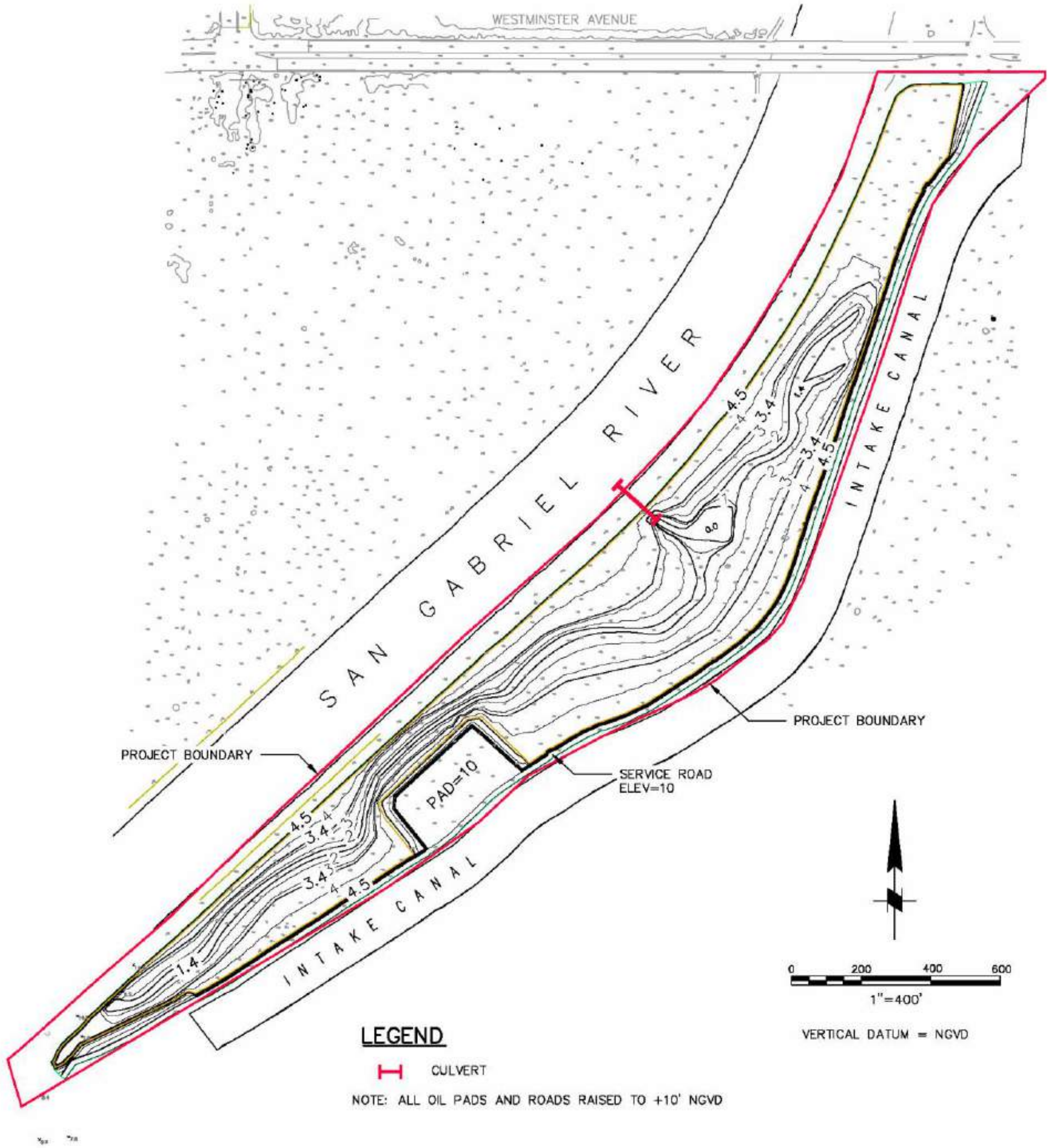
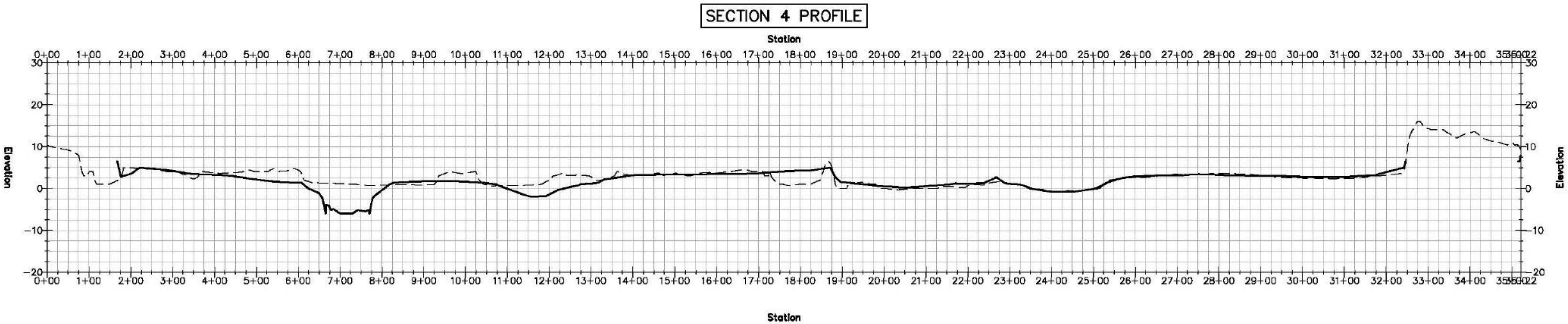


Figure 7-103. Conceptual Grading, Maximum Alteration, Isthmus

Figure 7-104. Conceptual Grading, Maximum Alteration, Southeast Area



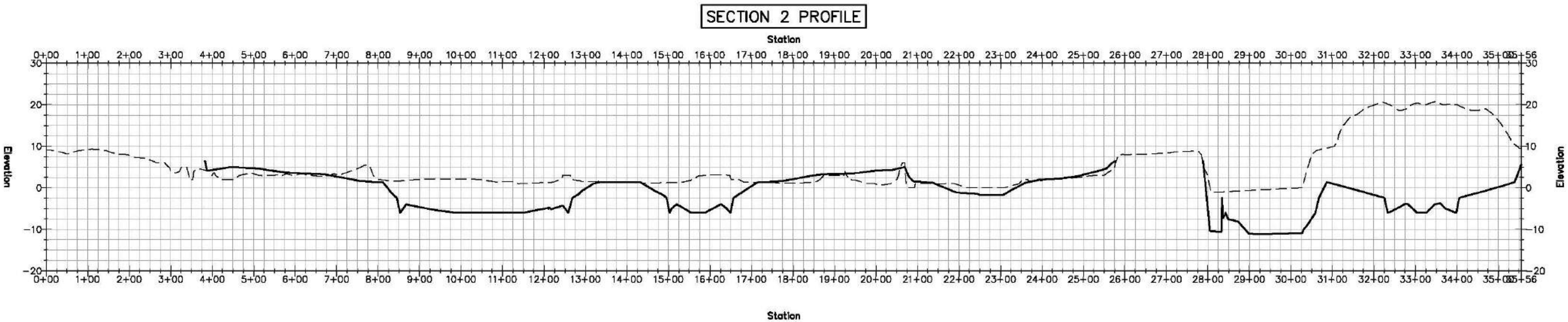
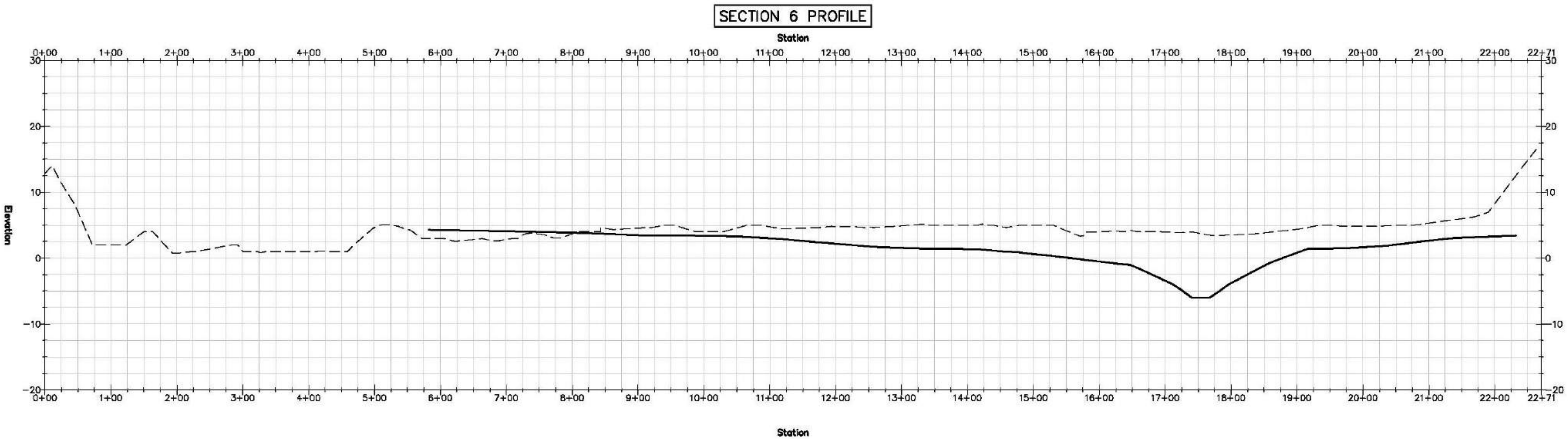


Figure 7-105. Conceptual Grading Cross-Sections, Maximum Alteration, Northern Area



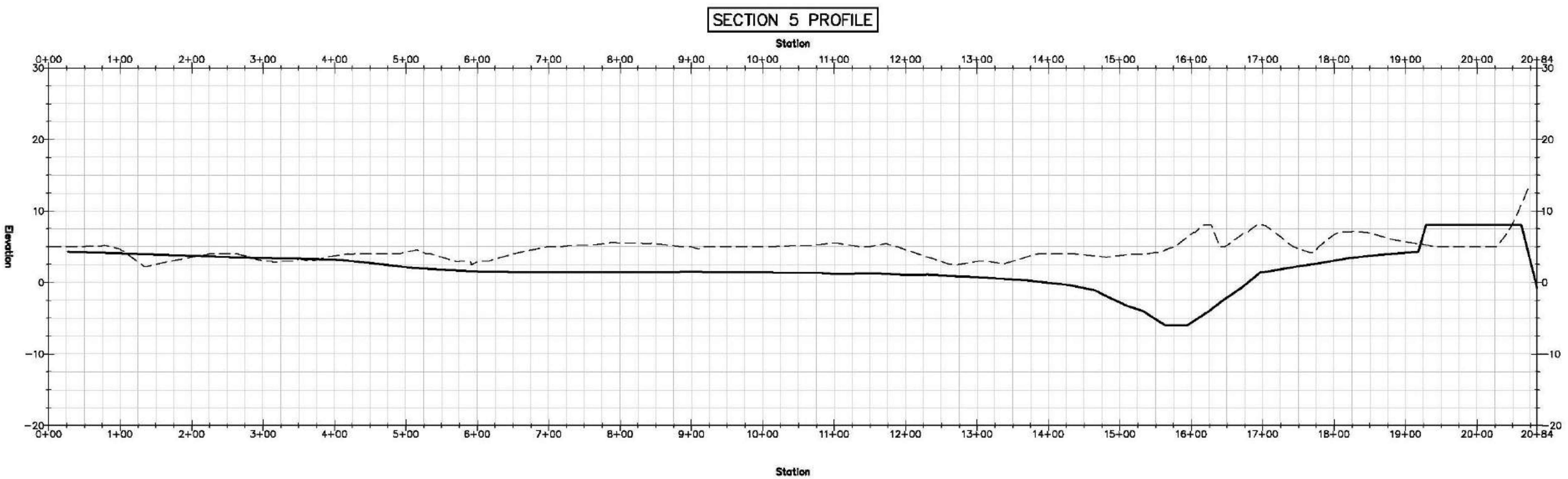
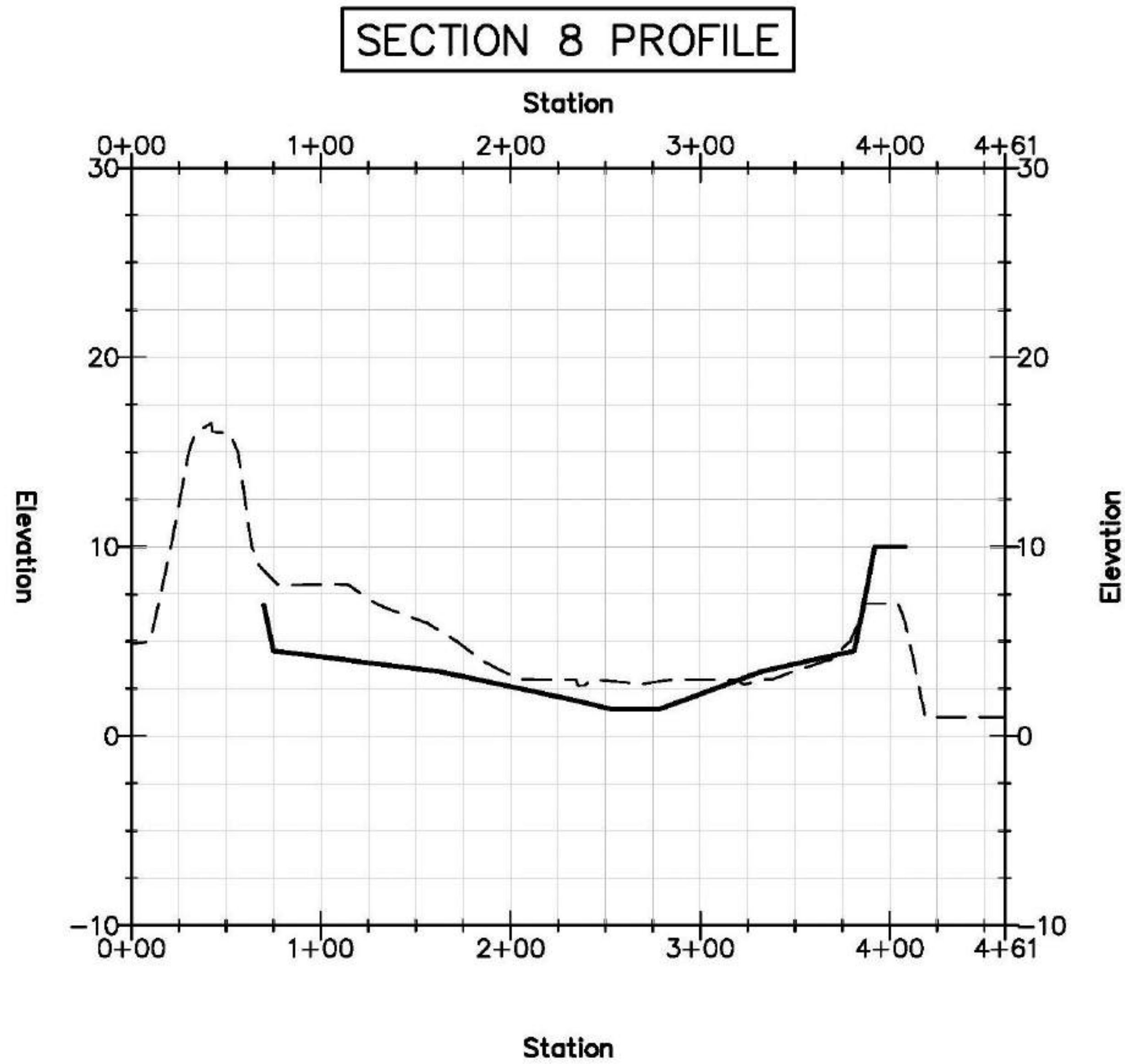


Figure 7-106. Conceptual Grading Cross-Sections, Maximum Alteration, Central Area



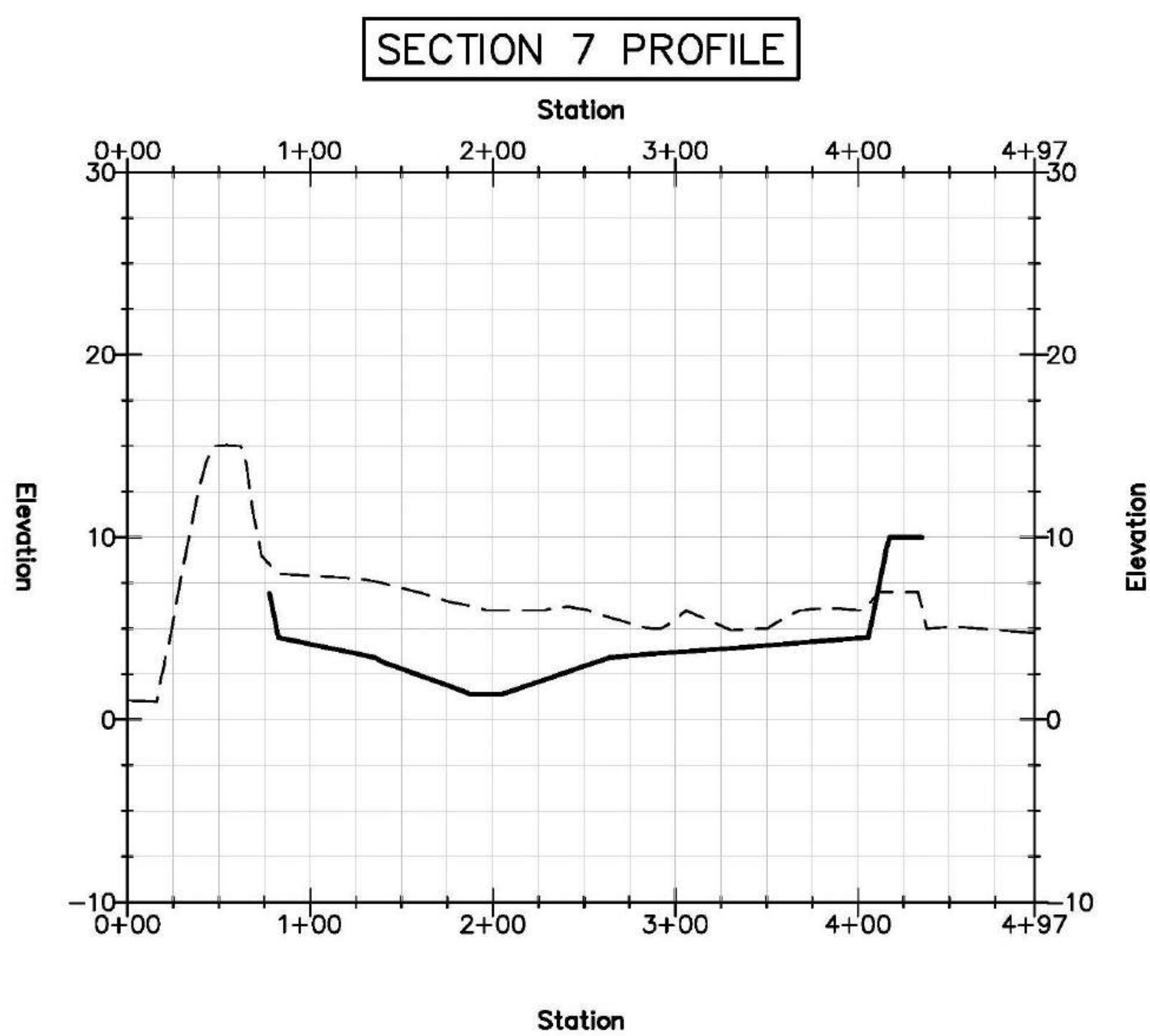
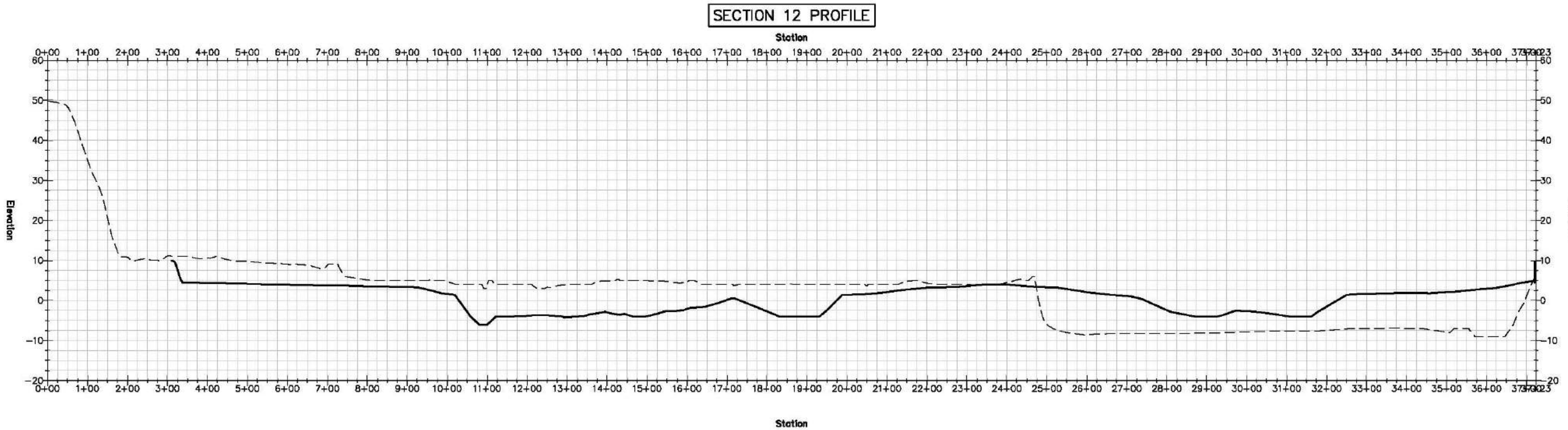


Figure 7-107. Conceptual Grading Cross-Sections, Maximum Alteration, Isthmus



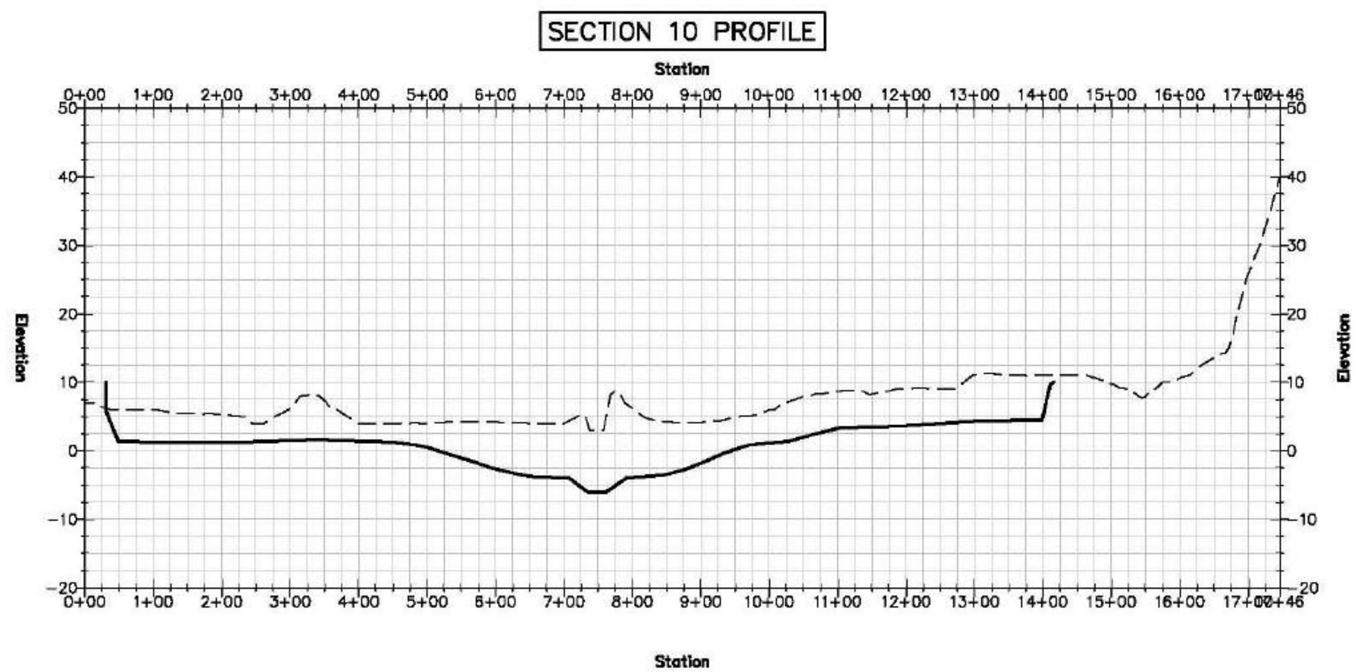


Figure 7-108. Conceptual Grading Cross-Sections, Maximum Alteration, Southeast

7.4.3 Habitat

The Maximum Alternative allows for significant functional lift. However, any resilience to even moderate SLR would probably require future sediment additions. Table 7-10 shows the habitat analysis of Alternative 3. Figure 7-109 through Figure 7-111show the habitat areas for each area under Alternative 3, with three sea level scenarios.

Table 7-10. Habitat Analyses Matrix for Alternative 3

Maximum Alternative	Northern Area	Central Area	Isthmus	Southeastern Area	Entire LCW Complex
Diversity of Salt Marsh Habitats	• Broad distribution of intertidal and sub-tidal habitats • Opportunities for intricate tidal channel networks with full tidal range	• Broad distribution of intertidal habitats • Opportunities for intricate tidal channel networks with full tidal range	• Broad distribution of intertidal habitats with emphasis on transition habitat • Limited opportunities for tidal channels due to small overall area	• Broad distribution of intertidal habitats • Significant adjacent uplands	• Full diversity of marsh habitats within each area and the complex • Each area supports a diversity of salt marsh habitats at current sea level
Overall Habitat Diversity	• Strong emphasis on intertidal salt marsh • Some storm-water-fed brackish habitat at current sea level • Narrow uplands along road edges • Biggest gain in sub-tidal versus other alternatives	• Emphasis on intertidal salt marsh • Significant storm-water-fed brackish habitat at current sea level • Transition and upland habitats are narrow and confined to the Bryant-retained property and the San Gabriel River levee	• Uplands are berms with limited habitat value	• Emphasis on intertidal salt marsh • Some freshwater wetlands • Considerable upland habitat	• Some non-tidal wetlands • Limited upland habitats
Habitat Connectivity	• Removal of roads and berms creates a large contiguous marsh • Less connection to existing salt marsh at Steam Shovel Slough than Moderate Alternative • Steep transitions between marsh habitats and uplands	• Removal of roads and berms creates a large contiguous marsh • Some filling of existing wetland basins needed to create natural ecotones and high intertidal and transition habitats • Open channel to the San Gabriel River allows good aquatic connectivity	• Narrow nature of this parcel limits the potential width of ecotones • Entire site isolated by berms with very steep slopes • Culverts may limit connectivity for some aquatic species	• Removal of roads and berms and filling of retarding basin creates a large contiguous intertidal marsh • Significant adjacent uplands but most wetland-upland transitions are very steep	• Full suite of salt marsh habitats are adjacent and well-connected in most areas at current sea level, though uplands are generally limited in area and steeply sloped • Different areas are isolated by major roads, berms and development
Resilience to Sea Level Rise (SLR)	• Decrease in high marsh and transition habitat, increase in most lower habitats with moderate SLR • Vegetated marsh virtually eliminated with significant SLR • Loss of brackish habitats • Almost no transgression of marsh habitats into current uplands due to steep slopes	• High intertidal areas lost and mid- and low-habitats sustained with moderate SLR • Vegetated marsh virtually eliminated with significant SLR • Almost no transgression of marsh habitats into current uplands	• High intertidal areas decrease and mid- and low-habitats expand with moderate SLR • Vegetated marsh virtually eliminated with significant SLR • Almost no transgression of marsh habitats into current uplands due to steep slopes	• Sub-tidal and mudflat expand and vegetated marsh decreases in area with moderate SLR • Vegetated salt marsh virtually eliminated with significant SLR • Almost no transgression of marsh habitats into current uplands due to steep slopes	• Higher intertidal and low marsh habitats decrease sharply with moderate SLR • Almost no vegetated marsh remains with significant SLR • Limited uplands are steep and do not allow for natural transgression of habitats with SLR • This alternative is the least resilient to SLR
Functional Lift	• Slight lift at Steam Shovel Slough due to newly restored adjacent salt marsh • Moderately high lift elsewhere with removal of berms and roads and increased tidal influence • High functioning maintained with moderate SLR; decreases sharply with significant SLR	• Moderately high lift throughout the area with removal of berms and roads and increased tidal influence • Functioning will decrease with moderate SLR; decreases sharply with significant SLR	• Moderately high functional lift due to increased area of tidal influence • Functioning will increase with moderate SLR; decreases sharply with significant SLR	• Extreme functional lift at current sea level due to increased tidal influence and removal of fill, berms and roads • Functioning decreases slightly with moderate SLR; decreases sharply with significant SLR	• Highest functional lift of any alternative at current sea level • Functioning drops with moderate SLR • Functioning severely decreases with significant SLR • This alternative maintains the least functioning with significant SLR
Take Home Message	• Substantial grading and expensive oil operation consolidation yields significantly expanded tidal salt marsh and sub-tidal habitat that is resilient to moderate SLR	• Extensive grading and expensive oil operation consolidation yields significantly expanded tidal salt marsh habitat that it is not resilient to SLR	• Extensive grading and expensive oil operation consolidation with substantial functional gains that are mostly dependent on moderate SLR	• Extensive grading and expensive oil operation consolidation yields a large tidal salt marsh that is not resilient to SLR	• The most expensive alternative, which yields significant intertidal habitat within each area but has minimal resilience to SLR

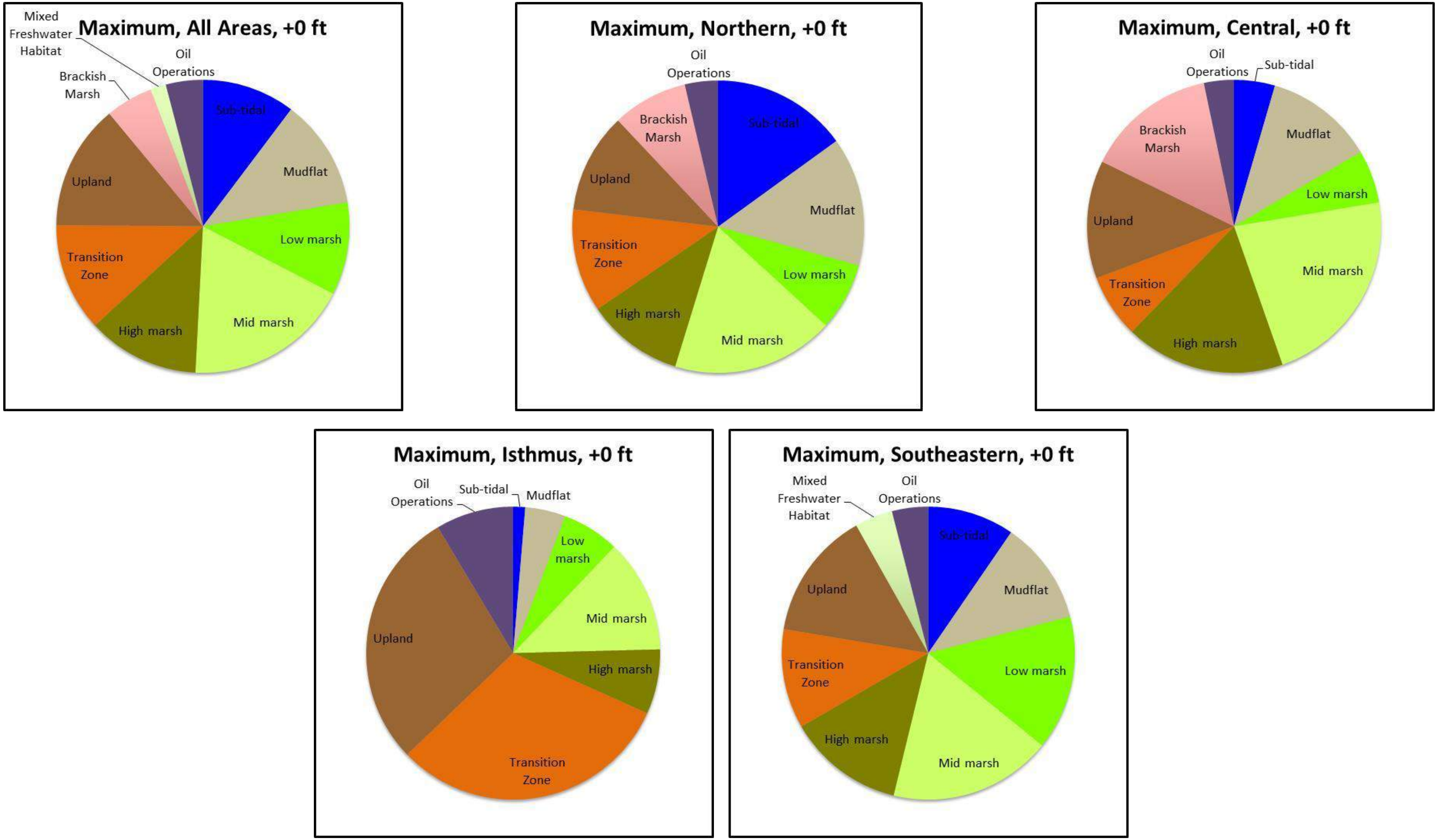


Figure 7-109. Habitat Acreage Alternative 3, Maximum Alteration SLR of +0 ft

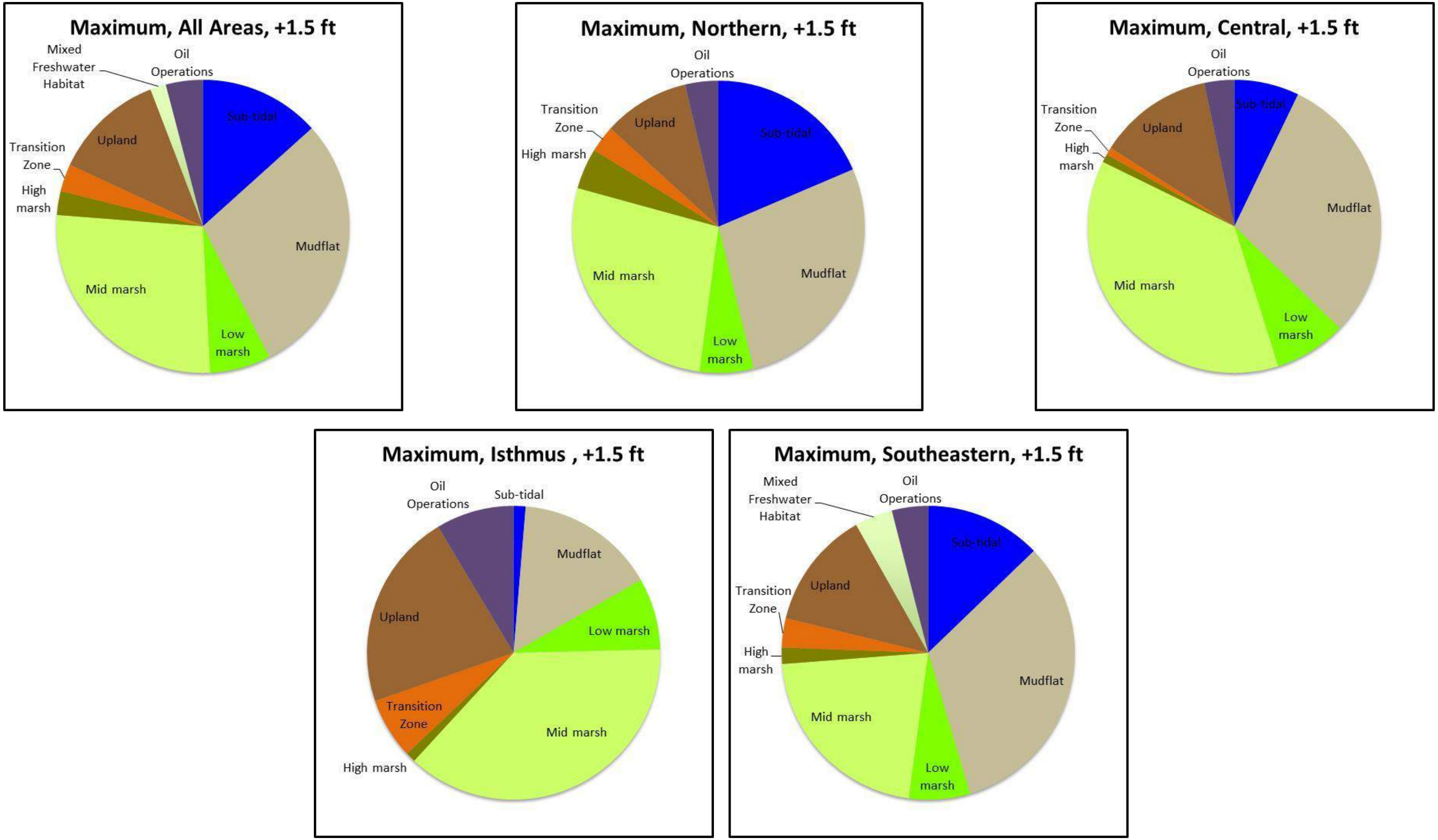


Figure 7-110. Habitat Acreage Alternative 3, Maximum Alteration SLR of +1.5 ft

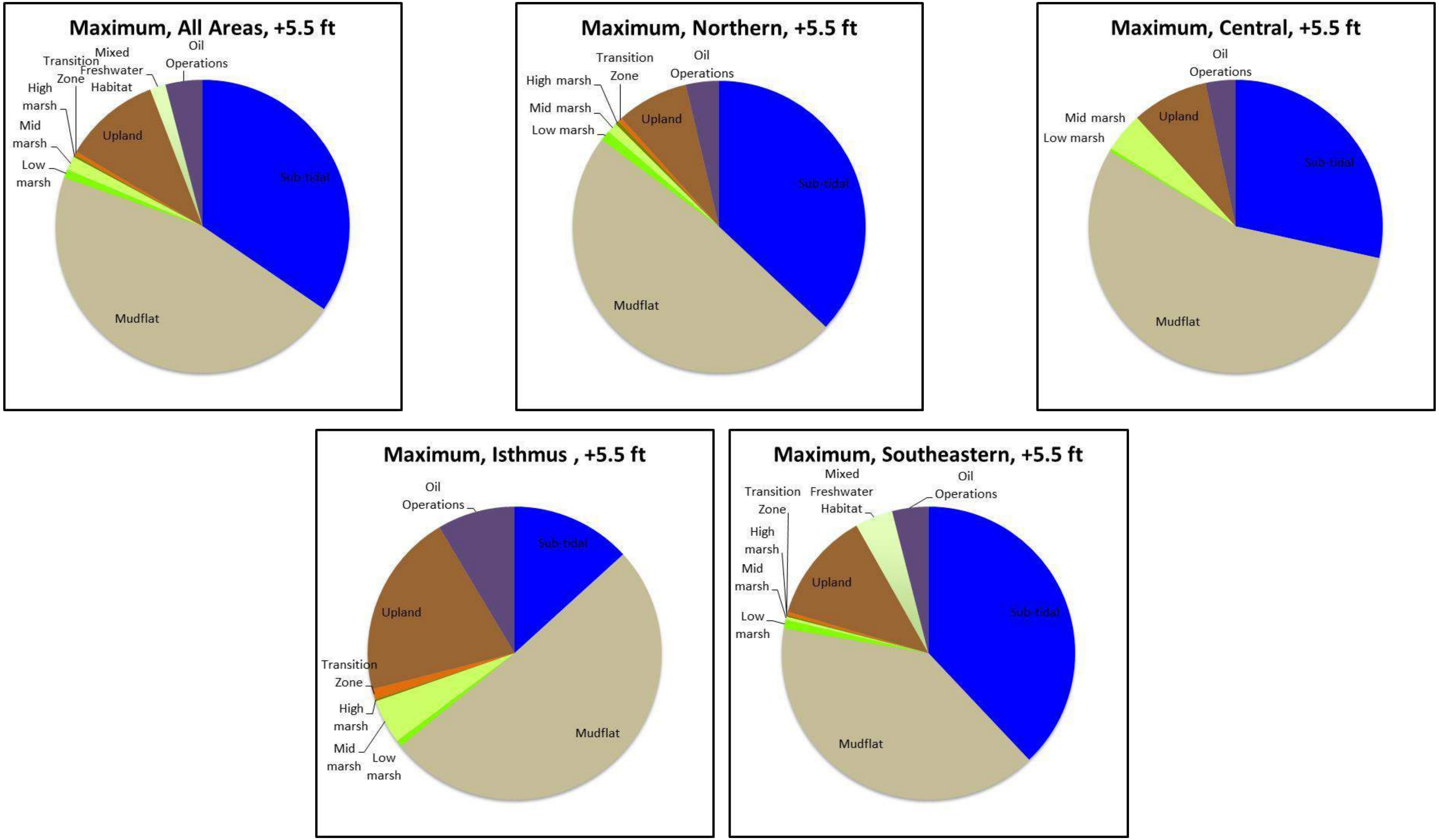


Figure 7-111. Habitat Acreage Alternative 3, Maximum Alteration SLR of +5.5 ft

7.4.4 Public Access Plan

PAP that describes how the public will access and experience the property, how habitat and public access coalesce, and how oil infrastructure will be secure/safe for public access.

The Maximum Alteration Alternative PAPs were developed with the three organizing concepts described above as Perimeter, Loop, and Urban Connectivity. The Perimeter concept provides the least access to the interior of the various wetland cells, while the other concepts build on the base of the preceding trails system, offering a set of options for consideration during design development phases of the project.

Maximum Alteration PAP, Northern Area

The Perimeter and Loop PAP concepts are shown for the North area in Figure 7-112. Given the historic nature and sensitivity of the Steam Shovel Slough original channel, this Loop trail follows the small levee that will remain to protect the slough, and is here proposed as a docent-led trail rather than a general public trail. This is proposed in part due to the cul-de-sac form of the trail, which may lead to slightly less general public use, but also be attractive to illegal encampments if left open. Gated access is proposed to minimize the potential for illegal use. The Urban Connectivity concept is not relevant to the North area of LCW, as no direct line between residential in the north and the commercial areas at Marketplace Shopping Center exist other than what is already provided by the perimeter trail.

Figure 7-112. Trail Opportunity Detail, Maximum Alteration, North Half

Maximum Alteration PAP, South- Perimeter Concept

The cells south of Westminster Avenue and 2nd Street are where the differences between the organizing concepts are most apparent, as shown in Figure 7-113. Since the Maximum Alteration Alternative would create the largest areas of intertidal restoration, the Perimeter trail approach provides the greatest buffer to, but also the most limited exposure to, the intertidal zones. In the Central Area therefore, the LCWA proposes to create a teaching wetland in close proximity to the commercial area. This would be accomplished by extending a narrow arm of high intertidal habitat to the west of the main tidal inlet, creating a tight gradient from commercial complex, to freshwater bioswales, to brackish marsh, to transitional marsh, to high intertidal - all within a short distance of the parking area. This area could be served from the docent storage building labeled in the diagram below.

The perimeter concept would keep pedestrians away from the wildlife bridges, one of which is a proposed replacement of a narrow footbridge at the HCC, and limit public access to the extreme edges of the intertidal zones for the most part. However, since this restoration alternative creates the greatest expanse of intertidal zones, even the perimeter path provides numerous interpretive points near intertidal habitat.

Figure 7-113. Trail Opportunity Detail, Maximum Alteration, South Half, Perimeter Concept

Maximum Alteration PAP, South- Loop Concept

Additional trails in this concept create secondary loops to enhance the access opportunities of the Perimeter Concept trail, as shown in Figure 7-114. These include both proposed docent-led loops (Central Area) and open public trails (Tongva Loop at Southeast Area). As a result, the Leisure World and HP neighborhoods each would be provided with shorter loop routes from their respective access points. These access ways require a significant length of elevated causeway or boardwalk where they cross intertidal areas.

Figure 7-114. Trail Opportunity Detail, Maximum Alteration, South Half, Loop Concept

Maximum Alteration PAP, South- Urban Connectivity Concept

As the name suggests, this alternative provides the greatest level of access from all points within the two-city area of Long Beach and Seal Beach, as shown in Figure 7-115. In this diagram we show the "Piazza" concept that would transform the Marketplace Shopping Center Parking lot into a multi-use hardscape space, while increasing its permeability and connection with the wetlands themselves, teaching important concepts about urban run-off in the process, and integrating the greatest number of guided and unguided visitors to this long forgotten part of the coastal fabric.

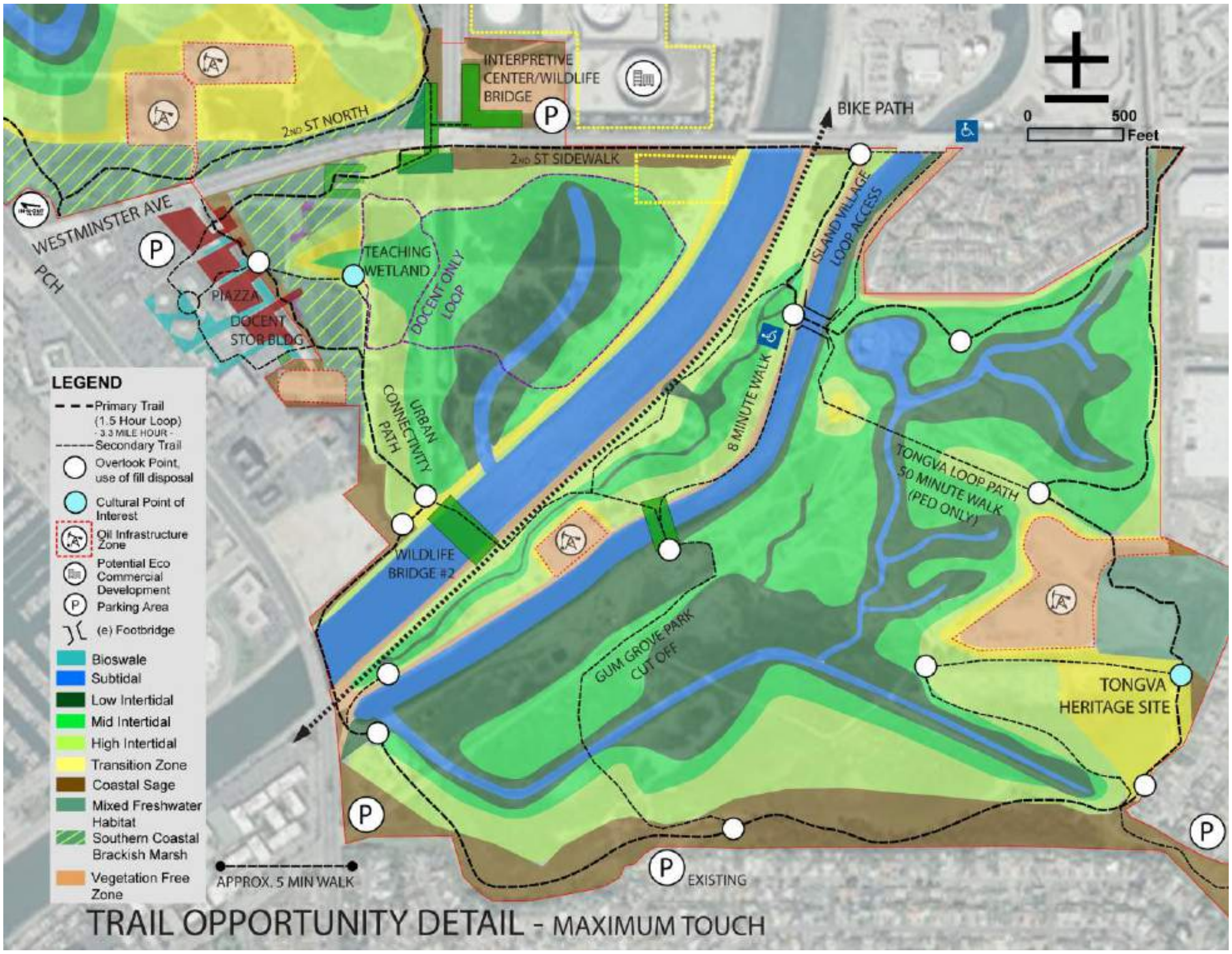


Figure 7-115. Trail Opportunity Detail, Maximum Alteration, South Half, Urban Connectivity Concept

The scheme adds the Gum Grove Park cutoff trail through the Southeast Area, providing direct access from that parking area and the neighborhood it serves, and drawing the visitors of this well-used urban park into the habitat for interpretive and educational benefit. This trail is also the most likely to be used as an urban foot-powered route, via the mixed pedestrian/wildlife bridges, to the services of Marketplace Shopping Center.

So while less protective of the new wetlands than other access schemes, the Urban Connectivity Concept proposes a "sustainable cities" approach. This is particularly applicable if the Gum Grove and Urban Connectivity trails were designed to allow for both bicycle and pedestrian traffic. It would also provide an alternative to the less appealing, and arguably more dangerous, stretch of PCH bike lane between Seal Beach and the Marketplace Shopping center. This less desirable route is shown in Figure 7-116 at the intersection with the popular HCC fishing access (note the groceries in the baskets of the tricycle pedaling against traffic).

Figure 7-116. Less Desirable Access Route along PCH

Currently, this section of PCH bicycle lane connects with the San Gabriel Bicycle Trail (SGBT) at the PCH bridge and the intersection is problematic in its mix of bikes and pedestrians. While all the PAP alternatives can address this problem by providing a parallel bicycle lane at the Perimeter Trail for the section that runs between the current 1st Street extension road and the SGBT, the Urban Connectivity Concept might provide other appropriate bicycling opportunities to help keep urban dwellers in Seal Beach out of their cars. The Maximum Alteration Alternative creates wetland edge along the entire length of the Isthmus, and so can take advantage of the duplication of access ways that is problematic elsewhere in the wetland complex. In this location, part of the current oil access road could remain, creating a grade separation between pedestrian and bicycle paths. The upper vantage of the SGBT could be accessed by pedestrians at the wildlife bridge intersection, as well as at other locations where interpretive nodes could be located upslope from the main pedestrian path but off the main flow of adjacent bicycle traffic. Figure 7-117 shows these sites.

Figure 7-117. PCH/SGBT Intersection and SGBT with Parallel Path

Feedback from the bicycle community and our team's bicycle consultant suggests that additional bike-accessed options through the wetlands would be welcomed by that community, and of the possible routes through the Southeast Area that might add bicycles, the Gum Grove route, connecting to the Urban connectivity path at the Central Area via the wildlife bridge would be the most direct mixed-use urban connector. On the other hand, the three through-routes shown above might be limited to two. If this limitation is carried through in the final design, maintaining the Gum Grove and easternmost Tongva Loop paths - eliminating the western segment of the Tongva loop path - will result in good urban connectivity (along with the stewardship benefits they can provide) while maintaining a large area of contiguous habitat between the two trails. In fact, if this pairing of through-routes in the Southeast Area is to be kept, as with all trail alignments, relatively small refinements in the restoration grading plans could significantly reduce the length and cost of the Gum Grove trail. These same adjustments would make for a more direct route to the western HCC footbridge (or wildlife bridge if that approach is selected) and, therefore, to the Marketplace area.

7.4.5 Tidal Hydrodynamics

Alternative 3 – Maximum Alteration, Existing Sea Level

Tides simulated for Alternative 3 are shown in Table 7-11. All sites except the Isthmus Area are connected to seawater sources with open channels, and internally they are composed of open channel networks. The exception is the Isthmus Area that is connected to the San Gabriel River by culverts. As a result, the Northern, Central, and Southeast Areas will possess a nearly full tide range, while the Isthmus Area will possess muted tidal ranges.

Table 7-11. Alternative 3 Spring Tidal Elevations and Ranges

Site Within the LCW	Specific Location on the Site	Existing Sea Level			1.5' Sea Level Rise			5.5' Sea Level Rise		
		High	Low	Range	High	Low	Range	High	Low	Range
Northern	Synergy Retained	4.3	-3.9	8.2	5.8	-2.4	8.2	9.8	1.6	8.2
Central	LCWA Phase I	4.2	-3.7	7.9	5.8	-2.4	8.2	9.8	1.6	8.2
Isthmus	Zedler Marsh	3.5	0.7	2.8	4.5	1.1	3.4	7.6	4.8	2.8
	Callaway Marsh	3.5	1	2.5	4.5	1.3	3.2	7.6	4.8	2.8
Southeast	LCWA Phase II and Hellman Retained	4.1	-3.3	7.4	5.7	-2.2	7.9	9.7	1.6	8.1

Alternative 3 – Maximum Alteration, SLR

As with Alternative 2, tide ranges and elevations increase at every site with SLR of 1.5 feet. This result indicates that culverts are sufficient in size to convey the increased volume of seawater between tide cycles. Further SLR of 5.5 feet results in a similar trend, with the exception of Zedler Marsh, which experiences a reduced tidal range compared to a SLR of 1.5 feet. Under SLR of 5.5 feet, the tidal conveyance of the culvert at Zedler Marsh limits the volume of seawater exchange to and from the San Gabriel River and the tidal range becomes compressed. If necessary, the culvert to Zedler can be re-evaluated in the future to provide a larger tidal range.

Tidal Inundation Frequency

Tidal inundation frequency analyses were also performed on Alternative 3 with tidal hydraulic modeling results. Tidal inundation frequency affects ultimate habitat distribution. Plots and analyses are provided presenting all areas under various sea level conditions for Alternative 3.

Northern Area, Alternative 3, Existing Sea Level

Alternative 3 is a system of two open channel connections to Los Cerritos Channel and open channels throughout the Northern Area, tidal conveyance is optimal. Figure 7-118 shows the tidal inundation frequency curve for existing sea level conditions at the Northern Area. The range of elevations for salt marsh habitat is broad and reflects a full tidal system. The habitat range is from +4.2 feet to -3.8 feet NGVD, which is very similar to that existing at Steam Shovel Slough at this time. The elevation range is unrestricted because there are two entrance channels that efficiently convey seawater water during tidal exchange.

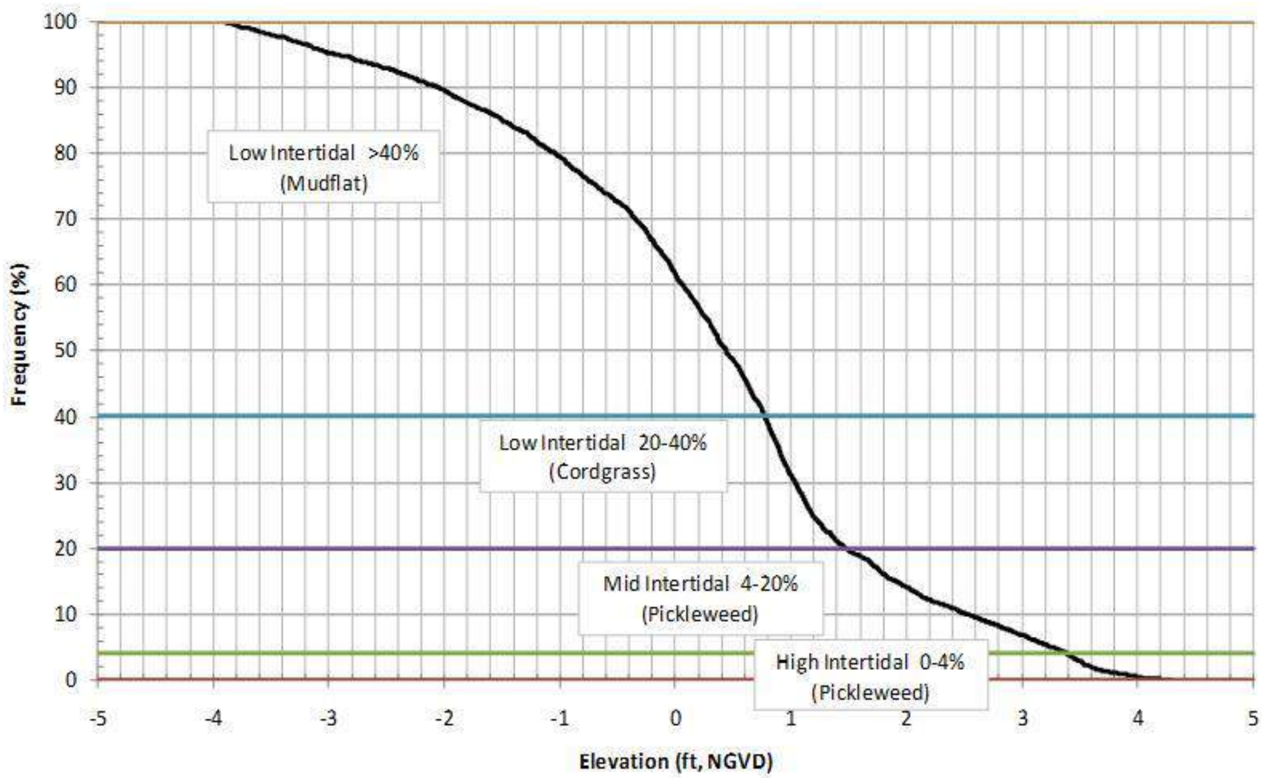


Figure 7-118. Tidal Inundation Frequency at the Northern Area for Alternative 3, Existing Sea Level

Northern Area, Alternative 3, Sea Level Rise of 1.5 Feet and 5.5 Feet

Figure 7-119 shows conditions under SLR of 1.5 feet. The range of elevations for salt marsh habitat reflects the full tidal condition with a range from +5.7 feet to -2.4 feet NGVD. The inundation frequency curve simply moves upward in elevation with SLR while retaining the same shape as the full tidal conditions. Habitat proportions change from primarily mid-marsh, to more equal components of mudflat and mid-marsh, with increased subtidal.

Figure 7-120 shows conditions under SLR of 5.5 feet. The range of elevations for salt marsh habitat is from +9.7 feet to 1.6 feet NGVD. The existing elevation of the site results in formation of a preponderance of mudflat and subtidal habitats under this scenario, with much less salt marsh than lower water conditions.

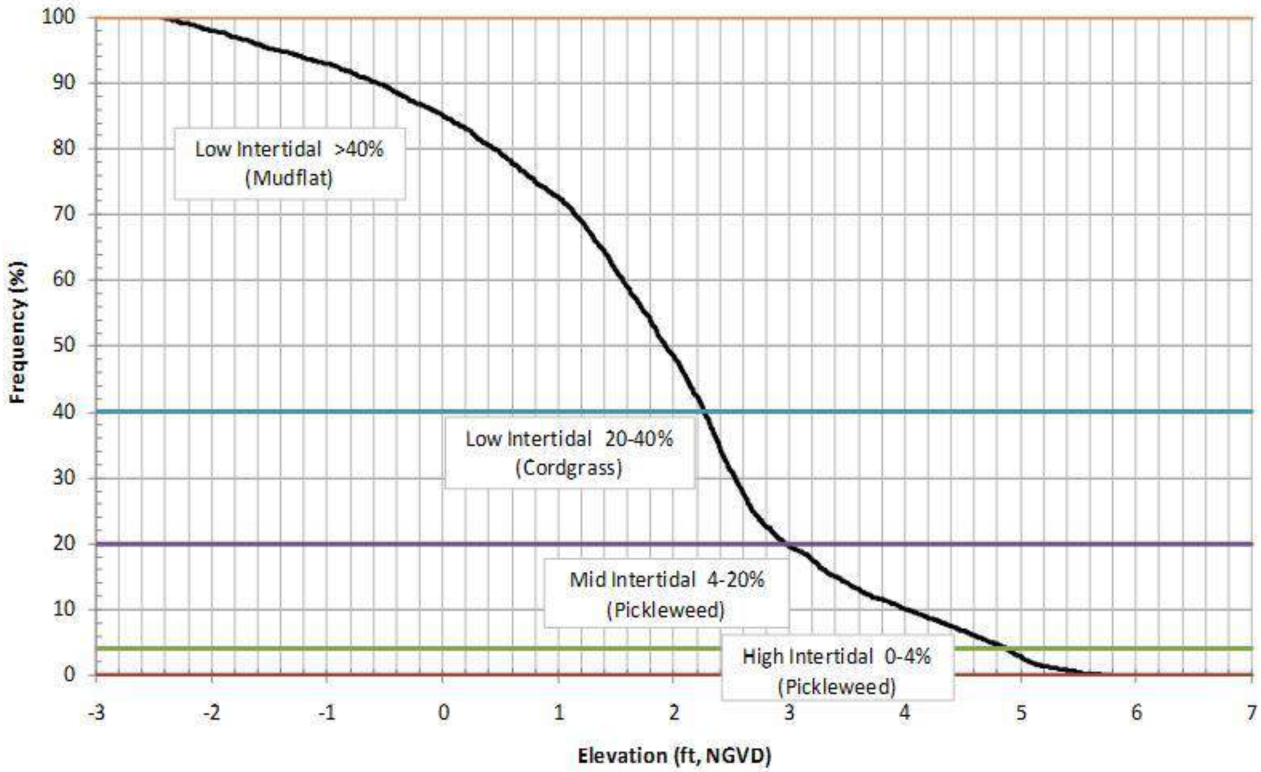


Figure 7-119. Tidal Inundation Frequency at the Northern Area for Alternative 3, SLR of 1.5 Feet

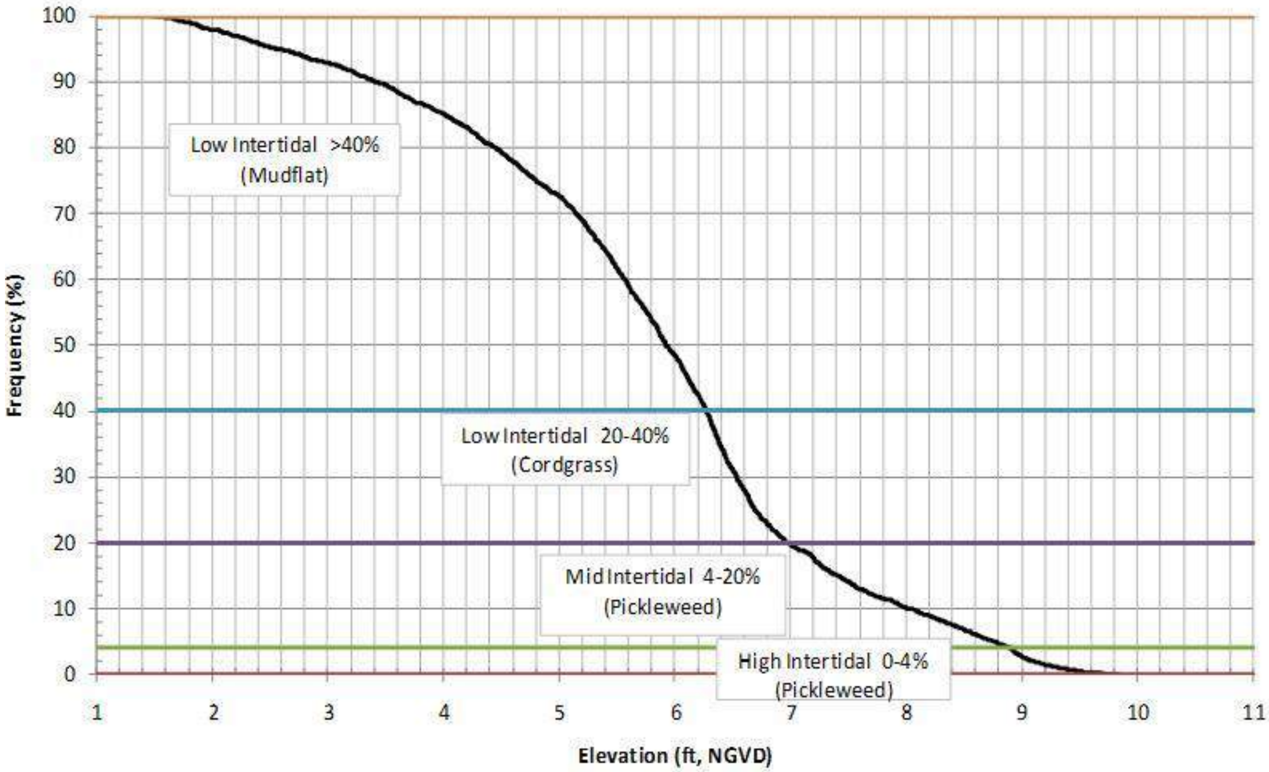


Figure 7-120. Tidal Inundation Frequency at the Northern Area for Alternative 3, SLR of 5.5 Feet

Central Area, Alternative 3, Existing Sea Level

Figure 7-121 shows the tidal inundation frequency curve for existing sea level conditions at the Central Area for Alternative 3. The wetland is connected to the San Gabriel River as the source of seawater. The range of elevations for salt marsh habitat is representative of full tidal conditions in all areas. The marsh ranges in elevation from +4.2 feet to -3.6 feet NGVD. Virtually no restrictions exist to tidal elevations other than the tide range of the San Gabriel River. Alternative 3 proposes creation of one main channel through the site to provide the full range of habitat elevations, and a dominance of salt marsh habitat will exist under this alternative.

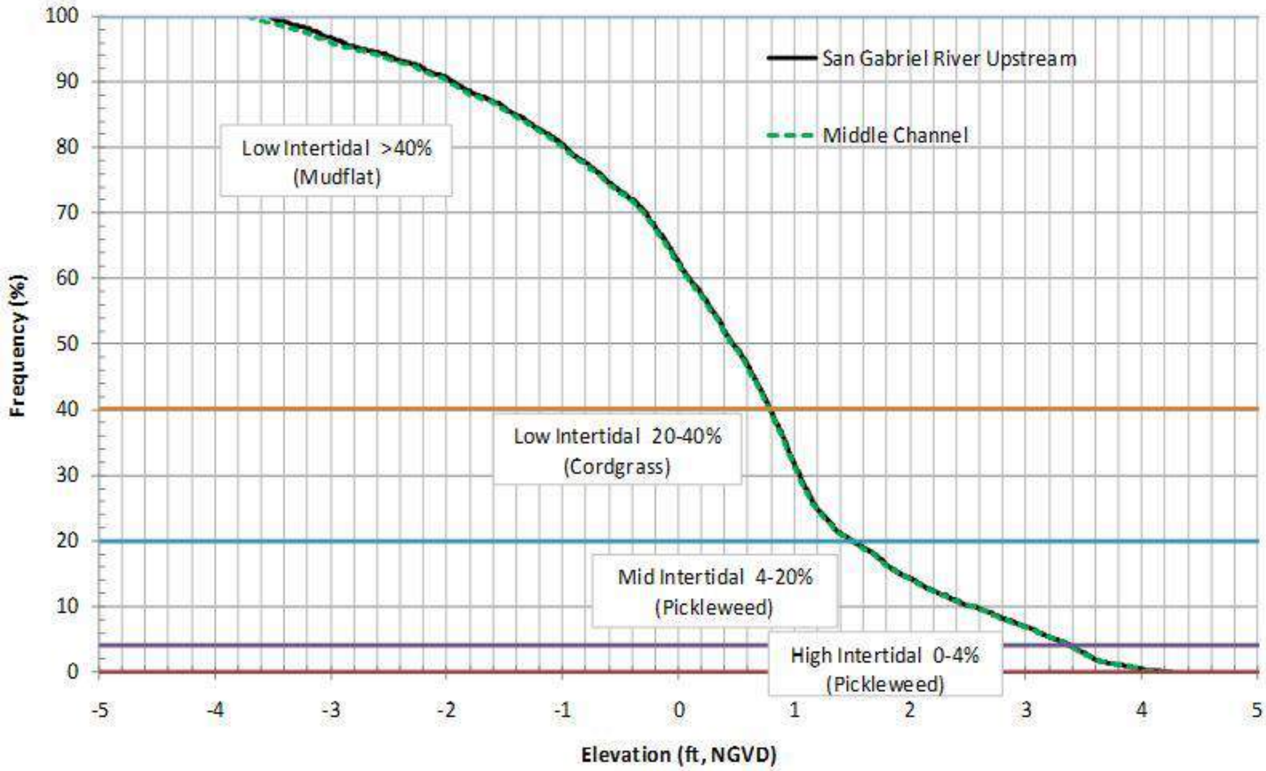


Figure 7-121. Tidal Inundation Frequency at the Central Area for Alternative 3, Existing Sea Level

Central Area, Alternative 3, SLR of 1.5 Feet and 5.5 Feet

Figure 7-122 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Central Area for Alternative 3. The range of elevations for salt marsh habitat still reflects full tidal conditions, as would be expected from an open channel connection. The marsh ranges in elevation from +5.8 feet to -2.3 feet NGVD. The elevation of the site is mainly within the range of mudflat and mid-marsh habitats, and less supra-tidal habitat area remains under this sea level rise scenario.

Figure 7-123 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Central Area. The range of elevations for salt marsh habitat remains full tidal, and the marsh ranges in elevation from +9.7 feet to +1.6 feet NGVD. No restrictions exist to tidal elevations reached in the marsh. However, with the elevation of the site being largely within the range of subtidal and mudflat habitats, very little marsh area remains under this SLR scenario.

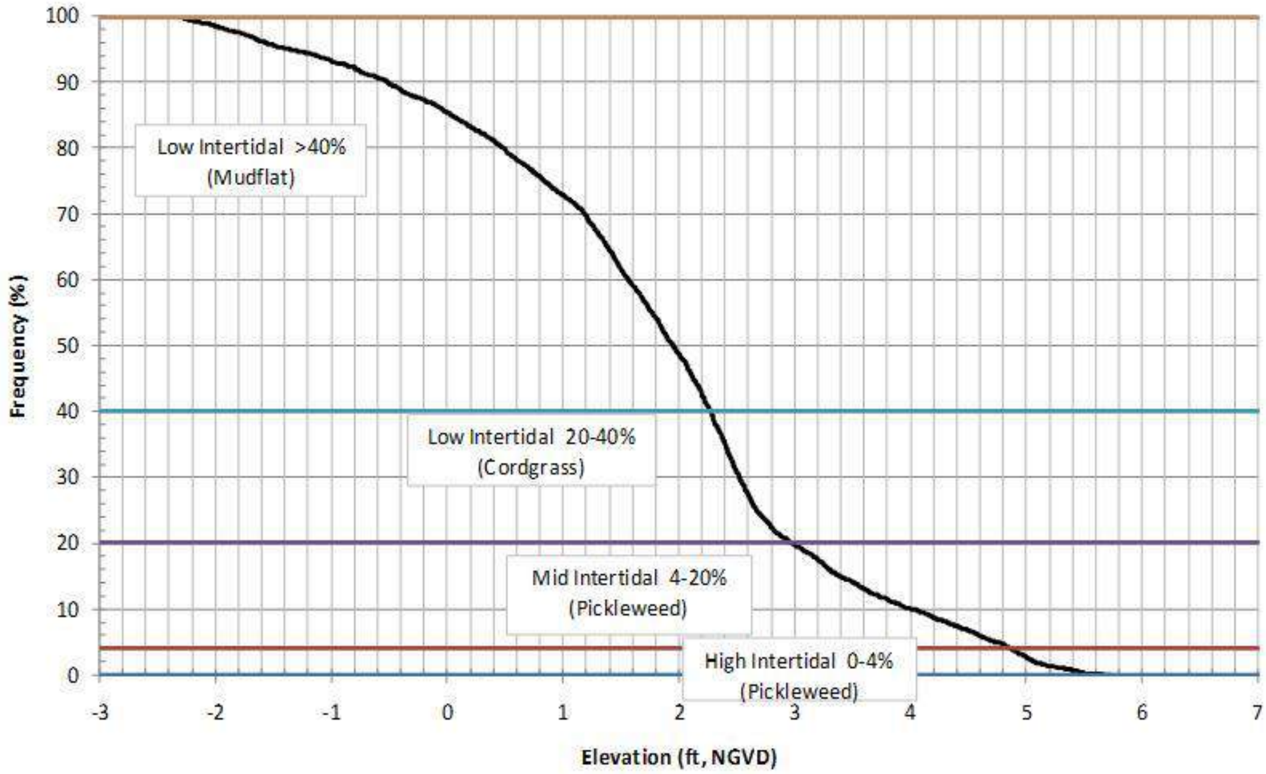


Figure 7-122. Tidal Inundation Frequency at the Central Area for Alternative 3, SLR of 1.5 Feet

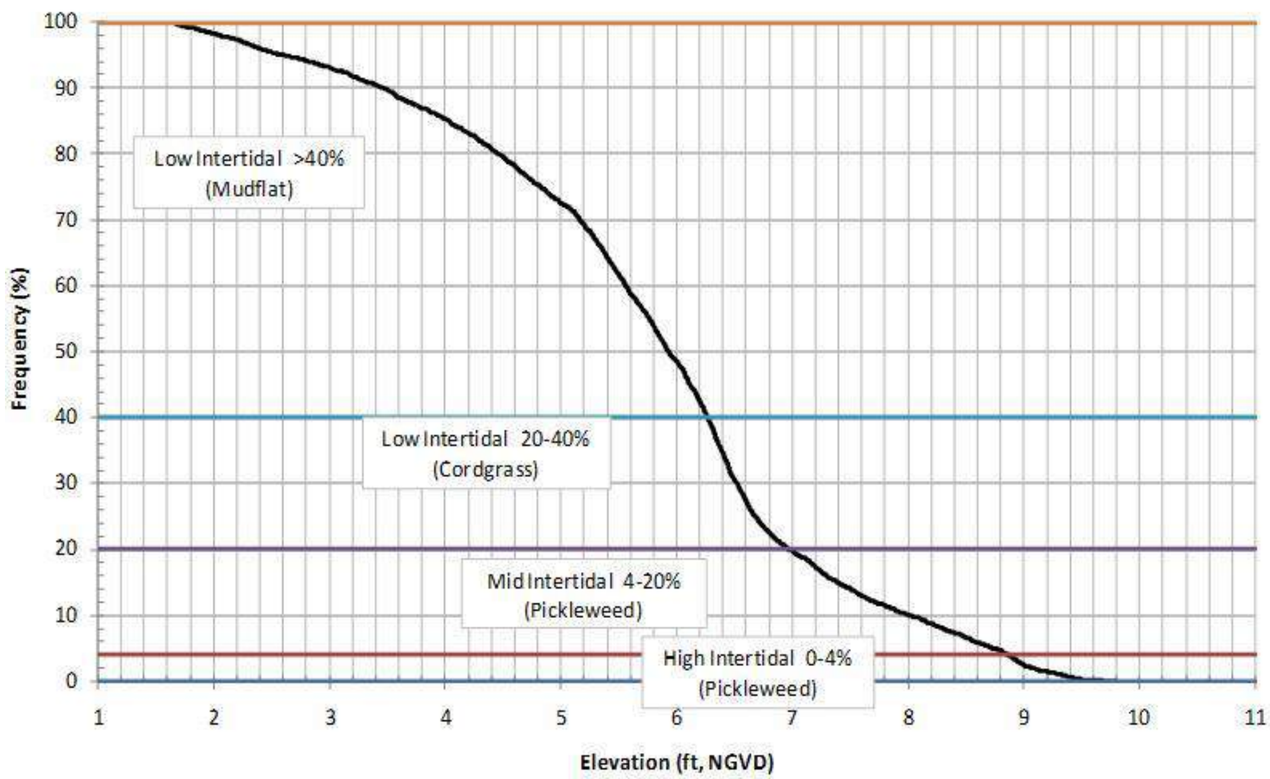


Figure 7-123. Tidal Inundation Frequency at the Central Area for Alternative 3, SLR of 5.5 Feet

Isthmus Area (Zedler and Callaway Marshes), Alternative 3, Existing Sea Level

Alternative 3 at the Isthmus Area is completely reconfigured compared to other alternatives, and the site is lowered in an effort to provide more marsh habitat. Therefore, tidal ranges for existing sea level are different from other alternatives. Figure 7-124 shows the tidal inundation frequency curve for existing sea level conditions at Zedler and Callaway Marshes on the Isthmus Area. The San Gabriel River is the source of seawater. The ranges of elevations for salt marsh habitat are limited to +3.6 feet to +1.0 feet NGVD at both marshes due to the increased tidal range that has to pass through the culverts. The limited vertical ranges of habitats are due to the limitation of the culvert connections to the San Gabriel River, with the invert at Callaway Marsh being at +1.0 feet NGVD and the culvert at Zedler Marsh being at +0.5 feet NGVD. As a result, the Isthmus is characterized mostly by supratidal habitats, with a reduced, but fairly even, spread of tidal habitats at existing sea level. Increasing the size of the culverts and/or lowering them may increase the elevation range of habitats.

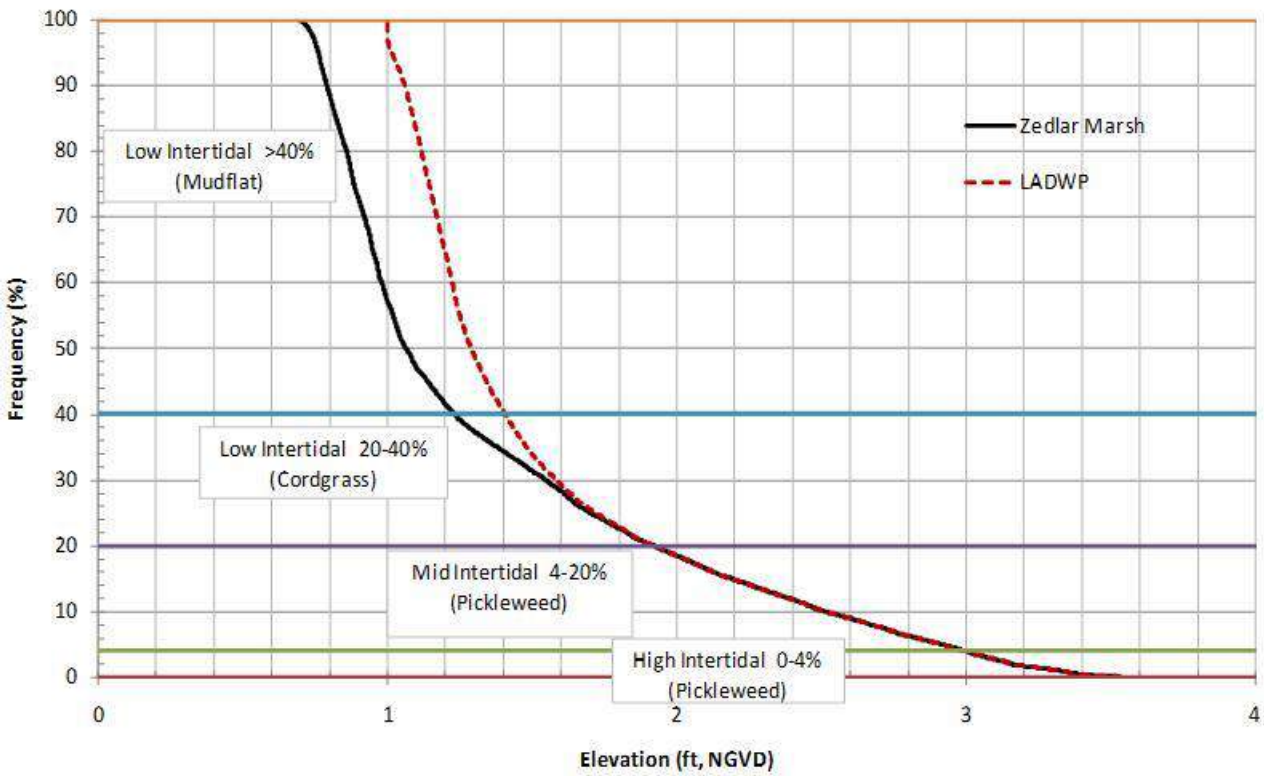


Figure 7-124. Tidal Inundation Frequency at the Isthmus Area for Alternative 3, Existing Sea Level

Isthmus Area (Zedler and Callaway Marshes), Alternative 3, SLR of 1.5 Feet and 5.5 Feet

Figure 7-125 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at Zedler and Callaway Marshes on the Isthmus Area for Alternative 3. The range of elevations for salt marsh habitat is still limited, but to a lesser extent than for existing sea level conditions. The marsh ranges in elevation from +4.5 feet to +1.2 feet NGVD. The same limitations and potential remedies apply for this situation as compared to existing conditions. Habitats are still dominated by supra-tidal areas, with increasing mid-marsh and mudflat.

Figure 7-126 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at Zedler and Callaway Marshes on the Isthmus Area. The range of elevations for salt marsh habitat remains limited in all areas, but to a lesser extent than both existing sea level conditions and with SLR of 1.5 feet. The marsh ranges in elevation from +7.6 feet to +4.8 feet NGVD at both sites. The same limitations and potential remedies apply for this situation as compared to existing conditions and with SLR of 1.5 feet, with the possible addition of larger culverts to convey the increased tidal prism possessed at the site. Habitat is dominated by mudflat and subtidal under this alternative.

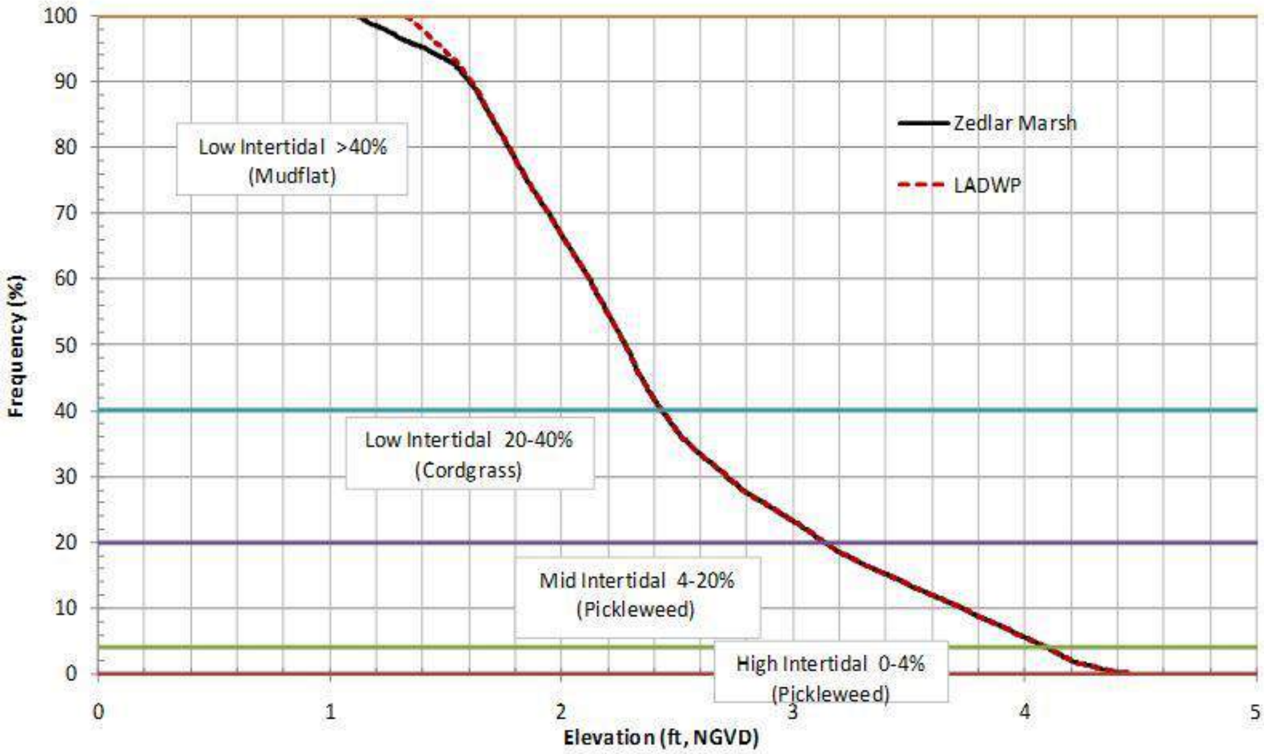


Figure 7-125. Tidal Inundation Frequency at the Isthmus Area for Alternative 3, SLR of 1.5 Feet

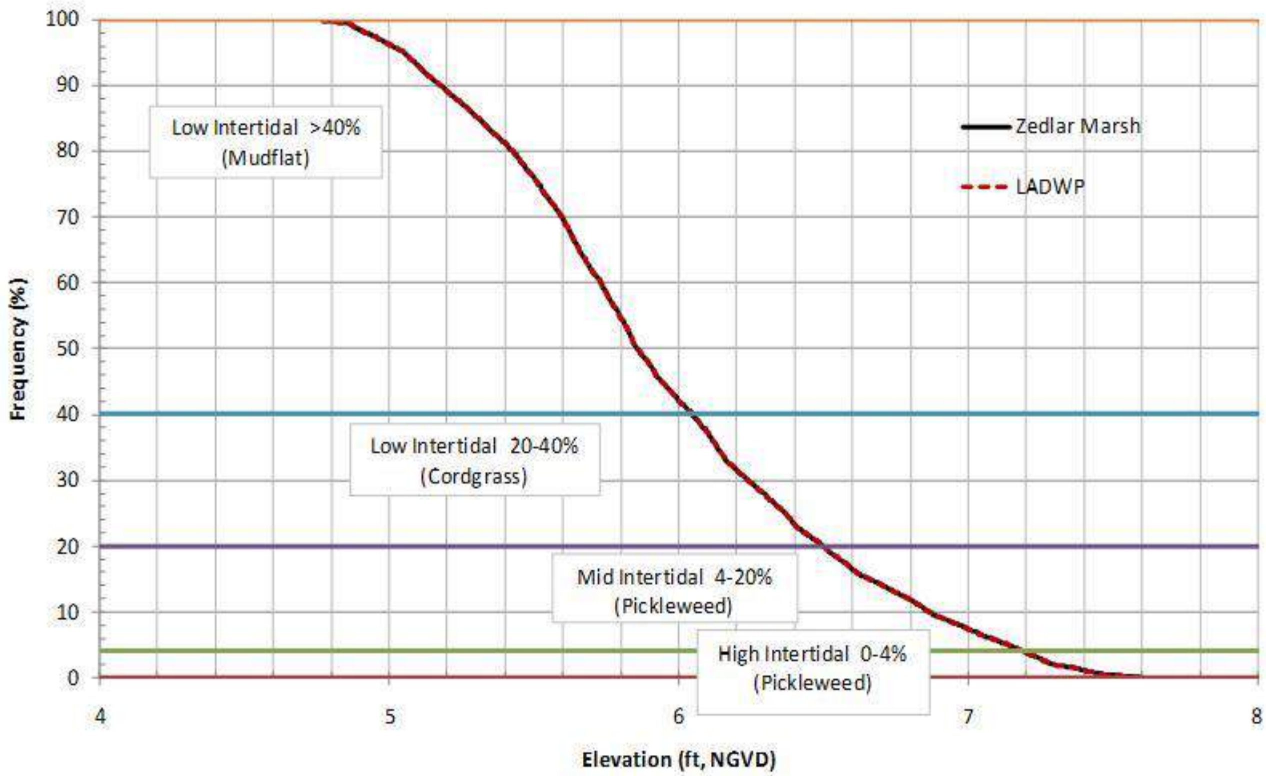


Figure 7-126. Tidal Inundation Frequency at the Isthmus Area for Alternative 3, SLR of 5.5 Feet

Southeast Area, Alternative 3, Existing Sea Level

Figure 7-127 shows the tidal inundation frequency curve for existing sea level conditions at the Southeast Area for Alternative 3. The HCC is the source of seawater and the site is connected with an open channel. The vertical range of habitat elevations represents full tidal conditions in all areas. The marsh ranges in elevation from +4.1 to -3.3 feet NGVD over the entire site. The proportions of habitats are evenly distributed between all habitat types. This alternative is one of the most balanced habitat distributions of any alternative.

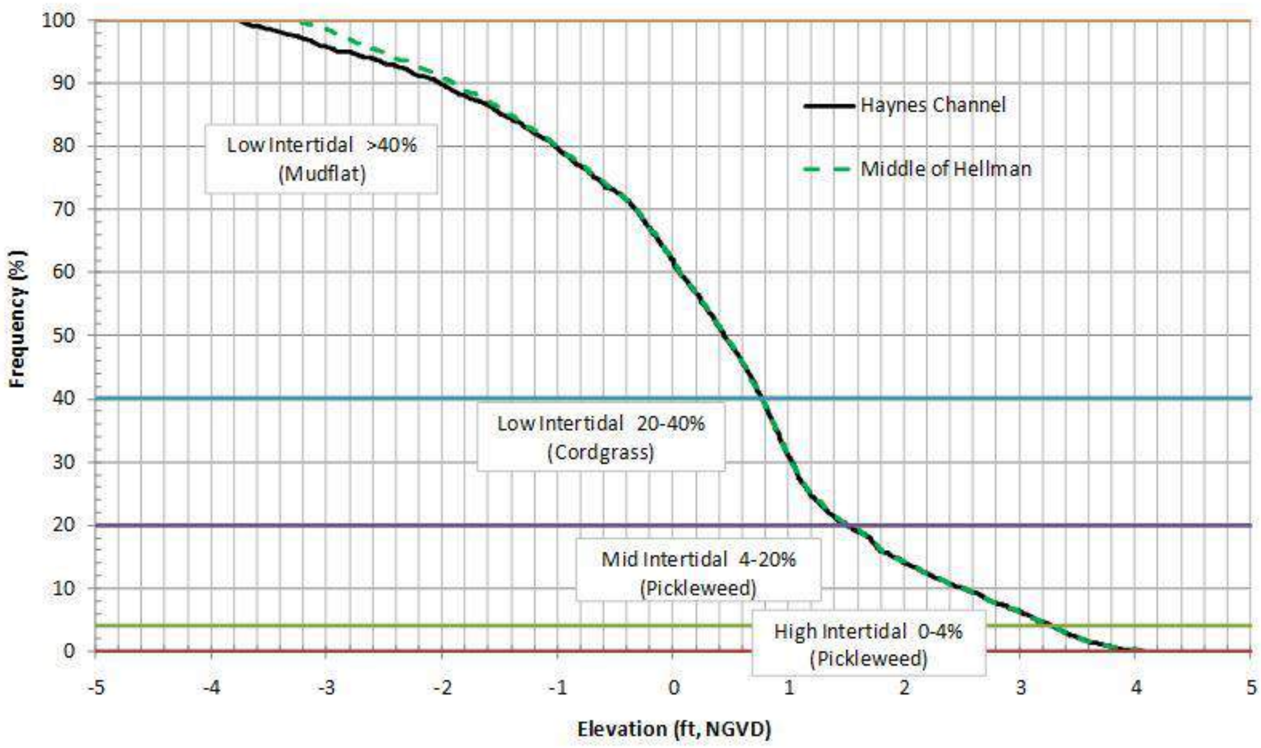


Figure 7-127. Tidal Inundation Frequency at the Southeastern Area for Alternative 3, Existing Sea Level

Southeast Area, Alternative 3, SLR of 1.5 Feet and 5.5 Feet

Figure 7-128 shows the tidal inundation frequency curve for SLR conditions of 1.5 feet at the Southeast Area for Alternative 3. The range of elevations for salt marsh habitat is still represented of full tidal conditions, and habitats range in elevation from +5.7 feet to -2.2 feet NGVD. Habitat distributions become more dominated by mudflat and mid-marsh habitats.

Figure 7-129 shows the tidal inundation frequency curve for SLR conditions of 5.5 feet at the Southeast Area for Alternative 3. The range of elevations for salt marsh habitat remains full tidal and the marsh ranges in elevation from +9.7 feet to +1.6 feet NGVD. Site elevations result in habitat being dominated by mudflat and subtidal habitats.

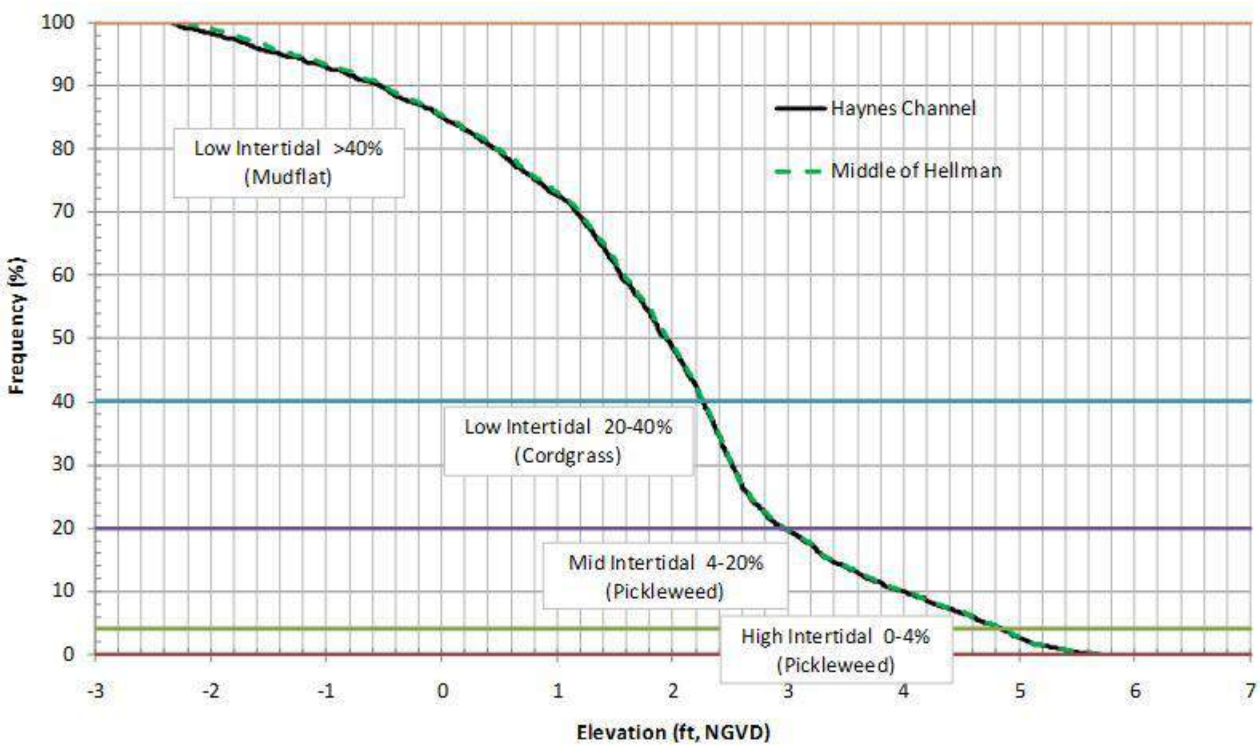


Figure 7-128. Tidal Inundation Frequency at the Southeast Area for Alternative 3, SLR of 1.5 Feet

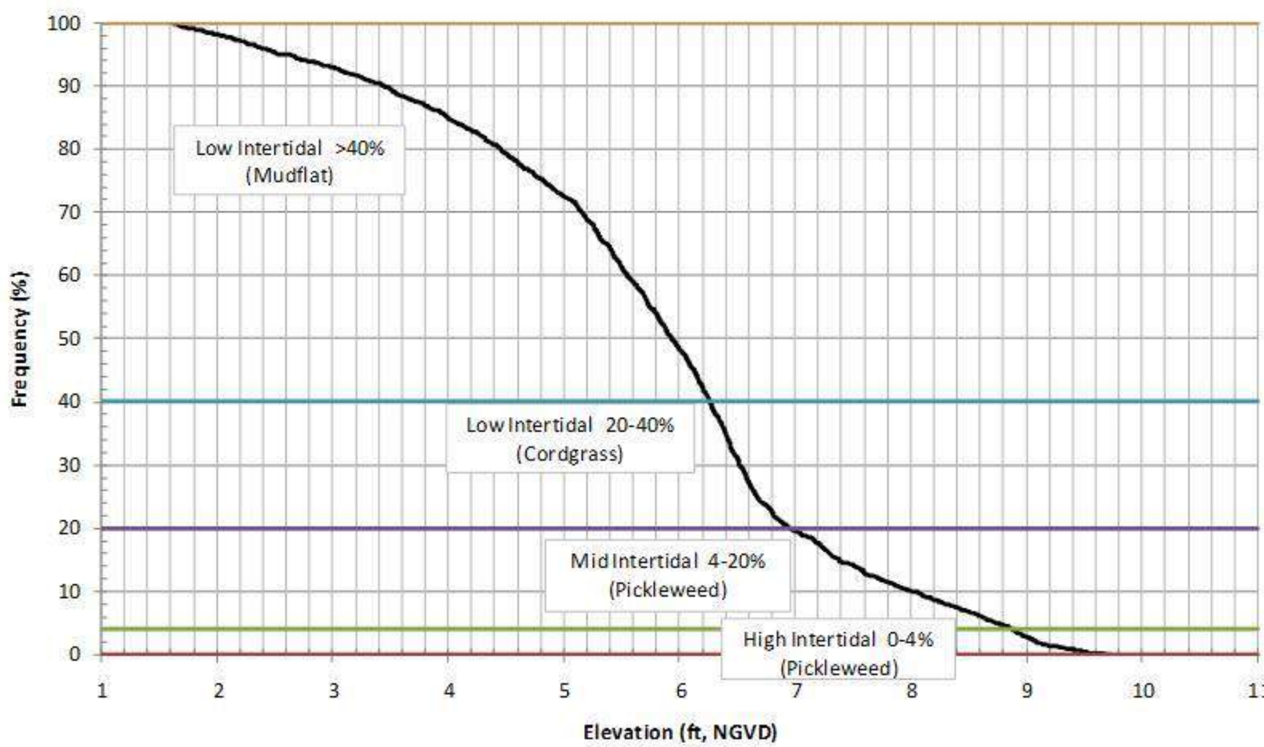


Figure 7-129. Tidal Inundation Frequency at the Southeast Area for Alternative 3, SLR of 5.5 Feet

The results of the tidal inundation frequency analyses are predicted habitat elevation bands for the alternatives. The analyses indicate the elevation ranges where habitat should occur, and these are shown on the grading plans that set elevations. Figure 7-130 through Figure 7-141 show the areas to be occupied by each habitat category under the three water level conditions of existing sea level, and SLR of 1.5 feet and 5.5 feet, respectively.

Figure 7-130. Habitat Elevation Bands, Maximum Alteration, Northern Area, Existing Sea Level

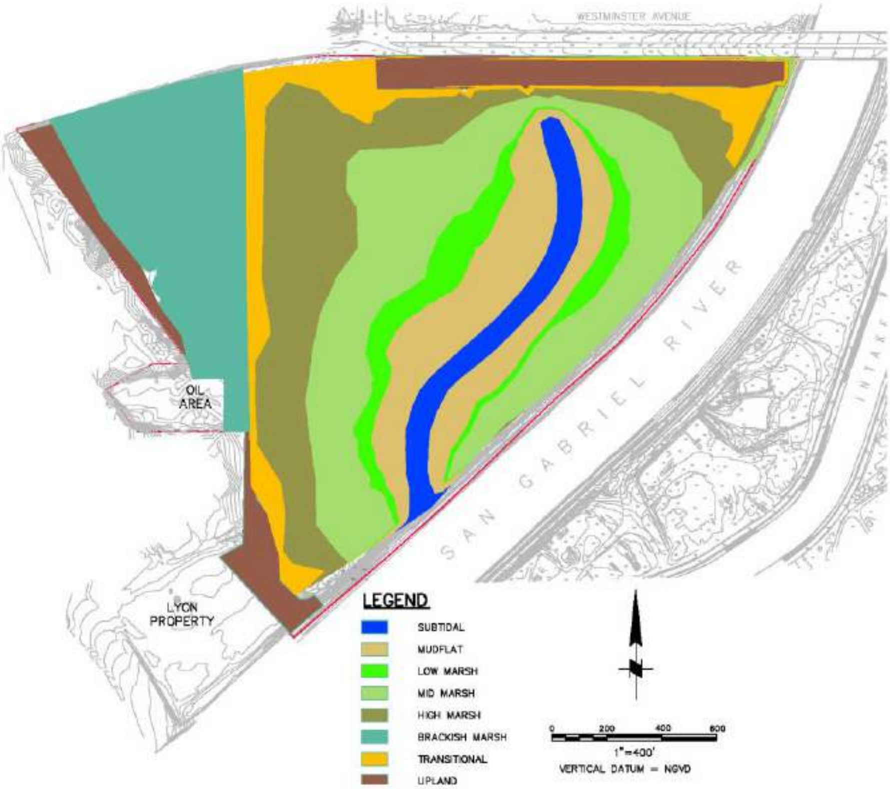


Figure 7-131. Habitat Elevation Bands, Maximum Alteration, Central Area, Existing Sea Level
Note: Blank areas are non-tidal.

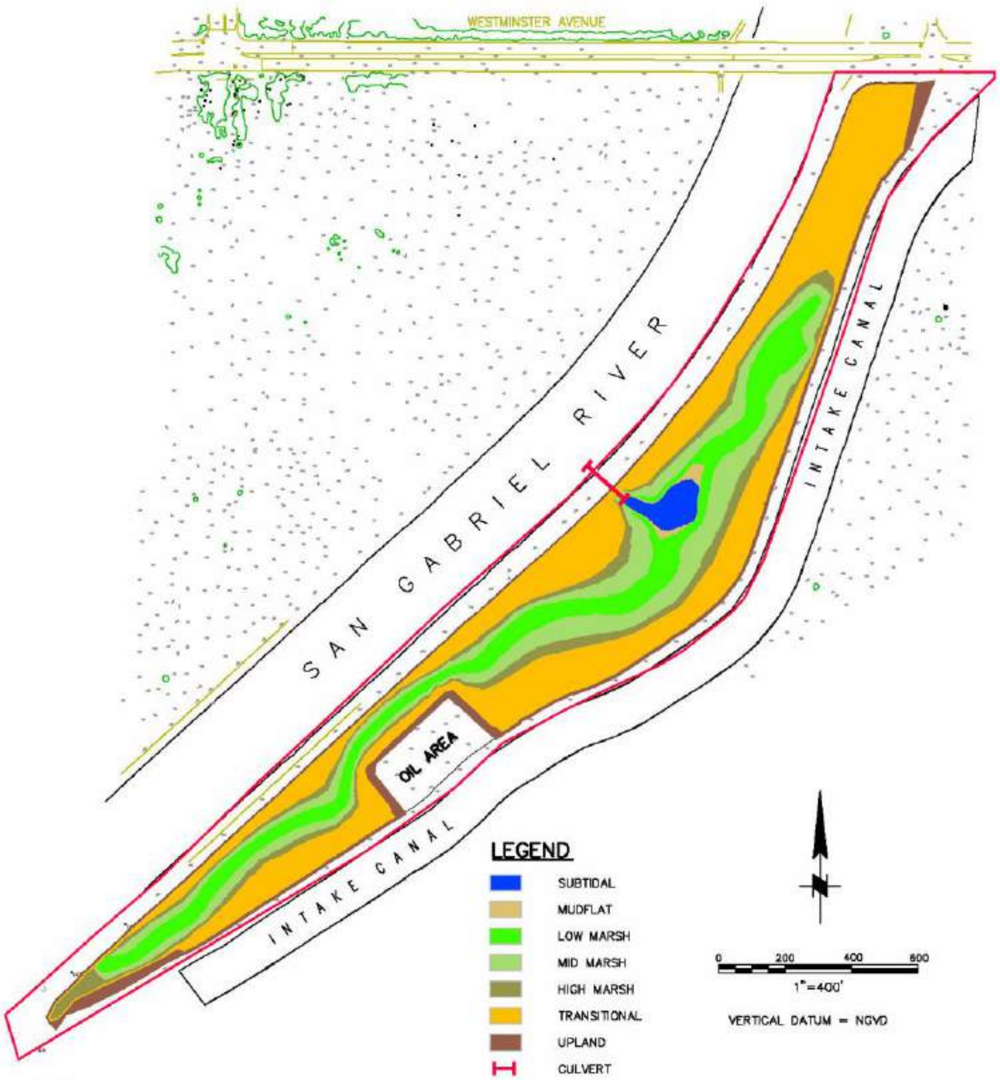


Figure 7-132. Habitat Elevation Bands, Maximum Alteration, Isthmus Area, Existing Sea Level

Figure 7-133. Habitat Elevation Bands, Maximum Alteration, Southeast Area, Existing Sea Level

Figure 7-134. Habitat Elevation Bands, Maximum Alteration, Northern Area, 1.5 Feet of SLR

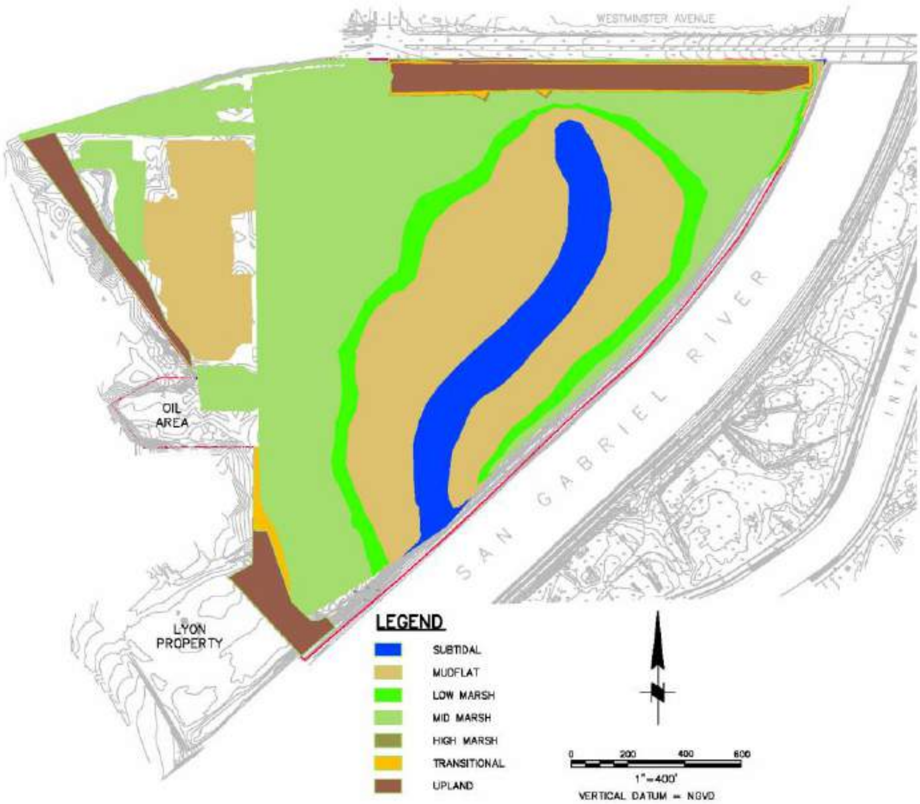


Figure 7-135. Habitat Elevation Bands, Maximum Alteration, Central Area, 1.5 Feet of SLR
Note: Blank areas are non-tidal.

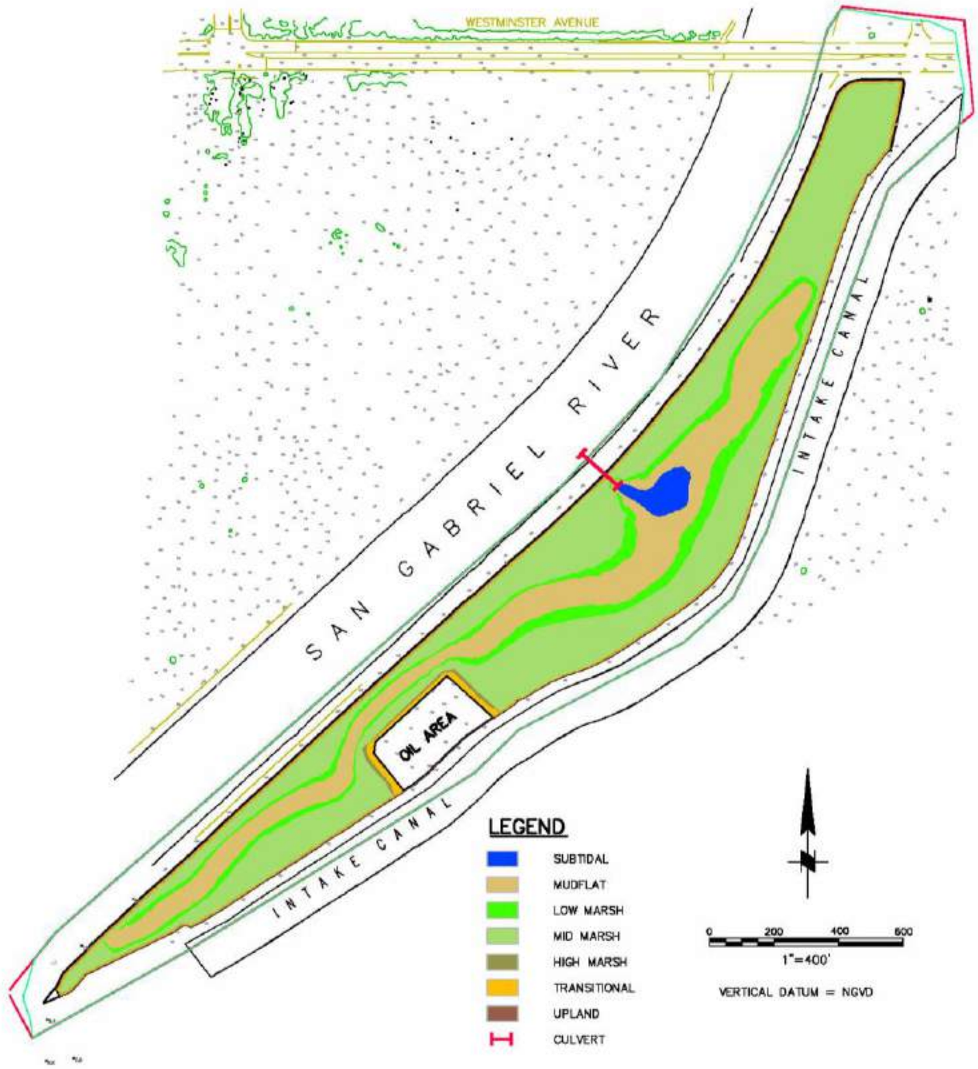


Figure 7-136. Habitat Elevation Bands, Maximum Alteration, Isthmus Area, 1.5 Feet of SLR

Figure 7-137. Habitat Elevation Bands, Maximum Alteration, Southeast Area, 1.5 Feet of SLR

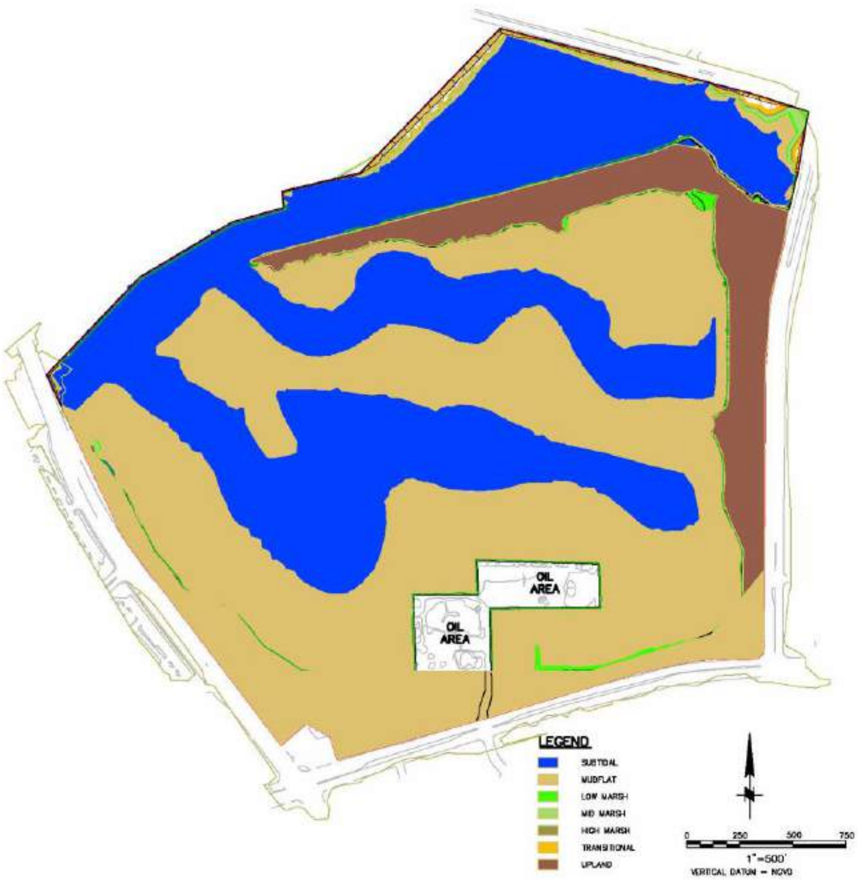


Figure 7-138. Habitat Elevation Bands, Maximum Alteration, Northern Area, 5.5 Feet of SLR

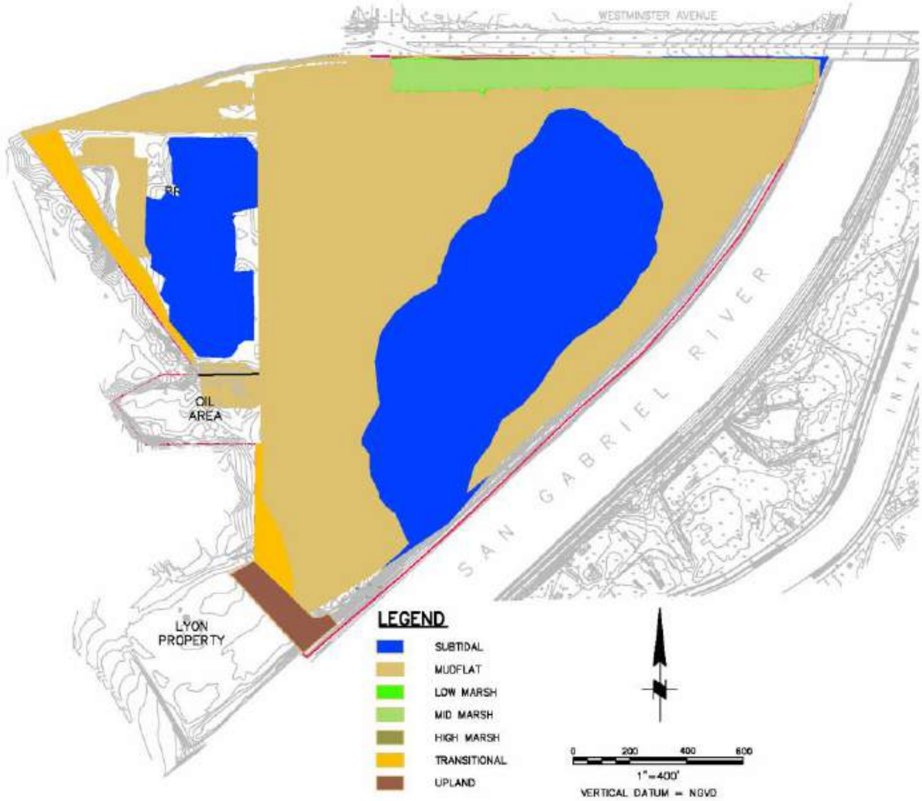


Figure 7-139. Habitat Elevation Bands, Maximum Alteration, Central Area, 5.5 Feet of SLR

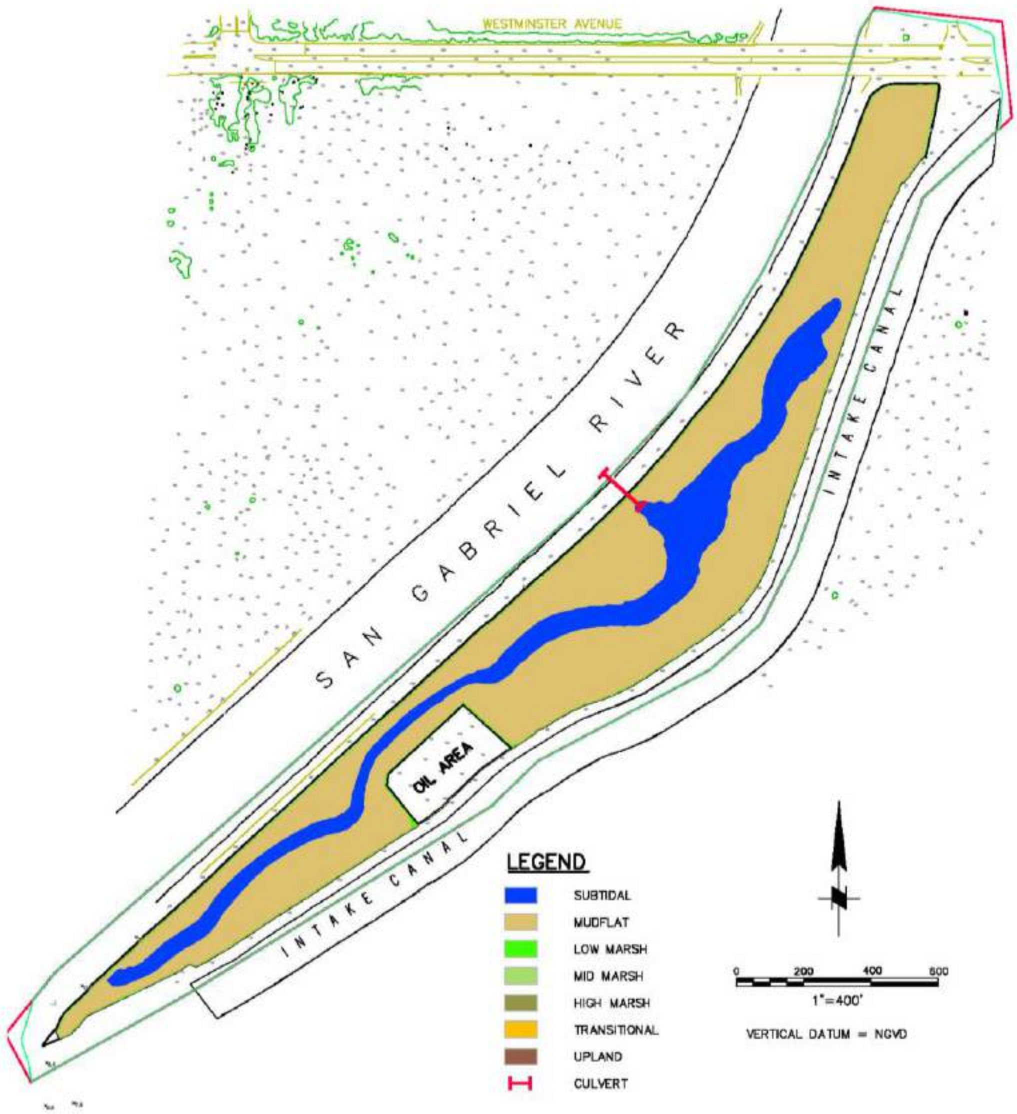


Figure 7-140. Habitat Elevation Bands, Maximum Alteration, Isthmus Area, 5.5 Feet of SLR

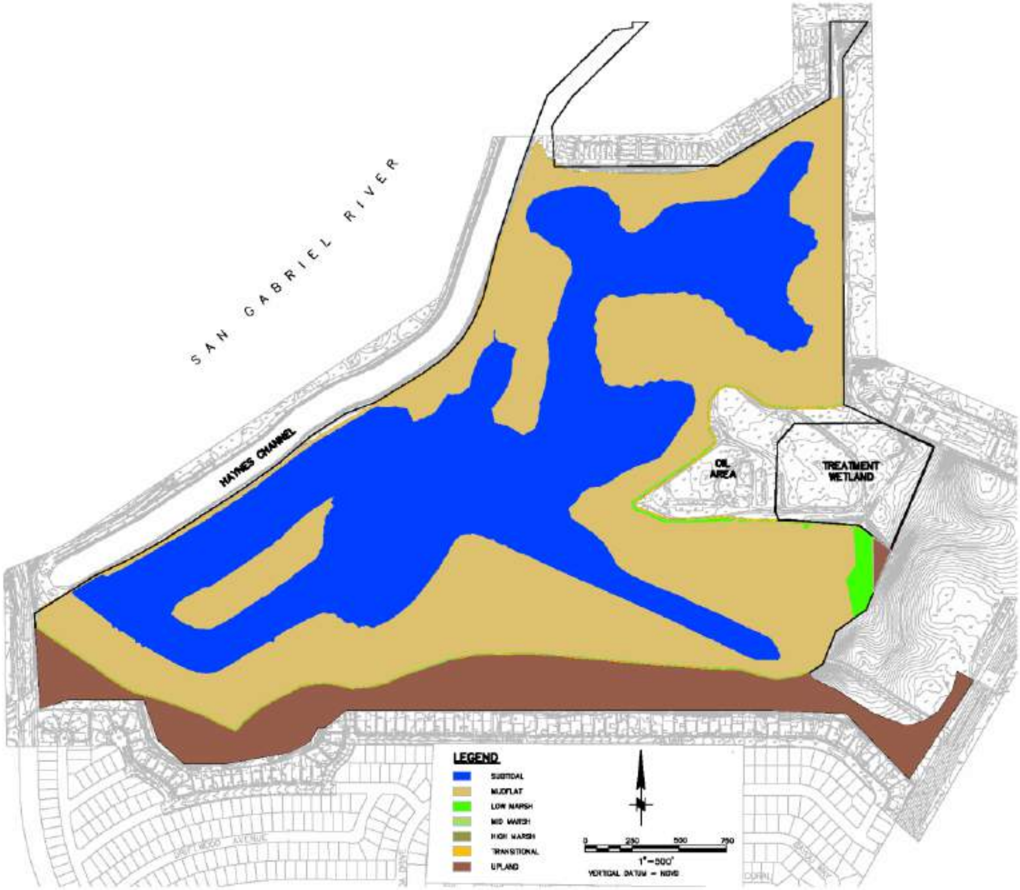


Figure 7-141. Habitat Elevation Bands, Maximum Alteration, Southeast Area, 5.5 Feet of SLR

7.4.6 Construction Methods

Alternative 3, Maximum Alteration, also lends itself to consideration of both “wet” and “dry” construction approaches. Two possible construction scenarios are summarized below for Alternative 3. These scenarios are hypothetical and are two of possibly multiple scenarios that a contractor could devise. As such, they should not be considered the only approaches to take, nor should they be the required approaches when restoration commences. They are provided to demonstrate actions to be expected on site to build the project for purposes of decision-making.

Wet Construction

Wet construction involves removing material below water by dredging. Equipment includes a dredge or barge-mounted backhoe, boats, barges, scows, tugs, pumps and discharge lines, booster pumps, and possibly other items. Dredging is suitable when a site is already under water or extremely saturated, connected to a water channel, and planned for subtidal habitat. The Northern, Central, and Southeast Areas would be full tidal with subtidal habitat, and connected to channels. The Isthmus Area is more suited for construction in the dry due to its confined area and lack of subtidal habitat.

Dredging needs to be considered in light of the following issues: 1) requiring water level control to constantly float the dredge; 2) disposal of the dredge slurry; and 3) multiple mobilizations of the dredge at separate Areas. Each item is summarized below.

Water levels at the dredge site need to be maintained. This is more feasible to do for Alternative 3 than Alternative 2 because more subtidal area is proposed, and at the Northern Area a dike will remain in place that can protect Steam Shovel Slough during construction. The dredge could dig its way into proposed new slough arms at each area except at the Isthmus Area, and work through the sites.

Alternative 3 may be more suited for dredging than other alternatives because of the opportunity to re-use the surplus material at the OC Retarding Basin. However, the volume of material to be dredged is so large that there would be a significant surplus of material even if filling of the retarding basin is assumed. The total material surplus after filling of the OC Retarding Basin is 1.5 million cy. Therefore, material disposal is still a major issue for Alternative 3, whether the project is constructed in the wet or the dry. Dredge slurry could be barged offshore to a designated disposal site such as LA-2 off San Pedro and/or LA-3 off Newport Beach, and possibly re-used at the Port of Long Beach.

As with Alternative 2, if some of the material were composed primarily of sand (80% or more), with the remaining portion being silts and clays, then it may be feasible to place some of it at the beach or nearshore coastal ocean off Long Beach as beneficial re-use. Another potential re-use option for sandy material could be creation of a nesting site within the project area. This alternative also does not include such a feature at this time, but it could potentially be considered in the future.

A dredge would need to be either mobilized and demobilized at each dredge site, or be floated into the proposed new channels at the Northern and Central Areas from the Los Cerritos Channel and San Gabriel River, respectively. Navigation in the San Gabriel River is hazardous and may not be preferred. Finally, access to the Southeast Area would have to be by land because no channels reach the site. The HCC is adjacent to that area, but it is connected to a siphon under PCH on one end and the Haynes Generating Station at the other end. The dredge would have to be delivered by truck and mobilized as a separate action for that site.

Dry Construction

Alternative 3 could also be constructed entirely in the dry from land using backhoes, excavators, earthmovers, scrapers, bulldozers, front-end loaders, dump trucks, and other land based equipment. As previously mentioned, the equipment operates above water in dry conditions, and reaches into wetter areas to remove earth material and grade the site. Construction equipment would enter the site and work from the existing oil and access roads to excavate earth material, as needed, to implement the grading plan. The work would consist of more extensive grading than Alternatives 1 and 2 on every site. Large-scale channel networks would be installed in the Northern, Central, and Southeast Areas, and a smaller channel network would be installed at the Isthmus Area. Installing these channels could require the contractor to install a temporary construction road network to increase the access to all site areas. In addition, specialized construction equipment that runs on tracks rather than on rubber tires may be needed to access extremely wet soil areas (*e.g.*, trucks, bulldozers, earthmovers, backhoes, etc.).

It is assumed that the overall approach for earthmoving could be to work “backward” from the most seaward portion of the site that is closest to the channel and designed to be the lowest point in elevation, back toward the higher portions of the site closer to the construction access location. Dewatering of all land-based construction sites would be required on an ongoing basis. The contractor may incrementally create a system of cells over the site using oil roads and dikes to dewater smaller portions off the site and excavate the desired channel pattern. Once the work in one cell is complete, the contractor may move on to a new area and erect a new dike to create another working subarea, and then remove the former dike. Alternatively, the contractor may leave cells diked off until excavation is complete and then remove all dikes from downstream to upstream (channel to upland) in one coordinated operation. This could potentially provide a benefit of reduced dewatering during excavation.

Performing earthwork in the dry season is preferred over working in the wet season to reduce dewatering and weather-related interruption to construction. As with all other alternatives, the timing of construction may be affected by the patterns of nesting and breeding birds. The nesting season window can extend from mid-February through mid-September, which coincides with a large portion of the dry season. As is the case for the previous alternative, the LCWA may need to work during the majority of the wet season to avoid nesting birds, and/or attempt to negotiate some type of exception to avoidance of the bird nesting season for construction.

Construction of alternatives that connect existing Steam Shovel Slough to new wetland areas may cause impacts to the Slough. Additional analyses and care in design must occur to minimize or avoid impacts to existing sensitive habitat.

7.4.7 Maintenance Regime

Alternative 3 will also require long-term maintenance. Items such as fencing, trails, culverts, etc., require maintenance to reduce the need and frequency of replacement. Maintenance actions for Alternative 3 are itemized below. As previously mentioned, partnerships between the LCWA and other site owners and managers (*e.g.*, oil operators at their surface lease sites, Los Angeles County Department of Public Works, and the OCFCD) should be maintained and encouraged to minimize burdens on the LCWA.

On-Going Maintenance

- Vegetation management - This includes: 1) non-native weed control, 2) dry brush control for fire, and 3) clearance of vegetation from around oil operations. Items 1 and 2 would be required of the LCWA (the LCW SP), while Item 3 would be done by the oil operators. Alternative 3 likely requires less vegetation management than Alternatives 1 and 2 because there is the least amount of upland habitat present and due to proposed consolidation of oil facilities and associated reduced level of disturbance and fragmentation. Alternative 3 provides the greatest level of tidal influence than the other alternatives, which should reduce non-native vegetation colonization.
- Culvert cleaning and repair – Culverts connecting the sites to seawater sources may need to be periodically cleaned or cleared of marine growth and/or obstructions, and repaired of any damage (*e.g.*, leaks, breaks). Only two culverts exist with Alternative 3 (and Alternative 2)

compared to Alternative 1, so a reduced degree of culvert cleaning and repair may be required.

- Internal road repair and accompanying culvert repairs – Roads within wetlands can experience localized subsidence or failure near culverts if water reaches the road around the culvert. There are no roads within the wetland for Alternative 3 so internal road repair and associated culvert repairs should not be necessary.
- Graffiti –Graffiti removal will be an ongoing concern for any structures. Alternative 3 should require less graffiti removal than Alternatives 1 and 2 because a greater degree of oil consolidation will occur offering the fewest sites to vandalize, and a greater area of the site would be covered by water, thereby inhibiting unauthorized access.
- Removal of trash – Significant volumes of trash reach the sites through the Los Cerritos Channel and San Gabriel River, and from adjacent streets. Trash removal will be an ongoing activity into perpetuity. Alternative 3 would require greater trash removal than Alternatives 1 and 2 because it includes larger open channel connections to sources of floating trash (*i.e.*, Los Cerritos Channel and the San Gabriel River). This action is well-suited for the LCW SP.
- Vector Control – Vector control will be implemented by the Vector Control Districts of both Orange and Los Angeles Counties. Site access to these groups is imperative for them to perform their function, and periodic vegetation removal may be required to reduce stagnation of circulation in certain areas. Increased tidal circulation should reduce vectors; therefore, restoration should reduce the need for vector control over time. The minimum degree of vector control would likely be required for Alternative 3 compared to Alternatives 1 and 2 due to the maximized tidal circulation expected on site.
- Fence and gate repair – Fences and gates bound the sites and may need to be erected in other areas. They typically require repair on a periodic basis after being damaged, vandalized, and/or weathered. The on-site oil operators will actively maintain their fences and gates, but fences and gates outside of the oil areas will require attention of the LCWA. A reduced degree of fence and gate maintenance would be required for Alternative 3 compared to Alternatives 1 and 2 due to slightly increased consolidation of oil operations.
- Access way (path) repair – Access pathways will need periodic repair and maintenance. Access path repair may be similar to all alternatives.
- Facilities maintenance – Certain project-related facilities such as parking lots, buildings, interpretive elements, storage areas, bike paths, and possibly other items need period inspection and repair. Any such elements that are installed as part of the project would require attention of the LCWA. Interpretive centers would likely include several, if not all, of these items. Alternative 3 includes a potential interpretive opportunity only at the OTD parcel so the maintenance need might be reduced from Alternatives 1 and 2.

Reactionary Maintenance by Contractors

- Possible erosion protection (unanticipated bank erosion) – Internal wetland shores may experience erosion on a variety of time and space scales, and local flood control levees are observed to be gradually eroding. There may be the need to install additional small rock or articulated block mats at sites of erosion, possibly near culvert headwalls. Alternative 3 may require increased erosion protection than Alternatives 1 and 2 because it assumes greater tidal flow in its channels than the other alternatives. Higher tidal flow velocities may cause unanticipated erosion at various locations.

- Sediment removal from unwanted locations – Sediment may deposit, or accrete, in areas that are not desired for sedimentation. This alternative could have greater potential for sedimentation because the larger connections to the San Gabriel River and Los Cerritos Channel provide greater opportunity for more sediment to enter, which could, in turn, settle in low velocity areas. In contrast, Alternative 3 should result in the greatest tidal circulation, higher flow velocities, and sediment remaining in suspension compared to Alternatives 1 and 2, so it results in the least sediment removal compared to other alternatives.
- Levee repair – Any levees installed may also need repair. Alternative 3 includes a breach to the San Gabriel River levee for the Central Area, so certain repairs to that levee may be needed.
- Bridge/boardwalk inspections and repairs – Any bridges or boardwalks for wildlife and public access need regular inspection for repairs. Alternative 3 (and Alternative 2) assumes a greater amount of bridge/boardwalk components compared to Alternative 1, so more inspection and repair could be necessary.

7.4.8 Cost Estimates

Opinions of probable construction costs were determined based on the components included in this alternative. As with the previous alternatives, comprehensive cost estimates were estimated for all phases of project implementation including preliminary engineering, environmental review (CEQA/NEPA), final engineering, permitting, construction, construction management, construction monitoring. A range in costs is provided here on a per acre basis. The costs for Alternative 3 are higher than those of the other two alternatives at between $273,000 and $473,000 per acre.

7.5 Optional / Future Phase Items

A number of potential optional items are worthy of consideration for implementation during restoration to render the project more successful and potentially create a greater return for the LCWA's investment. For each item, a general description, qualitative discussion of benefits, and conceptual-level cost estimates are provided.

7.5.1 Elevated Roadway / Bridge Along 2nd Street / Westminster Avenue

An elevated roadway/bridge on 2nd Street would be in the form of a roadway bridge over a low naturalized land bridge and/or channel connecting the Northern Area to the Central Area. A connection under 2nd Street would provide a significant benefit to wildlife as an uninterrupted undercrossing. Wildlife would likely use this type of crossing because it is direct, short, and does not force a change in direction of ambulation. Habitat fragmentation would be reduced with this feature. The bridge could also allow water to flow between the two land parcels and potentially improve circulation, tidal conveyance, fish habitat, and wetland function.

The concept could be a standard bridge that elevates the roadway high enough above the site to allow clearance during high water. Future high water levels could reach up to +10 feet NGVD during SLR of 5.5 feet. The bridge would need to clear that elevation and potentially possess a certain amount of freeboard. A rough concept could be a relatively low and short bridge to provide a soft-bottomed opening under the roadway. The length of the bridge could be approximately 100 feet, and the design could be a pile-foundation with a thin bridge section to keep the bridge deck low enough to minimize raising of the roadway approaches, and to reduce costs. One example of a similar type of structure is shown in Figure 7-142 below. It should be placed far enough west from the intersection to not require the intersection to have to be raised if possible. It should also be located along a reach of 2nd Street that is as high as possible to also minimize the need to elevate the roadway. A suitable location that fits both criteria would be the location of a land bridge across 2nd Street presently shown on the graphics of alternatives.

The cost for such a structure is on the order of $10 million.

Figure 7-142. Example Low and Short Bridge Over Soft-Bottomed Wetland Area
Highway 101 Over San Elijo Lagoon in Encinitas, CA
(Copyright © 2003-2010 Kenneth & Gabrielle Adelman - Adelman@Adelman.COM

7.5.2 Land Bridge (Pedestrian Bridge) Over 2nd Street/Westminster Avenue

A land bridge over 2nd Street is addressed conceptually in the Public Access section of this report for Alternatives 1, 2 and 3. Section 7.2.4 describes the concept as a “green bridge” and shows figures of multiple options. As presented in that section of this report, the terrestrial connection will not only provide connectivity between two otherwise isolated wetland areas, but will also provide an exceptional interpretive and educational overlook site. Design precedents exist for vegetated overpasses of similar span that combine wildlife and pedestrian trails, as in the proposal for Vail Pass over I-70 in Colorado. The rough cost of this concept is approximately $5 million, and the cost could be offset by revenue generated by the associated building. The concept is shown in Figure 7-143 below.

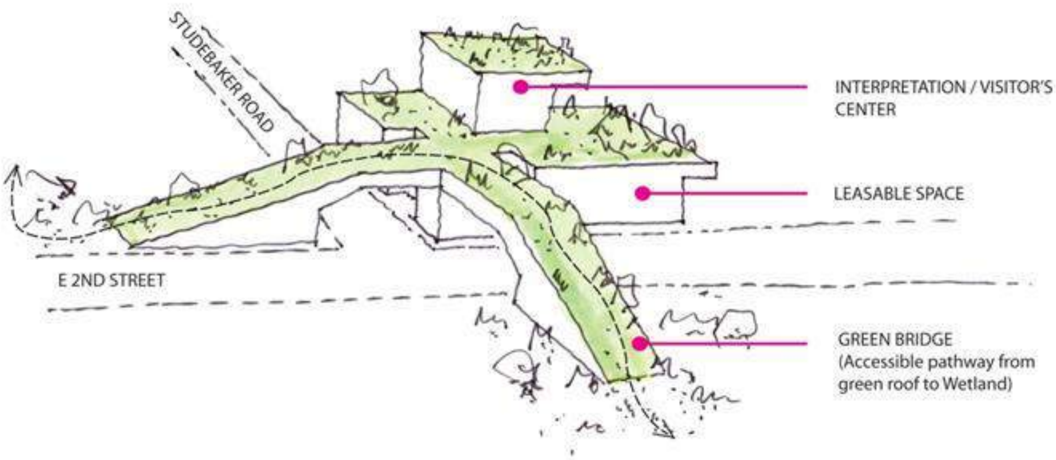


Figure 7-143. Concept of a Land Bridge Over 2nd Street

7.5.3 Culvert / Tunnel Connection under 2nd Street/Westminster Avenue

A tunnel under 2nd Street would function similar to a bridge, but would allow the roadway to remain in place. Tunnels are less attractive to wildlife and may not be used as widely as a corridor. However, excavating a tunnel connection may be less costly than a bridge with roadway improvements. Water would pass through the tunnel/culvert as well as wildlife. The cost for such a feature would range from $250,000 for a culvert to a higher cost for a tunnel, with the tunnel cost needing further research. The location could be at any point along the roadway, as roadway constraints are not as much a factor in its placement.

7.5.4 Hellman Channel Connection to Haynes Channel (For Alternative 1)

Connecting the Hellman oil-retained site to the HCC using an open channel would improve tidal hydraulics near the channel location. However, this benefit would only exist near the channel because there are multiple culvert connections throughout the remaining oil field that constrain tidal flow. The conceptual culverts connecting the HCC were designed to admit tides to the site at suitable elevations relative to the existing site elevation. Alternative 1 intends to require minimal site alteration. As the Hellman site is relatively high, installing an open channel may result in tidal elevations that drain the site to water levels at low tide that are too low, thus draining subtidal habitat.

Alternative 1 is likely not the optimum alternative for an open channel to the HCC. Another approach to this connection could be to fix the elevation of the connecting channel to keep water levels a bit higher to keep subtidal areas in Hellman ponded for fish habitat. This approach would result in the same effect as culverts. The cost for a new open channel connection would be approximately $100,000.

7.5.5 LCWA Phase 1 Parcel (West Side) Culvert Connection to the San Gabriel River (For Alternative 1)

This concept relates to installing a second culvert connection to the LCWA Phase I parcel west of the San Gabriel River to improve tidal conditions. The idea holds merit and should probably be strongly considered. Tidal ranges for Alternative 1 at this site are very small compared to the river. The concept would be a second 4-foot diameter culvert placed similarly to the one already proposed. It would be relatively inexpensive ($100,000+) and could be done coincident with installation of the culvert farther to the south. Benefits are that it provides a second connection to the site in case one connection becomes blocked, and could be used to facilitate culvert cleaning. It also would shorten the residence time for water in the area and improve water quality. Finally, it would increase fish passages by providing two locations for that activity rather than one. Some measure of scour protection should be considered on the inboard (wetland) side of the culvert for this alternative for high water and flow conditions.

7.5.6 LCWA Phase 1 Parcel (West Side) Connection to the San Gabriel River Via Removal of Most/All of the San Gabriel River West-Side Levee (For Alternatives 2 and 3)

This concept envisions large-scale removal of the west flood control levee along the San Gabriel River to allow water to freely flow into the LCW Central Area. Levee removal is a significant undertaking that requires a USACE Section 408 permit. Levee removal will allow floods and tides to enter the Central Area unimpeded. While this can provide benefits of a naturalized condition, it will also pose substantial challenges for the marsh.

The concerns of removing the levee pertain to several issues. First water levels would significantly increase in this area from existing conditions during stormflows. As a result, existing oil infrastructure will have to be raised to remain dry during high stormflows, and portions of the perimeter may also need to be raised to contain floodwaters on the site. A flood study would be needed to confirm water levels during 100-year storm flow conditions at the Central Area and the need for perimeter flood protection.

Another limitation of removing the levee is the quantity of trash that could enter the wetland during storm flows. While future conditions within the San Gabriel River could improve in the future due to TMDLs and storm water permit requirements, the river presently yields high volumes of trash from each storm event and that material could end up in the Central Area requiring its removal. Removing trash from wetlands is problematic due to its broad distribution and difficult access. It typically comes to rest along the high water line at the time of the event, and that can be within portions of the marsh that are difficult to access. Contributions of trash to the site may decrease over time. The Water Board is addressing this component through regulation, according to Water Board staff (Shirley Birosik, Personal Communication 2014). While not all of the impairments in the watershed have TMDLs completed for them yet, they all will have to be addressed in the future. In the meantime, the existing municipal stormwater permits require actions to reduce inputs of pollutants to storm drains. Those impairments that do have TMDLs established are being implemented through the stormwater permits (and through other regulatory actions) and include waste load allocations and implementation schedules (with timelines) to meet the allocations. So water quality should be expected to improve through time.

As specified by Water Board staff, the individual cities are now individually responsible to implement the new permit adopted in 2012 and have the option to form groups to develop and implement watershed management programs to meet permit requirements. There are several groups formed in the upper and lower San Gabriel River, Coyote Creek, and Alamitos Bay/Los Cerritos area. More information can be found at http://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/watershed_management/index.shtml.

Finally, water quality at the wetland may be impaired by the storm flow discharge if contaminants exist in it, and from prolonged freshwater exposure. Although future conditions may improve, the San Gabriel River presently has a reputation for discharging poor quality water during the first flush of stormflow events (Los Angeles County Department of Public Works 2012). Generally, past monitoring by the LA County Flood Control District (see monitoring report at http://dpw.lacounty.gov/wmd/NPDES/2011-12tc.cfm) during rain events found fairly regular exceedances of water quality objectives for dissolved copper and zinc at the Coyote Creek and San Gabriel River stations (both in the lower watershed) . Overall, most monitoring has found the highest levels of pollutants during the first flush and in particular during the first storm of the season. Subsequent storms, even large ones, may not carry as high concentrations of the pollutants (Shirley Birosik, Personal Communication 2014). While freshwater inputs can be beneficial, prolonged exposure to freshwater can be detrimental to a salt marsh. The threshold considered at Bolsa Chica for connection to a freshwater source was 24 hours.

Benefits of opening the levee would include a reduction in flood elevations on the river that might alleviate flood control needs upstream. Also, a natural geomorphic landform may form under tidal and fluvial processes that could be superior to man-made landforms. Finally, passage of fish and other constituents (organisms, nutrients, etc.) within the water column could enter the marsh freely for a more naturalized ecosystem. Water residence times in the marsh would be lower and resulting water quality should be better than using culverts.

The order-of-magnitude cost to implement this alternative would be fairly expensive at approximately $10 million.

7.5.7 Isthmus Tidal Connection to Haynes Cooling Channel (For Alternatives 2 and 3)

The Isthmus Area is presently connected to the San Gabriel River with culverts. Connecting the Isthmus Area to the HCC also warrants consideration because the water quality in the HCC is superior to that in the San Gabriel River. The drawback of this alternative is that presently the owner of the HCC (City of Los Angeles) has not issued permission to connect to the HCC, and staff indicated that future use of the channel is open to question (Katherine Ruben, Personal Communication with Chris Webb 2007). Assuming permission can be secured, the option of connecting the Isthmus Area to the HCC would solve several problems. Trash deposition at Zedler Marsh would decrease and removal operations reduced. Water quality at the Isthmus Area would improve. Connection could potentially be made with an open channel as opposed to one or more culverts. Culverts may be more suited for the connection for Alternative 2 due to the more limited wetland area, while an open channel may be more appropriate for connecting to Alternative 3 due to the larger wetland area. Costs would be approximately $100,000 for either option.

The cost to connect the Isthmus Area to the HCC is on the order of $1 million depending on the infrastructure existing in the path of the connection. A new steel sheetpile wall was recently installed by the City along that side of the HCC that will render connection more difficult and costly.

7.5.8 Removal of Fences

Fences exist throughout the project area for various purposes. Landowners tend to fence their sites to prevent trespassing and to limit liability. Fencing prevents free access throughout the LCW by humans and larger organisms (coyotes). Fences have also trapped birds, as witnessed on site, so their removal is considered a potential attribute. Certain fences are potentially strategic to remove to maximize habitat connectivity. Once the entire LCW Complex is restored, a significant benefit would occur from removing interior fences for habitat connection and erecting perimeter fences for wetland protection. Until the entire complex is restored, fences should remain between restored areas and unrestored neighboring sites. These fences would protect the wetland, while preventing trespass on private or unrestored parcels. One measure to reduce potential injury to fauna on site from remaining fences is to remove barbed wire from across the tops of fences. Barbed wire can injure mammals (coyotes) that can jump fences. Fence removal is a low cost action that can provide substantial benefits to wildlife. The cost to remove all fences is approximately $250,000.

7.5.9 Stormwater Best Management Practices

Stormflow runoff will potentially enter the wetland from outside areas. While this can benefit the marsh, it can also pose water quality issues. A prudent option to maintain water quality while contributing freshwater to the marsh is to develop bioswales at locations of point sources where appropriate. An example of this feature exists at the water quality feature for HP at the Southeast Area. Other areas that could benefit from this are the Northwest and Central Areas. The Isthmus may not receive a sufficient quantity of runoff from offsite to warrant this approach. The costs of such features depends on their size and complexity. A range of costs to install bioswales is $50,000 to $1,000,000, depending on the size and conditions of the site.

7.5.10 Design Optimizations to Various Alternatives

Optimizations to the designs of the various alternatives may be needed to provide sufficient upland habitat to support the wetlands, to provide flood protection to surrounding areas, etc. An example is to possibly add additional higher ground in the Central Area for Alternative 2, Moderate Alteration, where very little exists in the concept plan. Costs to perform design modifications and analyze the results at this conceptual stage are relatively low at approximately $50,000.

7.6 No Project

7.6.1 General Description

The No Project Alternative envisions no infrastructure changes on site. No consolidation of oil and gas operation infrastructure would be necessary. Vegetation management around equipment and access road maintenance would continue. Thus, removal of inoperable or abandoned equipment would be beneficial. All pipelines, roadways, power poles, non-operating equipment, and oil well site locations will be preserved as is. No well sites, pipelines, and roadways would be elevated to avoid flooding from tidal waters. All tank farm locations would be preserved and remain unchanged.

Hydrology will remain unchanged, and tides will be limited to conditions controlled by existing culverts and/or channels. The benefits assumed to come from this alternative include:

- No construction activities and associated costs,
- Relatively low costs of maintenance;
- Preservation of existing open space area,
- Relatively little impact to existing resources; and
- Maintaining compatibility with existing on-site uses.

The greatest impacts of this alternative consist of:

- Least quality of habitat of all alternatives;
- Attractive nuisance for homeless, vandals, and hazards associated with unauthorized site access; and
- Potentially progressive degradation of habitat over time if sea level remains as is; if sea level rises as is projected, then this process of habitat degradation may change into a process of habitat conversion into various types of brackish and salt marsh.

7.6.2 Habitat

The No Project Alternative yields gradual increases in intertidal and sub-tidal areas with SLR as tidal exchange improves through currently perched culverts and low levees are overtopped. Assuming no project was built, however, one could expect management of these areas to continue to prioritize protection of infrastructure and that modifications would be made to maintain very limited tidal exchange. Table 7-12 shows the effects of No Project on habitat. As indicated in Section 3, if left in its current environmental condition and sea level remains as is, much of the LCW Complex will become dominated by a mixture of freshwater wetland types bordered by ruderal uplands. If sea level rises as projected, then this process of habitat degradation may change into a process of habitat conversion into various types of brackish and salt marsh. The actual habitat formed will depend on variables such as tidal conveyance, site elevation, groundwater conditions, and likely other factors.

The successional pattern described above and observed on-site is not apparent at Steam Shovel Slough. This full tidal salt marsh appears to have changed little over the decades and is a model climax coastal salt marsh plant community. It is likely that this stability is due to its full tidal conditions and lack of major landform alteration. No Project would result in little to no change at Steam Shovel Slough. Figure 7-144 through Figure 7-146 show the habitat areas for each area under the No Project Alternative and for each sea level scenario.

Table 7-12. Habitat Analysis Matrix for No Project

No Project Alternative	Northern Area	Central Area	Isthmus	Southeastern Area	Entire LCW Complex
Diversity of Salt Marsh Habitats	• Broad distribution of intertidal habitats at Steam Shovel Slough • Southern area has limited tidally muted habitats and considerable non-tidal wetlands • Limited adjacent uplands and transition habitats	• Trivial tidal marsh habitat with a variety of other wetland types • Minimal tidal exchange on highest tides via drainage culverts	• Very small areas under regular tidal influence • Tidal muting with existing culverts	• Current habitats include sub-tidal channels, high intertidal marsh and transitional habitats • Tidal muting is significant	• Steam Shovel Slough will continue to be the only functioning salt marsh habitat • Salt marsh vegetation in non-tidal wetlands will gradually be replaced by freshwater species
Overall Habitat Diversity	• Existing high quality intertidal salt marsh at Steam Shovel Slough • Some storm-water-fed brackish habitat • Significant area of rainwater-fed basins with salt marsh vegetation that will eventually convert to freshwater habitats without tides • Weedy uplands	• Small area of very muted intertidal salt marsh • Considerable brackish wetland habitat • Significant area of rainwater-fed basins with salt marsh vegetation that will eventually convert to freshwater habitats without tides • Limited and weedy upland habitat	• Small muted tidal marshes • Uplands are highly disturbed with limited habitat value	• Skewed towards non-salt marsh habitats in near term • Significant area of disturbed freshwater wetlands and some brackish habitat • Large area of uplands dominated by invasive non-native plants	• Significant non-tidal wetlands fed by runoff and rainwater • Significant upland habitats that are highly disturbed and generally dominated by invasive non-native plants
Habitat Connectivity	• Habitats highly fragmented by roads and berms • Roads, levees and berms limit hydrological connectivity, and connectivity for most aquatic species • Steep transitions between marsh habitats and uplands	• Habitats highly fragmented by levees, roads, and berms • Almost no tidal connectivity	• Pocket marshes are isolated from each other by oil operations • Connectivity extremely limited	• Wetland habitats fragmented by roads and berms • Very poor aquatic connection • Many wetland-upland transitions are steep	• Lots of fragmentation due to oil roads and levees • Different areas are isolated by major roads, berms and development
Resilience to Sea Level Rise (SLR)	• Majority of the vegetated tidal marsh lost with moderate SLR at Steam Shovel Slough • Almost no vegetated tidal marsh left with significant SLR at Steam Shovel Slough • If not raised, current berms would be over-topped, allowing increased tidal influence around the current oil production area	• If current culvert is maintained, there will be more tidal influence with SLR; tides presumably severely muted	• Tidal habitats could expand slightly with moderate SLR or be lost if culverts are modified to reduce flooding risk to infrastructure	• Tidal habitats could expand slightly with moderate SLR or be lost if culverts are modified to reduce flooding risk to infrastructure	• Existing tidal salt marsh habitats largely lost with moderate SLR • Higher water levels could lead to an increased area of muted tidal influence in several areas if existing culverts are maintained • Increased risk of flooding for infrastructure will likely lead to culvert modifications that will keep tidal influence at or below current levels
Functional Lift	• No project, no lift • Functioning could increase or decrease with SLR as low berms are overtopped by tides	• No project, no lift • Functioning could increase or decrease with SLR depending on management practices	• No project, no lift • Functioning could increase or decrease with SLR depending on management practices	• No project, no lift • Functioning could increase or decrease with SLR depending on management practices	• No project, no lift • Functioning could increase or decrease with SLR depending on management practices
Take Home Message	• Steam Shovel Slough will continue to function and other areas will convert to freshwater wetlands	• Increased freshwater influence on wetlands will lead to loss of salt marsh vegetation	• Small pocket marshes will persist but remain very low functioning	• Low-functioning muted tidal areas will persist if existing culverts are not modified and weedy uplands will continue to provide limited habitat value	• As long as areas continue to be managed for non-habitat uses, non-tidal habitats will continue to be low-functioning

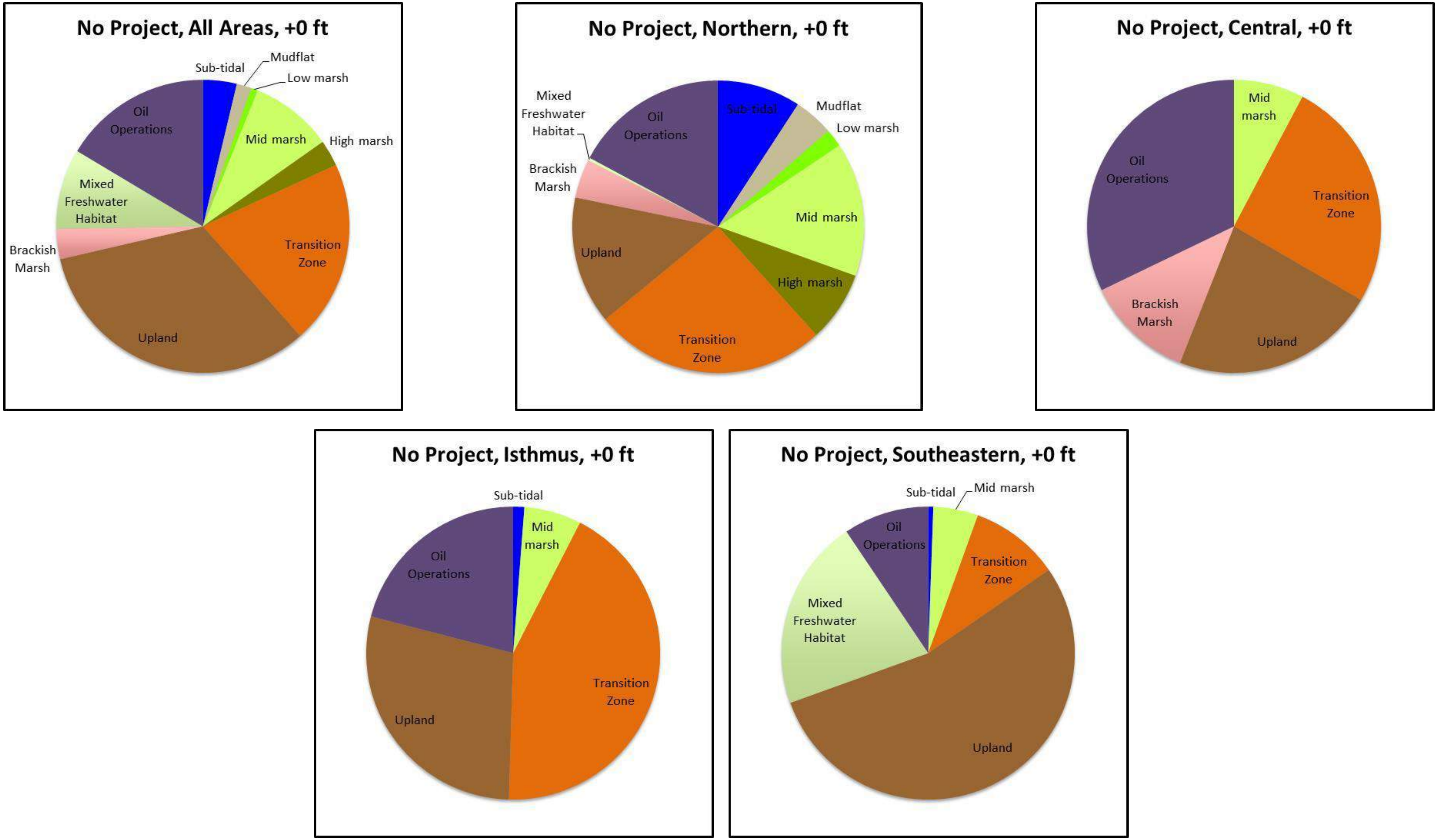


Figure 7-144. Habitat Acreage No Project SLR of +0 ft

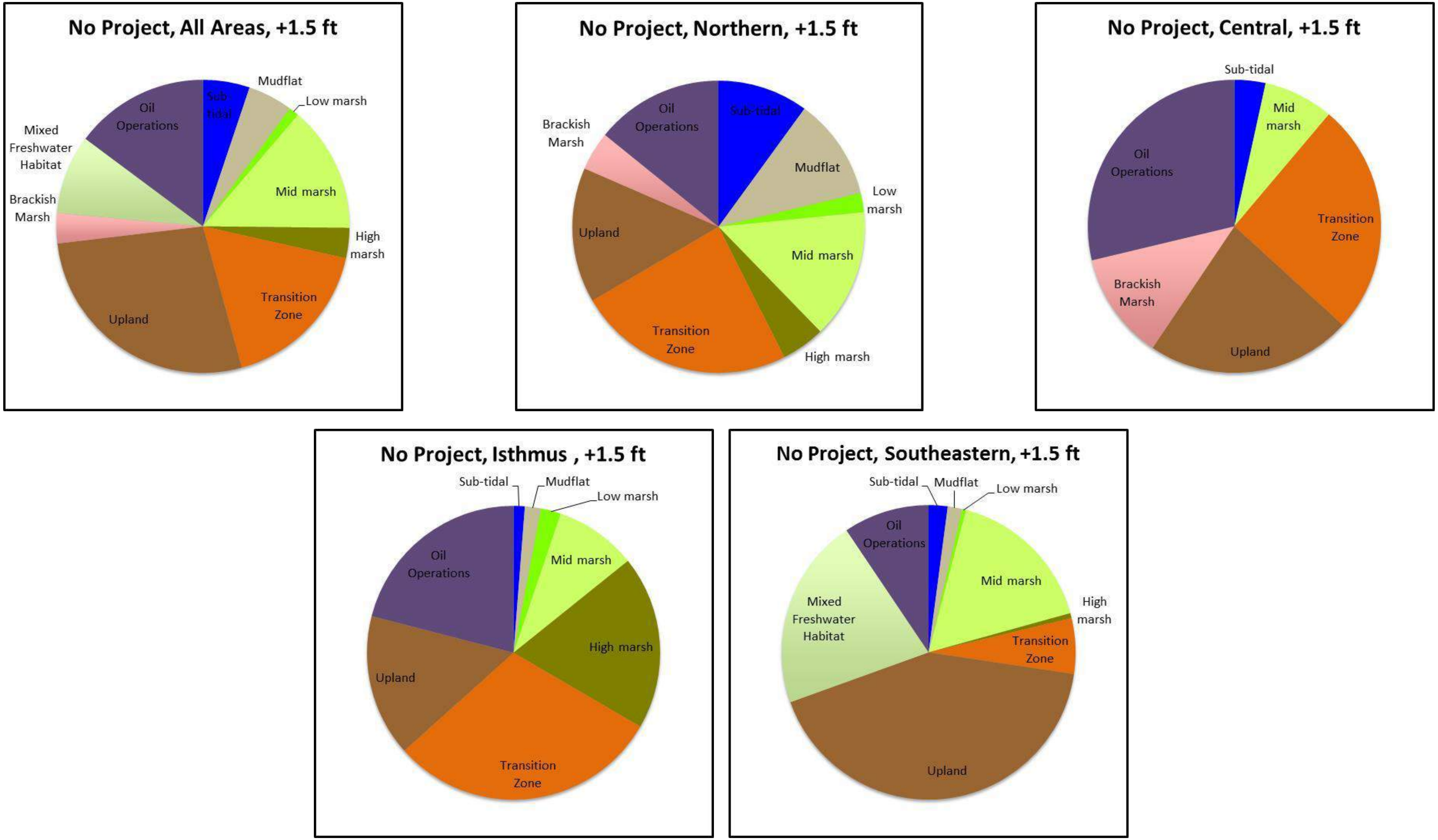


Figure 7-145. Habitat Acreage No Project SLR of +1.5 ft

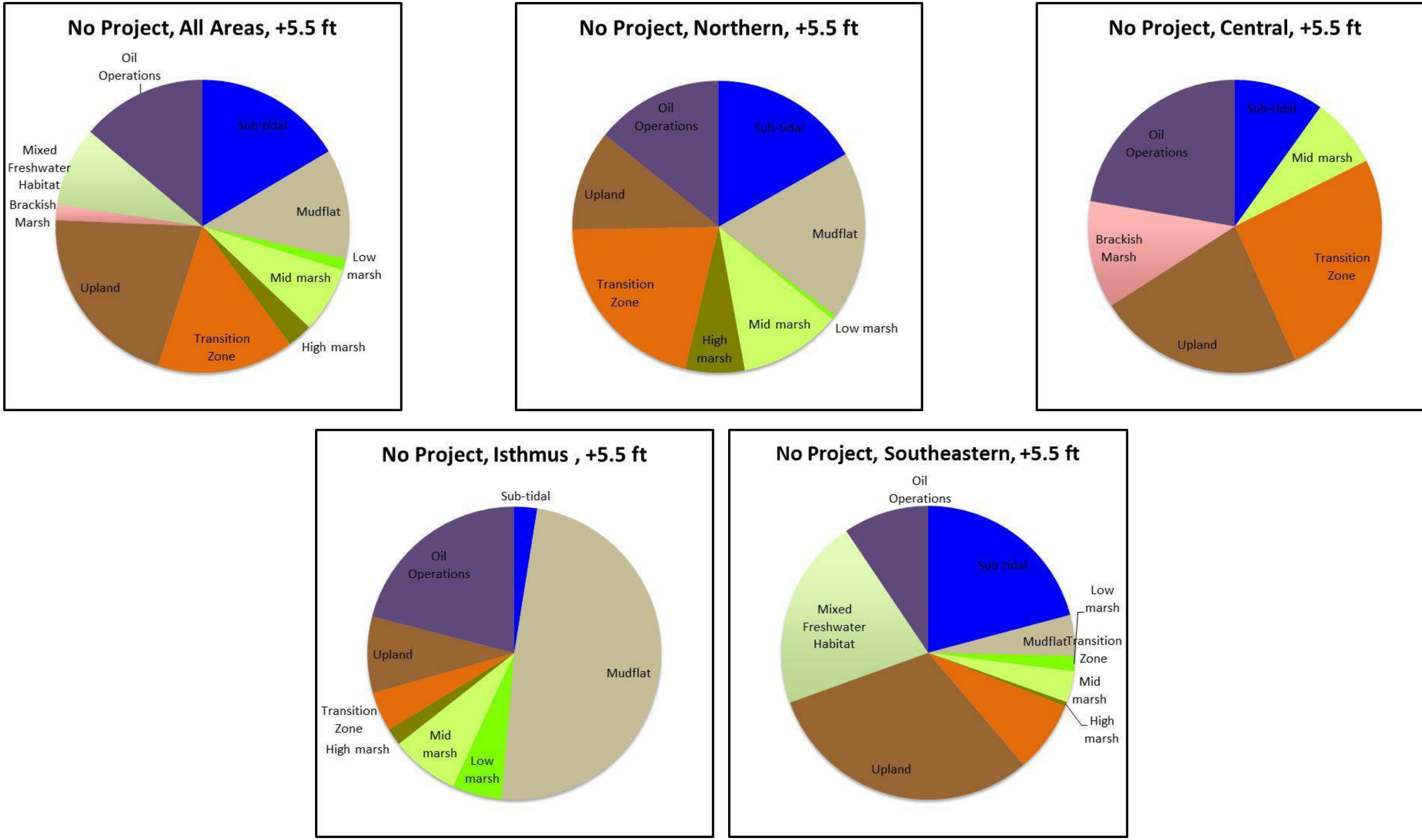


Figure 7-146. Habitat Acreage No Project SLR of +5.5 ft

7.6.3 Public Access Plan

Existing conditions for public access at the LCW are presented under the analysis for Alternative 1 and summarized again here. Public access at the LCW is extremely limited to peripheral trail areas, roads through the site, and the southeast San Gabriel River levee. A comprehensive access system does not yet exist due to multiple land owners, existing industrial activity, and sensitive habitat. Even the publicly-owned land is not accessible without an escort. Portions of the site are used for cycling (San Gabriel River levee and peripheral road network, hiking (Gum Grove Park and HP), birding (periphery), and fishing (PCH and the HCC channel site). The San Gabriel River Bike Path is currently the most heavily used public area in the LCW. Figure 7-1 shows existing bike and pedestrian paths.

The LCW SP nursery and operations center located between the San Gabriel River and HCC would remain as a docent-led hub for local stakeholder activities.

Although limited, the site would continue to present a valuable access opportunity for a highly urbanized area and a public benefit. It's massive potential for public access, interaction, interpretation and education would be significantly curtailed, however. As a result, site stewardship could suffer and not be as successful as a system that was more accessible and available for a learning landscape.

7.6.4 Tidal Hydrodynamics

Tidal conditions for the No Project Alternative are equivalent to existing conditions, and projected out into the future. Analyses for existing conditions are presented in Section 7.2 of this report, but are repeated below to apply specifically to the No Project Alternative.

No Project Alternative – Existing Conditions, Existing Sea Level

As presented in Section 7.2, existing tidal elevations were determined by measuring tides and obtaining data from others. Existing tides are shown in Table 7-13 provided previously and provided again below. Note that several sites within the complex do not possess daily tidal fluctuations at this time because they are not adequately connected to sources of seawater.

Only the Northern Area possesses a full tide range and that occurs at Steam Shovel Slough. All other sites within the LCW possess either no effective tidal connection or a limited and muted tidal range. The two sites with muted tides are Zedler Marsh at the Isthmus and the LCWA Phase II site (former Hellman) at the Southeast Area. Muted tidal conditions result from culvert connections with limited cross-sections serving as the means for tidal conveyance.

Table 7-13. Existing Spring Tidal Elevations and Ranges at the LCW Complex

Site Within the LCW	Specific Location on the Site	Existing Sea Level (No Rise)			1.5' Sea Level Rise			5.5' Sea Level Rise		
		High	Low	Range	High	Low	Range	High	Low	Range
Northern	Steam Shovel Slough	4.3	-3.9	8.2	5.8	-2.5	8.3	9.8	1.5	8.3
	LCWP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Central	LCWA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Isthmus	Zedler Marsh	4.1	0.7	3.5	5.2	0.8	4.4	7.6	3.8	3.8
	Callaway*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Southeast	Phase II	3.4	-0.4	3.8	4.3	0.1	4.2	7.4	4.3	3.1
	Phase II Future	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* Callaway Marsh is not effectively tidally-connected at this time, but it does receive some backwater during spring tides.

N/A refers to "not applicable" due to the respective sites not possessing any effective tidal influence at this time.

No Project Alternative – Existing Conditions, Sea Level Rise

As discussed in Section 7.2, tide ranges and elevations increase at every tidally-influenced site with SLR of 1.5 feet. However, further SLR of 5.5 feet results in mixed conditions of some sites experiencing increased tidal ranges and other sites experiencing reduced tidal ranges compared to existing sea level conditions. The LCWA Phase II portion of the Southeast area and Zedler Marsh at the Isthmus Area experience reduced tidal ranges for SLR of 5.5 feet, as compared to SLR of 1.5 feet. The Southeast Area also experiences a reduced tidal range with 5.5 feet of SLR compared to existing conditions. This mixed result is due to increased tidal volumes at each site having to pass through fixed culvert cross-sections. Therefore, the tidal conveyance of culverts at Zedler Marsh and the Southeast Area under SLR of 5.5 feet limit the volume of seawater exchange to and from each area and the tidal range becomes compressed.

Tidal Inundation Frequency

Tidal inundation frequency analyses were performed with tidal hydraulic modeling results. Extensive discussion of this property is provided in Section 7.2 that also applies to No Project. Those discussions are summarized below.

Northern Area, Steam Shovel Slough, No Project, Existing Sea Level and Sea Level Rise

Figure 7-37, shown previously in Section 7.2.5, shows the tidal inundation frequency curve for Steam Shovel Slough. The Steam Shovel Slough site is a full-tidal condition. At this location, the elevation range of wetland habitat is from +4.2 feet to -4.0 feet NGVD.

The conditions are the Northern Area at Steam Shovel Slough presented for alternatives under existing sea level, and under future SLR of 1.5 feet and 5.5 feet also apply to No Project. The condition of full tidal habitats is conserved, but their elevations increase as water levels increase.

Northern Area, Remaining Oil Field, No Project, Existing Sea Level and SLR

The remaining oil field in the Northern Area is essentially non-tidal, so tidal inundation frequency is not applicable to this scenario. There is a culvert that connects one cell at the northern end, but it is extremely constrained and experiences very little tidal fluctuation. No data exist of tides at that site. The remaining area is seasonally ponded or remains dry.

SLR conditions would likely result in more ponding in this area due to periodic overtopping of berms and oil roads, and increased groundwater elevations. Therefore, if no pumping occurs, there may be larger areas of perennial ponds on-site into the future. If ponding increases on the site with SLR, the need to raise oil roads and well pads may also occur.

Central Area, No Project, Existing Sea Level and SLR

The Central Area receives no effective, or regular, tidal flow at the present time, so tidal inundation frequency is also not applicable to this scenario. One small culvert exists on-site for storm drainage from the site into the San Gabriel River, and it provides for some very marginal inflow at extreme tides to the southwest corner of the site. Therefore, the site is assumed to be non-tidal from a hydraulics standpoint. The site does experience season ponding from rain and from high groundwater.

The Central Area under the No Project scenario will not experience a direct tidal connection to the San Gabriel River. However, SLR conditions would likely result in more ponding in this area due to increased groundwater elevations. As with the Northern Area, if no pumping occurs, there may be larger areas of perennial ponds on-site into the future. If ponding increases on the site with SLR, the need to raise oil roads and well pads may also occur.

The Isthmus Area, No Project, Existing Sea Level and Sea Level Rise

The Isthmus Area receives regular tidal flow through one culvert to Zedler Marsh on the northeastern portion of the site. The culvert to Zedler Marsh does not possess a flap gate. Tidal inundation frequency data for this site under existing sea level are presented and discussed in Section 7.2 above for Alternative 1, and the data also characterize the No Project scenario. Another small and high culvert exists on the Callaway Marsh site for storm drainage from the site into the San Gabriel River, and it possesses a flap gate. This culvert provides for some very marginal inflow during extreme tides to the southwestern portion of the site. The Callaway culvert is also slightly higher than the one at Zedler Marsh, so it conveys seawater less frequently. Therefore, Callaway Marsh is assumed to be non-tidal for hydraulics and no existing tidal flow occurs at that location, so tidal inundation frequency is not applicable to this scenario.

SLR conditions at Zedler Marsh will result in tidal inundation frequencies as presented in Section 7.2 above for Alternative 1, and the data also characterize the No Project scenario. Callaway Marsh is assumed to be not tidally-influenced for hydrology, so it would not experience a predictable tidal inundation frequency under SLR. Although Callaway Marsh would not experience a daily tidal cycle, SLR may cause seawater to penetrate the culvert more frequently than at present. SLR of 1.5 feet may increase the frequency of ponding on the site, and an increase of 5.5 feet would definitely result in more frequent ponding. Modeling of tides through a culvert with a flap gate is not possible, so predictions of possible tidal inundation frequency under SLR at Callaway Marsh are not provided.

Southeast Area, No Project, Existing Sea Level and SLR

The Southeast Area receives regular tidal flow through one culvert to the LCWA Phase II property on the southwestern portion of the site. Tidal inundation frequency for existing conditions is provided in Section 7.2 above for Alternative 1, and the data also characterize the No Project alternative.

SLR conditions at the LCWA Phase II property will result in tidal inundation frequencies as presented in Section 7.2 above for Alternative 1, and the data also characterize the No Project alternative.

7.6.5 Maintenance Regime

The existing land management approach is summarized in Section 3.5.1 of this report. Currently the LCWA manages approximately 175 acres of land for the purpose of wetlands conservation and restoration. The LCWA's land management objectives are to:

- protect existing sensitive habitat and associated species;
- provide safe and controlled public access; and
- maintain safe working conditions for mineral rights owners to access and operate their equipment.

The LCWA has agreements with current oil lease operators on their property that allows vegetation removal activities around their mineral extraction equipment. The oil operator compensates the LCWA for this impact with an annual endowment fee. Neighboring land owners also manage their properties for various purposes.

The LCWA uses its Stewardship Program for land management. The LCW SP began community-based programming in September 2009. The program is to promote community involvement with environmental education, maintenance, restoration, and monitoring of the wetland areas owned by the LCWA. The Stewardship Program guidelines focus volunteers, visitors, partners, easement holders and other guests to use the LCWA properties appropriately and perform safe and lawful services. The LCWA has four Memorandums of Agreement (MOA) with non-profit partners to perform management, restoration, and educational services on the LCWA's properties. The majority of the Stewardship Program's actions have been on a 10-acre restoration project at Zedler Marsh on the Isthmus. That project has attracted over 4,000 participants since May 2010 who have provided over 7,000 hours of service worth over $200,000 of in-kind volunteer services according to the independent sector. This work was funded by nearly $100,000 in competitive grant funding that paid for the installation of nearly 5,000 native plants, and removal of over 50,000 pounds of trash and debris.

Advantages and benefits from the current land management approach include:

- It is a low to no cost effort that provides in-kind services;
- It is self-sustaining and requires little or no capital investment;
- Low to no overhead (equipment and infrastructure) is required, which also requires maintenance;
- It can be applied successfully to hand-labor tasks such as weed control;
- It increases community awareness of the need for more significant maintenance using heavy equipment;
- The quality of work can oftentimes be superior to contractors because stewards are less rushed and do it for personal satisfaction rather than profit; and

- Many people can be mobilized to address labor needs, so resources are less limited compared to using contractors.

Disadvantages of the stewardship effort are:

- It is limited to only certain hand-labor tasks and not suited for larger, more physically difficult tasks requiring heavy equipment.
- An organization and outreach effort is required that taxes LCWA staff resources;
- Is generally a more “hands-on” effort for LCWA staff that also requires resources;
- There are greater liabilities associated with citizens performing work on-site as compared to a contractor performing the work;
- Work is limited in terms of frequency to when volunteers can get organized and mobilize as compared to a contractor with a potentially quicker response; and
- Responses to urgent issues may take more time than those of a contractor.

The stewardship program is well-suited for the No Project scenario and should be maintained and expanded as required.

7.6.6 Cost Estimates

There is no probable opinion of construction costs for the No Project Alternative because no construction will occur. Costs to implement this scenario are equivalent to existing maintenance costs. Very little maintenance presently occurs on the site so those costs are low.

7.7 Summary

7.7.1 Habitat

Overall, the four alternatives provide a very wide range of possible outcomes for the LCW Complex. Salt marsh functioning generally increased (in the near-term), as would be expected, from No Project through the Minimum Alteration, Moderate Alteration, and Maximum Alteration Alternatives. Tradeoffs become apparent though as longer timelines and even moderate SLR are considered.

This analysis revealed generally encouraging results. The LCW Complex is clearly an ideal location for tidal salt marsh restoration. Though the site is fragmented, each parcel is of sufficient size to support ecologically meaningful areas of a broad range of intertidal, sub-tidal and non-tidal habitats. However, it will be a challenge to restore a desirable diversity of intertidal habitats within each area. This will require considerable fine-tuning of grading plans in future planning phases, but it seems feasible.

Developing a desirable distribution of habitat types, while important, needs to be weighed against other realities, especially cost, current land ownership and the need for phasing of different projects on different parcels. The next phases of planning will need to balance all of these tradeoffs in the process of developing more detailed designs.

One overarching lesson that will apply to any future designs did emerge from this analysis. Designing a marsh that is resilient in the face of significant SLR based on topography alone results in less salt marsh functioning in the near-term as compared to the longer-term. This is due to the fact that with 5.5 feet of SLR and no natural sedimentation, vegetated marsh will occur only in areas that are currently above regular tidal influence. Therefore, there is a fairly direct tradeoff, area-wise, between salt marsh habitat today and salt marsh habitat in the future with significant SLR. This tradeoff could be met at LCW by either not grading high areas (Southeastern and Isthmus Areas) or by filling areas that are currently at tidal elevations (North and Central Areas). On relatively small parcels like these, such a tradeoff means severely reducing the amount of tidal wetland area in the near-term (see Moderate Alteration Alternative, Southeastern Area). It is better to design projects that facilitate up-slope migration of habitats and are resilient to moderate SLR. This can be done topographically by including more high marsh, transition, and adjacent upland habitat than many past Southern California projects have. These higher habitats are an important part of salt marsh systems anyway, so this approach results in high functioning habitat in the near-term and shifting but still high functioning habitats for many decades in to the future. Other methods will need to be developed to make salt marshes resilient to significant SLR. This might include gradual sediment additions to keep the soil surface slowly rising with sea level or placing fill in historical marshes that become sub-tidal to raise the soil surface.

There may be opportunity to optimize alternatives or create a hybrid alternative that is a combination of relatively minor tweaks and a blending of ideas from different alternatives to yield a final design that would be preferable in most ways to any of the presented alternatives. No matter the final design, the restoration of such a complex system will include many compromises and tradeoffs. This analysis of four preliminary concepts will foster important discussions about what kinds of tradeoffs are most important and help build consensus among stakeholders as to what a restored LCW Complex will ultimately look like. At this point there is no preferred alternative, and each alternative will entail environmental review. The outcome of this review is intended to be sufficient to identify the preferred alternative for implementation.

7.7.2 Tidal Hydrology

Tidal hydrology for all alternatives under various water level conditions was analyzed and results were mixed. Analyses were done for water levels of existing sea level, and for SLR scenarios of 1.5 feet and 5.5 feet. Generally, the sites with open channel connections to the sources of seawater experienced a broader range of tidal elevations (similar to full tidal) and a more varied tidal inundation frequency than sites with culvert connections. Varied tidal inundation frequency yields a broad elevation range for habitat formation, which is generally desirable. Culvert connections tend to result in tidal muting and truncation of tidal inundation frequency. Truncated tidal inundation frequency yields compressed habitat elevation ranges, which is generally undesirable. All alternatives produce increased tidal influence at the LCW. The increase in tide range associated with the No Project Alternative is attributed solely to future projections of SLR.

Alternative 1 relies largely on culvert connections, with only one open channel. As such, it increases areas of tidal influence but only provides one full tidal area at Steam Shovel Slough. All other areas are muted tidal. For existing sea level, muted tidal conditions lead to compressed habitat elevation ranges so those areas are typified by less diversity, and are skewed towards supra-tidal (non-tidal) habitat. As SLR occurs, the tidal range increases at all areas, resulting in increased areas of tidal influence and more tidally-influenced habitats on site. The proportions of habitats on site become more balanced. SLR of 5.5 feet also increases the areas of tidal influence with more tidally-influenced habitats on site, but habitat is skewed toward the low elevations habitat types of subtidal and mudflat.

Alternative 2 relies largely on open channel connections, with only two culverts at the Isthmus Area. It assumes the sites are slightly higher in elevation than Alternative 3, particularly at the Southeast Area, and have less low marsh and subtidal habitat. As such, it increases areas of tidal influence and provides multiple full tidal areas. The Northern and Central Areas are full-tidal, with the Isthmus Area and Southeast Area being muted tidal. Full tidal connections provide broad habitat elevation ranges that result in greater diversity of habitat types. For existing sea level, full-tidal areas are relatively balanced in proportions of habitat types. Muted tidal conditions lead to compressed habitat elevation ranges and areas are typified by less diversity, and are dominated by supra-tidal habitat. SLR of 1.5 feet results in expanded tide ranges in muted tidal areas and preservation of full tidal areas. Proportions of habitat areas remain relatively balanced at full tidal sites, with a shift towards increased mid- and low-marsh. SLR of 5.5 feet results in all areas being dominated by subtidal and mudflat habitat.

Alternative 3 also relies on open channel connections, with two culverts to the Isthmus, but lowers all sites to increase lower elevation habitat and increases channel size for more subtidal area. As such, it increases areas of tidal influence and provides full tidal areas everywhere except the Isthmus Area. The Northern, Central, and Southeast Areas are full-tidal, and the Isthmus is muted tidal. Full tidal connections provide broad habitat elevation ranges that result in greater diversity of habitat types. For existing sea level, full-tidal areas are relatively balanced in proportions of habitat types. Muted tidal habitat is dominated by supra-tidal habitat. SLR of 1.5 feet results in predominance of lower intertidal habitat at full tidal areas, and more mid- to high-marsh at the Isthmus Area. SLR of 5.5 feet results in full habitat skewed toward subtidal and mudflat habitats in all areas.

7.7.3 Goals and Objectives

Overview

Each of the four restoration areas (Northern Area, Central Area, Isthmus Area, and Southeast Area) associated with each of the three restoration alternatives (Alternative 1, Alternative 2, Alternative 3) were compared against the project goals to determine the area configuration that best met the project goals. This was accomplished by conducting a top level qualitative review of the project goals followed by a relative comparative analysis for each area under each alternative against the goals. The methodology used to conduct this analysis is presented below.

Method

The first step in the analysis was to review the project goals and associated objectives. The next step was to prepare a matrix for the six goals and associated objectives. Next, the four areas for each of the three final restoration alternatives were added to the matrix. A spatial and temporal qualitative review of each area under each alternative (twelve individual combinations of areas and alternatives) was then conducted for each project objective. A relative rating system was used for this analysis whereby the area under each alternative was compared to one another for each objective. The analysis was conducted at the objective level with the results “summed” to achieve the final relative comparison for each goal. No attempt was made to individually weight any of the objectives so the analysis carries the inherent assumption of equal weight across all objectives.

A color code was developed to graphically illustrate the analysis results. Dark green was selected to indicate the alternative under which an area best met the goal/objective. Light green was selected to indicate the alternative under which an area least met the goal/objective. Medium green was selected to indicate the alternative under which an area met the goal/objective between the other two. Yellow was selected to indicate that the goal/objective was not met under the alternative but it should be noted that the configuration could be modified to do so. Blue was selected to indicate situations in which there was no discernable difference between the configurations across the alternatives utilizing the analysis method.

The color coded analysis results were displayed in one consolidated matrix to facilitate rapid comparison between alternatives. This structure also makes it easy to identify the "best" configuration for each area, independent of restoration alternative. The matrix is presented in Table 7-14, along with a written explanation of the goal analysis by area.

Table 7-14. Goals and Objectives Analysis by Area Matrix

Goal/Objective No.	Goal/Objective Description	Northern Alt 1	Northern Alt 2	Northern Alt 3	Central Alt 1	Central Alt 2	Central Alt 3	Isthmus Alt 1	Isthmus Alt 2	Isthmus Alt 3	Southeast Alt 1	Southeast Alt 2	Southeast Alt 3
Goal 1	**Restore tidal wetland processes and functions to the maximum extent possible.**												
Objective 1a	Increase estuarine habitat with a mix of tidal channels, mudflat, salt marsh, and brackish/freshwater marsh and ponds												
Objective 1b	Provide adequate area for wetland-upland ecotone and upland habitat to support wetlands												
Objective 1c	Restore and maintain habitat that supports important life history phases for species of special concern (e.g., federal and state listed species), essential fish habitat, and migratory birds as appropriate												
Goal 2	**Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance.**												
Objective 2a	Maximize wildlife corridors within the LCW Complex and between the LCW Complex and adjacent natural areas within the region												
Objective 2b	Incorporate native upland vegetation buffers between habitat areas and human development to mitigate urban impacts (*e.g.*, noise, light, unauthorized human encroachment, domestic animals, wastewater runoff) and reduce invasion by non-native organisms												
Objective 2c	Design the edges of the LCW Complex to be respectful and compatible with current neighboring land uses												
Goal 3	**Create a public access and interpretive program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience.**												
Objective 3a	Build upon existing beneficial uses												
Objective 3b	Minimize public impacts on habitat / wildlife use of the LCW Complex												
Objective 3c	Design interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community												
Objective 3d	Solicit and address feedback from members of the surrounding community and other interested parties												

Goal/Objective No.	Goal/Objective Description	Northern Alt 1	Northern Alt 2	Northern Alt 3	Central Alt 1	Central Alt 2	Central Alt 3	Isthmus Alt 1	Isthmus Alt 2	Isthmus Alt 3	Southeast Alt 1	Southeast Alt 2	Southeast Alt 3
Goal 4	**Incorporate phasing of implementation to accommodate existing and future potential changes in land ownership and usage, and as funding becomes available.**												
Objective 4a	Include projects that can be implemented as industrial operations are phased out and other properties are acquired over the near-, mid- and long-term (next 5-25-100 years)												
Objective 4b	Investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings												
Objective 4c	Remove/realign/consolidate existing infrastructure (roads, pipelines, etc.) and accommodate future potential changes in infrastructure, to the maximum extent feasible												
Goal 5	**Strive for long-term restoration success.**												
Objective 5a	Implement an adaptive management framework that is sustainable												
Objective 5b	Restore habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife												
Objective 5c	Design habitats that will accommodate climate changes (e.g., incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels)												
Objective 5d	Provide economic benefit to the region												
Goal 6	**Integrate experimental actions and research into the project, where appropriate, to inform restoration and management actions for this project.**												
Objective 6a	Include opportunities for potential experiments and pilot projects to address gaps in information, (e.g., effect of warm river water on salt marsh ecosystem) that are protective of sensitive habitat and wildlife and that can be used to adaptively manage the restoration project												
Objective 6b	Include areas on the site, where appropriate, that prioritize research opportunities (such as those for adaptive management) over habitat sensitivities												

Results

Goal 1: Restore tidal wetland processes and functions to the maximum extent possible.

Northern Area

The configuration developed for the Northern Area under Alternative 3 (Northern Alt 3) best met the objectives associated with Goal 1; hence, it best met Goal 1. The configuration developed for the Northern Area under Alternative 1 (Northern Alt 1) least met the objectives associated with Goal 1. The configuration developed for the Northern Area under Alternative 2 (Northern Alt 2) fell in between the configurations for Alternative 3 and Alternative 1.

The Northern Area configuration developed for Alternative 3 provides the largest amount of estuarine habitat (tidal channels, mudflats, and salt marsh) and brackish/freshwater marsh (southern coastal brackish marsh) while the Northern Area configuration developed for Alternative 1 provides the least due primarily to the upland area preserved for oil production operations. The Northern Area configuration developed for Alternative 2 provides the largest amount of wetland-upland ecotone (transitional and upland areas) and upland habitat to support wetlands with upland habitats in direct connection with wetlands habitat and the most upland habitat transitioning from wetlands habitats.

Alternative 3 is slightly less than Alternative 2 in upland ecotone area, but is very similar. The Northern Area configuration developed for Alternative 1 provides the least amount of wetland-upland ecotone and upland habitat to support wetlands, again due primarily to the upland area preserved for oil production operations. Finally, the Northern Area configuration developed for Alternative 3 provides the most habitat that supports species of special concern (low intertidal, mid intertidal, and high intertidal), essential fish habitat (subtidal and low intertidal), and migratory birds (southern coastal brackish marsh and subtidal) while the Northern Area configuration developed for Alternative 1 provides the least such habitat due primarily to the upland area preserved for oil production operations.

Central Area

The configuration developed for the Central Area under Alternative 2 (Central Alt 2) best met the objectives associated with Goal 1; hence, it best met Goal 1. The configuration developed for the Central Area under Alternative 1 (Central Alt 1) least met the objectives associated with Goal 1. The configuration developed for the Central Area under Alternative 3 (Central Alt 3) fell in between the configurations for Alternative 2 and Alternative 1.

The Central Area configuration developed for Alternative 2 provides the largest amount of estuarine habitat (tidal channels, mudflats, and salt marsh) while the Central Area configuration developed for Alternative 1 provides the least due primarily to the upland area preserved for oil production operations. Although the configuration for Alternative 3 provides more brackish habitat than the configuration for Alternative 2, it was ranked lower due to preference for estuarine habitat over brackish habitat. The Central Area configuration developed for Alternative 2 provides the largest amount of transitional habitat (wetland-upland ecotone) in direct connection to wetlands than other alternatives because it completely encircles the wetland. The Central Area configuration developed for Alternative 1 provides the least amount of wetland-upland ecotone and upland habitat to support wetlands, again due primarily to the upland area preserved for oil production operations. Finally, the

Central Area configuration developed for Alternative 2 provides the most habitat that supports species of special concern (low intertidal, mid intertidal, and high intertidal), essential fish habitat (subtidal and low intertidal), and migratory birds (subtidal and low intertidal) while the Northern Area configuration developed for Alternative 1 provides the least such habitat due primarily to the upland area preserved for oil production operations.

Isthmus Area

The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) best met the objectives associated with Goal 1; hence, it best met Goal 1. The configuration developed for the Isthmus Area under Alternative 2 (Isthmus Alt 2) least met the objectives associated with Goal 1. The configuration developed for the Isthmus Area under Alternative 1 (Isthmus Alt 1) fell in between the configurations for Alternative 3 and Alternative 2.

The Isthmus Area configuration developed for Alternative 3 provides the largest amount of estuarine habitat (tidal channels, mudflats, and salt marsh) while the Isthmus Area configuration developed for Alternative 2 provides the least due to the upland area preserved for oil production operations and the area held for research (research micro marsh). The Isthmus Area configuration developed for Alternative 1 provides the largest amount of wetland-upland ecotone and upland habitat to support wetlands with upland habitats in direct connection with wetlands habitat and the most upland habitat transitioning from wetlands habitats. The Isthmus Area configuration developed for Alternative 3 provides the least amount of wetland-upland ecotone and upland habitat to support wetlands, due primarily to the almost complete conversion of upland area to estuarine habitat. Finally, the Isthmus Area configuration developed for Alternative 3 provides the most habitat that supports species of special concern (low intertidal, mid intertidal, and high intertidal), essential fish habitat (low intertidal), and migratory birds (low intertidal) while the Isthmus Area configuration developed for Alternative 2 provides the least of such habitat due primarily to the upland area preserved for oil production operations and held for research (research micro marsh).

Southeast Area

The configuration developed for the Southeast Area under Alternative 3 (Southeast Alt 3) best met the objectives associated with Goal 1; hence, it best met Goal 1. The configuration developed for the Southeast Area under Alternative 2 (Southeast Alt 2) least met the objectives associated with Goal 1. The configuration developed for the Southeast Area under Alternative 1 (Southeast Alt 1) fell in between the configurations for Alternative 3 and Alternative 2.

The Southeast Area configuration developed for Alternative 3 provides the largest amount of estuarine habitat (tidal channels, mudflats, and salt marsh) while the Southeast Area configuration developed for Alternative 2 provides the least due to upland area held for oil production operations, and transitional and upland habitat. The Southeast Area configuration developed for Alternative 2 provides the largest amount of wetland-upland ecotone and upland habitat to support wetlands with transitional and upland habitats in direct connection with wetlands habitat and the most upland habitat transitioning from wetlands habitats. The Southeast Area configuration developed for Alternative 3 provides the least amount of wetland-upland ecotone and upland habitat to support wetlands, again due primarily to the almost complete conversion of upland area to estuarine habitat. Finally, the Southeast Area configuration developed for Alternative 3 provides the most habitat that supports species of special concern (low intertidal, mid intertidal, and high intertidal), essential fish habitat (subtidal and low intertidal), and migratory birds (subtidal and low intertidal) while the Southeast Area configuration developed for Alternative 2 provides the least of such habitat due primarily to the upland area converted to upland habitat and preserved for oil production operations.

Goal 2: Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance.

<u>Northern Area</u>

The configuration developed for the Northern Area under Alternative 2 (Northern Alt 2) best met the objectives associated with Goal 2; hence, it best met Goal 2. The configuration developed for the Northern Area under Alternative 1 (Northern Alt 1) least met the objectives associated with Goal 2. The configuration developed for the Northern Area under Alternative 3 (Northern Alt 3) fell in between the configurations for Alternative 1 and Alternative 2.

The Northern Area configuration developed for Alternative 3 provides the most wildlife corridor within the LCW Complex while the Northern Area configuration developed for Alternative 1 provides the least. All three alternatives provide an equal level of wildlife corridor connectivity between the LCW Complex and adjacent natural areas (*e.g.,* Seal Beach NWR). The Northern Area configuration developed for Alternative 2 incorporates the most native upland vegetation buffers between habitat areas and human development, while the Northern Area configuration developed for Alternative 1 incorporates the least. The Northern Area configuration developed for Alternative 2 would include edges that are the most respectful and compatible with current neighboring land uses (*e.g.,* buffers exist between wetland and outside roads, except along PCH to the west) while the Northern Area configuration developed for Alternative 1 would include edges that are the least respectful and compatible with current neighboring land uses (*i.e.,* there is more direct contact between wetlands and internal oil roads).

<u>Central Area</u>

The configuration developed for the Central Area under Alternative 2 (Central Alt 2) best met the objectives associated with Goal 2; hence, it best met Goal 2, while Alternative 3 (Central Alt 3) least met the objectives associated with Goal 2. The configuration developed for the Central Area under Alternative 1 (Central Alt 1) fell in between the configurations for Alternative 2 and Alternative 3.

The Central Area configuration developed for Alternative 2 provides the most wildlife corridor within the LCW Complex while the Central Area configuration developed for Alternative 1 provides the least. Central Alt 3 is intermediate in wildlife corridor provision. All three alternatives provide an equal level of wildlife corridor connectivity between the LCW Complex and adjacent natural areas (*e.g.,* Seal Beach NWR). The Central Area configuration developed for Alternative 2 incorporates the most native upland vegetation buffers between habitat areas and human development while the Central Area configuration developed for Alternative 3 incorporates the least. The Central Area configuration developed for Alternative 1 would include edges that are the most respectful and compatible with current neighboring land uses (*e.g.,* roadways and the Marketplace) while the Central Area configuration developed for Alternative 2 would include edges that are the least respectful and compatible with current neighboring land uses due to losing the brackish marsh along Shopkeeper Road at the Marketplace.

Isthmus Area

The configuration developed for the Isthmus Area under Alternative 2 (Isthmus Alt 2) best met the objectives associated with Goal 2; hence, it best met Goal 2. The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) least met the objectives associated with Goal 2. The configuration developed for the Isthmus Area under Alternative 1 (Isthmus Alt 1) fell in between the configurations for Alternative 2 and Alternative 3.

The Isthmus Area configuration developed for Alternative 3 provides the most wildlife corridor within the LCW Complex while the Isthmus Area configuration developed for Alternative 2 provides the least. All three alternatives provide an equal level of wildlife corridor connectivity between the LCW Complex and adjacent natural areas (*e.g.,* SBNWR). The Isthmus Area configuration developed for Alternative 2 incorporates the most native upland vegetation buffers between habitat areas and human development while the Isthmus Area configuration developed for Alternative 3 incorporates the least. The Isthmus Area configurations developed for Alternatives 1 and 2 would include edges that are the most respectful and compatible with current neighboring land uses (*e.g.,* oil operations) while the Isthmus Area configuration developed for Alternative 3 would include edges that are the least respectful and compatible with current neighboring land uses.

Southeast Area

The configuration developed for the Southeast Area under Alternative 2 (Southeast Alt 2) best met the objectives associated with Goal 2; hence, it best met Goal 2. The configuration developed for the Southeast Area under Alternative 3 (Southeast Alt 3) least met the objectives associated with Goal 2. The configuration developed for the Southeast Area under Alternative 1 (Southeast Alt 1) fell in between the configurations for Alternative 2 and Alternative 3.

The Southeast Area configuration developed for Alternative 3 provides the most wildlife corridor within the LCW Complex while the Southeast Area configuration developed for Alternative 1 provides the least. All three alternatives provide an equal level of wildlife corridor connectivity between the LCW Complex and adjacent natural areas (*e.g.,* SBNWR). The Southeast Area configuration developed for Alternative 2 incorporates the most native upland vegetation buffers between habitat areas and human development while the Southeast Area configuration developed for Alternative 3 incorporates the least. The Southeast Area configuration developed for Alternative 1 would include edges that are the most respectful and compatible with current neighboring land uses (*e.g.,* oil operations) while the Southeast Area configuration developed for Alternative 3 would include edges that are the least respectful and compatible with current neighboring land uses.

Goal 3: Create a public access and interpretive program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience.

Northern Area

The configuration developed for the Northern Area under Alternative 1 (Northern Alt 1) best met the objectives associated with Goal 3; hence, it best met Goal 3. The configuration developed for the Northern Area under Alternative 3 (Northern Alt 3) least met the objectives associated with Goal 3.

The configuration developed for the Northern Area under Alternative 2 (Northern Alt 2) fell in between the configurations for Alternative 1 and Alternative 3.

The Northern Area configuration developed for Alternative 1 builds the most upon existing beneficial uses *(e.g.,* oil operations and existing habitats for protection from the outside, and for more internal pathways) while the Northern Area configuration developed for Alternative 3 builds the least upon existing beneficial uses. The Northern Area configuration developed for all three alternatives minimizes public impacts on habitat/wildlife use of the LCW Complex from the outside (not including internal oil operations). At this phase in project development there were no discernable differences between the three alternatives in designing interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community. At this phase in project development there were no discernable differences between the three alternatives in soliciting and addressing feedback from members of the surrounding community and other interested parties.

<u>Central Area</u>

The configuration developed for the Central Area under Alternative 1 (Central Alt 1) best met the objectives associated with Goal 3; hence, it best met Goal 3. The configuration developed for the Central Area under Alternative 3 (Central Alt 3) least met the objectives associated with Goal 3. The configuration developed for the Central Area under Alternative 2 (Central Alt 2) fell in between the configurations for Alternative 1 and Alternative 3.

The Central Area configuration developed for Alternative 1 builds the most upon existing beneficial uses (*e.g.,* oil operations, existing habitats, and surrounding land uses) while the Central Area configuration developed for Alternative 3 builds the least upon existing beneficial uses. The Central Area configuration developed for Alternative 1 best minimizes public impacts from the outside on habitat/wildlife use of the LCW Complex while the Central Area configuration developed for Alternative 2 least minimizes such impacts because there is no brackish water marsh along the west side. This analysis assumes that this objective does not pertain to oil operations *within* the project areas. At this phase in project development there were no discernable differences between the three alternatives in designing interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community. At this phase in project development there were no discernable differences between the three alternatives in soliciting and addressing feedback from members of the surrounding community and other interested parties.

<u>Isthmus Area</u>

The configurations developed for the Isthmus Area under Alternatives 1 and 2 (Isthmus Alt 1, Isthmus Alt 2) best met the objectives associated with Goal 3; hence, both configurations best met Goal 3. The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) least met the objectives associated with Goal 3.

The Isthmus Area configuration developed for Alternatives 1 and 2 build the most upon existing beneficial uses (*e.g.,* oil operations, existing habitats, and surrounding land uses) while the Isthmus Area configuration developed for Alternative 3 builds the least upon existing beneficial uses. The Isthmus Area configuration developed for all three alternatives minimizes public impacts on habitat/wildlife use of the LCW Complex from the outside (not including internal oil operations). At this phase in project development there were no discernable differences between the three alternatives in designing interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community. At this phase in project development there were no discernable differences between the three alternatives in soliciting and addressing feedback from members of the surrounding community and other interested parties.

Southeast Area

The configurations developed for the Southeast Area under Alternatives 1 and 3 (Southeast Alt 1, Southeast Alt 3) best met the objectives associated with Goal 3; hence, both configurations best met Goal 3. The configuration developed for the Southeast Area under Alternative 2 (Southeast Alt 2) least met the objectives associated with Goal 3.

The Southeast Area configuration developed for Alternative 1 builds the most upon existing beneficial uses (*e.g.*, oil operations, existing habitats, and surrounding land uses) while the Southeast Area configuration developed for Alternative 3 builds the least upon existing beneficial uses. The Southeast Area configuration developed for Alternative 3 best minimizes public impacts on habitat/wildlife use of the LCW Complex while the Southeast Area configuration developed for Alternatives 1 and 2 least minimizes public impacts on habitat/wildlife use of the LCW Complex. At this phase in project development there were no discernable differences between the three alternatives in designing interpretive concepts that promote environmental stewardship and the connection between the wetlands and the surrounding community. At this phase in project development there were no discernable differences between the three alternatives in soliciting and addressing feedback from members of the surrounding community and other interested parties.

Goal 4: Incorporate phasing of implementation to accommodate existing and future potential changes in land ownership and usage, and as funding becomes available.

Northern Area

The configuration developed for the Northern Area under Alternative 1 (Northern Alt 1) best met the objectives associated with Goal 4; hence, it best met Goal 4. The configuration developed for the Northern Area under Alternative 3 (Northern Alt 3) least met the objectives associated with Goal 4. The configuration developed for the Northern Area under Alternative 2 (Northern Alt 2) fell in between the configurations for Alternative 1 and Alternative 3.

The Northern Area configuration developed for Alternative 1 would best accommodate projects that can be implemented as industrial operations (*e.g.*, oil operations) are phased out and other properties acquired over the near-term, mid-term, and long-term (next 5-25-100 years) while the Northern Area configuration developed for Alternative 3 would least accommodate such projects. The Northern Area configuration developed for Alternative 1 would best investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings while the Northern Area configuration developed for Alternative 3 would least investigate such opportunities. The Northern Area configuration developed for Alternative 3 would remove/realign/consolidate the most existing infrastructure while the Northern Area configuration developed for Alternative 1 would remove/realign/consolidate the least.

Central Area

The configuration developed for the Central Area under Alternative 1 (Central Alt 1) best met the objectives associated with Goal 4; hence, it best met Goal 4. The configuration developed for the Central Area under Alternative 2 (Central Alt 2) least met the objectives associated with Goal 4. The configuration developed for the Central Area under Alternative 3 (Central Alt 3) fell in between the configurations for Alternative 1 and Alternative 2.

The Central Area configuration developed for Alternative 1 would best accommodate projects that can be implemented as industrial operations (*e.g.*, oil operations) are phased out and other properties acquired over the near-term, mid-term, and long-term (next 5-25-100 years) while the Central Area configuration developed for Alternative 2 would least accommodate such projects. The Central Area configuration developed for Alternative 1 would best investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings while the Central Area configuration developed for Alternative 2 would least investigate such opportunities. The Central Area configuration developed for Alternatives 2 and 3 would remove/realign/consolidate the most existing infrastructure while the Central Area configuration developed for Alternative 1 would remove/realign/consolidate the least.

Isthmus Area

The configurations developed for the Isthmus Area under Alternatives 1 and 2 (Isthmus Alt 1, Isthmus Alt 2) best met the objectives associated with Goal 4; hence, both configurations best met Goal 4. The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) least met the objectives associated with Goal 4.

The Isthmus Area configuration developed for Alternatives 1 and 2 would best accommodate projects that can be implemented as industrial operations (*e.g.*, oil operations) are phased out and other properties acquired over the near-term, mid-term, and long-term (next 5-25-100 years) while the Isthmus Area configuration developed for Alternative 3 would least accommodate such projects. The Isthmus Area configuration developed for Alternatives 1 and 2 would best investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings while the Isthmus Area configuration developed for Alternative 3 would least investigate such opportunities. The Isthmus Area configuration developed for Alternative 3 would remove/realign/consolidate the most existing infrastructure while the Isthmus Area configurations developed for Alternatives 1 and 2 would remove/realign/consolidate the least.

Southeast Area

The configuration developed for the Southeast Area under Alternative 1 (Southeast Alt 1) best met the objectives associated with Goal 4; hence, it best met Goal 4. The configuration developed for the Southeast Area under Alternative 3 (Southeast Alt 3) least met the objectives associated with Goal 4. The configuration developed for the Southeast Area under Alternative 2 (Southeast Alt 2) fell in between the configurations for Alternative 1 and Alternative 3.

The Southeast Area configuration developed for Alternative 1 would best accommodate projects that can be implemented as industrial operations (*e.g.*, oil operations) are phased out and other properties acquired over the near-term, mid-term, and long-term (next 5-25-100 years) while the Southeast

Area configuration developed for Alternative 3 would least accommodate such projects. The Southeast Area configuration developed for Alternative 1 would best investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings while the Southeast Area configuration developed for Alternative 3 would least investigate such opportunities. The Southeast Area configurations developed for Alternatives 2 and 3 would remove/realign/consolidate the most existing infrastructure while the Southeast Area configuration developed for Alternative 1 would remove/realign/consolidate the least.

Goal 5: Strive for long-term restoration success.

<u>Northern Area</u>

The configuration developed for the Northern Area under Alternative 2 (Northern Alt 2) best met the objectives associated with Goal 5; hence, it best met Goal 5. The configuration developed for the Northern Area under Alternative 1 (Northern Alt 1) least met the objectives associated with Goal 5. The configuration developed for the Northern Area under Alternative 3 (Northern Alt 3) fell in between the configurations for Alternative 2 and Alternative 1.

Since it is possible to implement an adaptive management framework under all three restoration alternatives, there was no discernable difference between the three alternatives relative to this objective. The Northern Area configuration developed for Alternative 3 would restore the most habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife, while the Northern Area configuration developed for Alternative 1 would restore the least such habitats in such areas. The Northern Area configuration developed for Alternative 2 would include habitats best designed to accommodate climate change (*e.g.,* incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels), while the Northern Area configuration developed for Alternative 1 would include habitats least designed to accommodate climate change. The Northern Area configuration developed for Alternative 1 would provide the most economic benefit to the region due to continued existing energy production, which outweighs eco-tourism and nursery habitat for commercial fish), while the Northern Area configuration developed for Alternative 3 would provide the least economic benefit due to oil's tightest consolidation. The oil operation on the Northern Area is larger than that at other areas, and so it exerts more influence on the decision.

<u>Central Area</u>

The configuration developed for the Central Area under Alternative 3 (Central Alt 3) best met the objectives associated with Goal 5; hence, it best met Goal 5. The configuration developed for the Central Area under Alternative 1 (Central Alt 1) least met the objectives associated with Goal 5. The configuration developed for the Central Area under Alternative 2 (Central Alt 2) fell in between the configurations for Alternative 3 and Alternative 1.

Since it is possible to implement an adaptive management framework under all three restoration alternatives, there was no discernable difference between the three alternatives relative to this objective. The Central Area configuration developed for Alternative 3 would restore the most habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife while the Central Area configuration developed for Alternative 1 would restore the least such habitats in such areas. The Central Area configuration developed for Alternative 3 would include habitats best designed to accommodate climate change (*e.g.,* incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels), while the Central Area configuration developed for Alternative 1 would include habitats least designed to accommodate climate change. The Central Area configuration developed for Alternative 2 would provide the most economic benefit (*e.g.*, energy production, eco-tourism, and nursery habitat for commercial fish) to the region while the Central Area configuration developed for Alternative 1 would provide the least economic benefit.

Isthmus Area

The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) best met the objectives associated with Goal 5; hence, it best met Goal 5. The configuration developed for the Isthmus Area under Alternative 1 (Isthmus Alt 1) least met the objectives associated with Goal 5. The configuration developed for the Isthmus Area under Alternative 2 (Isthmus Alt 2) fell in between the configurations for Alternative 3 and Alternative 1.

Since it is possible to implement an adaptive management framework under all three restoration alternatives, there was no discernable difference between the three alternatives relative to this objective. The Isthmus Area configuration developed for Alternative 3 would restore the most habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife while the Isthmus Area configuration developed for Alternative 1 would restore the least such habitats in such areas. The Isthmus Area configuration developed for Alternative 3 would include habitats best designed to accommodate climate change (*e.g.,* incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels), while the Isthmus Area configuration developed for Alternative 1 would include habitats least designed to accommodate climate change. The Isthmus Area configuration developed for Alternative 3 would provide the most economic benefit (*e.g.*, energy production, eco-tourism, and nursery habitat for commercial fish) to the region while the Isthmus Area configurations developed for Alternatives 1 and 2 would provide the least economic benefit.

Southeast Area

The configuration developed for the Southeast Area under Alternative 3 (Southeast Alt 3) best met the objectives associated with Goal 5; hence, it best met Goal 5. The configuration developed for the Southeast Area under Alternative 1 (Southeast Alt 1) least met the objectives associated with Goal 5. The configuration developed for the Southeast Area under Alternative 2 (Southeast Alt 2) fell in between the configurations for Alternative 3 and Alternative 1.

Since it is possible to implement an adaptive management framework under all three restoration alternatives, there was no discernable difference between the three alternatives relative to this objective. The Southeast Area configuration developed for Alternative 3 would restore the most habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife while the Southeast Area configuration developed for Alternative 1 would restore the least such habitats in such areas. The Southeast Area configuration developed for Alternative 2 would include habitats best designed to accommodate climate change (*e.g.,* incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels), while the Southeast Area configuration developed for Alternative 1 would include habitats least designed to accommodate climate change. The Southeast Area configuration developed for Alternative 3 would provide the most economic benefit (*e.g.,* energy production, eco-tourism, and nursery habitat for commercial fish) to the region while the Southeast Area configuration developed for Alternative 2 would provide the least economic benefit due to less of oil area and minimal fish habitat.

Goal 6: Integrate experimental actions and research into the project, where appropriate, to inform restoration and management actions for this project.

Northern Area

None of the configurations developed for the Northern Area met the overall goal associated with Goal 6.

None of the configurations developed for the Northern Area met the objectives associated with Goal 6.

Central Area

None of the configurations developed for the Central Area met the overall goal associated with Goal 6.

None of the configurations developed for the Central Area met the objectives associated with Goal 6.

Isthmus Area

The configuration developed for the Isthmus Area under Alternative 2 (Isthmus Alt 2) best met the objectives associated with Goal 6; hence, it best met Goal 6. The configuration developed for the Isthmus Area under Alternative 3 (Isthmus Alt 3) least met the objectives associated with Goal 6. The configuration developed for the Isthmus Area under Alternative 1 (Isthmus Alt 1) fell in between the configurations for Alternative 2 and Alternative 3.

The Isthmus Area configuration developed for Alternative 2 would include the most opportunities for potential experiments and pilot projects to address gaps in information (*e.g.,* effect of warm river water on salt marsh ecosystems) that are protective of sensitive habitat and wildlife and that can be used to adaptively manage the restoration project, while the Isthmus Area configuration developed for Alternative 3 would include the least of such opportunities. The Isthmus Area configuration developed for Alternative 2 would include the most areas on the site that prioritize research opportunities (*e.g.,* such as those for adaptive management) over habitat sensitivities while the Isthmus Area configuration developed for Alternative 3 would include the least of such areas on the site.

Southeast Area

None of the configurations developed for the Southeast Area met the overall goal associated with Goal 6.

None of the configurations developed for the Southeast Area met the objectives associated with Goal 6.

Summary

In summary, the three final restoration alternatives were analyzed against the project goals and associated objectives to determine how well the alternatives represent the goals and objectives. A qualitative analysis was performed via visual inspection of restoration measures associated with each alternative and subsequent ranking across alternatives to arrive at a relative comparison between each alternative. The results of the analysis were then used to determine how well each alternative met the objectives and goals. Based on the results of the analysis, it was determined that all alternatives met the goals and objectives to some degree. Some alternatives met the goals and objectives better than others. While some objectives were not met in the alternatives as currently envisioned, it was noted that the alternatives could be easily modified to meet the goals and objectives (*e.g.,* Goal 6, objectives a and b in the analysis matrix). In addition, it was found that some objectives were met equally among alternatives. In conclusion, the three final restoration alternatives adequately cover the project goals and objectives, thereby providing a solid foundation for future project development. The alternatives can be modified in the future to accommodate weighting of the goals and objectives to reflect input from project proponents.

8.0 Implementation Guidelines

Implementation of the various restoration actions outlined in this plan will begin only after funding is secured for specific projects and more detailed engineering plans are developed. These subsequent plans will need to provide significant detail on construction and implementation methods. Within the scope of this conceptual plan, general guidelines should be followed to avoid problems encountered on projects with the typical grading contractor and re-vegetation subcontractor on-site. Detailed future plans should adhere to these guidelines in order to maximize efficiency, cost-effectiveness and success of project implementation.

Implementation of large-scale tidal restoration projects is fraught with challenges. Unforeseen problems will arise in every stage, from grading through the plant establishment process and even through the long-term maintenance phases. These challenges are best met using an adaptive management approach that allows thoughtful adjustments of strategies in order to assure that project goals are met. The use of adaptive management is not an excuse for poor planning. Many lessons have been learned over the course of building other projects, often the hard way, regarding the types of actions to encourage or avoid during implementation. The goal of this section is to acknowledge several of the most important lessons here, early in the planning process, in order to help implement projects in the best way possible.

The general categories of guidelines to avoid foreseeable problems during implementation of the project include:

- Restoration team coordination;
- Phasing and budgeting;
- Natural resource protection;
- Soil management;
- Plant acquisition, installation and maintenance;
- Pre-project and implementation monitoring; and
- Use of experiments and pilot projects.

Basic guidelines for each of these categories are outlined below.

8.1 Restoration Team Coordination

The restoration project should be viewed as an integrated effort rather than distinct phases (grading then re-vegetation). Contractual arrangements should allow for efficient teamwork. The restoration team needs to be assembled early; communication should be efficient and actions coordinated. For example, the opportunities for efficient mechanical weed control during the grading phase can put the project a year ahead in the re-vegetation phase. This can save a large amount of money and advance the project toward its performance criteria. On the other hand, the costs of dealing with weed seeds carelessly spread across acres of newly graded surface can be substantial.

8.1.1 Construction Management

Include a qualified and experienced restoration ecologist in construction meetings through the grading phase of the project. Resolve any grading issues prior to the end of the construction phase of the project. Once grading tasks have been signed-off, the expense of re-mobilization and change orders or new contracts may be prohibitive and flaws in the implementation may not be corrected.

With an experienced restoration ecologist on site during grading many problems can be resolved quickly and inexpensively. For example, identifying drainage issues that might prevent plant establishment or might lead to mosquito nuisance issues can lead to inexpensive solutions if caught before equipment leaves the site.

8.1.2 The Need For Adaptive Management During Implementation

Adaptive management during implementation will increase efficiency and improve results. Conditions across restoration sites are not uniform. Some areas will respond successfully before others. This will allow efforts to be shifted to problem areas in increasingly smaller portions of the site. In addition, not all of the factors influencing success can be controlled during restoration. There may be pulses of sediments and nutrients from the watershed, such as occurred at Tijuana (Zedler 2000; El Nino events during construction (44 inches of rain after grading at Carpinteria Salt Marsh Nature Park in 1997-98), and/or colonization of the site by invasive species or rare native species. Recognition of the opportunities to save time and money when the restoration trajectory occurs naturally is an important part of project management because problem areas will require extra resources. It is important to track progress toward restoration goals and modify planned actions according to actual conditions.

The most important part of adaptive management is to maintain the original set of project goals. With clear end points in sight, methods, techniques and timelines can be shifted to approach goals in different ways. Effective restoration management will capitalize upon successes, and rapidly address problems.

8.2 Vegetation Phasing

Re-vegetation is usually one of the last phases of restoration projects. As timelines slide and budgets shrink against the onslaught of unexpected problems encountered during implementation, re-vegetation efforts frequently suffer.

To assure project success, re-vegetation goals must be valued consistently throughout the project. Allowing flexibility for adaptive management during the plant establishment phase will be most efficient in the long run as restoration ecologists can respond quickly to both the good and the bad conditions on the site (weed invasions and natural colonization by native species). This should allow a rapid adjustment from plant establishment efforts across large areas of the site to problem solving in smaller areas (weeds, erosion, etc.).

Many construction approaches can successfully produce topography and hydrology appropriate for tidal salt marsh functioning in Southern California, but success in establishing healthy salt marsh vegetation is much more challenging. Timing and careful site management in the early phases of a project is very important to setting a successful trajectory for vegetation communities. Some of the preparation for salt marsh restoration is straightforward, but some things (including soil preparation) can only be done right at the beginning (or would have to be re-done completely). Good soils are one of the most important resources available for growing healthy plant communities. Soil texture and compaction cannot be changed after a project is completed without completely disrupting established vegetation.

The compacted sub-soils exposed at the surface at the end of typical construction projects will not support good plant growth. Soils left exposed at the end of coastal wetland construction projects may have additional challenges in the form of salty fill soil left in upland settings, and mixtures of gravel and float rock left over from the challenges of grading in wet soil conditions.

8.2.1 Schedule

Schedule the project so that planting can occur during the rainy season (all seeds, nursery stock cuttings and other materials should ideally be installed between December and February).

8.3 Protect Existing Resources

8.3.1 Protect Wetlands and Ecological Resources

1) Insist on construction fencing for all sensitive habitat areas. Protect all resources indicated in the planning documents and encountered on the site;
2) Install fencing early, before any heavy equipment is moved onto the site; and
3) Do not move fencing even on a temporary basis.

8.3.2 Erosion Control Plan

The contractor will need to have an erosion control plan for the project. Ideally, this plan should be integrated with the long-term needs of the restoration project. The erosion control should fit the restoration plan, and the selection of materials used needs to be compatible with planting and weed control strategy.

8.4 Soil Management

8.4.1 Protect the Integrity of the Soils on Site

1) Work with contractor on choosing equipment and supply staging areas. Be deliberate about avoiding sensitive habitats including wetlands.
2) To the extent it is possible, avoid letting the contractor mix gravel or float rock with native soils. These coarse materials will never get sorted back out. Native soils compromised by compaction and/or the addition of non-local materials will never recover.
3) Choose construction access roads within the site carefully. They will never be the same for the purposes of growing plants.
4) Grade the site in driest possible conditions to minimize soil compaction. Grade before allowing tides into project, and de-water to keep the water table low.

5) When grading on wet soils, use low load equipment, spread equipment weight using moveable wooden pallets or similar approaches to spread loads and to minimize compaction and impacts to adjacent areas.

6) Wet soils with substantial slopes will "pipe" or creep during and after grading. It is important to understand that the finished grade of salt marsh channels will not be a fixed surface, but an evolving one. Repeated grading will not necessarily improve the product. Designs must anticipate how wet soil surfaces, erosion and deposition will develop over time.

8.4.2 Contract for Selective Grading by Soil Texture and Salinity

When contracts do not specify handling of cut and fill quantities on site, contractors will always choose the most efficient ways to move material while grading. In projects involving both salt marsh and upland restoration, where both soil texture and salinity will strongly influence the success of re-vegetation, restoration goals should be more important than grading efficiency.

Within areas selected for extraction, identify areas with good soil texture, and grade selectively. Salvage and stockpile. Use fine-textured soils in rooting zone areas of intertidal wetlands. Use coarse-textured soils elsewhere.

Avoid placing salty soils in settings intended for upland plants.

8.4.3 Soil Compaction

The use of heavy equipment during grading will leave compacted soils unsuitable for plant growth**.** Avoid driving on areas that do not need to be graded. Compacted soils limits root penetration and percolation of water. Ponding of water in local depressions on compacted soils also prevent seedling establishment.

When soils have been compacted, make an effort to return some texture to the site. Rip all soil surfaces to a depth of 24 inches after reaching finish grade and all other work is finished on site. See other recommendations for soil in the planting section.

8.4.4 Grading and Topographic Heterogeneity

Constructed wetlands tend to have smooth surfaces, large and straight channels, and suppressed erosion. Natural salt marsh systems have complex topography, and intricate steep-sided channel networks which create complicated flow patterns with ongoing sediment erosion and deposition processes (Zedler 2000) and diverse microhabitat features. Contract specifications must be clear on expectations about micro-topography.

8.4.5 Project Design, Topographic Survey Quality, Ground Truth, Staking for Grading and Reality Check

1) All grading projects rely on survey data. Base-map data should be carefully cross-checked for two reasons: grading volumes will depend on a surveyor's layout on the ground, which can be very different than an auto-cad drawing based on faulty data (and potentially much

more expensive), and restoration of tidal flows (and other drainage patterns) are sensitive to actual topography.

2) The entire project site should be checked after grading stakes have been installed to see if the layout makes sense. Common problems should be identified and corrected before grading begins. Look for areas indicated for:

    a. fill in wetlands or other sensitive habitats.

    b. fill in places where plans called for cuts.

    c. cuts in wetlands or other sensitive habitats.

    d. cuts where plans had called for fill.

3) Look for areas that will not drain (that will pond water).

4) When possible, avoid minor cuts and fills on native soil surfaces. The importance of intact native soils will generally outweigh the benefits of two or three inches of change in grade with the accompanying disturbance.

8.5 Plant Acquisition, Installation and Maintenance

Schedule the project to allow planting in the middle of rainy season. The site should be planted to allow seeds and transplanted material to grow during the natural growing season.

Soil preparation. Add organic soil amendments and rip compacted saline soils that will be planted. Although a substantial proportion of the soils on the site may have originally been wetland soils, prolonged exposure to aerobic conditions has likely oxidized organic components of the soils (Zedler 2000). Use organic soil amendments to improve planting areas as needed.

Nutrients. In wetland soils, nutrients are largely recycled from organic pools (Zedler 2000). Nutrients are quickly leached from coarse-textured wetland soils.

The restoration team should plan to salvage salt marsh plants disturbed by grading on site, and to use the material after grading is finished.

The restoration may anticipate greater success using local genetic stock for plant propagation and seed sources when possible.

Diversity is an important component of ecological communities. Restoration ecologists can encourage plant diversity in salt marsh communities by minimizing planting of local dominant species (Zedler 2000). Add diversity early.

High intertidal and upland settings. Unvegetated areas at high intertidal elevations will develop high salinity crusts at the surface (especially on compacted fine-textured soils, and outside of the rainy season) that will suppress seedling establishment and plant growth. To facilitate plant establishment, rip soil surface, add organic amendments, plant in the rainy season and irrigate occasionally.

Restoration is likely to be more successful if it uses multiple methods for introducing plant species to the restoration site. Use multiple techniques if they are available (seeding, sprigging, and planting container stock).

By planting small nursery stock, many small plants can be introduced to a site and the plants can quickly adjust their root/shoot ratios to natural conditions and do most of their growing on site rather than in nursery conditions.

Irrigation may be necessary for plant establishment. Use irrigation occasionally, as needed, especially at elevations above the regular reach of tides. Irrigated areas will need extra weed control.

Weed control. Goals of weed control include killing established weeds, preventing new seed production, and reducing weed seed bank in soils on site.

8.6 Pre-Project and Implementation Monitoring

8.6.1 Photomonitoring

1) Start photo-monitoring before any heavy equipment is allowed on site.
2) Choose points with good views that will capture important changes to site.
3) Document locations carefully with GPS, Google Earth and compass headings.
4) Take photographs regularly during construction (at least monthly) and seasonally during the monitoring period.
5) Include a table with location and direction information as well as maps showing locations of photo-points in all monitoring reports.

8.6.2 Landscape Approach to Ecosystem Monitoring

We recommend a landscape approach to ecosystem monitoring at LCW. Monitoring hydrology, sediment dynamics and plant cover will be all important in understanding both the vegetation and the geomorphic responses of the tidal salt marsh system. Recognizing that these complex, large-scale interactions between tidal flows and sediment accretion and erosion patterns may not be in equilibrium initially, may be important in understanding how to manage different parts of the site under future conditions including SLR.

8.6.3 Hydrology

Monitor hydrology to assess tidal dynamics relative to design parameters and local ocean tides. Adjust expectations for zonation of plants at the restoration site if necessary.

8.6.4 Sediment

Tidal salt marshes are generally depositional systems (Zedler 2000) characterized by low velocity flows in tidal channels and over the marsh plain at high tide. Under conditions with substantial suspended sediment loads, salt marsh plains can accrete at measureable rates. Without sediment inputs, the sediment balance for salt marshes will be negative and the systems will become erosional. Sedimentation rates will likely be very low in the LCW because of the lack of connections to littoral processes, limited local watershed, the high level of watershed controls in the upper San Gabriel River watershed and the hard-channelized condition of the connections to tidewaters.

8.6.5 Vegetation

Monitoring will be necessary to assess restoration efforts and progress towards performance criteria. Because of the complicated nature of the LCW sites and the importance of changing sea levels, monitoring should include efforts to relate vegetation to tidal functions. Tidal salt marsh vegetation is strongly controlled by tidal inundation frequency (submergence time) and the functional relationship should be an important element in setting both initial restoration expectations and longer term goals in relation to SLR.

8.7 Opportunities for Manipulative Experiments and Pilot Projects

In the course of restoration of the LCW, there will be opportunities to learn about increasing the effectiveness of methods to accomplish goals at the site. Pilot projects and manipulative experiments can inform larger scale restoration both at the site level and the wetland complex level. Because the LCW are likely to be restored in phases, the opportunities for optimizing site specific methods should be exploited and carefully documented. Early efforts to understand topics such as planting methods, irrigation techniques, weeding, soil modification (texture, organic amendments), introduction of tidal exchange, slopes (especially in muted environments) have the potential to benefit the overall effort in the long run.

9.0 Suggested Management Alternatives

Coastal wetlands in Southern California require dedicated long-term management. This includes stewardship of existing biological resources and infrastructure and management and/or implementation of restoration projects. Management can be challenging due to the fact that most wetlands have multiple landowners and stakeholders who often have differing priorities. The LCW Complex provides an excellent example of complex ownership within one system. Bringing all the landowners and important stakeholders together under one managing entity would be a great benefit to the biological resources and future restoration at the LCW. The LCWA would be a natural choice to organize and lead a formal managing entity for the entire LCW Complex.

There are many different models for management of coastal wetlands in Southern California. Management may be led by federal or state agencies, non-profits, or a combination of entities. Given the complicated ownership structure and the multiple jurisdictions involved with LCW, it may worth investigating a range of different models. Several potential models of joint management are summarized here, organized by the entity or agency that acts as the lead. Some of these are not directly applicable to the LCW but are included to show the range of approaches being used.

9.1 The Conservancy Model

This is potentially the most applicable model for the LCW Complex. The San Elijo Lagoon Conservancy (SELC) is a good example of this approach. The SELC protects and restores the natural resources of San Elijo Lagoon Ecological Reserve (San Diego County), its watershed, and related ecosystems for the benefit of current and future generations. The SELC owns several parcels within the 915-acre reserve. The conservancy also holds more than 45 acres of conservation easements over private and public property. They work with private property owners and local jurisdictions to minimize development impacts on lands within the watershed. The SELC employs several full time staff members.

SELC oversees important management and restoration actions within the lagoon. Since 1987, a biological management plan for continued restoration of the reserve has included annual breaching of the lagoon's inlet to create natural tidal flushing. Monthly volunteer restoration projects tackle disturbed areas of the reserve for invasive plants, removal of trash, trail maintenance, and other actions as needed. Day-to-day, Conservancy scientists are in the field monitoring vegetation and wildlife. This work contributes data critical to strategic planning for future restoration within San Elijo Lagoon.

Other Southern California examples include the Huntington Beach Wetlands Conservancy and the Bolsa Chica Conservancy.

9.2 Federal Models

The National Estuarine Research Reserve System (NERRS) is a network of protected areas established for long-term research, education, and stewardship. Through a partnership between the NOAA's Estuarine Reserves Division and the coastal states, the NERRS plays a critical role in sustaining the nation's estuaries and coastal communities. There are currently 28 Reserves located throughout the United States, comprising more than one million acres of estuarine land and water.

Reserves conduct research, monitoring, restoration, education, and training designed to improve our understanding and management of estuaries. There are three NERR's in California at the Tijuana Estuary, Elkhorn Slough, and San Francisco Bay.

The US Navy owns two major estuaries. Mugu Lagoon, within Naval Base Ventura County, is managed solely by the Navy. The Seal Beach Wetlands, within the Seal Beach Naval Weapons Station, is also a National Wildlife Refuge and, therefore, managed jointly by the Navy and the U.S. Fish and Wildlife Service (USFWS).

9.3 State Models

Several coastal wetlands are part of the California Ecological Reserve System managed by the California Department of Fish and Wildlife (CDFW). These include Goleta Slough in Santa Barbara County, Ballona Wetlands in Los Angeles County, Upper Newport Bay and Bolsa Chica in Orange County and six Lagoons in San Diego County. The Ecological Reserve System, authorized by the California Legislature in 1968, is designed to conserve areas for the protection of rare plants, animals and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Most of the coastal wetland Ecological Reserves are managed jointly with local governments and non-profits. CDFW provides different levels of management support and leadership at different reserves.

The University of California (UC) Natural Reserve System includes several coastal wetlands, including Carpinteria Salt Marsh (Santa Barbara County) and the Kendall-Frost Mission Bay Marsh (San Diego County). The UC Natural Reserve System is a network of protected natural areas throughout California. Its 38 sites include more than 750,000 acres, making it the largest university-administered reserve system in the world. Founded in 1965 to provide undisturbed environments for research, education, and public service, the UC Natural Reserve System contributes to the understanding and wise stewardship of the earth.

10.0 Next Steps

A series of steps need to be taken to implement the project. That course of action is presented below.

10.1 Additional Preliminary Engineering Investigations

A number of issues remain to be addressed to move the project forward. Below is a list of work needed to more fully analyze the LCW Complex sufficiently for subsequent approvals to restoration. Respective budgets will be determined at a later date. These tasks were not completed as part of this CRP due to funding limitations. Completion of additional engineering may take six months.

- Optimizing the existing three alternatives to provide more of needed habitat types in the short- and long-term;
- Consider developing a hybrid alternative by combining various options at the different areas to optimize a preferred alternative (if desired), analyzing it equally with other alternatives, and reporting the results;
- Conducting focused ecological surveys;
- Hydraulic modeling improvements;
- Reviewing all existing available soils contamination data for the complex;
- ESA Phase I soil contamination studies;
- ESA Phase II soil contamination studies;
- Soil sampling and testing for grain size and chemistry;
- Improved topographic surveys; and
- Improvements/updates related to oil infrastructure and utilities.

10.2 Apply for Funding

Funding is required to perform any of the actions needed to bring this project to reality. Securing funding is typically a longer-lead time item compared to other tasks, so applications should be submitted to appropriate sources as soon as a proposed project is identified. Funding would specifically enable additional engineering investigations, environmental review, permitting, engineering for construction, construction, construction management, and post-construction monitoring either as a comprehensive package or as individual steps. Funding applications may have to be ongoing to generate sufficient funds to fully implement the project if one large funding source does not become available. Possible funding sources include the:

- Ocean Protection Council through the State Natural Resources Agency;
- Ports of Long Beach and Los Angeles;
- Caltrans;
- Counties of Los Angeles and Orange;
- Cities of Long Beach and Seal Beach;
- On-Site Oil Operators;
- USFWS;
- USEPA;
- NOAA’s National Marine Fisheries Service;

- USACE;
- State Water Resources Control Board; and
- Local organizations/agencies that could provide funding for special studies in exchange for potential mitigation credits.

10.3 Wetland Delineation

A formal wetland delineation will be necessary to secure permits and to quantify wetland area affected by proposed actions. The delineation is to be done according to State (CDFW) and Federal (USACE) wetland definitions and criteria. A wetland delineation can be completed within a month for each site in need.

10.4 Public Participation

Continued public participation is important to the project. Additional public meetings should occur as the project moves forward through subsequent phases to keep the public informed and to obtain public feedback. Specifically, the development of a process for an on-going and personal stakeholder coordination process with the Gabrileno -Tongva peoples is recommended for future phases. This process should allow for a sufficient number and sequence of meetings and workshops with Gabrileno -Tongva representatives to guide the restoration, public access, and interpretive elements to share traditional knowledge and stories.

10.5 Environmental Review

Environmental review is required for this project to satisfy the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Environmental review should be performed for all three proposed alternatives. The document must reflect the phasing, but the project should be processed comprehensively rather than being processed at each phase (piecemealed). An Environmental Initial Study should be performed as part of a subsequent task to indicate the level of environmental review required. Due to the sensitivity of the existing site, the potential for contaminants to be present and potential controversy from multiple stakeholder groups, an Environmental Impact Report (EIR) and Environmental Impact Statement (EIS) may be appropriate for this project.

For conservatism in planning, it is assumed that the appropriate document will be a joint CEQA/NEPA document and likely an EIR/EIS. A joint EIR/EIS may be the most appropriate document to prepare to address all issues comprehensively. Completion of the CEQA/NEPA process may take up to one and one-half years. Overall environmental impacts are assessed in a CEQA Initial Study. The Lead Agency for CEQA would be the LCWA and the NEPA would be the USACE or USFWS. This document is to be the basis for identifying the preferred alternative.

10.6 Permitting

Permits are required from various agencies with jurisdiction over the project area. The preferred alternative should be the subject of permits. Protocol bird surveys may need to be completed in the spring season prior to applying for permits. Permit applications will need to be submitted to the following jurisdictional agencies at a minimum:

- Cities of Long Beach and Seal Beach –Special Use Permits (assuming Coastal Development Permits (CDPs), CDPs would be processed by the State);
- City of Los Angeles –Special Use Permits (assuming the CDP for work at Callaway Marsh and use of Haynes Channel would be processed by the State), and possibly Counties of Los Angeles and Orange – Encroachment Permits;
- Regional Water Quality Control Board – See below:
    - Section 401C Water Quality Certification;
    - NPDES Permit;
    - Waste Discharge Requirements; and a
    - Dewatering Permit.

- California Coastal Commission – Coastal Development Permit approval would be by the State;
- State Lands Commission – Lease of State Lands for work below the mean high tide line and any modifications to the State Lands Parcel;
- Department of Fish and Wildlife – Possibly a Streambed Alteration Agreement if a river or stream is modified (Los Cerritos Channel and San Gabriel River);
- USACE – Sections 10 and 404 permit; Section 105 permit if disposal occurs offshore; a Section 408 permit would be required for any modifications to the San Gabriel River levee and that process requires a long lead time (more than a year).

The USACE indicates the following should occur relative to their permits:

1. Early coordination with the local sponsor (e.g., Cities, Counties) and the USACE Engineering and Asset Management Divisions regarding any proposed modifications to the San Gabriel River levees and any other USACE-built structures;
2. A delineation of waters of the U.S. for receipt and verification by the USACE;
3. At some point, a "No federal action" alternative will need to be analyzed. This is not the "No project" alternative, but rather the project that could be built without obtaining a USACE permit; and
4. This project may require preparation of an EIS.

Securing all permits may require a time period of approximately one and a half years. Coordination with permit agencies needs to start immediately. The LCWA has initiated this process by forming a TAC with agency representatives, however certain agencies are not presently represented on the TAC (*e.g.,* City of Los Angeles, CDFW) or are not actively participating and need to be contacted.

10.7 Final Engineering for Construction

Final engineering for construction is to be completed prior to awarding a contract for construction. This step is to generate engineering plans, construction specifications, and a construction cost estimate for each phase and the entire project. A contractor bid package is also generated to solicit contractor bids to perform the construction work. Final engineering can take from one to three years to complete, depending on which alternative is selected, the availability of funding, and if engineering submittals are required at multiple steps in the process, such as at the 30%, 65%, 90%, and 100% design progress.

A great deal of additional technical work may be needed in the final engineering process. This work may entail additional:

- soils analyses (the need for soil amendments for use in habitat creation);
- hydrologic modeling;
- biological surveys, and
- extensive coordination with other landowners on site and determination of oil consolidation areas).

Typically the final engineering documents include final permits to inform the contractor of all restrictions and requirements, so final engineering cannot be formally complete until permits are secured. Also, if modifications to the Los Cerritos Channel and San Gabriel River are proposed, the Federal Emergency Management Agency (FEMA) may require that the floodplains of these channels be remapped. The remapping exercise is done with a Conditional Letter of Map Revision (CLOMAR), which also requires approximately 1.5 years to process.

10.8 Pre-Restoration Monitoring

Monitoring prior to restoration should occur at the LCW Complex and should continue through construction and after construction. Monitoring should include parameters that may be changed by the project including biological considerations (*e.g.* habitat distribution and diversity, birds, fish, invertebrates, etc.), tidal elevations, tidal flow velocities, topographic/bathymetry, water quality, and possibly other parameters. Pre-restoration monitoring will document the baseline values of the monitoring components so changes can be tracked into the future after restoration to measure restoration success and enable adaptive management. The LCWA may consider adopting a monitoring protocol used at other large restoration projects in the region (*e.g.*, San Dieguito Wetlands Restoration Project; South San Diego Bay Restoration and Enhancement Project) so the results can be compared against sites and used to inform future management elsewhere. This same approach would carry through monitoring during construction and post-construction.

10.9 Construction

The project would be constructed within an appropriate timeframe to avoid sensitive environmental windows for nesting birds. Depending on which alternative is implemented, it may be prudent to phase construction to provide areas of refugia during construction of others areas. Phasing is already expected because of multiple landownership throughout the LCW Complex, and may need to consider environmental issues as well. However, construction costs are lower and its duration is minimized if all work can occur concurrently. Construction may cause disturbance to on-site oil operations and nearby neighbors.

The first phase of the project is expected to be on land already owned by the LCWA (Phases I and II areas). Construction could be accomplished in approximately one year minimum and four years maximum, depending on which alternative is implemented and whether phasing would require construction at one area at a time.

Construction approaches are provided in Section 8 of this document for each alternative.

10.10 Post-Restoration Monitoring

Monitoring requirements may vary depending on the purpose of the restoration. If the project is implemented as a mitigation project, then monitoring of tides, water quality, and habitat distribution and diversity could be required over the long-term to quantify changes. Monitoring data could be archived to the project GIS database and linked to the LCWA website for public use. Results of monitoring data analyses could also be reported on an annual basis to resource agencies over the first five full years after restoration of each phase if required. A longer monitoring period may be required if the system fails to develop in accordance with predicted conditions during the first five years, or ecosystem stability is not achieved during the first five years.

A different monitoring approach may be required if the project is funded as a restoration project without associated mitigation requirements. Restoration monitoring could take the form of a less intense data gathering and analysis approach, with more scientific/research types of work being performed to inform other restoration projects. Similar components may need to be monitored, but temporal permit requirements (*e.g.* 5-year performance) may not be imposed.

10.11 Adaptive Management

Monitoring data will inform site management. Corrective actions may need to be taken as identified from future analyses of monitoring results to maintain the site into perpetuity. Natural dynamics will occur, but major problems or sensitive habitat losses would need to be addressed. Adaptive management may apply to modifications of culverts or other features, such as site elevations.

10.12 Schedule

The project will require a significant amount of time for implementation due to the multiple steps and complexities involved. The overall timeline for installing the first phase of restoration may be up to 5 to 7 years from 2014. A rough timeline of implementation is below by task:

1. Preliminary Engineering - 6 to 12 months from finalization of the CRP;
2. Environmental Review – 24 months after completion of preliminary engineering (cumulative time is 30 months or 2.5 years after CRP);
3. Permitting – 12 months after certification/recording of the Final EIR/EIS, respectively (cumulative time is 42 months or 3.5 years after CRP);
4. Final Engineering for Construction (includes advertisement for bids by contractors, selection of contractor, and contracting) – 6 months after permits secured (cumulative time is 48 months or 4 years after CRP);
5. Pre-Restoration Monitoring – Initiates at a minimum of one year prior to the start of construction;
6. Construction of Phase 1 – 18 to 24 months after completion of final engineering for construction if construction is shut-down during certain environmental windows (cumulative time is 66 to 72 months or 5.5 to 6 years after CRP); and
7. Post-Restoration Monitoring – 60 months after completion of construction (cumulative time is 126 to 132 months or 10.5 to 11 years after CRP).

10.13 Existing Conditions Implementation Plan with Cost Analysis

The LCWA requested specific implementation instructions for the land presently owned by the public (the Base Project area) for a near-term project. The Base Project area consists of land shown in Figure 10-1. These properties could potentially be restored earlier in time than other parcels within LCW because they are not in private ownership. Implementation instructions follow.

Figure 10-1. Base Project Area at LCW

The steps to restoration of the Los Cerritos Base Project area are enumerated below, as synthesized from information presented previously in this section. This work is assumed to occur with oversight and input from the SC and TAC. A schedule of the work is shown on the following pages as Figure 10-2.

I. Perform Additional Engineering – Complete the tasks listed below concurrently over a total time period of 8 months.
   A. Optimize the existing three alternatives – 2 months;
   B. Develop a hybrid alternative – 4 months;
   C. Improve and re-run the hydraulic model for all alternatives – 8 months;
   D. Conduct a Phase I soils investigation – 2 months;
   E. Conduct a Phase II soils investigation – 4 months;
   F. Prepare an aerial topographic/bathymetric map – 4 months; and
   G. Update the oil infrastructure map – 4 months.

II. Apply for Funding – Apply for all available funds over the first year, and continue thereafter as needed.

III. Update the Existing Wetlands Delineations – Update existing delineations as needed over 4 months concurrent with preliminary engineering.

IV. Continue Public Meetings – Conduct public meetings annually until construction starts in 5 years.

V. Prepare the CEQA/NEPA Document – Complete CEQA/NEPA over 2 years after preliminary engineering is complete.

VI. Permitting – Initiate permitting at the Final CEQA/NEPA document stage and complete it over one and a half years.

VII. Perform Pre-Project Monitoring – Monitor the site for up to 2 years prior to construction and overlapping with the permitting period.

VIII. Conduct Protocol Surveys – Conduct protocol surveys at one year prior to construction overlapping with final engineering.

IX. Prepare Final Engineering Documents – Prepare all plans, specifications, and estimates for project construction after the environmental document is complete, and concurrent with permitting.

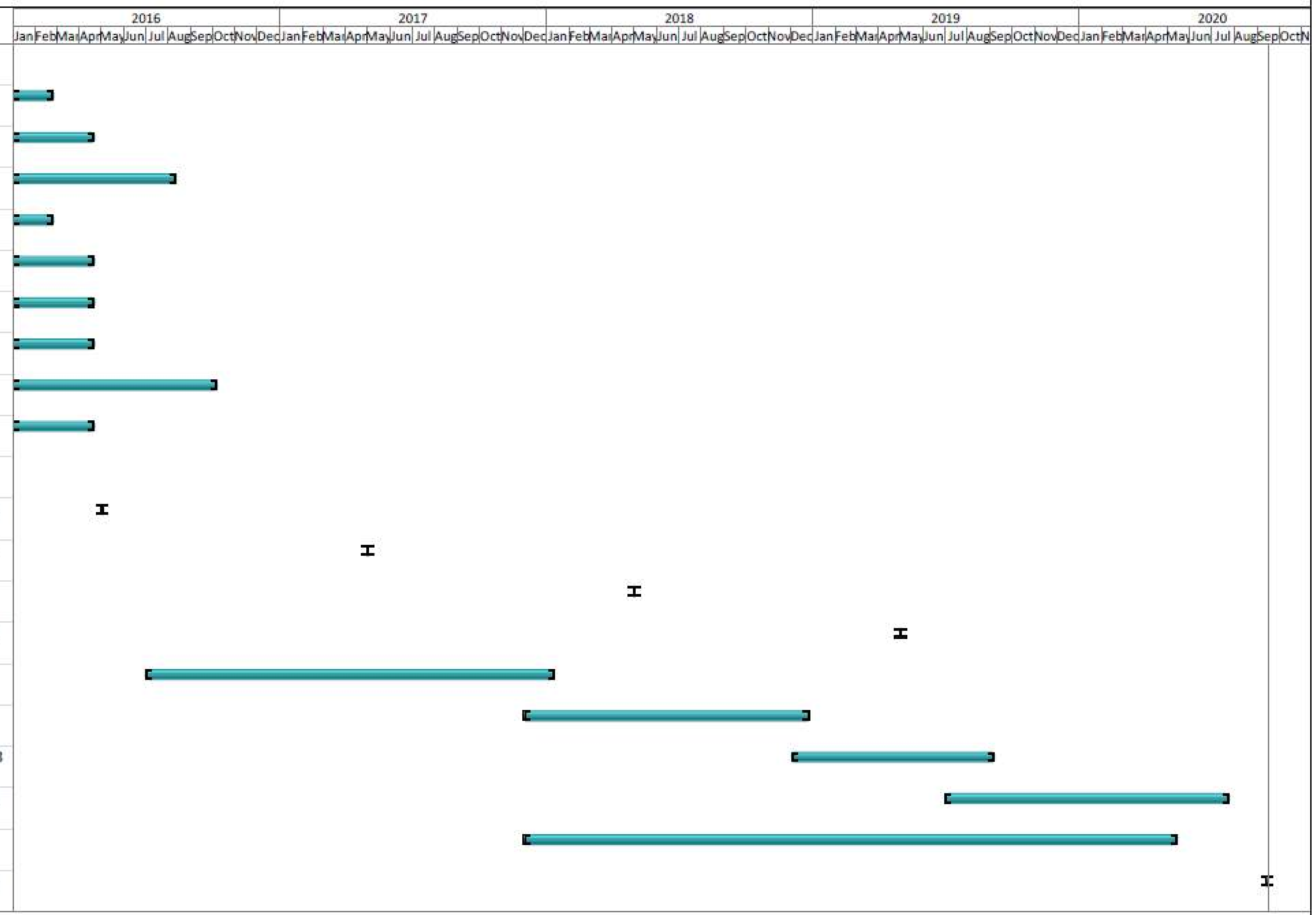
X. Construction – Build the project after all previous tasks are complete.

The estimated costs for this work are shown in Table 10-1. These estimates are preliminary and subject to change depending on the scopes of work and evolution of the alternatives over time. Roughly $3.1 million may be required to bring the project to the point of construction. Construction will be a completely separate budget and may be a much higher cost, depending on the alternative selected.

Construction of the Base Project area should not require internal phasing of parcels, but rather completion of construction over the entire area in one effort.

Schedule for
Los Cerritos Wetlands
Base Project Implementation

ID	Task Name	Duration	Start
1	**1. Additional Engineering**		
2	A. Optimize Alternatives	2 mons	Fri 1/1/16
3	B. Develop Hybrid Alternative	4 mons	Fri 1/1/16
4	C. Improve Hydraulic Model and Re-run	8 mons	Fri 1/1/16
5	D. Phase I Soil Investigation	2 mons	Fri 1/1/16
6	E. Phase II Soil Investigation	4 mons	Fri 1/1/16
7	F. Aerial Topographic Map	4 mons	Fri 1/1/16
8	G. Update Oil Infrastructure Map	4 mons	Fri 1/1/16
9	**2. Apply for Funding**	10 mons	Fri 1/1/16
10	**3. Update Wetlands Delineation**	4 mons	Fri 1/1/16
11	**4. Continue Public Meetings**		
12	**Continue Public Meetings**	1 day	Mon 5/2/16
13	**Continue Public Meetings**	1 day	Mon 5/1/17
14	**Continue Public Meetings**	1 day	Tue 5/1/18
15	**Continue Public Meetings**	1 day	Wed 5/1/19
16	**5. Prepare CEQA/NEPA Document (EIR/EIS)**	20 mons	Fri 7/1/16
17	**6. Permitting**	14 mons	Fri 12/1/17
18	**7. Protocol Surveys**	10 mons	Mon 12/3/18
19	**8. Final Engineering for Construction**	14 mons	Mon 7/1/19
20	**9. Pre-Project Monitoring**	32 mons	Fri 12/1/17
21	**10. Construction Start**	1 day	Tue 9/15/20



Project: Los Cerritos Wetlands Ba
Date: Mon 3/30/15

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

Figure 10-2. Preliminary Timeline for Base Project Area Restoration at LCW

Table 10-1. Estimated Costs for Project Implementation

EXISTING CONDITIONS IMPLEMENTATION PLAN WITH COST ANALYSIS			
1	Additional Preliminary Engineering		
A	Optimize Alternatives		$ 10,000
B	Develop Hybrid Alternative		$ 10,000
C	Improve Hydraulic Model and Re-Run It		$ 100,000
D	Phase I Soils Study		$ 5,000
E	Phase II Soils Study		+ $35,000
F	Aerial Topo Map/Bathymetryic Map		$ 60,000
G	Update Oil Infrastructure Maps		$ 15,000
		Subtotal	$ 200,000
2	Apply for Funding		$ 25,000
3	Update Wetlands Delineation		$ 25,000
4	Continue Public Meetings (assume 5)		$ 50,000
5	CEQA/NEPA Document		$ 750,000
6	Permitting		$ 300,000
a	Protocol Surveys		$ 15,000
		Subtotal	
7	Pre-Construction Monitoring		$ 175,000
8	Final Engineering		
	Soil Sampling for Disposal		$ 50,000
	PS&E		$ 650,000
	Advertise for Bids/Contract Construction		$ 35,000
		Subtotal	$ 735,000
9	Construction		Unknown
10	Post-Construction Monitoring		$ 800,000
		GRAND TOTAL	**$ 3,075,000**

11.0 Conclusions

LCW is a large-scale wetland restoration project planned for the future. The entire wetland complex is 565 acres of degraded wetland and oil field properties straddling the San Gabriel River in Los Angeles and Orange Counties. Approximately 170 acres of the complex are publicly-owned and considered the Base Project area for possible near-term restoration. The remaining 395 acres are privately-owned and may comprise future wetland restoration in the longer-term.

A SC of members of the LCWA and a TAC consisting of the SC and applicable stakeholders, and resource and permit agencies guided the process of alternatives formulation and analyses. Results were presented to the public at several workshops. This CRP lays out the site history and conditions, describes alternatives for restoration, and presents results of detailed analyses. Results and conclusions are presented below.

The three restoration alternatives developed for restoration consisted of:

1. Minimum Alteration – The relative minimum amount of change required to the site to provide restoration benefits;
2. Moderate Alteration – A relatively moderate amount of change so the site to provide restoration benefits; and
3. Maximum Alteration – A relative maximum amount of change required to the site to provide restoration benefits.

The No Project alternative was also analyzed.

Alternatives were analyzed for predicted conditions of habitat, public accessibility, tidal hydrology, likely construction scenarios, maintenance requirements, and construction costs. The conclusions listed below are provided for each alternative.

11.1 Alternative 1 – Minimum Alteration

Alternative 1 is a viable approach to restoring the site and lends the advantages of being less costly and resulting in less environmental impact from restoration activities than the other alternatives. It may also be an advantage in the future under projected SLR conditions due to the opportunity for tide controls with culverts. However, it presents the disadvantages of yielding relatively lower quality habitat compared to other alternatives, experiences greater fragmentation, and is dependent on culverts for tide conveyance. Specific results for each area of investigation are below.

1. Habitat types and distributions are based on maintaining existing areas in their present configurations, while introducing tidal flows to areas presently isolated from the tides. As such, conditions at each internal area varies from the others, and this alternative functions differently than the other alternatives. Habitat consists of more upland than other alternatives, and more of the site is occupied by oil production. However, long-term sustainability of habitat appears to be best with this alternative due to tide control during projected future SLR.

2. Public access would be generally limited to the peripheral areas, and access to interior areas would only be on the existing oil access road network. This alternative provides the greatest number of low cost opportunities for trails to experience the site than other alternatives.

3. This alternative is characterized mainly by mute tides, with the exception of Steam Shovel Slough that remains fully tidal. SLR of 1.5 feet results in expanded tidal ranges at all sites, while SLR of 5.5 feet results in greater expansion, except at the Isthmus and the Southeast Area due to limitations of culverts.

4. Alternative 1 would be constructed in the dry using land-based equipment. Construction would consist of installing culverts under roads, and breaching certain levees while erecting others. Work would require equipment capable of traversing extremely soft soils (on tracks rather than wheels), and less surplus soil would be generated compared to other alternatives, requiring beneficial re-use or offsite disposal. A significant amount of additional soil investigation is needed to identify if contamination exists on site that could require remediation and/or removal. Both Phase I and Phase II studies would be required, particularly privately-owned sites (outside of the Base Project Area). Results of these studies would not likely result in modification to the configuration of this alternative, but may result in elimination of certain wetland cells from restoration.

5. Certain types of maintenance, such as that for culverts, flap gates, and man-induced issues related to oil company access may be significant for Alternative 1 due to the number of culverts and proximity to oil operations. Less trash removal will be required compared to other alternatives due to isolation from main channels by levees.

6. Construction costs are lowest for Alternative 1 compared to Alternatives 2 and 3. Costs are provided on a per-acre basis, and include all items required for implementation including planning, engineering, construction, construction management, contingencies, and escalation. The range of costs to restore Alternative 1 is between $106,000 and $159,000 per acre.

11.2 Alternative 2 – Moderate Alteration

Alternative 2 is a different, but very appropriate approach to restoring the site from Alternative 1. It presents the advantages of creating higher quality/functioning habitat in the near-term compared to Alternative 1, and is less reliant on tide control (culverts). However, it is more costly and results in greater environmental impact from restoration activities than Alternative 1. It may also be disadvantageous in the long-term future under certain projected SLR conditions due to habitat conversion from lowering of the site. Specific results for each area of investigation are below.

1. Habitat diversity would increase with less area occupied by oil production. Large areas of uplands and transitional areas would initially exist. The Northern and Central Areas are lowered, while other areas left higher in elevation. Less fragmentation of habitats would occur, and quality would increase compared to Alternative 1, and would be similar to Alternative 3. Long-term sustainability of habitat may be jeopardized by lowering of the site and lack of tide control.

2. Public access would include a primary trail system at the periphery of the sites. Oil infrastructure is consolidated, so additional opportunities for access points and loops would

require new access plans. This alternative provides opportunities for enhanced urban connectivity compared to Alternative 1. The three possible themes by which access could be developed are "perimeter," "loop," and "urban connectivity," in order of increasing access opportunity.

3. Areas north of the San Gabriel River would be fully tidal, and areas south of the San Gabriel River would experience muted tides. SLR of 1.5 feet results in tidal ranges expanding at all sites. SLR of 5.5 feet results in tidal ranges increasing further, except at Zedler Marsh on the Isthmus due to culvert limitations.

4. Alternative 2 also lends itself to construction in the dry using land-based equipment. If desired, water-based dredging could occur in the Northern Area. Construction consists of earthwork to install a new channel system and to consolidate oil operations on multiple sites. Land-based work could require significant dewatering unless equipment capable of traversing extremely soft soils (on tracks) were able to perform the work. A large quantity of soil requires beneficial re-use or offsite disposal. Additional soil investigations are also needed to identify if contamination exists on site that would require remediation and/or removal. Both Phase I and Phase II studies would be required, particularly at sites not publicly-owned (outside of the Base Project Area). Results of these studies could potentially change the configuration of this alternative, and/or significantly drive up the costs.

5. Larger-scale restoration over broad areas may generate more maintenance associated with wetlands restoration, such as for vegetation planting and for erosion and sedimentation control from greater tidal circulation. Trash removal will increase compared to Alternative 1 due to direct connections with major channels. Oil is consolidated so less human-wetland interaction will occur and less human use-related maintenance is required for Alternative 2 as compared to Alternative 1.

6. Construction costs are higher for Alternative 2 compared to Alternative 1 due to more earthwork needed, but lower than Alternative 3. Costs are provided on a per-acre basis, and include all items required for implementation including planning, engineering, construction, construction management, contingencies, and escalation. The range of costs to restore Alternative 2 is between $158,000 and $260,000 per acre.

11.3 Alternative 3 - Maximum Alteration

Alternative 3 is yet another different, yet appropriate approach to restoring the site from Alternatives 1 and 2. It creates the highest quality/functioning habitat in the near-term compared to Alternatives 1 and 2, and is less reliant on tide control (culverts). However, it is the most costly alternative and results in greater environmental impact from restoration activities than other Alternatives. It may be disadvantageous in the long-term future under projected SLR conditions due to habitat conversion from lowering all areas of the site except the Isthmus. Specific results for each area of investigation are below.

1. Habitat types and distributions are based on very significant changes proposed to all sites. Areas are modified from their present configurations to allow more direct tidal connections. The greatest diversity would exist initially with the least area occupied by oil production.

Less area of uplands and transitional habitats would also exist. Similarity of habitat types would exist throughout the entire Complex. Minimal fragmentation of habitats would occur, and quality would increase compared to Alternatives 1 and 2. Long-term sustainability of habitat during future projected SLR is sacrificed by lowering of the larger areas of the site and lack of tide control.

2. Public access would be similar to Alternative 2 as both options significantly reconfigure the sites. Access would include a primary trail system at the periphery of the sites. Oil infrastructure is consolidated, so additional opportunities for access points and loops would require new access plans. This alternative also provides opportunities for enhanced urban connectivity compared to Alternative 1. The three possible themes by which access could be developed are "perimeter," "loop," and "urban connectivity," in order of increasing access opportunity.

3. All areas are full tidal, except the Isthmus, which would remain muted. SLR of 1.5 feet results in tidal ranges expanding at all sites. SLR of 5.5 feet results in tidal ranges increasing further, except at the Isthmus due to culvert constraints.

4. Alternative 3 could be constructed by dredging and/or construction in the dry using land-based equipment. Water-based dredging could occur in all areas except the Isthmus. Construction consists of earthwork to install new channels and to consolidate oil operations on all sites. Land-based work would require significant dewatering, unless equipment capable of traversing extremely soft soils (on tracks) were able to perform the work. The maximum quantity of soil would require beneficial re-use or offsite disposal, even with proposed filling at the OC Retarding Basin. As with the other alternatives, additional soil investigations are needed to identify if contamination exists on-site that would require remediation and/or removal. Both Phase I and Phase II studies would be required, particularly at sites not presently owned by the public (outside of the Base Project Area). Results of these studies could potentially change the configuration of this alternative, and/or significantly drive up the costs.

5. Similar to Alternative 2, large-scale restoration over broad areas may generate more maintenance associated with wetlands restoration, such as trash removal, plantings, and erosion and sediment control. Oil is consolidated so less human-wetland interaction will occur and less human use-related maintenance is required for Alternative 3 as compared to Alternative 1.

6. Construction costs are highest for Alternative 3 due to the greatest amount of earthwork of any alternative and costly material disposal. Costs are provided on a per-acre basis, and include all items required for implementation including planning, engineering, construction, construction management, contingencies, and escalation. The range of costs to restore Alternative 1 is between $273,000 and $473,000 per acre.

11.4 No Project – Existing Conditions

No Project assumes the existing condition remains in place into perpetuity and no further restoration actions occur. This alternative does not result in improved habitat conditions, nor does it achieve the project goals and objectives. Specific results for each area of investigation are below.

1. No Project preserves existing habitat, and the site would continue to be managed for non-habitat uses, so non-tidal habitats will continue to be relatively low-functioning. Habitat is highly fragmented and disturbed over large areas, with relatively small areas of high-value. SLR of 1.5 feet results in relatively little change in habitat due to tidal isolation with levees and control by culverts, while hypothetically SLR of 5.5 feet may result in higher groundwater and greater ponding on certain areas of the site.

2. Portions of three areas receive tides, while the Central Area possesses no functioning tidal connection. Tides are muted in all areas except Steam Shovel Slough, where tides range fully under existing sea level. SLR of 1.5 feet results in slightly increased tide ranges at tidal sites. SLR of 5.5 feet results in further tidal range increase at tidal sites, and reduced tidal range at muted tidal areas from effects of culverts.

3. Public access is limited to peripheral area on existing trails and behind fences, without opportunities to penetrate the site except with a landowner or owner's representative.

4. No construction would occur for the No Project Alternative so construction methods are not pertinent to address.

5. Maintenance would remain modest for the No Project Alternative, relying on the existing Stewardship Program.

6. No construction costs would be incurred for No Project.

Other items presented in this report include implementation guidelines and next steps. Implementation guidelines consist of restoration recommendations and specifications. Next steps are a list of future actions and timelines. Budgets for next steps will be generated in subsequent project phases. The project will require additional funding, and may take up to between 5 and 7 years to implement the first phase if work continues uninterrupted. Finally, a summary Implementation Plan for the publicly-owned sites is presented to inform the LCWA about how to initiate and complete a project in the near-term. A series of steps are presented, along with a schedule and budget for each task to accomplish restoration. The site can be restored for near- and long-term success.

12.0 References

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APPENDIX A:

PUBLIC MEETING NOTES

APPENDIX B:

TAC MEETING MINUTES

APPENDIX C:

HABITAT ASSESSMENT REPORT

APPENDIX D:

SOILS ASSESSMENT REPORT

APPENDIX E

SOILS ASSESSMENT SUPPLEMENTARY MEMO

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OIL OPERATORS – MEETING DATES AND OBJECTIVES OF THE MEETINGS

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OPPORTUNITIES AND CONSTRAINTS REPORT