Draft

BALLONA WETLANDS RESTORATION PROJECT

Preliminary Design Report

Prepared for
California State Coastal Conservancy

May 8, 2013

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May 8, 2013

Mr. Richard Leifield
Chief of Engineering and Levee Safety Officer
U.S. Army Corps of Engineers, Los Angeles District
P.O. Box 532711
Los Angeles, CA 90053-2325

Subject: Ballona Wetlands Restoration Project Preliminary Design Report

Dear : Mr. Leifield

Please find enclosed the Ballona Wetlands Restoration Preliminary Design Report (PDR) as part of the Section 408 Initial Submittal A to the U.S. Army Corps of Engineers for the Ballona Wetlands Restoration Project.

This PDR documents the preliminary restoration engineering design including preliminary plans for the proposed new perimeter levees, Ballona Creek realignment, habitat restoration, and grading; anticipated O&M requirements; and preliminary geotechnical and structural engineering analyses.

The following analyses will be completed subsequent to Submittal A for CEQA/NEPA review and detailed analysis and design for Submittal B:

- This PDR includes a Preliminary Geotechnical Design Summary. A Geotechnical Report including analysis of recently collected geotechnical data is being prepared.
- This PDR includes a preliminary discussion of sediment chemical quality. A sediment quality memorandum including analysis of recently collected sediment quality data is being prepared.
- The design for managed wetland restoration behind the proposed new Culver levee, including new water control structures, is being further developed.

These additional geotechnical, sediment quality, and managed wetland design analyses will be submitted as addenda to the PDR during Summer/Fall 2013.

This PDR also refers to a draft Restoration and Adaptive Management Plan that describes the revegetation approach. The preliminary revegetation design will be developed during Summer/Fall 2013.

The Ballona Wetlands Restoration Project Preliminary Hydrology and Hydraulics Report (H&H Report) (ESA PWA 2013) documents preliminary H&H technical analyses for the Project. Please note that the H&H Report assesses a prior iteration of the Project design and that this PDR presents the current restoration design. Since the completion of analyses in the H&H Report, the preliminary design has been updated. The key differences between the design in this H&H Report and the PDR are the treatment of the existing natural gas wells in west Area A and West Area B. Section 1.2 of this PDR describes these differences. Refinements to the hydraulic analyses will evaluate the current design in greater detail and will be included in Submittal B.

Sincerely,

Nicholas Garrity, P.E.
Southern California Manager / Project Manager
ESA PWA | Environmental Hydrology

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1. INTRODUCTION

This Preliminary Design Report (PDR) documents the main project elements included in the Ballona Wetlands Restoration Project (the Project) at the preliminary design level. The Project entails several key design considerations and this PDR addresses these considerations in order to focus engineering efforts toward completion of the project design.

1.1 BACKGROUND AND KEY ISSUES

The Ballona Wetlands Restoration Project (Ballona Project) entails expansion and enhancement of wetlands adjacent to lower Ballona Creek, and associated site modifications necessary to avoid adverse effects to surrounding property and interests. The project covers about 600 acres between Marina Del Rey (to the north) and Playa Del Rey (to the south), and from about 2,000 feet east of the Pacific Ocean to about 10,500 feet farther upstream along Ballona Creek (Figure 1; PWA and others, 2008).

The site is divided into several areas (See site plan: Figure 1):

- Area A: North of Ballona Creek and west of Lincoln Boulevard;
- Area B: South of Ballona Creek, subdivided into:
  - West Area B
  - South Area B
  - East Area B
  - North Area B
- Area C: North of Ballona Creek, east of Lincoln Boulevard, subdivided into:
  - North Area C, north of Culver; and,
  - South Area C, south of Culver (further subdivision for a visitors center may occur).

The project is progressing with simultaneous environmental review, design and permitting. The work is being accomplished by a team consisting of several consultants, under several contracts (ESA PWA, 2012a).

1.2 FLOOD CRITERIA

The project entails realignment of flood control levees subject to approval by the US Army Corps of Engineers and Los Angeles County (ESA PWA, 2012b). The governing flood source is Ballona Creek when high flows resulting from rainfall in the tributary watershed increase flowrates toward the ocean. The project flood control objective is to provide an equivalent or increased level of flood protection relative to existing conditions.

The LA District Corps of Engineers' Operation and Maintenance Manual identifies the design capacity as 46,000 cfs with a minimum of two feet of freeboard based on the original 1935 Corps channel design. However, more contemporary flood management criteria may need to be applied as the result of permitting and other requirements, even if the new criteria represent an “upgrade” relative to the original design and/or the existing level of flood protection. Flood flows with and without project, including anticipated future sea levels, have been modeled in a separate Ballona Wetlands Restoration Project Preliminary Hydrology and Hydraulics Report (H&H Report) (ESA PWA, 2013).

The site overlays a deeply buried natural gas storage facility. Associated with this facility are near-surface and surface features in the site. Removal of much of these facilities is expected, and the preliminary design is configured to address the most likely scenario (extent of facility removal) based on discussions with the Gas Company. Still, there remains uncertainty about the timing of gas monitoring well removal (also called "abandonment" even though the near surface components are completely removed) in Areas A and B. Therefore, the preliminary design includes two options for removing the wells in Area A: one in which the wells remain in the initial phase of the restoration (Option A shown in Figure 5A) and one in which the wells are removed for the initial phase (Option B shown in Figure 5B).

Note that the H&H Report assesses a prior iteration of the design that is similar to the current design presented in this PDR. Since the completion of analyses in the H&H Report, the preliminary design has been updated. The key differences between the design in the H&H Report and this PDR are the treatment of the existing natural gas wells in west Area A and West Area B. The Interim Build Out - Option A condition depicted in Figure 5A is consistent with the modeled condition and results reported in the H&H report. In West Area B, the current Full Build Out condition in this PDR shows the upland habitat peninsula as a smaller feature, but with a similar functional intent as modeled in the H&H report. We anticipate updating the modeling subsequent to Submittal A.

The elevations in Area B and some adjacent properties are below flood levels, and tributary properties rely on Area B for storm runoff storage (ESA PWA, 2012b). Area B currently receives limited tidal circulation and drains to Ballona Creek through the existing tide gates. Tributary areas adjacent to Area B rely on the site to accept local rainfall runoff without backing up onto developed areas. These drainage ways are:

- Freshwater Marsh (FWM) for Playa Vista (East Area B); Depending on the water surface elevation maintained in it, the FWM is designed to overflow into south area B above a 1 to 2 year rainfall runoff event for the Playa Vista development. Therefore, the water level in Area B must not exceed the overflow weir at FWM, and the high water level in Area B must be low enough to accommodate overflow from FWM.
- Playa del Rey (West Area B); The area of Playa del Rey at the southwest corner of Area B experiences localized flooding under some circumstances. This is a symptom of poor drainage for this area in a sump condition. The project concept now includes allowing an area for a storm water detention basin on the inboard (Playa del Rey) side of the new levee.
- Roadways (Area B); The Culver and Jefferson roadways in Area B are low in elevation and close to groundwater. There is a ground water infiltration gallery at the intersection of these two roads. Hence, the low area of roadway is along Culver, west of the junction with Jefferson. Earth berms may be required to reduce the risk of high water flooding, along with the installation of conveyance and storage channels, culverts and tide gates.

- Gas Company facilities (primarily Area B, but also west Area A); There are industrial facilities in south Area B that are constructed on fill but are low enough to be flooded under some higher tidal waters.

Water control structures are being designed to enhance wetland ecology in South Area B through increasing tidal exchange. These new culverts will replace existing culverts. Both existing and new culverts will include gates to limit high water. Other actions such as berms and new channels may be included as part of the enhancement. The existing culverts serving Area B have self-regulating-tide-gates and provide a very useful example for consideration.

The coastal flood sources (high tides, storm surge, surface waves and tsunami) are not expected to govern levee design since these water levels are lower than the fluvial design water levels (i.e., lower than the flood levels associates with rainfall-runoff storm events and resulting Ballona Creek flows).

Sea level is expected to rise at an accelerated rate. Relative sea level rise is the addition of vertical land motion with sea level change. The restoration and flood management approach would consider the effects of future sea-level rise (per the California Governor’s Executive Order S-13-08 and the State Coastal Conservancy’s Climate Change Policy adopted June 4, 2009) (ESA PWA, 2012b). The restoration is being designed to accommodate future accelerated sea level rise scenarios. This may involve either constructing new levees to higher elevations or constructing levees that can easily accommodate future elevation increases based on actual sea level rise.

A report addressing sea level rise for the west coast of the continental US was just released (NAS, 2012), and will be used to update the State’s interim guidance. The new sea level rise estimates are similar to the interim guidance, except for a slightly lower “maximum” rise by the year 2100. United States Army Corps of Engineers recently re-issued federal agency guidance that is currently consistent with that of the State of California (USACE, 2011). This guidance document requires consideration of several sea level rise scenarios forming a range of sea level rise acceleration. These sea level rise scenarios are similar to the State guidance documents, and we anticipate selection of scenarios that satisfy both State and Federal requirements. In the mean time, we use the more conservative USACE (2011) estimate and assume that sea level rise will amount to approximately 59 inches by 2100.

1.3 SOIL CHEMSITRY

As part of the site reconnaissance and assessment, tests are being conducted to determine the location and concentrations of potential sources of soil contamination. They will guide specific construction techniques, sediment removal, and sediment management. While the site has a history of uses that may have introduced contaminates, the existing data indicate that the earth to be excavated can be reused on site, with select materials used in surface and habitat areas.

The use history includes agriculture, oil drilling and natural gas storage. In addition, the soil chemistry below previously filled areas may be affected by low oxygen levels or limited organics. The soil chemistry is important from the perspectives of appropriate sequestration in fill areas, biological uptake in restored areas, and vegetation establishment. A detailed field exploration effort has been undertaken to investigate the chemical properties of the soils to be excavated and those to be at or just below the anticipated finished grades. The data collection plans and observations during sampling are provided in Appendix B. Pending completion of the laboratory testing and interpretation, we anticipate that soil chemistry is consistent with storage in fill areas, and that offhaul of material due to contamination is not required. Also, we will evaluate the benefit of soil amendments or backfill with selected soils to enhance vegetation establishment and wetland ecology.

1.4 PUBLIC USES

Existing public uses will be accommodated and/or mitigation will be provided. Culver Boulevard, Jefferson Boulevard and Lincoln Boulevard (State Highway One) traverse the project site and will be maintained. A gas storage facility in south Area B is accessed from these roads, and there are multiple monitoring wells and several pipes within the project limits. Public access exists along the north Ballona Creek levee on a County maintained bike path all other public access is only allowed by issuance of an access permit from the Department of Fish & Game.

A public access plan is being developed to maintain existing uses and provide additional access opportunities. Anticipated elements, such as a pedestrian bridge across Ballona Creek are included in this preliminary design. Also shown in the preliminary design is parking and access at the southwest corner of Area B, where existing parking and trails are heavily used. Other elements, such as a visitor center and parking, are anticipated but not sufficiently developed to include in the preliminary drawings.

1.5 EARTHWORK

The Project will entail movement of between one and two million cubic yards of earth. Earth movement between Areas will require crossing roads (Lincoln and possibly Culver in Areas A and C; and Culver and/or Jefferson in Area B), and crossing Ballona Creek. The project also includes re-alignment of Ballona Creek, which will entail construction of new channel segments and filling of existing channel segments. Construction is expected to take several years and consist of several phases. The intent is to balance earthwork on site with placement in Areas B and C.

1.6 PHASING

Earthwork and restoration will occur in several phases. These phases are described in more detail in Section 3 of this report. Broadly, the construction phases include:

1. Phase 1 will involve excavation in Area A and construction of new levees around the enhanced wetland areas in Areas A and B. This phase is expected to require 2 to 4 years.
2. Phase 2 will involve excavation of new meander bends for Ballona Creek, breaching the existing Ballona Creek Levees, and filling in Ballona Creek within the meander bends. The completion of this phase restores full tidal action to Area A and North Area B. This is referred to as the "Interim Project" because the project site will remain in this interim state for a period of years

while habitat establishes in Area A and North Area B. Note that the preliminary design includes two options for the "Interim Build Out:"

a. Option A: if the gas wells in west Area A are not removed prior to the Interim Build Out, the area around the wells will remain at existing grade and the wells will be protected in place.
b. Option B: if the Area A gas wells are removed as part of the Interim Build Out, the area around the wells will be excavated to create restored wetland, transition zone, and upland habitats.

3. Phase 3 involves restoring tidal action to West Area B by lowering and breaching the remaining Ballona Creek levee at West Area B. This phase will commence once the restoration of Area A and North Area B meets the performance criteria set forth in the environmental documents, permits, and an Adaptive Management Plan.

2. PRELIMINARY DESIGN

The project site with major work areas is presented in Figure 1. Existing topography and utilities are provided in Figures 2 and 3.

A graphic presenting the proposed restored habitats is presented in Figure 4. Preliminary grading plans for the project are presented in Figures 5A - 5C, showing the Interim and Full Build Out plan for the project site with and without the gas wells.

The preliminary grading plan shows the major project elements including:

- New engineered levees set back from the existing Ballona Creek channel.
- Realigned Ballona Creek channel with more natural meanders through the project reach.
- Lowering of fill in Area A to create a mosaic of tidal wetlands, salt pans, transitional ecotone habitat, upland habitat, and seasonal wetlands.
- Lowering of fill in North Area B to create tidal marsh adjacent to Ballona Creek.
- A network of new and/or enhanced tidal channels in Area A and Area B (shown in greater detail in Figure 9).
- New hydraulic structures to allow for controlled tidal exchange from Ballona Creek to Area B South and East.
- Fill mounds in Area C and in Area B between Culver Blvd and Jefferson Blvd.
- Abandonment of select natural gas monitoring wells, with options for protection of other natural gas monitoring infrastructure in the Interim Build Out condition. Full Build Out conditions allow for the abandonment of all natural gas wells within the restoration footprint.

2.1 EXISTING TOPOGRAPHY AND UTILITIES

The project civil engineering consultant, PSOMAS, prepared current topographic base maps for the project using Aerial Photogrammetry, ground surveys, and bathymetric surveys. The topographic base map for the project site is presented in Figure 2. Existing utility maps area provided in Figure 3. Appendix A provides more detailed existing topographic maps and information on PSOMAS's survey protocols and results.

PSOMAS also prepared a real estate analysis of existing property boundaries and easements that is presented separately (Appendix A).

Coastal water levels and tidal datums are listed in Table 1 below.

Table 1 Coastal Water Levels and Datums.

	MLLW (ft)	NAVD (ft)	NGVD (ft)
100-year tide (FEMA)	9.1	8.9	6.5
Max. observed (11/30/1982 7:54)	8.5	8.3	5.9
HAT (12/2/1990 16:12)	7.3	7.1	4.6
MHHW	5.4	5.2	2.8
MHW	4.7	4.5	2.1
MTL	2.8	2.6	0.2
MSL	2.8	2.6	0.2
NGVD	2.6	2.4	0.0
MLW	0.9	0.7	-1.7
NAVD	0.2	0.0	-2.4
MLLW	0.0	-0.2	-2.6
LAT (1/1/87 0:00)	-2.0	-2.2	-4.6
Min. observed (12/17/1933 15:42)	-2.8	-3.0	-5.5

Notes: Tidal datums from NOAA/NOS Santa Monica Tide Station 9410840, 1983-2001 Epoch
NAVD to NGVD conversion from NOAA/NGS
100-year tide from FEMA (2008) Flood Insurance Study for Los Angeles County (based on studies completed in 1984)
HAT = highest astronomical tide
MHHW = mean higher high water
MHW = mean high water
MTL = mean tide level
MSL = mean sea level
MLW = mean low water
MLLW = mean lower low water
LAT = lowest astronomical tide
NAVD = North American Vertical Datum of 1988
NGVD = National Geodetic Vertical Datum of 1929

2.2 SOILS AND GEOTECHNICAL INVESTIGATIONS

The majority of construction involves earthwork, primarily excavation to realign Ballona Creek and to create tidal marsh and transitional habitat in Area and fill to build new engineered flood control levees set back from the Ballona Creek channel. Therefore, the geotechnical and engineering properties, levels of chemicals and metals, and general agronomy are key soil properties to understand when developing earthwork plans.

The project is performing geotechnical investigations and sampling and analysis for chemicals, metals and general agronomic properties to inform design decisions to optimize the use of soils at the project site.

2.2.1 Geotechnical Engineering Properties

The project Geotechnical Engineer, Group Delta, is performing a geotechnical investigation and analyses to develop design and construction recommendations for the new flood control levees and to examine stability of existing levees. The geotechnical investigation includes a field program with soil borings to collect samples for laboratory analysis and Cone Penetration Testing (CPT) in areas of the new proposed levees, near existing levees, and within areas of planned excavation to inform design level geotechnical analysis. The field program and laboratory analyses were performed starting in September 2012. The design level geotechnical report is anticipated in June 2013.

The primary engineering soil parameters that will affect earthwork include:

- Grain size, fraction of organics
- Bulk density, moisture content and volume change with compaction
- Shear strength, plasticity
- Permeability
- Seismic response, liquefaction potential
- Consolidation, settlement
- Slope stability, bearing capacity
- Active / passive pressure
- Other (existing levee stability, offsets for excavation adjacent to existing levees, etc.)

To help inform preliminary design, Group Delta provided a Preliminary Geotechnical Design Summary based on available data taken from previous studies (provided in Appendix B). The available data are not sufficient to support current requirements for final design. There were significant areal gaps in the previous borings and also primarily addressed physical properties rather than the engineering properties of the site soils. Thus, the preliminary report provided provisional assessments based upon conservative assumptions and limited available data.

Materials for construction of the new perimeter levels will be primarily excavated from Area A. Soils within Area A are layered reflecting the placement of hydraulic dredge material from the construction of the adjacent Marina del Rey in the upper 10 to 15 feet underlain by native silts. The hydraulic fill primarily consists of inorganic, low plasticity silts and silty sands with some lean clay and elastic silts. In general, this material is anticipated to be acceptable for levee construction.

The Preliminary Geotechnical Design Summary provided provisional analysis of the static stability and dynamic loading of the proposed and existing levees. In addition, estimates of the anticipated settlement of the new levees and seepage rates for work near Ballona Creek were provided.

The preliminary analyses indicated that the proposed levees provided adequate Factors of Safety for both static and dynamic conditions for the loading conditions analyzed. The design approach based on the preliminary geotechnical recommendations for specific levee sections are described below in Section 2.3.2.

2.2.2 Chemical Properties

The project site has a history of oil and gas exploration. Previous investigations in Area A performed by Weston Solutions for the Port of Los Angeles in 2008 indicated that the soils were non-hazardous in the areas tested and therefore suitable for upland placement. However, there were levels of iron and arsenic that, while consistent with ambient concentrations in marine sediments, exceeded residential California Human Health Screening Levels in a number of samples. There was also one sample that exceeded the human health screening level for benzo [a] pyrene (39.7 ug/kg vs 38 ug/kg) for residential use. In addition, soil samples from several locations had elevated photoionization detector (PID) readings, however none of the samples analyzed for petroleum hydrocarbons exceed human health screening levels.

Several samples slightly exceeded the low range ER-L screening levels for ocean disposal of dredge material for metals (including Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, and Silver), however, no samples had metals concentrations above the medium range ER-M screening level. One sample exceeded the ER-L for organochlorine pesticide 4,4 DDE.

To help determine if specific soils at the project site would be suitable for upland and/or wetland material within the restoration project, Weston Solutions developed a Sampling and Analysis Work Plan (SAP) to further characterize sediments to be excavated from Area A and Area B (Attached in Appendix C). The SAP provides for both discrete and composite sampling with analysis for general chemistry, organics, inorganics, and petroleum hydrocarbons (if samples exhibit staining or register on PID analysis). In addition, at select locations at the design surface elevation, bioassays are planned to help assess the suitability of the material for wetland cover. The SAP provided screening tools and guidelines that will be used to assess the suitability of onsite soils for use as:

- Wetland Cover Material – materials that meet the regulatory requirements for wetland cover based on ER-M screening and bioassay results (pending regulatory review and approval). Wetland cover may be used anywhere on site, but will be prioritized for use in the upper three feet of the channel and wetland surface.
- Upland Cover Material – materials that meet the human health screening levels, but exceed wetland cover standards. Upland cover material would be used for any upland placement or below three feet of wetland cover material within the channels or wetland surface.
- Non-Hazardous Material – materials that are below the state and federal thresholds for hazardous waste (Title 22), but exceed the human health screening levels. Non-hazardous material may be placed in upland areas (levees and soil mounds) capped with a minimum of three feet of upland cover material.
- Hazardous Materials – materials that exceed the state and federal thresholds for hazardous waste (Title 22) will be disposed of offsite.

Soil samples were collected for analysis under the SAP in conjunction with the geotechnical borings in September and October, and analysis results are expected in November 2012.

Preliminary observations during sampling indicate that some petroleum contamination was observed in the following locations:

- Area A – Proposed Channel alignment. A petroleum odor and dark staining was noted about 10-14 feet below ground surface (bgs). The impacted sediment was limited to about a 2 to 4 feet thick layer. Samples were collected for analysis from the impacted layer and just above and below to further characterize the area. The impacted layer is within the planned excavation depth for the realigned creek, i.e. the creek surface would be below the impacted layer.
- Area A – Marshplain & Transition Zone. North east of the existing gas wells at the west end of Area A (Del Rey 14), a petroleum odor and staining was noted about 10.5 feet bgs (near the planned marsh/transition surface). The odor and staining was limited to about a 1.5 feet thick layer near design grade.
- Area B – Proposed Channel and Marshplain. In borings in the vicinity of the existing gas wells in Area B a petroleum odor and staining was noted between 6-6.5 feet bgs near gas well Del Rey 12 relatively close to design grade. A less significant odor and staining was noted 4-8 feet bgs from within the planned channel alignment through Area B.

Laboratory analysis results will provide more detailed data at these and other sample locations.

These preliminary findings indicate that in some areas within the planned wetland habitat, materials that do not meet the wetland cover standards may be present. In these areas, materials that are not suitable for wetland cover will likely be over excavated and replaced with soil selected to be appropriate for a wetland. Another measure under consideration is application of soil amendment to improve soil chemistry.

Based on this limited data, the project may anticipate over-excavation and replacement of up to 50,000 to 100,000 cubic yards (CY) of material.

2.2.3 Wetlands and Uplands Suitability (Agronomy)

In conjunction with the chemical and geotechnical sampling, sediment samples are also being analyzed for general agronomic characteristics. The ability for plants to establish rapidly is associated with the soil chemistry. Since the excavated finished grades are well below the existing ground surface in Area A, the chemistry may not be conducive to plant establishment.

Agronomy tests include analyses for soluble and exchangeable major nutrients, boron, USDA texture, organic matter, micronutrients, and neutralization/acid generation potential. These analyses are intended to identify general soil parameters that may impede the establishment of marsh and upland transition vegetation at the site or other factors that may impact the evolution of the site to support a healthy mosaic of vegetated habitat. These tests will inform decisions on the need to identify select materials from the project site for use as “top soil” or the potential need to augment the post-construction surface soils to address nutrient or organic matter deficiencies.

2.3 NEW PERMETER LEVEES

A primary project element includes replacing the existing Ballona Creek levees with new engineered flood control levees set back from Ballona Creek. The proposed levees will be engineered to meet or exceed current flood control standards.

The proposed flood control levees are shown on the levee plan presented on Figure 6.

2.3.1 Levee Crest Elevations

The H&H Report has performed hydraulic modeling to estimate water surface elevations along the project site for a number of flood events including the design flow rate for Lower Ballona Creek (46,000 cfs) cited in the LA District Corps maintenance manual (USACE 1999) with a variety of tail water conditions including the LA County design tail water of 7.6-feet NAVD. Hydraulic modeling has been performed for the existing channel conditions (based on recent survey by PSOMAS) and for the preliminary grading plans presented in Figures 3, 5a - 5c respectively. The hydraulic modeling approach, methods, and results are presented in detail in the H&H Report.

Existing conditions model results are presented below in Table 2. Table 2 provides the estimated freeboard at a number of locations along the project site. Freeboard for existing conditions along Area A/North Area B ranges from 5.01 to 6.46 feet and averages 5.85 feet. Along the West Area B reach, freeboard ranges from 3.08 to 3.84 and averages 3.49. Freeboard was also estimated for the existing channel configuration for the Year 2100 sea level rise scenario with the downstream tailwater increased to account for 4.6 feet of sea level rise. Accounting for sea level rise, freeboard dropped to an average of 2.62 feet along Area A and -0.45 feet along West Area B (indicating that the levees would over top for the design event).

One design objective for the new proposed flood control levees is to provide a similar level of freeboard for the design flood event both with current tail water elevations and with tail water elevation adjusted for predicted sea level rise by year 2100 based on Coastal Conservancy Policy and USACE guidance (7.6 feet NAVD + 4.9 feet of sea level rise).

Proposed conditions model results for estimated freeboard are also presented in Table 2. Note that these results are from the H&H Report and a prior iteration of the design as described in Section 1.2. At the preliminary design level, the perimeter levees have been designed with a constant levee crest of EL 20.5 feet NAVD. The hydraulic modeling was run against the current design tail water elevation for both the Interim Project design scenario with West Area B remaining as managed marsh habitat and with the Full Restoration scenario after West Area B becomes fully tidal. Along Area A/North Area B, the Interim Project (conditions similar to Option A), provides between 6.01 and 7.88 feet of freeboard with an average of 6.36 feet of freeboard (about a 0.3 feet increase over existing conditions). Along West Area B, freeboard ranges from a low 7.97 feet to 10.7 feet in West Area B and averages 9.76 feet along the reach. Under the Full Project scenario, freeboard increases to an average of 6.79 along Area A/North Area B and 9.37 along West Area B. For the Year 2100 sea level rise scenario, the proposed project increases freeboard to an average of 4.06 feet along Area A/ North Area B and 5.51 feet along West Area B.

For West Area B, model results show significant increases in freeboard for the Left Bank under project conditions, reflecting the increased levee heights proposed for West Area B. Through most of this reach, however, the Right Bank consists of the existing levee/jetty that is not shown as being modified under the preliminary project design. Elevated water levels in the vicinity of Area B under project conditions reduce the amount of freeboard provided by the existing levee/jetty along the Right Bank by up to one foot. The majority of the Right Bank is formed by the jetty that separates Ballona Creek from the Marina Del Rey and a reduction in freeboard along the jetty may not represent a significant increase in flood risk. However, as discussed in Section 2.3.2.1, there is a section of the existing levee between the upstream end of the jetty and the downstream end of the new proposed North Area A levee that may need to be raised in order to maintain or improve the existing level of flood protection.

Based on the preliminary H&H Report, estimated freeboard increases at the downstream project limits (with the exception noted in the preceding paragraph). During later design phases, following a full risk and uncertainty analysis, the levee heights may be refined and lowered to provide adequate freeboard to meet the requirements of the US Army Corps of Engineers, LA County, and FEMA for the Year 2100 sea level rise tail water levels.

Table 2 Freeboard for Existing Conditions and Proposed Project

Design Flood (46,000cfs)	Area A/B North (RS 6079 to 10019) Left Bank Reach Average	Area A/B North Left Bank Maximum	Area A/B North Left Bank Minimum	Area A/B North Right Bank Reach Average	Area A/B North Right Bank Maximum	Area A/B North Right Bank Minimum	West Area B (RS 3055 to 5853) Left Bank Reach Average	West Area B Left Bank Maximum	West Area B Left Bank Minimum	West Area B Right Bank Reach Average	West Area B Right Bank Maximum	West Area B Right Bank Minimum
Existing Conditions[1]	6.22	6.68	5.35	5.70	6.27	5.01	3.63	3.84	3.48	4.94	6.43	4.11
Existing Conditions w/ SLR[12]	3.17	4.10	1.71	2.65	3.33	1.37	-0.34	0.19	-0.76	0.97	2.78	-0.22
Interim Project[3]	6.32	7.88	5.97	6.38	7.88	6.01	3.63	3.84	3.48	5.99	9.35	3.91
Full Project[4]	6.76	8.47	6.33	6.70	7.97	5.95	9.15	10.60	8.65	5.11	8.70	3.01
Full Project w/ SLR[2,4]	4.02	4.90	3.81	3.97	4.64	3.33	5.28	6.73	4.95	1.24	5.00	-0.76

Freeboard (ft)

[1] Existing conditions freeboard is the difference between the predicted water surface and the existing levee elevation based on 2012 surveys.

[2] SLR = Sea level rise of 59 inches.

[3] Interim project conditions freeboard along Area A/B North is the difference between the predicted water surface and a flat levee crest of EL 20.5 ft NAVD included for the preliminary design for the proposed levees. Along West Area B,interim project conditions freeboard is the difference between the predicted water surface and the 2012 surveyed elevation of existing levees to remain in the interim phase..

[4] Full project conditions freeboard is the difference between a flat levee crest of EL 20.5 ft NAVD and the predicted water surface, except for the right bank along West Area B where the existing levee elevation was assumed for preliminary design analyses (see discussion in Section 2.3.2.1).

2.3.2 Levee Design Sections and Construction

Preliminary levee design sections for the proposed new flood control levees are provided on Figures 6A and 6B. In general, the proposed levee designs include a compacted core constructed of low permeability material with a wide flat slope along the Ballona Creek channel side of the levees that would serve as a stability berm. The preliminary design for the compacted core incorporates 2H:1V slopes on the dry side and flatter 3H:1V slopes on the creek side. Subgrade preparation varies based on location and material, and is described for each levee reach below.

On the creek side, the outboard stability berms are shown with flat 10H:1V slopes. These slopes are intended to support vegetated habitat including low high marsh plantings and upland transitional plantings. The slopes would provide a wide flat bench to dissipate wind-waves and to protect the levee core from erosion. As the design progresses, the idealized 10H:1V slope will be refined to provide a more complex shoreline. At the western margins of the site, these slopes may incorporate sandy dune features to support sand dune habitat. Along the eastern, upstream reaches, the slopes would be graded to provide more of an undulating shoreline with variation in both steepness and elevation.

Armoring of the new flood control levees would vary, as described below, incorporating rock (or concrete) on the levee face in areas of high velocity and erosion potential, to buried rock or soil cement in areas of moderate erosion potential, to vegetation in areas where the levees are separated from the creek channel by hundreds of feet with very gradual slopes.

The new perimeter levees would also support an access road that will serve as access for LA County inspections and maintenance and provide public pedestrian and bicycle paths.

General geotechnical recommendations provided in the Preliminary Geotechnical Design Summary, include:

- Subgrade preparation including removal of vegetation and soft unsuitable materials, over-excavation, and compaction.
- Over-excavation and removal of abandoned utility lines.
- Removal of any standing water from the excavated subgrade, back fill and compaction to at least 90%.
- Construction of levees slowly with fill placement in thin layers, moisture conditioned, and compacted with total compacted lift thickness of no more than 6-inches.
- Slow construction in lifts will tend to reduce post construction settlement. As the preliminary design moves toward final design, the project will consider post construction settlement and adjust design height as needed to account for anticipated settlement.
- Lifts shall be placed along the entire length of the levee prior to placement of the following lift.
- Compaction testing for every 500 cubic yards of fill or two feet of thickness.

Specific features for the each levee reach are described below.

2.3.2.1 North Area A Levee

The preliminary plan layout for the North Area A levee is shown on Figure 6 and a typical preliminary levee design section is presented in Figure 6A. The proposed North Area A levee would tie into the existing Ballona Creek levee at Culver Boulevard at the upstream limit of the marsh restoration area. The proposed levee would follow the perimeter of Area A with a minimum 30 feet offset from Fiji Way and Lincoln Boulevard and set just south of the Fiji channel. The proposed levee will be offset 20 feet to maintain the existing parking lots along Fiji Way and to avoid existing natural gas monitoring well, Del Rey 17.

The Preliminary Design and grading plans show the downstream end of the new North Area A levee tying into the existing levee at the west end of Area A. Preliminary hydraulic modeling shows about a 1' increase in the design flood water surface profile downstream of this location, and an equivalent reduction in freeboard for the existing north levee/jetty downstream of Area A (i.e., along West Area B; see the H&H Report, Section 3.3). The design will therefore consider extending the North Area A levee downstream along a section of the existing north levee/jetty (i.e., raising a section of the existing north levee/jetty downstream of Area A) as needed to maintain or improve the level of flood protection for development at the end of Fiji Way.

In Area A the new proposed flood control levee is generally located 800 to 1200 feet from the realigned Ballona Creek channel. The levee incorporates an idealized 10H:1V slope from the EL 20.5 feet crest down to EL 11.0 feet. Below EL 11.0 feet, the levee gradually slopes down to the Area A tidal wetlands basins at EL 5.0 with a gradually varying flat transitional slope from 40:1 to 150:1. This wide flat slope will support dense wetland and transitional vegetation which is will protect the levee core from higher velocity flows in the main Ballona Creek channel.

Area A is comprised of 15 to 25 feet of loosely consolidated dredge material from the excavation of Marina del Rey above historic Ballona marsh soils. Given the unconsolidated existing materials, subgrade preparation will be particularly important in Area A. Subgrade preparation in Area A is anticipated to include:

- Removal of existing vegetation and over-excavation to a depth of 4 feet below grade.
- Along the levee core, over-excavation may be extended down to 6 feet below grade to provide a keyway.

Hard rock or soil cement armoring is not planned for most of the Area A perimeter levee due to the wide flat slopes and tidal wetland basins between levee and creek channel.

2.3.2.2 Culver Levee

Plan view layout of the Culver levee is shown on Figure 6 and design sections are presented on Figure 6A and 6B. The Culver Levee extends from the south end of the Culver Boulevard Bridge where it ties in to the existing Ballona Creek levee along Culver Boulevard to West Area B.
The Culver Levee included three distinct design sections:

- A wide plateau at the upstream limit between Culver Boulevard and the old railroad alignment. This wide section is intended to vary the widening of the restored Ballona Creek floodplain to help even out the hydraulic drop of flood levels as flood flows enter the Ballona Wetlands Restoration Project site.
- A narrow section (20 feet top width) along Culver Boulevard to the intersection with Jefferson Boulevard.
- A wide section (100 feet top width) along Culver Boulevard from Jefferson Boulevard to West Area B.

The levee core would be located adjacent to Culver Boulevard, and the wider sections would support vegetated habitat closer to Ballona Creek. Beyond the levee top, each section incorporates a flat idealized 10H:1V slope down to EL 6.5 ft with a flatter 20H:1V transitional slope to the adjacent tidal marsh plain.

In Area B, the subgrade is generally comprised of historic marsh soils, which are relatively close to groundwater. Preliminary plans for subgrade preparation for the Culver Levee incorporate:

- Removal of existing vegetation and over-excavation to a depth of 2 feet below grade.
- Along the levee core, over-excavation may be extended down to 4 feet below grade to provide a keyway.

Armoring including either buried rock or soil cement would be utilized along the Plateau and Narrow sections of the levee where the levee is within (200 to 800 feet of Ballona Creek. Armoring is not planed in the Wide section where the levee core would be separated from Ballona creek by at least 80 feet of vegetated high ground.

2.3.2.3 West Area B Levee

The preliminary layout for the West Area B Levee is shown on Figure 6 and a typical design section is shown on Figure 6B. The alignment of the West Area B Levee has been updated from the previous conceptual design. First, the levee has been shifted north to avoid existing natural gas monitoring well Vidor 18. Second, after considering a number of potential alignments along the western limits of the project site, the levee was shifted to the east through the existing marsh. The considered alignments and the analysis for each alignment described in detail in the levee alignment memorandum included in Appendix D-1.

Along the west end of the project site, the conceptual alignment included use of existing high ground to provide flood protection. While this high ground was at an adequate elevation, the area is comprised of a former sand dune which introduced and number of concerns related to flood protection:

- A former sand dune would be subject to liquefaction limiting seismic stability.
- The sand dune would permit seepage, potentially impacting adjacent properties.
- Installing a cutoff wall to address seepage impacts could cause vibration impacts to adjacent properties.
- The sand dune could be subject to erosion, potentially leading slope stability impacts.

- Use of the dune would limit the ability of the County to traverse the length of the levee for inspection and maintenance.
- Placing an engineered levee/access road along the dune to provide for County access, could lead to impacts to adjacent properties due to excavation, fill and compaction activities causing differential settlement at adjacent properties on sand subsoils.
- Also an engineered levee/ access road would impact adjacent high-value dune habitat to the east.

To address these concerns, the levee was realigned to the east of the existing high-value dune habitat along the western edge of the managed marsh habitat in West Area B.

The West Area B levee includes an idealized 3H:1V slope along the existing dunes to the west and a 10H:1V slope down to the existing managed marsh to the east. Along the existing dunes, the project plans to create additional dune habitat along the levee shoulder. Along the wetland side of the levee, the transitional slope would vary to create a natural undulating shoreline. An artist's rendering of the West Area B levee is provided in Figure 6C and the design section showing the topographic variation is presented in Figure 6B.

Similar to the Culver levee, the West Area B levee will be constructed on historic marsh soils with high groundwater. In addition the West Area B levee will cross existing channels in several locations. Subgrade preparation is anticipated to include:

- Removal of existing vegetation and over-excavation to a depth of 2 feet below grade.
- Along the levee core, over-excavation may be extended down to 2 to 4 feet below grade to provide a keyway.
- At channel crossings, the channels will be blocked on either side of the levee core and dewatered. Loose, unsuitable material will be over excavated and the channel area will be rebuilt with compacted fill.

West Area B will be primarily a backwater area during flood events, and erosion potential is expected to be limited along most of the levee reach. Therefore, we anticipate that armoring will be limited to the downstream most reach of the levee. We expect to use rock facing at the tie-in to the existing Ballona Creek South levee transitioning to buried soil cement or rock protection of the levee core along the downstream most reach of the levee.

2.3.2.4 Temporary Area B Levee

The project will be phased with full restoration of West Area B delayed for a number of years until the restoration in Area A demonstrates success. During this interim period, a temporary levee will connect the Culver Levee to the existing Ballona Creek South Levee just north of the existing natural gas monitoring well cluster in West Area B. This temporary levee is shown on the levee plan in Figure 6 and in section on Figure 6B. This temporary levee is constructed with steeper 5H:1V side slopes on the Ballona Creek side. Subgrade preparation will be similar to the Culver and West Area B levees discussed above.

The Temporary Levee will incorporate buried rock or soil cement armoring along much of its length. Rock facing is planned at the tie in with the South Ballona Creek levee, the project anticipating using.

2.3.3 Armoring

Armoring of the existing side slopes of the Ballona Creek consists of two types, concrete and rock. However, the new flood control levees will be set back away from the Ballona Creek channel. The additional flow capacity provided by the setback levees and the resulting reduction in flow velocities and shear stresses provide opportunities to utilize alternative measures for levee protection.

With the primary intent of the project being to create and restore habitat, it is the intent to keep the use of traditional armor, and especially concrete, to a minimum. Where flow velocities and scouring potential allow, we plan to use vegetation to armor the levees. Where additional risk is identified, the priority for levee armoring is a levee core consisting of compacted and stabilized soil with a protective cladding of either rock or soil cement, covered by less compacted soils that allow planting and habitat establishment. The typical levee cross-sections for Area B presented on Figures 6A and 6B illustrates this approach. Along Area A, where the perimeter levee is set back from Ballona Creek by 800 to 1200 feet, the preferred armoring method would be to rely upon vegetation established on the flat, vegetated transitional slopes (100:1 sloping up to 40:1 and 10:1). Where higher flows do occur and scour potential is increased, we propose a rock cladding. This cladding will be designed to allow limited vegetation intrusion, similar to the rock facing currently in the channel. And finally, at existing and proposed bridge locations, we will propose soil cement where applicable and concrete surfacing where required.

Figure 6D shows the relative risk of erosion based on velocities predicted by hydraulics models for the 100-year return period flowrate (please see the H&H Report). There are four (4) levels of erosion risk, as follows:

- Level 1: Level 1 is the highest level of erosion risk. These areas are the most likely to include surface rock revetment or possibly concrete channel lining.
- Level 2: Level 2 areas have reduced erosion likelihood due to lower predicted velocities. However, the velocities are high enough to pose some erosion risk and the consequences of erosion are relatively high. For example, the levee along Culver Boulevard is included primarily because erosion impacting levee integrity may affect the roadway. In these areas, buried armoring consisting of soil cement or rock revetment are considered most likely.
- Level 3: Level 3 areas include erosion potential but the consequences of erosion are considered low. For example, erosion of the north bank of the new Ballona Channel during a high flow event would be a manifestation of natural processes in the restoration area, and could provide ecological benefit with no damage to infrastructure.
- Level 4: All other areas not marked are either outside the project or the erosion potential and the damage risk due to the project are low. In the low risk areas within the project limits, vegetation and possibly turf reinforcement (where needed) would be used.

Further analysis is required to refine the need for armoring, and its design. Discussions with the Los Angeles County and US Army Corps of Engineers will inform the selected armoring approaches and locations, including the use of vegetation. A more detailed discussion is included in Appendix D-2. Please see the H&H Report for descriptions of predicted hydraulics.

2.3.4 Existing Levee Improvements

For those portions of Areas A and B where new levees will join the existing levees, ground improvements will be constructed for the transition of the new proposed levees and the existing levees per the Preliminary Geotechnical Design Summary (Appendix B). The transitional distance for the ground improvements will be based on the mitigation of loads imposed by the new proposed levees upon the existing levees.

2.3.4.1 Levee Tie-Ins

Levee tie-ins refer to the locations where new levees abut existing levees, and construction activity is included in the preliminary design to develop an integrated and seamless flood control system. Tie-ins are located at the upstream and downstream limits of the Area A Levee, at the upstream limit of the Culver Levee and at the downstream limits of the West Area B and Interim Levees. In areas where the existing Ballona Creek levees will remain long term the project geotechnical engineer provisionally recommends implementation of ground improvements, such as deep soil mixing, to increase seismic stability and to reduce seismic deformations. The extent of ground improvement will be revisited during final design following analysis of the results of the geotechnical investigation.

In addition, the existing levee crest elevations would be raised in areas at the tie in locations..

2.3.4.2 Ballona Creek Levees – Area A & B

During construction in Area A and Area B, the project will maintain a minimum 70 feet wide offset for excavations adjacent existing levees to maintain an adequate static Factor Safety during a design flood event during construction. The offset will provide a stability berm against the existing levees. Excavation within the offset would only occur immediately prior to breaching.

2.3.4.3 Ballona Creek Levee - Area C and between Jefferson and Culver

In the conceptual design, two areas of fill are conceptually located adjacent to existing levees. In Area C, the South Area C Fill Mound is located adjacent to the existing North Ballona Creek Levee. In Area B, the fill mound between Jefferson and Culver Boulevards is located adjacent to the Ballona Creek South Levee.

The project is currently considering two potential approaches for these reaches of the existing levees:

1. Perform ground improvements along the full length of the levees as described above for the levee tie-ins.
2. Construct new engineered flood control levees behind the existing Ballona Creek levees. The new flood control levees would be tied into the existing Ballona Creek levees at the upstream and downstream limits. The existing levees would undergo ground improvements and raised as needed at the tie-ins. This approach offers some distinct advantages:

- The planned fill mounds are already above flood elevations with the required freeboard and may include a levee core within the design section.
- Incorporating a new levee core into the planned fill mounds limits the need for costly ground improvements along long reaches of existing levee adjacent to the planned fill mounds.
- Replacing the existing levees provides additional opportunities for restoration adjacent to Ballona Creek and increases flood conveyance.
- Opening the Ballona Creek section upstream of the currently planned restoration reach may help even out drops in the flood water surface profile between Centinela Avenue and Lincoln Boulevard.

2.4 BALLONA CREEK REALIGNMENT

The realigned Ballona Creek Channel is presented in Figure 7 and channel sections are presented in Figures 7A and 7B. A fully-connected Ballona Creek channel and wetland system would be restored across the site, beginning west of the Culver Bridge and extending through the site to the southwest (downstream) project boundary. The existing levees would be removed, and a more sinuous channel with two meander bends would be created through the site. The existing Ballona Creek channel would be filled between the meanders. The proposed channel alignment is designed to mimic natural channel forms and support the desired habitat, vegetation, and wildlife species. The channel alignment is also intended to avoid cultural resource areas identified by Tongva tribal representatives; however, actual locations of any cultural resources are not known.

Once constructed, the earthen channel would not be confined to a rigid alignment. Some gradual channel migration and localized erosion and sedimentation would occur. The overall channel location would be guided by the sloping restored marshplain and adjacent upland habitats. The channel alignment would only be fixed where required to protect adjacent infrastructure. In these locations, the restoration proposes some setback bank armoring (e.g. buried rock protection; see Section 2.4.3). The restored Ballona Creek banks and floodplain would experience periodic erosion and deposition, which are typical for natural river and estuary environments. The goal is to accommodate and support this level of channel and floodplain dynamics, while protecting developed areas outside the project boundaries..

2.4.1 Channel Sizing

The realigned channel is generally sized to match the existing channel dimensions, with a top width of approximately 250 feet at MHHW. Channel depths would be similar to existing depths, ranging from about 2 to 8 feet below MLLW (channel bed invert elevation of about EL -2 to -8 ft NAVD). The channel banks would be graded to slopes of approximately 5H:1V (horizontal:vertical) to provide intertidal sediment flats and low marsh habitat. On the inside of each meander bend, the channel bank has a flatter slope to create a channel bar or bench typical of natural river systems to add to habitat complexity. The bench extends at a 20H:1V slope from EL 4.5 ft. to EL 0.5 ft. This bench results in a low flow channel that is about 60 feet narrower (at EL 0.5 ft) than the existing channel. ESA PWA identified the San Elijo Lagoon/Escondido Creek channel in Del Mar, CA as a reference site for the channel design and cross-section. Additional reference data and channel cross-section refinements will be considered in subsequent design phases.

ESA PWA analyzed potential equilibrium channel dimensions for typical fluvial and tidal flows using empirical hydraulic geometry relationships (see H&H Report Section 6). This assessment indicates that the existing and proposed channel dimensions are somewhat larger than the predicted equilibrium channel dimensions; however, the predicted equilibrium dimensions assume adequate sediment supply, Ballona Creek is a sediment-supply limited system, and channel dimensions may therefore never fill in to equilibrium dimensions. A smaller channel size closer to equilibrium dimensions may be considered in subsequent design refinement (see H&H Report Section 6).

2.4.2 Sinuosity

The realigned channel sinuosity (ratio of channel length to distance between channel endpoints) is 1.2, which is comparable to the sinuosity of other natural Southern California creek and tidal wetland systems (i.e., natural existing and historic systems).

2.4.3 Armoring

The project anticipates that meanders will be constructed by filling the channel with rock dikes to form the channel crossings and buttress fill placed between them. The dikes would be created with a rock gradation that includes a wide range of sizes to limit migration of sediment between the voids. Between the upstream and downstream rock dikes, the existing channel would be filled with earth to form the channel crossings.

Following construction, the rock dikes would be left in place to help armor the channel meander bends. Larger rock will be placed as an overlay on the rock dikes to armor against high velocity and turbulence induced scour. During final design, the project will determine the height and width of these rock dikes to provide adequate armor at the channel meanders.

2.4.4 Berms and Islands

Berms and islands are included adjacent to the realigned Ballona Creek channel at the top of bank of the channel. These features are intended to mimic the low berms that form adjacent to natural tidal channels as coarser sediment drops out of suspension where overbank flows leave the channel. These features are also intended to divide the main Ballona Creek corridor from adjacent marsh drainage basins to support larger (higher order) tributary tidal channel networks within the marsh (see Section 2.5.3). In addition, these features help guide more frequent flood flows to overbank areas away from the flood control levees and away from the existing straight Ballona Creek alignment.

Islands are larger features located on the inside of the first two meander bends. In the preliminary grading plans, the islands extend up to EL 8.0 ft and would support high marsh and transition zone plants. These islands would provide refuge during high tides and moderate storm flows and provide an area for wildlife away from predators, humans, and pets.

Berms are lower features located along the channel extending up to EL 6.5 ft. The berms help to concentrate flows into the higher order tidal drainage channel networks that convey tidal exchange into the marsh basins adjacent to the larger Ballona Creek channel. The berms would support mid and high marsh plants and provide high tide refuge for wildlife.

2.4.5 Levee Breaching and Lowering

The existing Ballona Creek levee would be lowered to match grades as shown on the grading plans. At locations where the new Ballona Creek alignment crosses the existing levee, the existing levee would be breached to the full width and depth of the planned Ballona Creek section taking into account the oblique angle of the crossing. The existing concrete and rock armoring would be removed. Concrete armor may be recycled for use on site.

2.5 AREA A – TIDAL WETLAND, TRANSITION ZONE, AND UPLAND RESTORATION

The existing elevations in Area A, which range from about EL 10 to 23 ft NAVD, are 5 to 18 ft above present-day wetland elevations due to the placement of dredged material during the construction of Marina del Rey harbor, the Ballona Creek channel, and other facilities. The restoration proposes to excavate and grade Area A to restore marsh, transition zone, and upland habitats as shown in Figure 8. The restoration would create a long gently-sloping transition from upland habitats along the northern perimeter of Area A down to vegetated marsh habitat and mudflat habitat adjacent to the restored Ballona Creek channel. The preliminary design includes two options for treating the gas wells in west Area A for the Interim Build Out. Option A (Figure 5A) will be implemented if the gas wells are not removed prior to the Interim Build Out. In Option A, the gas wells will remain and be protected in place and the area around the wells will not be excavated. In Option B (Figures 5B), the wells will be removed and the area around the wells will be excavated to create restored wetland, transition zone, and upland habitat. In the Full Build Out (Figure 5C), the Area A wells will be removed as in Option B. Preliminary design sections for the Full Build Out are presented in Figure 8A.

The broad transitional slopes between wetland and upland habitats are intended to increase the resiliency of the restored wetlands to future sea-level rise. These gradual slopes would allow wetland habitats to transgress up slope with rising sea levels through the conversion of upland transition habitats to wetland habitats. This process of “coastal rollover” has occurred over geologic time, and is expected to continue and accelerate with projected sea level rise. The H&H Report (Section 6) includes an assessment and figures showing estimated habitat projections for future sea-level rise scenarios.

Table 3 lists habitat elevations used for the Preliminary Design of restored habitats in Area A and B.

Table 3 Habitat elevations.

Habitat elevations		Elevation		
Bottom of:	**Top of:**	**ft MLLW**	**ft NAVD**	**Note**
Upland	Transition Zone	9.8	9.6	9.8 ft MLLW per Zedler (2001)
Transition Zone	High Marsh	7.5	7.3	7.5 ft MLLW per Zedler (2001), 0.3 ft below highest observed tide level
High Marsh	Mid Marsh	6.5	6.3	1 ft abve MHHW, consistent with San Dieguito / Josselyn and Whelchel (1999); exceeded by spring tides
Mid Marsh	Low Marsh	4.8	4.6	MHW, similar to (0.2 ft lower than) San Dieguito / Josselyn and Whelchel (1999)
Low Marsh	Mudflat	3.8	3.6	1 ft above MTL, similar to San Dieguito / Josselyn and Whelchel (1999)
Mudflat	Subtidal - Small Subtidal Channel	0.0	-0.2	MLLW
Subtidal - Small Subtidal Channel	Subtital - Large Subtidal Channel	-2.8	-3.0	

2.5.1 Tidal Marsh

Preliminary grading plans for the Area A tidal marsh are presented on Figure 8 and design sections are presented on Figure 8A. The Area A restored tidal marshplain will range in elevation from low marsh (EL 4.5 ft NAVD) at the channel bank up to high marsh (EL 7.3 ft NAVD) at the upland transition zone (see habitat elevations in Table 3). Marshplain slopes will range from about 100H:1V to 150H:1V.

The marshplain will be graded to slope and drain towards two networks of tributary tidal channels (see Section 2.7.1) extending from the outside of the Area A channel meander bend. This grading will form two marsh "drainage basins," one in east Area A and one in west Area A. These marsh drainage basins will encourage the restoration of larger (higher order) tidal channel systems and associated habitat complexity. The eastern marsh channel basin is also intended to convey Ballona Creek overbank flows during storm events.

WRA's CHRAMP (Comprehensive Habitat Restoration and Adaptive Management Plan) describes the tidal marsh revegetation plan. For the purposes of this PDR, we assume the following tidal marsh revegetation approach:

- Introduction of cordgrass to establish low marsh vegetation.
- Rely on natural recruitment of pickleweed and other salt marsh vegetation in mid marsh areas between El 4.5 ft and EL 6.3 to 6.5 ft NAVD.
- Planting of pickleweed and other salt marsh vegetation in high marsh areas between EL 6.3 to 6.5 ft NAVD and EL 7.3 ft NAVD since natural recruitment in this high marsh zone is expected to take many years.

2.5.2 Salt Pans

Salt pans will be created by excavating by excavating 0.5 to 1 foot depressions around the perimeter of Area A tidal marsh that are intended to allow infrequent tidal inundation during spring high tides, shallow ponding, evaporation, high soil salinity (e.g., salt crust formation), and decreased vegetation establishment. Salt pan habitat will be created along the edge of the high marsh and transition zone habitats in wider high marsh areas between channels (Figures 4, 5A - 5C; note salt pans are not currently show on grading plans). Salt pan depressions will be over-excavated by 1 to 2 feet and back-filled with compacted clay material to encourage ponding. Sill elevations will be between EL 5.5 and 6.5 ft NAVD to provide the appropriate frequency of tidal inundation.

With future sea-level rise, salt pans are expected to eventually become vegetated marsh as they are increasingly inundated. Restored seasonal wetlands (Section 2.5.4) are intended to provide future salt pan habitat with sea-level rise.

2.5.3 Transition Zone and Upland

Preliminary grading plans for the Area A transitional Zone and Upland are presented on Figure 8 and design sections are presented on Figure 8A. Transition zone and upland habitats will be restored around the perimeter of Area A. This wetland-upland transition zone is intended to provide ecotone habitat and provide areas for marsh transgression with projected future sea-level rise. Undulating transition and upland habitat areas will be graded, with shallower slopes of 80H:1V to 100H:1V forming peninsulas and steeper slopes of up to 40H:1V forming coves. The flatter peninsulas will provide areas for salt pans and the coves will provide tidal marsh drainage areas for smaller tidal channels. Higher upland mounds (shown as idealized land forms at EL 20 feet in Figures 5A - 5C) will provide irregular upland topography and the opportunity to restore dune habitat.

Transition zone habitats will be between EL 7.3 to 9.6 ft NAVD and upland habitats will be above El 9.6 ft NAVD per Table 3. WRA's CHRAMP describes the transition zone and upland revegetation plan. For the purposes of this PDR, we assume these areas will be planted and irrigated/maintained as appropriate.

2.5.4 Seasonal Wetlands

Seasonal wetlands will be created by excavating by excavating 0.5 to 1 foot depressions in upland areas around the perimeter of Area A that are intended to capture and pond runoff from upland areas. Seasonal wetlands may be created in marsh/upland coves as shown in Figures 4, 5A - 5C (note seasonal wetlands are not currently show on grading plans). Seasonal wetland depressions will be over-excavated by 1 to 2 feet and back-filled with compacted select material to encourage ponding. Seasonal wetland sill elevations will be between EL 7.0 and 8.0 ft NAVD. The design will include a variety of seasonal wetland depths and sill elevations to provide a range of hydrology (e.g., as in the Hamilton Army Airfield Wetland Restoration design by PWA (Dec 2008))

With future sea-level rise, seasonal wetlands are expected to eventually become tidally inundated. The seasonal wetlands are intended to provide future salt pan habitat with sea-level rise.

2.6 AREA B – TIDAL WETLAND, TRANSITION ZONE, AND UPLAND RESTORATION

Restoration of Area B includes:

1. North Area B full tidal wetland restoration between the new Culver levee and the realigned Ballona Creek channel (Section 2.6.1)
2. West Area B full tidal wetland restoration of the existing West Area B managed muted marsh in the final phase of the Project (Section 2.6.2)
3. South and East Area B managed wetland restoration inboard (behind) the Culver levee (Section 2.6.3).

2.6.1 North Area B – Tidal Wetland, Transition Zone, and Upland

Preliminary grading plans for the North Area B tidal wetland, transitional zone and upland are presented on Figure 8 and design sections are presented on Figure 8A.

Tidal marsh will be restored between the new Culver Levee and the realigned portion of Ballona Creek in north Area B, with a full tidal connection between the wetlands and Ballona Creek. Existing elevations in north Area B range from about EL 6 to 9 ft NAVD. The higher areas are filled above current marsh habitat elevations. North Area B will be graded to create a marshplain drainage basin between the realigned channel and the new levee, with elevations from 4.5' NAVD to 6.5' NAVD. The marshplain basin would slope towards a tidal channel system that drains downstream to the outside bend of the Area B channel meander. The marshplain basin and channel system are also intended to convey Ballona Creek overbank flows during storm events. A gently sloping transition zone and upland habitats will be created between the marshplain and the new levee, which may include dunes and a small upland peninsula at the curve in the Culver Levee as shown in Figures 4, 5A - 5C.

2.6.2 West Area B – Tidal Wetland, Transition Zone, and Upland

In the Interim Phase of the Project (after Phase 1 and 2; see Section 1.6), the majority of the existing managed marsh in West Area B will be maintained and managed as is. In the final phase of the Project, West Area B will be restored to full tidal wetland by removing the existing tide gate, creating an open tidal channel by breaching the existing Ballona Creek levee, and removing/ lowering the Ballona Creek levee. Implementation of the final phase will proceed within an adaptive management plan (see WRA's CHRAMP). A component of the adaptive management plan is to successfully restore habitats in other areas of the site in Interim Phase to minimize potential impacts of West Area B full tidal restoration.

2.6.2.1 Interim Phase

A new levee will be constructed between the Culver levee and the existing West Area B levee to protect West Area B during the Interim Phase. This levee section will be removed for the Full Build Out and is therefore referred to as a temporary Interim Levee.

The new West Area B perimeter levee will be constructed in the Interim Phase in anticipation of the final phase of the project below (see Section 2.3.2.3). Transition zone and upland habitats will be restored on a gently-graded undulating slope (approximately 10 to 20H:1V) between the existing managed wetlands and new levee. These restored habitats may include dunes and shallow depressions to function as small salt pans under full tidal conditions in the Final Phase of the Project (as shown in Figures 4 and 5C).

2.6.2.2 Final Phase

In the Final Phase of the Project or Full Build Out, West Area B will be restored to full tidal wetland by removing the existing tide gate, creating an open tidal channel by breaching the existing Ballona Creek levee, lowering the Ballona Creek levee, and removing a portion of the Interim levee. The open tidal channel would provide a full range of tides and creek water levels in west Area B. The existing levee would be lowered to about EL 5 ft NAVD to restore mid marsh habitat. The existing system of channels in the managed marsh may be enhanced by excavating new channels as shown in Figure 9. The preliminary design for the levee breach and tidal channels is discussed in Section 2.7.

The Interim levee will be dismantled, with the material moved to create the upland West Habitat Peninsula, roughly in the same location. This action would take place after the Gas Company's wells are decommissioned (see discussion in Section 2.10.1). If the gas wells are not removed prior to the Full Build Out, the Interim Levee will be reconfigured and extended around the gas wells to provide flood protection, and a stormwater drainage culvert will be installed in the levee to maintain storm drainage for the gas well area enclosed by the levees.

The upland habitat peninsula as shown in Figures 4, 5A - 5C is intended to:

1. Provide larger areas of upland habitat and high tide refuge for wildlife along the south side of the channel.
2. Guide and re-converge Ballona Creek storm flows though the realigned Ballona Creek channel back into the existing channel alignment downstream in the Final Phase.
3. Beneficially re-use soil excavated to restore wetlands in Area A in the Interim Phase.

The West Area B managed marsh is at elevations that are expected to support mudflat, low marsh and mid marsh habitat after full tidal restoration. These areas will therefore remain at existing grade (without grading to raise or lower the marshplain). A large portion of the existing pickleweed vegetation in this area is at elevations that would support mudflat and low marsh under full tidal conditions. The pickleweed is not expected to persist at low marsh elevations; however, mid marsh channel berms may be created when tidal channels are excavated as described in Section 2.7.

WRA's CHRAMP includes a revegetation plan. For the purposes of this PDR, we assume that cordgrass will be introduced to West Area B to establish vegetated low marsh habitat. In the absence of cordgrass, West Area B is expected to convert to mudflat habitat over time.

2.6.3 South and East Area B – Managed Wetland Restoration and Enhancement

Inboard or behind the new Culver Levee, the following wetland areas will be restored:

1. South Area B: the existing muted tidal managed wetland south of Culver Blvd. and west of the Gas Company road (referred to as South Area B) would be retained and enhanced by restoring tidal channels.
2. East Area B: the existing non-tidal pickleweed seasonal wetland south of Jefferson Blvd. and east of the Gas Company road (East Area B) would be restored to managed tidal wetland by providing a new tidal connection and excavation of tidal channels.

The existing areas of pickleweed and other mid marsh plants in South and East Area B are at the appropriate tidal elevation to persist as mid marsh habitat after restoration. In South and East Area B, sinuous and branching tidal channel networks will be excavated through the marsh habitats (see Section 2.7.3 and 2.7.4). These tidal channel systems would connect to the restored Ballona Creek channel to create tributary tidal channel networks.

Water levels in the South and East Area B managed wetlands will be controlled by two new water control structures at the locations shown in Figures 5A - 5C (see Section 2.8.1 for more details). The water control structures will provide tidal inundation up to an elevation acceptable for flood management and storm drainage, but will close during larger storm events in Ballona Creek to limit high water levels in South and East Area B (see Section 1.2). The managed wetlands and water control structures will be designed to protect Culver Blvd., the Gas Company facilities, and areas draining to the FWM from flooding during the design storm event (LA County capital flood). Note that the FWM was designed to overflow into East, South, West, and North Area B. The FWM was designed assuming managed tidal wetland restoration in Area B, with an average managed high tide level near mean higher high water (EL 5.2 ft NAVD, Psomas 1999). In this scenario, Psomas (1999) showed that Culver Blvd. and the Gas Company would not be flooded in the design storm event.

The existing levee between the FWM and East Area B is above the elevation of normal ocean high tides and would be maintained as is.

In subsequent phases of the design, South and East Area B flood scenarios and water levels will be analyzed. Appendix H includes calculated rainfall-runoff hydrology for areas draining to East and South Area B. Hydraulic analyses will be performed to design the South and East Area B water control structures and assess water levels for flood conditions.

If needed, a berm may be constructed in East Area B between Culver Blvd. and the managed wetlands to protect the low point in Culver Blvd. from flooding. Additional berms may be constructed around the perimeter of East and South Area B to protect Gas Company facilities if needed. These berms are not currently included in the preliminary grading plans.

The design will consider and allow for South and East Area B wetland management options, which may include:

- Muted managed tidal inundation

- Brackish marsh management, primarily in East Area B, supported by freshwater discharge from the FWM
- Seasonally-closed wetland habitat similar to historic 1850s wetland habitats at Ballona, in which the water control structures would be closed to limit tidal circulation and create ponded/evaporative conditions
- Salt pan habitat creation
- Future management options with projected sea-level rise.

These management options will be assessed further in subsequent phases and the South and East Area B water control structure and tidal channel designs will be refined to accommodate the preferred set of management options. Water control structures, including the FWM structures, are discussed in Section 2.8. Tidal channels are discussed in Section 2.7.

2.7 TIDAL CHANNELS

Networks of branching, sinuous tidal channels will be excavated in the restored wetlands. The tidal channel networks will extend from and drain to Ballona Creek. The purpose of the tidal channels is to convey tidal flows and sediment to the restored wetlands, providing tidal circulation (inundation and drainage) to support wetland vegetation and functions.

The tidal channel planform layout (e.g., channel length per marsh area and sinuosity) and sizing (cross-section dimensions) are based on empirical tidal channel layout/sizing data from reference wetlands (tidal channel hydraulic geometry relationships; PWA 1995 and Williams and others 2002). The larger (higher order) tidal channels branch (bifurcate) into smaller (lower order) channels. The largest channel systems are fifth order, meaning the channels branch into smaller channels five times (ending in the smallest or first order channels). The Preliminary Design assumes excavation of the full channel network, including first order channels, because complete tidal channel networks are not expected to form naturally after restoration. The intent is to restore larger (higher order) channel systems to create a greater range of channel habitats and habitat complexity. The larger channel systems are generally laid out to drain to the outside bends of the realigned Ballona Creek channel as in natural wetland systems.

Figure 9 shows the preliminary tidal channel layout by channel order. The smaller channels (second order and the smallest/first order channels) are not shown in Figure 9, except for smaller channels draining directly to Ballona Creek. Tidal channels are not currently shown in the preliminary grading plans. Table 4 lists preliminary tidal channel dimensions by channel order. Area A and B tidal channel networks are discussed in the sections below.

Table 4 Tidal Channel Dimensions by Channel Order.

Channel order	Top width at MHHW (ft)	Bottom width (ft)	Side slope (H:V)	Invert elevation (ft NAVD)	Depth (ft below MHHW)	Depth (ft below MLLW)	Note
5	80	10	5	-1.8	7	1.6	Subtidal
4	35	5	3	0.2	5	-0.4	Subtidal/intertidal
3	20	4	2	1.2	4	-1.4	Intertidal
2	10	4	1	2.2	3	-2.4	Intertidal
1	7	3	1	3.2	2	-3.4	Intertidal

Note: Channels are ordered from smallest (first order) to largest. Two first order channels join to form a second order channel, two second order channels join to form a third order channel, etc.

Within existing marsh areas in West, South, and East Area B, material excavated to construct tidal channels will likely be placed adjacent to the excavated channels (sidecast) to form higher marsh channel berms adjacent to the channels. These berms would be a few feet high, depending on the elevation of the adjacent wetland. This approach creates channel berms and higher marsh habitat that are found in natural marsh systems and provides an efficient method for handling excavated material while limiting impacts to existing marsh areas.

2.7.1 Area A

Two large (fourth order) channel systems will be restored in Area A (see Figures 9, 5A - 5C, and Table 4). These channel systems will connect to the outside of the Area A meander bend and will extend into the Area A marsh areas to the east and west. The ends of the channel systems will drain the marsh coves (see Section 2.5). The east Area A channel system will also convey Ballona Creek overbank storm flows through the restored marsh floodplain and back into Ballona Creek. Channel berms along the realigned Ballona Creek will define the marsh drainage areas and outlets for the Area A tidal channel systems (see Section 2.4.4).

One smaller (second order) channel system will be restored at the west end of Area B as shown in Figures 9, 5A - 5C. This channel may also convey some overbank storm flow.

2.7.2 North Area B

A large (fourth order) channel system will be excavated in the restored marsh area between the realigned Ballona Creek channel and the Culver Levee (see Figures 9, 5A - 5C and Table 4). This channel system is intended to convey overbank storm flows. The Ballona Creek berm at the upstream end of this channel system (along the outside of the first Ballona Creek meander bend) will be armored to reduce the potential for scour and channel avulsion (see Section 2.4.3).

The East Area B tidal channel system (fifth order) will continue through a water control structure (see Section 2.8.1) connected to the North Area B channel system to connect to Ballona Creek. Smaller channels will drain the restored marsh to the west (e.g., first order channels shown in Figures 9, 5A - 5C).

2.7.3 East Area B

The Preliminary Design includes excavation of a large (fifth order) channel system in the East Area B restored managed marsh. This channel system would connect to Ballona Creek through a new water control structure (see Section 2.8.1) and North Area B. The intent of this channel system is to convey tidal flows and provide tidal inundation throughout the managed marsh. Different East Area B management options will be considered and allowed for in the final design (see Section 2.6.3). The East Area B channel design will be refined to accommodate the preferred management options. These refinements may include:

- Extending larger channels to the FWM outflow locations to convey freshwater discharges and encourage brackish marsh development. The FWM outflow structures to East Area B are discussed in Section 2.8.2.
- Excavating fewer channels if consistent with certain management options
- Connecting the East Area B and South Area B channel systems through the water control structure in the Gas Company Road (e.g., a new structure or an improvement of the existing culver; see Section 2.8.3).

Note that the main East Area B tidal channel will cross the existing gas pipeline in this area (see Figure 3). A section of the gas pipeline may be replaced to run under the channel as described in Section 2.10.40. No other channels will be excavated across the pipeline to preserve access to the pipeline from the south and north.

2.7.4 South Area B

The Preliminary Design includes excavation of a large (fifth order) channel system to enhance the South Area B managed marsh. The channel system would connect to West Area B through a new water control structure (see Section 2.8.1). The channel design may be refined to accommodate different marsh management options (see Section 2.7.3 and 2.6.3).

2.7.5 West Area B

The Preliminary Design includes excavation of a large (fifth order) channel system in West Area B in the Final Phase of the Project. The Interim Phase of the Project will likely only include channel excavation to connect the West and South Area B channel systems through the new water control structure. The main channel and levee breach to Ballona Creek will have similar dimensions to the fifth order channel dimensions listed in Table 4.

The West Area B tidal channel design will be refined based on further consideration of restored West Area B low marsh and mudflat habitat conditions and functions. These refinements may include less channel excavation.

2.8 HYDRAULIC STRUCTURES

2.8.1 Culver Levee Water Control Structures

Two new water control structures will be installed in the new Culver Levee and across Culver Boulevard and Jefferson Boulevard:

1. For the South Area B managed wetland enhancement, a bank of culverts with gates will be installed in the new Culver levee and under Culver Blvd. between South and West Area B.
2. For the East Area B managed wetland restoration, a second bank of culverts with gates would be installed in the new Culver Levee and under the intersection of Culver Blvd. and Jefferson Blvd. to restore a tidal connection between east Area B and Ballona Creek.

The proposed water control structure locations are shown in Figures 5A - 5C.

These culverts will be sized as a minimum to convey the 100-year storm events for the local area flows out to Ballona Creek. The size may be increased to allow tidal action. The structures will be box culverts within the roadways as there are utilities that must be crossed that in one case (A City of Los Angeles 230 kV electrical line) would be difficult to relocate. Before and after the roadway, the conduits may be transitioned to a series of pipes to allow installation of traditional flap gates for protection against Ballona Creek flows, and to allow managed tidal circulation. There are three conduits crossings for flows generated from south of Area B. From east to west, the conduits must convey approximately 230 cfs for East Area B, 160 cfs for South Area B, and 180 cfs for the existing Pershing Drain between Jefferson and Culver Blvds. Assuming an available head of 2.0 feet, the flow rates will require conduits with cross sectional areas of approximately 50 s.f., 37 s.f., and 34 s.f. respectively (from east to west). These numbers assume a conduit length of approximately 300' for the east and middle conduits to allow sufficient length to cross the roadway and proposed levee, and 150' to get to the parking lot detention area.

Each of the two banks of culverts with gates in the Culver levee would each consist of multiple culverts and gates (e.g., six 5-feet diameter culverts with gates). The gates will be designed to close or limit inflow during certain storm events in Ballona Creek to limit high water levels in South and East Area B (e.g., self-regulating tide gates or gated culverts that provide only limited inflow and the required outflow capacity). Appendix H includes additional discussion of water control structures.

The existing drainage culvert under the Gas Company Rd. between South and East Area B will be modified (e.g., by expanding the culvert and/or installing gates). The modified culvert will be used to manage the connection between South and East Area B (e.g., for wetland habitat management, stormwater management, and to maintain circulation while other water control structures are maintenanced).

2.8.2 Freshwater Marsh Water Control Structures

The existing FWM is situated at the easterly edge of Area B, south of Jefferson Boulevard. The FWM serves multiple functions including acting as the downstream end of a stormwater conveyance system, providing attenuation of upstream storm flow volume and flow rate, providing water quality treatment of urban inflow, and providing freshwater habitat.

There are a number of key functional elements of the FWM that will be maintained as is or adjusted with the project. These include:

1. Existing habitat areas within the perimeter berm of the FWM will remain undisturbed.
2. The existing overflow weir into the Brackish Marsh area will be maintained as is relative to location. A design feature of the overflow weir is the ability to adjust the overflow elevation. The overflow weir will be modified to raise the overtopping elevation as needed to provide appropriate flood protection with sea level rise, and to provide necessary storage volume for the overflows.
3. Until the existing levees are removed, the existing outflow pipe to the Ballona Channel must be maintained to provide regular outflow to maintain circulation from the FWM for water quality purposes. After levee removal, connection of this outlet will be relocated through the new levee to provide final overflow for larger storm events, and may also be modified to route into the Brackish Marsh area through an existing supplemental overflow pipe in Jefferson Boulevard. There is also a small existing overflow pipe at the south end of the FWM that has a valve structure currently closed. These outflows must be maintained for minor, non-storm flows, to maintain circulation.
4. The FWM storm flows cannot be routed in their entirety to the Brackish Marsh since the available storage volume to contain up to the 100-year storm within the project area south of Jefferson and Culver Boulevards is insufficient to eliminate flooding of low-lying, upstream properties. Further analysis is required to ascertain the effects of sea level rise on the available storage, and whether increased tidal range can be accommodated (see additional discussion in Section 2.6.3).

There are three water control outlet structures from the FWM. The existing northerly outlet drain from the FWM is a multi-stage conduit, depending on its location. The main conduit is a 10 feet wide by 6 feet tall reinforced concrete box. Where it crosses Jefferson and Culver Boulevards, it is transitioned to a double, 10 feet wide by 3 feet tall reinforced concrete box. This allows the same cross sectional area in half the height. At the connection to the Ballona Creek, the conduit transitions to a triple 5 feet diameter reinforced concrete pipe (RCP). The triple 5 feet dia. pipes connect to the Ballona Creek with flap gates to eliminate backwater into the FWM from the Creek. With the project, this pipe will substantially remain in place. The most northerly portion will be reconfigured to meet the proposed levee location with the same concept of triple 5 feet diameter RCP's and flap gates. At the south end of this conduit is a specially designed weir allowing elevation adjustments from approximately EL -0.3 ft to 7.3 ft NAVD. This wide range allows full dewatering of the FWM for maintenance if that is ever necessary. This internal weir structure controls the water surface elevation in the FWM and will remain as is.

The next structure is an overflow weir directing overflow from upstream storm events into East Area B. This weir design allows for some adjustment in elevation. Its lowest and currently set elevation is approximately EL 7.0 ft NAVD. Its highest setting is at an elevation of 9.25 ft NAVD. With additional structural modification, it is possible to set the elevation as high as approximately 10.0 ft NAVD before causing upstream drainage impacts. At its current crest elevation of 7.0 ft NAVD, and with closure of the flap gate with Ballona Creek flows, overtopping into the Brackish Marsh occurs for storms over approximately the one-year storm. Depending on the desires of the project, and with concurrence of the organization responsible for maintenance of the FWM, the weir structure elevation could be adjusted to the elevation range between 7.0 ft and 10.0 ft NAVD.

The final water control structure is a 24-inch diameter pipe stub out toward the south end of the FWM. This pipe was installed for multiple functions – as an alternate drain location for dewatering of the FWM for maintenance, for water quality circulation if needed within the FWM, and for "freshening" of brackish marsh in East Area B if needed. This pipe has a valve assembly that is currently closed. A drainage channel may be required to extend from a tidal channel in East Area B to the end of this pipe that would allow it to be opened if desired.

2.8.3 Culver Boulevard Stormwater Management

Stormwater drainage for the west end of Culver Boulevard will be managed as described below. In addition, a drainage swale will be created in the area between the new Culver Levee and Culver Boulevard. Culver Boulevard stormwater management features are shown in Appendix H.

2.8.3.1 Existing Conditions

At the southwest corner of Area B is a developed commercial area fronting Culver Boulevard. This development is at a very low elevation in some cases below 6.0 ft NAVD. This is a low point of Culver Boulevard and has historically had flooding problems at, and adjacent to, the intersection of Culver Boulevard and Nicholson. There are a number of storm drains in the area with the primary collection drain for flows from the Westchester Bluffs area conveyed westerly of the intersection toward the ocean. This drain is under sized for larger storm flow events. This was recognized and an overflow drain in Nicholson exists to convey the excess overflow to the north outletting on the north side of Culver Boulevard at the intersection. There is a small ditch that routes this overflow runoff into Area B to one of the small tidally influenced ditches in the area. Due to tidal action, the capacity of this overflow ditch and the surrounding area that is available for storm water storage is sometimes exceeded causing flooding of Culver and a few of the adjacent properties.

2.8.3.2 Proposed Drainage Conditions

With the construction of the proposed levees, tidal influence in this area will be eliminated. However storage volume for the excess overflow drainage will also be eliminated. Therefore, replacement storm water storage volume will be provided by creating a low area to approximately elevation 4.0 ft NAVD between the commercial properties and the proposed levee. This storage basin will be sized to accommodate the overflow volume as well as the local drainage in the area. A public storm drain pipe from a downstream drain system can be extended to dewater this area if desired, or storage volume could be provided to fully contain the overflow. This basin will also function as a water quality treatment measure to address the minor increase in pollutant load from the proposed paved fire access road behind the commercial properties, as well as a portion of the runoff from the existing paved area of Culver Boulevard. Other areas of Culver Boulevard further east will drain to a shallow roadway shoulder ditch provided to keep stormwater runoff away from the paved area, as well as provide an infiltration and treatment function for the roadway.

2.9 AREA B AND C UPLAND FILL PLACEMENT AND HABITAT RESTORATION

The soils that are to be transported to uplands areas within Areas B and C fall into four categories:

- structural,
- non-structural,
- contaminated (non-hazardous), and
- stockpile.

For the proposed bike path and parking lot within Area B, soils will be placed in a structural manner to reduce settlement issues of these pavement areas. Soils in other areas throughout Areas B and C will be placed with a modest level of compaction that will not be considered structural fill. This will allow efficient and relatively uniform compaction (although some wet soils in the later stages may have almost no compaction), while still providing ability for plant and habitat establishment. Any marginally impacted, non-hazardous soils would be placed in Areas B and C and covered with a minimum of three feet of clean cover (Upland Cover). Soils classified as hazardous, will be offhauled and properly disposed of according to state and federal regulations. And finally some soils will be required to be stockpiled for subsequent phases or for removal off-site for disposal.

It is expected that short term stockpiling operations will occur throughout the project at various times. But that stockpiling necessary for non-contiguous construction phasing, or stockpiling needs that would span a rainy season would likely be located in the Area B upland fill area to minimize impacts to other grading operations and provide the shortest distances for the multiple movements that will be necessary.

It is expected that the uplands areas have the capacity to allow adjustment in the final earthwork volumes moved. As with all grading operations, volumes can be quite variable and are based on many factors. If we end up with less soils volume for these areas, the grades can be lowered. And if we have more soils than expected, grades can be raised. When all major grading operations are completed, the uplands areas will be given a final surface contouring into their ultimate configuration. The goal will be to provide as natural an appearance as possible with variations ranging from flat areas, mounds, slopes, depressions, etc.

Once grading is complete, the areas will be revegetated to restore upland habitat. WRA's CHRAMP includes a revegetation plan

2.9.1 Area B – Upland Fill

In the existing area of upland and seasonal wetland between Culver Blvd., Jefferson Blvd., and Lincoln Blvd., soil excavated to restore wetlands in Area A will be placed and upland habitats will be restored. Preliminary grading plans for this fill placement area are shown on Figure 10. Drainage will be contoured into this fill area generally from north to south and east to west. An existing drainage inlet will be adjusted to the final grade. This area may also be graded so that rainfall flows into and supports seasonal wetlands and other upland habitats. A bike path and walking trail will be extended off the proposed bridge across the Ballona Creek and then routed toward the easterly edge connecting to the intersection of Lincoln and Jefferson Boulevards. Elevations will vary as ultimately determined by the soil volumes necessary, but are expected to range from 15 to 35 feet, or from a few feet to twenty plus feet above adjacent street level. Grades are currently from five to fifteen feet below street level.

If the excess soil volume is less and soil placement in Area B is not needed (e.g., if another entity agrees to accept and transport the excess soil material off-site by), then this portion of Area B could be restored to managed wetland as an option within the Project design.

2.9.2 Area C – Upland Fill

The preliminary grading plans for Area C North and South are presented in Figure 11.

2.9.2.1 Area C North

In Area C North, excess fill from the restoration of Area A will be placed to create upland habitats with varying topography and elevations. Fill in Area C North will be contoured so that drainage generally flows towards the central portions of site to the existing Fiji Ditch. The existing Fiji Ditch will be improved.North Area C area may also be graded so that rainfall flows into and supports seasonal wetlands and other upland habitats. Elevations will vary as ultimately determined by the soil volumes necessary, but are expected to range from 30 to 40 feet, or from a ten to thirty feet above Culver Boulevard. Grades are currently from ten to fifteen feet above Culver Boulevard.

If the excess soil volume is less than the preliminary design estimate, less earth disposal in Area C will be required. Reduced filling could result from lower in situ soil density in Area A or more substantively if another entity agrees to accept and transport the excess soil material off-site. Depending on the actual soil disposal requirement, the design of Area C may be revised. For example, the grades could be left as is or the northwest portion of Area C could be restored to tidal wetland connected to Fiji Ditch as an option within the Project design.

2.9.2.2 Area C South

The following section is based on information provided by the Annenberg Foundation, who is leading planning and design of a visitor center in Area C South.

Area C South is roughly bounded by Ballona Creek to the southeast, the State Route 90 (the Marina Freeway) to the northeast, Culver Boulevard to the west, and the Culver Boulevard/Lincoln Boulevard intersection to the southwest. New visitors' facilities would be created in Area C South. The Annenberg Foundation in partnership with the Department of Fish & Wildlife would design, construct, maintain, and operate the Ballona Interpretive Center and supporting infrastructure. The Ballona Interpretive Center would have five primary components (Interpretive Center, habitat restoration, walking trails system, bicycle access, ball fields and parking) and would involve:

1. Creating an interpretive center of approximately 46,000 square feet (enclosed space) to fulfill a variety of interpretive and programmatic functions;
2. Restoring native habitat by removing invasive species and regrading and replanting with native species;
3. Creating walking trails and bike paths with interpretation in the native uplands habitat and connecting to the existing Ballona Creek bike path and greater BWER;
4. Replacing existing parking on gravel with environmental "best practices" parking and include a new curb cut for access to Culver Boulevard;
5. Enhancing the current ball fields to allow for Little League use 3-4 months a year and other public access uses for the remainder of the year;

Site Development:

Development in Area C South would include an Interpretive Center. The overall architectural space would be approximately 46,000 square feet, with a footprint of approximately 33,000 square feet. The center would contain both visitor-serving elements and exhibits and multi-purpose program spaces designed to provide a variety of learning opportunities for adults and school-aged children. The building would house three categories of uses: educational space (50 percent of the building), administrative space (25 percent), and live animal support space (25 percent).

The structure would consist of concrete over metal deck and structural steel. Foundations would consist of piers or piles due to the soft soil conditions and the potential presence of methane gas. The facility would include green roofs and berming around the building to integrate it into the landscape.

An upland habitat zone would be established over approximately 15 acres of the Area C South. This habitat restoration would maximize wildlife adjacencies with the remainder of the BWER habitats. In conjunction with the overall biological intent for the Reserve, invasive plants listed by Cal-IPC as "moderate" or "high" would be targeted for removal. Planting areas would be cleared and grubbed to remove existing trees, shrubby growth and brush, vines, ground covers, stumps, roots, weeds, stones, wood and trash. An ongoing maintenance program consistent with the CHAMP would continue to monitor and remove invasive species. The planting palette and principles behind the creation of underlying habitat would be controlled by and consistent with the CHAMP with the following exceptions: 1) A permanent drip irrigation system would be used to irrigate landscape along the entry drive and immediately around the building's public and private areas; 2) The native turf areas at the multi-purpose fields would be irrigated by a permanent system of pop-up rotary or sprinkler heads. Otherwise, new upland planting would be irrigated with a two-year temporary system of pop-up rotary or sprinkler heads to establish plants.

Approximately 4,800 linear feet of fully accessible pedestrian trails would be developed throughout Area C South, connecting amenities and habitat zones, and providing access to the Ballona Creek bicycle trail as well as trails in the remainder of the BWER. Trails would range in width from 6 to 12 feet, and would be constructed of materials that would demonstrate high permeability, such as stabilized decomposed granite and/or wooden boardwalks. The walking trails would encompass between 0.75 and 1.25 acres of Area C south.

The new paths would provide scenic detours, allowing slower observation separated from the existing path. These detours loops would extend no more than 100 feet from the existing bike path. The bike loops would also be fully accessible, approximately 6 to 12 feet wide, and surfaced with decomposed granite or compacted gravel to provide permeability. A gateway node along one of the detour would provide an area for cyclists to dismount, park, and secure their bicycles in order to access the remainder of Area C South on foot. Bike traffic would be limited elsewhere within Area C South, for safety of pedestrians and habitat protection.

Development in Area C south would include the reconfiguration of the existing ball fields. Currently these ball fields occupy approximately 6.2 acres of land. The ball fields would be reconfigured and enhanced with native plant materials to increase the total vegetated area of the site and improve the compatibility of the recreational and habitat areas. The existing concession building would be reconstructed within a newly created berm.

The existing dirt parking area for approximately 250 cars would be replaced with two smaller parking areas designed for environmental compatibility. Parking for 150 cars would be located adjacent to the reconfigured ball fields. This parking would also be used for bus parking for school and other group outings. The remaining 100 spaces for cars would be relocated to a linear parking area, parallel to Culver Boulevard, with an additional driveway located at least 600 feet southwest of the existing Culver Boulevard intersection with the eastbound on-ramp to the Marina Freeway.

All proposed program elements for Area C South would avoid encroachment on the narrow drainage swale on the eastern edge of the site defined by the U.S. Army Corps of Engineers as “wetland.” The area lies at the toe of an embankment that would not be altered nor impacted by the proposed layout of new design elements. Efforts to enhance the biodiversity of plant life within this zone by selectively removing non-native species and replacing with native wetland species would be developed.

Grading and Drainage:
The existing topography of Area C South is a relatively level at an average elevation of approximately 22 ft NAVD, which roughly joins the top of the existing Ballona Creek levee to the southeast. The site slopes generally and gently from northeast to southwest with steeper slopes at the perimeter to join Culver Boulevard to the west at an elevation of approximately 13 ft NAVD and the Marina Freeway to the north, at an average elevation of approximately 13 ft NAVD. In addition there is an existing drainage basin to the south adjacent to the Culver Boulevard/Lincoln Boulevard intersection.

The proposed grading for the site consists of earth moving to achieve a building pad with parking and undulating site mounds, depressions, drainage paths, walking paths and bike paths across the entire property. Up to approximately 100,000 cubic yards of soil excavated for the restoration will either be exported off-site or transported across Culver Blvd. to south Area C. The height of earth mounds in various parts of the site will be on the order of 10 feet above the existing grade or to an approximate elevation of 32 ft NAVD.

Excavations, fill slopes, and structures would be set back from the Ballona Creek levee at least 100 feet from the existing levee to avoid imposing surcharge loads on the existing levee. Grading within the 100-foot setback zone would be minimal, would not exceed slopes of 5%, and would roughly match existing grades.

The existing unpaved parking areas adjacent to the baseball fields would be re-designed to provide for treatment of storm water runoff from the parking lot.

Storm water would be directed to existing storm water drainage facilities in Culver Blvd.

An "arroyo" feature will also be constructed to provide storm water functions and aesthetic values. Storm water from the Interpretive Center and facilities will be directed to an "arroyo" feature The arroyo would extend into Area C North and connect to the existing Fiji channel, which would be enhanced to improve habitat within the restoration.

Drainage for the proposed site would be collected on site through a network of graded surface swales and channels and underground storm drainage conduits. Drainage would be directed to existing drainage facilities in Culver Boulevard and to the existing drainage basin located to the south of the property adjacent to the Culver Boulevard/Lincoln Boulevard intersection.

2.9.3 Seasonal Wetlands

Seasonal wetland may be created in the Area B and Area C upland fill areas. These areas would be graded to direct rainfall runoff into shallow seasonal wetland depressions. The seasonal wetland areas would be over-excavated by 1 to 2 feet and backfilled with compacted clay material to encourage ponding.

2.10 NATURAL GAS STORAGE FACILITIES

The Southern California Gas Company (SoCalGas) owns and operates natural gas storage wells and associated pipelines within the Ecological Reserve property and holds easements over these areas. Some of the wells in the restoration project area are not actively being used in the storage operations and can be considered for abandonment without being relocated. Abandonment entails removing all near surface components, which would eliminate constraints on restoration. Other wells are monitoring wells that are necessary for storage operations and would need to be relocated. SoCalGas' long-term plan is to consolidate gas infrastructure within its property and facility along the southern bluff by abandoning gas wells in the wetlands and installing replacement wells within their facilities to the extent possible. The Project is working closely with SoCalGas to coordinate the restoration with gas infrastructure plans. The coordinated plans involve three general priorities for gas infrastructure decommissioning:

1. Priority 1 (required for restoration): Certain gas wells and pipelines must be abandoned and/or modified to facilitate the restoration, while other gas infrastructure can be avoided by the restoration by protecting the infrastructure in place.
2. Priority 2 (desired for restoration): Abandonment of other gas infrastructure is desirable for the restoration and to SoCalGas because it increases the extent of restoration and progresses SoCalGas' long-term plan; however, these modifications are not required for the restoration.

3. Priority 3 (desired by SoCalGas): The remaining gas infrastructure can be avoided by the restoration without compromising the extent or function of the restoration, but is desired by SoCalGas to accomplish their long-term plan.

SoCalGas conducts all work related to the facilities they own. Some gas infrastructure (e.g., some abandoned wells and pipelines) may not be owned by SoCalGas, in which case the Project may conduct any work needed to modify the infrastructure. SoCalGas' plans to decommission their onsite infrastructure are dependent on funding. Figure 3 shows the Gas Company facilities and Appendix F shows the gas infrastructure modification plan. The EIR/S will analyze the potential impacts associated with the removal, abandonment and/or replacement of all gas infrastructure within the Ecological Reserve.

2.10.1 Gas Infrastructure Decommissioning Plan

The prioritized plan for gas infrastructure decommissioning is included below.

Area A:

Priority 1 (required for restoration)

- Abandon inactive Area A pipeline
- Avoid Area A wells

Priority 2 (desired for restoration)

- Plug and abandon Del Rey (DR) 13 and 14
- DR 16 (abandoned) – re-abandon or over-excavated as needed to accommodate grading

Priority 3 (desired by SoCalGas)

- Drill a new well to main plant area to replace DR 19 (can be avoided by restoration)
- Plug and abandon DR 15 and 17 (can be avoided by restoration)
- Abandon active pipeline serving DR 18 (if Gas Co abandons DR 18 on Fiji/offsite)

Area B:

Priority 1 (required for restoration)

- Drill new wells to main plant area to replace DR 12 and plug and abandon DR 12 (to allow for channel meander excavation)
- Plug and abandon Vidor 3 (as needed to allow for Culver levee fill placement)
- Modify pipeline from proposed Culver levee to existing Creek crossing (e.g., replace section of pipe at lower elevation to accommodate levee construction and wetland restoration). Note that this pipeline may be abandoned (see Area A, Priority 3)

Priority 2 (desired for restoration)

- Drill new wells to main plant area to replace DR 9
- Plug and abandon DR 4 and 5 and Vidor 1 and 2

Priority 3 (desired by SoCalGas)

- Drill new well to main plant area to replace Vidor 18
- Plug and abandon DR 11 and Vidor 5 and 14

Note: Vidor 4 (abandoned) – re-abandonment is assumed to not be necessary to allow for eventual tidal restoration

Abandonment must occur prior to construction, or grading will be conducted around the facilities to avoid impacts. At a minimum, the project plans to abandon the Priority 1 wells listed above. New wells drilled to replace abandoned wells will be drilled within the Gas Co property along the southern bluff.

During construction, wells that are to remain (e.g., for the Interim Build Out) will be provided a setback and flood protection. Flood protection will primarily consist of construction of a levee around well areas that are below flood elevations. Full-time all-weather access for heavy equipment will need to be maintained to all wells that remain.

2.10.2 Interim Build Out Well Abandonment

For the Interim Build Out, wells in Area A would be abandoned according to the priorities above. This area will be restored to upland habitat and excavated to create transition habitat sloping down to marshplain as shown in Figures 5A - 5C. DR 17 along Fiji Way will be avoided by constructing the new Area A perimeter levee to the east of this well.

If wells in Area A are not abandoned within the time frame for the Interim Build Out, the wells to remain will be avoided. The wells in Area A are currently above flood elevations. The Project would restore upland habitat and/or excavate around any wells to create sloping upland transition habitat. Once the wells are abandoned, the area will be graded and restored as shown in the Interim Build Out.

Within Area B, DR 12 will be abandoned to allow for the channel realignment in the Interim Build Out. Vidor 3 will also be abandoned as needed to allow construction of the new Culver levee. The temporary levee between the new Culver levee and the existing south Ballona Creek levee along West Area B will be constructed to protect and avoid the cluster of wells in West Area B, which includes Vidor 1 and 2 and DR 4, 5, and 9. The Interim Build Out allows for these wells to be maintained as is or to be abandoned to facilitate restoration to marsh connected to West Area B during Full Build Out. The project plans to avoid Vidor 18 by aligning the new West Area B levee to the north of this well.

2.10.3 Full Build Out

For the Full Build Out, Vidor 1 and 2 and DR 4, 5, and 9 in West Area B would be abandoned to allow for full tidal restoration of West Area B. If these wells are not abandoned within the timeframe of the Full Build Out, a levee will be constructed around the wells between the Culver levee and the Interim Build Out temporary levee to create a ring levee around the wells. A drainage culvert would be installed in the levee to provide storm drainage. Once the wells are abandoned, the ring levee will be removed to restore habitats as shown for the Full Build Out (Figure 5C). The project will lower any levees to create the upland peninsula, transitional and marsh habitats.

2.10.4 Pipeline Protection and Relocation

Appendix F shows the gas pipeline relocation plan. The section of the gas pipeline between the new Culver levee and the existing Creek crossing to Area A would be modified to allow levee construction and wetland restoration (e.g., by replacing the section of pipe at lower elevation and by placing the pipe in a sleeve under the new Culver levee to address the potential of differential settlement of the pipeline) This entire pipeline may be abandoned once wells in Area A are abandoned.

In East Area B, the portion of the Line 1167 30-inch natural gas transmission pipeline crossing the wetland to Jefferson Blvd. will be relocated along the Gas Company Road (see Section 2.10.4 and Attachment F). These relocations must be completed prior to grading within their respective areas. Other gas pipelines to remain in place will be avoided by setting earthwork back by an appropriate distance.

The existing abandoned pipeline through Area A and along the north Ballona Creek levee will be capped at both ends beyond the limits of restoration earthwork. The abandoned pipeline section within Area A will be removed as needed for restoration grading. Other abandoned pipelines may be encountered during restoration grading and will be removed. Other pipelines can remain in place and will be set back an appropriate distance.

2.11 ENGINEER'S ESTIMATES

Preliminary estimates of earthwork quantities and construction costs have been developed based on the preliminary grading plans and design approaches described in this PDR.

2.11.1 Earthwork Quantities

The engineer's estimate of earthwork volumes is provided in Table 5. At this preliminary design level, the earthwork volume estimates indicate that the project will include excavation of about 2,170,000 cubic yards of material (in-place). Material for creation of levees, upland transitional habitat, and marsh topographic features including islands, berms, pans, and seasonal wetlands will include placement of about 1,420,000 cubic yards of excavated material (based on in-place excavation volumes adjusted for density changes). The net offhaul to the onsite upland fill placement areas in Area B and Area C is about 770,000 to 870,000 cubic yards, and the preliminary grading plans for these fill placement areas provide about 870,000 cubic yards of capacity including an allowance of 100,000 cubic yards of fill placement in Area C South or off-site export.

Mass earthwork volume estimates was prepared using AUTOCAD Civil 3D software by examining volumetric differences between existing grade based upon the site base topography prepared by PSOMAS and the preliminary grading plans for presented in previous sections. The mass grading estimates were further refined to account for density changes between in-place excavation of primarily, loosely consolidated material in Area A to compacted fill placed in lifts primarily for levees and stability berms. At the preliminary stage, a volumetric reduction of 15 to 25 percent was assumed between in-place excavation and in-place fill. In addition, settlement estimates for levees in Area A and Area B were incorporated into estimates of levee core volumes reflecting about 2 inches of settlement per foot of fill. Estimates of volumetric changes due to compaction and settlement were based upon preliminary recommendations documented the Preliminary Geotechnical Design Summary. Earthwork estimates for levees also reflected the geotechnical recommendations for subgrade preparation including over-excavation and compaction. The earthwork estimates will be updated based upon the recommendations included in the Final Geotechnical Design Report.

Estimates for excavation of tidal channels within Area A and North Area B assumed that all channel material excavated from these areas would be utilized to create upland transitional fill or placed in the

Area B and C fill placement areas. Channels excavated in West, South, and East Area B assumed that all excavated material would be side cast to create low berms adjacent to the excavated channels. This approach limits the need to truck material out of these areas that currently support sensitive existing marsh habitat.

The preliminary earthwork estimates do not reflect special handling of any materials that do not meet the wetland cover or upland cover standards or any hazardous materials. Following completion of the soils analyses to better understand the level and extent of any existing impacts and consultation with the regulating agencies regarding appropriate standards for materials classification, handling, and cover depths, the earthwork quantities will be refined to reflect any special handling that is anticipated.

2.11.2 Cost Estimates

A list of items of work is included in the Table 6. The items of work provides major project elements related to earthwork, rock/soil cement slope protection, bridges, public and County access, and plantings. These work items are provided along with the anticipated measurement unit for the construction contract.

As the design is refined, the work items table will be updated to reflect total units and unit costs for each work item to develop a construction cost estimate.

Table 5: Preliminary Estimates of Earthwork Volumes

WORK ITEM	CUT CY	Average FILL* CY	Min FILL* CY	Max FILL* CY
AREA A				
PERIMETER LEVEE				
Levee Subgrade & Keyway	25,200	30,200	29,000	31,500
Levee Core - Compacted Fill + Settlement	-	34,600	33,100	36,000
Outboard Stability Berm	-	16,400	15,700	17,100
Inboard Stability Berm	-	36,100	34,600	37,600
Levee Road Surface	-	3,100	3,100	3,100
PERIMETER LEVEE - SUBTOTAL	**25,200**	**120,400**	**115,500**	**125,300**
WETLAND MASS GRADING				
Clearing & Grubbing	54,400	-	-	-
Mass Excavation to Marshplain & Transitional Slopes	990,500	-	-	-
Fill to Create Upland Mounds adjacent to Levee	-	28,400	27,200	29,600
Fill around Existing Gas Wells	-	30,500	29,200	31,700
WETLAND MASS GRADING - SUBTOTAL	**1,044,900**	**58,900**	**56,400**	**61,300**
WETLAND FINE GRADING				
Excavate New Tidal Channels	19,200	-	-	-
Tidal Pans	2,800	3,400	3,200	3,500
Seasonal Wetlands	4,400	5,300	5,100	5,500
WETLAND FINE GRADING - SUBTOTAL	**26,400**	**8,700**	**8,300**	**9,000**
GRADING ALONG NORTH BALLONA CREEK				
Excavation of North Meander Bend	193,100	-	-	-
Excavation of West Breach	35,600	-	-	-
Excavation of East Breach	53,900	-	-	-
Lower North Ballona Creek Levee	117,300	1,100	1,000	1,100
Grading of Existing Channel	26,100	46,100	44,200	48,000
Fill West Channel Meander	-	102,700	98,400	107,000
EXCAVATION ALONG BALLONA CREEK - SUBTOTAL	**426,000**	**149,900**	**143,600**	**156,100**
AREA A SUBTOTAL - Interim Build Out, Option A	**1,522,500**	**337,900**	**323,800**	**351,700**
AREA A Well Lowering				
Lowering Well pad and regrading	**208,000**	**8,800**	**8,400**	**9,100**
AREA A SUBTOTAL - Interim Build Out, Option B	**1,730,500**	**346,700**	**332,200**	**360,800**
AREA B				
CULVER LEVEE				
Levee Subgrade & Keyway	7,800	9,800	9,400	10,100
Levee Core - Compacted Fill + Settlement	-	59,300	56,800	61,800
Outboard Stability Berm	-	84,200	87,700	80,700
Inboard Stability Berm	-	62,100	59,500	64,700
Levee Road Surface	-	1,700	1,700	1,700
CULVER LEVEE - SUBTOTAL	**7,800**	**217,100**	**215,100**	**219,000**

Table 5: Preliminary Estimates of Earthwork Volumes

WORK ITEM	CUT CY	Average FILL* CY	Min FILL* CY	Max FILL* CY
INTERIM AREA B LEVEE				
Levee Subgrade & Keyway	2,800	3,500	3,400	3,600
Levee Core - Compacted Fill + Settlement	-	46,900	45,000	48,900
Outboard Stability Berm	-	29,400	28,100	30,600
Inboard Stability Berm	-	84,900	81,400	88,500
Levee Road Surface	-	700	700	700
INTERIM AREA B LEVEE - SUBTOTAL	**2,800**	**165,400**	**158,600**	**172,300**
WEST AREA B LEVEE				
Levee Subgrade & Keyway	10,800	13,500	13,000	14,000
Levee Core - Compacted Fill + Settlement	-	181,600	174,000	189,100
Outboard Stability Berm	200	51,100	49,000	53,300
Inboard Stability Berm	-	136,400	127,900	145,000
Levee Road Surface	-	2,300	2,300	2,300
WEST AREA B LEVEE - SUBTOTAL	**11,000**	**384,900**	**366,200**	**403,700**
NORTH AREA B WETLAND GRADING				
Clearing & Grubbing	25,000	-	-	-
Grading to Create Marshplain	43,900	100	100	100
East Habitat Peninsula	5,900	2,300	2,200	2,400
Excavate New Tidal Channels	6,900	-	-	-
NORTH AREA B WETLAND GRADING	**81,700**	**2,400**	**2,300**	**2,500**
GRADING ALONG SOUTH BALLONA CREEK				
South Meander Bend	84,700	-	-	-
Excavation of Breaches	82,300	100	100	100
Lower South Ballona Creek Levee	48,900	700	700	700
Fill East Channel Meander	-	112,200	107,800	116,700
GRADING ALONG SOUTH BALLONA CREEK - SUBTOTAL	**215,900**	**113,000**	**108,600**	**117,500**
WEST, SOUTH & EAST AREA B RESTORATION				
Excavate South Area B Channels	6,100	6,100	6,100	6,100
Excavate East Area B Channels	3,300	3,300	3,300	3,300
Excavate West Area B Channels	4,600	4,600	4,600	4,600
Lower Interim Levee	86,800	700	700	700
Fill Habitat Peninsula	200	38,900	38,900	38,900
Lower and Breach South Ballona Creek Levee	21,700	69,100	69,100	69,100
WEST, SOUTH & EAST AREA B RESTORATION - SUBTOTAL	**122,700**	**122,700**	**122,700**	**122,700**
AREA B SUBTOTAL	**442,000**	**1,006,000**	**974,000**	**1,038,000**
AREA A & B TOTAL	**2,172,500**	**1,352,700**	**1,306,200**	**1,398,800**
AREA C & AREA B - NET FILL PLACEMENT REQUIRED		**819,800**	**866,300**	**773,700**

Table 5: Preliminary Estimates of Earthwork Volumes

WORK ITEM	CUT CY	Average FILL* CY	Min FILL* CY	Max FILL* CY
FILL PLACEMENT AREAS				
Area C North	-	500,000		
Area C South (or off-site export)	-	100,000		
Area B - Between Jefferson & Culver	-	270,000		
TOTAL AVAILABLE FILL PLACEMENT MOUNDS	**-**	**870,000**		

* Fill Volumes for select earthwork items increased by 20% (avg) and 15% (min) to 25% (max) to account for volume differences between cut volumes and compacted, inplace fill.

Table 6: Schedule of Work Items for Future Cost Estimates

WORK ITEM	Quantity	Unit	Unit Cost	Item Cost
Mobilization				
Initial Mobilization	1	LS		
Seasonal Mobilization	7	LS		
Water Control (by Season)	7	LS		
Access Control (by Season)	7	LS		
Stormwater Management (by Season)	7	LS		
Demo				
Abandon Gas Well	1	LS		
Channel Armoring	9,900	LF		
Freshwater Marsh Outlet Headwall	1	LS		
Culver Road Culvert	1	LS		
West Area B Water Control Structure	1	LS		
Gas Well Access Road Culvert	1	LS		
Earthwork				
Permiter Levees				
Area A Levee	120,400	CY		
Culver Levee	217,100	CY		
Temporary Area B Levee	165,400	CY		
West Area B Levee	384,900	CY		
West Area B Levee - Completion	69,100	CY		
Levee Armoring				
Type 1	?	LF		
Type 2	?	LF		
Type 3	?	LF		
Marsh & Transitional Grading				
Area A	1,103,800	CY		
Area A - Well Pad Lowering	208,000	CY		
Area B North	69,000	CY		
Wetland Fine Grading - Channels, Panes and Ponds				
Area A Tidal Channels	19,200	CY		
North Area B Tidal Channels	6,900	CY		
East Area B Tidal Channels	3300	CY		
South Area B Tidal Channels	6,100	CY		
West Area B Tidal Channels	4,600	CY		
Seasonal Wetlands	4,400	CY		
Tidal Pannes	2,800	CY		
Create Upland Peninsulas	47,000	CY		
Culver Road Detention Basin & Swale	?	CY		

Table 6: Schedule of Work Items for Future Cost Estimates

WORK ITEM	Quantity	Unit	Unit Cost	Item Cost
Ballona Creek Realignment				
Excavate Meanders	277,800	CY		
Fine grading In Channel	72,200	CY		
Breach Levees	171,900	CY		
Fill Meanders	214,900	CY		
Lower Levees	168,000	CY		
West Area B Restoration				
Breach Levee	?	CY		
Lower Levee	21,700	CY		
Water Control Structures				
Culver/Jefferson East Area B Structure				
Culverts - X, Y dia	?	LF		
Headwalls	?	EA		
Gates	?	EA		
Culver / South Area B Structure				
Culverts - X, Y dia	?	LF		
Headwalls	?	EA		
Gates	?	EA		
West Area B Structure				
Culverts - Y dia	?	LF		
Headwalls	?	EA		
Gates	?	EA		
Culver Road Detention Basin				
Culverts - Y dia	?	LF		
Headwalls	?	EA		
Gates	?	EA		
Public Access				
Pedestrian, Bicycle & Construction Bridge				
Piers	?	EA		
Bridge	?	LF		
Access Trail/Road	?	LF		
Access Control - Bollards/gates	?	EA		
Signs	?	EA		
Planting/Erosion Control				
Upland Plantings				
X Containers	?	EA		
Hydroseeding	?	AC		
Transitional Plantings				
X Containers	?	EA		
High Marsh Plantings				
X Containers	?	EA		
Total Construction Cost				

2.12 CONSTRUCTION METHODS

There are several important considerations affecting construction:

- Transport of soil between Area A and Areas C and B, which entails crossing Ballona Creek and or busy roadways;
- Levee Lowering and Breaching of existing levees to inundate Areas A and B, and new channel meanders;
- Soil Bearing and Construction Equipment: Ground water elevation relative to finished grades, which will affect the feasibility of using conventional construction equipment.
- Channel Excavation and Berm Fill. The project entails excavating channels in existing wetland;
- Re-alignment of the Ballona Channel, which entails filling the existing flood control channel;
- Stability of the existing levee along the north side of Ballona Creek during excavation of Area A;
- Relocation of interfering utilities;
- Construction or support of new drainage facilities to avoid upstream drainage impacts;
- Interim stockpiling of soils between phases;
- Drying of soils to re-use as structural fill;
- Environmental windows and habitat establishment (previously discussed);
- Clearing and grubbing to allow for grading and treatment of invasive vegetation removed;
- Revegetation of restored habitats;
- Gas well abandonment and replacement process;
- Other considerations.

These considerations are addressed in the following sections.

2.12.1 Soil Transport

The intent for our grading design is that at the completion of construction, we will be balanced on-site. This means that no import or export of soils is anticipated other than if contaminated soils are discovered at levels that require offhaul and offsite disposal. And volumes for these are expected to be negligible from a grading quantities standpoint. Therefore truck routes and other transport methods should be limited to the projects areas and the immediately adjacent roadways. A series of exhibits are provided showing the routing options expected.

Soil transport is expected to be accomplished using one or more of the methods identified in Table 7. The likelihood of different construction methods will be revisited based on additional geotechnical analysis of soil conditions.

Wheeled scrapers and trucks can traverse adjacent roadways, but the strong preference is to provide routes that limit the requirement to impact roadways. This puts a premium on installation of a bridge or crossing across Ballona Creek, and a temporary bridge across Lincoln Boulevard. Both options are available which could leave the transport of soils to the uplands areas of east Area B as the only area that would require transport on roadways. The relatively small volumes of soils this area is capable of accepting may make it cost prohibitive to do anything other than simply crossing Culver.

Table 7 Earthwork Transport Options

Method	Associated with	Cost	Conditions	Application
Scrapers	Self contained	Low unit cost	Dry, firm, open	Within Area A, and if possible to C and portions of Area B,
Trucks	Excavators, Dozers	Moderate unit costs, with multiple handling		Possible means to reduce impacts to crossings between areas and support to other methodology listed
Conveyor	Excavators, Dozers, Trucks	Moderate unit cost plus mobilization	Confined without vehicular access	Possible means of crossing Ballona Creek and roads
Low ground pressure	Excavators, Dozers, Trucks, Mats	High unit cost	Wet, weak	Anticipated for areas below groundwater elevation, wetland channel excavation and sidecast berms
Hydraulic	Dredge	High mob, low unit cost	Open water, ample water supply	Not anticipated but possible in lowest areas

Photographs of a conveyor in operation are provided in Appendix E.

2.12.1.1 Across Ballona Channel

Methods for moving earth across Ballona Channel are provided in Table 8.

Table 8 Ballona Creek Crossing Methods

	Appropriate Equipment			
Method	**Expected**	**Possible**	**Conditions**	**Application**
Existing Bridge	Trucks	Scrapers	Road closures, restricted hours	Use Culver, close one direction during selected dates and times
Temporary Bridge	Trucks, Scrapers	Conveyor	Mobilization	Use old railway alignment to cross Lincoln and or Ballona Creek
Barge / floating crossing	Scrapers, Trucks	Conveyor	Mobilization, dry season	Straight between A and B across Ballona; wide enough for scrapers
Temporary ford	Scrapers, Trucks	Conveyor	Mobilization, dry season	Two options: (1) straight between A and B and (2) along north bank under Culver and Lincoln Bridges
Permanent Bridge	Scrapers, Trucks	Conveyor	Mobilization, phasing	Crossing Ballona Creek
Culver	Conveyor		Limited space, dry season	Fiji channel from A under Lincoln to C North under Culver to C South

2.12.1.2 Across Roadways

See Table 8, above, for Ballona Crossing. Additional consideration is needed to determine how to get earth between Culver and Jefferson using Ballona Crossings other than the existing Culver roadway or a new bridge that crosses Culver as well.

2.12.2 Levee Lowering and Breaching

Levee lowering involves a phased removal of earth to maximize the quantity that is moved prior to breaching and to limit the risk of uncontrolled breaching. The figure "Levee Lowering" in Appendix E shows how this work is staged. In multi-year construction, the minimum section of earth levee to remain through the winter is specified (e.g. "Phase 2" in drawing). The construction contractor is also required to sequence his work to prevent site inundation, and typically does this by leaving a small raised area (e.g. the "check berm" in the photograph) until final earthwork. The final earthwork often consists of dozer operation to quickly remove the check berm and side cast earth into the site. This last work may be timed for a neap tide (approximately one week period) and staged to maintain egress along portions of the levee (that is, consideration of access and breach locations) to facilitate phased lowering as portions of the project are completed. Alternatively the contractor may use steel sheet pile coffer dams along the levee to allow for levee lowering at all tide levels.

Breaching is also phased, similar to levee lowering. If possible, shoring is avoided because installation and removal induce additional environmental impacts and costs. The breaching is usually accomplished by two long reach excavators working on the lowered levee on either side of the breach to be excavated. At first, earth may be loaded to trucks and taken elsewhere. However, once the levee section is reduced to the point of incipient breaching at the next high tide, the operation shifts into a high production rate mode with excavated material sidecast. Often, other excavators and low-ground pressure dozers re-handle the side cast earth and displace it farther away from the breach, thereby limiting the height of the side cast and maximizing the excavation rate. The work continues until the breach is excavated or the tides approach the levee surface. For larger breaches, multiple days or weeks may be required, resulting in relatively high potential velocities. In this case, an internal and potentially external earth berm (sometimes called a "donut" or "dredge lock") can be constructed to limit the area of impact during construction. Steel sheet pile coffer dams may also be used to limit tidal inundation of breach excavations. See Figure "Breaching" in Appendix E.

2.12.3 Soil Bearing and Construction Equipment

Much of the Ballona earthwork may be accomplished by traditional land based equipment. In particular, the maximum use of scrapers will provide the greatest economy.

Wetland restoration construction requires special equipment and construction methods. High ground water and weak soils can preclude use of traditional land equipment and increases the unit costs of construction. The Construction Equipment figure in Appendix E provides pictures of some examples. These are as follows:

- Low ground pressure: smaller, lighter equipment with large surface area tires or treads that reduce bearing pressure.

- Mats: Timber planks (thick) lashed together and moved by bucket-type equipment.
- Long reach excavator: Track or wheel mounted excavator with a long arm and small bucket to allow extended reach to over 40 feet.
- Clamshell and Dragline Crane: Usually track mounted, can reach 60 feet or more.
- Amphibious Excavator: Can float, and can excavate in shallow standing water.
- Rotary Ditcher: Excavates with rotating wheels that spray sediment across adjacent areas, resulting in a narrow ditch. Typically pulled behind other equipment but can be self propelled.
- Floating equipment: Cranes and excavators can be floated on barges for both transport and operation. Equipment can be trucked in and assembled to work in land-locked water bodies.
- Hydraulic dredge: A water and sediment mixture can be excavated and pumped. (Not expected in this project)

2.12.4 Tidal Channel Excavation and Earth Berm / Terrace Fill

PWA has developed and implemented approaches for restoring tidal marsh morphology using limited earthwork, strategically configured to limit costs and intervention, that lead to enhanced and more rapid habitat establishment. Tidal channel and marsh berm construction are one of the tools used. The concept is depicted in the Tidal Channel and Berm Figure in Appendix E. Channels are excavated and material side cast to form low height, flat sloped embankments (berms). The berms are shaped by the excavation bucket and or other equipment, but are not typically compacted. An exception is berms placed above tidal wetland for riparian or wetland forest habitat, which are more readily compacted.

2.12.5 Ballona Channel Realignment

The project includes a realignment of Ballona Channel from a straight to a meandering planform. This will require filing the existing channel. We anticipate that this can be accomplished with the following construction sequence:

- The new channel is excavated
- The new channel is breached
- The old channel is blocked on the upstream and downstream ends, with flows bypassing to the new channel
- The old channel is filled between the blocked areas.

Blocking the channel can be accomplished in several ways:

- Rubble fill: A rock dike is constructed with floating equipment or “over the top” from land. The rock is graded to have a wide range of sizes, limiting contiguous voids and subsequent sediment migration.
- Sheet piling is placed. The plan form could be a linear wall with steel or concrete, or have a cellular structure with steel.
- Precast concrete gravity structures, interlocking
- Use of temporary fabric and sheet structures such as
    - Water or soil filled fabric tubes
    - Metal frames and plastic sheets.

Filling the blocked channel can be accomplished several ways

- Dumping of earth from the sides; and building out
- Hydraulic slurry of sands, with subsequent earth moving above water
- Land based equipment in a dewatered condition.

Figure "Fill in Water" in Appendix E shows how islands and port fills are constructed.

Given that the Area A earth source is above grade and primarily silty, use of hydraulic dredge methods is not preferred, but may be necessary in certain areas. Given that Ballona Creek is shallow and relatively calm water, use of temporary fabric and sheet structures may be preferred. Dewatering of the fill area may be practical, and land based equipment may be used.

2.12.6 Construction Period Levee Stability

Construction period levee stability will be addressed by staged construction with geotechnical recommendations.

Levee construction often requires a phased construction to compensate for settlement and to avoid overloading the subgrade and causing shear failure and mass movements. The increased weight of an earth levee will typically result in consolidation of underlying soils and settlement. The increased weight will also increase the shear stresses in the foundation soils, and can cause shear failure and deformation, and greatly compromise the levee construction. Consequently, levee construction often requires a second construction phase one or more years later to compensate for settlement. The risk of slope failure can be reduced and the rate of construction increased by using flatter slopes. Conceptually, placing more material with a flatter slope reduces the gradient in loading and the maximum shear stress in the underlying earth. The Levee figure in Appendix E shows examples of mud levees on weak soils with "stability berms." Stability berms are an additional mass, typically in the form of a bench or terrace, beyond the "core" of the levee. The stability berms can provide attributers such as ecologic ecotone, wave protection and access. The Levee figures and photos in Appendix E shows a two phase construction with anticipated initial settlement.

2.12.7 Clearing and Grubbing and Invasive Plant Material Treatment

Vegetation will be cleared and grubbed prior to grading. Native plants can be salvaged and reused for revegetation of restored areas. Invasive plants will be stockpiled on-site and treated (e.g., composted). The preferred approach will be to bury invasive plant material in upland fill areas at a depth below which the invasive vegetation cannot reestablish. WRA's draft RAMP discusses this consideration and future phases of the design will detail the approach for handling invasive vegetation.

2.12.8 Revegetation

WRA has developed a draft Conceptual Restoration and Adaptive Management Plan (RAMP) that includes a conceptual revegetation plan and outlines revegetation design considerations. The RAMP and subsequent revegetation design will be incorporated into future phases of the Project design. Revegetation of restored wetland areas will rely on natural recruitment (see Section 2.5.1), with the possibility of targeted installation of salt marsh vegetation as discussed in the RAMP. Transition zone and upland habitats will required active revegetation and irrigation. The suitability of topsoil for target vegetation is an important consideration (see Section 2.2.3) and management of topsoil may be required, particularly for revegetated upland areas where soil amendment or leaching of soil salinity may be needed.

2.12.9 Gas Well Abandonment and Replacement Process

The following information was provided by SoCalGas on the process for abandoning gas wells and drilling new wells to replace abandoned wells.

2.12.9.1 Site Preparation

Access Roads: Two inches of compacted ¾-inch base rock will be used to bring the access roads to the wells to 12 feet in width on the straightaways and 20 feet in width at the corner of the turns, and capable of supporting standard highway permitted trucks up to 80,000 pounds.

Well Site Locations: Two inches of compacted ¾-inch base rock will be used to create a work pad 120 feet by 170 feet centered at the wellhead.

The project duration will require a minimum of five (5) working days per well.

The following parameters are required to effectively provide for the abandonment of gas storage wells operated by SoCalGas in the Ballona Wetlands:

- Certain well abandonments will need to be undertaken before the levees are removed, to avoid flooding of the wellsite locations.
- Other wells will need to be abandoned prior to grading activity.
- If wells are being replaced, replacement wells must be drilled and determined to be successful before the well being replaced is abandoned.

Once the wells are abandoned, the restoration of the wellsite locations can be undertaken in conjunction with the planned restoration grading and site construction planned by the Ballona Wetlands Restoration Project.

2.12.9.2 Well Abandonment

Well abandonment should be undertaken after the access road and the well site location have been prepared. The process of abandoning a well includes bringing in a workover rig to remove downhole piping and setting cement plugs to isolate the producing zones. The wellhead is removed and the well casing is cut and capped approximately five (5) feet below grade. All concrete cellar material and piping is then removed.

Each well abandonment will require a minimum of 30 to a maximum of 45 12-hour work days (8 AM to 8 PM) to complete.

The following equipment will be required to complete the well abandonment work:

1 - Mobile Production Rig with 106-foot high mast
1 - Mobile Rig Pump with engine and circulating pit with shaker
1 - Solids Bin
1 - Rig Equipment Truck
1 - Portable Generator
1 - Rig Crew Trailer
2 - 500 bbl portable liquid storage tanks
1 - Roll Off Trash Bin
2 - Roll Off Cement Bins
1 - Portable Restroom and Service Truck
1 - Cement Pump Truck
1 - Bulk Cement Truck
3 - Wireline Logging Trucks (USIT/perforating/Misc. tools)
1 - 120 bbl or 80 bbl Vacuum Truck
6 - Service Pickup Trucks (various onsite contractors)
1 - Delivery Truck (Tractor/Flatbed Trailer)
1 - Stinger Truck with flatbed trailer

Each wellsite will need to be accessible to install soil gas monitoring probes and monitor for gas leakage for two months following abandonment. If no gas leakage is detected during the initial two month period following abandonment, direct access to the well will no longer be required. If gas leakage is detected, deeper probes will need to be installed and monitored for six months. After it has been determined that there is no further gas leakage, the probes can be removed. SoCalGas will continue to conduct well gas leakage surveys on each abandoned well every six months. In the case of the well subsequently being submerged under water, another means of monitoring the well will be determined, such as checking for gas bubbles percolating in the water above the abandoned well.

If well leakage occurs that requires re-abandonment, then the appropriate responsible entity (SoCalGas or the State) will re-establish roads and wellpads to execute such work.

2.12.9.3 Drilling New Well

The process of drilling a new well involves moving in a large rig capable of working 24 hours per day and having the necessary equipment to drill and install casing. The drilling rig is moved in on as many as 30 flatbed trucks and then assembled on location. Prior to move in, a cellar is first dug and shored using a cellar ring or concrete walls. Then a conductor pipe is installed in the ground and the drilling rig is rigged up. The drilling operation involves directional drilling a hole to the zone of interest. Once the hole is drilled to the proper depth, casing is installed and cemented in place. The drilling rig is then disassembled and moved out of the location. A smaller work-over rig is then needed to complete the well by installing tubing and other completion equipment.

Each new well will require a minimum of thirty-five to a maximum of fifty 24-hour work days. The following equipment will be required to complete the drilling of a new well:

1 - Drilling Rig with substructure, catwalk, drawworks, 149-foot high mast, with 11-inch Class IIIB 5M BOPE
2 - Skid Mounted Rig Pumps
1 - 600 bbl Mud Pit with shakers, circulating pumps, mud cleaner, centrifuge, mud mixing dock
2 - Solids Bins for drill cuttings
3 – Diesel (or NatGas powered) Electric Generators with SCR House
1 - Accumulator Unit
1 - Top Drive Power Unit
1 - Dog House/Tool Room/Crew Change Room
2 - Portable Generators
4 - 500 bbl portable liquid storage tanks
1 - Cement Pump Truck(s)
1 - Bulk Cement Truck(s)
3 - Wireline Logging Trucks (Open Hole Logging/USIT/perforating/Misc. tool running)
2 - 120 bbl or 80 bbl Vacuum Truck
1 - Roll Off Trash Bin
2 - Roll Off Cement Bins
1 - Portable Restroom(s) and Service Truck
8 - Service Pickup Trucks (various onsite contractors)
2 - Delivery Trucks (Tractor/Flatbed Trailer)
1 - Stinger Truck with flatbed trailer
4 - Residential Trailers (for onsite supervision)
1 - Mud Logging Trailer/Unit
1 - Directional Drilling Trailer/Control Room
1 - Casing Running Equipment/Crew
1 - Forklift (8 ton rated)
1 - Rig Equipment Truck
2 - 90 or 150 ton Cranes (for rig up/rig down)
30 to 50 Flat Bed Trailers and Trucks (for move in and move out)
1 - Backhoe

2.12.9.4 New Well Completion Operations

A workover rig is used to install the downhole tubing and associated monitoring equipment following move out of the drilling rig. All surface piping including monitoring and instrumentation is then installed after the workover rig is moved out.

Each completion will require seven to ten 12-hour work days (8 AM to 8 PM).

The following equipment will be required for the new well completion operations:

- 1 - Mobile Production Rig with 106-foot high mast
- 1 - Mobile Rig Pump with engine and circulating pit with shaker
- 1 - Rig Equipment Truck
- 1 - Portable Generator
- 1 - Rig Crew Trailer
- 2 - 500 bbl portable liquid storage tanks
- 1 - Roll Off Trash Bin
- 1 - Portable Restroom and Service Truck
- 2 - Wireline Trucks (USIT/Misc tools)
- 1 - 120 bbl or 80 bbl Vacuum Truck
- 5 - Service Pickup Trucks (various onsite contractors)
- 1 - Delivery Truck (Tractor/Flatbed Trailer)
- 1 - Stinger Truck with flatbed trailer

2.12.9.5 Investigate and Remediate Contamination from Abandonment or Drilling of Gas Wells

During the abandonment, work-over, or drilling of gas wells at Playa del Rey, heavy petroleum hydrocarbons (e.g., crude oil) may be present in near-surface soil. This is incidental contamination from normal oil field activities, such as spills of work-over fluid, small oil spills or leaks. Before the wells are drilled and after well abandonment, SoCalGas and its consultants will perform an investigation of potential oil contamination in near-surface soils (down to 15 feet below ground surface). If significant amounts of petroleum are found, SoCalGas and its contractor will remediate or remove the contamination for off-site disposal. Cleanup levels are normally 10,000 ppm, 1,000 ppm, or 100 ppm of Total Petroleum Hydrocarbons, depending on depth to ground water and soil type.

Each investigation may take up to two (2) weeks to complete; remediation work at each site may continue for up to two (2) months.

The following equipment will be required to complete remediation activities:

- 1 - Drilling Rig
- 1 - Backhoe
- 4 - Trucks

2.13 CONSTRUCTION SEQUENCING

The Project will be implemented in multiple stages occurring over several years. Figures 5A and 5B show two options for the Interim Phase: Interim Build Out Option A with the gas wells protected in west Area A and Interim Build Out Option B with the gas wells removed. Figure 5C shows the Full Build Out for the Final Phase of the restoration. The Final Phase of the restoration will be implemented using an adaptive management approach. Targeted monitoring of habitat establishment in the Interim Phase will be used to evaluate if and when adaptive management criteria are met for proceeding with the Final Phase of the Project. WRA's CHRAMP includes discussion of the adaptive management plan.

The likely construction stages are outlined below. Appendix F includes exhibits showing specific construction sequences for a likely construction sequencing scenario. Note that stockpiling of excavated material may be required between stages.

Interim Phase:

1) **Stage 1. Area C South Grading and Visitor Center (see Appendix F, Sequences 1-2)**
2) **Stage 2. East and South Area B Restoration**
    - Relocate 30-in gas transmission line as needed (Sequence 3)
    - Water control structure(s) (Sequence 4) (may be deferred to Stage 3)
    - Wetland enhancements (e.g., tidal channel excavation, marshplain grading, invasive plant removal) (Sequence 5)
2) **Stage 3. Area A Excavation, Start Channel Meanders Excavation, and Levee Construction (two to four construction seasons)**
    a) Area A wetland restoration
        - Site prep:
            - Area A gas line removal and well abandonment (Sequence 6): abandon or protect in place gas wells in Area A (Del Rey 13, 14, 15, and 19), and Del Rey 17 in Fiji Way; abandon and/or remove, or protect in place, associated pipelines (see Section 2.10.1)
            - Construct Ballona Creek pedestrian/bike bridge (Sequence 7)
            - Construct Lincoln bridge to connect Area A to Area C (Sequence 8)
            - Clear and grub (Sequence 9)
        - Area A wetland and tidal channel excavation (Sequence 10), including partial excavation of Ballona Creek meander, and interim water management
        - Area A perimeter levee construction (Sequence 11)

    b) Area B wetland restoration
        - Site prep:
            - Abandon or protect in place gas wells; relocate gas line (see Section 2.10.1) (Sequence 12)
            - Clear and grub North Area B (Sequence 13)
            - Install temporary water control structure to maintain south Area B drainage during levee construction (Sequence 4)
        - Area B Levee Construction (estimated two-year duration to manage settlement) (Sequences 14 - 15)
            - Culver Road Levee
            - West Area B Levee
        - Partial Excavation of Ballona Creek meander, and interim water management
        - Stockpile earth to fill Ballona Channel at new downstream meander
        - Area B managed wetland water control structures (Sequence 22)

    c) Other Areas and Features

- Site prep for Area C and B fill placement areas: clear and grub (Sequences 16 and 18)
- Start Area C fill placement (non-levee material) (Sequence 19)
- Start Area B fill placement and upland habitat restoration between Culver, Jefferson, and Lincoln Blvds (non-levee material) (Sequence 17)
- West Culver Blvd. stormwater drainage improvement

3) Stage 3. Ballona Channel Realignment and Levee Removal (one construction season)

a) Step 1: Channel Meanders (Sequence 23)
  - Complete excavation of channel meanders (two) and lower adjacent levee (for stability)
  - Complete wetland area tidal channel excavation and grading (pannes, seasonal wetlands)
  - Breach remaining levee sections to connect meanders to existing channel (four locations)
  - Planting and erosion control Areas A and North Area B

b) Step 2: Fill Existing Ballona Channel (Sequence 24)
  - Block Ballona channel at meanders (rock dikes and or cofferdams)
  - Fill channel between blockages

c) Step 3: Complete Realignment (Sequence 25)
  - Levee removal
  - Armoring
  - Dredging
  - Modify water control structures

d) Step 4: Complete Area C and Area B fill areas (Sequence 20)
  - Place and compact earth from excavations
  - Grade seasonal wetlands
  - Planting and erosion control

e) Step 5: Public Access features (Sequence 21, 26, 28)

Final Phase:

4) Stage 4. West Area A and West Area B Restoration

a) West Area B wetland restoration
  - West Area B channel enhancement (Sequence 27)
  - Northwest Ballona Creek levee and Interim levee lowering and upland peninsula grading
  - North Ballona Creek levee breach at existing tide gate (Sequence 29)

b) Northwest Ballona Creek levee lowering/removal (Sequence 30)

c) Placement earth from excavations in Area B fill area if needed (Sequences 31 – 32)

3. OPERATIONS AND MAINTENANCE

The intent of the Project is to restore a wetland and creek habitat and flood protection system that is sustained by natural processes and requires minimal operations and maintenance (O&M) activities. A new long term O&M Agreement (between LACFCD, CDFG and all project proponents) will need to be established identifying all new operation and maintenance responsibilities that address 1) the newly modified channel and levees 2) water control structures 3) habitat and vegetation and 4) a number of other miscellaneous proposed items. The new long term O&M Agreement will identify those responsible for flood control and non-flood control aspects of the project.

3.1 EXISTING LA COUNTY O&M

The LA County Flood Control District currently performs maintenance of the existing flood control channel. The USACE (1999) *LA District Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual, Los Angeles County Drainage Area, CA* documents O&M responsibilities and procedures. Table 9 lists current LA County maintenance activities (P. Holland, LA County DPW, pers. comm.) and which activities are anticipated to be continued for the Project.

Table 9 Existing LA County O&M activities and anticipated continuation of existing O&M.

Current LA County O&M Activities	Anticipated Continuation of Existing O&M Activities	Note
1. Clean channel invert	No	See Section 4.2
2. Clean trash net	Yes	No change anticipated
3. Inspect and lock gates	Yes	Some new gate locations
4. Inspect and service flap gates	Yes	Existing West Area B SRT flap gates to remain in the Interim Phase; new structures and gates (see Section 4.4 and 2.8)
5. Inspect and service sub-drains	Yes	For existing sub-drains to remain within Project area
6. Maintenance and repair of fence and gates	Yes	Some new fence and gate locations
7. Maintenance and repair of weep holes	Yes	For existing levees and weep holes to remain
8. Midge control	TBD	
9. Operation and maintenance of tidal gates	Yes	Existing West Area B SRT flap gates to remain in the Interim Phase; new structures and gates (see Section 4.4 and 2.8)
10. Pre-emergent weed control	TBD	
11. Spill response	Yes	
12. Weed removal	TBD	
13. Trash free contract	TBD	

TBD = to be determined in coordination with LA County

3.2 BALLONA CREEK CHANNEL - MONITORING AND MAINTENANCE

The restored Ballona Creek channel is intended to have no substantial maintenance requirements. A monitoring and as-needed maintenance program will be developed for the channel. The level of channel erosion and deposition during storm flow events is anticipated to be acceptable for the restoration and flood management. The levee heights will be designed to meet flood criteria with a reduced channel cross-section (see the H&H Report Section 6 for additional discussion). This reduced channel cross-section will define a maintenance limit for the channel. The channel cross-section will be monitored to confirm that the cross-section and flood performance is within the maintenance limit. Any major debris or blockage of the channel that may negatively affect flood protection or restoration performance would need to be removed; however, this is not anticipated.

In locations where armoring is installed to limit erosion, the scour protection would be inspected and maintained as-needed maintenance; however, maintenance is not anticipated to be needed.

3.3 PERIMETER LEVEES - MONITORING AND MAINTENANCE

The levees themselves are intended to have no substantial maintenance requirements. The expected maintenance along the levees will be the periodic repaving of the bike path and walking trail, replacement or repair of fencing that may be installed, replacement or repair of any overlook or educational equipment placed along the walking trail, and trash collection and graffiti removal is encouraged for public involvement and habitat care. It is possible that minor erosion measures may be needed periodically.

3.4 WATER CONTROL STRUCTURES

Flap gates will need regular inspection and maintenance to ensure proper operation. Inspection of other structures will also periodically occur, but problems are unlikely except in the very long term. Gates may be adjusted seasonally for habitat management (see Section 2.8)

3.5 HABITAT AND VEGETATION – MONITORING AND MAINTENANCE

Portions of the restored site will be planted (e.g., upland, transition zone, high marsh, and low marsh), while other marsh areas may rely on natural recruitment of salt marsh vegetation (e.g., mid marsh). WRA’s CHRAMP includes a revegetation plan, including monitoring and maintenance. Vegetation maintenance, irrigation, and weeding may be required for certain habitats (e.g., for transition and upland habitat plantings).

Trash removal may also occur for some trash from that is not caught at the existing trash net/boom between Lincoln Blvd. and Culver Blvd. upstream of the restored wetlands and enters restored habitats at accessible locations.

4. LIST OF ACRONYMS

bgs	below ground surface
CHRAMP	Comprehensive Habitat Restoration and Adaptive Management Plan
FWM	Freshwater Marsh
H&H Report	Preliminary Flood Hydrology and Hydraulics Report
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MTL	Mean Tide Level
NAVD	North American Vertical Datum of 1988
NGVD	National Geodetic Vertical Datum of 1929
O&M	Operations and Maintenance
PDR	Preliminary Design Report
PID	Photoionization Detector
RS	River Stationing
SAP	Sampling and Analysis Work Plan

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