APPENDIX G

TIDAL HYDRAULICS STUDY FOR COLORADO LAGOON RESTORATION PROJECT EIR

TIDAL HYDRAULICS STUDY
FOR COLORADO LAGOON RESTORATION PROJECT EIR

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April 14, 2008

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1.0 INTRODUCTION

A tidal hydraulics study was performed in support of the Colorado Lagoon Restoration Project EIR. The EIR defines a proposed project and four alternatives. The hydraulics study was performed to analyze the changes to the existing condition resulting from the proposed project and alternatives. Finite element RMA2 and RMA4 numerical models were constructed.

The proposed project includes changes to the Lagoon's bathymetry resulting from dredging and short-term and long-term changes to the tidal connection between Colorado Lagoon and Marine Stadium. The short-term (Phase 1) change is to clean out the existing underground culvert and remove impedances to tidal exchange. The long-term (Phase 2) change is to replace the existing culvert with an open channel.

The four alternatives defined in the EIR are:

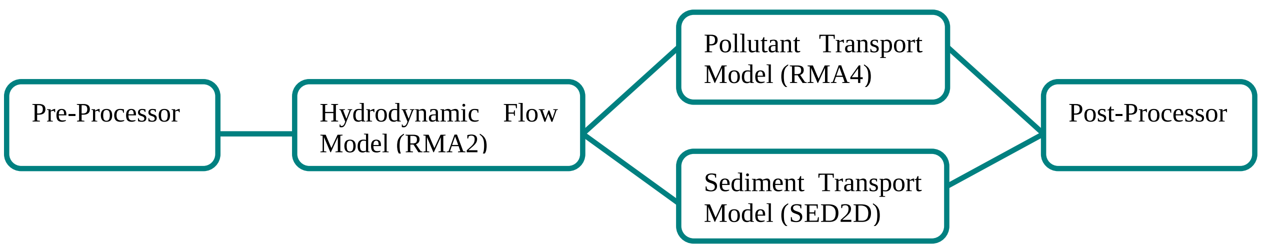
- Alternative 1 – No Project. The hydraulics of this alternative would be the same as for the existing condition.
- Alternative 2 – Reduced Project Alternative. This alternative does not include an open channel but does include changes to the Lagoon's bathymetry and cleaning of the existing culvert. The hydraulics of this alternative would be the same as for the proposed project's short-term change scenario.
- Alternative 3 – Recreation Alternative / No Open Channel, Develop a Parallel Culvert. This alternative is to retain and clean the existing culvert and construct a similar parallel underground culvert in order to increase tidal exchange. It does also include changes to the Lagoon's bathymetry.
- Alternative 4 – Alternative Channel Alignment. This alternative is similar to the proposed project long-term change, except that the alignment of the open channel is different and the channel is approximately 40 feet longer.

2.0 MODEL SELECTION AND DESCRIPTION

The numerical modeling systems used in this study are summarized in the following sections.

The TABS2 (McAnally and Thomas, 1985) modeling system was developed by the U.S. Army Corps of Engineers (USACE), and consists of two-dimensional, vertically averaged finite element hydrodynamics (RMA2), pollutant transport/water quality (RMA4) and sediment transport models (SED2D). TABS2 is a collection of generalized computer programs and pre- and post-processor utility codes integrated into a numerical modeling system for studying two-dimensional (2-D) depth-averaged hydrodynamics, transport and sedimentation problems in rivers, reservoirs, bays, and estuaries. The finite element method provides a means of obtaining an approximate solution to a system of governing equations by dividing the area of interest into smaller sub-areas called elements. Time-varying partial differential equations are transformed into finite element form and then solved in a global matrix system for the modeled area of interest. The solution is smooth across each element and continuous over the computational area. This modeling system is capable of simulating tidal wetting and drying of marsh and intertidal areas of the estuarine system.

A schematic representation of the system is shown below. TABS2 can be used either as a stand-alone solution technique or as a step in the hybrid modeling approach. RMA2 calculates water surface elevations and current patterns which are input to the pollutant transport (RMA4) and sediment transport (SED2D) models. Existing and proposed geometry can be analyzed to determine the impact of project designs on flow circulation, salinity, water quality and sedimentation in the estuary system. All models utilize the finite element method with Galerkin weighted residuals.



TABS2 Schematic

The hydrodynamic model simulates 2-D flow in rivers and estuaries by solving the depth-averaged Navier Stokes equations for flow velocity and water depth. The equations account for friction losses, eddy viscosity, Coriolis forces and surface wind stresses. The general governing equations are:

Continuity equation:

$$\frac{\partial h}{\partial t}+\frac{\partial (hu)}{\partial x}+\frac{\partial (hv)}{\partial y}=0$$

Conservation of momentum equations:

$$h\frac{\partial u}{\partial t}+uh\frac{\partial u}{\partial x}+vh\frac{\partial u}{\partial y}+gh\frac{\partial a}{\partial x}+gh\frac{\partial h}{\partial x}-h\frac{\varepsilon_{xx}}{\rho}\frac{\partial^2 u}{\partial x^2}-h\frac{\varepsilon_{xy}}{\rho}\frac{\partial^2 u}{\partial y^2}+S_{f_x}+\tau_x=0$$

$$h\frac{\partial v}{\partial t}+uh\frac{\partial v}{\partial x}+vh\frac{\partial v}{\partial y}+gh\frac{\partial a}{\partial y}+gh\frac{\partial h}{\partial y}-h\frac{\varepsilon_{yx}}{\rho}\frac{\partial^2 v}{\partial x^2}-h\frac{\varepsilon_{yy}}{\rho}\frac{\partial^2 v}{\partial y^2}+S_{f_y}+\tau_y=0$$

where:

u,v = x and y velocity components

t = time

h = water depth

a = bottom elevation

Sf_x = bottom friction loss term in x-direction

Sf_y = bottom friction loss term in y-direction

τ_x = wind and Coriolis stresses in x-direction

τ_y = wind and Coriolis stresses in y-direction

ε_{xx} = normal eddy viscosity in the x-direction on x-axis plane

ε_{xy} = tangential eddy viscosity in the x-direction on y-axis plane

ε_{yx} = tangential eddy viscosity in the y-direction on x-axis plane

ε_{yy} = normal eddy viscosity in the y-direction on y-axis plane

For this project study, the RMA2 hydrodynamic model and RMA4 water quality model were applied.

3.0 MODEL SETUP

Setup for the tidal and flood hydraulic model for existing conditions included determination of the model area, bathymetry, mesh selection, and boundary conditions. The RMA2 model was originally set up for the Colorado Lagoon Feasibility Study (M&N, 2004). The model was updated to reflect the proposed dredged lagoon condition and the proposed tidal connections between the Lagoon and the Marine Stadium.

The purpose of this modeling study was primarily focused on comparisons of the proposed project and alternatives versus the existing condition. Pumping at two local power plants would affect the tidal conditions in the lagoon; however the pumping effects would be similar on the existing condition, proposed project and alternatives, and they are not included in the modeling. Storm flows were not modeled as this was not an objective of the study. However, flood control would not be adversely affected by the proposed project nor the alternatives and would probably even improve over the existing condition. The groundwater flow input into the lagoon was not considered in the modeling since the groundwater level in the vicinity is lower than that in the lagoon. The groundwater movement direction should be from the lagoon. Also, the groundwater movement compared to tidal exchange is negligible.

3.1 MODEL AREA

The model area covers Alamitos Bay, Marine Stadium, Colorado Lagoon and nearshore ocean, as shown in Figure 1. The model mesh covers a relatively large area. The model's ocean boundary (at an average contour elevation of -45 feet relative to the NGVD29 vertical datum) is approximately one mile from the shoreline. The side boundaries are also approximately one mile northwest and southeast from the project site. Designating the open model boundaries far from the area of interest minimizes boundary effects.

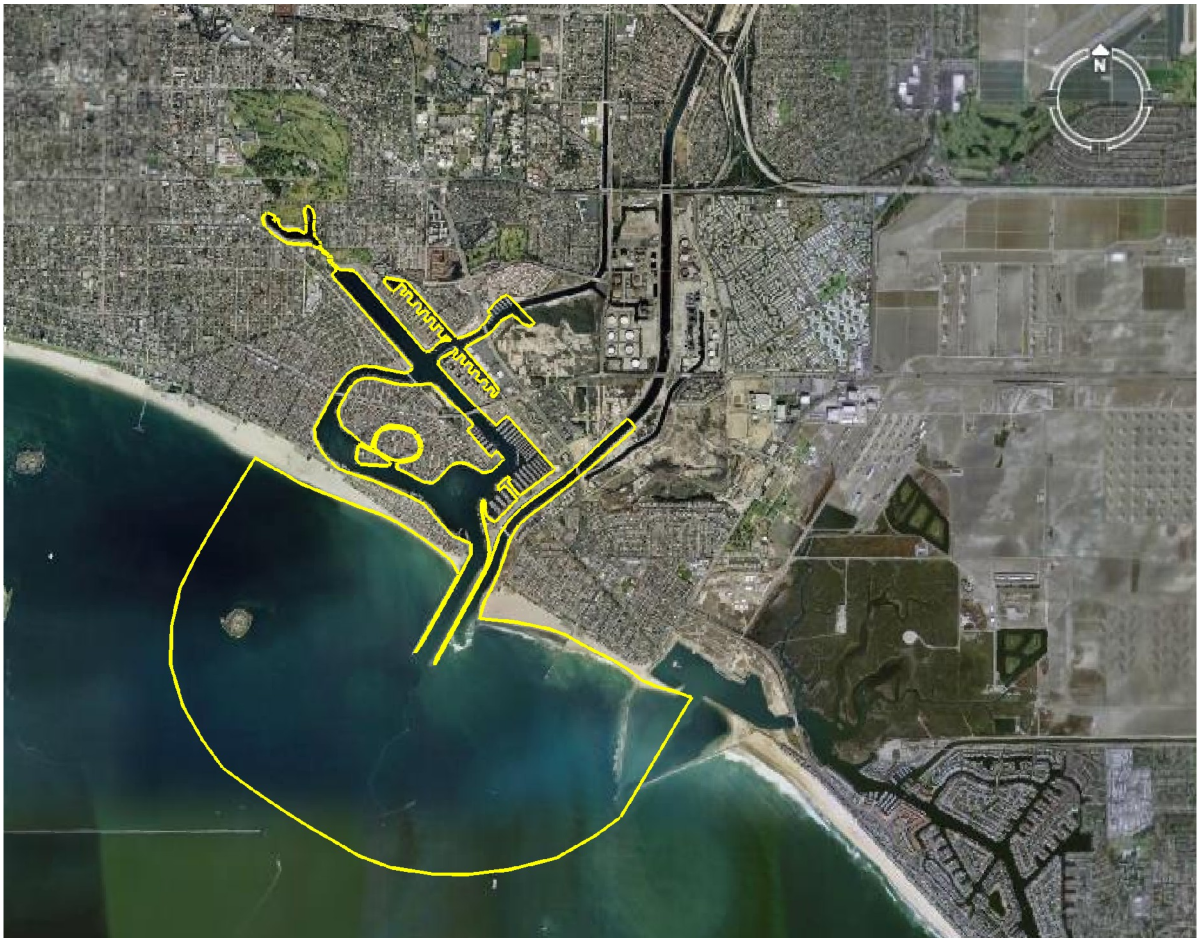


Figure 1. Modeling Area

3.2 BATHYMETRY

The Alamitos Bay and ocean bathymetry are based on data obtained from the National Oceanic and Atmospheric Administration (NOAA) chart 18749. The bathymetry of Colorado Lagoon and a portion of the Marine Stadium near the culvert connecting the Colorado Lagoon are based on a February 2004 survey by the Los Angeles County Department of Public Works (LACDPW). Design drawings and surveys of the culvert connecting Marine Stadium and the Colorado Lagoon were provided by the City of Long Beach. The flow through the culvert is simulated as a rating curve in the RMA2 model. The rating curve for the existing condition was calibrated during the model calibration (M&N 2004).

Figure 2 shows the bathymetry of the entire modeling domain. Figure 3 shows details of Colorado Lagoon for the proposed project and alternatives with bathymetry changes. The study uses the NAD 83 California Zone 6 horizontal coordinate system and the NGVD29 vertical datum. (NGVD29 is approximately 0.18 feet lower than Mean Sea Level of the latest tidal epoch for this area.) English units (feet, feet per second, etc.) are used throughout the model.

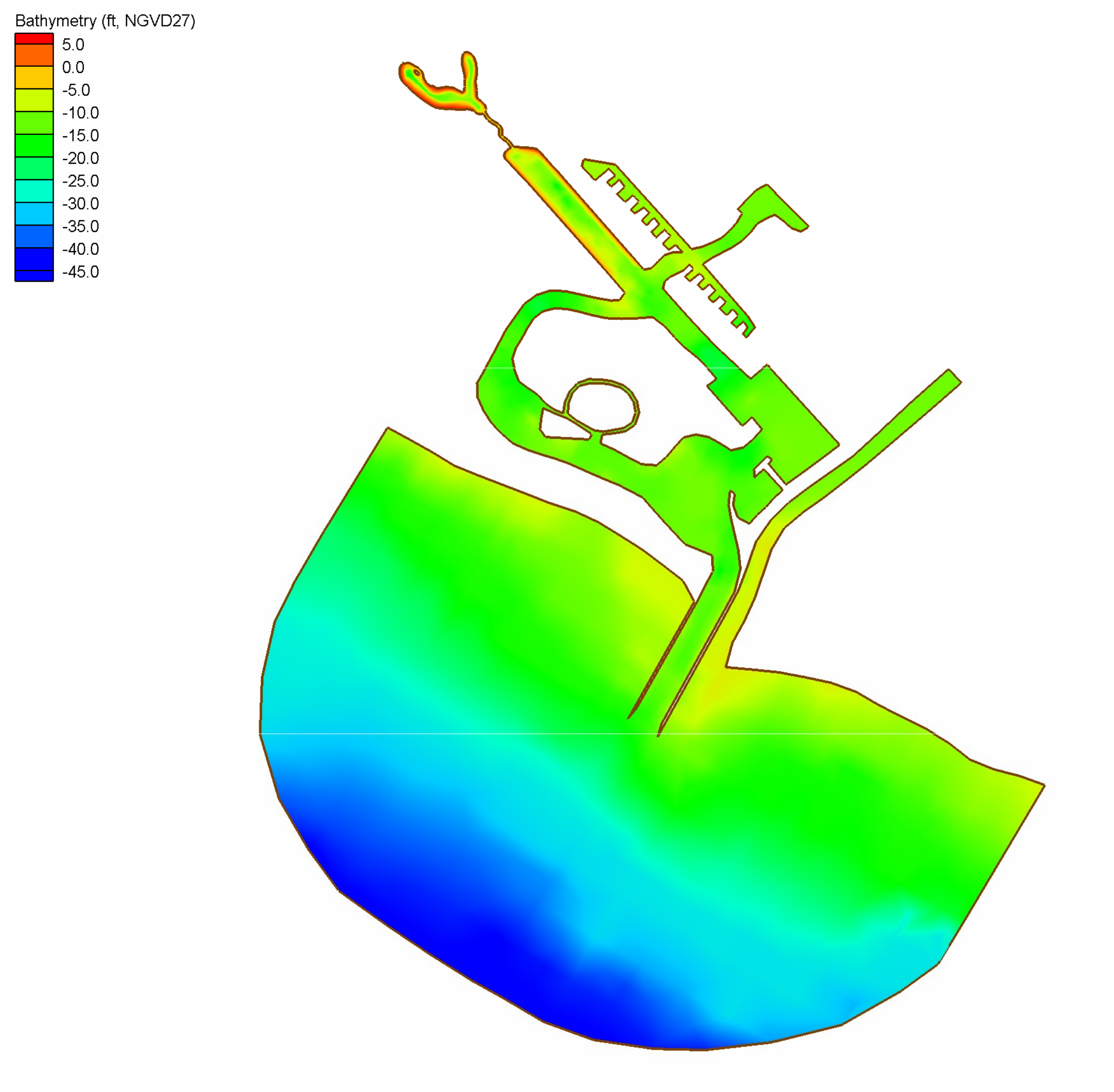


Figure 2. Bathymetry of the Entire Modeling Area

Figure 3. Bathymetry of the Colorado Lagoon

3.3 MODEL MESH

The RMA2 model requires the estuarial system to be represented by a network of nodal points defined by coordinates in the horizontal plane and water depth, and elements created by connecting these adjacent points to form areas. Nodes can be connected to form 1- and 2-D elements, having from two to four nodes. The resulting nodal/element network is commonly called a finite element mesh and provides a computerized representation of the estuarial geometry and bathymetry. The results discussed herein correspond to 2-D analyses with the exception of the culverts leading to the Colorado Lagoon which are represented by 1-D elements.

The two most important aspects to consider when designing a finite element mesh are: (1) determining the level of detail necessary to adequately represent the estuary, and (2) determining the extent or coverage of the mesh. The model described in this section is numerically robust and capable of simulating tidal elevations, flows, and constituent transport with reasonable resolution. Accordingly, the bathymetric features of the lagoon generally dictate the level of detail appropriate for the mesh.

There are several factors used to decide the aerial extent of a mesh. First, it is desirable to extend mesh open boundaries to areas which are sufficiently distant from the proposed areas of change so as to be unaffected by that change. Additionally, mesh boundaries must be located along sections where conditions can reasonably be measured and described to the model. Finally, mesh boundaries can be extended to an area where conditions have been previously collected to eliminate the need to interpolate between the boundary conditions from other locations.

The finite element mesh for the existing condition is shown in Figure 4. The mesh contains a section of ocean sufficiently large to eliminate potential model boundary effects. The lagoon portion of the mesh is bounded by the +5 foot contour relative to the vertical datum of NGVD29 considered to sufficiently contain the outermost extents of tidal and flood influence. The lagoon area mesh is shown in Figure 5.

The entire modeling area, approximately 5 square miles, is represented as a finite element mesh consisting of about 2,800 elements and 8,200 nodes.

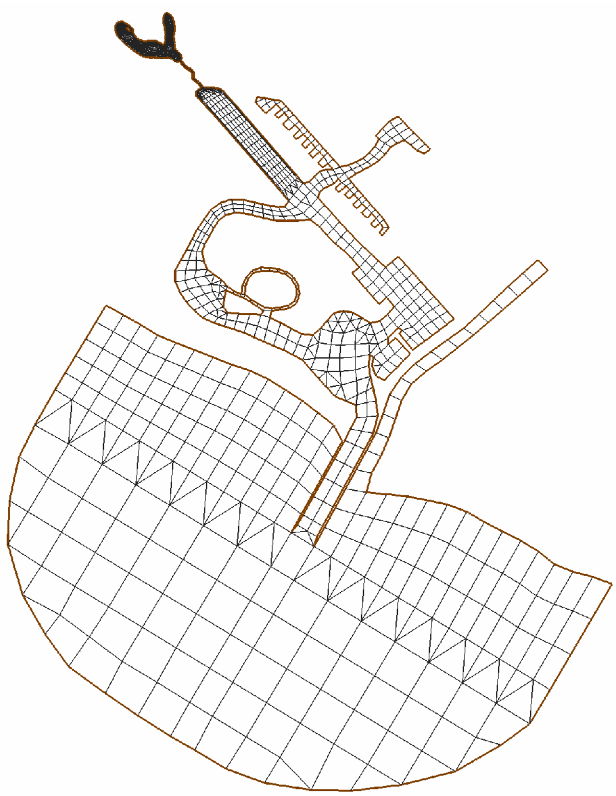


Figure 4. Entire Numerical Modeling Mesh

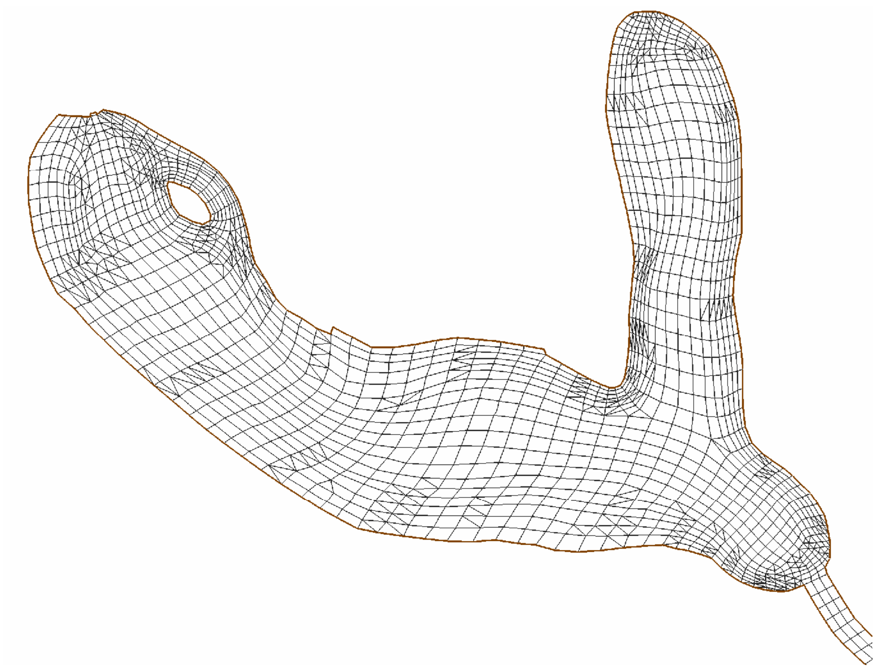


Figure 5. Numerical Modeling Mesh of the Colorado Lagoon

3.4 BOUNDARY CONDITIONS

3.4.1 Ocean Tides

Since there are no tide stations in Alamitos Bay, the Los Angeles Outer Harbor tide gage was used to define the ocean boundary tidal condition. These recorded water levels, relative to both MLLW and NGVD29 datums, are shown in Table 1. The diurnal tide range from Mean Lower Low Water (MLLW) to Mean Higher High Water (MHHW) is approximately 5.49 feet. Mean Sea Level (MSL) is at +2.82 feet relative to MLLW.

Table 1. Recorded Water Levels at Los Angeles Outer Harbor (1983-2001 Tidal Epoch)

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

Water level measurement data provide astronomical tides and other components including barometric pressure tide, wind setup, seiche, and the El Nino Southern Oscillation. Tidal variations can be resolved into a number of sinusoidal components having discrete periods. The longest significant periods, called tidal epochs, are approximately 19 years. In addition, seasonal variations in MSL can reach amplitudes of 0.5 feet in some areas, such as Los Angeles Outer Harbor. Superimposed on this cycle is a 4.4-year variation in the MSL that may increase the amplitude by as much as 0.25 feet in San Pedro Bay. Water level measurement data are typically analyzed over a tidal epoch to account for these variations and obtain statistical water level information (e.g., MLLW and MHHW).

3.4.2 Parametric Mean Periodic (PMP) Tidal Series

A synthetic tidal series, referred to as a parametric mean periodic (PMP) tide developed by M&N (1994b), is used to simulate long-term average water levels for determining residence times (RMA4 analysis). The series matches the mean water levels (i.e., MHHW, MLLW, etc.) and phase differences of the existing tidal epoch. This provides short duration (days) tidal conditions similar to the 19-year tidal epoch as shown in Figure 6 to reduce modeling time while still generating accurate results.

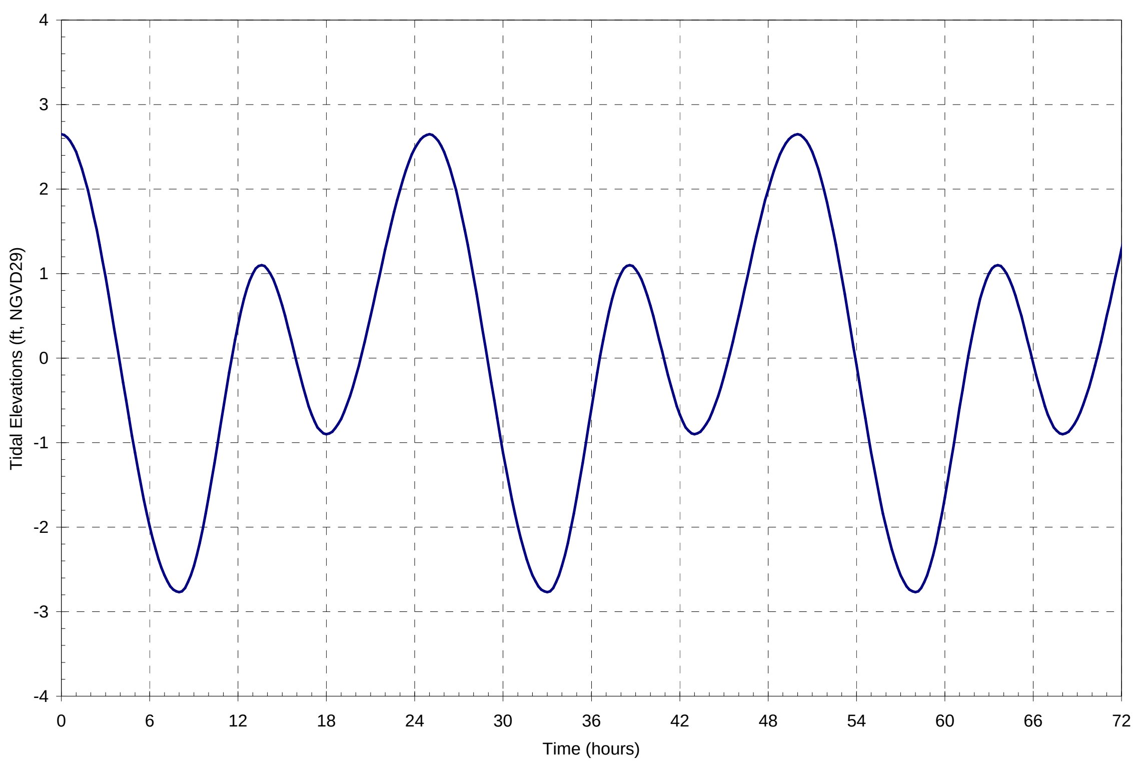


Figure 6. Parametric Mean Periodic (PMP) Tidal Series

3.4.3 Tidal Epoch Analysis (TEA) Tidal Series

The TEA tide is a synthetic 14-day tidal series developed statistically to match the cumulative distribution of water levels over a 19-year tidal epoch (1960-1978). The TEA tide includes both spring and neap tidal ranges shown in Figure 7. The largest 3-day spring tide period inside the red rectangular box in Figure 7 was selected to evaluate tidal muting in the Colorado Lagoon under the existing, proposed and alternative project conditions (RMA2 analysis). This spring tide period represents the average spring tidal condition in the ocean. In this area, spring tide ranges in mid-summer (July/August) and mid-winter (December/January) are usually larger than the average spring tidal range.

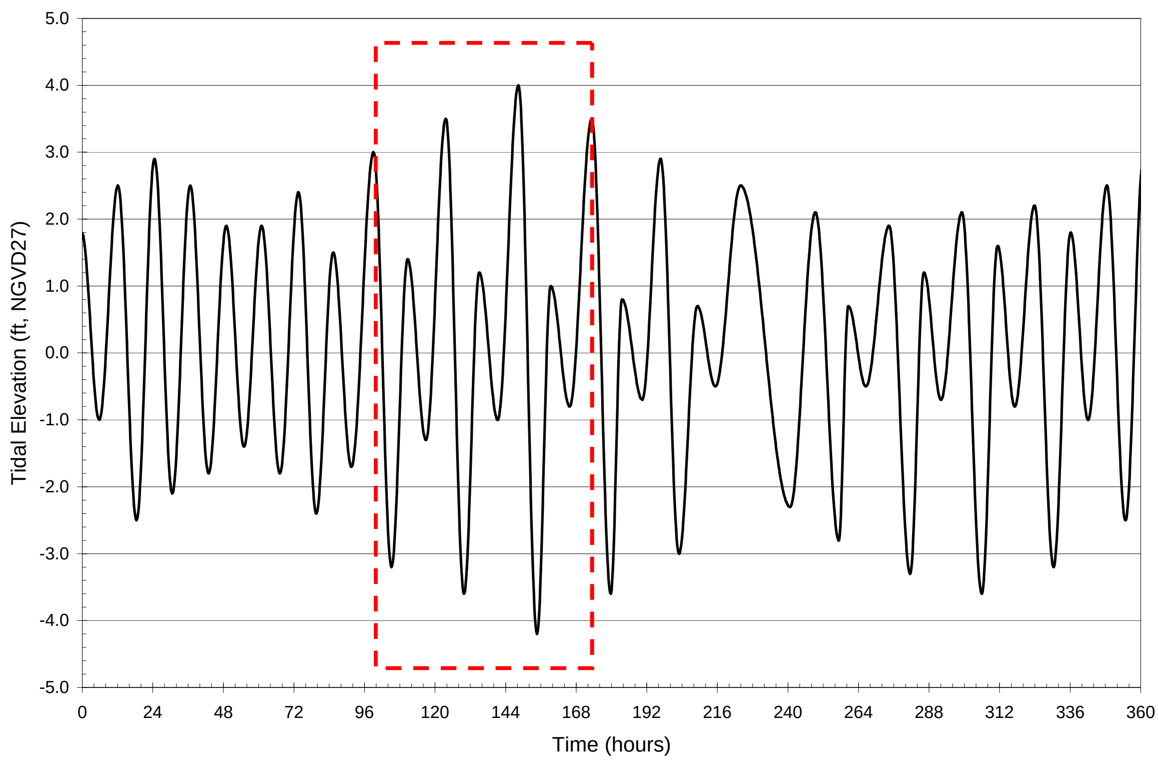


Figure 7. Tidal Epoch Analysis (TEA) Tidal Series

3.5 MODEL CALIBRATION

RMA2 calibration involves matching model predictions with measured data by selecting appropriate input variable values to model [e.g., Manning's roughness coefficient (n), and turbulence exchange coefficients (eddy viscosity)].

The RMA2 User's Manual recommends ranges of values for Manning's roughness coefficient (n) and eddy viscosity to be used in the model (USACE WES, 1996b). The value of Manning's roughness coefficient (n) is a function of the characteristics of the hydraulic system and represents the roughness of the channel bed. As discussed in Chaudhry (1993), values can range from 0.011 to 0.075 or higher for natural rivers and estuaries. Relatively high values (0.04 to 0.05) are specified for rough surfaces, such as channels with cobbles or large boulders. Mid-range values (0.03) represent clean and straight natural streams. Low values (0.013 to 0.02) are specified for smooth surfaces, such as concrete, cement, wood, or gunite. Values of Manning's roughness coefficient (n) used for this analysis are in the middle range of the recommended values.

Eddy viscosity represents the degree of turbulence in the flow. In this application, the values range from 50 to 300 lb-sec/ft^2. The modeling grid size depends on and is limited by the Peclet number and eddy viscosity. The Peclet number is defined as $\frac{\rho V \Delta X}{E_{ij}}$, in which ρ, V, ΔX, and E_{ij} are the water density, velocity, grid size and eddy viscosity, respectively. In order for the solution to be stable, the Peclet number has to be less than 50. The Peclet number can be reduced by increasing the mesh density or by increasing the eddy viscosity. However, it is unrealistic and time-consuming to perform the modeling with a very fine grid. Therefore, a relatively high value of eddy viscosity is used in order to preserve numerical stability, and to streamline the modeling efforts.

The detailed model calibration was carried out in the feasibility study (M&N 2004). The RMA model is relative robust and is not very sensitive to the roughness and eddy viscosity parameters. The modeling parameters used in this study are presented in Table 2.

Table 2. Setup Values for Model Calibration

Model Area	Manning's Roughness Coefficient (n)	Eddy Viscosity Coefficient (lb-sec/ft^2)
Lagoon Intertidal Areas	0.037	300
Lagoon Subtidal Areas	0.035	150
Marine Stadium Intertidal Areas	0.035	120
Narrow Channels and Marinas	0.025	50
Marine Stadium Subtidal & Alamitos Bay Areas	0.025	150
Nearshore Surf Zone	0.025	250
Offshore from surf Zone	0.03	250

The time step is a very important parameter in the modeling. Sensitivity tests were conducted and results showed that the RMA2 model becomes unstable with an increasing time step if the wetting and drying processes are considered. A time step of 0.1 hour was used in order for the solution to be stable and to reflect the dynamic tidal fluctuations.

4.0 TIDAL HYDRAULICS MODELING RESULTS

The calibrated RMA2 numerical model was applied to evaluate tidal range under the average spring tidal condition for the existing, proposed and alternative project scenarios. The tidal series in the Colorado Lagoon south end, shown in Figure 8, under proposed project and alternative conditions are compared with that in the ocean. The gage locations shown in Figure 8, where modeling results were extracted, are fixed, although the connection between the lagoon and Marine Stadium varies from alternative to alternative. (Both the Colorado Lagoon South End and the Marine Stadium Northwest End gage locations were used for the residence time analysis).

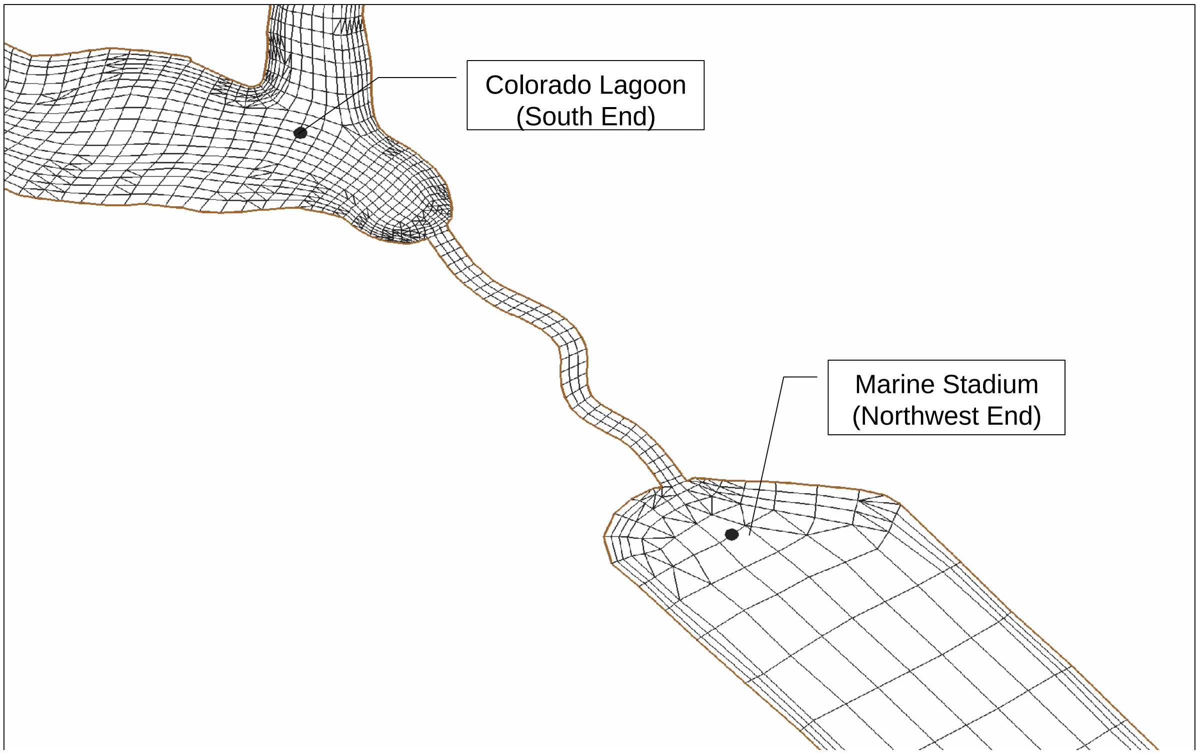


Figure 8. Modeling Output Gage Locations

The tidal range, high tide muting, low tide muting and low tide phase lag in the lagoon comparing with those in the ocean are summarized in tables and figures below. The high tide muting is calculated by subtracting the highest ocean tide by the highest lagoon tide, and a positive number indicates the lagoon high tide is muted. The low tide muting is calculated by subtracting the lowest ocean tide by the lowest lagoon tide, and a negative number indicates the lagoon tide is truncated. The low tide phase lag is the lag time of the low tide in the lagoon comparing with that in the ocean.

For the scenarios with the dredged Lagoon bathymetry (proposed project and all alternatives), the revised bathymetry creates a larger Lagoon tidal prism and thus tends to further mute the tidal range versus the existing condition tidal range. However, the relative effect of the revised bathymetry is probably small in proportion to the tidal condition changes resulting from the changes to the tidal connection.

Under Phase 1 of the proposed project condition, the spring tide range comparisons are shown in Figure 9. Table 3 summarizes the spring tide ranges, high/low tide mutings and low tide phase lags in the lagoon compared with the ocean. Both high and low tides are muted under both the existing and proposed project Phase 1 conditions. Under the existing condition, the spring tide range is 4.4 ft, which is only about 54% of the ocean tide range. Under the proposed project Phase 1 condition, the muting is less than that under the existing condition (tide range of about 69% of the ocean tide range); however, it is still very significant with a low tide muting of 2.12 ft and a phase lag of 2.2 hours.

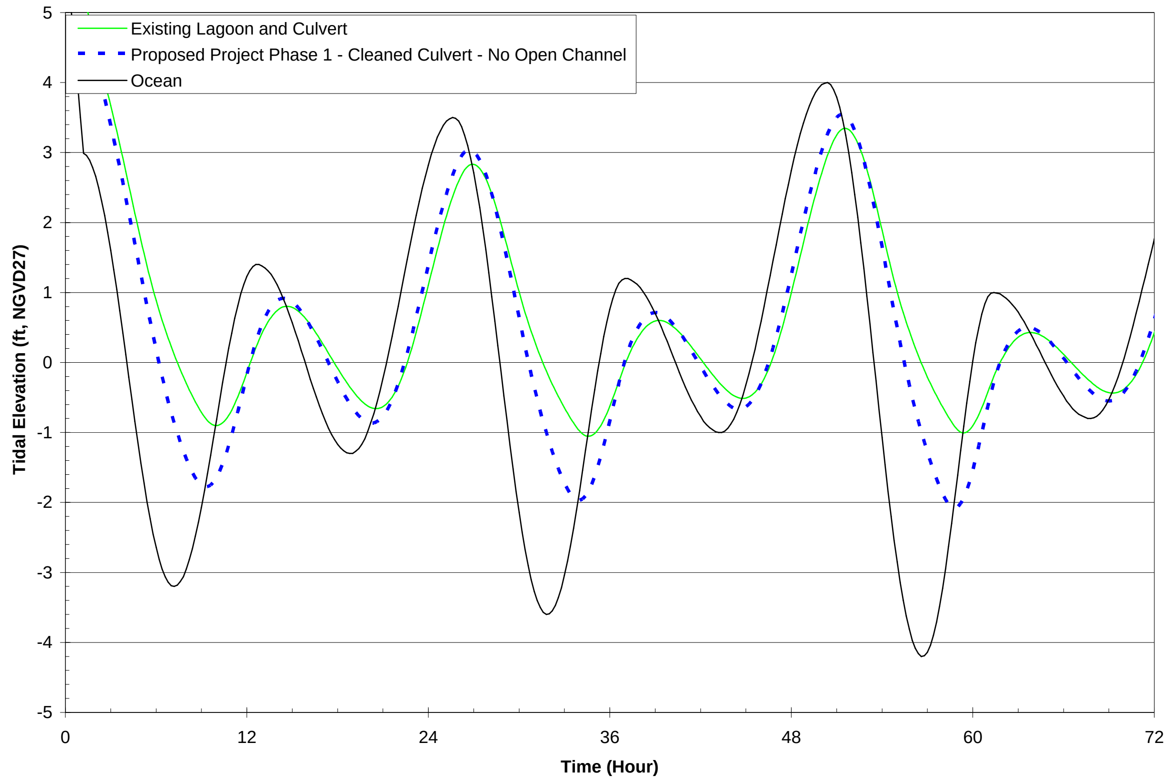


Figure 9. Spring Tide Range Comparisons – Proposed Project Phase 1

Table 3. Summaries of Spring Tide Range Comparisons - Proposed Project Phase 1

Scenario	Tidal Range (ft)	High Tide Muting (ft)	Low Tide Muting (ft)	Low Tide Phase Lag (hours)
Existing Lagoon and Culvert	4.40	0.66	-3.15	2.80
Proposed Project Phase 1 – Cleaned Culvert (No Open Channel)	5.63	0.45	-2.12	2.20
Ocean	8.20	N/A	N/A	N/A

Under Phase 2 of the proposed project condition, the spring tide range comparisons are shown in Figure 10. The spring tide ranges, high/low tide mutings, and low tide phase lags in the lagoon comparing with the ocean are summarized in Table 4. Both lagoon high tide and low tide reach the ocean tide range, i.e. 100% achievement of ocean tide range. The low tide phase lag is 0.40 hours, which is 2.40 hours less than the existing condition. The model results indicate the proposed project with an open channel connection will significantly improve the hydraulic condition in the lagoon.

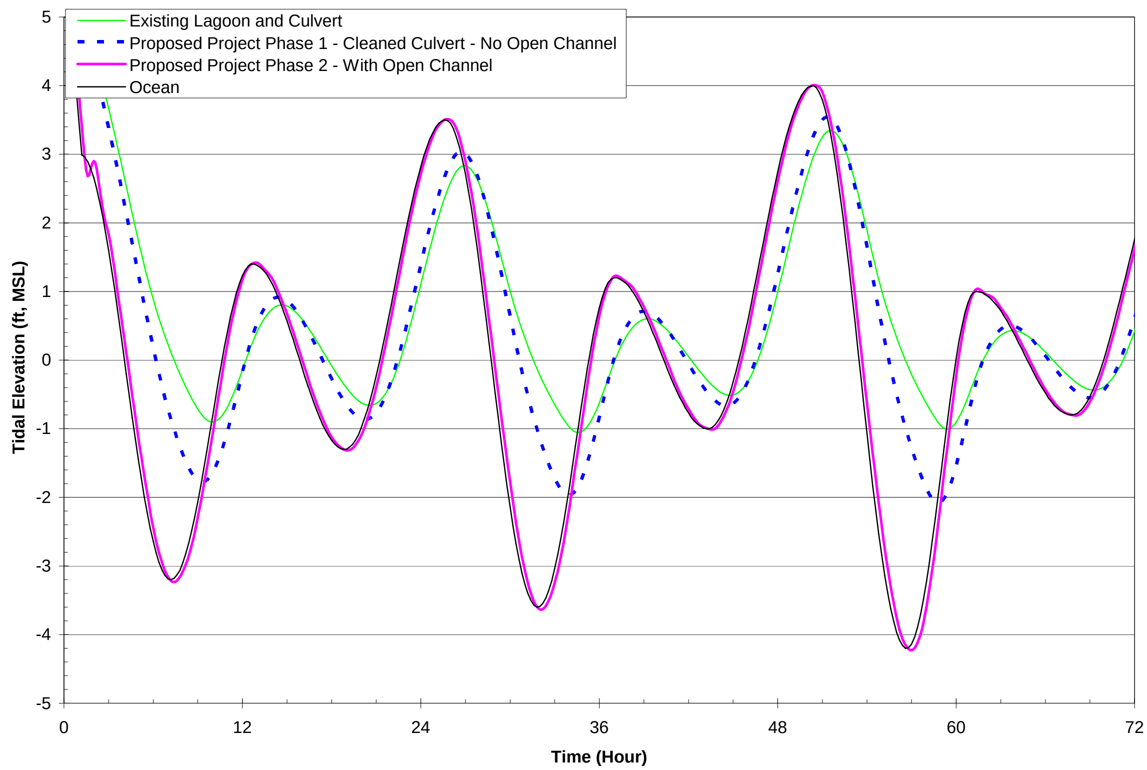


Figure 10. Spring Tide Range Comparisons - Proposed Project Phase 2

Table 4. Summaries of Spring Tide Range Comparisons - Proposed Project Phase 2

Scenario	Tidal Range (ft)	High Tide Muting (ft)	Low Tide Muting (ft)	Low Tide Phase Lag (hours)
Existing Lagoon and Culvert	4.40	0.66	-3.15	2.80
Proposed Project Phase 1 – Cleaned Culvert (No Open Channel)	5.63	0.45	-2.12	2.20
Proposed Project Phase 2 – With Open Channel	8.20	0.00	0.00	0.40
Ocean	8.20	N/A	N/A	N/A

Two hydraulically-different alternatives were analyzed. Figure 11 shows the tide range comparisons between the existing condition and proposed project and alternatives. The spring tide ranges, high/low tide mutings, and low tide phase lags in the lagoon comparing with the ocean are summarized in Table 5. The hydraulic performance of Alternative 4 is very similar to that of the proposed project Phase 2, and that of Alternative 3 is between Phase 1 and Phase 2 of the proposed project. The phase lag of Alternative 4 is very similar to that under the proposed project condition, or the difference is within the model time step of 0.1 hours.

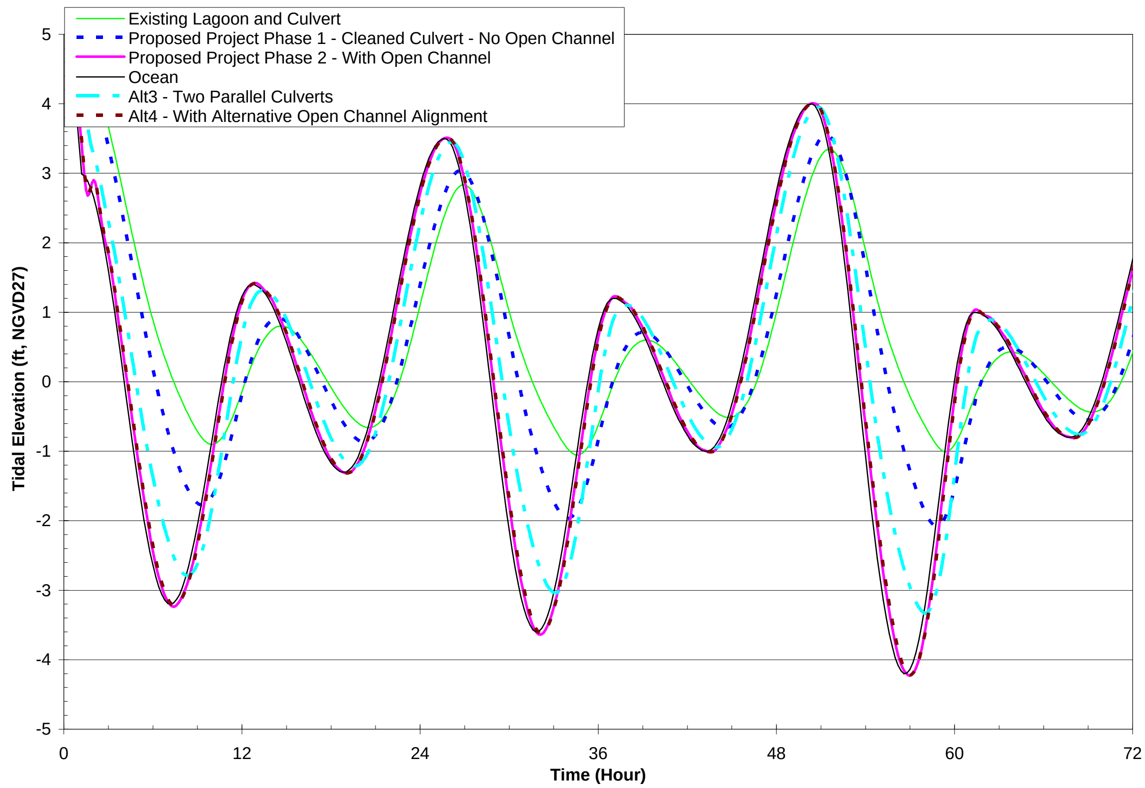


Figure 11. Spring Tide Range Comparisons - Alternatives

Table 5. Summaries of Spring Tide Range Comparisons - Alternatives

Scenario	Tidal Range (ft)	High Tide Muting (ft)	Low Tide Muting (ft)	Low Tide Phase Lag (hours)
Existing Lagoon and Culvert	4.40	0.66	-3.15	2.80
Proposed Project Phase 1 – Cleaned Culvert (No Open Channel)	5.63	0.45	-2.12	2.20
Proposed Project Phase 2 – With Open Channel	8.20	0.00	0.00	0.40
Alt3 – Two Parallel Culverts	7.29	0.05	-0.87	1.40
Alt4 – With Alternative Open Channel Alignment	8.20	0.00	0.00	0.40
Ocean	8.20	N/A	N/A	N/A

5.0 RESIDENCE TIME ANALYSIS

5.1 METHDOLOGY DESCRIPTION

Constituent concentrations in a water body reflect a balance between the rate of constituent supply and the rate of constituent removal by tidal flushing. Residence time (i.e., average time a particle resides in a hydraulic system) provides a useful measure of the rate at which water in the hydraulic system is renewed. Accordingly, residence time provides a means for indirectly assessing the water quality of a hydraulic system.

Consider the reduction of a tracer concentration in a tidal embayment due to flushing after being released (Fischer et al., 1979), in which C_0 is initial concentration, K is a reduction coefficient and C(t) is the concentration at time t.

$$C(t) = C_0 e^{-Kt}$$

The residence time of the tracer in the embayment is determined from

$$T_r = \frac{\int_0^\infty t\, C(t)\, dt}{\int_0^\infty C(t)\, dt} = \frac{1}{K}.$$

Since the concentration at t = T_r is

$$C(T_r) = C_0 e^{-1} = \frac{C_0}{e}$$

T_r can be calculated from a regression analysis of the tracer concentration time series computed by the numerical model RMA4.

Based on the above methodology, the general procedure of computing the residence times for different parts of a tidal embayment is as follows:

- Assign an initial tracer concentration of one over the entire embayment (entire bay for this study) and a value of zero at the open water boundaries to simulate an instantaneous release of a contaminant in an embayment;
- Run the numerical model RMA4 for an adequate number of tidal cycles until substantial reductions of tracer concentrations have occurred due to tidal flushing at the locations of interest;
- Analyze the computed concentration results by regression analysis to obtain the tracer reduction distributions at the locations of interest; and
- Find the residence times for the locations of interest from the distribution curves.

5.2 RESIDENCE TIME MODELING RESULTS

Water surface elevations and current patterns simulated by the RMA2 hydrodynamic model were input to the pollutant transport RMA4 model to estimate water residence times. As there are no data and budget available for RMA4 model calibration, the modeling parameters used were based on literature and past similar project experiences. Two power plants, namely the AES power plant and Haynes power plant, intake cooling water from Alamitos Bay and discharge it into the San Gabriel River (SGR). These affects are not considered in the modeling. The residence times will vary with power plant pumping included. However, the results without pumping are considered sufficient for the purpose of alternatives comparisons.

The residence time will also vary under different tide conditions such as spring and neap tide cycles. In this study, a synthetic tidal series representing a long term average tidal condition (PMP tidal series discussed in Section 3.4.2) was used in determining residence times. The residence times are shorter for locations relatively close to the ocean entrance and longer for areas farther upstream such as Colorado Lagoon.

The south end of the Lagoon (near the culvert) and the northwest end of the Marine Stadium, as shown in Figure 8, were the locations selected to compare residence times. In general, the northwest end of Marine Stadium represents the best possible condition attainable by the Colorado Lagoon. Table 6 summarizes residence times at these locations under the different scenarios. The residence time is shortest under the proposed project Phase 2 condition. The residence time in the lagoon for Alternative 4 is slightly longer than that for proposed project. This is likely a result of a longer open channel connection. The dredged Lagoon bathymetry creates a larger tidal basin (tidal prism) and thus results in slightly higher residence times than what would result with the existing bathymetric condition, i.e. the proposed project and alternative numbers in the table below would be slightly lower if the Lagoon was not dredged.

Table 6. Residence Time Summary

Modeling Scenarios	Residence Time (days)	
	Colorado Lagoon	**Marine Stadium**
Existing Lagoon and Culvert	8.5	6.9
Proposed Project Phase 1 - Dredged Lagoon and Cleaned Culvert, No Open Channel	8.0	6.2
Proposed Open Project Phase 2 – With Open Channel	7.3	6.1
Alt3 – Two Parallel Culverts	7.8	6.2
Alt4 – With Alternative Open Channel Alignment	7.6	6.1

6.0 SUMMARY

The RMA2 numerical model created and calibrated in the Colorado Lagoon Restoration Feasibility Study (M&N 2004) was modified to reflect the current proposed project and alternative conditions. The RMA2 and RMA4 models were applied, respectively, to predict: a) tide muting under the average spring tide condition and b) tidal circulation (as measured by residence time) under the average parametric mean periodic tide condition. All modeling were performed under the dry weather condition; no storm waters were considered.

Under the existing condition, the model results show that the spring low tides in the Colorado Lagoon are cut off by about 3.1 feet compared to the ocean tide and the spring high tides are muted about 0.7 feet. The existing residence time in the lagoon, for the model conditions, is approximately 1.6 days longer than that at the northwest end of the Marine Stadium. The tidal fluctuations at Marine Stadium are very similar to the ocean, thus indicating the culvert is the restriction on lagoon circulation.

Under the proposed project Phase 1 (Lagoon dredged plus cleaned culvert), the spring low tide is cut off by approximately 2.1 feet compared to the ocean tide, i.e. about one foot less muting than that under the existing condition. The spring high tide elevation in the lagoon is also muted less. The Lagoon residence time for the phase 1 proposed project is approximately 0.5 days shorter than for the existing condition. Residence time in the Marine Stadium is also improved under this scenario.

Under the proposed project Phase 2 (Lagoon dredged plus open channel connection), both spring high and low tides in the lagoon reach the ocean tide range. The Lagoon residence time is approximately 1.2 days shorter than for the existing condition. Residence time in the Marine Stadium is also improved.

Under the alternative conditions, both the tidal circulation and residence time fall between the proposed project Phase 1 and Phase 2. The lagoon's residence time in Alternative 4 is slightly longer than that under the proposed project Phase 2 condition since the Alternative 4 open channel alignment is about 40 feet longer than that of the proposed project.

7.0 REFERENCES

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APPENDIX H

NOISE IMPACT ANALYSIS

NOISE IMPACT ANALYSIS

COLORADO LAGOON RESTORATION PROJECT

LONG BEACH, CALIFORNIA

LSA

May 2008

NOISE IMPACT ANALYSIS

COLORADO LAGOON RESTORATION PROJECT

LONG BEACH, CALIFORNIA

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LSA Project No. CLB0702

May 2008

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INTRODUCTION

This noise impact analysis has been prepared to evaluate the potential noise impacts and mitigation measures associated with the habitat and recreation improvements to the Colorado Lagoon (Lagoon) and adjacent areas, including Marina Vista Park, which comprise a 48.61-acre (ac) project area/park site in the City of Long Beach (City), as shown on Figure 1.

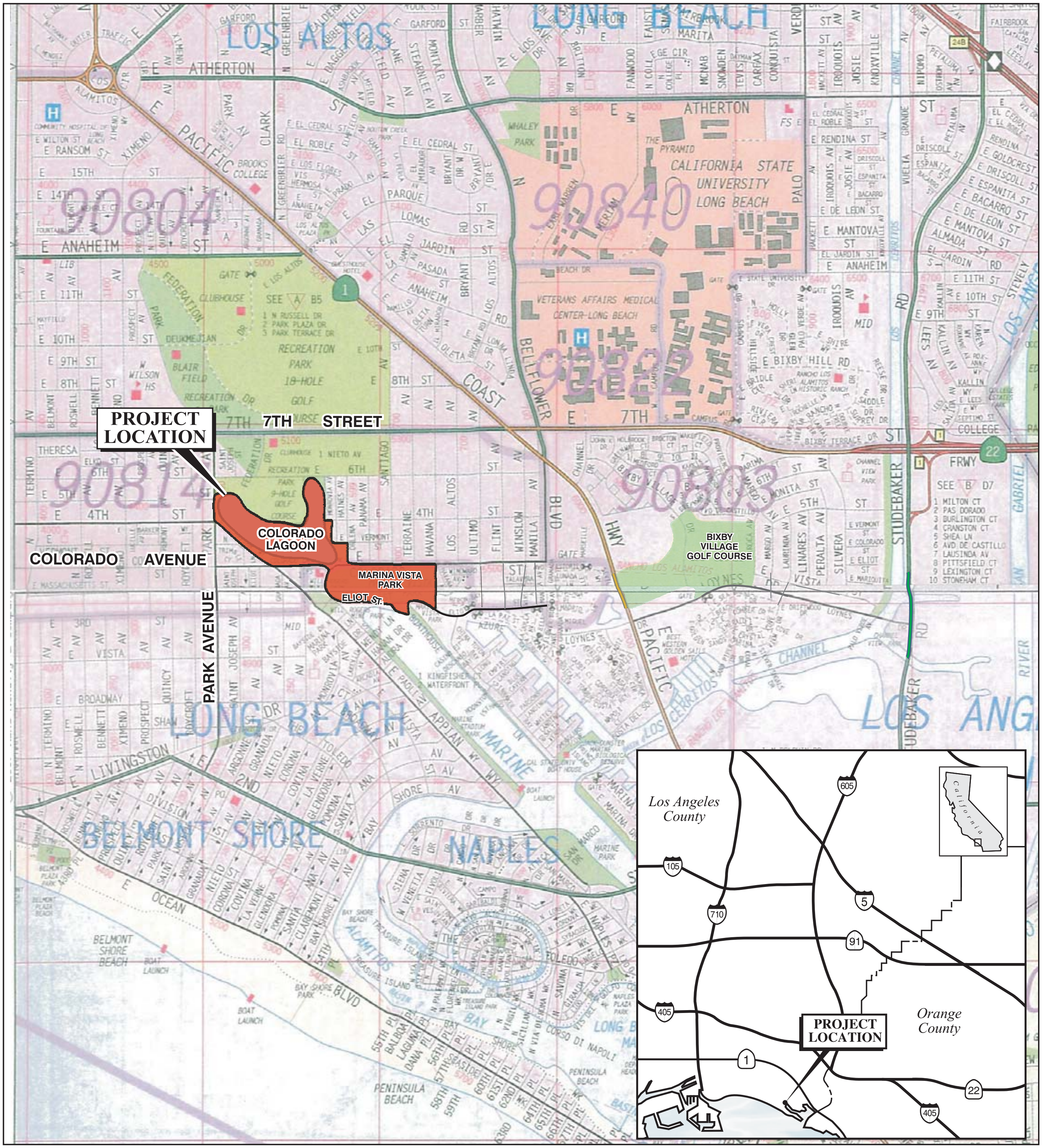
The Lagoon is an approximately 11.7 ac tidal water body[1] that is connected to Alamitos Bay and the Pacific Ocean through an underground tidal culvert to Marine Stadium. The Lagoon is located in a park setting and is owned and maintained as a City park by the City Department of Parks, Recreation, and Marine. The Lagoon serves three main functions: hosting estuarine habitat, providing public recreation (including swimming), and retaining and conveying storm water drainage. The water and sediment quality within the Lagoon are degraded. The Lagoon is listed on California's 303(d) list of impaired water bodies due to elevated levels of lead, zinc, chlordane, and polycyclic aromatic hydrocarbons (PAHs) in the sediment and chlordane, dichlorodiphenyltrichloroethane (DDT), dieldrin, and polychlorinated biphenyls (PCBs) in fish and mussel tissue. In addition, testing confirmed the presence of PCBs, cadmium, copper, mercury, and silver as secondary contaminants of concern. Bacterial contamination of the Lagoon water is also a major concern. The purpose of the proposed project is to restore the site's ecosystem, provide enhanced recreation facilities, and improve water and sediment quality while managing storm water.

PROJECT LOCATION

The City is approximately 20 miles (mi) south of downtown Los Angeles and is adjacent to the Pacific Ocean. The Lagoon and Marina Vista Park (proposed project site) are located in the southwestern portion of the City. The Lagoon lies northwest of the mouth of the San Gabriel River and is north of Marine Stadium and Alamitos Bay. The Lagoon is primarily accessible from East Appian Way and East Colorado Street via Park Avenue from East 7th Street. However, many local streets provide access to the Lagoon and its surrounding areas. Regional access to the project site is provided by Interstate 405 (I-405), Interstate 605 (I-605), and Interstate 710 (I-710) to the north and west. Figure 1 shows the project location.

Recreation Park is adjacent to the Lagoon on the north and includes a 9-hole and 18-hole golf course, a baseball stadium, a casting pond, picnic areas, a dog park, tennis courts, a community center, lawn bowling, and a playground. In addition, Marina Vista Park is located to the southeast of the Lagoon, on the south side of East Colorado Street. Marina Vista Park overlooks the water of Marine Stadium to the south and provides the following amenities: two soccer fields, tennis courts, a baseball diamond, play equipment, picnic areas, and restrooms. Additionally, Marina Vista Park is the

1 Lagoon water body acreage was estimated by LSA Associates, Inc. (LSA) geographic information systems (GIS) based on a 2006 aerial photo and varies with the tides.



LSA

FIGURE 1

PROJECT AREA

0 1000 2000
FEET

SOURCE: Thomas Guide, 2007

Colorado Lagoon Restoration Project

Project Location

I:\CLB0702\G\Location2 fig1.cdr (4/7/08) site of municipal band concerts in the summer. Both Recreation Park and Marina Vista Park are owned and operated by the City Department of Parks, Recreation, and Marine. Residences and public schools surround the other portions of the Lagoon. The proposed project includes improvements within Marina Vista Park.

The Colorado Lagoon Playgroup Preschool, which is a program for three- to five-year-old children, and a model boat shop are located on the south side of the Lagoon. Other on-site facilities include the City's Colorado Lagoon Marine Science Center, which is staffed by the City and Friends of the Lagoon (FOCL), restrooms, parking, a pedestrian bridge, a lifeguard station, sandy shoreline areas, play equipment, picnic areas, and grassy open-space areas.

PROJECT OBJECTIVES

Pursuant to Section 15124 of the California Environmental Quality Act (CEQA) Guidelines, the description of the proposed project contains a statement of the objectives sought for development of the proposed project.

The Lagoon Restoration Project is a comprehensive plan for enhancement of the Lagoon, which is owned and maintained by the City Department of Parks, Recreation, and Marine. The City is committed to preserving and improving the open space, recreational resource, and biodiversity that this area provides. The primary goals of the proposed project are to: (1) create habitat that can successfully establish and support native plant and animal communities in the long term, (2) implement long-term water quality control measures, and (3) enhance the Lagoon's value as a recreational resource. The proposed project provides a framework to coordinate these various and potentially competing interests.

Specifically, the objectives of the proposed project are to:

- Reduce and treat storm and dry weather runoff to minimize contamination of water and sediment in the Lagoon.
- Improve water quality by increasing the Lagoon's circulation and enhancing the tidal connection with Marine Stadium.
- Improve water quality by removing contaminated sediments.
- Restore and maintain the estuarine habitats.
- Balance flood control, water quality, and the recreation demands of the Lagoon.
- Enhance public enjoyment of the Lagoon.

The project objectives listed above are intended to implement the following goals, objectives, and policies of the City's Open Space and Recreation Element of the General Plan and the Long Beach Department of Parks, Recreation, and Marine Strategic Plan:

- Develop well-managed, viable ecosystems that support the preservation and enhancement of natural and wildlife habitats (Open Space and Recreation Element, Goals/Objectives 1.1).
- Preserve, keep clean, and upgrade beaches, bluffs, water bodies and natural habitats (Open Space and Recreation Element, Goals/Objectives 1.2).
- Design and manage natural habitats to achieve environmental sustainability (Open Space and Recreation Element, Goals/Objectives 1.4).
- Promote the creation of new and reestablished natural habitats and ecological preserves, including wetlands, woodlands, native plant communities, and artificial reefs (Open Space and Recreation Element, Policy 1.1).
- Protect and improve the community's natural resources, amenities, and scenic values, including nature centers, beaches, bluffs, wetlands, and water bodies (Open Space and Recreation Element, Policy 1.2).
- Promote and assist with the remediation of contaminated sites (Open Space and Recreation Element, Policy 1.4).
- Restore Lagoon to serve as both a productive wetland habitat and recreational resource by reducing pollutant discharges into the water, increasing water circulation with Alamitos Bay, and/or restocking or planting appropriate biological species (Open Space and Recreation Element, Program 1.6).
- Maintain a sufficient quantity and quality of open space in the City to produce and manage natural resources (Open Space and Recreation Element, Goals/Objectives 2.1).
- Preserve, enhance, and manage open areas to sustain and support marine life habitats (Open Space and Recreation Element, Policy 2.4).
- Make all recreation resources environmentally friendly and socially and economically sustainable (Open Space and Recreation Element, Goals/Objectives 4.5).
- Establish lifetime use opportunities. Recreation programs and facilities will be designed to develop and serve a lifetime user through active, passive, and educational experiences (Department of Parks, Recreation, and Marine Strategic Plan, Strategy 9, page 62).
- The Department of Parks, Recreation, and Marine should be a steward for preserving the environmental, cultural, and historical resources in the City (Department of Parks, Recreation, and Marine Strategic Plan, Strategy 11, page 63).
- Support efforts to improve the water quality and cleanliness of City beach areas (Department of Parks, Recreation, and Marine Strategic Plan, Strategy 13, page 66).

PROJECT COMPONENTS

Improvements Benefiting Water and Sediment Quality

Improved water and sediment quality would enhance recreational opportunities at the Lagoon, may lead to a more diverse invertebrate and fish community, and would increase the potential for the Lagoon to support a variety of plant and animal species.

Clean Culvert and Remove Tidal Gates, Sill, and Other Structural Impedances. This is a short-term project component that would be superseded by development of the open-channel component, as described later in this Section.

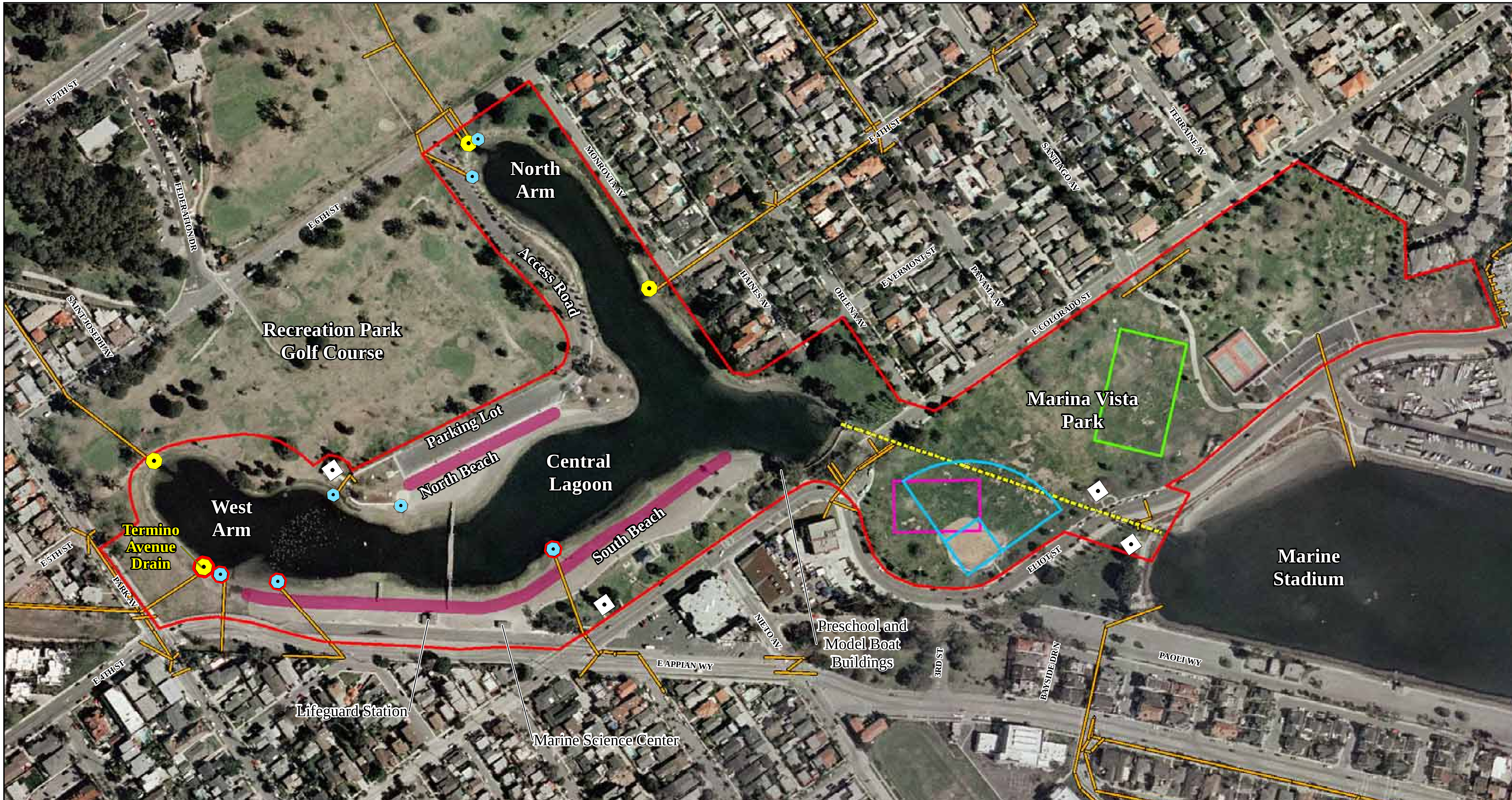
Currently, the Lagoon is connected to Marine Stadium via an underground box culvert under Marina Vista Park. The culvert is approximately 900 feet (ft) long and provides tidal exchange between the Lagoon and Marine Stadium. The cross-section of the culvert is not constant throughout its length. The opening on the Lagoon side is 14 ft wide by 7 ft high, and the opening on the marine stadium side is 12 ft wide by 8 ft high. The existing culvert location and length are shown in Figure 2. The existing culvert design and degraded condition is limiting the amount of tidal flushing between Marine Stadium and the Lagoon, which contributes to the Lagoon's water quality problem. Measured tide data shows that spring low tides in the Lagoon are perched above those of Marine Stadium and the ocean by approximately 3 ft. This indicates that something in the culvert restricts the low tide elevation from dropping below a certain level. There is also a tidal time lag between the Marine Stadium and the Lagoon, which further indicates a reduction in tidal exchange.

The existing culvert has not been cleaned since it was built in the 1960s. Because of this, the culvert is impeded by sediment that has accumulated on the bottom, extensive marine growth that has accumulated on the sides and ceiling, and debris that is trapped within the trash racks on the tide gate screens at both ends of the culvert. The culvert was most recently inspected via a dive survey in 2005, which covered the entire length of the culvert, and measurements were taken every 50 ft. The amount of sediment buildup on the floor ranged from 9 to 30 inches (in) along the length of the culvert and was mainly clam and mussel growth with some sand mixed in. The side walls had up to 3 in of soft and hard barnacle and mussel growth on them. The top of the culvert had up to 4 in of soft and hard mussel growth.

In addition, sills exist within the culvert. The sills perch the Lagoon's low tide level, thus limiting the Lagoon's tidal range and tidal flushing. On the Marine Stadium side, there is a visible rock basin sill at the entrance to the culvert that causes impedance of tidal flow. The 2005 dive survey noted that rocks are 3.5 ft above the invert and "are impeding the flow out of the Lagoon." A structural sill may also be present within the culvert at the Lagoon end.

There are side-by-side motorized tide gates on the Lagoon end of the culvert that are in a degraded condition. The gates were designed to be able to open 7 ft on the Lagoon side. However, lack of maintenance has caused the gates to not operate to this design capability and to only open to approximately 5.5 ft high.

Cleaning the existing culvert and removing impedances to flow is a short-term component of the proposed project. To implement this component, the culvert would have to be plugged to prevent flow through it. This would be done by removing the trash racks and installing "stop logs" (sheet pile or timber panels) within the vertical slots found on both ends of the culvert. The remaining water would be pumped out to the nearest water body. The culvert design includes removable access panels on the top to allow for a small track-loader and cleaning equipment to be lowered into the culvert by crane. The track-loader and hydroblasting equipment would scrape the bottom, sides, and ceiling to remove sediments and marine growth. The sediment collected by the track-loader would be removed via excavator (or a crane with a bucket) through an access opening and hauled off site. All of the



LSA

0 125 250 Feet

LEGEND

- Project Boundary
- Culvert
- Sand Nourishment Areas
- Existing Storm Drain Pipelines
- Existing Restrooms
- Major System Outfall
- Local Drain
- Indicates Drain Diverted by Termino Project
- Baseball Field
- Adult Soccer Field
- Youth Soccer Field

FIGURE 2

Colorado Lagoon Restoration Project
Existing Conditions

SOURCE: Air Photo USA (2007), Moffat & Nichol (2007), Thomas Bros. (2007).

I:\CLB0702\GIS\ExistingConditions_Fig3.2.mxd (5/9/08) impedances would be removed from in and around the culvert, and the tide gates would be removed to provide a maximum culvert opening size. It is estimated that up to 900 cubic yards (cy) of sediment and trash and 130 tons of rock would be removed and hauled off site.

Cleaning the culvert and trash racks and removing the tidal gates, sill, and other structural impedances would result in an increase in the tidal range and tidal flushing, which would in turn increase water circulation throughout the Lagoon. Increased tidal ranges and tidal flushing are anticipated to result in a notable improvement in water quality. As mentioned previously and further described below, culvert cleaning and removing impedances is a near-term component. The ultimate improvement would be replacement of the culvert with an open channel.

Build Open Channel between Lagoon and Marine Stadium. This is a long-term project component that will supersede the previous component. This component consists of replacing the existing concrete box culvert with an open channel that would run from the Lagoon through Marina Vista Park to Marine Stadium in generally the same alignment as the existing culvert. Creating an open channel would improve tidal flushing by increasing the tidal range and result in a corresponding improvement in water and habitat quality. In addition, it would provide improved flood flow conveyance.

The proposed open channel would run a meandering course from the Lagoon to Marine Stadium in approximately the same alignment as the existing culvert. The channel would have curvilinear edges to create a natural-looking feature. The open channel will be characterized by a soft bottom and gently sloping banks and constructed with erosion-control blankets and riprap on the curves to maintain the integrity of the channel design, native landscaping buffer areas along the banks, and a walking trail along the eastern bank. The open channel would be 14 ft deep, have 3:1 (H:V) side slopes, and would be approximately 100 ft across at the top. This design would provide an aesthetically pleasing, natural-looking feature and also provide for biological enhancements such as marsh areas and eelgrass beds.

The existing culvert will be daylighted and excavated further as part of the open channel construction. The open channel design has a cross-sectional area large enough to provide unrestricted tidal flows between the Lagoon and Marine Stadium, which would maximize tidal flushing of the Lagoon. The channel would be deeper than the lowest predicted tidal water level and higher than the highest predicted design flood levels. This would be at least as low as 7 ft below the mean sea level (msl) for tides and as high as 2 ft aboveground (low dikes) along its banks to provide sufficient freeboard to protect against a 50-year flooding event.

A landscaped buffer would be installed along the sides of the channel. The landscaped buffer would contain a mixture of armor rock and native plantings that would also create a safety barrier where necessary. A meandering walking trail would be installed on the eastern side of the channel. This walking trail would connect to the proposed walking trail at the Lagoon, across East Colorado Street. Two vehicular bridges with pedestrian and bicycle facilities would be built over the open channel at East Colorado Street and East Eliot Street crossings, in order to maintain existing traffic circulation. One bridge would be for East Colorado Street and one for East Eliot Street. In addition, two existing public restrooms near the Marine Stadium end of the proposed open channel (one in Marina Vista

Park and one south of East Eliot Street) will be demolished and replaced with the new public restroom design that is recommended by the Long Beach Police Department.

Remove Contaminated Sediment in the Western Arm. The Lagoon is listed as impaired on California's 303(d) list of water quality limited segments, due to lead, zinc, chlordane, and PAHs in the sediment and chlordane, DDT, dieldrin, and PCBs in tissues of marine organisms. These contaminants were deposited over time from the particulates in the runoff brought to the Lagoon through the existing storm drains. Sediment sampling was conducted in 2004 and 2006 to determine the depths and spatial distribution of contamination within the Lagoon. Both surveys confirmed the presence of the 303(d) list constituents and indicated a strong contamination gradient with high levels of contaminants in the western arm of the Lagoon, transitioning to much lower levels toward the central Lagoon area. Five metals, including cadmium, copper, lead, mercury, and zinc, exhibited this distributional pattern. Among the organic contaminants, DDT compounds, chlordane, dieldrin, PCBs, and PAHs also demonstrated this strong gradient. It is estimated that the layer of contaminated sediment reaches 4 to 5 ft deep. Removal of sediment to a depth of 6 ft provides a safeguard that only clean sediment remains. Hence, the excavation design is based on removing 6 ft of sediment at the uppermost portion of the western arm, with the excavation depth gradually decreasing toward the footbridge. The sediment assessments concluded that the existing pedestrian footbridge provides a reasonable and conservative boundary for removal of the contaminated sediment. The depth of excavation at the deepest point would be down to 19 ft below the msl point of 1929. The width of the excavation footprint is intended to be as wide as possible to remove the maximum quantity of sediment while still providing for stable side slopes around the Lagoon perimeter. Slopes are to be dredged to create a smooth transition from the Lagoon floor up the side slopes. Approximately 16,000 cy of sediment would be removed from the western arm of the Lagoon.

There are two methods related to dredging and disposing of the contaminated sediment within the western arm of the Lagoon. The dry dredge method would install a temporary cofferdam just west of the footbridge to isolate the west arm of the Lagoon. The dredge areas would be drained of water, and the bottom sediment would be dewatered. An excavator would be used to remove the dry sediment, which would be temporarily stockpiled in the parking lot along the Lagoon's north shore. Plastic tarps and containment structures would be placed under and around the stockpile area to minimize runoff back into the Lagoon and surrounding areas. Due to the contamination levels within the western arm of the Lagoon, the dredge materials from this Lagoon location would be hauled to a Class 1 hazardous waste disposal facility or an approved Port of Long Beach site via truck.

The second method, which is the wet dredge method, would not dewater the west arm of the Lagoon prior to dredging. The dredge areas would be isolated by a silt curtain to maintain water quality. Clamshell/bucket-type dredging equipment would be used and temporary shore-perpendicular berms or piers would be built into the Lagoon to allow the dredger to access depths not within reach from the Lagoon's shores. Similar to the first method, the dredged material would be temporarily stock-piled in the parking lot along the northern shore until it was drained and loaded onto trucks. Plastic tarps and containment structures would be placed under and around the stockpile areas to minimize runoff back into the Lagoon and surrounding areas.

Remove Sediment in the Central Lagoon. The sediments in the central region of the Lagoon contain levels of lead, mercury, silver, DDT, and chlordane that are not hazardous per State standards. This project component would remove sediment and sand that has eroded and been deposited into the Lagoon waters over the years and create a larger subtidal area. Approximately 5,500 cy of sediment would be removed from the central Lagoon utilizing the wet dredge method discussed previously.

Storm Drain Upgrades. There are 11 storm drains that currently discharge into the Lagoon, as identified on Figure 2. Four of these are major system outfalls, serving large areas of the watershed. One of the major system outfall structures entering the Lagoon is called the Termino Avenue Drain and is currently proposed by the County of Los Angeles to be modified to no longer discharge into the Lagoon. Instead, the drain would bypass the Lagoon and discharge storm water flows into Marine Stadium and dry weather flows into the sanitary sewer system. This project would also redirect flows from three other storm drains located on the south shore of the Lagoon that currently discharge into the Lagoon. The drains that would be diverted by the County Termino Avenue Drain Project (TADP) are shown on Figure 2. The purpose of the TADP is to construct a storm drain that would alleviate flooding problems in the area and accommodate a 50-year storm event.

The implementation of the County project affects the proposed improvements to the Lagoon because one major storm drain and three local storm drains would no longer discharge into the Lagoon. In addition, the TADP would abandon in place the four existing drain discharge structures at the Lagoon. The proposed Lagoon project would close off the ends of these drains and remove the outlet structures. For the purposes of the proposed project and environmental documentation, it is assumed that the TADP will be implemented.

The storm drain upgrade components of the Lagoon Restoration Project would upgrade the seven remaining storm drains (three major system outfalls and four local drains) that discharge into the Lagoon. These components would redirect or treat storm and low flows from these drains to minimize contamination of water and sediment. Specifically, this project component consists of:
(1) development of vegetated bioswales to treat discharge from the four local drains along the north shore of the Lagoon (discussed further below under a separate project component); (2) construction of low-flow and storm first-flush diversions to a water storage area (wet well) that would discharge into the sanitary sewer system from the three remaining major system outfall drains; and (3) installation of trash separation devices on the same three remaining major system outfall drains.

The trash separation devices would trap trash and debris prior to entering the wet well for the diverted runoff and/or discharge into the Lagoon during storm events. These filtration devices would be installed within the pipe just upstream of the diversion structure. These filtration devices would need to be cleaned on a periodic basis. The storm drain locations and the proposed upgrades are shown in Figure 3.

To divert dry weather flow and the first storm flows, diversion structures/mechanisms would be installed a short distance upstream of the discharge ends of the three major system outfalls. The diversion system would be designed so that storm flows would bypass the diversion and discharge directly into the Lagoon, whereas the dry weather runoff and storm first-flush discharges would be diverted to a wet well. The diversion system would include flow meters and valve control devices such that during a large storm event, the control device would shut off when the meter indicated that the flow had reached the upset limit of the available storage within the wet well. One-way flap gates would be installed at the end of these storm drain pipes so as to preclude tidal saltwater from entering into the storm drain (and, thus, potentially the sanitary sewer diversion system) while allowing storm flows to freely discharge into the Lagoon.

New diversion pipes would be installed underground to carry the diverted storm water from the storm drain outlet locations to the underground wet well. The underground wet well and aboveground pump station would be built on the golf course at the corner of East 6th Street and Park Avenue. The size of the underground wet well would be approximately 40 ft by 40 ft and 12 ft deep. The locations of the new diversion pipes and wet well are shown on Figure 3. The runoff collected in the wet well would be pumped via the County sewer line located on East 6th Street near the intersection of Park Avenue to the Los Angeles County Sanitation Districts treatment plant. Due to a County-imposed restriction, pumping operations would be limited to only certain times of day (midnight to 5:00 a.m.).

Replace Local Hard Drain Outlets in the Lagoon with Vegetated Bioswales. As discussed above, 4 of the 11 storm drains that discharge into the Lagoon would be diverted to Marine Stadium as part of the TADP, and this project would upgrade the remaining three major outfall drains with end-of-pipe diversion systems and trash separation devices. The flows from the remaining four local storm drains would be treated via vegetated bioswales. Bioswales would also be developed on the north shore between the Lagoon and Recreation Park Golf Course. These vegetated bioswales would treat storm water and dry weather runoff through filtration to remove sediment and pollutants prior to discharge into the Lagoon. The bioswales would treat the discharge from the local drains and any runoff from the golf course. The swales are designed to be 3 ft deep and 15 ft wide at the top. The swales would have a V-shaped cross-section with sides sloping at a 2:1 ratio down to the channel centerline.

Approximately 2,500 cy of sediment would be removed as a result of the development of the bioswales. The sediment from the proposed bioswale areas is not considered hazardous and will be disposed of at an appropriate undesignated landfill.

Habitat Improvements

Remove North Parking Lot and Access Road and Create Side Slope Recontouring and Revegetation. This component would remove the existing access road from East 6th Street and the parking lot on the north shore of the Lagoon and create native upland, marsh, and intertidal habitat areas around the Lagoon. Habitat areas would be created through native vegetation planting and Lagoon bank recontouring that would promote the establishment of salt marsh habitat, including intertidal zones. The objective of this component is to restore and improve the estuarine habitat. This component also includes demolishing the existing restroom on the north shore of the Lagoon. The existing recreation improvements (e.g., barbeques and picnic tables) will remain on the north shore of the Lagoon.

The north parking lot and access road would be removed to provide more space for native vegetation planting and habitat restoration. The existing access road from East 6th Street is a private road on City property that is open to the public. The road functions as a driveway to the north parking lot.

LSA

0 100 200 Feet

LEGEND

- Project Boundary
- Major System Outfall with Trash Separation Device
- Proposed Bioswale
- Proposed Open Channel (Top of Channel 100')
- Proposed Stormwater Diversion Pipes
- Proposed Wetwell
- Existing Storm Drain Pipelines
- Dredge Area
- Shrubs
- Vegetated Buffer/Berm

FIGURE 3

Colorado Lagoon Restoration Project

Proposed Water and Sediment Quality Improvements

SOURCE: Air Photo USA (2007), Moffat & Nichol (2007), Thomas Bros. (2007).

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In many areas of the Lagoon, the existing banks are steep and intertidal habitat area is limited. In addition, no substantial native upland habitat exists at the Lagoon. Most of the shoreline areas of the Lagoon are composed of ornamental landscaping and nonnative vegetation.

The slopes of several areas of the Lagoon shoreline would be recontoured to create areas for the establishment of salt marsh habitat. The approach to designing the area of intertidal habitat is to flatten the entire intertidal slope by installing a bench-type of feature between elevations of -1.75 ft and +1.5 ft above mean sea level (amsl). The bench represents a longer, flatter, sandy-bottomed slope that is exposed at low tide and inundated at high tide and where cordgrass (*Spartina foliosa*) and mudflat habitat would colonize. The new side slope profiles would be designed to maximize the area within this elevation range. Pickleweed (*Salicornia* spp.) habitat will colonize elevations between +1.5 and +2.75 ft amsl (mid-marsh). High marsh/upland habitat will be established at elevations between +2.75 ft and +5.0 ft amsl. Any existing exotic vegetation in this area would be removed. Native salt marsh species would be planted in the appropriate elevation ranges and maintained until the habitats are established and self-sustaining (Figure 4).

Vegetated biological buffer strips consisting of aesthetically appealing native shrubs and grasses would be installed in various areas. The buffer strip species would be selected and located according to the desired viewsheds throughout the buffer alignment to allow for a combination of visual screening using taller species and to allow for viewsheds through the use of low-growing species and species that can be selectively pruned. Additionally, a dune would be constructed on the north shore to provide a buffer area between the golf course and Lagoon. Soils from the central Lagoon dredge area would be used to construct the dune.

Recontouring of the side slopes would be done concurrently with sediment removal of the western arm and central Lagoon areas. The recontouring component would generate approximately 5,100 cy of material. Some of this material is presumed to be contaminated. Therefore, the excess recontouring sediment would be disposed of with the dredge material from the western arm.

A meandering trail (as also discussed under recreational improvements and shown in Figure 5) composed of compacted decomposed granite would course the perimeter of the Lagoon, with the exception of the western arm. The trail would be generally 8 ft wide, except along the north shore where the access trail from Sixth Street would be 12 ft wide to provide emergency access along the western shore of the northern arm.

The removal of nonnative vegetation and installation of native vegetation would include the following areas:

- **Western Arm/Western Shore.** The existing exotic vegetation (grass) would be removed, existing native saltgrass (*Distichlis spicata*) would be salvaged for transplantation in appropriate areas, and native vegetation (including an area with upland habitat) would be installed.
- **Western Arm/Eastern Shore.** The existing exotic vegetation (shrubbery and grass) would be removed, and native vegetation would be installed.
- **Northern Arm/Northwestern Corner.** The existing exotic vegetation, Mexican fan palms (*Washingtonia robusta*), would be removed, and native vegetation would be installed.

LSA

0 100 200 Feet

LEGEND

- Project Boundary
- Low Marsh (Coastal Salt Marsh, Cordgrass, Unvegetated Mud Flats)
- Mid Marsh
- High Marsh/Upland
- Native Upland CSS Vegetation
- Park
- Parking/Road
- Sand
- Shrubs
- Trail (Decomposed Granite)
- Vegetated Buffer/Berm
- Proposed Bioswale
- Existing Sidewalk
- Proposed Bridge
- Proposed Open Channel (Top of Channel 100')
- Proposed Viewing Platform

FIGURE 4

Colorado Lagoon Restoration Project

Proposed Habitat Improvements

SOURCE: Air Photo USA (2007), Moffat & Nichol (2007), Thomas Bros. (2007).

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LSA

0 125 250 Feet

Project Boundary
Swimming Area
Sand Nourishment Area
Existing Sidewalk
Proposed Bioswale
Bird Island
Proposed Trail (Decomposed Granite)
Vegetated Buffer/Berm
Proposed Bridge
Proposed Open Channel (Top of Channel 100')
Proposed Viewing Platform
Baseball Field (New Location)
Adult Soccer Field (Existing Location)
Youth Soccer Field (New Location)
Access Road and Parking Lot to be removed with proposed project

SOURCE: Air Photo USA (2007), Moffat & Nichol (2007), Thomas Bros. (2007).

FIGURE 5

Colorado Lagoon Restoration Project

Proposed Recreation Components

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- **Northern Arm/Northeastern Corner.** This area would remain in the existing condition. The park setting will be retained to allow for ongoing existing public recreational uses.
- **Eastern Shore.** The existing exotic vegetation (iceplant) would be removed, and a native vegetation buffer consisting of selected coastal sage scrub components would be installed.
- **Southern Shore.** Low shrubs would be installed between the concrete walk path and the sand (near the playground equipment), along the street-side sidewalks of East Colorado Street and East Appian Way, along the East Appian Way parallel parking strip (near the lifeguard station), and along the edge of the sand. In addition, the asphalt strip that currently exists between East Appian Way and the Lagoon access road parking area would be removed and planted with native trees and shrubs. The type and spacing of the trees and shrubs would be designed to minimize obstruction of the view from the homes to the southwest. This portion of the component would involve some demolition of pavement. Pavement debris would be hauled off site. New topsoil would be imported as necessary for the areas to be replanted. Irrigation lines and new plants would be installed. In addition, along the southwestern shore, a berm would be installed along Park Avenue. Both the shrubs and the berm would reduce the storm water sheet flow that currently enters the Lagoon from these areas during storm events.

A conceptual planting plan showing the proposed new vegetation communities is shown on Figure 4. These habitats would support a diversity of native plant species that would be used by native birds, primarily for foraging and resting. The restored habitat is expected to increase the abundance and diversity of birds using the Lagoon and would provide viewing and educational opportunities for the public.

Import and Plant Eelgrass in the Lagoon. There are small patches of eelgrass currently existing in the Lagoon that would be supplemented by planting additional eelgrass and creating eelgrass beds. Eelgrass beds are nutrient-rich and extremely productive, providing food and shelter for a variety of marine invertebrates and fishes.

Eelgrass (*Zostera*) is a marine flowering plant that grows in soft sediments in coastal bays and estuaries, and occasionally offshore to depths of 50 ft. Eelgrass canopies are approximately 2 to 3 ft long (consisting of shoots and leaves). This vegetation enhances the abundance and diversity of the habitat by attracting many marine invertebrates, fishes, and marine life. Diverse communities of bottom-dwelling invertebrates (i.e., clams, crabs, and worms) live on eelgrass or within the soft sediments that cover the root and rhizome mass system. The vegetation also serves a nursery function for many juvenile fishes, including species of commercial and/or sports fish value (California halibut [*Paralichthys californicus*] and barred sand bass [*Paralabrax nebulifer*]). Eelgrass beds are critical foraging centers for seabirds (such as the endangered California least tern [*Sternula antillarum brownii*]) that seek out baitfish (i.e., juvenile topsmelt) attracted to the eelgrass cover. Last, eelgrass is an important contributor to the detrital (decaying organic) food web of bays, as the decaying plant material is consumed by many benthic invertebrates (such as polychaete worms) and reduced to primary nutrients by bacteria.

The newly introduced eelgrass beds would be located in the north arm of the Lagoon and in the newly developed open channel, and would be located below the lowest tidal elevation. The eelgrass plants would be hand-planted via scuba diver on the bottom of the Lagoon and channel.

Develop a Bird Island. A bird island to provide a safe refuge for roosting birds will be developed by excavating (approximately 6,600 cy of soils) an area adjacent to the north shoreline in the western arm of the Lagoon. Maintenance requirements are assumed to be minimal, consisting of periodic cleaning, inspection, and repairs as needed.

Recreational Improvements

Construct a Walking Trail around the Lagoon and Open Channel. This component would provide additional public recreation amenities at the Lagoon through improved pedestrian access and learning opportunities. A walking trail would be extended around portions of the perimeter of the Lagoon and the eastern side of proposed open channel, extending through areas that currently provide no public access. As shown on Figure 5, the trail would not extend around the western arm of the Lagoon. A viewing platform will be located at the end of the trail toward the western arm. The trail would connect to the existing footbridge on both the north and south shores of the Lagoon. As mentioned previously, the existing recreation improvements (e.g., barbeques and picnic tables) will remain on the north shore of the Lagoon.

The trail would be generally 8 ft wide, except along the north shore where the access trail from Sixth Street would be 12 ft wide to provide emergency access along the western shore of the northern arm. The trail would be constructed of decomposed granite in the new areas, which would connect to the existing sidewalk. Interpretive kiosks, seating benches, picnic tables, and shade structures would be installed along the trail. The kiosks would provide educational information about the Lagoon.

Reconfigure Sports Fields in Marina Vista Park. Due to the location of the proposed open channel, the baseball diamond in Marina Vista Park would be moved slightly north. The new location would provide an area large enough to maintain functionality for league sports and provide for a youth soccer field overlay (as currently provided). The adult-sized soccer field would remain in its current location. In summary, the proposed project would reconfigure the existing fields, but continue to provide the same number of fields and the same functionality that is currently provided in the park.

Operational Components

These are operational features that could be implemented without additional CEQA clearance and that complement the water quality strategies described above.

Implement Trash Management Protocols. More frequent and effective trash management would reduce refuse in the water and adjacent areas, especially during summer months, when the Lagoon is utilized most by picnickers. Proposed trash management protocols include ensuring that all trash containers are covered, disallowing trash trucks to drive on the sand areas, providing additional trash containers at key locations, educating Lagoon users on litter control and its effect on the environment, and enforcing littering laws. The use of landscaping as barriers to prevent trash from blowing across the site and into the Lagoon will also be considered.

Implement Bird Management Protocols. The objective of this component is to reduce direct contribution of bird feces (bacteria) into the Lagoon, thereby improving water quality. This component would prohibit the release of domestic birds such as ducks and geese and involve installing signs to discourage people from feeding any birds.

Modify Sand Nourishment Practices. The City imports sand for beach fill at the Lagoon. Beach fill is currently done on the north and south shores of the Lagoon, mostly in the swimming areas. Approximately 60–100 cy of sand is brought in annually, and some of this sand erodes into the Lagoon waters. Hence, there is a concern that this sand is filling the Lagoon, as well as adversely impacting the Lagoon's intertidal habitat. Because of these concerns, this component would modify the existing sand nourishment practices by limiting sand nourishment to only the south shore swimming area to the east of the footbridge. This component would require half of the amount of sand that is currently being imported. Additionally, sand quality would be assessed to optimize grain size so that it remains on the beach longer. Figure 5 shows the proposed sand placement area.

PROJECT PHASING

It is anticipated that phase one would involve the improvements at the Lagoon and phase two would involve improvement within Marina Vista Park. Specifically, the improvements within Marina Vista Park are anticipated to occur at least one year after the Lagoon improvements depending on the availability of funding. The components of each phase are listed below.

- Phase 1: Lagoon Improvements
  - Clean the culvert and remove tidal gates, sill, and other structural impedances at the culvert. Implement trash and bird management protocols and modified sand nourishment practices.
  - Dredge the western arm and central Lagoon areas. Recontour the Lagoon side slopes. Develop bird island.
  - Implement storm drain upgrades, including the development of a storm water diversion system and bioswales.
  - Remove the north parking lot and access road, and restroom on the north shore of the Lagoon.
  - Recontour Lagoon side slopes, develop bird island, revegetate land areas, and plant eelgrass.
  - Develop the walking trail and viewing platform at the Lagoon.
- Phase 2: Marina Vista Park Improvements
  - Build the open channel between the Lagoon and Marine Stadium. Construct two roadway bridges spanning the open channel at East Colorado Street and East Eliot Street. Demolish and replace two public restrooms in Marina Vista Park.
  - Develop the walking trail on the eastern side of the open channel and vegetation buffers on both sides of the channel.

METHODOLOGY RELATED TO NOISE IMPACT ASSESSMENT

Evaluation of noise impacts associated with a proposed project typically includes the following:

- Determine the short-term construction noise impacts on on-site and off-site noise-sensitive uses with industry-recognized noise emission levels for construction equipment
- Determine the long-term operational noise impacts, including vehicular traffic and aircraft activities, on on-site and off-site noise-sensitive uses
- Determine the required mitigation measures to reduce short-term and long-term noise impacts from all sources

CHARACTERISTICS OF SOUND

Sound is increasing to such disagreeable levels in our environment that it can threaten our quality of life. Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep. To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect our ability to hear. Pitch is the number of complete vibrations or cycles per second of a wave that result in the tone's range from high to low. Loudness is the strength of a sound that describes a noisy or quiet environment and is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity refers to how hard the sound wave strikes an object, which in turn produces the sound's effect. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound intensity and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound intensity is measured through the A-weighted scale (i.e., dBA) to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound similar to the human ear's de-emphasis of these frequencies. Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale, representing points on a sharply rising curve. For example, 10 decibels (dB) are 10 times more intense than 1 dB, 20 dB are 100 times more intense, and 30 dB are 1,000 times more intense. Thirty decibels (30 dB) represent 1,000 times as much acoustic energy as 1 dB. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the loudness of the sound. Ambient sounds generally range from 30 dBA (very quiet) to 100 dBA (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. For a single point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source such as highway traffic or railroad operations, the sound decreases 3 dB for each doubling of distance in a hard site environment. Line source noise in a relatively flat environment with absorptive vegetation decreases 4.5 dB for each doubling of distance.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. However, the predominant rating scales for human communities in the State of California are the Equivalent-Continuous sound level (L_{eq}) and Community Noise Equivalent (CNEL) based on A-weighted decibels (dBA). L_{eq} is the total sound energy of time-varying noise over a sample period. CNEL is the time-varying noise over a 24-hour period, with a weighting factor of 5 dBA applied to the hourly L_{eq} for noises occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours) and with a weighting factor of 10 dBA from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). The noise adjustments are added to the noise events occurring during the more sensitive hours. Day-night average noise (L_{dn}) is similar to the CNEL but without the adjustment for nighttime noise events. CNEL and L_{dn} are normally exchangeable and within 1 dB of each other. Other noise-rating scales of importance when assessing annoyance factor include the maximum noise level, or L_{max}, and percentile noise exceedance levels, or L_N. L_{max} is the highest exponential time-averaged sound level that occurs during a stated time period. It reflects peak operating conditions and addresses the annoying aspects of intermittent noise. L_N is the noise level that is exceeded "N" percent of the time during a specified time period. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level and half the time it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the lowest noise level experienced during a monitoring period. It is normally referred to as the background noise level.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects our entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions and thereby affecting blood pressure, functions of the heart, and the nervous system. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. When the noise level reaches 120 dBA, a tickling sensation occurs in the human ear even with short-term exposure. This level of noise is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by the feeling of pain in the ear. This is called the threshold of pain. Dizziness and loss of equilibrium may occur between 160 and 165 dBA. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying less developed areas.

Table A lists "Definitions of Acoustical Terms." Table B shows "Common Sound Levels and Their Sources." Table C shows "Land Use Compatibility for Exterior Community Noise" recommended by the California Department of Health, Office of Noise Control.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of level that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in one second (i.e., number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1 percent, 10 percent, 50 percent, and 90 percent of a stated time period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all encompassing noise associated with a given environment at a specified time, usually a composite of sound from many sources at many directions, near and far; no particular sound is dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, 1991.

Table B: Common Sound Levels and Their Noise Sources

Noise Source	A-Weighted Sound Level in Decibels	Noise Environment	Subjective Evaluation
Near Jet Engine	140	Deafening	128 times as loud
Civil Defense Siren	130	Threshold of Pain	64 times as loud
Hard Rock Band	120	Threshold of Feeling	32 times as loud
Accelerating Motorcycle at a Few Feet Away	110	Very Loud	16 times as loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very Loud	8 times as loud
Ambulance Siren; Food Blender	95	Very Loud	
Garbage Disposal	90	Very Loud	4 times as loud
Freight Cars; Living Room Music	85	Loud	
Pneumatic Drill; Vacuum Cleaner	80	Loud	2 times as loud
Busy Restaurant	75	Moderately Loud	
Near Freeway Auto Traffic	70	Moderately Loud	Baseline
Average Office	60	Quiet	One-half as loud
Suburban Street	55	Quiet	
Light Traffic; Soft Radio Music in Apartment	50	Quiet	One-quarter as loud
Large Transformer	45	Quiet	
Average Residence without Stereo Playing	40	Faint	One-eighth as loud
Soft Whisper	30	Faint	
Rustling Leaves	20	Very Faint	
Human Breathing	10	Very Faint	Threshold of Hearing
	0	Very Faint	

Source: Compiled by LSA Associates, Inc., 1998.

Table C: Land Use Compatibility for Exterior Community Noise

Land Use Category	Noise Range (L_{dn} or CNEL), dB			
	I	II	III	IV
Passively-used open spaces	50	50–55	55–70	70+
Auditoriums, concert halls, amphitheaters	45–50	50–65	65–70	70+
Residential: low-density single-family, duplex, mobile homes	50–55	55–70	70–75	75+
Residential: multifamily	50–60	60–70	70–75	75+
Transient lodging: motels, hotels	50–60	60–70	70–80	80+
Schools, libraries, churches, hospitals, nursing homes	50–60	60–70	70–80	80+
Actively used open spaces: playgrounds, neighborhood parks	50–67	—	67–73	73+
Golf courses, riding stables, water recreation, cemeteries	50–70	—	70–80	80+
Office buildings, business commercial and professional	50–67	67–75	75+	—
Industrial, manufacturing, utilities, agriculture	50–70	70–75	75+	—

Source: Office of Noise Control, California Department of Health, 1976.

Noise Range I—Normally Acceptable: Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Noise Range II—Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features are included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning, will normally suffice.

Noise Range III—Normally Unacceptable: New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Noise Range IV—Clearly Unacceptable: New construction or development should generally not be undertaken.

CNEL = community noise equivalent level
dB = decibels
L_{dn} = day-night average noise level

SETTING

SENSITIVE LAND USES IN THE PROJECT VICINITY

Certain land uses are considered more sensitive to noise than others. Examples of these include residential areas, educational facilities, hospitals, childcare facilities, and senior housing. The sensitive land uses within the vicinity of the proposed project include the existing residences to the west, south, and northeast, Marina Vista Park to the east, the north and south Lagoon beaches, an on-site preschool, and a recreational park golf course. These land uses are located within 50 to 100 ft of the on-site construction areas.

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

The primary existing noise sources in the project area are transportation facilities. Traffic on Park Avenue and East Appian Way is the dominant source contributing to area ambient noise levels at the residences to the west. Noise from motor vehicles is generated by engine vibrations, the interaction between the tires and the road, and the exhaust system.

THRESHOLDS OF SIGNIFICANCE

A project will normally have a significant effect on the environment related to noise if it will substantially increase the ambient noise levels for adjoining areas or conflict with adopted environmental plans and goals of the community in which it is located. The applicable noise standards governing the project site are the criteria in the City's Noise Element of the General Plan and Municipal Code.

City of Long Beach Noise Standards

Noise Element of the General Plan. The Noise Element of the General Plan contains noise standards for mobile noise sources. These standards address the impacts of noise from adjacent roadways and airports. The City specifies outdoor and indoor noise limits for residential uses, places of worship, educational facilities, hospitals, hotels/motels, and commercial and other land uses. The noise standard for exterior living areas is 65 dBA CNEL. The indoor noise standard is 45 dBA CNEL, which is consistent with the standard in the California Noise Insulation Standard.

Municipal Code. The City has adopted a quantitative Noise Control Ordinance, No. C-5371, Long Beach 1978 (Municipal Code, Chapter 8.80). The ordinance establishes maximum permissible hourly noise levels (L_{50}) for different districts throughout the City. Tables D and E list exterior noise and interior noise limits for various land uses. For the purposes of the proposed project, the exterior noise standard of 70 dBA L_{max} has been applied to all of the sensitive land uses, the residences, the preschool, and the open space located within the vicinity of the project construction areas.

Table D: Exterior Noise Limits, L_N (dBA)

Receiving Land Use	Time Period	L_{50}	L_{25}	L_8	L_2	L_{max}
Residential (District One)	Night: 10:00 p.m.–7:00 a.m.	45	50	55	60	65
	Day: 7:00 a.m.–10:00 p.m.	50	55	60	65	70
Commercial (District Two)	Night: 10:00 p.m.–7:00 a.m.	55	60	65	70	75
	Day: 7:00 a.m.–10:00 p.m.	60	65	70	75	80
Industrial (District Three)	Anytime[1]	65	70	75	80	85

[1] For use at boundaries rather than for noise control within industrial districts.
dBA = A-weighted decibels
L_N = percentile noise exceedance level

Table E: Maximum Interior Sound Levels, L_N (dBA)

Receiving Land Use	Time Interval	L_8	L_2	L_{max}
Residential	10:00 p.m.–7:00 a.m.	35	40	45
	7:00 a.m.–10:00 p.m.	45	50	55
School	7:00 a.m.–10:00 p.m. (while school is in session)	45	50	55
Hospital and other noise-sensitive zones	Anytime	40	45	50

dBA = A-weighted decibels
L_N = percentile noise exceedance level

The City's Noise Control Ordinance also governs the time of day that construction work can be performed. The Noise Ordinance prohibits construction, drilling, repair, alteration, or demolition work between the hours of 7:00 p.m. and 7:00 a.m. on weekdays or at any time on Sundays or federal holidays if the noise would create a disturbance across a residential or commercial property line or violate the quantitative provisions of the ordinance.

Vibration. Vibration energy propagates from a source through intervening soil and rock layers, to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by the occupants as motion of building surfaces, rattling of items on shelves or hanging on walls, or a low-frequency rumbling noise. The rumble noise is caused by the vibrating walls, floors, and ceilings radiating sound waves. Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (rms) velocity or peak particle velocity (PPV). Rms is best for characterizing human response to building vibration and PPV is used to characterize potential for damage. Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can achieve the audible and feelable ranges in buildings very close to the site. Problems with ground-borne vibration from construction sources are usually localized to areas within about 100 ft from the vibration source.

IMPACTS AND MITIGATION MEASURES

SHORT-TERM CONSTRUCTION-RELATED IMPACTS

Short-Term Construction-Related Noise Impacts

Two types of short-term noise impacts would occur during project construction. The first is the increase in traffic flow on local streets, associated with the transport of workers, equipment, and materials to and from the project site. The pieces of heavy equipment to be utilized during construction will be moved to the site and remain for the duration of each construction phase. The increase in traffic flow on the surrounding roads due to construction traffic is expected to be small. The associated increase in long-term traffic noise will not be perceptible. However, there will be short-term intermittent high noise levels associated with trucks passing by from the project site.

The second type of short-term noise impact is related to the noise generated by heavy equipment operating within the project area. The proposed Lagoon restoration project will be divided into multiple phases throughout project area. Each phase of construction will consist of multiple tasks. The activities that will occur during these tasks will include:

- Existing Culvert Improvements
- Western Arm Sediment Removal
- Central Area Sediment Removal
- Storm Drain Treatments
- Bio-Swales
- North Parking Lot, Access Road, and Restroom Demolition
- Side Slope Recontouring
- Trail and Viewing Platform Construction
- Open Channel Construction

The following construction equipment will be required to complete the above tasks:

- Bulldozers
- Loaders
- Backhoes
- Excavators
- Graders
- Cranes
- Pile Driver

- Paving Equipment
- Pumps
- Generators
- Dredge Tender Boat

Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase. Table F lists typical construction equipment noise levels recommended for noise impact assessments, based on a distance of 50 ft between the equipment and a noise receptor.

Table F: Typical Construction Equipment Noise Levels

Type of Equipment	Range of Maximum Sound Levels Measured (dBA at 50 feet)	Suggested Maximum Sound Levels for Analysis (dBA at 50 feet)
Pile Drivers, 12,000 to 18,000 ft-lb/blow	81–96	93
Rock Drills	83–99	96
Jackhammers	75–85	82
Pneumatic Tools	78–88	85
Pumps	74–84	80
Scrapers	83–91	87
Haul Trucks	83–94	88
Cranes	79–86	82
Portable Generators	71–87	80
Rollers	75–82	80
Dozers	77–90	85
Tractors	77–82	80
Front-End Loaders	77–90	86
Hydraulic Backhoe	81–90	86
Hydraulic Excavators	81–90	86
Graders	79–89	86
Air Compressors	76–89	86
Trucks	81–87	86

Source: Noise Control for Buildings and Manufacturing Plants, Bolt, Beranek & Newman, 1987.
dBA = A-weighted decibels
ft-lb/blow = foot-pounds per below

Pile driving will be the noisiest activity on-site generating up to 93 dBA L_{max} at a distance of 50 ft. Other construction equipment used on-site, such as loaders and backhoes, would generate up to 86 dBA L_{max} at a distance of 50 ft.

The following sensitive land uses are located within the vicinity of the proposed construction activities.

On-site Preschool. The on-site preschool is located within the vicinity of the central Lagoon dredge area and the open channel construction area. Standard construction equipment that would generate up to 86 dBA L_{max} at a distance of 50 ft would be required for the central Lagoon dredging. Pile driving equipment that would generate up to 93 dBA L_{max} at a distance of 50 ft would be required for the construction of the open channel and the viewing platform. Standard construction activities that occur within 315 ft and pile driving that occurs within 706 ft of the preschool would generate noise levels in excess of the City's daytime exterior noise standard of 70 dBA L_{max}. The preschool shall be closed whenever construction or pile driving would occur within 315 and 706 feet, respectively.

Residential Developments. Residential developments are located within close proximity of each of the proposed project's construction phases. The highest noise levels would be generated by the pile driving required to construct the open channel through Marina Vista Park. The existing homes in this area are located within 150 ft of the active construction areas and would be exposed to pile driving noise levels of up to 81 dBA L_{max}. Homes located within 315 ft of the standard construction equipment and 706 ft of the pile driving would be exposed to noise levels in excess of the City's daytime exterior noise standard of 70 dBA L_{max}.

Open Space Land Uses. Open space land uses, such as the Marina Vista Park, the north and south Lagoon beaches, and the recreational park golf course, are located within close proximity of each of the proposed project's construction phases. The highest noise levels within these uses would be generated by the pile driving required to construct the open channel and the viewing platform. Sensitive open space land uses located within 315 ft of the standard construction equipment and 706 ft of the pile driving would be exposed to noise levels in excess of the City's daytime exterior noise standard of 70 dBA L_{max}.

Sensitive Land Uses Along the Haul Truck Routes. Sensitive land uses located along the proposed haul truck routes, such as residences, parks, and schools, would be exposed to noise levels of up to 86 dBA L_{max} at a distance of 50 ft. However, the increase in traffic flow on roads due to construction traffic is expected to be small. Therefore, the associated increase in long-term traffic noise will not be perceptible.

Due to the distance between construction activities and the existing sensitive receptors, project construction activities would result in a significant noise impact; however, the noise impact would be intermittent and temporary. The City's regulations allow these noise sources between permitted hours during construction because the noise sources are temporary. Adherence to the City's noise regulations and implementation of the mitigation measures listed below would reduce construction impacts; however, the construction period noise impacts would remain significant and unavoidable. Construction-related short-term noise levels would be higher than existing ambient noise levels in the project area today but would no longer occur once construction of the project is completed.

Short-Term Construction-Related Vibration Impacts

The primary source of vibration during construction would be generated by the proposed pile driving. The closest pile driving activities to a sensitive receptor would occur at a distance of 112 ft from the residential uses in the project vicinity. Using Equation 9 and Table 17 from the Caltrans *Transportation and Construction-Induced Vibration Guidance Manual* (Jones & Stokes, June 2004) it was estimated that the vibration level at this structure would be 0.07 inches per second (in/sec). Although perceptible, this level would not exceed the 0.1 in/sec threshold below which there is virtually no risk of resulting in architectural damage to normal buildings. Therefore, the proposed project would not result in any significant vibration impacts.

LONG-TERM NOISE IMPACTS

Long-Term Operational Noise Impacts. The primary existing noise sources in the project area are transportation facilities. Traffic on streets adjacent to the project site is the dominant source contributing to ambient noise levels in the project vicinity. Noise from motor vehicles is generated by engine vibrations, the interaction between the tires and the road, and the exhaust system.

The proposed project would implement habitat and recreation improvements to the existing project area. The proposed project would retain the existing recreation and open space uses of the project site, and any change in park attendance and patterns of use is expected to be negligible as a result of project implementation. Likewise, the proposed project would not result in additional traffic and traffic-related noise sources. In addition, the proposed project does not involve the use of on-site noise-generating equipment, with the exception of the pumps for the stormwater diversion system. The pumps would be below ground and in the bottom of the wet well. The noise generated by the pumps would be very minimal. Therefore, the proposed project would not result in a substantial permanent increase in ambient noise levels in the project vicinity, and impacts related to long-term operational noise sources are less than significant.

Airport Noise Impacts. The Long Beach Municipal Airport is located approximately 3 miles north of the project site. Based on the aircraft noise contours produced by the airports, the project site does not lie within the 60 dBA CNEL contour of the airport. Therefore, the potential for a significant impact from airport-related activities is small, and a single-event noise impact analysis is not warranted for this site.

MITIGATION MEASURES

Construction Impacts

The City of Long Beach (City) Noise Control Officer shall ensure that the construction contractor limits construction activity, which produces loud or unusual noise that annoys or disturbs a reasonable person of normal sensitivity to between the hours of 7:00 p.m. and 7:00 a.m. Monday through Friday and 9:00 a.m. and 6:00 p.m. on Saturdays and no construction activities on Sundays and federal holidays in accordance with City standards.

The following measures can be implemented to reduce potential construction noise impacts on nearby sensitive receptors:

1. During all site excavation and grading, the project contractors shall equip all construction equipment, fixed or mobile, with properly operating and maintained mufflers consistent with manufacturers' standards.
2. The project contractor shall place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site.
3. The construction contractor shall locate equipment staging in areas that will create the greatest distance between construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.
4. Prior to issuance of a grading permit, the construction contractor shall provide evidence to the City of Long Beach Building Official (or designee) that on-site sensitive land uses, such as the on-site preschool and the beaches, shall be closed or relocated when construction activities occur within 315 feet or pile driving occurs within 706 feet.

Level of Significance after Mitigation

The mitigation measures identified above would reduce temporary construction-related noise impacts; however, the impacts would remain significant and unavoidable.

REFERENCES

Bolt, Beranek & Newman. 1987. Noise Control for Buildings and Manufacturing Plants.

City of Long Beach. 1975. Noise Element of the General Plan.

City of Long Beach. 1988. Municipal Code.

Federal Highway Administration. 1977. Highway Traffic Noise Prediction Model, FHWA RD-77-108.

United States Environmental Protection Agency (EPA). 1978. Protective Noise Levels: Condensed Version of EPA Levels Document.