Tidal Hydraulics of Wetlands Restoration Alternatives In the Otay River Flood Plain, Carlsbad Desalination Project Marine Life Mitigation Plan

by
Scott A. Jenkins, Ph. D. *
& Joseph Wasyl

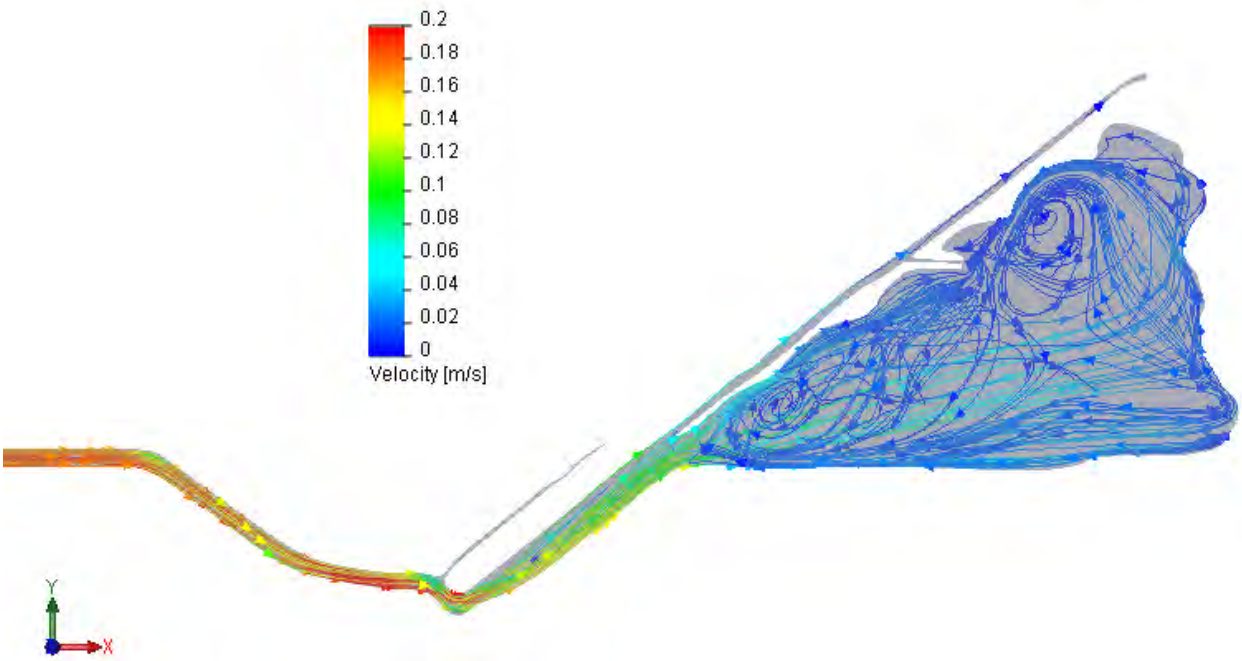

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Exhibit 6

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ABSTRACT

This is a hydrodynamic feasibility study of conceptual site plans for a proposed wetland restoration site. This study employs a well-tested and peer-reviewed hydrodynamic model to evaluate the tidal hydraulics of three alternative tidal basin and channel concepts for Poseidon's Marine Life Mitigation Plan in the Otay River floodplain. The proposed new tidal basin would occupy a land parcel known as *Otay River Floodplain* and would have a triangular foot print and receive its marine source water from south San Diego Bay through a connection with the Otay River. There are three grading concepts being considered for this triangular basin: *Alternative-1* is graded for an approximately prototypic balance between subtidal and intertidal habitat and is referred to as a *mixed-habitat plan*; *Alternative-2* is graded for an emphasis on subtidal habitat and is referred to as a *maximum subtidal plan*; while the grading of Alternative-3 emphasizes intertidal habitat and is referred to as a *maximum intertidal plan*. The estimated minimum subtidal acreage needed to meet fish productivity requirements of Poseidon's Marine Life Mitigation Plan is 11 acres; while the minimum required acreage of restored tidal wetland is 66 acres.

The model, analysis methods, and supporting data bases used herein are the same as those utilized in the Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the San Dieguito Wetland Restoration Project, (EIR/EIS, 2000), and for the preparation of the San Dieguito Wetlands Restoration Project, Final Restoration Plan, (SCE, 2005). Monitoring data for the newly completed San Dieguito Lagoon Restoration Project was also used to calibrate tidal hydraulics model. San Dieguito Lagoon was selected as a proxy for the restoration alternatives because of morphologic similarities: in particular, both restoration sites have a long "goose-neck" feeder channel connecting source water to interior tidal basins of comparable acreage and distance from the source water. Habitat surveys conducted during the San Dieguito Lagoon Restoration Project by Josselyn & Whelchel (1999) were also used to develop functional relationships between habitat breaks and amounts of time for wetting and drying (hydroperiod functions). These relationships were used to transpose tidal hydraulics model output into calculations of acreage of various wetland habitat types created by the three restoration alternatives. Calculations of habitat creation were based on long-term tidal hydraulics

simulations using tidal forcing at the mouth of the Otay River based on the 1980-2009 period of record for San Diego Bay tides measured by the NOAA tide gage #941-0170 located at the Navy Pier.

Table ES-1 summarizes habitat creation computed from the long term tidal hydraulics simulations of the three restoration alternatives. Inspection of Table ES-1 reveals that all of the alternatives create significantly more than the required minimum of 66 acres of tidally influenced wetland, achieving maximum areas of salt water inundation of between 82.6 acres and 82.8 acres. In this regard, the restoration designs provide a safety margin in habitat creation of about 17.6 acres – 17.8 acres or about 27%. Furthermore, all of the restoration alternatives provide significantly more than the minimum 11 acres of subtidal habitat required for fish production. Alternative-1 provides on average 18.5 acres of subtidal habitat, and is never less than 16.9 acres. Thus the critical threshold for adequate fish productivity (11 acres of subtidal habitat) is satisfied with a safety margin of at least 5.9 acres. Alternative-2 provides on average 32.8 acres of subtidal habitat while it is never less than 31.3 acres. Hence Alternative-2 (the maximum sub-tidal plan) provides substantially more subtidal habitat than Alternative-1 by a factor of 1.9, and easily exceeds the critical threshold for adequate fish productivity (11 acres of subtidal habitat) with a safety margin of at least 20.3 acres. Alternative-3 provides on average 14.8 acres of subtidal habitat and is never less than 14.3 acres, a safety margin of at least 3.3 acres.

Hydrodynamic simulations of tidal exchange and dilution rates give residence time estimates of τ_1 = 3.75 days for Alternative-1; τ_2 = 3.29 days for Alternative-2; and for Alternative-3, a residence time estimate of τ_3 = 3.93 days. Residence times for all three restoration alternatives are comparable to those measured or calculated for healthy tidal lagoon systems such as the W-1 tidal basin in the newly restored San Dieguito Lagoon (Coastal Environments, 2009) and in the East Basin at Agua Hedionda Lagoon (Elwany, et. al., 2005).

Tidal exchange simulated during spring tides show for all three restoration alternatives that Otay River channel velocities generally remain less than the threshold of sediment motion (0.6 ft/sec or 0.18 m/s) and greater than the deposition threshold (0.27 ft/ sec or 0.08 m/sec) and consequently, an equilibrium channel is achieved with the native sediments. There is sediment

[*]Table ES-1: Habitat Creation for Restoration Alternatives in the Otay River Floodplain

Habitat Areas	Alternative -1 (Mixed Habitat)	Alternative -2 (Max Subtidal)	Alternative -3 (Max Intertidal)
Perpetual Sub-Tidal (acres)	16.92	31.27	14.27
Mean Sub-Tidal (acres)	18.50	32.80	14.81
Frequently Flooded Mud Flat (acres)	27.73	13.63	25.24
Frequently Exposed Mud Flat (acres)	8.90	6.31	11.17
Low Salt Marsh (acres)	7.55	9.29	11.81
Mid Salt Marsh (acres)	12.80	10.55	13.35
High Salt Marsh (acres)	7.51	10.50	5.71
Transitional Habitat (acres)	1.22	1.24	1.24
Maximum Intertidal Area (acres)	65.71	51.52	68.52
Maximum Area of Salt Water Inundation (acres)	82.63	82.79	82.79
Mean Intertidal Area (acres)	42.07	29.81	45.22
Mean Area of Salt Water Inundation (acres)	60.57	62.61	60.03

[*]These acreages based on the following exposure times for each habitat type:

Subtidal Exposure < 0%;

0% < **Frequently Flooded Mud Flat Exposure** < 50%;

50% < **Frequently Exposed Mud Flat Exposure** < 61.8%

61.8% < **Low Salt Marsh Exposure** < 81.7%

81.7% < **Mid Salt Marsh Exposure** < 96.2%

96.2% < **High Salt Marsh Exposure** < 99.8%

99.8% < **Transitional Exposure** < 100%

transport down channel but not deposition, and hence a maximum likelihood of self-maintaining channel. Furthermore, the inlet channel and the mouth of the Otay River are not subject to littoral transport by shoaling ocean waves, as South San Diego Bay provides complete sheltering from high energy shoaling swells. Consequently, the inlet channel is not likely to infill or close from sand influx in the source water, making the site significantly easier to maintain. But, there is one isolated erosion concern, and that occurs during flooding spring tides in Alternative-2 along the narrower east/west reach. Because of the larger tidal prism of this alternative, the channel currents accelerate to 0.2 m/sec (0.66 ft/sec) before entering the Alternative-2 tidal basin. This exceeds the 0.18 m/s (0.6 ft/sec) threshold of motion for the 0.3 mm sized native sediments, and erosion will occur and persist until the channel cross sectional area is enlarged sufficiently to lower local channel currents to less than 0.18 m/s (0.6 ft/sec). If Alternative-2 is selected for final design, it would be appropriate to provide additional grading to this reach of channel to enlarge its cross section.

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1) Introduction:

This study investigates the tidal hydraulics of three wetlands restoration alternatives located in the lower floodplain of the Otay River in south San Diego Bay, CA, (see Figure 1). The restoration alternatives involve creation of a new tidal basin on a parcel of land known as *Otay River Floodplain* shown in Figure 2, which is located south of the Otay River between Ponds 20 & 22 and the Interstate 5 (cf. Figure 1). The proposed new tidal basin would have a triangular foot print and would receive its marine source water from south San Diego Bay through a connection with the Otay River at the western vertex of this triangular basin, (see Figure 3). There are three grading alternatives being considered for this triangular basin: *Alternative-1* is graded for an approximately prototypic balance between subtidal and intertidal habitat and is referred to as a *mixed-habitat plan*; *Alternative-2* is graded for an emphasis on subtidal habitat and is referred to as a *maximum subtidal plan*; while the grading of Alternative-3 emphasizes intertidal habitat and is referred to as a *maximum intertidal plan*. The objective of this study is to perform hydrodynamic simulation of the tidal exchange that would occur in each of these restoration alternatives, and make quantitative evaluation of the acreages of each habitat type that would be created. The hydrodynamic simulations will also asses the velocities of tidal flows and the stability and potential maintenance requirements of the approximately 7,000 ft long river channel that connects the new tidal basin with south San Diego Bay.

The computer models used in this study are finite element types. The tidal hydraulics model is the research model, *TIDE_FEM*, [Inman & Jenkins, 1996] and the littoral transport model is TIDE_FEM/SEDXPORT**.** TIDE_FEM was built from some well-studied and proven computational methods and numerical architecture that have been successful in predicting shallow water tidal propagation in Massachusetts Bay [Connor & Wang, 1974] and estuaries in Rhode Island, [Wang, 1975], and have been reviewed in basic text books [Weiyan, 1992] and

Figure 1: Otay River floodplain in south San Diego Bay, CA.

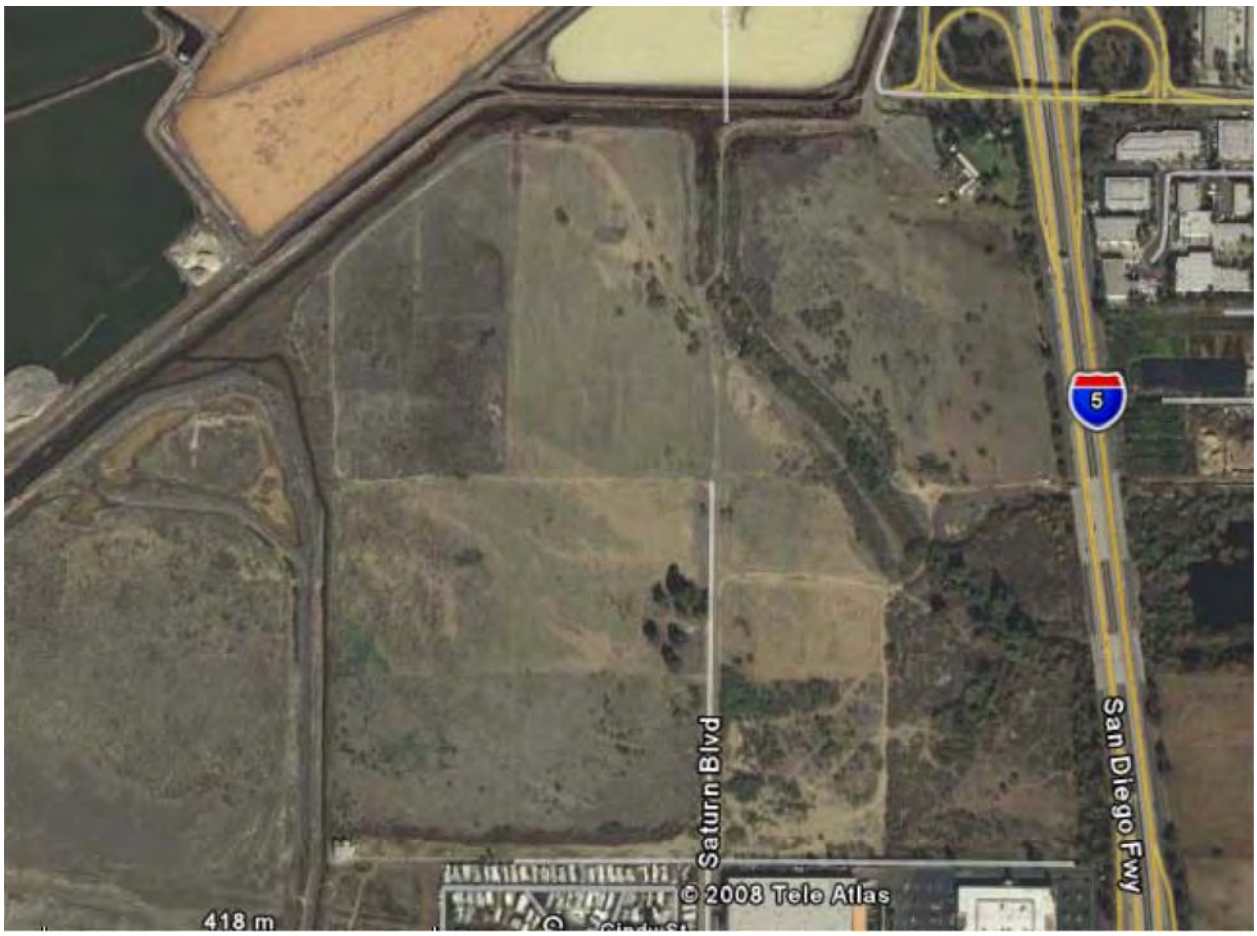

Figure 2: Otay River floodplain, site of the wetland restoration alternatives.

Figure 3: Schematic of the proposed new tidal basin to be constructed in the Otay River floodplain and connected at it western end to the lower reach of the Otay River.

symposia on the subject, e.g., Gallagher (1981). A discussion of the physics of TIDE_FEM is given in Jenkins and Wasyl (2003 & 2005).

In its most recent version, the TIDE_FEM/TIDE_FEM/SEDXPORT modeling system has been integrated into the Navy's Coastal Water Clarity Model and the Littoral Remote Sensing Simulator (LRSS) (see Hammond, et al., 1995). The TIDE_FEM/SEDXPORT code has been validated in mid-to-inner shelf waters (see Hammond, et al., 1995; Schoonmaker, et al., 1994). A detailed description of the architecture and codes of the TIDE_FEM/SEDXPORT is given in Jenkins and Wasyl (2005) that is available on-line at the University of California digital library at: http://repositories.cdlib.org/sio/techreport/58/.

Validation of the TIDE_FEM/SEDXPORT code was shown by three independent methods: 1) direct measurement of suspended particle transport and particle size distributions by means of a laser particle sizer; 2) measurements of water column optical properties; and, 3)

comparison of computed stratified plume dispersion patterns with LANDSAT imagery. Besides being validated in coastal waters of Southern California, the TIDE_FEM/SEDXPORT modeling system has been extensively peer reviewed. Although some of the early peer review was confidential and occurred inside the Office of Naval Research and the Naval Research Laboratory, the following is a listing of 5 independent peer review episodes of TIDE_FEM/SEDXPORT that were conducted by 9 independent experts and can be found in the public records of the State Water Resources Control Board, the California Coastal Commission and the City of Huntington Beach.

1997- Reviewing Agency: State Water Resources Control Board
Project: NPDES 316 a/b Permit renewal, Scripps Beach, Carlsbad, CA
Reviewer: Dr. Andrew Lissner, SAIC, La Jolla, CA

1998- Reviewing Agency: California Coastal Commission
Project: Coastal Development Permit, San Dieguito Lagoon Restoration
Reviewers: Prof. Ashish Mehta, University of Florida, Gainesville;
Prof. Paul Komar, Oregon State University, Corvallis;
Prof. Peter Goodwin, University of Idaho, Moscow

2000- Reviewing Agency: California Coastal Commission
Project: Coastal Development Permit, Crystal Cove Development
Reviewers: Prof. Robert Wiegel, University of California, Berkeley;
Dr.Ron Noble, Noble Engineers, Irvine, CA

2002- Reviewing Agency: California Coastal Commission
Project: Coastal Development Permit, Dana Point Headland Reserve
Reviewers: Prof. Robert Wiegel, University of California, Berkeley;
Dr. Richard Seymour, University of California, San Diego

2003- Reviewing Agency: City of Huntington Beach
Project: EIR Certification, Poseidon Desalination Project
Reviewer: Prof. Stanley Grant, University of California, Irvine

Lagoon water levels and tidal currents are studied using numerical transport models that are run over a historic surrogate time period for which environmental forcing is well-known. In all such *boundary value problems* input variables are divided between two general classes,

forcing functions and boundary conditions. The primary forcing function is San Diego Bay water level variation. The important boundary conditions are basin and feeder channel bathymetry, sediment grain size, and river channel scour configurations. Input for San Diego Bay water level variations are discussed below in Section 2.1. The remaining variables are site specific and will be dealt with separately for Alternative-1 in Section 3.1, Alternative-2 in Section 4.1 and Alternative-3 in Sections 5.1.

2) Source Water Forcing, Properties and Calibration

Source water for the proposed new tidal basin in the Otay River floodplain is San Diego Bay water that engages in tidal intrusion up the Otay River. The tidal range in south San Diego Bay and the quality of that source water are critical to achieving a functioning salt water wetland at the Otay River floodplain site. One special attribute of this site is that the inlet channel and the mouth of the Otay River are not subject to littoral transport by shoaling ocean waves, as south San Diego Bay provides complete sheltering from high energy shoaling swells. Consequently, the inlet channel is not likely to infill or close from sand influx in the source water, making the site significantly easier to maintain.

2.1 San Diego Bay Water Level Variation: The flow of sea water into and out of the Otay River Channel is driven by the time variation in San Diego Bay water level. San Diego Bay level variations for the 1980-2009 simulation period were obtained from the nearest tide gage, located at the Navy Pier in San Diego Bay. This tide gage (NOAA #941-0170) was last leveled using the 1983-2001 tidal epoch. Elevations of tidal datums referred to NGVD29 are given in the second column of Table 1 and compared with tides on the open coast in the third column based on the Scripps Pier tide gage (NOAA #941-0230). Tidal data in Table 1 indicates that tidal ranges in San Diego Bay are greater than those found on the open coast. Mean diurnal tidal ranges are 5.72 ft as compared to 5.33 ft on the open coast, an increase of 0.39 ft of diurnal range in San Diego Bay. The extreme water level range is 11.23 ft in San Diego Bay as compared to 10.51 ft on the open coast, an increase of 0.72 ft of extreme range in the bay. All high water datum in the bay exceed those on the open coast and all the low water level datum are lower in the bay than on the open coast. This occurs because San Diego Bay is a resonant tidal system

Table 1: San Diego Bay & Coastal Ocean Tidal Datums, 1983-2001 Tidal Epoch

	San Diego Bay Tides: NOAA #941-0170 Navy Pier	Coastal Ocean Tides NOAA# 941-0230 Scripps Pier La Jolla
HIGHEST OBSERVED WATER LEVEL	5.63 ft NGVD	5.35 ft NGVD
MEAN HIGHER HIGH WATER (MHHW)	3.21 ft NGVD	3.03 ft NGVD
MEAN HIGH WATER (MHW)	2.48 ft NGVD	2.30 ft NGVD
MEAN TIDE LEVEL (MTL)	0.45 ft NGVD	0.46 ft NGVD
MEAN LOW WATER (MLW)	-1.67 ft NGVD	-1.39 ft NGVD
MEAN LOWER LOW WATER (MLLW)	-2.51 ft NGVD	-2.30 ft NGVD
LOWEST OBSERVED WATER LEVEL	-5.60 ft NGVD	-5.16 ft NGVD

where higher harmonics of the K1 lunar-solar diurnal tidal constituent and the M2 principal lunar semi-diurnal tidal constituent are bathymetrical trapped in the bay, leading to a build up in tidal amplitude. The tidal resonance of San Diego Bay provides additional tidal energy for forcing tidal inundation of the proposed tidal basin in the Otay River floodplain, and is another attribute of this site that increases the chance of achieving a sustainable functioning wetland restoration.

A 30-year simulation time period of San Diego Bay tides, 1980-2009, was used to drive the model in the present analysis. This period was chosen because it represents the longest unbroken record for which there existed the simultaneous availability of a number of critical input data sets, in particular an unbroken verified ocean water level record. This time period is sufficiently long to characterize and capture the effects of climate variability, and contained a number of significant climate cycles, including the warm/wet El Niño events of 1980, 1983,

1993, 1995 and 1997, as well as the cool/dry La Niña events of 1986-88 and 2000-01. These climate events embedded in the 1980-2009 period of record assure that the hydrodynamic simulations were able to account for the effects of climate cycle extremes on ocean water levels and ultimately on tidal inundation of the restoration project.

In order to use of observations of historic San Diego Bay water levels in hydraulic modeling exercises we must reconstruct the water level time series at time steps much shorter than the observation intervals (6 minutes). Reconstruction of water level variations at 2 second time step intervals is necessary for achieving stable modeling simulations of the hydraulic response of the lagoon. The ocean water levels were reconstructed at 2 second time step intervals from astronomic tidal constituents for the Navy Pier using daily offsets to the astronomic tidal elevations to compensate for sea level anomalies (see Flick & Cayan, 1984) and achieve agreement with the daily high and low water elevations measured by the Navy Pier tide gage. These daily offsets were obtained by a minimization of the mean squared error between the predicted and measured water level. The short time step reconstruction from tidal constituents with daily offsets was accomplished with the TID_DAYS program, detailed in Jenkins and Wasyl (2005).

For representative spring-neap cycle analysis of tidal circulation in the proposed Otay River floodplain tidal basin, the record was searched for a two-day block having the maximum and minimum diurnal range and for another two-day block whose diurnal range most closely matches the 5.72 ft. range between the MHHW and MLLW of the 1980-2009 tidal epoch. Once these two-day blocks were identified at six minute time step intervals, they were subsequently reassembled in $\Delta t = 2$ sec. time step intervals to produce the tidal forcing functions used in the high resolution tidal circulation analysis of each alternative design.

2.2 San Diego Bay Water Quality: The Southwest Wetland Interpretive Association (SWIA) has operated a self recording water quality monitoring station since 2007 at the mouth of the Otay River at the location noted in yellow in Figure 1. This monitoring station (referred to as the Otay River Sonde) has recorded salinity and dissolved oxygen at 15 minute intervals from December 2007 through April 2010. Figure 4 gives the temporal variation of the salinity in parts per thousand (ppt) recorded by the sonde during this period, while Figure 5 gives the dissolved

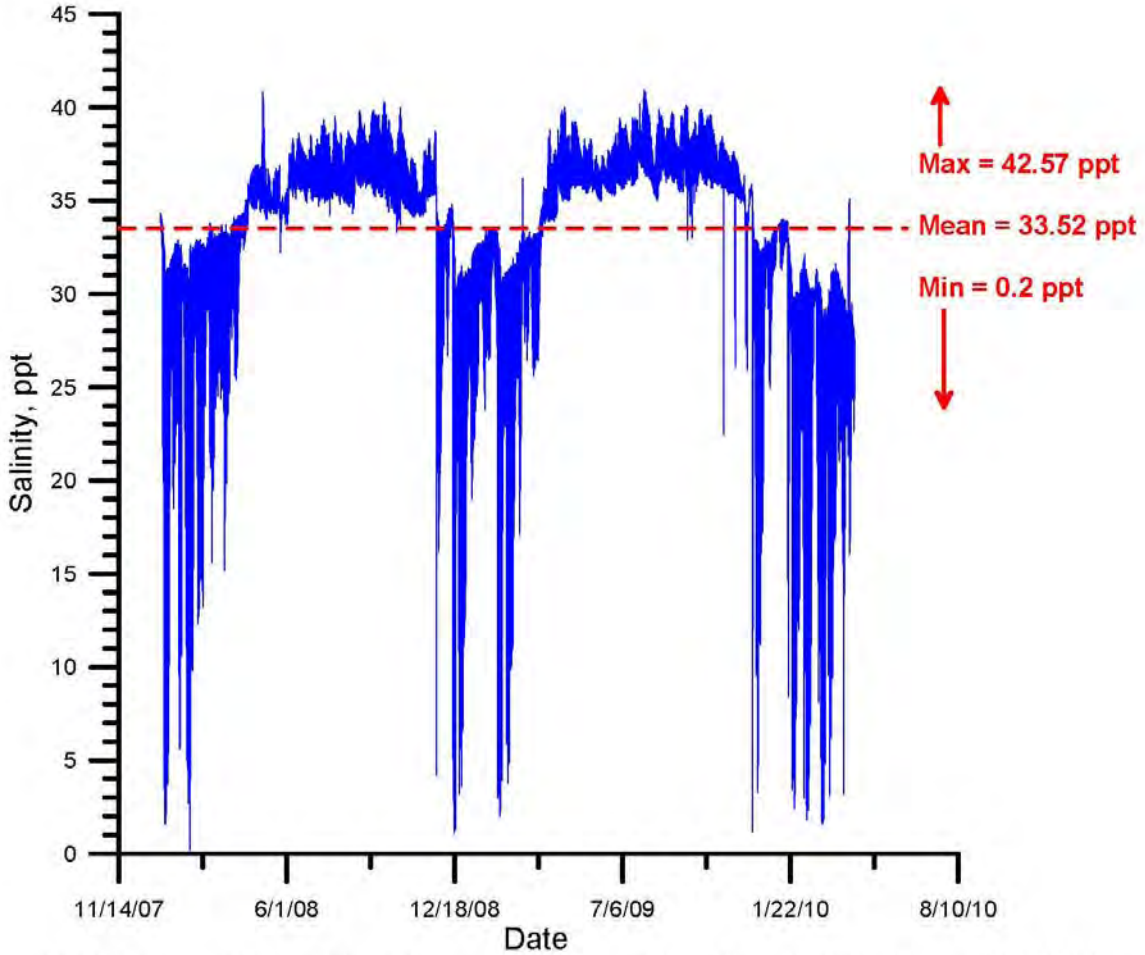

Figure 4: Salinity variation Otay River mouth, from Otay Sonde data base, 2007-2010.

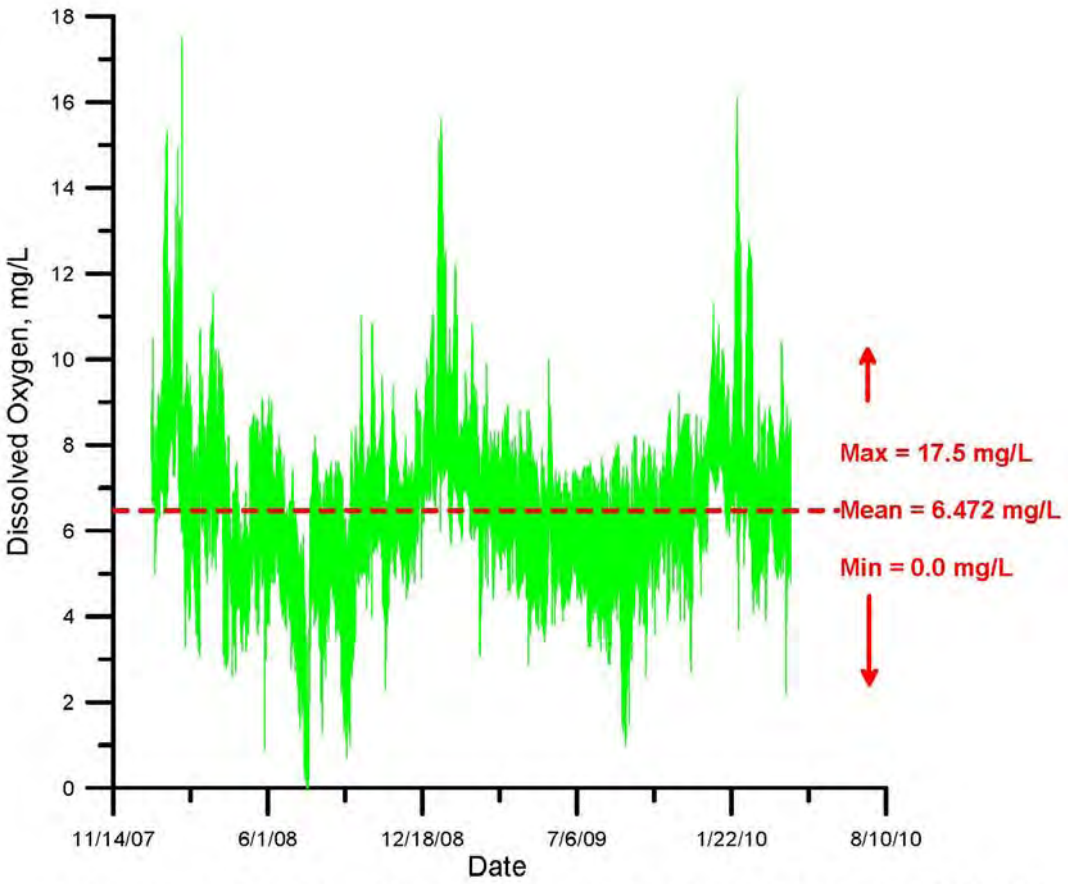

Figure 5: Dissolved oxygen variation Otay River mouth, from Otay Sonde data base, 2007-2010.

oxygen in mg/L. The maximum salinity reached during the dry, evaporative summer months is 42.57 ppt, while the minimum salinity during wet winter periods reaches as low as 0.2 ppt, but the average salinity is 33.52 ppt, identical to the average salinity recorded on the open coast at Scripps Pier. These salinity ranges are comparable to what has been measured in the San Dieguito Lagoon on the open coast by Boland (1998), and are suitable for sustaining a healthy functioning salt water wetland. The dissolved oxygen readings (DO) in Figure 5 show a maximum DO reached during the wet, winter months of 17.5 mg/L, while the minimum DO occurs during summer and can reach 0.0 mg/L. However, the average DO is 6.47 mg/L, about the same as found in nearshore waters along the open coast as measured at Scripps Pier. DO readings at the Otay River sonde are roughly equivalent to what Boland (1998) reported for San Dieguito Lagoon. Percent departures from the mean for salinity and DO are compared in

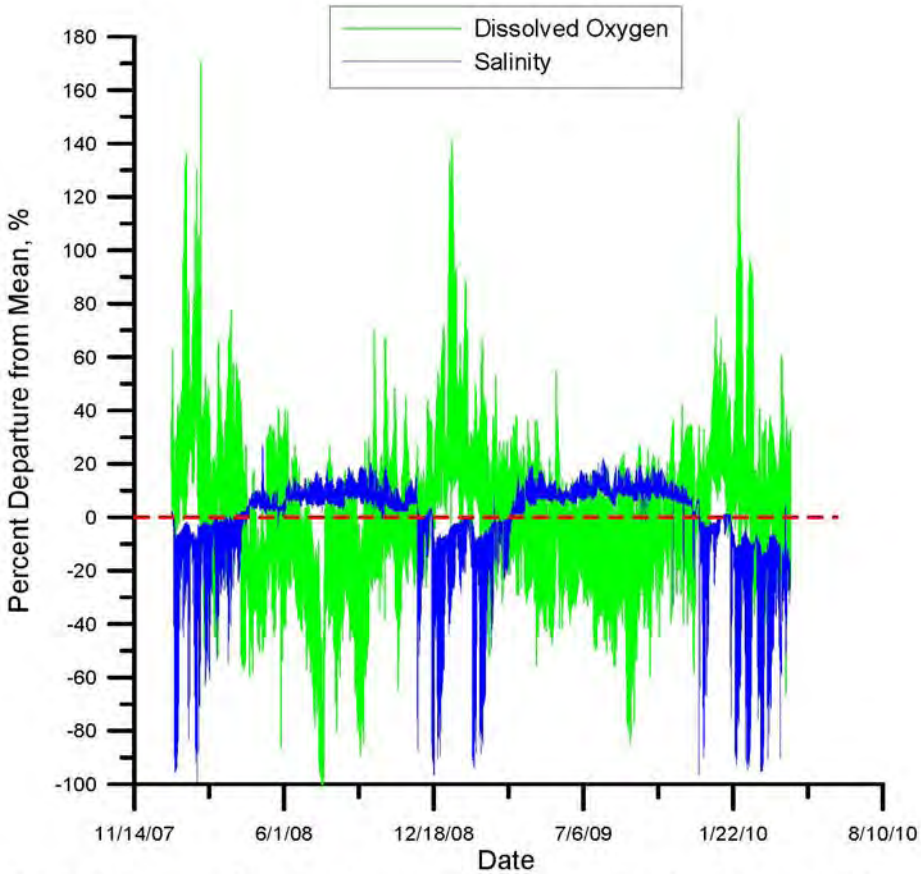

Figure 6: Variation in departures from the mean for salinity and dissolved oxygen in Otay River mouth, from Otay Sonde data base, 2007-2010.

Figure 6 indicating that DO maximums occur when Otay River flooding occurs and the salinity is depressed to minimum values, and conversely, DO minimums occur during warm evaporative months in summer when south San Diego Bay waters turn hyper saline. Regardless, variability in salinity and dissolved oxygen at the Otay River sonde are within normal limits of a healthy functioning salt water wetland.

2.3 Model Calibration: We use monitoring data for the newly completed San Dieguito Lagoon Restoration Project to calibrate the TIDE_FEM tidal hydraulics model; and then use that calibration to simulate tidal inundation of the three wetland restoration alternatives in the Otay River flood plain. The San Dieguito Lagoon monitoring data was collected by Coastal Environments (2009) during September 2009. We select the W-16 tidal basin at San Dieguito Lagoon as a proxy for the proposed tidal basin in the Otay River floodplain because of

morphologic similarities between the two cases: in particular both have a long “goose-neck” feeder channel connecting source water to interior tidal basins of comparable acreage and distance from the source water.

Spring, neap and mean tidal range simulations of the tidal hydraulics of San Dieguito Lagoon were performed using astronomic tidal forcing functions at = 2 sec time step intervals for the period 1980-2007, as discussed in Section 2.1. Computed water surface elevations and depth averaged velocities from the global solution matrix were converted to lagoon waterline contours and flow trajectories. Calibrations for determining the appropriate Manning factors and eddy viscosities were performed by running the TIDE_FEM model on the San Dieguito bathymetry file and comparing calculated water surface elevations in the W-16 tidal basins against water level measurements by Coastal Environments (2009) during the monitoring period of 14-18 September 2009. Iterative selection of Manning factor n_0 = 0.03511 and an eddy viscosity of ε = 7.129 ft^2/sec gave calculations of water surface elevation and inlet that reproduced the measured values to within 2% over the 2009 monitoring period at San Dieguito Lagoon.

Figure 7 provides a quantitative assessment of predictive skill of the calibrated model using water level measurements in the newly created W-16 Tidal Basin located east of I-5 off the north bank of the San Dieguito River. Here we compare W-16 Tidal Basin water level variations predicted by the model (purple trace) with the water level measurements (black crosses) during the post-construction monitoring of the Edison Plan by Coastal Environments, (2005). The W-16 Basin water level variations are found to lag the ocean water levels by as much as 3.79 hr during the mid-range tides of the monitoring period. High tide water levels equal or exceed those in the ocean due to trapping of higher harmonics of the K1 lunar-solar diurnal tidal constituent and the M2 principal lunar semi-diurnal tidal constituent, similar to what occurs in San Diego Bay. However, low tide water levels in the W-16 basin never drop below + 1.49 ft NGVD and are well above ocean low tide water levels due to frictional impedance and depth limiting travel time of the tidal wave propagation in the long sinuous feeder channels that connect the W-16 tidal basin with the ocean. Low tide levels in W-16 could fall no lower than +0.23 ft NGVD due to the present elevation of the hard channel bottom under the I-5 bridge. The amplitudes and degree of

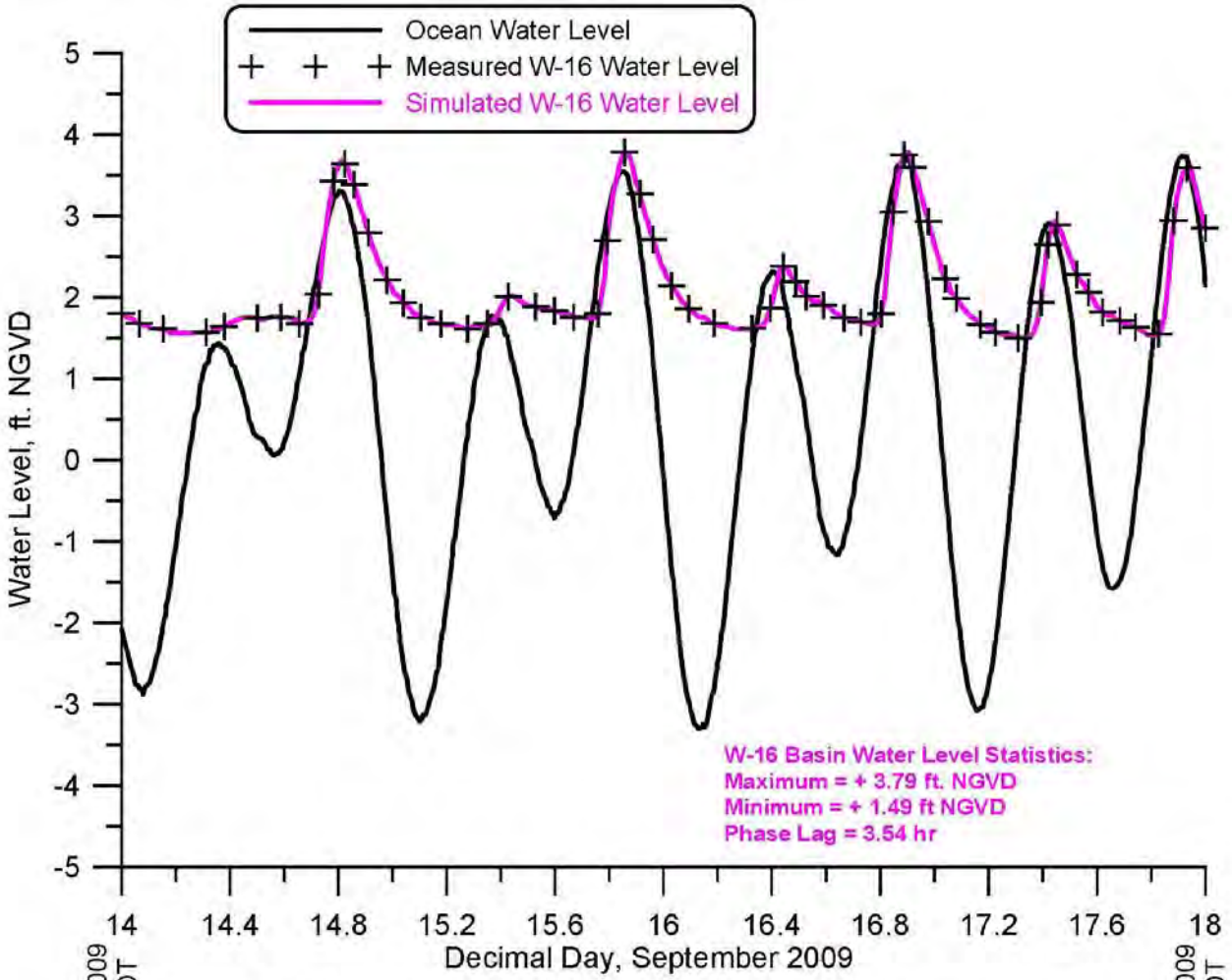

Figure 7. Water level calibration based on the W-16 tidal basin measurements, San Dieguito Lagoon, 14 - 18 September 2009. Ocean water level (black) compared to measured W-16 basin water levels (black crosses) vs calibrated model simulation (red). Measurements by Coastal Environments (2009).

non-linearity in the W-16 Basin water level time series are accurately simulated by the model and closely duplicate those features observed in the measured lagoon tides.

In Figure 7, the calibration error appears to exhibit a systematic tendency. When amplitude errors occur, they tend to over estimate the water elevation of the LLW tidal stage and under estimate the water elevation of the HHW tidal stage. Although these errors are quite small and may be considered high predictive skill, this error mode is consistent with *bathymetry errors* in which depth has been under estimated, Weiyan (1992). Bathymetry errors are the most common cause of modeling errors.

3) Tidal Hydraulics Analysis of Restoration Alternative-1

Figure 8 details the elevation contours of the Alternative-1 tidal basin merged with the Otay River bathymetry. The Alternative-1 tidal basin was designed by Nordby Biological and KTU+A to satisfy mitigation requirements placed upon Poseidon Resources Corporation by the California Coastal Commission (CCC) and San Diego Regional Water Quality Control Board (RWQCB). The design concept for Alternative-1 is based on achieving sufficient subtidal acreage to meet the fish productivity requirements of the RWQCB mitigation requirements while maintaining an appropriate balance with intertidal habitat to achieve maximum biodiversity of an optimal salt water wetland. It is therefore referred to as the *mixed-habitat plan*. The estimated minimum subtidal acreage to meet fish productivity requirements of the RWQCB mitigation is 11 acres; while the minimum required acreage of restored tidal wetland is 66 acres.

3.1 Bathymetric Input for Alternative-1 : Grading contours for Alternative-1 were provided in 0.5 ft intervals between -6.0 ft NGVD and + 6 ft NGVD by KTU+A. The TIDE_FEM tidal hydraulics model presented in Jenkins and Inman (1999) was gridded for a computational mesh of Alternative-1 built off the Figure 8 bathymetry. Of particular interest to the finite element mesh is the *hydraulic friction slope coefficient*, S_{fj}, providing tidal muting effects. Two separate formulations are used. One is given for the 3-node triangular elements situated in the interior of the mesh which do not experience successive wetting and drying during each tide cycle. The other formulation is for the elements situated along the wet and dry boundaries of the lagoon. These have been formulated as 3-node triangular elements with one

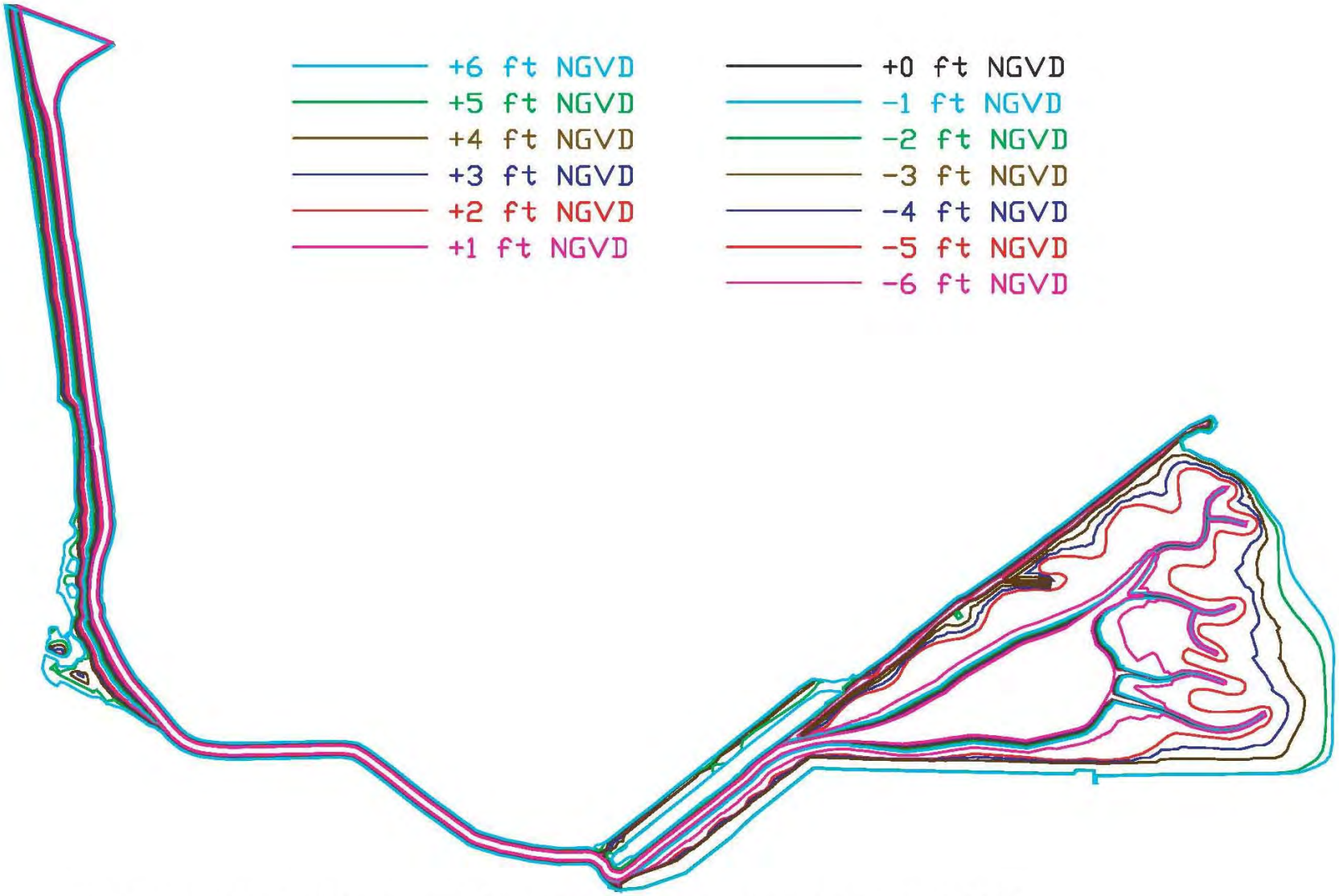

Figure 8. Contours for proposed Otay River tidal basin, Alternative-1, ft. NGVD.

curved side based upon the cubic-spline matrices developed by Weiyan (1992). These two sets of elements were assembled into a computational mesh of the lagoon conforming to the + 6 ft. NGVD contour in Figure 8. The wet-dry boundary coordinates of the curved waterline, (x', y'), are linearly interpolated for any given water elevation from the contours stored in the tidal basin and feeder channel bathymetry file.

Aside from gridding the TIDE_FEM tidal model, stage area and storage rating functions were calculated from the bathymetric contours of Figure 8. Figure 9a gives the stage area function of the Alternative-1 tidal basin in isolation, while Figure 9b gives the storage rating function of the tidal basin merged with the tidally influenced lower reach of the Otay River. The stage area and storage rating functions are used in the initialization of the TIDE_FEM tidal hydraulics model in order to enforce mass conservation in the tidal inundation simulations (see Jenkins and Inman, 1999). The initialization involves fitting a series of high-order polynomials to the areas and volumes of the stage area function in Figure 9a and the storage rating function in Figure 9b, respectively. To accommodate possible future sea level rise the polynomial fits were carried up to a daylight contour chosen at +6.0 ft NGVD, even though the tidal inundation in San Diego Bay has never been observed above +5.63 ft NGVD. A ninth-order polynomial was fitted to the stage area function in Figure 9a with a coefficient of determination of $r^2 = 0.979$ while a fifth- order polynomial was fitted to the storage rating function in Figure 9b with a coefficient of determination of $r^2 = 0.998$.

For tidal inundation up to the historic extreme high water level of San Diego Bay (EHW = +5.63 ft NGVD, upper red dashed line in Figure 9a), Alternative-1 could provide as much as 82.6 acres of tidally influenced wetland and high salt marsh. In subsequent tidal hydraulics simulations, we will find that Alternative-1 provides on average 18.5 acres of subtidal habitat (lower dashed blue line in Figure 9a); while the amount of subtidal habitat is never less than 16.9 acres (lower dashed red line in Figure 9a). Thus the critical threshold for adequate fish productivity (11 acres of subtidal habitat) is satisfied with a safety margin of 5.9 acres. The maximum volume of San Diego Bay water that is exchanged with the Alternative-1 tidal basin is 515 acre-ft during an extreme high water event (dashed red line limits in Figure 9b), and the average diurnal tidal prism of Alternative-1 is 235 acre-ft (dashed blue line limits in Figure 9b).

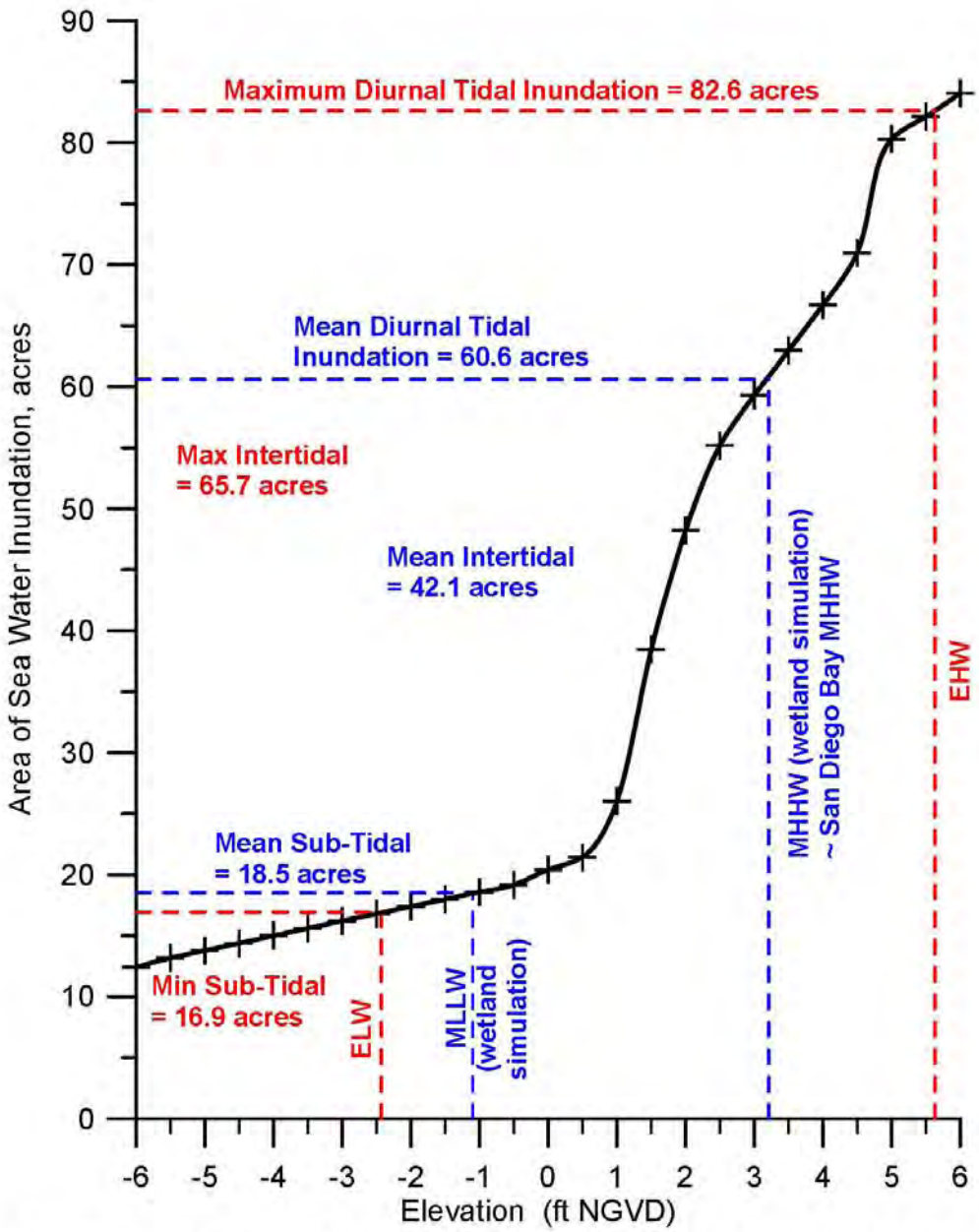

Figure 9a. Stage area function of the tidal basin for Alternative-1 Otay Wetland Restoration Project. Water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

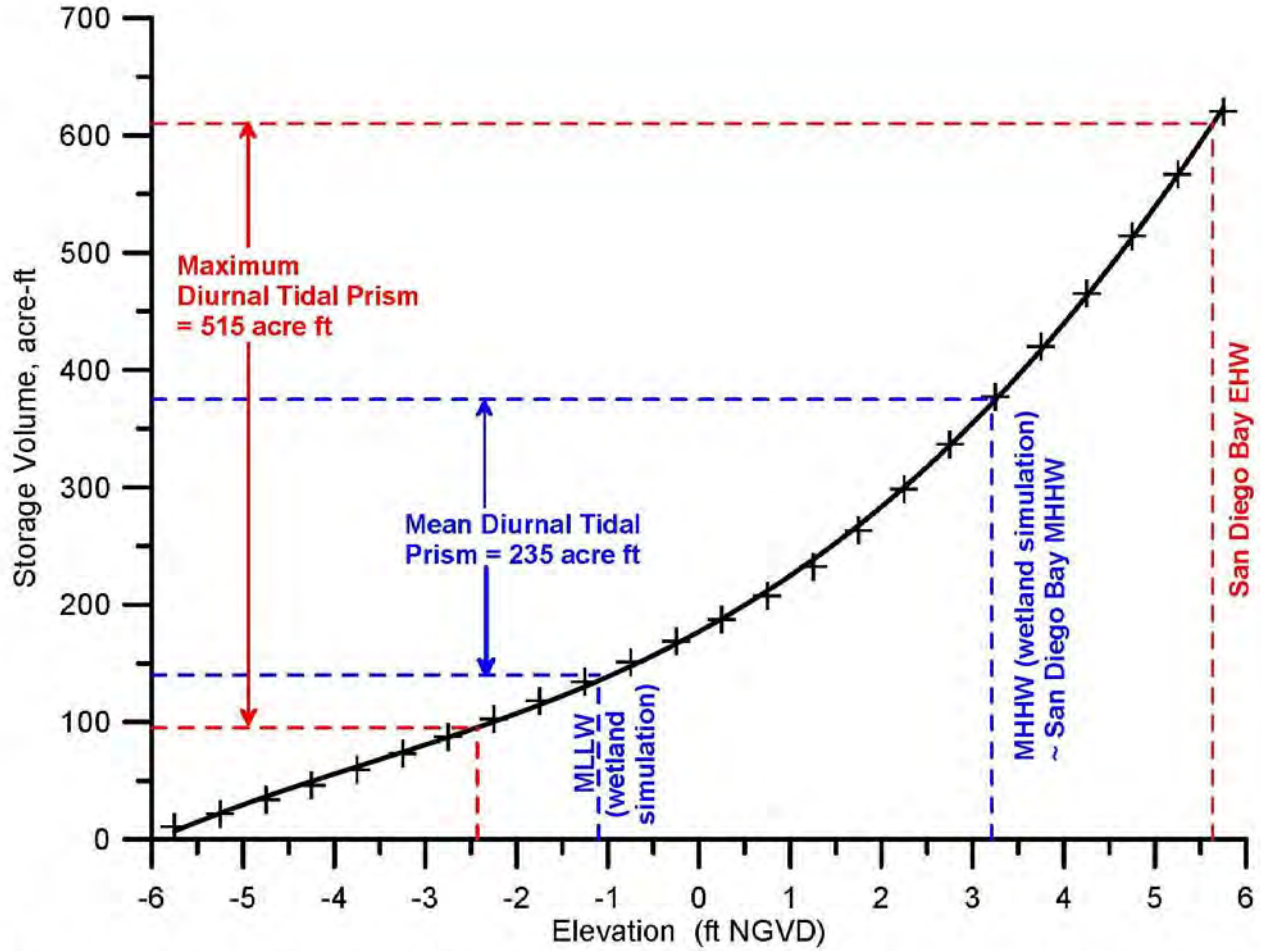

Figure 9b. Storage rating function of the tidal basin and Otay River feeder channel for Alternative - 1 of the Otay Wetland Restoration Project. Water level data from NOAA tide gage 941-0170, Navy Pier, San Diego Bay.

3.2 Alternative-1 Tidal Flow Simulations: The TIDE_FEM grid of Alternative-1 at MHHW is nested in the farfield of south San Diego Bay as shown in Figure 10, and was subjected to 30 years of historic tidal forcing using the 1980-2009 period of record for verified water level data from the NOAA tide gage #941-0170 at the Navy Pier in San Diego Bay. The TIDE_FEM model is driven by San Diego Bay water level variations at the mouth of the Otay River located where the flood/ebb double headed arrow is shown in Figure 10. Figure 11 gives the flow trajectories and depth averaged tidal currents computed by the calibrated TIDE_FEM model during spring flooding tides on 18 September 2009. Velocities of tidal currents are portrayed according to the color coded velocity scale appearing in both the upper and lower panel of Figure 11. Maximum flooding spring tidal currents in the deeper sections of the inlet channel (north/south reach of the Otay River near its mouth) are about 0.10 m/sec (0.33 ft/sec), and then accelerate in the narrower east/west reach to 0.18 m/sec (0.59 ft/sec) before entering the Alternative-1 tidal basin. Flood tide currents entering the tidal basin initially form a well defined jet at the west bank with speeds of about 0.08 m/s (0.26 ft/sec). This entry jet quickly diverges into a complex set of counter rotating eddies that populate the interior of the tidal basin. Eddy speeds in the tidal basin are on the order of 0.02 m/sec (0.07 ft/sec), insufficient to transport fine sand but an important stirring mechanism for mixing the tidal basin water mass to maintain high oxygen levels and to sustain fine silt and clay sized sediment particles in suspension.

Figure 12 shows the TIDE_FEM grid of Alternative-1 at MLLW nested in the farfield of south San Diego Bay, while Figure 13 gives the flow trajectories and depth averaged tidal currents computed by the TIDE_FEM model during spring ebbing tides on 18 September 2009. The wetted area of the tidal basin in Figure 13 is significantly reduced relative to the flood tide area in Figure 11, due to the lower water levels acting on the stage area curve in Figure 9a. In Figure 13 creeping flow drains from the complex of dendritic channels on the east side of the basin, forming a feeder current across the main body of the basin with speeds on the order of -0.06 m/sec (-0.19 ft/sec) to -0.08 m/sec (-0.26 ft/sec). This feeder current evacuates the tidal

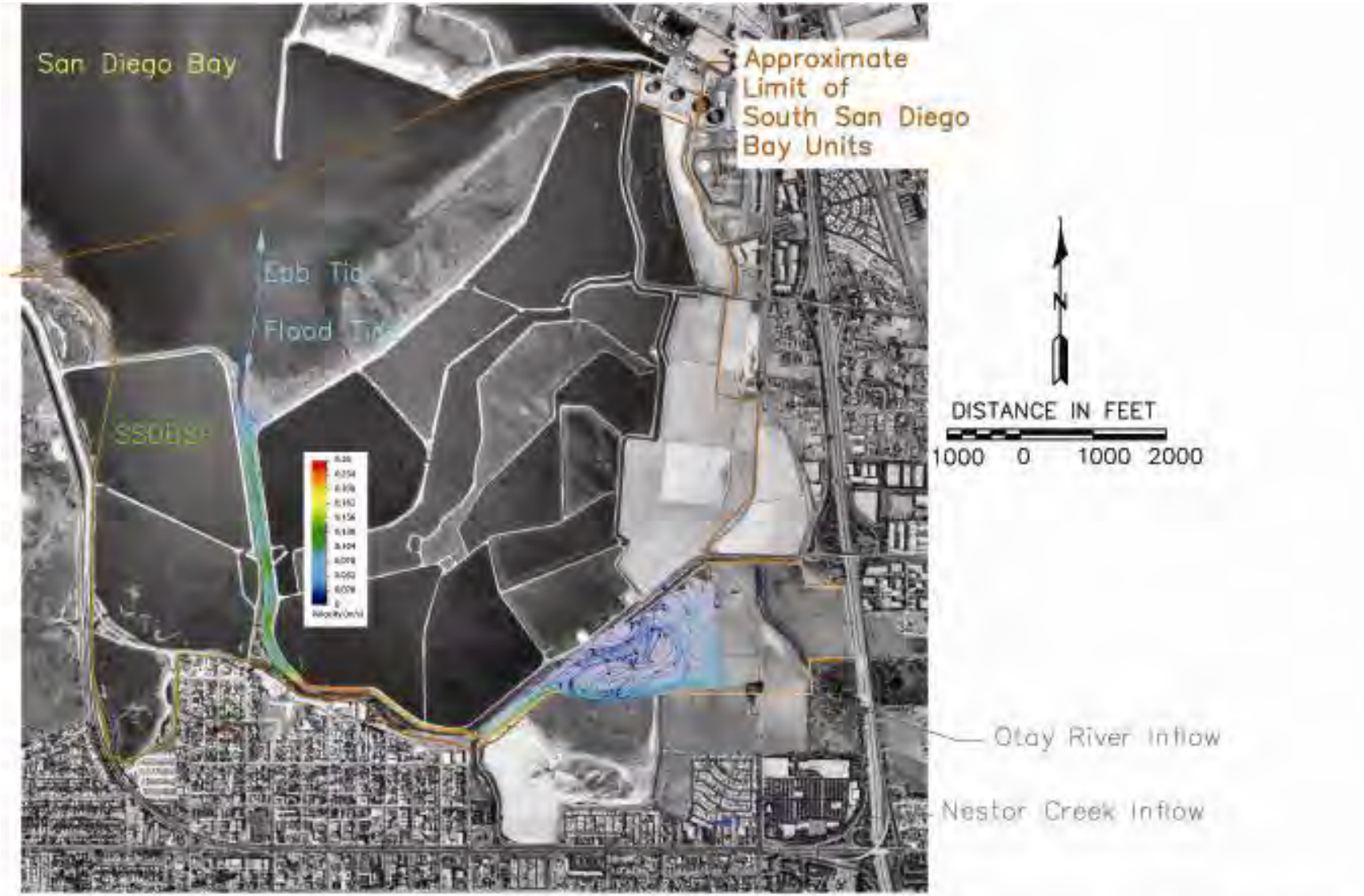

Figure 10. Far field of hydrodynamic simulation of mean flood tide flow into proposed Otay River tidal basin.

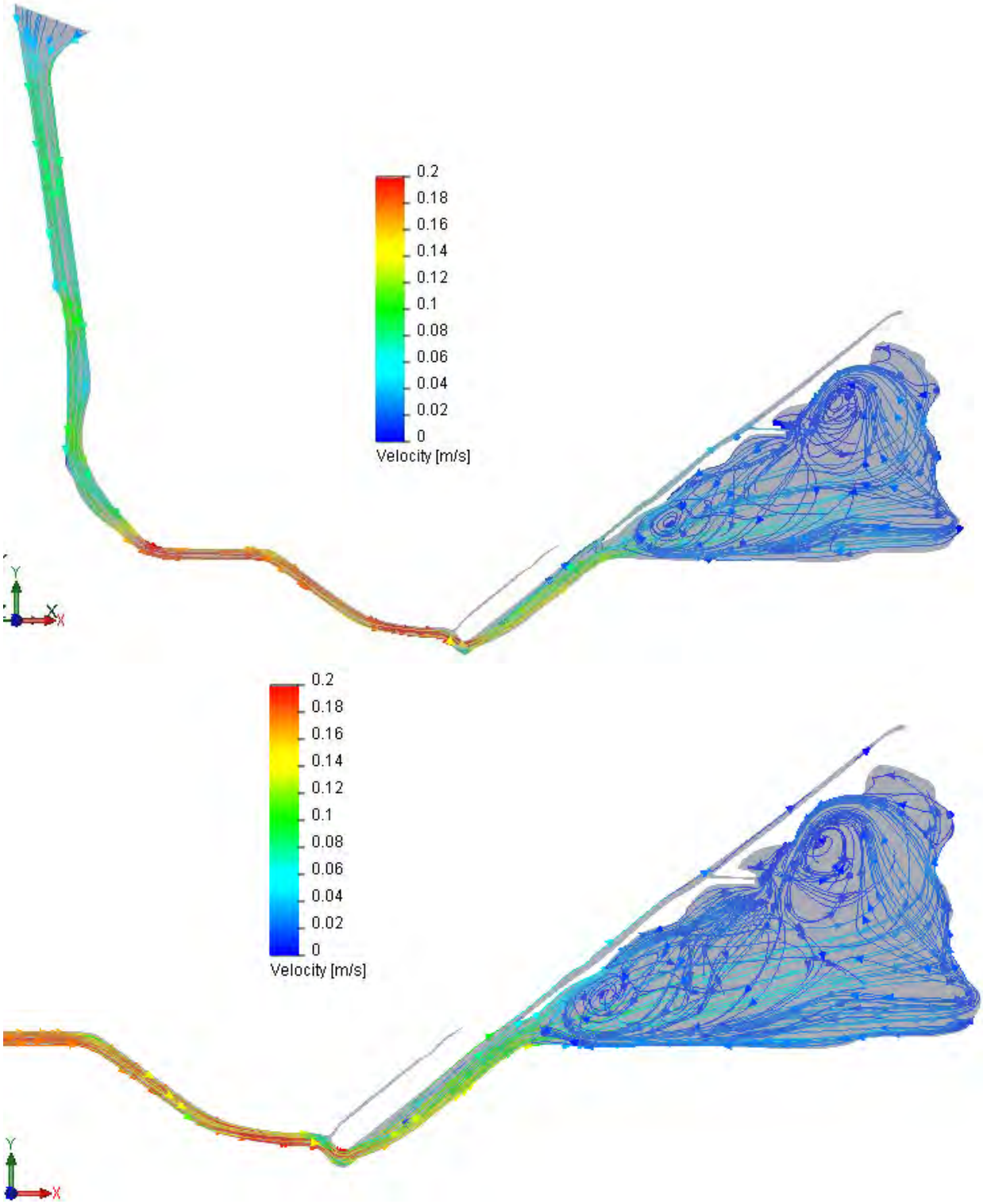

Figure 11: Hydrodynamic simulation of maximum flood flow during spring tides for Alternative-1, Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

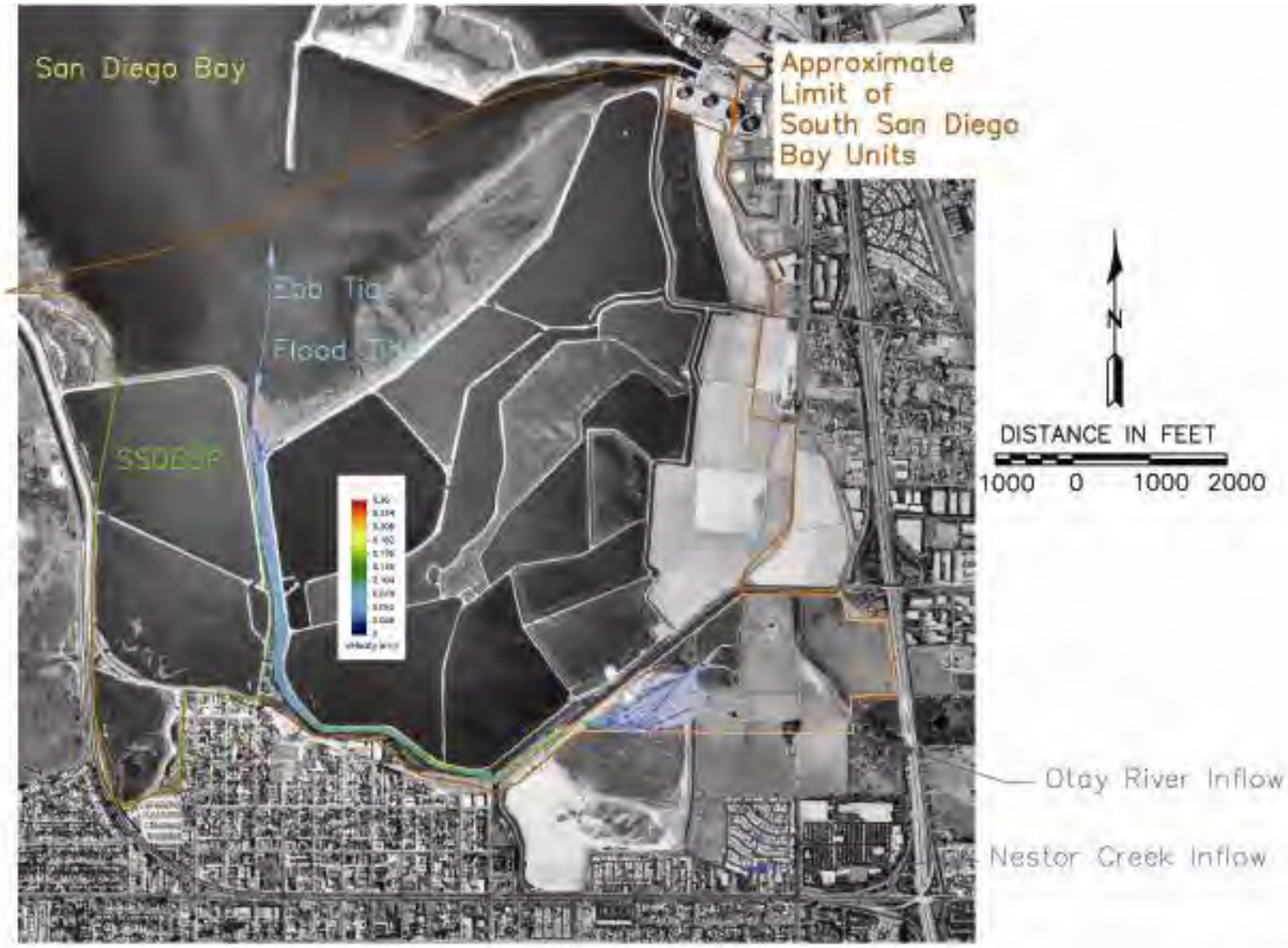

Figure 12. Far field of hydrodynamic simulation of mean ebb tide flow out of proposed Otay River tidal basin.

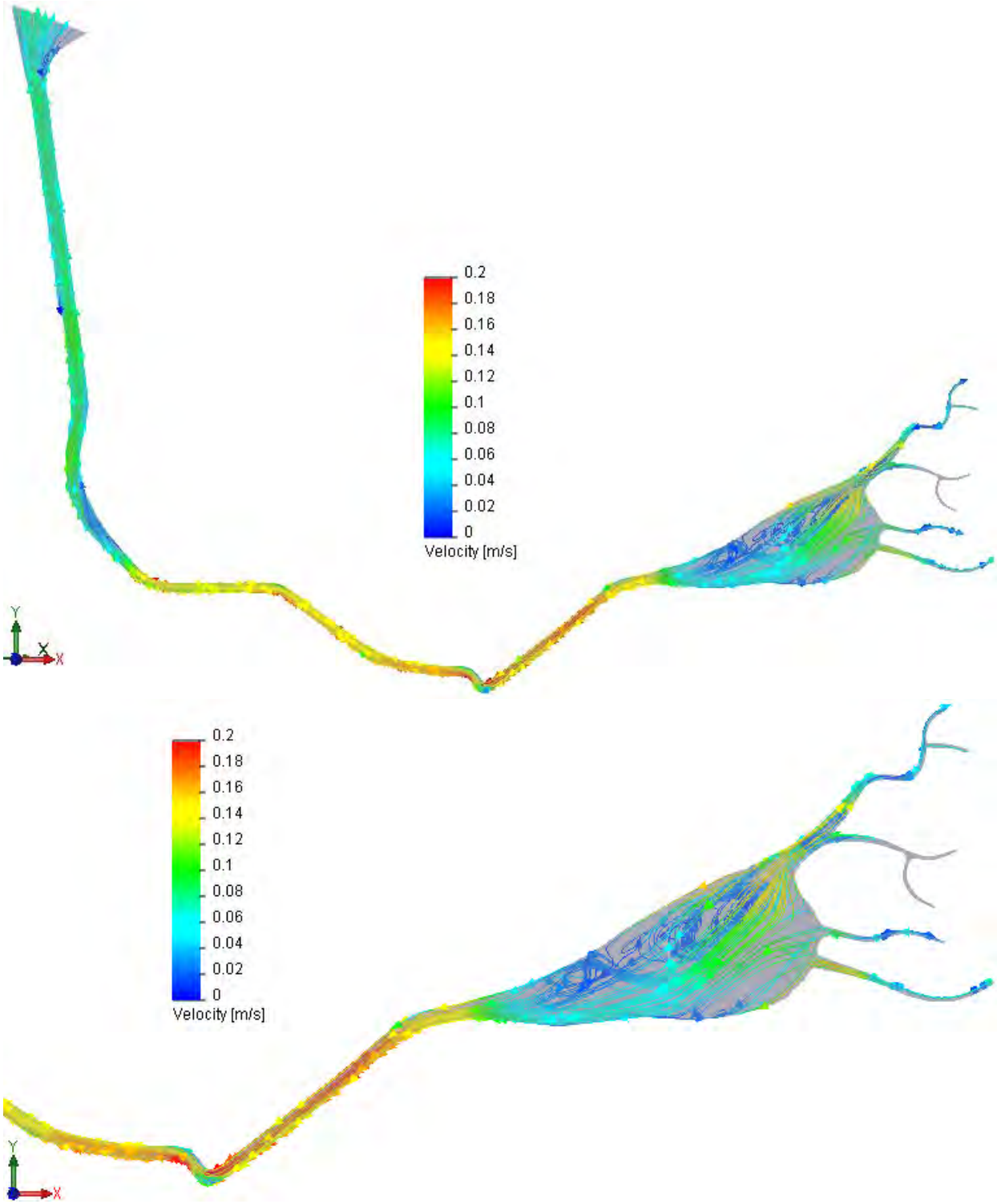

Figure 13: Hydrodynamic simulation of maximum ebb flow during spring tides for Alternative-1 of the Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

basin and then accelerates to -0.16 m/sec (-0.52 ft/sec) as it passes through the pinch point under the railroad bridge in the narrow east/west reach of channel. (We adopt the convention of negative velocities for ebb tide flows and positive velocities for flood tide flows.) Ebb flow in the channel then decelerates to -0.10 m/sec (-0.33 ft/sec) in the deeper north/south reach before discharging into San Diego Bay.

Similar flow patterns to Figures 11 & 13 are found in the Alternative-1 tidal basin during mean range tides and neap tides in Appendix A. The flow trajectories and depth averaged tidal currents during mean range flood and ebb tides are found in Figures A1 & A2, while the neap tide flows are shown in Figures A3 & A4.

Water elevations in the Alternative-1 tidal basin are shown in Figure 14a for spring tides that occurred during 14-18 September, 2009, the same time period used for the model calibration with the proxy tidal system at San Dieguito Lagoon in Figure 7. Figure 14a provides a comparison between the Alternative-1 tidal basin water level variations predicted by the model (red trace) versus the actual San Diego Bay water level measurements (green) reported the Navy Pier tide gage #941-0170. The Alternative-1 tidal basin water level variations in red are found to lag the Bay water levels by as much as 27 minutes at higher high water (HHW) levels on flooding tides while this phase lag averages 2.46 hours at lower low water (LLW) level during ebb tides. Lower low water levels in the Alternative-1 tidal basin are as much as 2.48 ft above Bay water levels. Thus the Alternative-1 tidal basin does not fully drain on ebbing tides due to the long phase lag in reaching lower low water levels. The failure to completely drain on ebb tide is what ultimately limits the tidal range and tidal prism of Alternative-1, but is an unavoidable consequence to frictional impedance and depth limited tidal propagation speeds down the 7,000 ft long channel that connects the Alternative-1 tidal basin with the Bay.

Higher high water levels in the Alternative-1 tidal basin sometimes exceed those in the Bay by as much as +0.31 ft, (Figure 14a), due to a trapped tidal modes (standing wave) typical of lagoons with large tidal basins and multiple choke point linkages to the ocean tides (Lamb, 1932; LeBlond & Mysak, 1978). Figure 14b shows these trapped modes are higher harmonics of the K1 lunar-solar diurnal tidal constituent and the M2 principal lunar semi-diurnal tidal constituent.

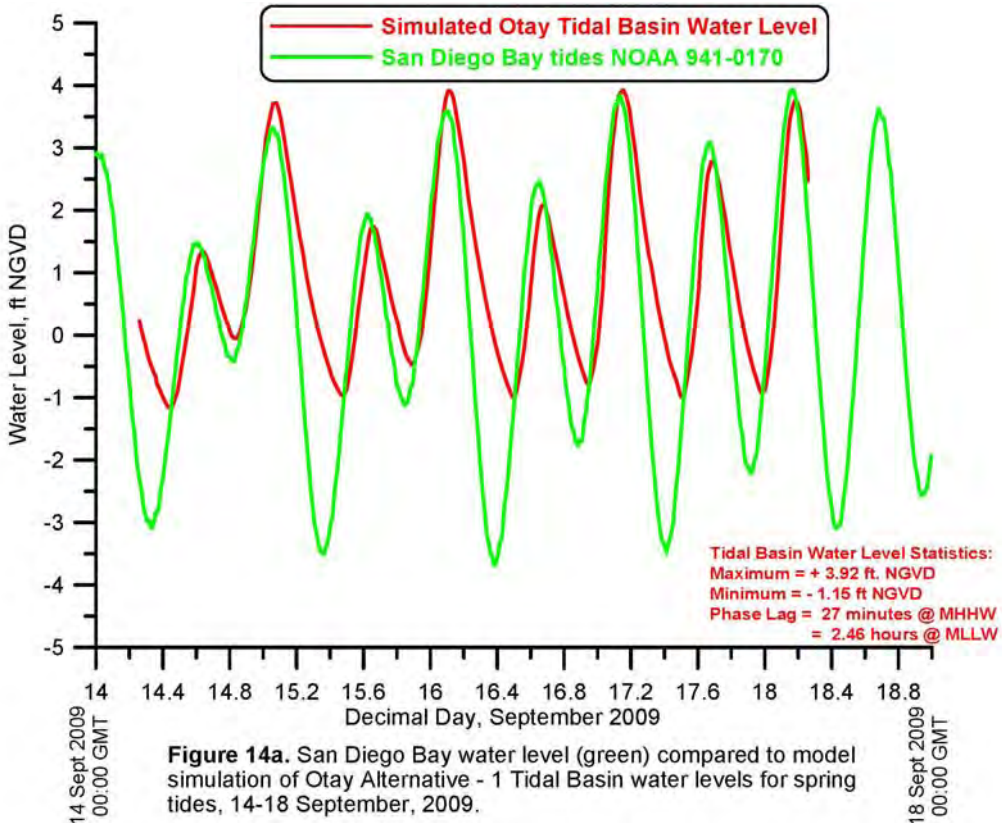

Figure 14a. San Diego Bay water level (green) compared to model simulation of Otay Alternative - 1 Tidal Basin water levels for spring tides, 14-18 September, 2009.

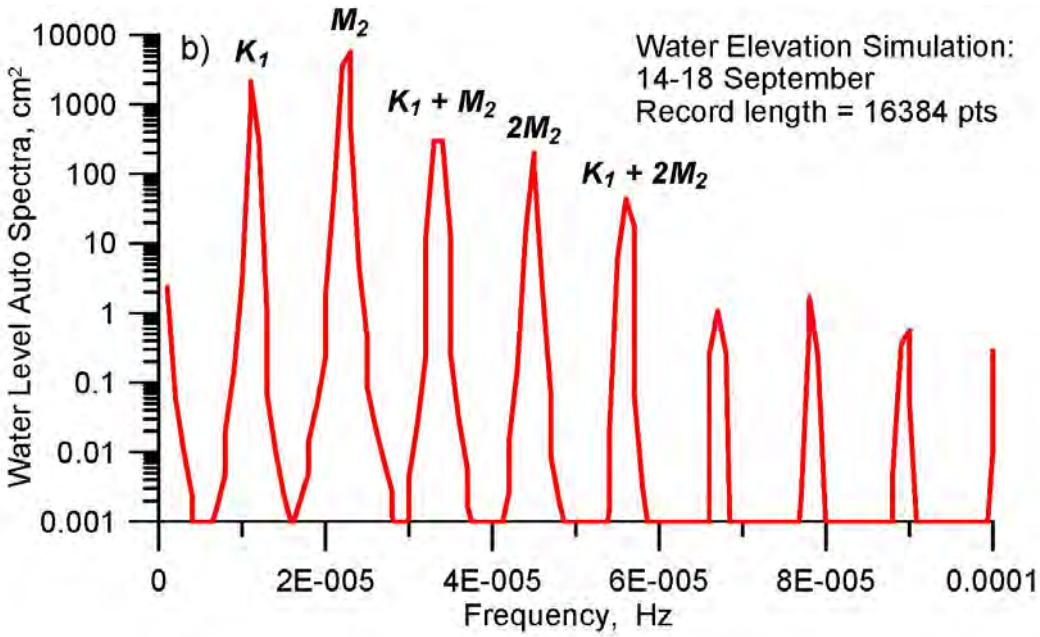

Figure 14b. Auto spectra of water level in the tidal basin of Alternative -1, Otay River Wetland Restoration Project.

Figure 14b plots the auto spectra of the Alternative-1 tidal basin tides and shows the predominant energy is centered on a diurnal frequency of the K1 lunar-solar diurnal tidal constituent at $f_{K1} = 1.16079 \text{ x } 10^{-5}$ Hz and the M2 principal lunar semi-diurnal tidal constituent, $f_{M2} = 2.2365 \text{ x } 10^{-5}$ Hz. The higher harmonics that lead to elevated basin high tide levels are a baroclinic *resonance* formed by a *triad* at the sum of the frequencies of the K1 and M2 barotropic tides, ie a diurnal third harmonic at a frequency $f_3 = f_{K1} + f_{M2} = 3.3973 \text{ x } 10^{-5}$ Hz. This diurnal third harmonic is a baroclinic tide excited by the barotropic K1 and M2 tides interacting with the bottom topography, principally the long inlet channel to the Alternative-1 tidal basin. Another baroclinic resonance apparent in the spectra of the ocean tides in Figure 14b is a second harmonic of the barotropic M2 tide appearing at a frequency of $2 f_{M2} = 4.4730 \text{ x } 10^{-5}$ Hz. An additional non-linear resonance appears as a triad formed by the sum of the K1 barotropic mode and the baroclinic second harmonic of the M2 tide, $f_{K1} + 2 f_{M2} = 5.6338 \text{ x } 10^{-5}$ Hz. Apparently this mode is excited by non-linear tidal interaction with the tidal basin and channel bathymetry.

3.3 Alternative-1 Hydroperiod Simulations: The hydroperiod function gives the percentage of exposure for each elevation throughout the full range of lagoon water level variation. This is the primary physical factor limiting the type of habitat that will thrive at a particular elevation in the lagoon. The San Diego Bay water levels for the 1980-2009 period of record were used to drive the TIDE_FEM model at the mouth of the Otay River in order to solve for the time series of the water level variation in the Alternative-1 tidal basin based on the stage area and storage rating functions in Figures 9a & b. The computations involved N_o = 2,629,800 time steps, each 6 minutes in length, in order to sweep the 30 year period of record. At each time step the average basin water elevation, $\hat{\eta}$ was calculated from the ensemble average of the solutions at the nodes in the computational mesh. Conditional if statements and counting loops inserted into the TIDE_FEM code would count the number time steps, N, for which the average lagoon water elevation was less than a particular elevation, Z_i. The percent time that elevation Z_i was exposed over the period of record was calculated as:

$$E_i = \frac{100\%}{N_o} \sum N(\hat{\eta} < Z_i)$$

The green line in Figures 15 shows the hydroperiod function calculated for the Alternative-1 tidal basin. Water levels in the Alternative-1 tidal basin reached an extreme high water level of +5.63 ft NGVD in response to San Diego Bay water levels on 13 November 1997, while extreme low water in the Alternative-1 tidal basin dropped to – 2.43 ft NGVD in response to 10 January 2009 water levels in the Bay. The elevations dividing the various sub-tidal and intertidal habitat types are based on the 1992 biological survey and supporting literature data as detailed in Josselyn & Whelchel (1999). These elevations were mapped into the corresponding exposure percentages for each habitat type using the hydroperiod function computed for the existing San Dieguito Lagoon at the time of the biological survey. From this procedure, the following exposure times were assigned to each habitat break:

Subtitidal Exposure < 0%;

0% < Frequently Flooded Mud Flat Exposure < 50%;

50% < Frequently Exposed Mud Flat Exposure < 61.8%

61.8% < Low Salt Marsh Exposure < 81.7%

81.7% < Mid Salt Marsh Exposure < 96.2%

96.2% < High Salt Marsh Exposure < 99.8%

99.8% < Transitional Exposure < 100%

We can map the elevations of the habitat breaks from the hydroperiod function in Figure 15 against the stage area function Figure 9a to estimate the acreages of each habitat type that would populate Alternative-1 tidal basin. This procedure gives the minimum subtidal and maximum intertidal habitat types since the hydroperiod function is based on the full range of water level variation over long periods of time (1980-2009 period of record). By that procedure, the minimum (perpetual) sub-tidal area of the Alternative-1 tidal basin is 16.92 acres; there are maximum of 27.73 acres of frequently flooded mud flat; 8.90 acres of frequently exposed mud flat; 7.55 acres of low salt marsh; 12.80 acres of mid salt marsh; 7.51 acres of high salt marsh;

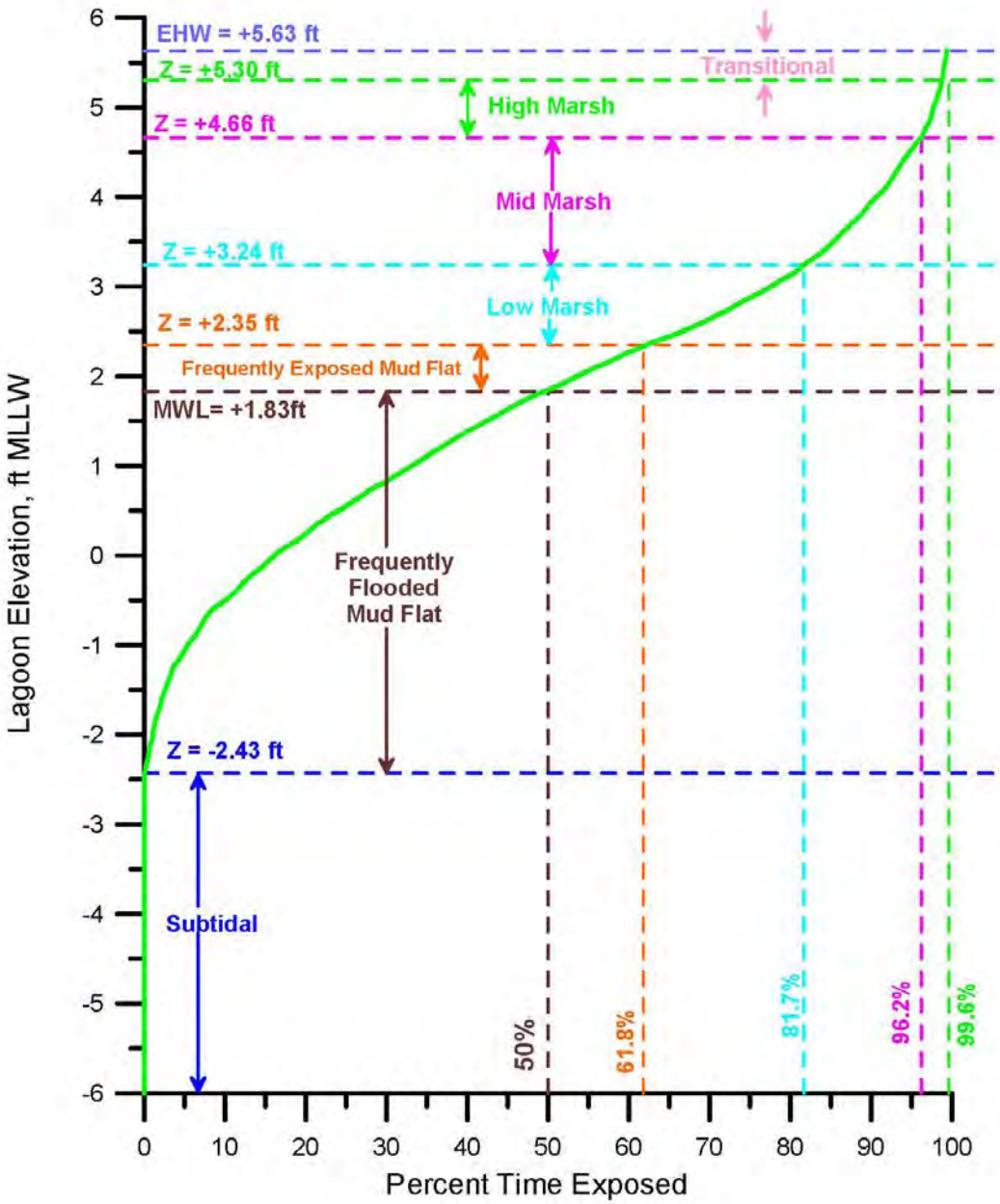

Figure 15. Hydroperiod function of the tidal basin for Alternative -1 Otay Wetland Restoration Project. Based on water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

and 1.22 acres of transitional habitat. The maximum area inundated by salt water at extreme high water is 82.63 acres with at most 65.71 acres of intertidal habitat that experiences tidal inundation at least once in the period of record. An average of 60.57 acres experiences tidal inundation up to MHHW resulting in an average of 42.07 acres of intertidal habitat and 18.50acres of sub-tidal habitat.

3.4 Alternative-1 Tidal Scour and Erosion: The tidal currents calculated in the lower Otay River and feeder channel during spring tides (cf Figures 11 & 13; A1-A4) are compared against grain size data to estimate the potential for scour and erosion. A 1985 geotechnical investigation of the Otay River Floodplain was conducted by GEOCON in 1985 that included boring locations and some gradation curves in the lower Otay River channel. Figure 16a gives the grain size distribution from one such boring, indicating the river channel sediments are fairly well sorted (due to hydraulic sorting during river floods and perhaps relict wave action) with a median grain size of D_{50} = 0.3 mm. Comparing this median grain size against the Hjulstrom Curve in Figure 16b indicates these river channel sediments have a threshold of motion of 0.6 ft/sec (0.18 m/s). Tidal current speeds between 0.27 ft/ sec (0.08 m/sec) and 0.6 ft/sec would lead to bed load transport but not erosion. Erosion and scour would only occur for tidal currents that exceed 0.6 ft/sec, while currents less 0.27 ft/sec would yield deposition.

Comparing these current speed thresholds to the tidal currents predicted in the Alterntive-1 channel during spring tides (Section 3.2) we conclude the only potentially problematic areas are at the two pinch points in the east/west reach of channel during flooding tides (Figure 11). Here local currents speed reach but do not exceed the threshold of motion of 0.6 ft/sec (0.18 m/s). However, without exceedence, erosion does not occur since the sedimentary bed remains in a steady state of bed load transport. Everywhere else along the channel with Alternative-1, speeds remain less than 0.6 ft/sec (0.18 m/s) and greater than 0.27 ft/ sec (0.08 m/sec) during both flooding and ebbing flow. Thus and equilibrium channel is achieved,

wherein there is sediment transport down channel but not deposition, and hence a maximum

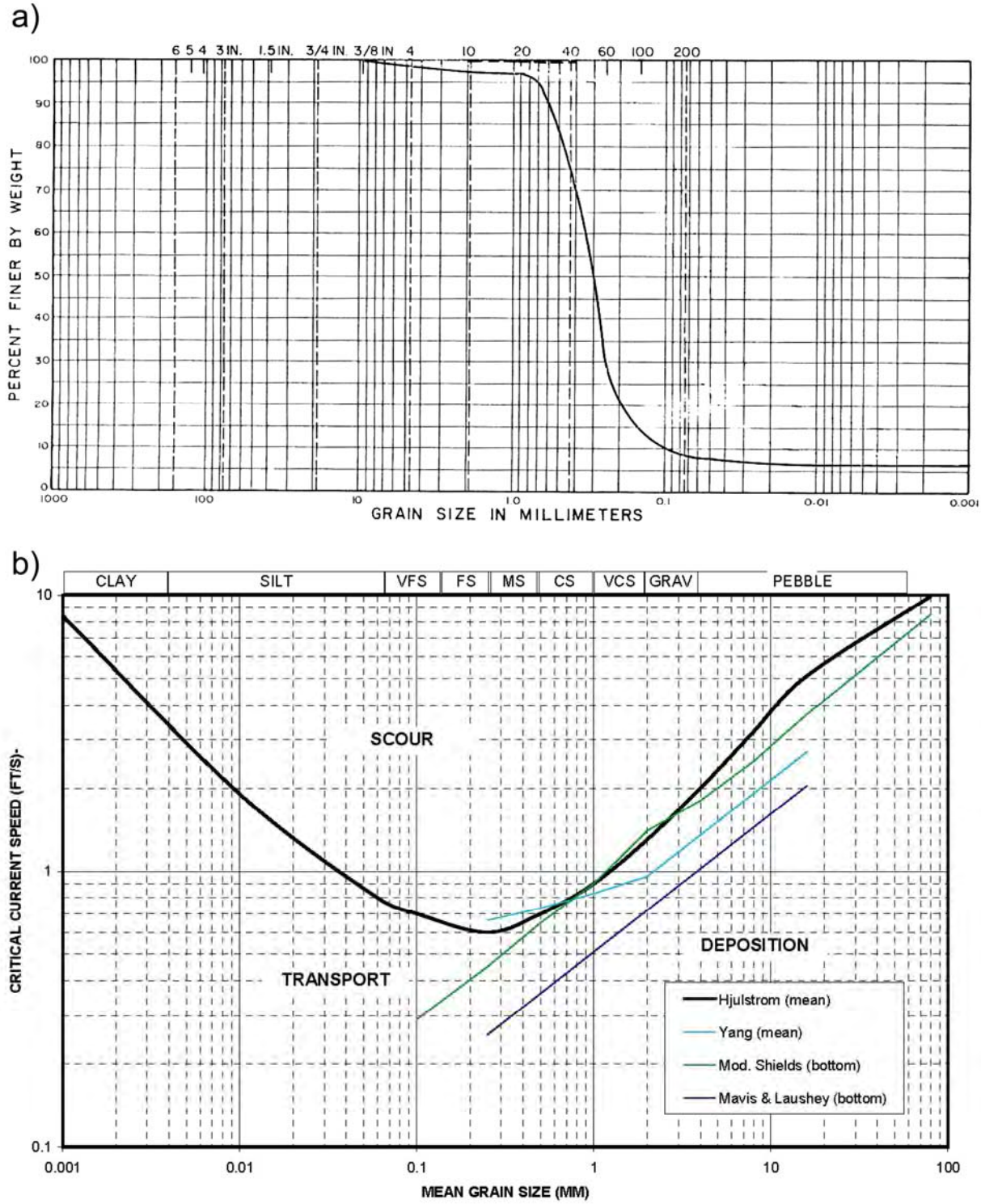

Figure 16. a) Grain size distribution, lower Otay River Channel, [data from GEOCON,1985] b) Critical current speeds for quartz sediment as a function of mean grain size, [from Everest,2007].

likelihood of self-maintaining channel.

4) Tidal Hydraulics Analysis of Restoration Alternative-2

Figure 17 details the elevation contours of the Alternative-2 tidal basin merged with the Otay River bathymetry. The Alternative-2 tidal basin was designed by Nordby Biological and KTU+A to satisfy mitigation requirements placed upon Poseidon Resources Corporation by the CCC and RWQCB. The design concept for Alternative-2 is based on achieving maximum subtidal acreage to meet the fish productivity requirements of the RWQCB mitigation requirements while maintaining sufficient intertidal habitat to achieve adequate biodiversity for a fully functional salt water wetland. It is therefore referred to as the *maximum subtidal- plan*. The estimated minimum subtidal acreage to meet fish productivity requirements of the RWQCB mitigation requirement is 11 acres; while the minimum required acreage of restored tidal wetland is 66 acres.

4.1 Bathymetric Input for Alternative-2: Gridding Alternative-2 for the TIDE_FEM model followed the same 3-node element descretization of the grading contours that was detailed in Section 3.1 for Alternative-1. Figure 18 gives the stage area function of the Alternative-2 tidal basin in isolation. For tidal inundation up to the historic extreme high water level of San Diego Bay (EHW = +5.63 ft NGVD, upper red dashed line in Figure 18), Alternative-2 could provide as much as 82.8 acres of tidally influenced wetland and high salt marsh. We will find that Alternative-2 provides on average 32.8 acres of subtidal habitat (lower dashed blue line in Figure 18); while the amount of subtidal habitat is never less than 31.3 acres (lower dashed red line in Figure 9a). Thus Alternative-2 (the maximum sub-tidal plan) provides substantially more subtidal habitat than Alternative-1 by a factor of 1.9, and easily exceeds the critical threshold for adequate fish productivity (11 acres of subtidal habitat) with a safety margin of at least 20.3 acres. The storage rating function for Alternative-2 in Figure 19 shows that the maximum volume of San Diego Bay water that is exchanged with the Alternative-2 tidal basin is 577 acre-ft during

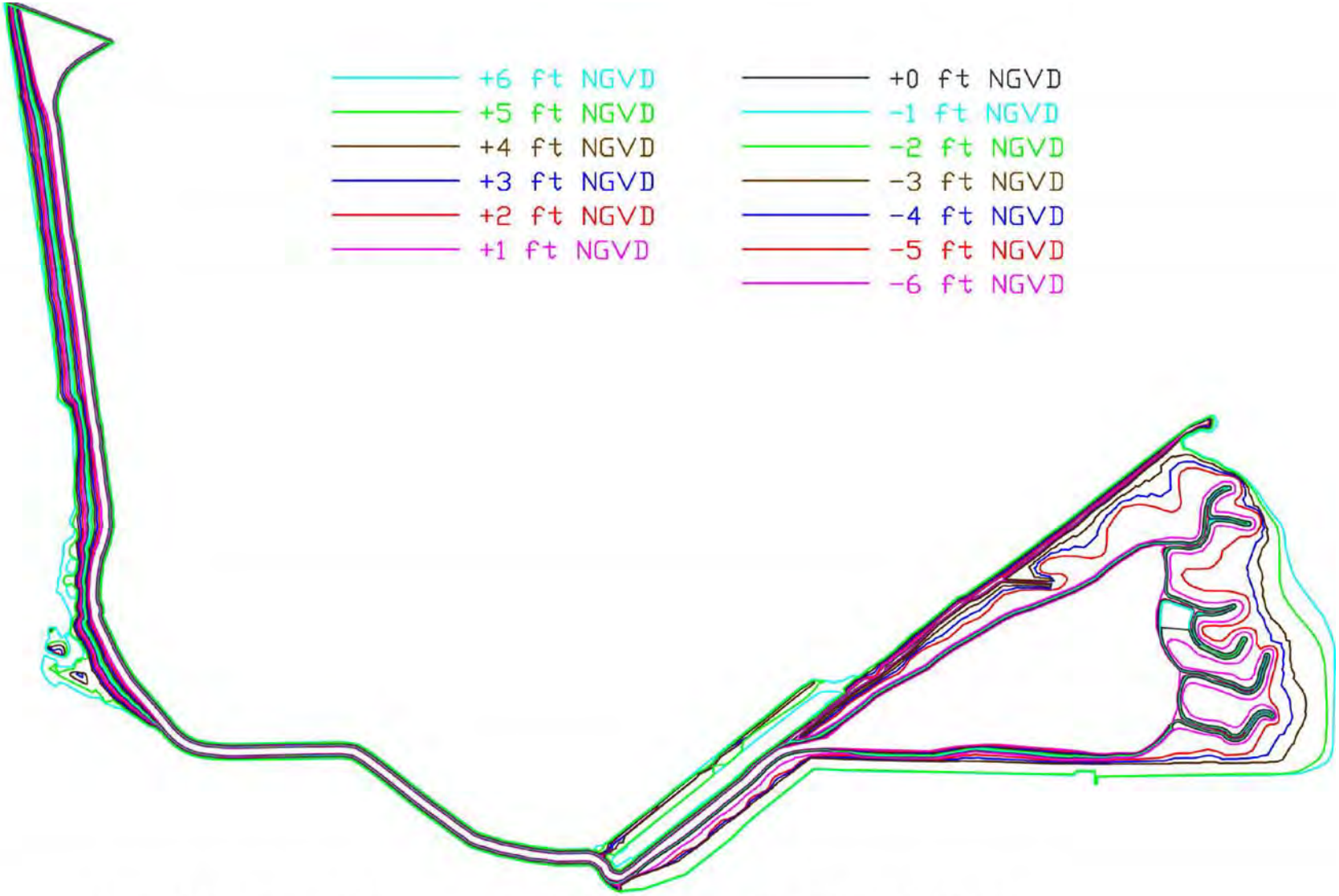

Figure 17. Contours for proposed Otay River tidal basin, Alternative-2, ft. NGVD.

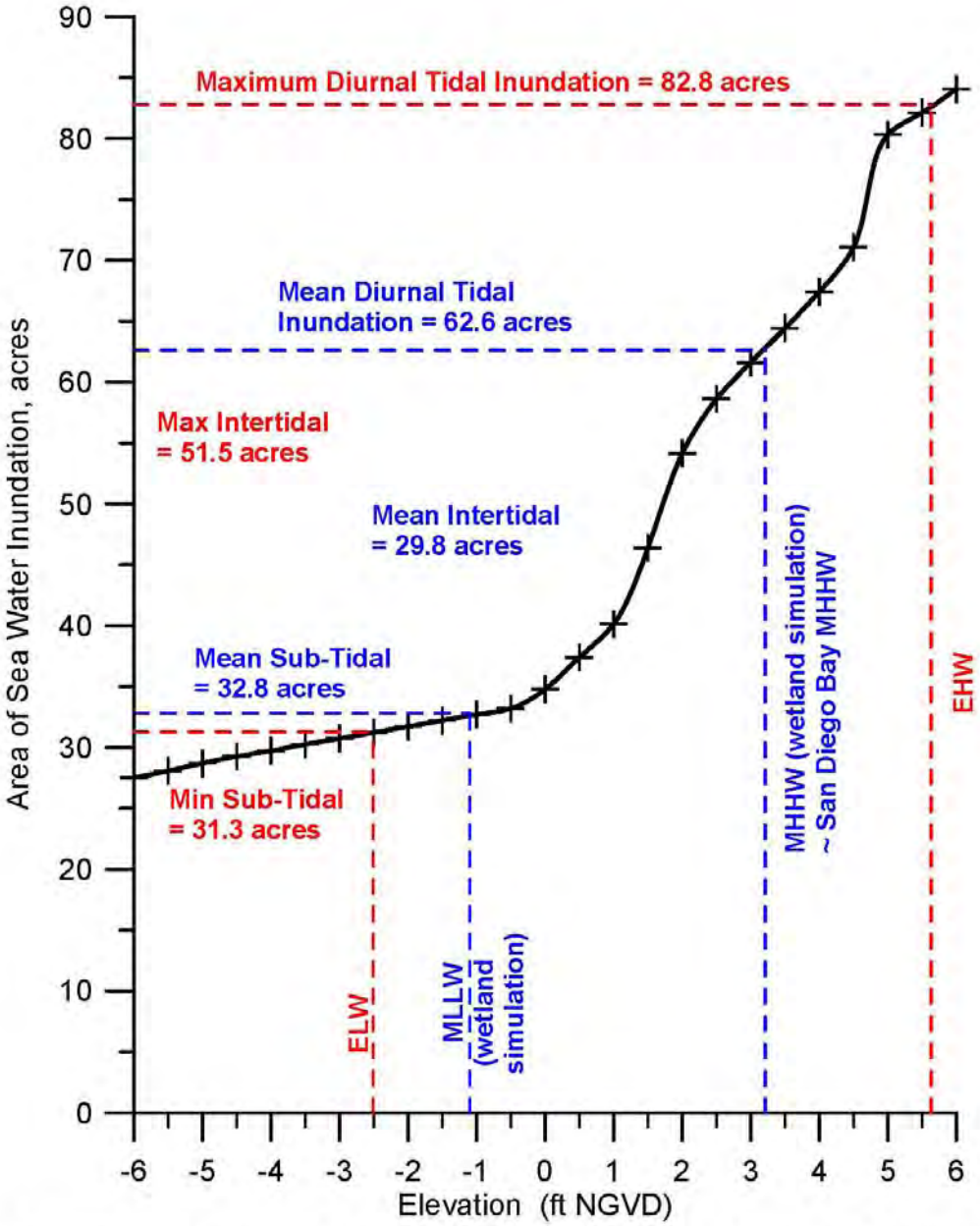

Figure 18. Stage area function of the tidal basin for Alternative-2 Otay Wetland Restoration Project. Water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

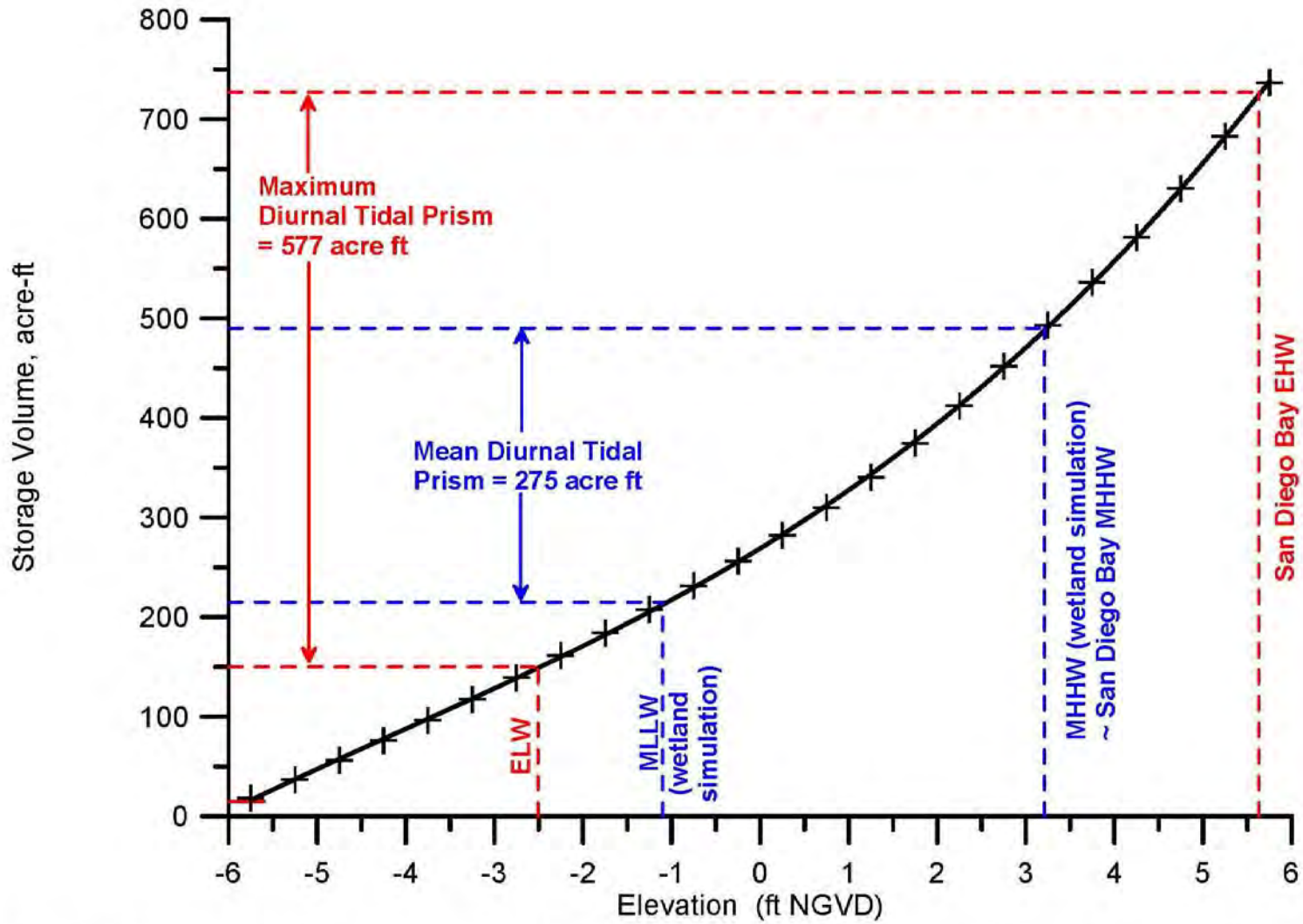

Figure 19. Storage rating function of the tidal basin and Otay River feeder channel for Alternative - 2 of the Otay Wetland Restoration Project. Water level data from NOAA tide gage 941-0170, Navy Pier, San Diego Bay.

an extreme high water event (dashed red line limits in Figure 19). The average diurnal tidal prism of Alternative-2 is 275 acre-ft (dashed blue line limits in Figure 19). Thus Alternative-2 has about 12%-17% more tidal prism than Alternative-1, (depending on tidal range), thereby giving it more flow energy to transport nutrients and sediment alike.

4.2 Alternative-2 Tidal Flow Simulations: Figure 20 gives the flow trajectories and depth averaged tidal currents in Alternative-2 as computed by the calibrated TIDE_FEM model during spring flooding tides on 18 September 2009. Maximum flooding spring tidal currents in the deeper sections of the inlet channel (north/south reach of the Otay River near its mouth) are about 0.11 m/sec (0.36 ft/sec), and then accelerate in the narrower east/west reach to 0.2 m/sec (0.66 ft/sec) before entering the Alternative-2 tidal basin. Flood tide currents entering the tidal basin initially form a well-defined jet along the south bank with speeds of about 0.08 m/s (0.26 ft/sec). This boundary current quickly diverges into a large central counter-clockwise gyre in the center of the tidal basin. Thus the flood tide basin current system in Figure-20 is more well-ordered than was found for Alternative-1 in Figure 11. Gyre speeds in the tidal basin are on the order of 0.02 m/sec (0.07 ft/sec), insufficient to transport fine sand but an important stirring mechanism for mixing the tidal basin water mass to maintain high oxygen levels and to sustain fine silt and clay sized sediment particles in suspension.

Figure 21 gives the flow trajectories and depth-averaged tidal currents in Alternative-2 computed by the TIDE_FEM model during spring ebbing tides on 18 September 2009. The wetted area of the tidal basin in Figure 21 is significantly reduced relative to the flood tide area in Figure 20, due to the lower water levels acting on the stage area curve in Figure 18. In Figure 21, drainage from the complex of dendritic channels on the east side of the basin forms a pair of spiral eddies in the eastern end of the sub-tidal basin of Alternatie-2. The spiral eddies unravel in the central portion of the subtidal basin forming a broad band of creeping flow that evacuates the basin. The spiral eddies and creeping flow band across the main body of the basin have speeds on the order of -0.02 m/sec (-0.07 ft/sec). At the west end of the subtidal basin in Figure 21, a feeder current forms that evacuates the tidal basin and then accelerates to -0.18 m/sec (-0.59 ft/sec) as it passes through the pinch point under the railroad bridge in the narrow east/west reach of channel. Ebb flow in the channel then decelerates to -0.11 m/sec (-0.36 ft/sec) in the deeper

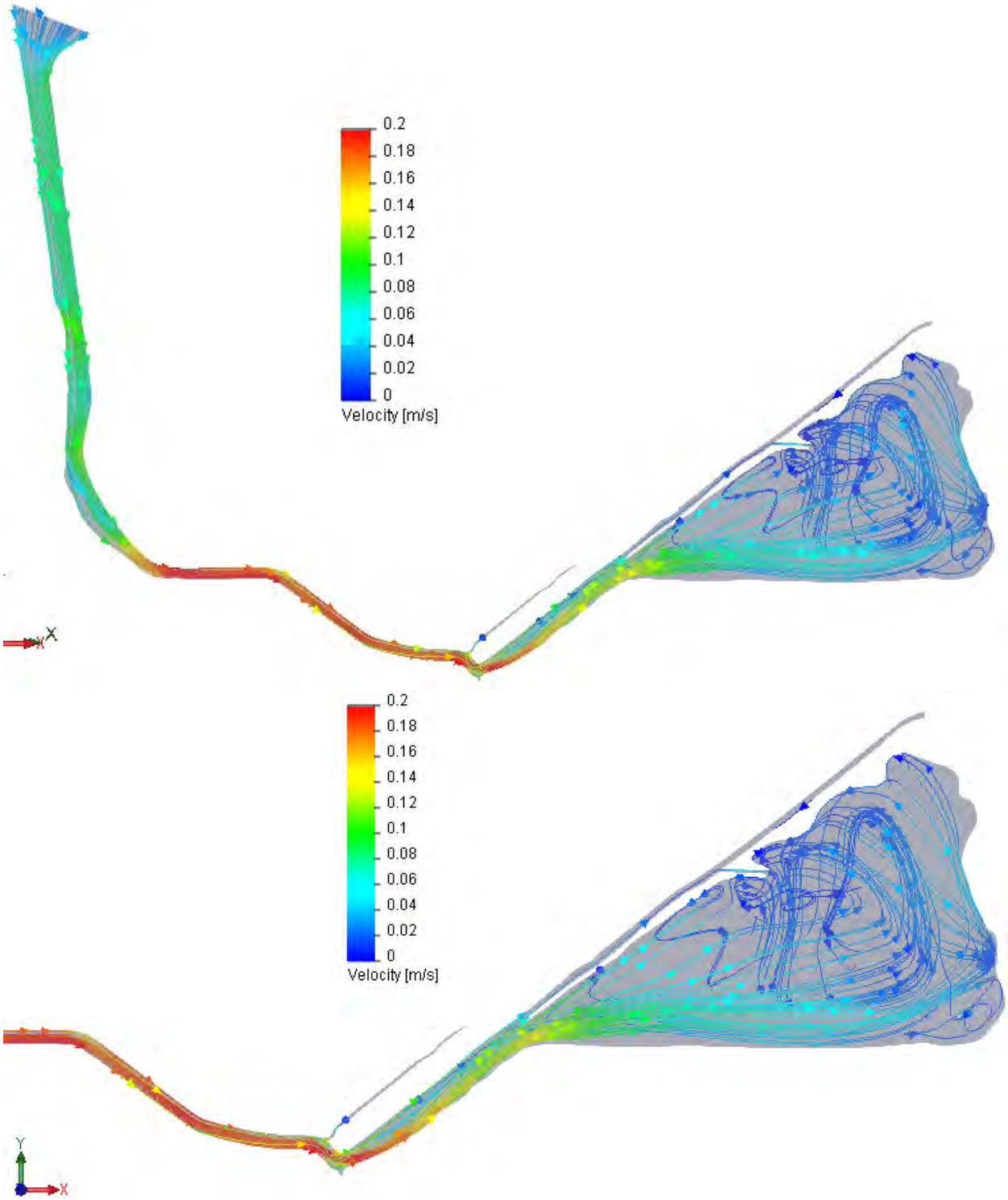

Figure 20: Hydrodynamic simulation of maximum flood flow during spring tides for Alternative-2 of the Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

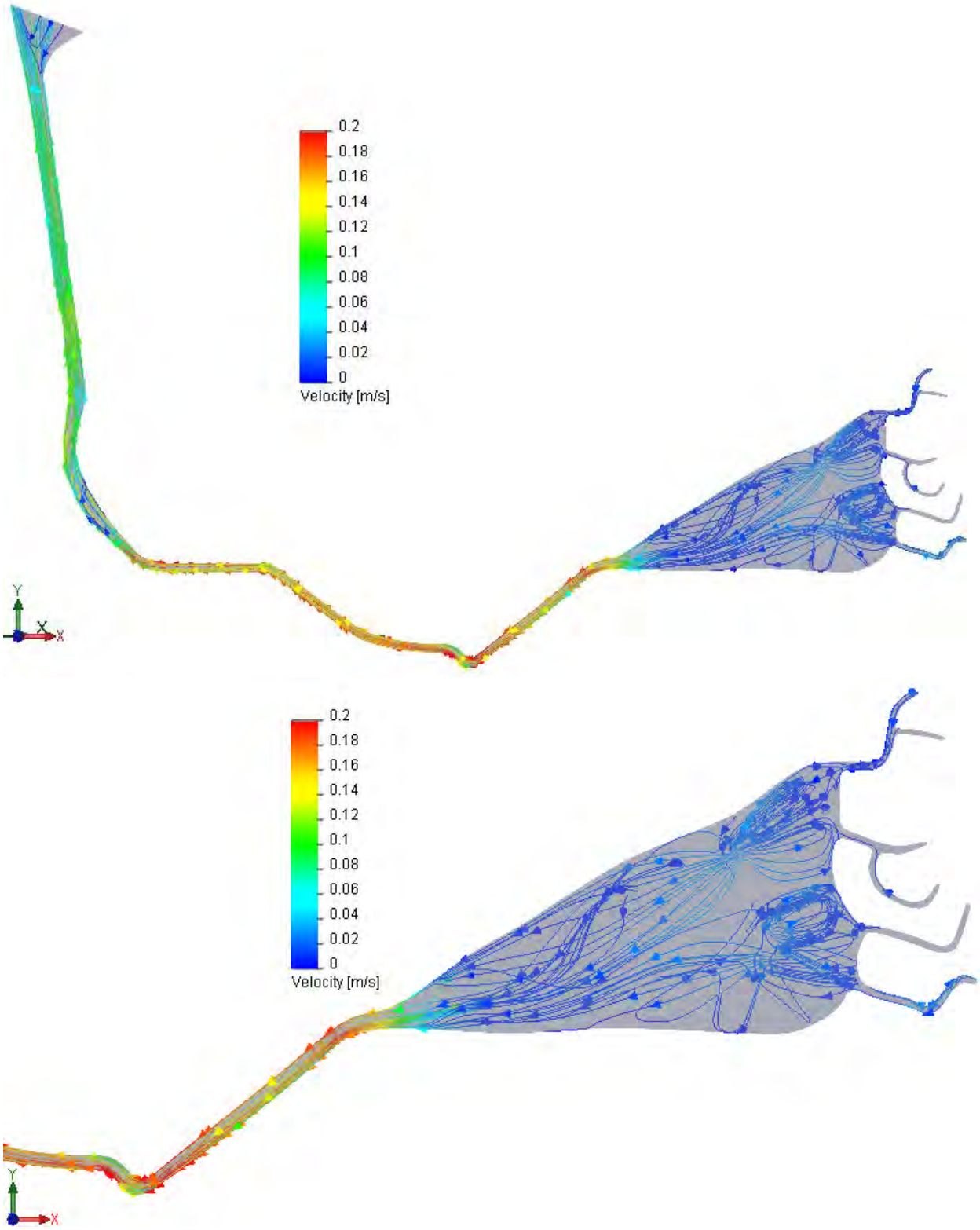

Figure 21: Hydrodynamic simulation of maximum ebb flow during spring tides for Alternative-2 of the Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

north/south reach before discharging into San Diego Bay. In general, currents in Alternative-2 are everywhere greater than those found for Alternative-1 by a factor proportional to the relative size of the diurnal tidal prisms.

Similar flow patterns to Figures 20 & 21 are found in the Alternative-2 tidal basin during mean range tides and neap tides in Appendix A. The flow trajectories and depth averaged tidal currents during mean range flood and ebb tides are found in Figures A5 & A6, while the neap tide flows are shown in Figures A7 & A8.

4.3 Alternative-2 Hydroperiod Simulations: The hydroperiod function for Alternative-2 was calculated from forcing based on the 1980-2009 period of record of San Diego Bay water levels using the same procedures and exposure levels for habitat breaks detailed in Section 3.3 for Alternative-1. The blue line in Figures 22 shows the hydroperiod function calculated for the Alternative-2 tidal basin. Water levels in the Alternative-2 tidal basin reached an extreme high water level of +5.63 ft NGVD in response to San Diego Bay water levels on 13 November 1997, while extreme low water in the Alternative-2 tidal basin dropped to – 2.51 ft NGVD in response to 10 January 2009 water levels in the Bay, slightly lower than what was found for Alternative-1. Mapping the elevations of habitat breaks in Figure 22 onto the stage area function in Figure 18, we find: the perpetual sub-tidal area of the new Alternative-2 tidal basin increases by 14.35 acres, to 31.27 acres from 16.92 acres for the Alternative-1 tidal basin, while the mean subtidal area with the Alternative-2 tidal basin increases by 14.30 acres to 32.80 acres, from 18.50 acres for the Alternative-1 tidal basin; frequently flooded mud flat is decreased by 14.10 acres, from 27.73 acres for the Alternative-1 tidal basin to 13.63 acres for the Alternative-2 tidal basin; frequently exposed mud flat is decreased by 2.59 acres, from 8.90 acres for the Alternative-1 tidal basin to 6.31 acres for the Alternative-2 tidal basin; low salt marsh is increased slightly by 1.74 acres, from 7.55 acres for the Alternative-1 tidal basin to 9.29 acres for the Alternative-2 tidal basin; mid salt marsh is decreased by 2.25 acres, from 12.80 acres for the Alternative-1 tidal basin to 10.55 acres for the Alternative-2 tidal basin; high salt marsh is increased by 2.99 acres, from 7.51 acres for the Alternative-1 tidal basin to 10.50 acres for the Alternative-2 tidal basin; transitional habitat is increased very slightly by 0.02 acres from 1.22 acres for the Alternative-1 tidal basin to 1.24 acres for the Alternative-2 tidal basin. Maximum intertidal

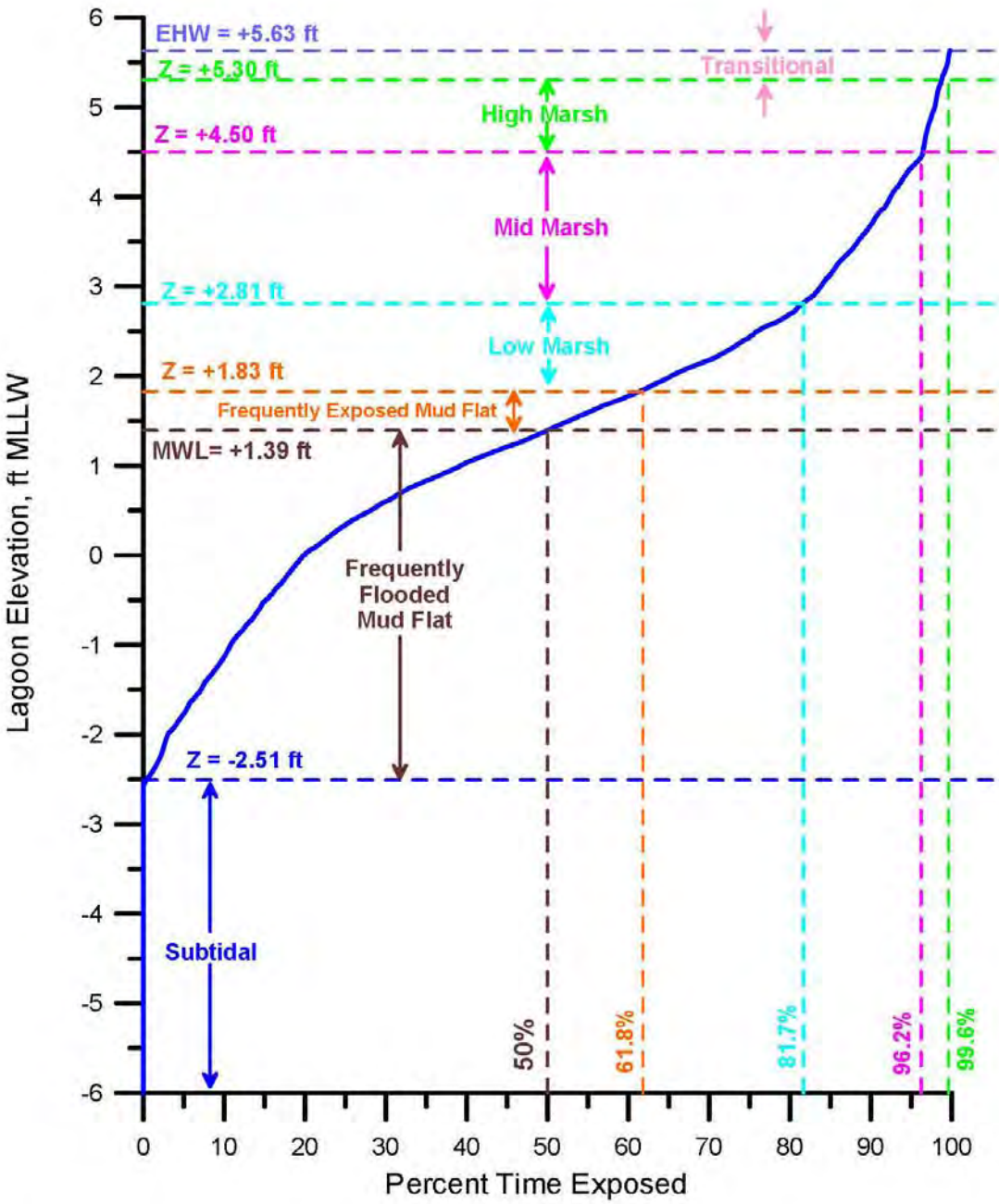

Figure 22. Hydroperiod function of the tidal basin for Alternative -2 Otay Wetland Restoration Project. Based on water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

habitat is decreased significantly by 14.19 acres to 51.52 acres with the Alternative-2 tidal basin as compared to 65.71 acres for the Alternative-1 tidal basin; and the mean area experiencing tidal inundation up to MHHW is increased by 2.04 acres from 60.57 acres for the Alternative-1 tidal basin to 62.61 acres for the Alternative-2 tidal basin resulting in an average 29.81 acres of intertidal habit, a substantial decrease of 12.26 acres over the Alternative-1 tidal basin. Thus, Alternative-2 has about 77% more subtidal habitat than Alternative-1, but about 29% less intertidal habitat.

4.4 Alternative-2 Tidal Scour and Erosion: The tidal currents calculated in the lower Otay River and feeder channel during spring tides (cf. Figures 20 & 21; A5-A8) are compared against grain size and threshold of motion data in Figure 16 to estimate the potential for scour and erosion. In general the channel velocities calculated during spring tides in Figures 20 & 21 show that for the most part current speeds with Alternative-2 remain less than 0.6 ft/sec (0.18 m/s) and greater than 0.27 ft/ sec (0.08 m/sec) and consequently, an equilibrium channel is achieved with the native sediments. There is sediment transport down channel but not deposition, and hence a maximum likelihood of self-maintaining channel. But there is one exception to this condition, and that occurs during flooding spring tides along the narrower east/west reach where the channel currents accelerate 0.2 m/sec (0.66 ft/sec) before entering the Alternative-2 tidal basin. This exceeds the 0.6 ft/sec (0.18 m/s) threshold of motion for the 0.3 mm sized native sediments, and erosion will occur and persist until the channel cross sectional area is enlarged sufficiently to lower local channel currents to less than 0.6 ft/sec. If Alternative-2 is selected for final design, it would be appropriate to provide additional grading to this reach of channel to enlarge its cross section.

5) Tidal Hydraulics Analysis of Restoration Alternative-3

Figure 23 details the elevation contours of the Alternative-3 tidal basin merged with the Otay River bathymetry. The Alternative-3 tidal basin was designed by Nordby Biological and KTU+A to satisfy mitigation requirements placed upon Poseidon Resources Corporation by the

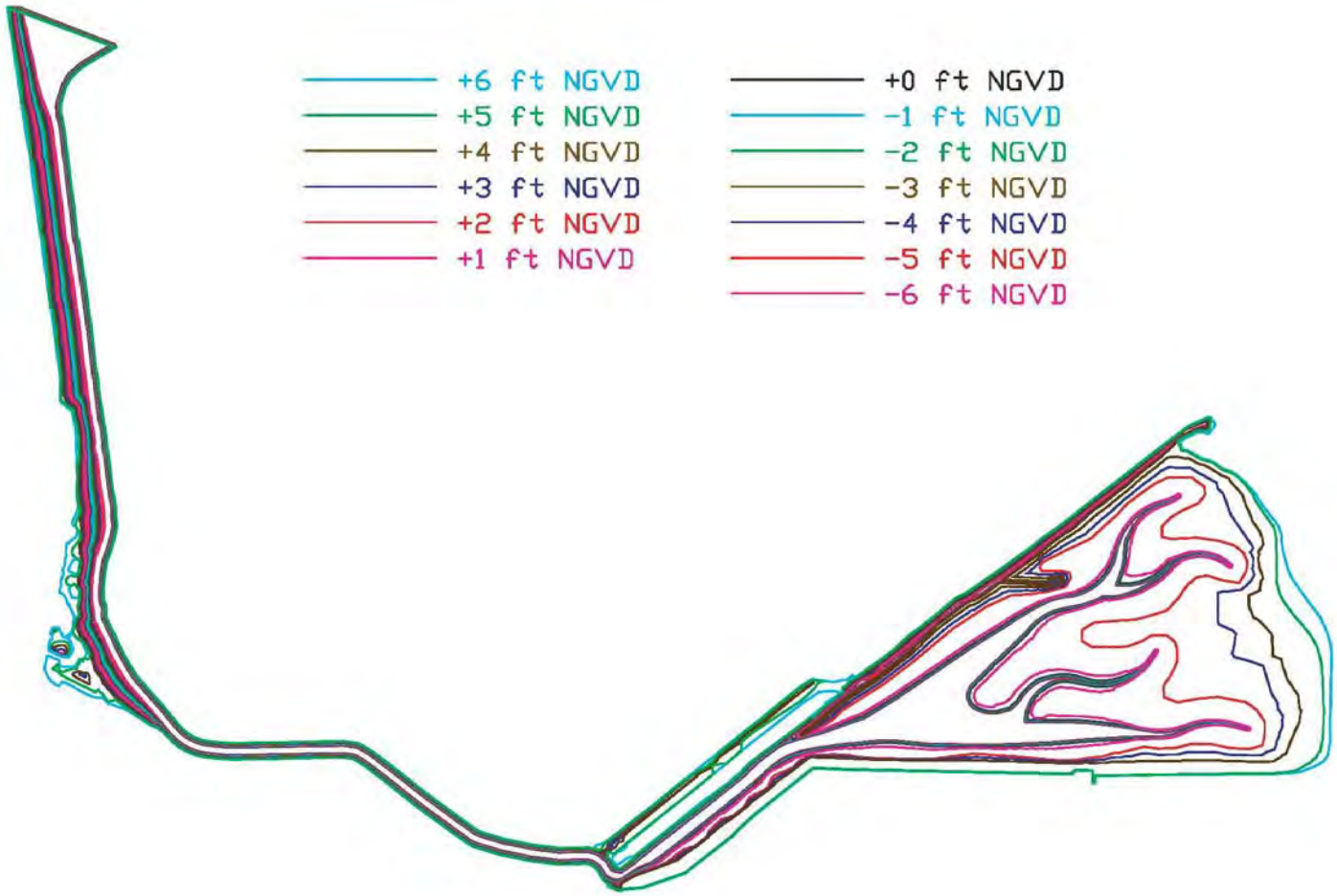

Figure 23. Contours for proposed Otay River tidal basin, Alternative-3, ft. NGVD.

CCC and RWQCB. The design concept for Alternative-3 is based on achieving maximum intertidal acreage while maintaining adequate subtidal acreage to meet the fish productivity requirements of the RWQCB mitigation requirements. It is therefore referred to as the *maximum intertidal- plan*. The estimated minimum subtidal acreage to meet fish productivity requirements of the RWQCB mitigation requirement is 11 acres; while the minimum required acreage of restored tidal wetland is 66 acres.

5.1 Bathymetric Input for Alternative-3: Gridding Alternative-3 for the TIDE_FEM model followed the same 3-node element descretization of the grading contours that was detailed in Section 3.1 for Alternative-1. Figure 24 gives the stage area function of the Alternative-3 tidal basin in isolation. For tidal inundation up to the historic extreme high water level of San Diego Bay (EHW = +5.63 ft NGVD, upper red dashed line in Figure 24), Alternative-3 could provide as much as 82.8 acres of tidally influenced wetland and high salt marsh. We will find that Alternative-3 provides on average 14.8 acres of subtidal habitat (lower dashed blue line in Figure 24); while the amount of subtidal habitat is never less than 14.3 acres (lower dashed red line in Figure 9a). Subtracting these subtidal acreages from the total inundated areas in Figure 24 (upper blue and red dashed lines), it appears Alternative-3 can provide an average of 45.2 intertidal acres and a maximum of 68.5 intertidal acres. Comparing these intertidal acreage numbers against those in Figure 9a for Alternative-1, it is apparent that Alternative-3 (the maximum intertidal plan) provides on average about 3.1 more acres of intertidal habitat than Alternative-1 yet still exceeds the critical threshold for adequate fish productivity (11 acres of subtidal habitat) with a safety margin on average of about 3.3 acres.

The storage rating function for Alternative-3 in Figure 25 shows that the maximum volume of San Diego Bay water that is exchanged with the Alternative-3 tidal basin is 488 acre-ft during an extreme high water event (dashed red line limits in Figure 25). The average diurnal tidal prism of Alternative-3 is 223 acre-ft (dashed blue line limits in Figure 25). Thus Alternative-2 has about 5% less tidal prism than Alternative-1, thereby providing less transport energy than either Alternatives 1 & 2.

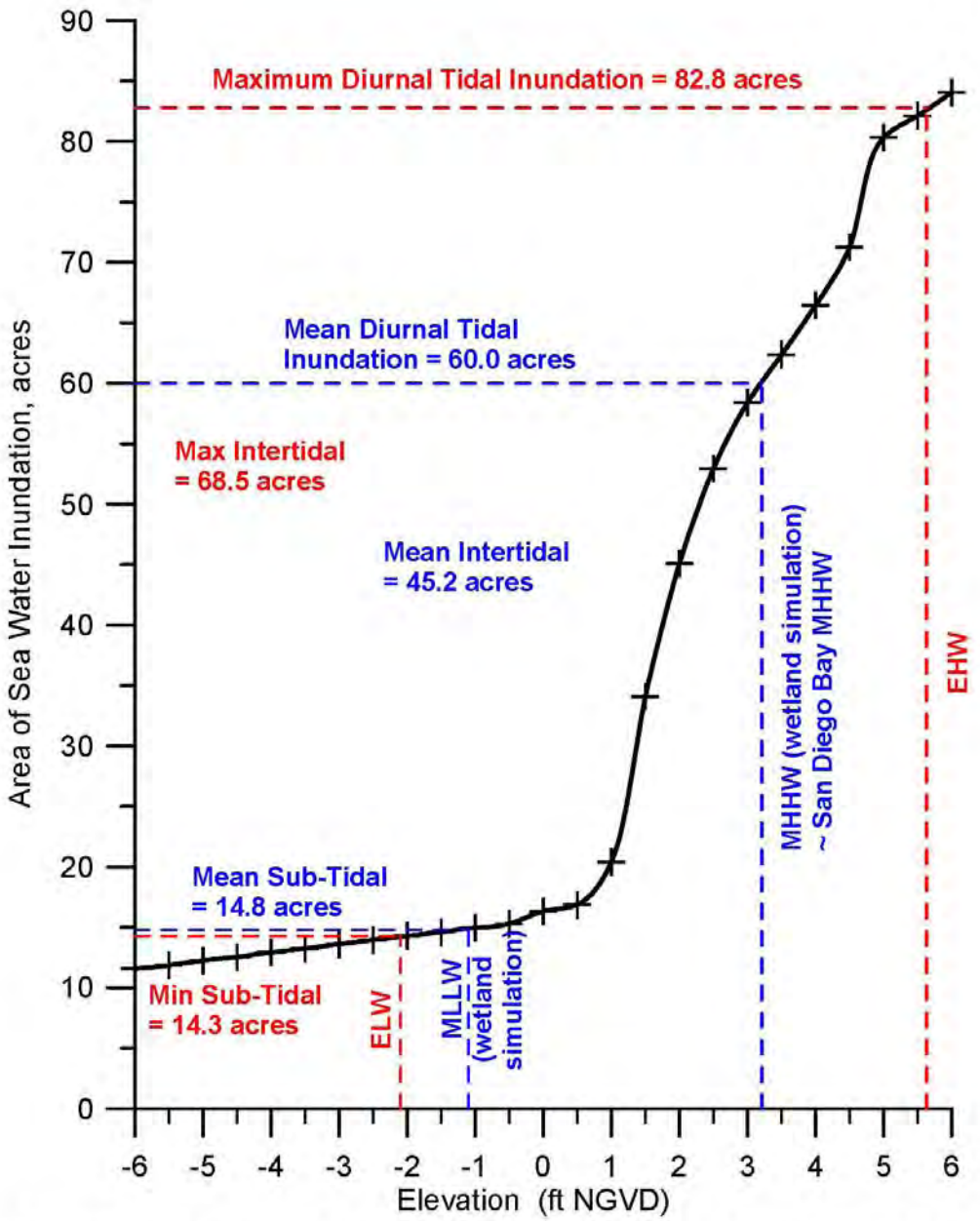

Figure 24. Stage area function of the tidal basin for Alternative - 3 Otay Wetland Restoration Project. Water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

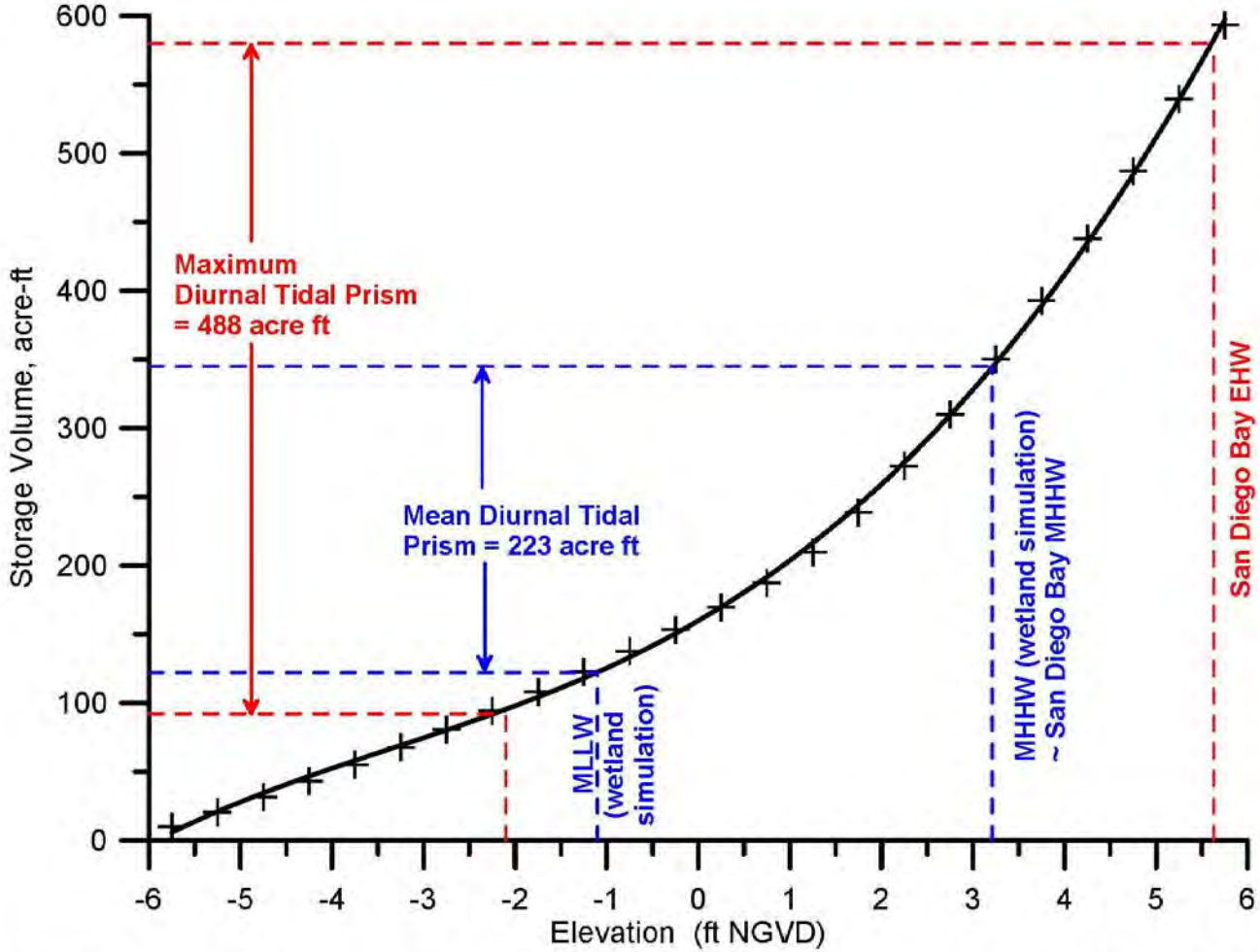

Figure 25. Storage rating function of the tidal basin and Otay River feeder channel for Alternative - 3 of the Otay Wetland Restoration Project. Water level data from NOAA tide gage 941-0170, Navy Pier, San Diego Bay.

5.2 Alternative-3 Tidal Flow Simulations: Figure 26 gives the flow trajectories and depth averaged tidal currents in Alternative-3 as computed by the calibrated TIDE_FEM model during spring flooding tides on 18 September 2009. Maximum flooding spring tidal currents in the deeper sections of the inlet channel (north/south reach of the Otay River near its mouth) are about 0.095 m/sec (0.31 ft/sec), and then accelerate in the narrower east/west reach to 0.17 m/sec (0.56 ft/sec) before entering the Alternative-3 tidal basin. Flood tide currents entering the tidal basin initially form a boundary current along the south bank with speeds of about 0.06 m/s (0.20 ft/sec). This boundary current quickly diverges into a pair counter-rotating eddies in the center and in the eastern quadrant of the tidal basin. The flood tide basin current system in Figure-26 is weaker but a bit more ordered than was found for Alternative-1 in Figure 11. Eddy speeds in the tidal basin are on the order of 0.02 m/sec (0.07 ft/sec), insufficient to transport fine sand but an important stirring mechanism for mixing the tidal basin water mass to maintain high oxygen levels and to sustain fine silt and clay sized sediment particles in suspension.

Figure 27 gives the flow trajectories and depth averaged tidal currents in the Alternative-3 tidal basin computed by the TIDE_FEM model during spring ebbing tides on 18 September 2009. The wetted area of the tidal basin in Figure 27 is significantly reduced relative to the flood tide area in Figure 26, due to the lower water levels acting on the stage area curve in Figure 24. In Figure 27, drainage from the complex of dendritic channels on the east side of the basin merges in the center of the sub-tidal basin of Alternatie-3, forming a single feeder current in the western end that evacuates the basin. The feeder current converges at the western end of the basin and accelerates to about -0.05 m/sec (-0.16 ft/sec). As it passes through the pinch point under the railroad bridge it further accelerates in the narrow east/west reach of channel to about -0.10 m/sec (-0.33 ft/sec). Ebb flow in the channel then decelerates to -0.095 m/sec (-0.31 ft/sec) in the deeper north/south reach before discharging into San Diego Bay. In general, currents in Alternative-3 are everywhere about 5% less than those found for Alternative-1, roughly proportional to the relative size of the diurnal tidal prisms.

Similar flow patterns to Figures 26 & 27 are found in the Alternative-3 tidal basin during mean range tides and neap tides in Appendix A. The flow trajectories and depth averaged tidal

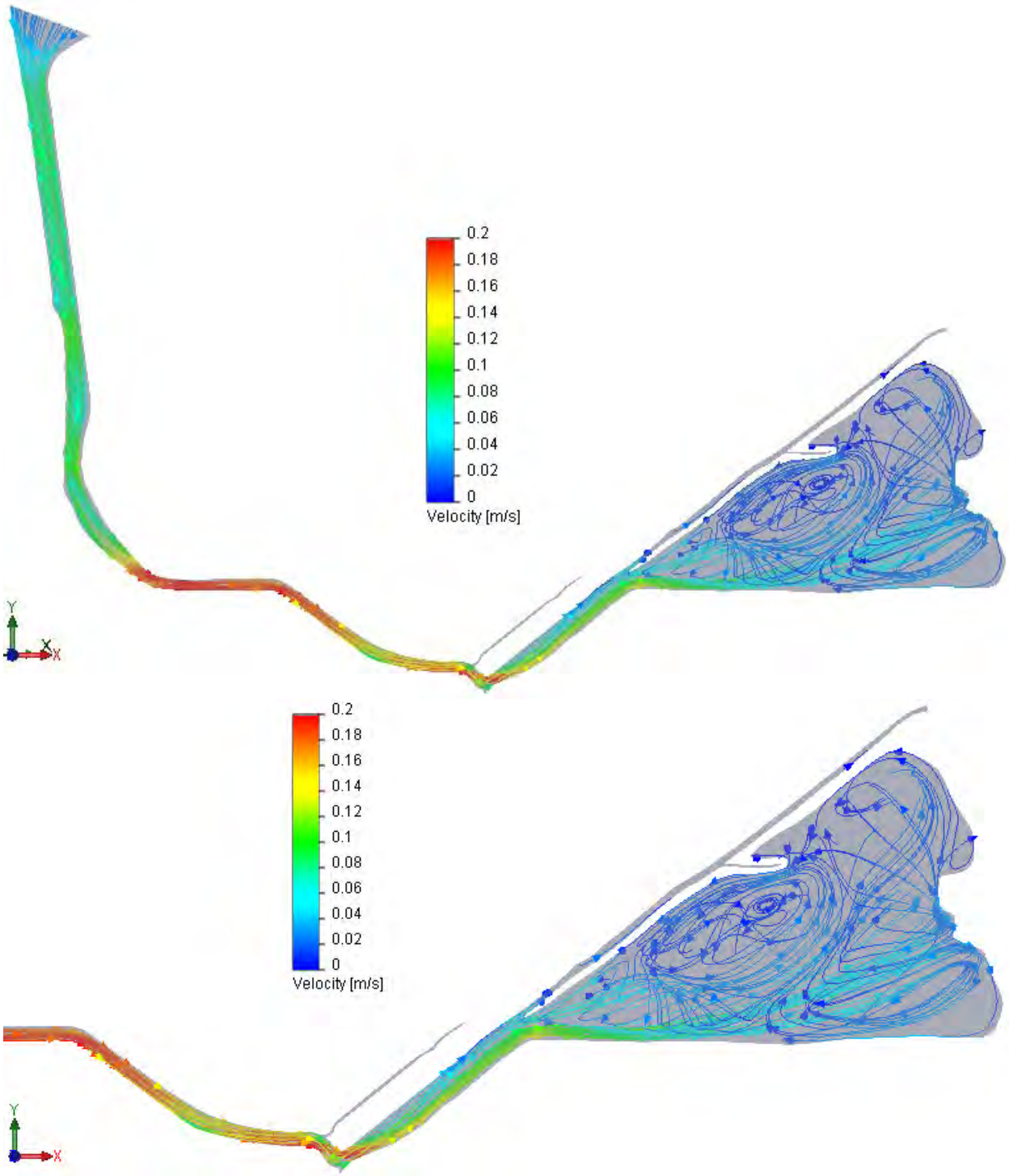

Figure 26: Hydrodynamic simulation of maximum flood flow during spring tides for Alternative-3 of the Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

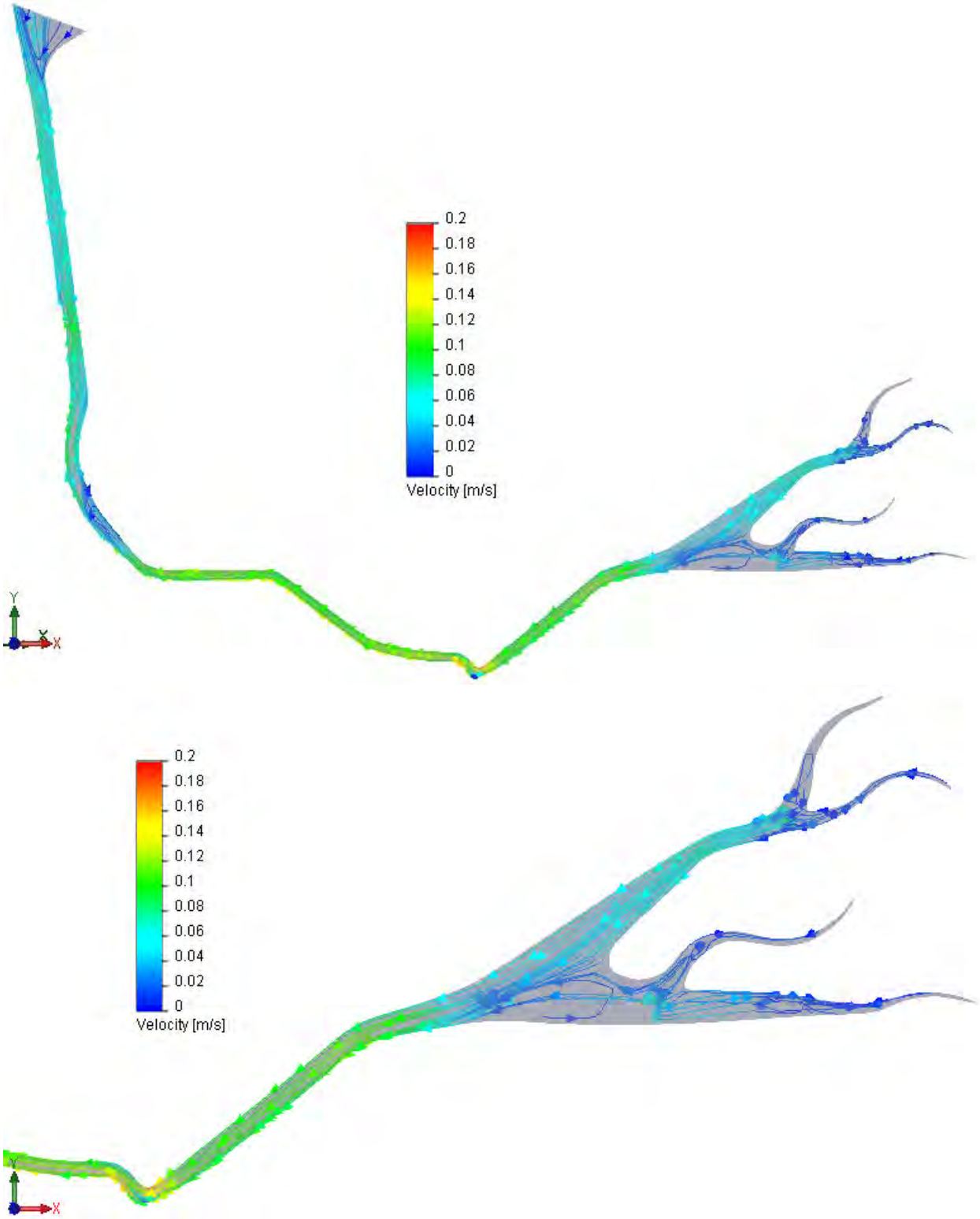

Figure 27: Hydrodynamic simulation of maximum ebb flow during spring tides for Alternative-3 of the Otay Wetlands Restoration Project, based on San Diego Bay tides 18 September, 2009.

currents during mean range flood and ebb tides are found in Figures A9 & A10, while the neap tide flows are shown in Figures A11 & A12.

5.3 Alternative-3 Hydroperiod Simulations: The hydroperiod function for Alternative-3 was calculated from forcing based on the 1980-2009 period of record of San Diego Bay water levels using the same procedures and exposure levels for habitat breaks detailed in Section 3.3 for Alternative-1. The red line in Figures 28 shows the hydroperiod function calculated for the Alternative-3 tidal basin. Water levels in the Alternative-3 tidal basin reached an extreme high water level of +5.63 ft NGVD in response to San Diego Bay water levels on 13 November 1997, while extreme low water in the Alternative-2 tidal basin dropped to – 2.10 ft NGVD in response to 10 January 2009 water levels in the Bay, slightly lower than what was found for Alternative-1.Thus, with less flow energy, Alternative-3 drains less completely than either Alternatives 1 or 2.

Mapping the elevations of habitat breaks in Figure 28 onto the stage area function in Figure 14, we find: the perpetual sub-tidal area of the Alternative-3 tidal basin decreases by 2.65 acres, to 14.27 acres from 16.92 acres for the Alternative-1 tidal basin, while the mean subtidal area with the Alternative-3 tidal basin decreases by 3.69 acres to 14.81 acres, from 18.50 acres for the Alternative-1 tidal basin; frequently flooded mud flat is decreased by 2.49 acres, from 27.73 acres for the Alternative-1 tidal basin to 25.24 acres for the Alternative-3 tidal basin; frequently exposed mud flat is increased by 2.27 acres, from 8.90 acres for the Alternative-1 tidal basin to 11.17 acres for the Alternative-3 tidal basin; low salt marsh is increased by 4.26 acres, from 7.55 acres for the Alternative-1 tidal basin to 11.81 acres for the Alternative-3 tidal basin; mid salt marsh is increased slightly by 0.55 acres, from 12.80 acres for the Alternative-1 tidal basin to 13.35 acres for the Alternative-3 tidal basin; high salt marsh is decreased by 1.80 acres, from 7.51 acres for the Alternative-1 tidal basin to 5.71 acres for the Alternative-3 tidal basin; transitional habitat is increased very slightly by 0.02 acres from 1.22 acres for the Alternative-1 tidal basin to 1.24 acres for the Alternative-3 tidal basin. Maximum intertidal habitat is increased by 2.81 acres to 68.52 acres with the Alternative-3 tidal basin as compared to 65.71 acres

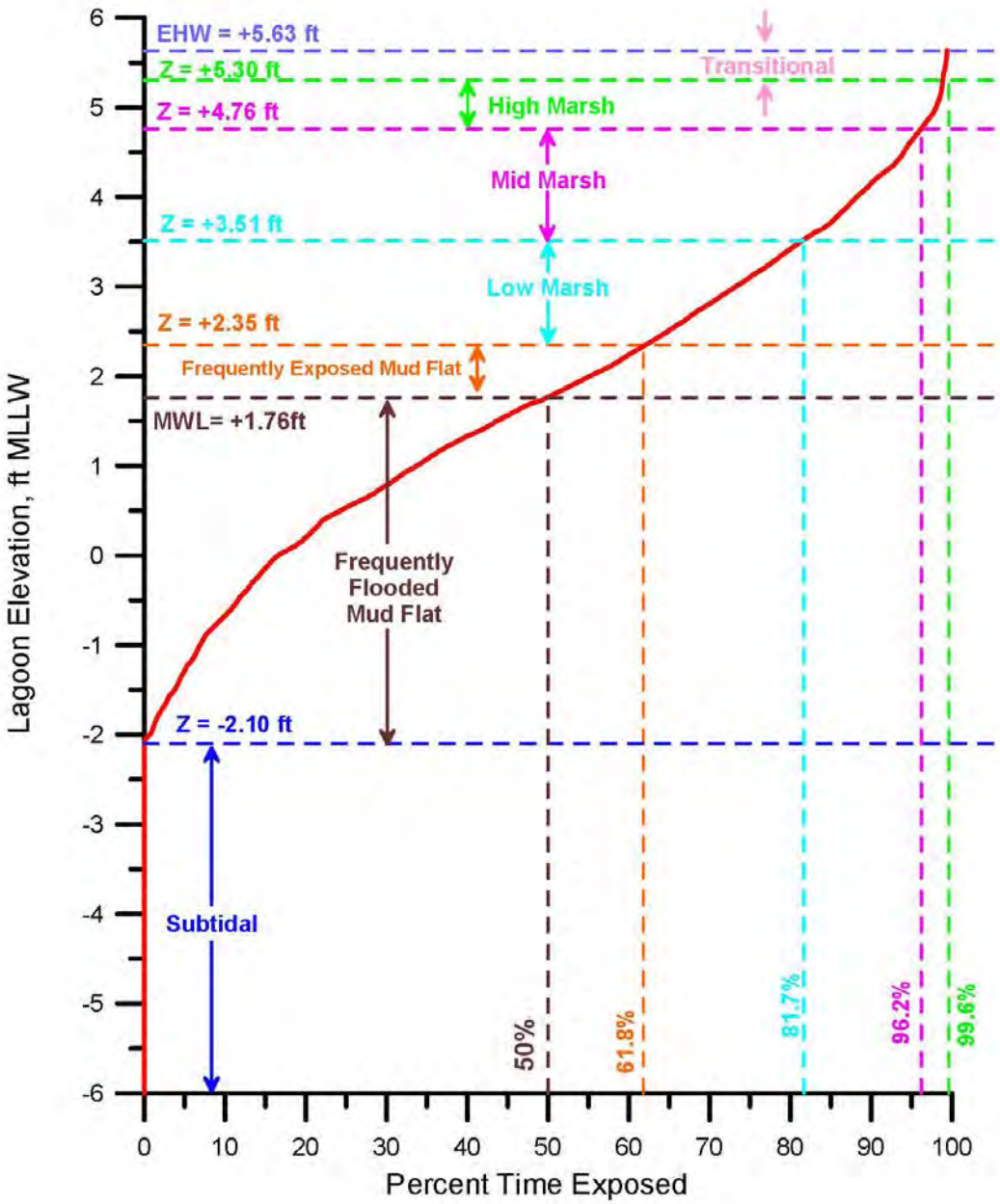

Figure 28. Hydroperiod function of the tidal basin for Alternative -3 Otay Wetland Restoration Project. Based on water level data from NOAA tide gage #941-0170, Navy Pier, San Diego Bay.

for the Alternative-1 tidal basin; and the mean area experiencing tidal inundation up to MHHW is decreased slightly by 0.54 acres from 60.57 acres for the Alternative-1 tidal basin to 60.03 acres for the Alternative-3 tidal basin resulting in an average 45.22 acres of intertidal habit, an increase of 3.15 acres over the Alternative-1 tidal basin. Thus, Alternative-3 has on average about 20% less subtidal habitat than Alternative-1, but only about 7.5% more intertidal habitat.

5.4 Alternative-3 Tidal Scour and Erosion: The tidal currents calculated in the lower Otay River and feeder channel during spring tides (cf. Figures 26 & 27; A9-A11) are compared against grain size and threshold of motion data in Figure 16 to estimate the potential for scour and erosion. In general the channel velocities calculated during spring tides in Figures 26 & 27 show that current speeds with Alternative-3 are everywhere less than 0.6 ft/sec (0.18 m/s) and greater than 0.27 ft/ sec (0.08 m/sec) and consequently, an equilibrium channel is achieved with the native 0.3 mm size sediments. Consequently, there is sediment transport down channel but not deposition, and hence a maximum likelihood of self-maintaining channel.

6) Residence Time

Residence time refers to the average amount of time source water spends in a particular tidal system. Residence time begins from the moment a *material element of water* (a parcel that contains the same collection of water molecules) enters a tidal system on flooding tide and ends when that same element leaves the system on ebbing tide. At lowest order, the residence time in a particular tidal system can be approximated by *removal time*, which is a ratio of the storage capacity of that system at mean higher high water to the rate of tidal exchange during a mean diurnal tidal period (Horikawa, 1988), or :

$$\bar{\tau} = \frac{V_s}{V_p} T$$

Where $\bar{\tau}$ is the removal time; V_s is the storage capacity of a particular restoration alternative at mean higher high water (including both the inlet channel and tidal basin); V_p is the mean diurnal tidal prism of a particular restoration alternative, and T is a diurnal tidal period equal to 1.0347 days (24 hours and 50 minutes). From this simple relation the removal time varies

between each restoration alternative according to the volume ratio of storage capacity to diurnal tidal prism, V_s/V_p . For Alternative 1, we find from Figure 9b that V_s/V_p = 1.59 and hence $\bar{\tau}_1$=1.65 days. From Figure 19 we find that V_s/V_p = 1.78 for Alternative 2 and thus $\bar{\tau}_2$ = 1.84 days; and for Alternative 3, Figure 25 indicates V_s/V_p = 1.55 and $\bar{\tau}_3$= 1.60 days. Therefore, removal time is roughly comparable between each the three restoration alternatives, with Alternative 2 having the longest removal time since it has a larger subtidal volume.

However, removal time is only a simple algebraic proxy for residence time in these cases because the mean diurnal tidal prism for each of the restoration alternatives is less than the storage capacity of those alternatives at MHHW, and it takes a number of tide cycles to completely replace all of the *old water* in each of those systems. Old water is defined as the water that remains in the tidal system (including both the inlet channel and tidal basin) after water outflow during ebb tide. As new water comes into the inlet channel and tidal basin, the old water becomes more diluted with each tidal cycle until all the old water is eventually replaced by new water. We utilize the mass conservation and transport algorithms of the TIDE_FEM model to solve for this progressive dilution of old water in each of the restoration alternatives. To facilitate comparisons of residence time calculations performed at other coastal lagoons, we adopt the convention of assigning residence time as the time required for old water to dilute to less than 2% of the storage capacity of the system (Elwany, et. al., 2005; Coastal Environments, 2009).

Figure 29 gives the TIDE_FEM hydrodynamic tidal simulations of the time dilution of old water in each of the tidal systems (inlet channel + tidal basin) of the three restoration alternatives. Time to dilute to 2% for old water in Alternative-1 gives a residence time estimate of τ_1 = 3.75 days. For Alternative 2, the residence time estimated from decay rates of old water is τ_2 = 3.29 days; and for Alternative 3, Figure 29 gives a residence time estimate of τ_3 = 3.93 days. As with the removal time calculations, residence times are comparable for all three restoration alternatives, and are in the same range (3 days-4 days) as residence times measured in healthy tidal lagoon systems such as the W-1 tidal basin in the newly restored San Dieguito Lagoon

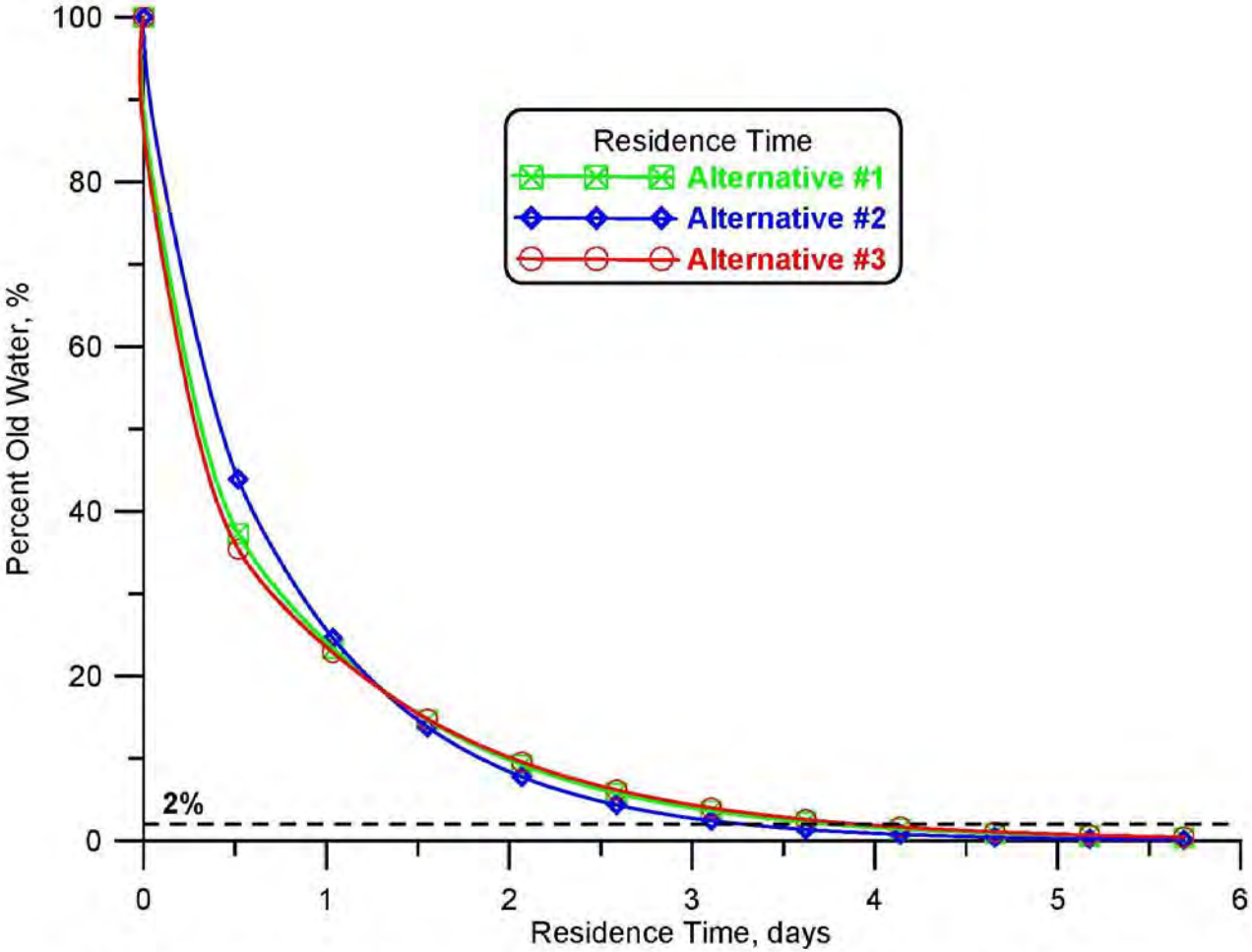

Figure 29 . Residence time for water in tidal basin of Otay River Floodplain Restoration Alternatives 1-3.

(Coastal Environments, 2009) and in the East Basin at Agua Hedionda Lagoon (Elwany, et. al., 2005). Although Alternative 2 had a longer removal time owing to a larger storage to tidal prism volume ratio; it none the less produced a slightly smaller residence time in the hydrodynamic simulations due to more rapid mixing of old water with new water as a result of stronger tidal basin currents and more vigorous eddy systems, (cf: Figures 20, A5, & A7)

7) Summary and Conclusions:

This is a hydrodynamic feasibility study of conceptual site plans for a proposed wetland restoration site. This study employs a well-tested and peer-reviewed hydrodynamic model to evaluate the tidal hydraulics of three alternative tidal basin and channel concepts for Poseidon's Marine Life Mitigation Plan in the Otay River floodplain. The proposed new tidal basin would occupy a land parcel known as *Otay River Floodplain* and would have a triangular foot print and receive its marine source water from south San Diego Bay through a connection with the Otay River. There are three grading concepts being considered for this triangular basin: *Alternative-1* is graded for an approximately prototypic balance between subtidal and intertidal habitat and is referred to as a *mixed-habitat plan*; *Alternative-2* is graded for an emphasis on subtidal habitat and is referred to as a *maximum subtidal plan*; while the grading of Alternative-3 emphasizes intertidal habitat and is referred to as a *maximum intertidal plan*. The estimated minimum subtidal acreage needed to meet fish productivity requirements of Poseidon's Marine Life Mitigation Plan is 11 acres; while the minimum required acreage of restored tidal wetland is 66 acres.

The model, analysis methods, and supporting data bases used herein are the same as those utilized in the Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the San Dieguito Wetland Restoration Project, (EIR/EIS, 2000), and for the preparation of the San Dieguito Wetlands Restoration Project, Final Restoration Plan, (SCE, 2005). Monitoring data for the newly-completed San Dieguito Lagoon Restoration Project was also used to calibrate the tidal hydraulics model. San Dieguito Lagoon was selected as a proxy for the restoration alternatives because of morphologic similarities: in particular, both restoration sites

have a long “goose-neck” feeder channel connecting source water to interior tidal basins of comparable acreage and distance from the source water. Habitat surveys conducted during the San Dieguito Lagoon Restoration Project by Josselyn & Whelchel (1999) were also used to develop functional relationships between habitat breaks and amounts of time for wetting and drying (hydroperiod functions). These relationships were used to transpose tidal hydraulics model output into calculations of acreage of various wetland habitat types created by the three restoration alternatives. Calculations of habitat creation were based on long-term tidal hydraulics simulations using tidal forcing at the mouth of the Otay River based on the 1980-2009 period of record for San Diego Bay tides measured by the NOAA tide gage #941-0170 located at the Navy Pier.

Table 2 summarizes habitat creation computed from the long term tidal hydraulics simulations of the three restoration alternatives. Inspection of Table 2 reveals that all of the alternatives create significantly more than the required minimum of 66 acres of tidally influenced wetland, achieving maximum areas of salt water inundation of between 82.6 acres and 82.8 acres. In this regard, the restoration designs provide a safety margin in habitat creation of about 17.6 acres – 17.8 acres or about 27%. Furthermore, all of the restoration alternatives provide significantly more than the minimum 11 acres of subtidal habitat required for fish production. Alternative-1 provides on average 18.5 acres of subtidal habitat, and is never less than 16.9 acres. Thus the critical threshold for adequate fish productivity (11 acres of subtidal habitat) is satisfied with a safety margin of at least 5.9 acres. Alternative-2 provides on average 32.8 acres of subtidal habitat while it is never less than 31.3 acres. Hence Alternative-2 (the maximum sub-tidal plan) provides substantially more subtidal habitat than Alternative-1 by a factor of 1.9, and easily exceeds the critical threshold for adequate fish productivity (11 acres of subtidal habitat) with a safety margin of at least 20.3 acres. Alternative-3 provides on average 14.8 acres of subtidal habitat and is never less than 14.3 acres, a safety margin of at least 3.3 acres.

Hydrodynamic simulations of tidal exchange and dilution rates give residence time estimates of τ_1 = 3.75 days for Alternative-1; τ_2 = 3.29 days for Alternative-2; and for Alternative-3, a residence time estimate of τ_3 = 3.93 days. Residence times for all three

***Table 2: Habitat Creation for Restoration Alternatives in the Otay River Floodplain**

Habitat Areas	Alternative -1 (Mixed Habitat)	Alternative -2 (Max Subtidal)	Alternative -3 (Max Intertidal)
Perpetual Sub-Tidal (acres)	16.92	31.27	14.27
Mean Sub-Tidal (acres)	18.50	32.80	14.81
Frequently Flooded Mud Flat (acres)	27.73	13.63	25.24
Frequently Exposed Mud Flat (acres)	8.90	6.31	11.17
Low Salt Marsh (acres)	7.55	9.29	11.81
Mid Salt Marsh (acres)	12.80	10.55	13.35
High Salt Marsh (acres)	7.51	10.50	5.71
Transitional Habitat (acres)	1.22	1.24	1.24
Maximum Intertidal Area (acres)	65.71	51.52	68.52
Maximum Area of Salt Water Inundation (acres)	82.63	82.79	82.79
Mean Intertidal Area (acres)	42.07	29.81	45.22
Mean Area of Salt Water Inundation (acres)	60.57	62.61	60.03

*These acreages based on the following exposure times for each habitat type:

Subtidal Exposure < 0%;

0% < **Frequently Flooded Mud Flat Exposure** < 50%;

50% < **Frequently Exposed Mud Flat Exposure** < 61.8%

61.8% < **Low Salt Marsh Exposure** < 81.7%

81.7% < **Mid Salt Marsh Exposure** < 96.2%

96.2% < **High Salt Marsh Exposure** < 99.8%

99.8% < **Transitional Exposure** < 100%

restoration alternatives are comparable to those measured or calculated for healthy tidal lagoon systems such as the W-1 tidal basin in the newly restored San Dieguito Lagoon (Coastal Environments, 2009) and in the East Basin at Agua Hedionda Lagoon (Elwany, et. al., 2005).

Tidal exchange simulated during spring tides show for all three restoration alternatives that Otay River channel velocities generally remain less than the threshold of sediment motion (0.6 ft/sec or 0.18 m/s) and greater than the deposition threshold (0.27 ft/ sec or 0.08 m/sec) and consequently, an equilibrium channel is achieved with the native sediments. There is sediment transport down channel but not deposition, and hence a maximum likelihood of self-maintaining channel. Furthermore, the inlet channel and the mouth of the Otay River are not subject to littoral transport by shoaling ocean waves, as south San Diego Bay provides complete sheltering from high energy shoaling swells. Consequently, the inlet channel is not likely to infill or close from sand influx in the source water, making the site significantly easier to maintain. But, there is one isolated erosion concern, and that occurs during flooding spring tides in Alternative-2 along the narrower east/west reach. Because of the larger tidal prism of this alternative, the channel currents accelerate to 0.2 m/sec (0.66 ft/sec) before entering the Alternative-2 tidal basin. This exceeds the 0.6 ft/sec (0.18 m/s) threshold of motion for the 0.3 mm sized native sediments, and erosion will occur and persist until the channel cross sectional area is enlarged sufficiently to lower local channel currents to less than 0.6 ft/sec. If Alternative-2 is selected for final design, it would be appropriate to provide additional grading to this reach of channel to enlarge its cross section.

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APPENDIX -A : Additional Flow Simulations for Mean and Neap Tidal Ranges

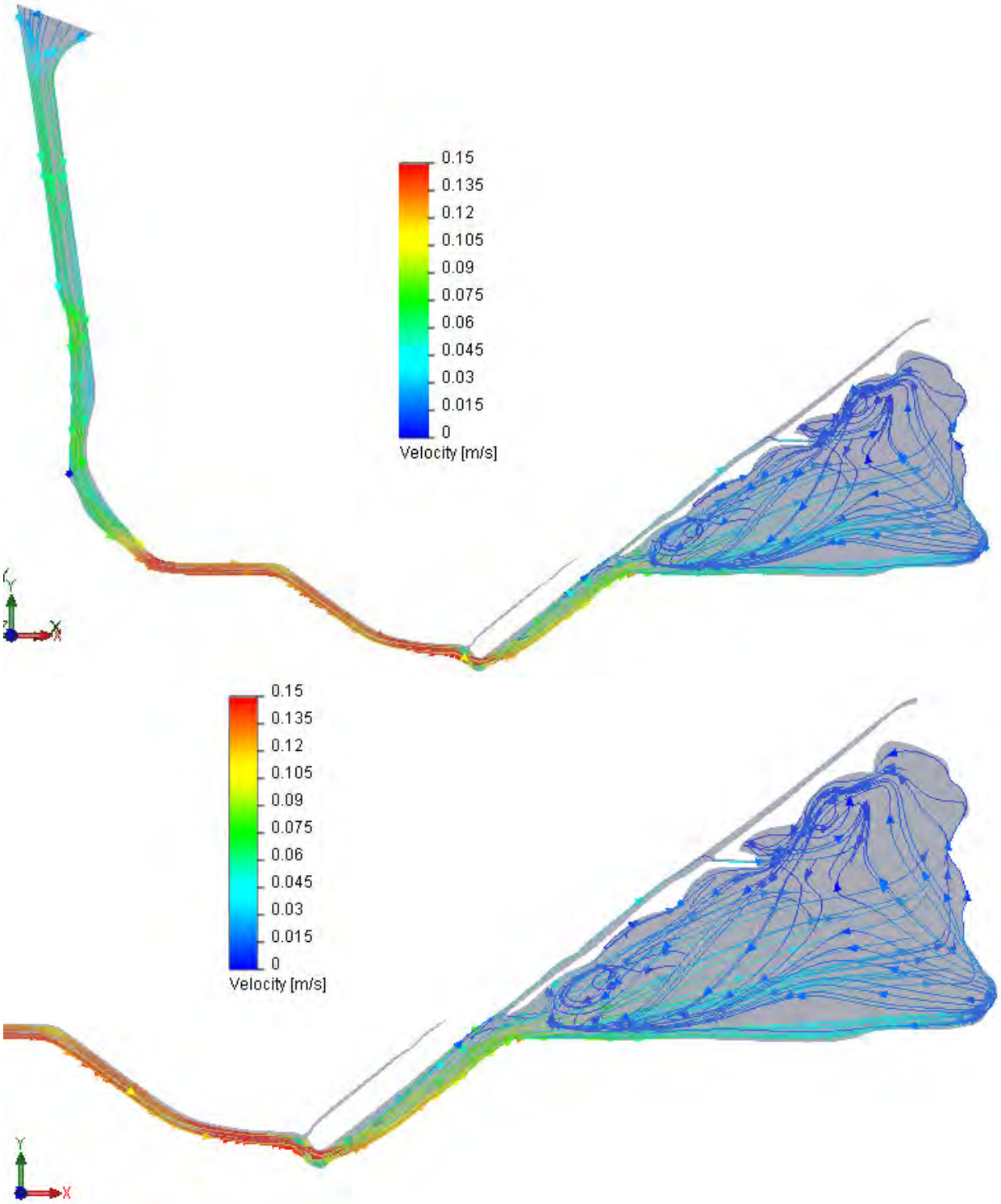

Figure A1: Hydrodynamic simulation of maximum flood flow during mean tides for Alternative-1 of the Otay Wetlands Restoration Project.

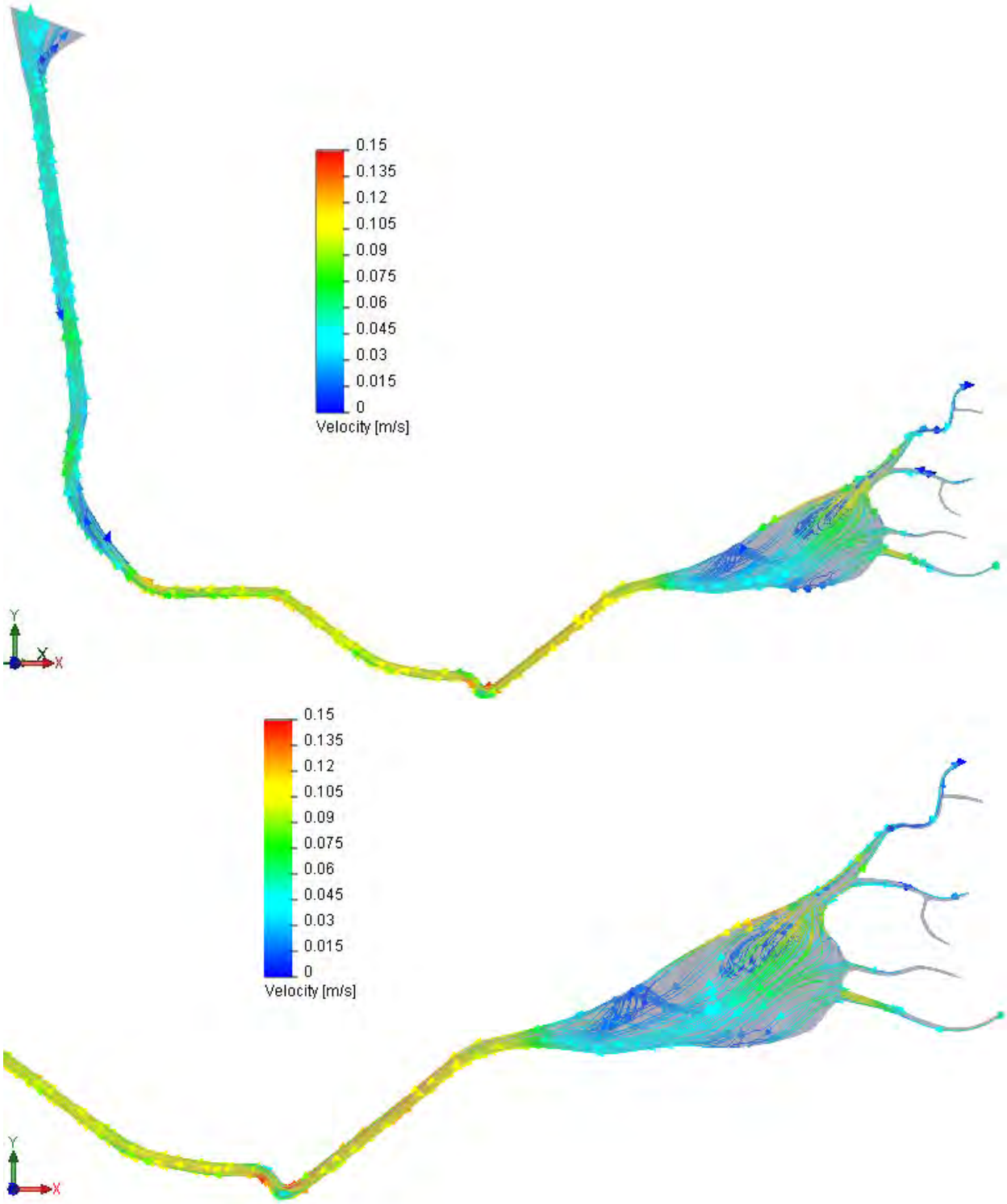

Figure A2: Hydrodynamic simulation of maximum ebb flow during mean tides for Alternative-1 of the Otay Wetlands Restoration Project.

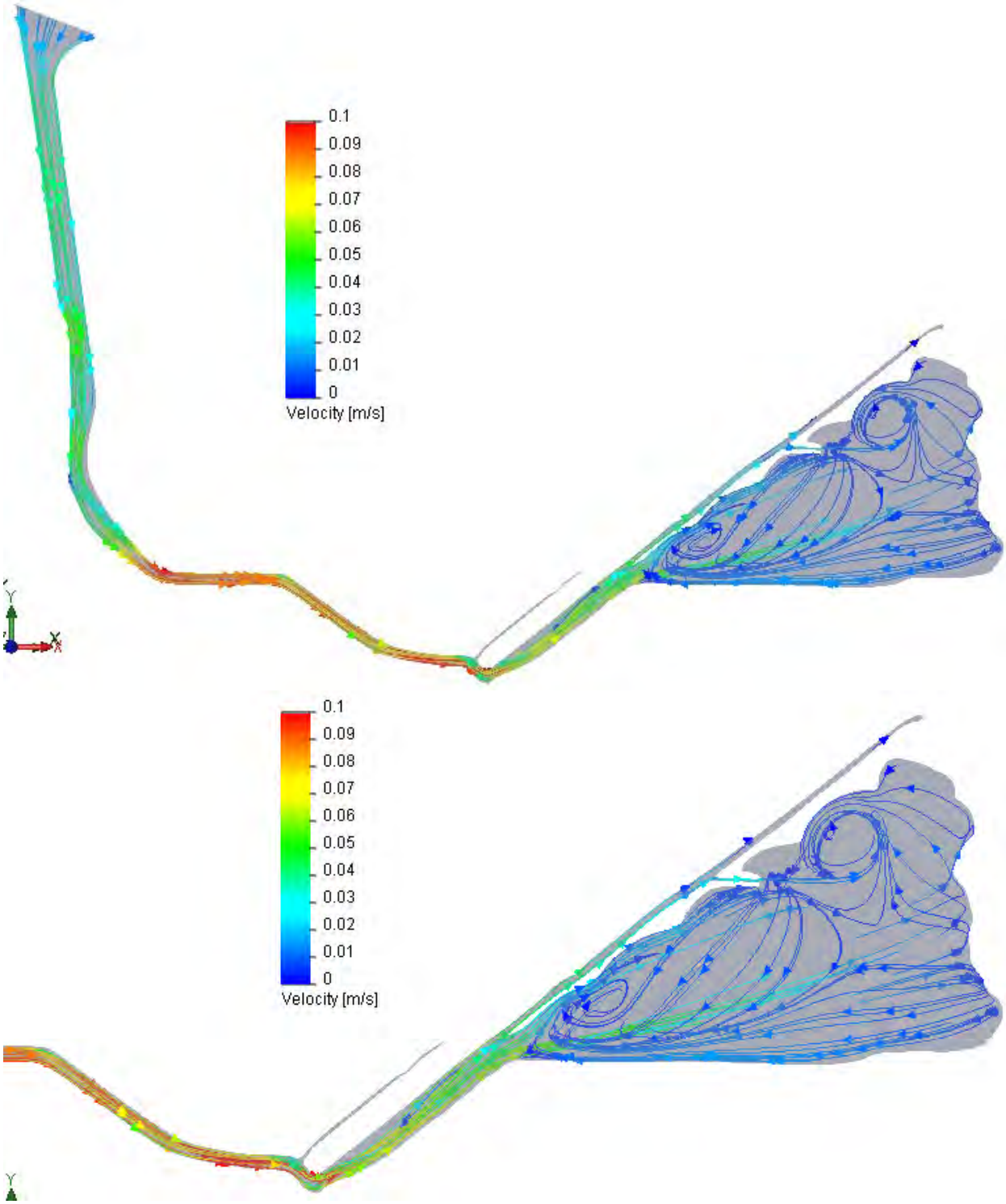

Figure A3: Hydrodynamic simulation of maximum flood flow during neap tides for Alternative-1 of the Otay Wetlands Restoration Project.

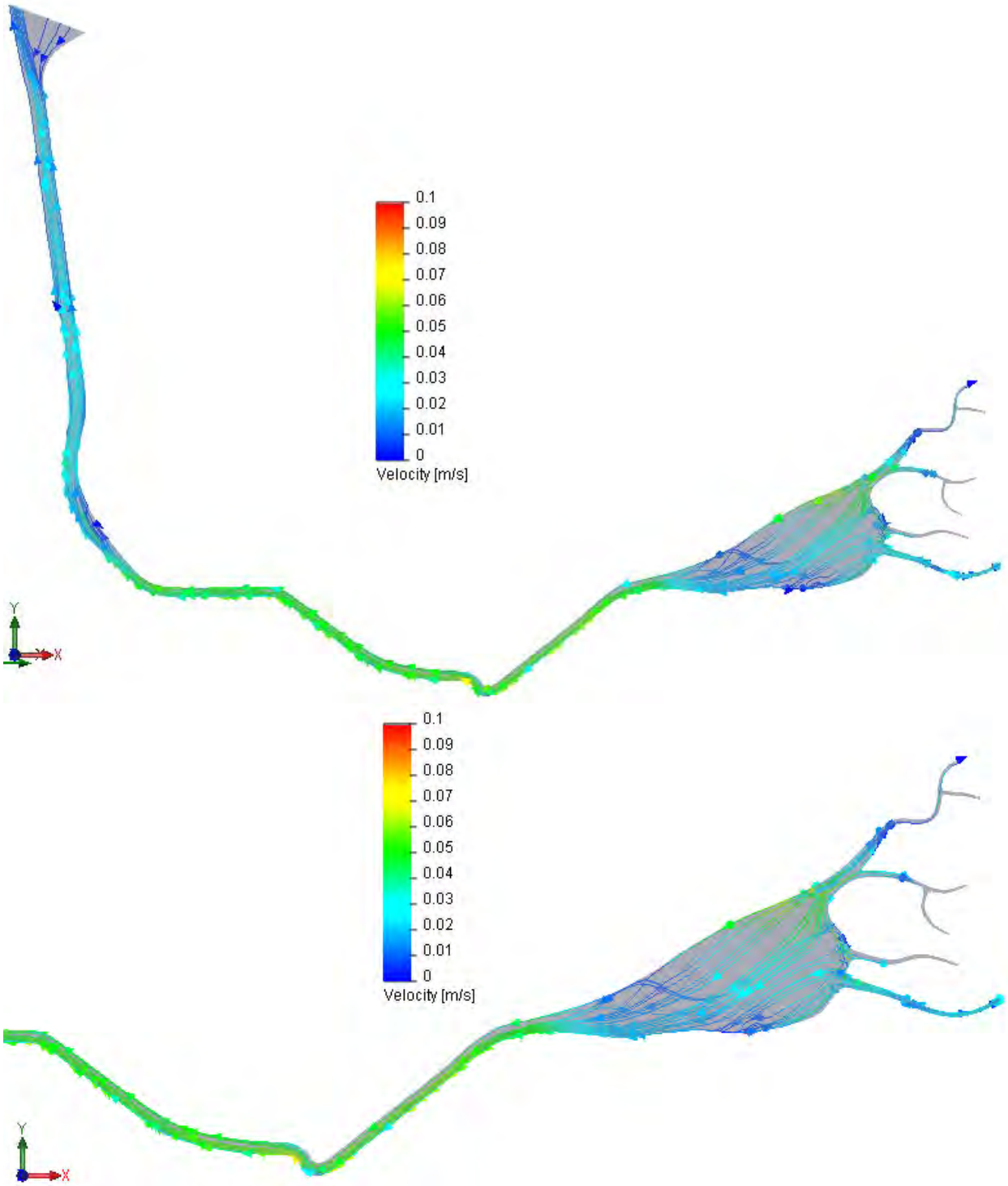

Figure A4: Hydrodynamic simulation of maximum ebb flow during neap tides for Alternative-1 of the Otay Wetlands Restoration Project.

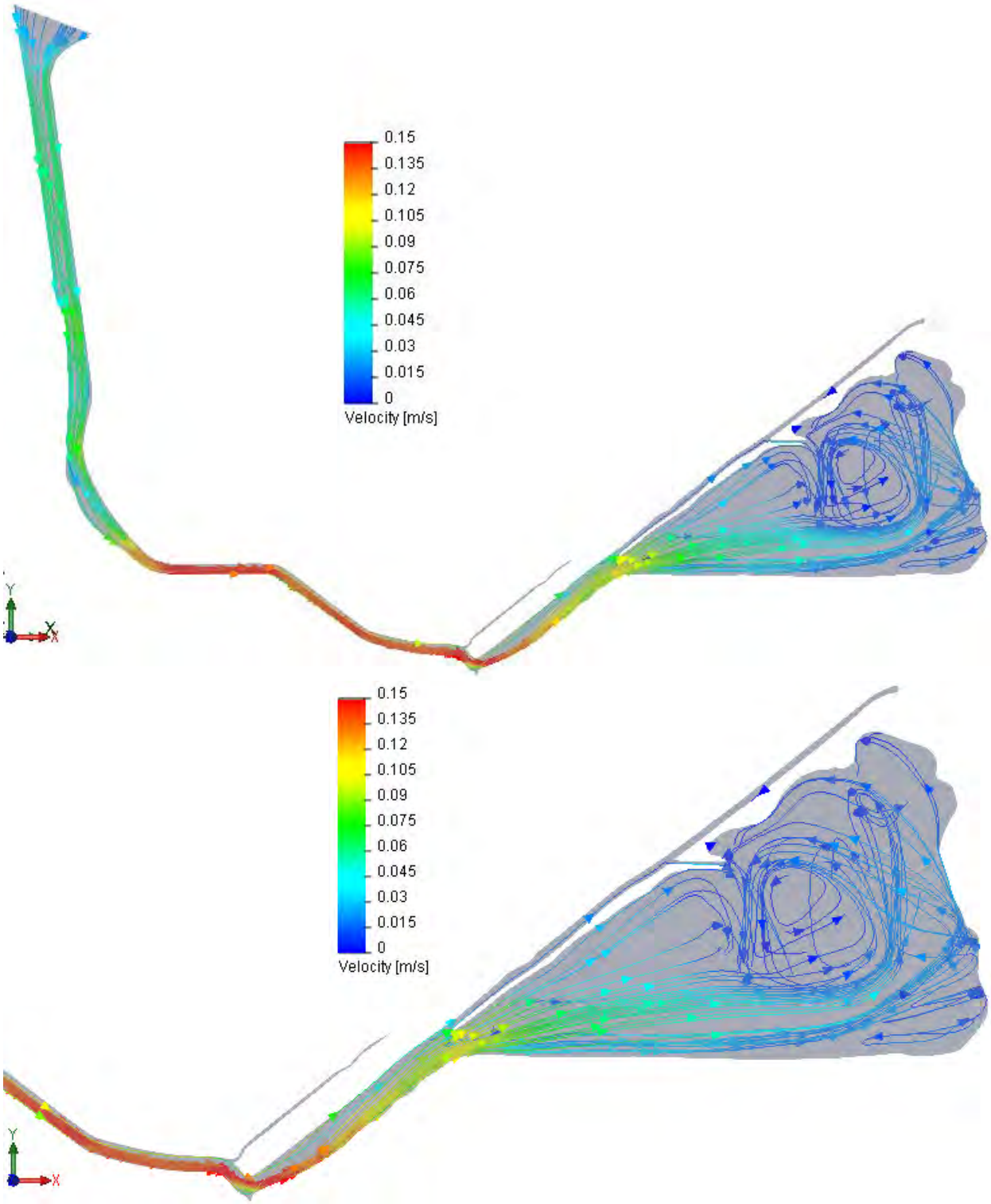

Figure A5: Hydrodynamic simulation of maximum flood flow during mean tides for Alternative-2 of the Otay Wetlands Restoration Project.

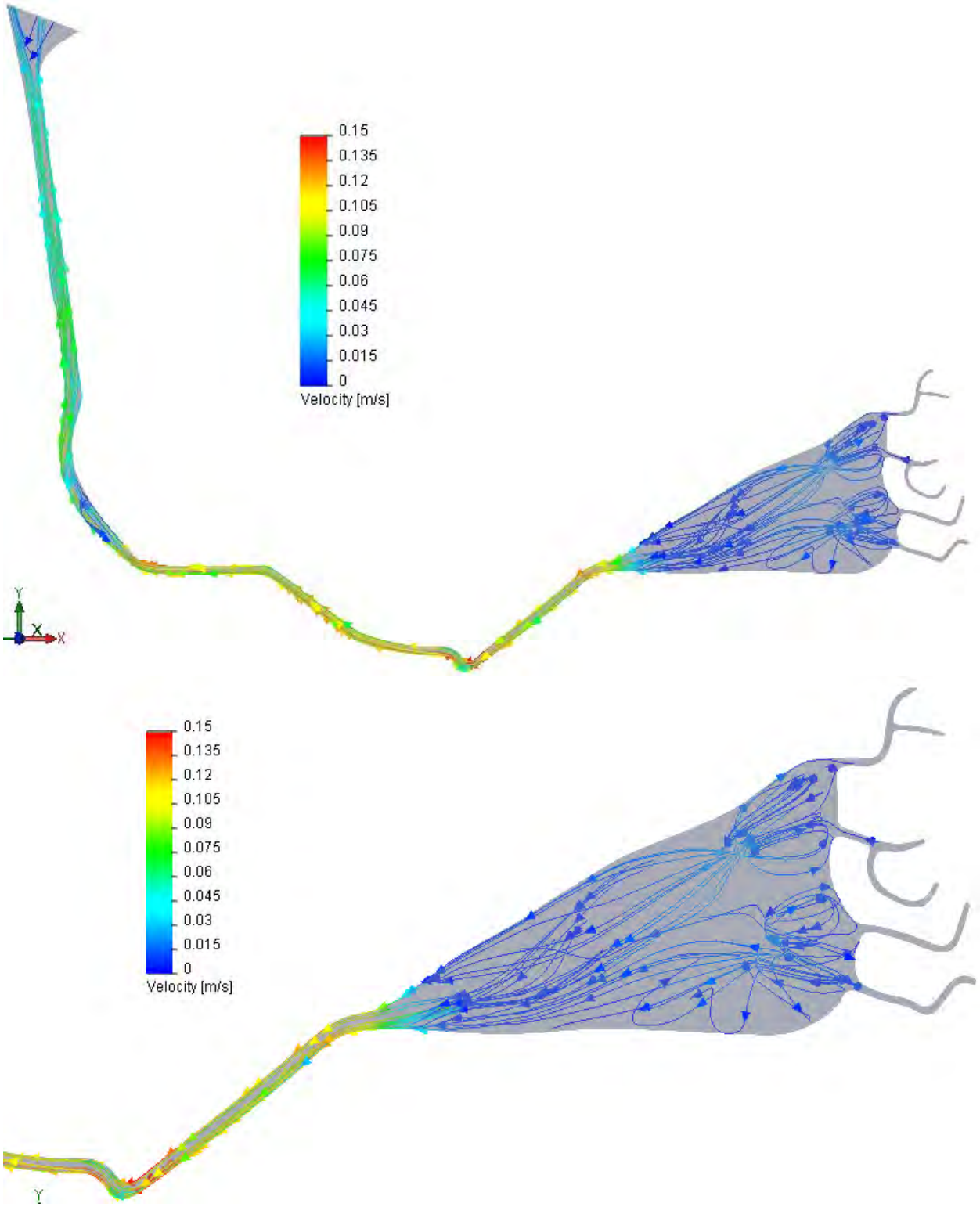

Figure A6: Hydrodynamic simulation of maximum ebb flow during mean tides for Alternative-2 of the Otay Wetlands Restoration Project.

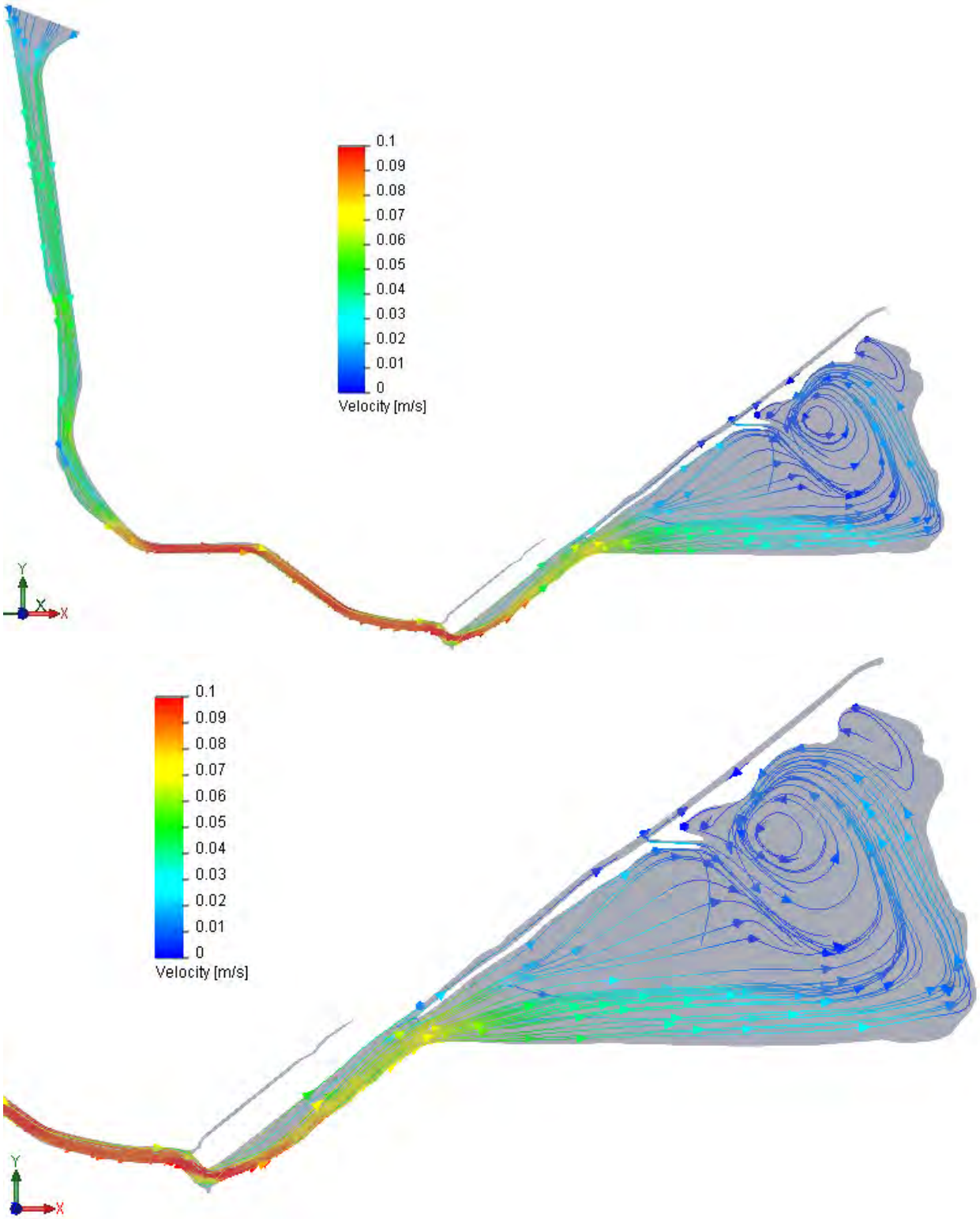

Figure A7: Hydrodynamic simulation of maximum flood flow during neap tides for Alternative-2 of the Otay Wetlands Restoration Project.

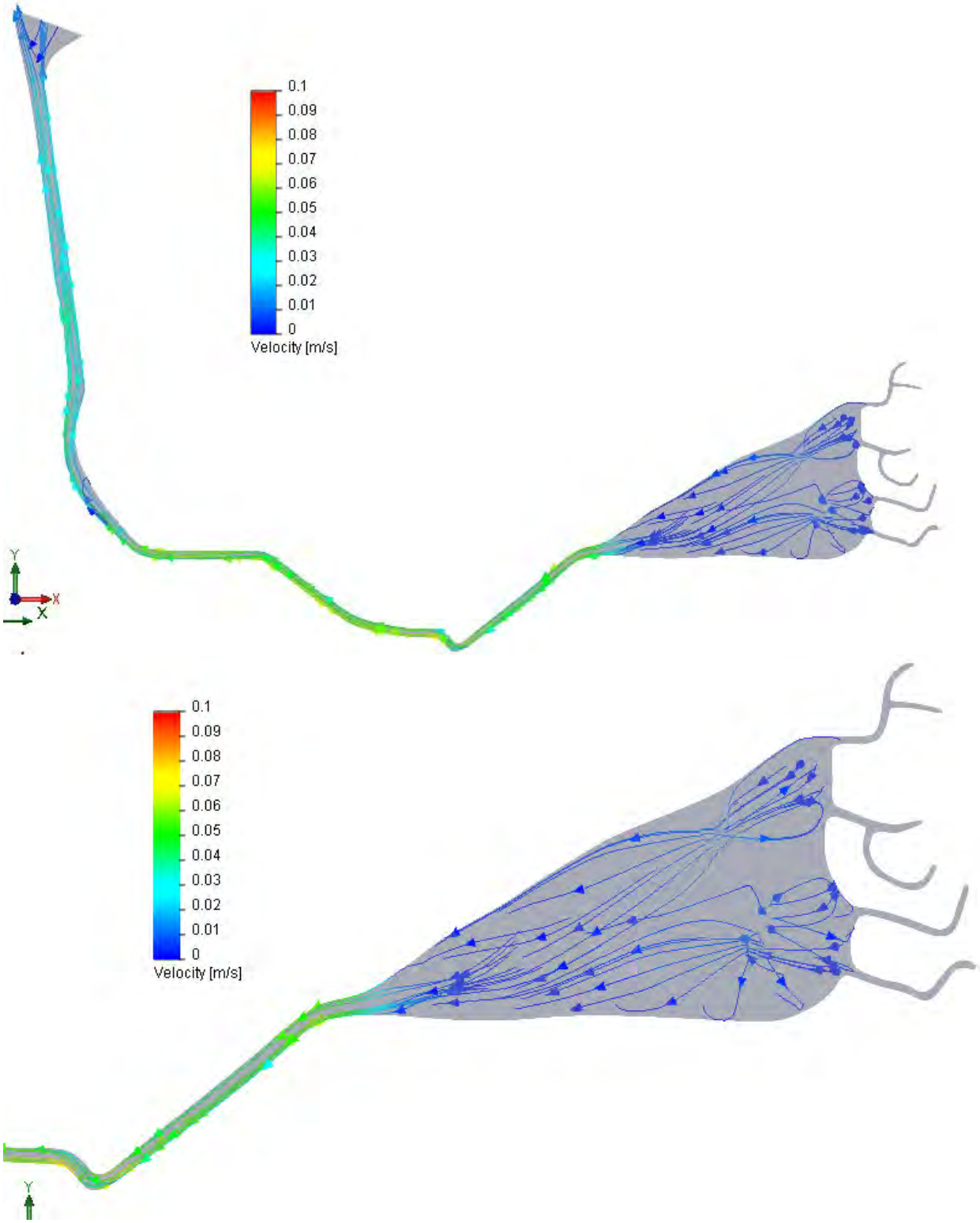

Figure A8: Hydrodynamic simulation of maximum ebb flow during neap tides for Alternative-2 of the Otay Wetlands Restoration Project.

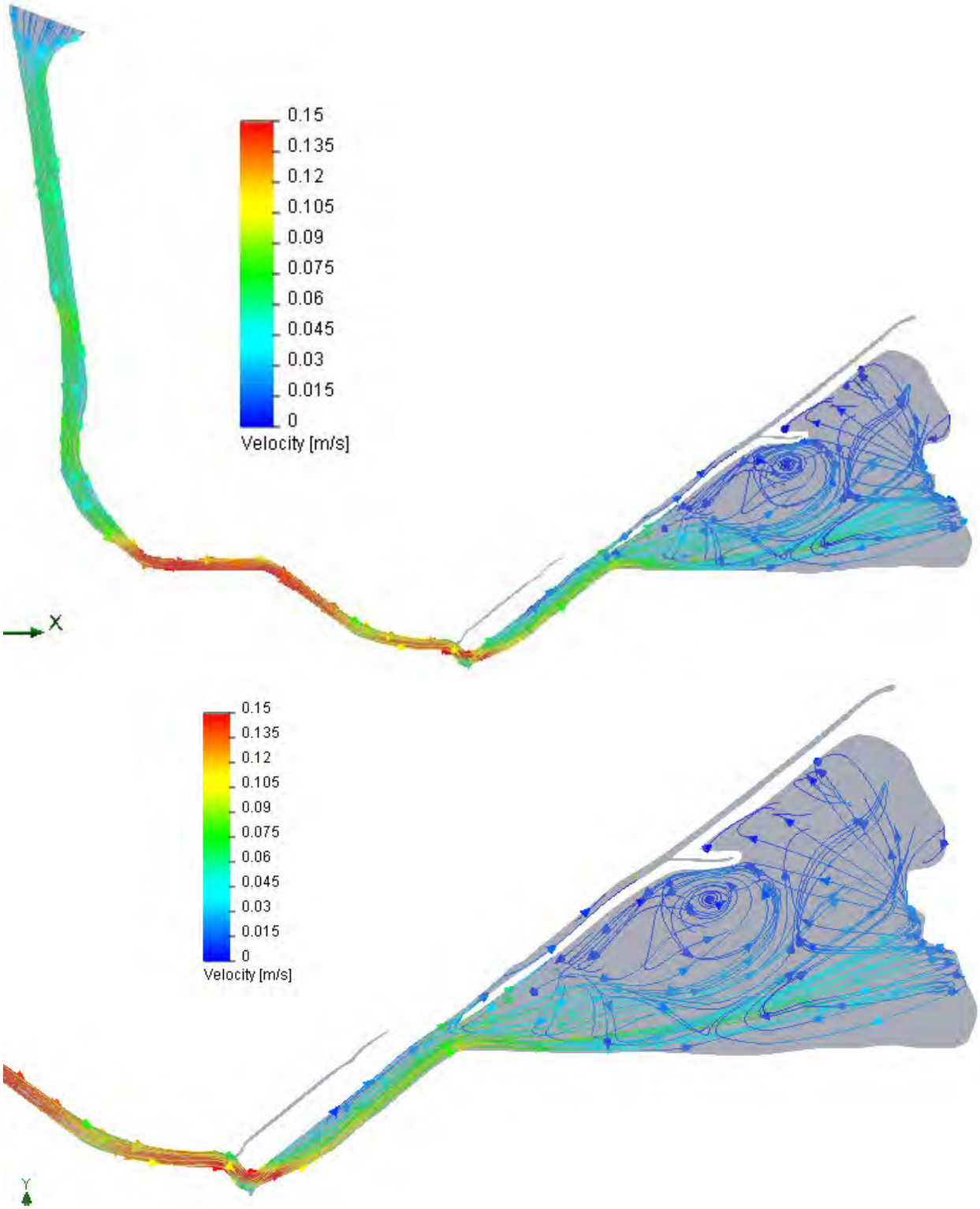

Figure A9: Hydrodynamic simulation of maximum flood flow during mean tides for Alternative-3 of the Otay Wetlands Restoration Project.

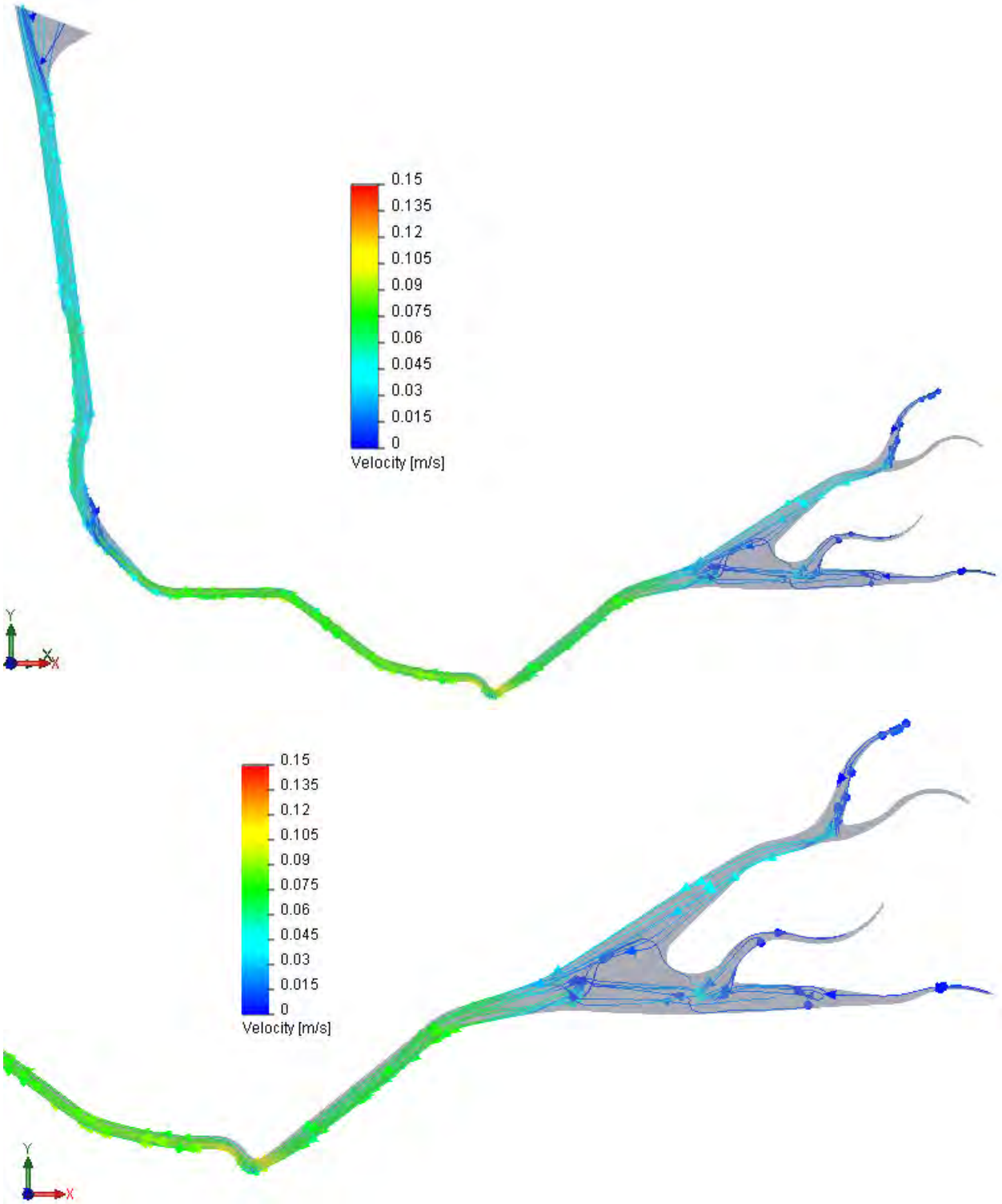

Figure A10: Hydrodynamic simulation of maximum ebb flow during mean tides for Alternative-3 of the Otay Wetlands Restoration Project.

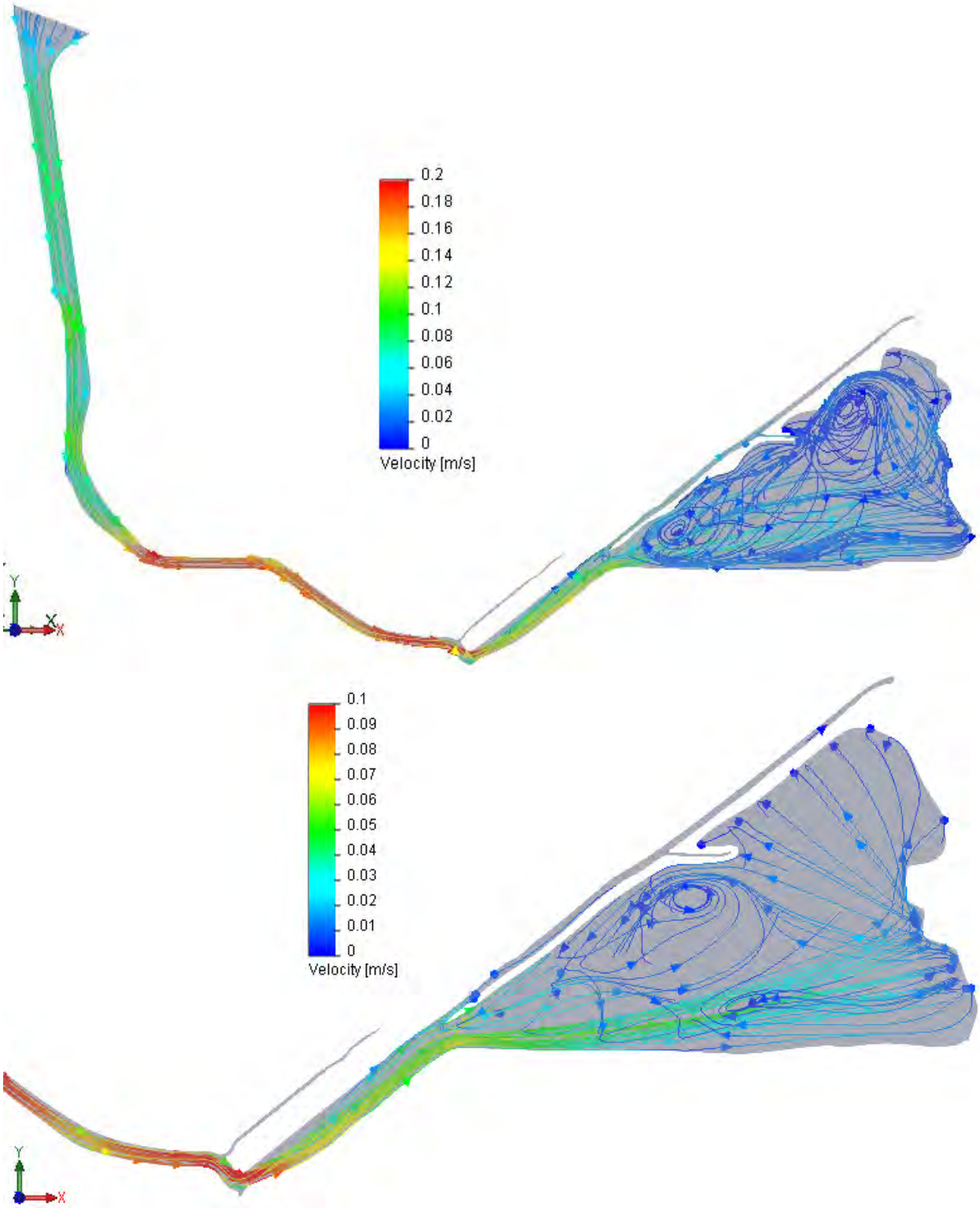

Figure A11: Hydrodynamic simulation of maximum flood flow during neap tides for Alternative-3 of the Otay Wetlands Restoration Project.

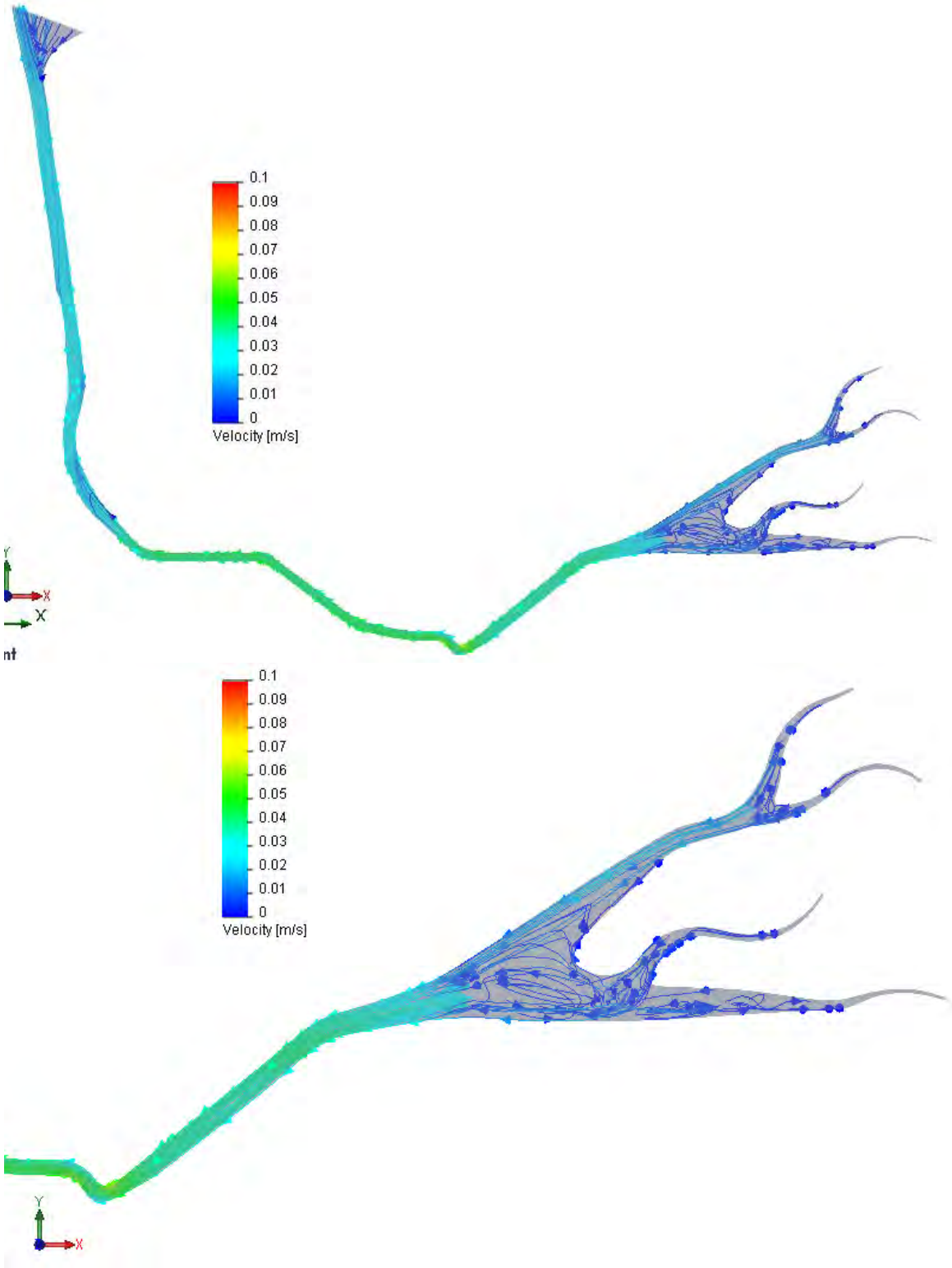

Figure A12: Hydrodynamic simulation of maximum ebb flow during neap tides for Alternative-3 of the Otay Wetlands Restoration Project.

Coastal Conservancy

September 21, 2010

Commissioner Bonnie Neely, Chair
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Re: Condition compliance for Commission-approved CDP Application No. E-06-013

Dear Chairperson Neely:

Your staff requests the Coastal Conservancy's approval for the proposed use of certain San Diego Bay National Wildlife Refuge property (San Diego County Assessor's Parcel Nos. 622-151-01, 621-030-18; 20, 622-120-18) (the "Property") as a mitigation site for the Poseidon Resources ("Poseidon") desalination plant in Carlsbad, California (the "project"). This letter provides our approval for use of this Property as a mitigation site, subject to two conditions: 1. Prior to Coastal Commission final approval of the Poseidon Project, the Conservancy shall review and approve the final mitigation plans to determine their consistency with the Memorandum of Agreement, Lower Otay River Wetlands Enhancement Plan and the Comprehensive Conservation Plan for the Refuge; and 2. Poseidon Resources shall acquire an interest in the Property sufficient to ensure implementation of its mitigation project.

Background:
As part of its project before the Commission, Poseidon proposes to restore wetlands in the South San Diego Bay Unit of the San Diego Bay National Wildlife Refuge ("Refuge") as mitigation for its project construction impacts. The proposed site for this mitigation is property purchased with funding from the Conservancy; the property currently is held by the U.S. Fish and Wildlife Service ("Service") as part of the Refuge.

Prior to transfer of the Property to the Service, the Conservancy , the Service and the Southwest Wetlands Interpretive Association entered into a Memorandum of Agreement, dated January 27, 2000, restricting the Property uses to wetland and riparian restoration and preservation, and public access as more particularly described in the Lower Otay River Wetlands Enhancement Plan, adopted by the Conservancy in October 1989 ("Enhancement Plan") and the funding conditions of the Conservancy's authorization and its grant agreement no. 98-098 ("Conservancy's grant agreement") The Enhancement Plan identified a preferred restoration alternative for the Property. The Enhancement Plan recommendations were subsequently modified and incorporated into the Comprehensive Conservation Plan ("CCP") for the Refuge in August 2006.

The Conservancy's grant agreement contains a prohibition against use of the Property for mitigation purposes without prior approval of the Conservancy's Executive Officer. The review by the Conservancy's Executive Officer considers, on a case-by-case basis, whether the mitigation would provide a benefit which would not

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Oakland, California 94612-2512
510·286·1015 Fax: 510·286·0470

Exhibit 7

otherwise enure to the property acquired (or restored) with Conservancy funding. This evaluation protects the public's investment in and expectation that state funding will provide additional protection and conservation of the environment. This is in contrast to mitigation, which is used to substitute or compensate for adverse environmental effects; yet, the mitigation project might not provide additional environmental benefits.

Discussion:
In this matter, the Conservancy's Executive Officer must provide consent to the use of the Property for Poseidon's proposed mitigation project. The CCP for the Refuge contains measures to improve the Property which are similar to the mitigation measures for Poseidon's project. Thus, use of the Property for Poseidon's mitigation would advance the Conservancy's programmatic goals for the Property.

However, we understand that Poseidon's mitigation plans are in draft form and the Property must be approved as a mitigation site by the Commission before Poseidon will finalize the plans. Therefore, our approval is subject to the condition that, prior to Commission final approval of the Poseidon project, the Conservancy's Executive Officer shall review and consider approval of the final mitigation plans to determine their consistency with the MOA, CCP and Enhancement Plan. This conditional approval to use the Property as a mitigation site shall not be interpreted as support for Poseidon's proposed desalination plant project. Rather, the Conservancy recognizes the responsibility of the Commission and other regulatory agencies to provide approval for Poseidon's project.

We also wish to acknowledge for the record an additional problematic issue with respect to use of property acquired or restored with public funds for mitigation requirements. Mitigation requirements do not include compensation for the use of the property where the mitigation will take place. In the private market, this fee would be captured in the negotiation between the landowner and the project applicant/mitigator. For example, if the proposed mitigation project were taking place on private land, Poseidon would need to purchase the property or pay a fee for its use. But where mitigation projects take place on public land, capturing this cost is not as simple.

The Conservancy recognizes that the public should be compensated for the use of property purchased with public funds for private mitigation projects. We request as an additional condition to our approval for use of the Property for Poseidon's mitigation project, that Poseidon compensate the State of California, on behalf of the Conservancy, for the use of the Property as a mitigation site. Specifically, Poseidon should acquire an interest in the Property sufficient for it to implement its mitigation project. The cost of this interest would be based on a state-approved appraisal. The interest in the Property sufficient for Poseidon's mitigation project would be established by the Service, Conservancy and Poseidon and could be a lease, license, easement or other possessory interest.

Thank you for your consideration of this matter. Please contact me or Megan Cooper, Conservancy project manager, mcooper@scc.ca.gov, if you have any questions.

Sincerely,

Sam Schuchat
Executive Officer

cc: Andy Yuen, Project Leader, San Diego National Wildlife Refuge Complex

California Regional Water Quality Control Board

San Diego Region

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http:// www.waterboards.ca.gov/sandiego

September 21, 2010

In reply refer to:
SWU:9000001103:jebsen

Peter Douglas
Executive Director
California Coastal Commission
45 Fremont Street, Ste 2000
San Francisco, CA 94105

Dear Mr. Douglas

SUBJECT: MITIGATION SITE PROPOSAL, POSEIDON RESOURCES, INC. CARLSBAD DESALINATION PROJECT, NPDES ORDER NO. R9-2009-0038, SAN DIEGO COUNTY

California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) NPDES Order No. R9-2009-0038 (Order) requires Poseidon Resources, Inc. (Poseidon) to implement mitigation for entrainment and impingement impacts of the proposed Carlsbad Desalination Project. Finding 43 of the Order requires Poseidon to propose a site to mitigate for these impacts to the Coastal Commission and to the San Diego Water Board for approval. On July 29, 2010, Poseidon submitted a proposed mitigation site at the Otay River Floodplain within the U.S. Fish and Wildlife Service's San Diego Bay National Wildlife Refuge near the City of Imperial Beach.

Consideration of the proposed mitigation site selection is tentatively scheduled for the San Diego Water Board's November 10, 2010 meeting. We will be recommending approval of the proposed mitigation site.

In the subject line of any response, please include the requested "**In reply refer to:**" information located in the heading of this letter. For questions pertaining to the subject matter, please contact Jody Ebsen at 858-636-3146 or jebsen@waterboards.ca.gov.

Respectfully,

DAVID W. GIBSON
Executive Officer

DWG:dtb:esb:jme