APPENDIX G-4

Eelgrass and Widgeongrass Survey
and
Bathymetric Survey Report

Hercules Multimodal Transit Facility Project

Eelgrass and Widgeongrass Presence/Absence Survey and Bathymetric Survey

Data Collection Report

April 2007

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CD CONTENTS

This data report
Raw bathymetric survey data (text file and ESRI point shapefile)
Raster bathymetry DEM (ESRI grid)
1 ft contour lines (ESRI line shapefile)

Executive Summary

Wetlands and Water Resources, Inc. (WWR) was retained by Impact Sciences, Inc. to perform a survey for sensitive aquatic habitats, particularly eelgrass (*Zostera marina*) and widgeongrass (*Ruppia maritima*) beds, in the vicinity of the proposed Hercules Multimodal Transit Facility. On March 1, 2, 3 and 5, 2007, Environmental Data Solutions (EDS) and WWR performed a Side-Scan Sonar (SSS) survey for eelgrass beds within the project boundaries. This survey effort also included a Class 1 hydrographic survey (USACE 2002) of the San Pablo Bay seafloor to provide updated bathymetric data in the project area and to correlate to eelgrass observations.

The survey footprint covered approximately 650 acres between the shoreline and -6.6 ft (-2 m) Mean Lower Low Water (MLLW) in the area where the proposed navigation channels will be dredged and where ferry wake wash could be a factor. Prior research indicates that the lower limit of eelgrass in San Francisco Bay is approximately -6.6 ft MLLW and previous eelgrass studies conducted in the bay have utilized this lower depth limit (Zimmerman et al. 1991, Merkel and Associates 2004, NOAA 2003).

The hydrographic surveys utilized Class 1 methods and accuracies as outlined in the Army Corps of Engineers' January 2002 *Hydrographic Surveying Manual* (EM 1110-2-1003). The raw survey data were used to create a raster Digital Elevation Model (DEM) with a 1 m^2 cell size from which 1 ft contour lines were created using the Spatial Analyst extension in ArcGIS 9.2.

The eelgrass survey was conducted using a *Marine Sonics* side-scan sonar towfish operating at a 600 kHz frequency. Each SSS image was reviewed twice: first during the acquisition surveys, and second during image post-processing. During the surveys, seafloor types with different sonar return signatures were identified and re-visited to inspect in further detail using a ponar-type grab sampler. Following the review of the post-processed images, several locations were identified for further field investigation by SCUBA divers. The diver surveys were performed on April 6, 2007.

No eelgrass or widgeongrass beds or individual shoots were detected in the survey area. A total of six different seabed types were identified during the surveys: 1) mud, 2) mud with oyster and clam shells, 3) mud with oyster and clam shells colonized by tunicates (small, sessile marine invertebrates), 4) industrial debris piles, 5) cordgrass beds along the Bay margin, and 6) mud with standing pilings.

1 Introduction

Wetlands and Water Resources, Inc. (WWR) was retained by Impact Sciences, Inc. to perform a survey for sensitive aquatic habitats, particularly eelgrass (*Zostera marina*) and widgeongrass (*Ruppia maritima*) beds, in the vicinity of the proposed Hercules Multimodal Transit Facility. On March 1, 2, 3 and 5, 2007, Environmental Data Solutions (EDS) and WWR performed a Side-Scan Sonar (SSS) survey for eelgrass beds within the project boundaries. This survey effort also included a Class 1 hydrographic survey (USACE 2002) of the San Pablo Bay seafloor to provide current bathymetric data in the project area and to correlate to eelgrass observations. The 2-person field crew included Mr. James Kulpa (Hydrographer - EDS), and Mr. Darren Gewant (Oceanographer – WWR).

This report outlines survey methodologies and protocols utilized to determine the presence/absence of eelgrass and achieve a Class 1 bathymetric survey. It also presents the results of the survey efforts. In addition to this report, a companion electronic CD contains this data collection report, the raw bathymetric survey data (survey points), and processed bathymetric data (DEM and contour lines). The raw SSS data are not included with this report due to the large volume (over 22 gigabytes). The data are stored at the WWR office and can be viewed on site, or provided on DVD if desired.

2 Data Collection and Processing

2.1 Survey Area

The survey footprint covered approximately 650 acres between the shoreline and -6.6 ft (-2 m) Mean Lower Low Water (MLLW) in the area where the proposed navigation channels will be dredged and where ferry wake wash could be a factor. This survey extent was determined through conversations with staff from Coast and Harbor Engineering and related to their separate efforts to predict wake effects. Prior research indicates that the lower limit of eelgrass in San Francisco Bay is approximately -6.6 ft MLLW and previous eelgrass studies conducted in the bay have utilized this lower depth limit (Zimmerman et al. 1991, Merkel and Associates 2004, NOAA 2003). The survey area extends 1.25 miles west into San Pablo Bay and approximately 1.3 miles along the central Hercules shoreline (Figure 1). The survey footprint covers a range of bathymetry from +2.0 ft MLLW to subtidal areas approximately -7.0 ft MLLW.

A total of 120 shore-parallel transects, spaced at 60 ft intervals, were scanned for the presence of eelgrass, with approximately 90 of these transects also surveyed for bathymetry (Figure 2). Four shore-perpendicular transects were surveyed as a cross-reference to verify the accuracy of the shore-parallel bathymetric transects. The average length of each transect was 1.2 miles.

2.2 Bathymetric Survey

2.2.1 Data Collection

The survey crew utilized a 17' Boston Whaler survey vessel, compliant with all U.S. Coast Guard safety regulations, to perform the survey. A graph displaying the results from a squat correction test conducted for the vessel in March 2003 is aboard the vessel (per U.S. Army Corps of Engineers' specifications).

The hydrographic surveys utilized Class 1 methods and accuracies as outlined in the Army Corps of Engineers' January 2002 *Hydrographic Surveying Manual* (EM 1110-2-1003). Bathymetric data were collected using an *Odom Hydrotrac* survey-grade fathometer with a 3-degree 200-kHz transducer. Position data (geographic coordinates) were collected using a *Trimble Ag123* Differential GPS placed above the fathometer. Survey vessel motion (heave, pitch and roll) was measured by using a *TSS CMS-25* motion sensor (the motion sensor was also attached to the top of the fathometer). Vessel motion data were applied to the raw sounding data before being logged to the computer. The data stream was collected using a *Toshiba* laptop running *Hypack Max* (Version 6.2a) survey planning, data collection and reduction software.

Horizontal position control data were collected in geographic coordinates (latitude and longitude in decimal degrees) based on the North American Datum of 1983 (NAD83) via the *Trimble* system. *Corpscon* Version 6.0 was used to convert the geographic coordinates to California State Plane Zone 3 (NAD83, feet) coordinates.

In order to correct raw sounding data for changing water depths resulting from tidal cycles, a recording tide gage (*Instrumentation Northwest PS9800* vented pressure transducer) was installed on an offshore pile (Figure 3). The tide sensor was programmed to measure and record a water level at six minute intervals. The sensor was calibrated multiple times during the course of the deployment using project vertical control points which were tied into existing National Ocean Service (NOS) tidal and geodetic benchmarks. All calibrations were within ± 0.05 ft of the pressure transducer measurements. Water surface elevation time series are presented in Appendix C.

2.2.2 Tidal Datum to Geodetic Datum Conversion

Bathymetric data are referenced to the local tidal datum (ft MLLW). The survey temporary benchmarks, used for tide gage calibration, were tied into three NOS tidal benchmarks and one National Geodetic Survey (NGS) benchmark using Real Time Kinematic (RTK) GPS. Figure 3 shows the locations of these benchmarks and Appendix B contains metadata describing each tidal benchmark and associated survey data.

This survey also determined the vertical offset (in feet) between the tidal (ft MLLW) and geodetic-based (ft North American Vertical Datum of 1988 (NAVD88)) datums (Table 1). The survey crew's attempt to re-occupy historic tidal benchmarks located on the Hercules shoreline was unsuccessful as the benchmarks no longer exist. Therefore, the conversion between ft MLLW and ft NAVD88 drew upon prior reported and newly surveyed data from Point Pinole. The conversion was found to be: **ft NAVD88 = ft MLLW + 0.1ft**

Table 1 – Tidal Datum to Geodetic Datum Conversion Table

Note: RTK vertical error ± 0.10 ft

HERCULES

Tidal BM	Reported Elevation ft MLLW	Reported Elevation ft NAVD88	Surveyed Elevation ft NAVD88	Elevation Difference (ft)
tidal 2	10.49	10.70	destroyed	0.21
tidal 4	14.09	14.20	destroyed	0.11
tidal 5	11.61	11.70	destroyed	0.09
			Average	**0.14**

POINT PINOLE

Tidal BM	Reported Elevation ft MLLW	Reported Elevation ft NAVD88	Surveyed Elevation ft NAVD88	Elevation Difference (ft)
tidal 5056 C	34.75	n/a	34.86	0.11
tidal 5056 B	20.90	n/a	20.99	0.08
tidal 556 P	60.12	60.00	not surveyed	0.12
			Average	**0.10**

2.2.3 Data Processing

The raw bathymetric sounding data were converted into ft MLLW and filtered down to a 10 m horizontal point resolution. These data were used to create a Triangulated Irregular Network (TIN) using the 3D Analyst extension in ArcView 3.2. This TIN was then converted into a raster Digital Elevation Model (DEM) with a 1 m^2 cell size from which 1 ft contour lines were created using the Spatial Analyst extension in ArcGIS 9.2.

2.3 Eelgrass and Widgeongrass Survey

2.3.1 Data Collection

Side scan image data were collected using a *Marine Sonics* side scan sonar (SSS) towfish operating at a 600 kHz frequency (Figure 4). The SSS towfish was mounted and towed from the bow of the survey vessel using a Kevlar-sheathed data and control cable. Towfish operations were controlled using *Marine Sonics PC Acquisition* software running on an *Intel* / *Windows* PC, separate from the computer running the *Hypak Max* software.

The towfish makes a sonar scan of a swath of the seafloor and records the strength of the echoes from objects on the bottom. The towfish is towed just above the seafloor while continuously emitting focused beams of sound perpendicular to the path of motion. The control software records the strength of the echo signal and then draws the entire sonar record line on the screen. An image of the seafloor is formed, line by line, as the sonar record is returned and drawn on the screen.

The 600 kHz towfish has a maximum range of approximately 250 ft on both sides. For this survey, the operating range of the fish was programmed to 33 ft. The smaller range enables a finer resolution – which is needed to detect the sparse shoots of eelgrass that are characteristic to San Francisco Bay. As a result of the tighter range, survey transect spacing was set at 60 ft intervals. This spacing ensured that SSS survey data lines would overlap and provide maximum seafloor coverage.

The navigation system consisted of a *Trimble AG123* Differential GPS (DGPS) connected to a *Toshiba* laptop running *Hypack Max* bathymetric survey control and processing software (Version 6.2a). Survey coverage (bathymetric and SSS) was ensured by navigating along pre-determined survey lines which were programmed into *Hypack* (Figure 2). Vessel position relative to current survey line is displayed on a heads-up monitor. *Hypack* also provided a position data stream to the *Marin Sonics PC Acquisition* software. These data were corrected for the position of the SSS towfish relative to the DPGS antenna (known as layback) and then integrated into the side scan imagery data files. This navigation and image integration facilitated the georectification of the SSS data during post-processing.

Final SSS navigation data had a resolution of approximately ± 10.0 ft. This error is a combination of the DGPS error (± 3.3 ft) and potential SSS position error due inaccuracies in layback measurements and georectification post-processing.

2.3.2 Data Processing

Each SSS image was reviewed twice: once during the acquisition surveys, and second during image post-processing. During the surveys, seafloor types with different sonar return signatures were identified and re-visited to inspect in further detail using a ponar-type grab sampler. The field team collected over 30 grab samples.

Image post-processing consisted of loading the SSS data files into *Isis Seafloor Mapping and Analysis* Software (Version 6.0) and performing numerous signal processing algorithms in order to reveal further image detail. In addition, each image was corrected for slant and range of the acoustic swath in order to facilitate georectification.

Following the review of the post-processed images, several locations were identified for further field investigation by SCUBA divers (Figure 5). The diver survey was conducted on April 6, 2007.

3 Quality Assurance / Quality Control

3.1 Bathymetric Survey

In order to achieve Class 1 accuracy requirements, metadata describing various hydrographic survey variables were measured, recorded and utilized before, during and after each survey day. Quality assurance and quality control protocols and metadata are presented in this section.

3.1.1 Weather Conditions

Table 2 presents the environmental metadata.

Table 2 - Environmental Metadata

Date	1 - March - 07	2 - March - 07	3 - March - 07	5 - March - 07
Weather	Sunny, clear	Sunny, clear	Sunny, clear	Sunny, clear
Wind	0 – 5 knts	0 – 5 knts	0 knts	0 knts
Water Surface Conditions	Smooth	Smooth	Smooth	Smooth
Stage (ft MLLW)	6.1>6.6>-0.1	6.0>6.4>-0.2	4.0>6.1>5.0	1.7>5.4>1.7
Survey Time Period (pst)	10:00 – 17:00	10:13 – 18:00	9:45 – 14:00	9:10 – 18:10
Bottom Type	Hard Mud / Shell	Hard Mud / Shell	Hard Mud / Shell	Hard Mud / Shell

3.1.2 Fathometer Calibration

There are two standard procedures used to check the accuracy of the fathometer output: 1) water column speed of sound calculation and 2) fathometer barcheck calibration. Fathometers calculate water depth by using algorithms based on the speed of sound through water. Since the speed of sound is affected by water temperature and salinity, these values were recorded each day before the bathymetric surveys began utilizing an *Odom Digi-Bar Pro* speed of sound sensor. The average water column speed of sound was then programmed into the fathometer. The average water column temperature and salinity for all four survey days were 10.2° C and 9 ppt respectively, resulting in a speed of sound constant of 4783 ft/sec.

The second protocol is a barcheck calibration performed on the fathometer before and after each survey. This procedure consists of lowering a 36 inch diameter, weighted steel plate below the fathometer transducer and recording the actual depth of the disc (via markings on a cable) and the fathometer output (output was corrected for the transducer depth offset). Appendix A contains the results of each barcheck calibration.

3.2 Side Scan Sonar

Quality assurance protocols related to SSS output consist mainly of adjusting certain gain and sensitivity values on the SSS output in order to produce a detailed image of the seafloor. Prior to the collection of SSS data along the survey transects, the survey crew performed numerous “calibration” exercises with the towfish to ensure image output was the sharpest possible.

Multiple buoy lines (anchors attached to buoys with line of varying diameters) were deployed within the survey area. The survey crew then steamed past each buoy line at varying distances and velocities while monitoring the SSS imagery. Controls affecting sonar backscatter return strength, sensitivity, contrast, beam width and other variables were adjusted until the returned images of the buoys lines were as clear and sharp as possible.

In addition to the buoy line calibration, the survey crew performed *in-situ* scans on known beds of sub-aquatic vegetation to understand their return signals. These scans included cordgrass (*Spartina foliosa*) beds found on-site.

4 Results

Figure 6 shows the survey vessel track lines throughout the survey footprint.

4.1 Bathymetry

Figure 7 shows the DEM and 1 ft contour lines of the project area.

4.2 Eelgrass and Widgeongrass Mapping

No eelgrass or widgeongrass beds or individual shoots were detected in the survey area. A total of six different seabed types were identified during the surveys: 1) mud, 2) mud with oyster and clam shells, 3) mud with oyster and clam shells colonized by tunicates (small, sessile marine invertebrates), 4) industrial debris piles, 5) cordgrass beds along the Bay margin, and 6) mud with standing pilings. Figure 8 shows detailed SSS images of each seafloor type along with photographs of field samples taken at the location of the sonar image. The geographic location of each of these samples in the study area is also shown.

5 References Cited

U.S. Army Corps of Engineers. 2002. Hydrographic Survey Manual, Engineering and Design Manual No. EM-1110-2-1003, Washington D.C.

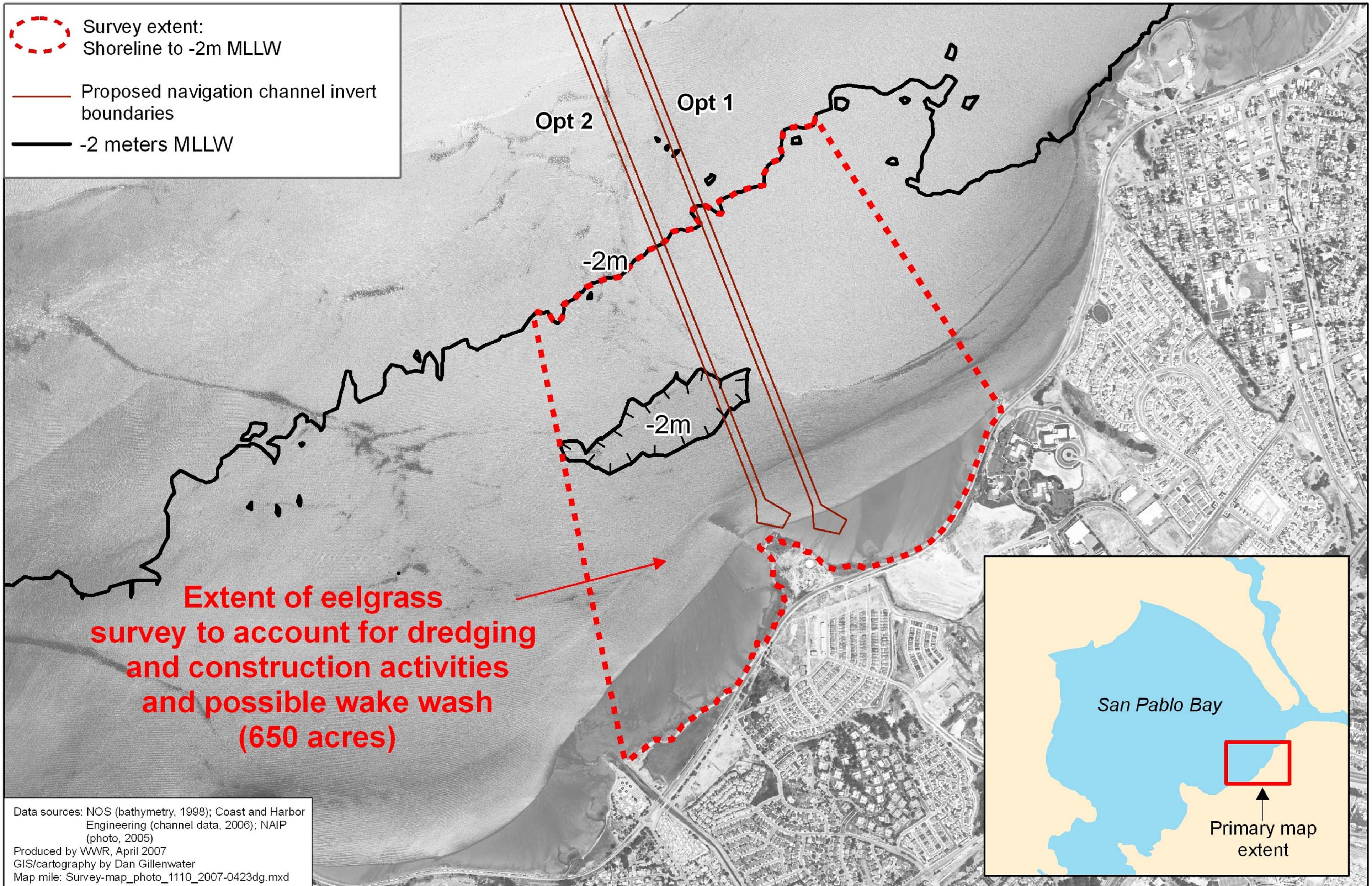
Merkel and Associates, Inc. 2004. Eelgrass Habitat Surveys for the Emeryville Flats and Clipper Cover, Yerba Buena Island (October 1999 through October 2003). Prepared for Caltrans Disctict 4.

NOAA. 2003. San Francisco Bay Watershed Database and Mapping Project, Release 2.

Wyllie-Escheverria, S. and M. Fonseca. 2003. Eelgrass (*Zostera marina L.*) research in San Francisco bay, California from 1920 to the present. NOAA Literature Review, February 2003.

Zimmerman, R., J. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn, and R. Alberte. 1991. Assessment of environmental suitability for growth of *Zostera marina L.* (eelgrass) in San Francisco Bay. Aquatic Botany, 39. 353-366.

Figures



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N W E S

1:21,600 (1" = 1,800' at letter layout)

0 1,800 3,600 Feet

0 550 1,100 Meters

WETLANDS AND WATER RESOURCES

PLANNED EELGRASS SURVEY EXTENT

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

April 2007	Project No. 1110	**Figure 1**

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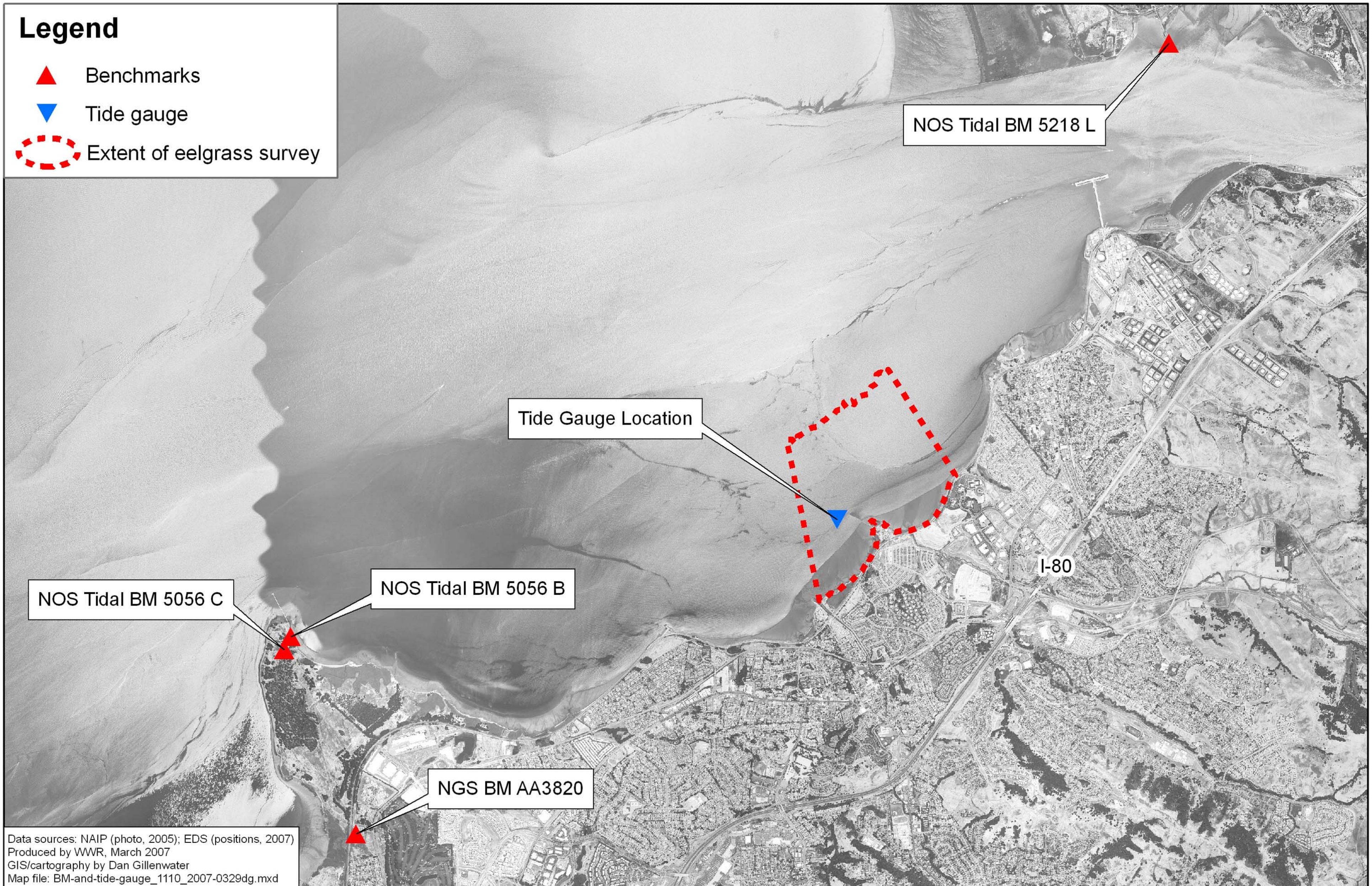
WETLANDS AND WATER RESOURCES

PLANNED EELGRASS SURVEY LINES

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

March 2007	Project No. 1110	Figure 2

survey-lines_1110_2007-0329dag.ai



Environmental Data Solutions

N W E S

1:60,000 (1" = 5,000' at letter layout)

0 5,000 10,000 Feet

0 1,500 3,000 Meters

WETLANDS AND WATER RESOURCES

TIDAL BENCHMARK AND TIDE GAUGE LOCATIONS

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

March 2007	Project No. 1110	**Figure 3**

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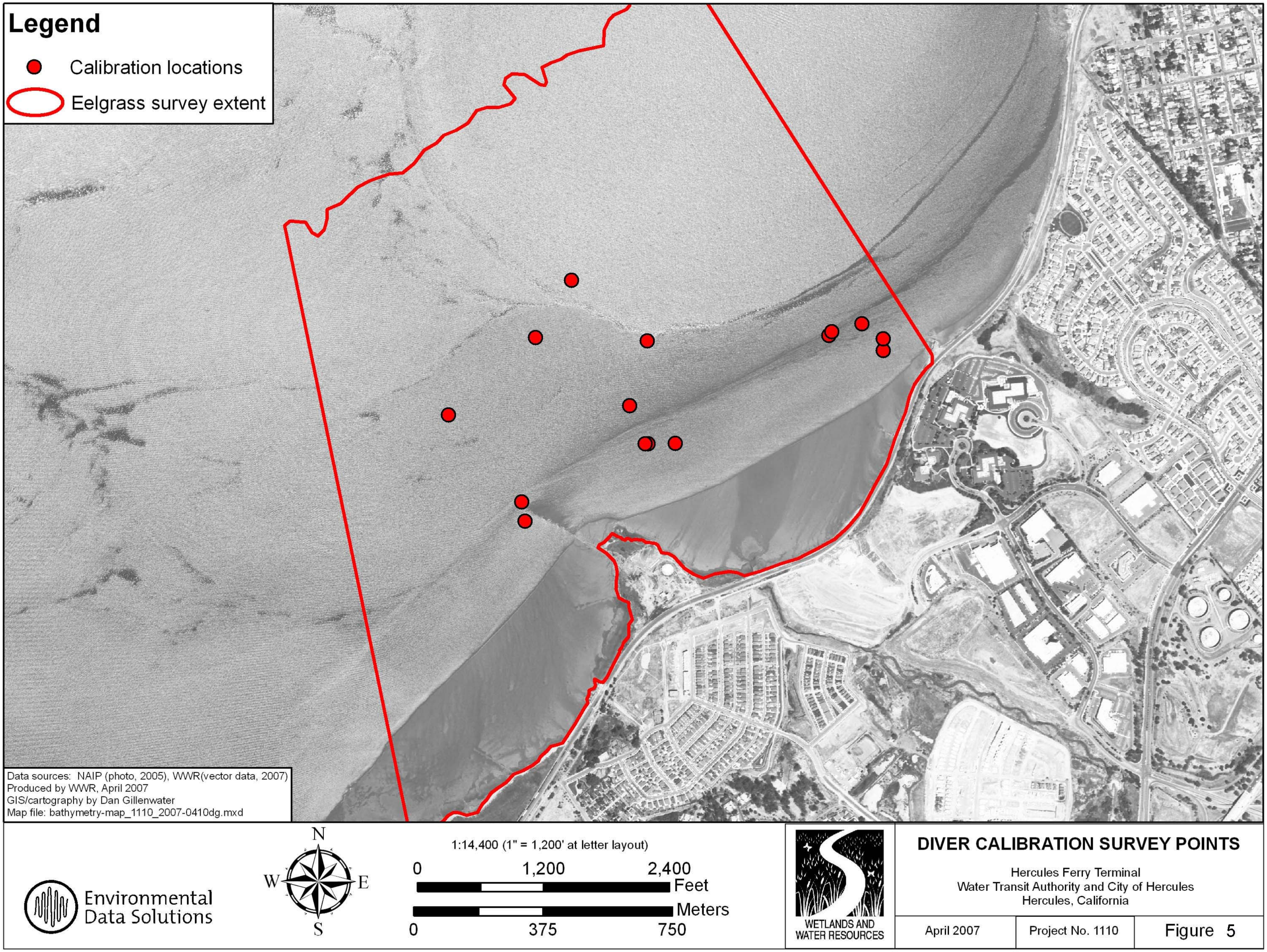
WETLANDS AND WATER RESOURCES

SIDE-SCAN SONAR TOWFISH

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

March 2007	Project No. 1110	Figure 4

towfish-picture_1110_2007-0329dag.ai



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WETLANDS AND WATER RESOURCES

DIVER CALIBRATION SURVEY POINTS

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

April 2007	Project No. 1110	Figure 5

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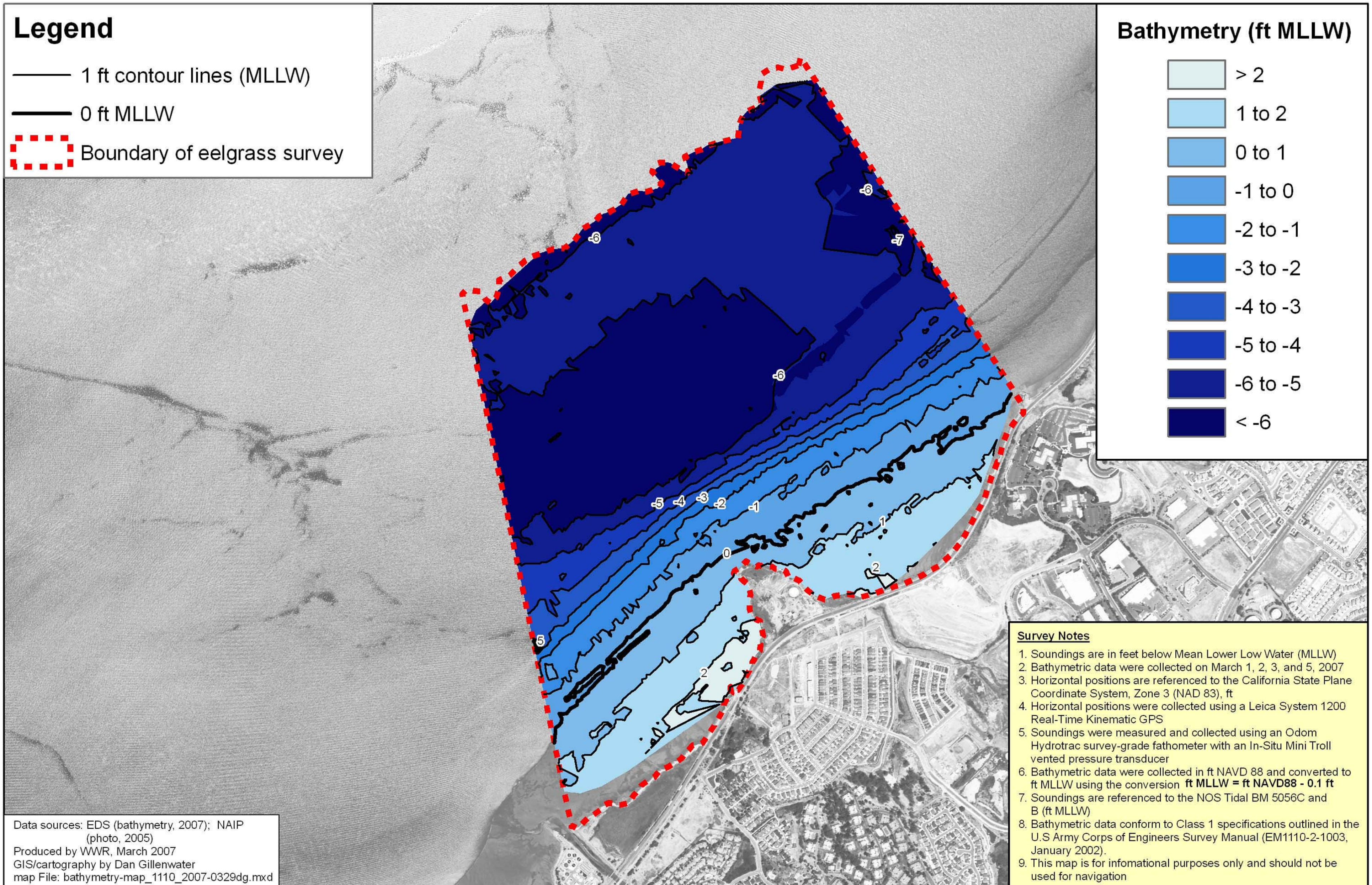
WETLANDS AND WATER RESOURCES

SURVEY VESSEL TRACKLINES

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

March 2007	Project No. 1110	Figure 6

survey-tracklines_1110_2007-0329dag.ai



Survey Notes

1. Soundings are in feet below Mean Lower Low Water (MLLW)
2. Bathymetric data were collected on March 1, 2, 3, and 5, 2007
3. Horizontal positions are referenced to the California State Plane Coordinate System, Zone 3 (NAD 83), ft
4. Horizontal positions were collected using a Leica System 1200 Real-Time Kinematic GPS
5. Soundings were measured and collected using an Odom Hydrotrac survey-grade fathometer with an In-Situ Mini Troll vented pressure transducer
6. Bathymetric data were collected in ft NAVD 88 and converted to ft MLLW using the conversion **ft MLLW = ft NAVD88 - 0.1 ft**
7. Soundings are referenced to the NOS Tidal BM 5056C and B (ft MLLW)
8. Bathymetric data conform to Class 1 specifications outlined in the U.S Army Corps of Engineers Survey Manual (EM1110-2-1003, January 2002).
9. This map is for infomational purposes only and should not be used for navigation

Data sources: EDS (bathymetry, 2007); NAIP (photo, 2005)
Produced by WWR, March 2007
GIS/cartography by Dan Gillenwater
map File: bathymetry-map_1110_2007-0329dg.mxd

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N W E S

1:18,000 (1" = 1,500' at letter layout)

0 1,500 3,000 Feet

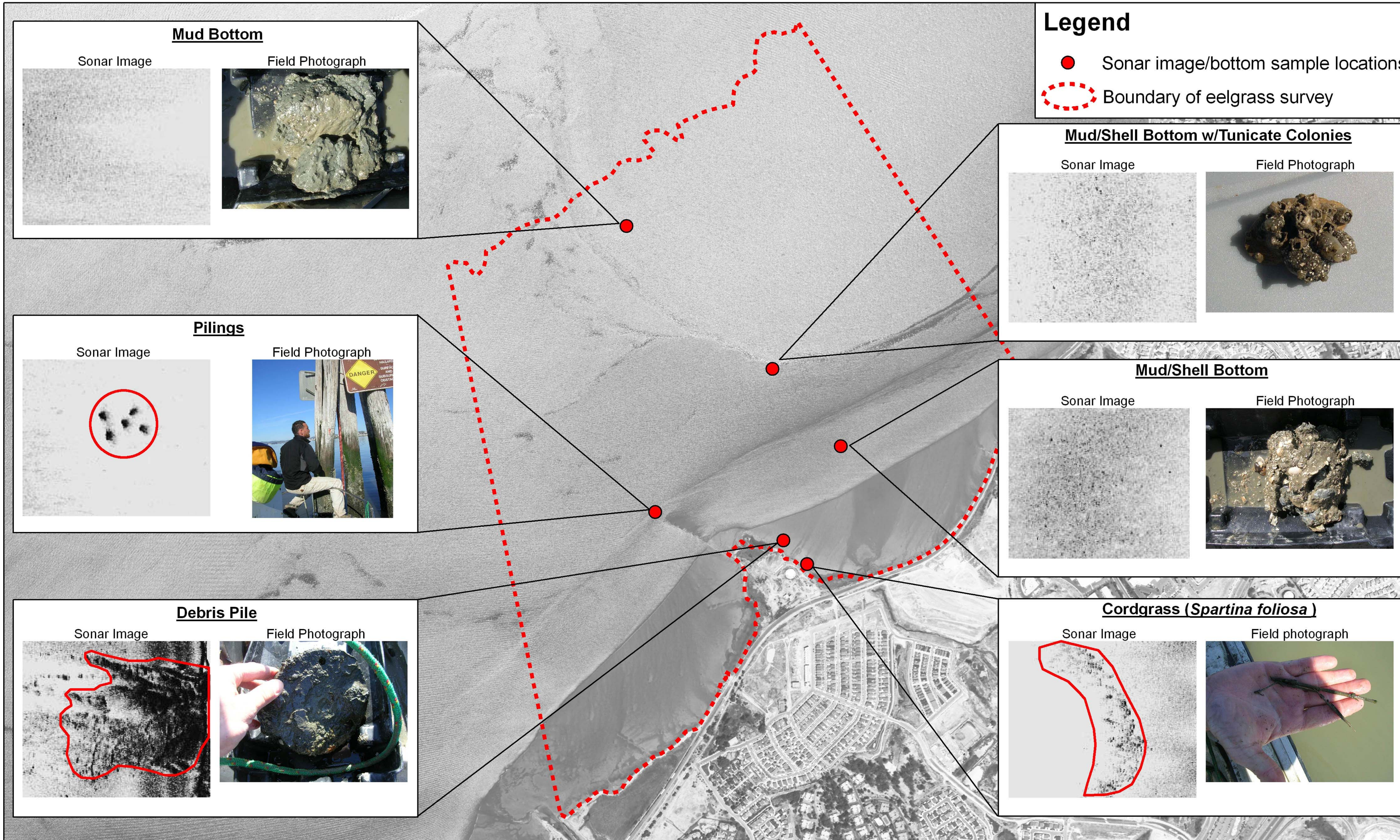
0 450 900 Meters

WETLANDS AND WATER RESOURCES

STUDY AREA BATHYMETRY

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

March 2007	Project No. 1110	**Figure 7**



Data sources: NAIP (air photo, 2005); EDS (sonar imagery and photos, 2007)
Produced by WWR, April 2007
GIS/cartography by Dan Gillenwater
Map file: sonar-images_1110_2007-0417dg.mxd

N W E S

1:12,000 (1" = 1,000' at tabloid layout)

0 500 1,000 2,000 Feet

0 150 300 600 Meters

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WETLANDS AND WATER RESOURCES

SONAR IMAGES AND ASSOCIATED BOTTOM TYPES

Hercules Ferry Terminal
Water Transit Authority and City of Hercules
Hercules, California

April 2007	Project No. 1110	Figure 8

Appendix A
Fathometer Barcheck Results

Date	Barcheck Depth (ft)	Fathometer Output (ft)
1 March 07 (pre)	2.5	2.5
	3.0	3.0
	3.5	3.5
	6.0	6.0
1 March 07 (post)	2.5	2.5
	3.0	3.0
	3.5	3.5
	6.0	6.0
2 March 07 (pre)	2.0	2.0
	3.0	3.0
	3.5	3.5
	6.5	6.5
2 March 07 (post)	2.0	2.0
	3.0	3.0
	3.5	3.5
	6.5	6.5
3 March 07 (pre)	2.0	2.0
	3.0	3.0
	3.5	3.5
	6.5	6.5
3 March 07 (post)	2.0	2.0
	3.0	3.0
	3.5	3.5
	6.5	6.5
5 March 07 (pre)	2.0	2.0
	3.0	3.0
	3.5	3.5
	4.0	4.0
	5.0	5.0
5 March 07 (post)	3.0	3.0
	3.5	3.5
	4.0	4.0
	5.0	5.0

Appendix B
Tidal and Geodetic Benchmark Datasheets

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Datums Page

Station ID: 9415074 **PUBLICATION DATE: 05/01/2003**
Name: HERCULES WHARF CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 1.4' N**
USGS Quad: MARE ISLAND **Longitude: 122° 17.5' W**

To reach the tidal bench marks from San Pablo Avenue in Pinole, proceed NE along San Pablo Avenue through the town to the first major intersection with a shopping center on the west side of the intersection, then turn left at the intersection and follow the road to Hercules, Inc. The bench marks are on the abandoned Hercules, Inc. property. The tide station was on the NE end of the Hercules, Inc. abandoned and burned pier.

T I D A L B E N C H M A R K S

PRIMARY BENCH MARK STAMPING: 2 1921
DESIGNATION: TIDAL 2

MONUMENTATION: Tidal Station disk VM#: 8530
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: JT0560
SETTING CLASSIFICATION: Drain tile

The primary bench mark is a disk set in the top of a drain tile filled with cement located near the burned and abandoned pier, 8 m (26 ft) south of fire alarm box #117, 2 m (6 ft) west of the first iron fire hydrant on the solid ground at the intersection of two roads SE of the pier, and 0.15 m (0.5 ft) above ground level.

BENCH MARK STAMPING: 4 1921
DESIGNATION: TIDAL 4

MONUMENTATION: Tidal Station disk VM#: 8531
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: JT0558
SETTING CLASSIFICATION: Concrete foundation

The bench mark is a disk set in the top of the concrete foundation at the NW corner of the abandoned power plant, the only large brick building north of the Southern Pacific railroad tracks, 0.76 m (2.5 ft) above ground level.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415074 **PUBLICATION DATE: 05/01/2003**
Name: HERCULES WHARF
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 1.4' N**
USGS Quad: MARE ISLAND **Longitude: 122° 17.5' W**

T I D A L   B E N C H   M A R K S

BENCH MARK STAMPING: 5 1936
DESIGNATION: TIDAL 5

MONUMENTATION:	Tidal Station disk	VM#: 8532
AGENCY:	US Coast and Geodetic Survey (USC&GS)	PID#: JT0557
SETTING CLASSIFICATION:	Concrete base	

The bench mark is a disk set in the top of the east corner of the concrete base for double semaphore #234-235 on the SE side of the Southern Pacific railroad tracks, and 0.3 km (0.2 mi) SW of the Hercules railroad station, 5.67 m (18.6 ft) east of the east rail of the main track, and 0.15 m (0.5 ft) above the level of the tracks.

BENCH MARK STAMPING: 5074 F 1976
DESIGNATION: 941 5074 F

MONUMENTATION:	Tidal Station disk	VM#: 8533
AGENCY:	National Ocean Survey (NOS)	PID:
SETTING CLASSIFICATION:	Copper-clad steel rod	

The bench mark is a disk located near the Southern Pacific railroad tracks, 20 m (67 ft) WSW of brick building #8102, 19 m (62 ft) WNW of the westernmost of four rails, and 7.47 m (24.5 ft) SSW of three culverts at the outer fence of Hercules, Inc., property. The bench mark is set 0.12 m (0.4 ft) above grade, crimped to the top of a copper-clad steel rod driven 6.7 m (22 ft), and encased in a PVC pipe.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415074 **PUBLICATION DATE: 05/01/2003**
Name: HERCULES WHARF
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 1.4' N**
USGS Quad: MARE ISLAND **Longitude: 122° 17.5' W**

T I D A L   B E N C H   M A R K S

BENCH MARK STAMPING: 5074 G 1976
DESIGNATION: 940 5074 G

MONUMENTATION:	Tidal Station disk	VM#:	8534
AGENCY:	National Ocean Survey (NOS)	PID:	
SETTING CLASSIFICATION:	Copper-clad steel rod		

The bench mark is a disk located 122 m (400 ft) north of the centerline of the intersection of Railroad and Santa Fee Streets, 48 m (157 ft) SSW of the SW corner of Hercules, Inc. building #9, 45 m (149 ft) NNE of Southern Pacific railroad switch #2823, 13 m (42 ft) ESE of the easternmost rail, and 2 m (5 ft) WSW of building #10. The bench mark is set 0.15 m (0.5 ft) above grade, crimped to the top of a copper-clad steel rod driven 11.3 m (37 ft), and encased in a PVC pipe.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415074 **PUBLICATION DATE: 05/01/2003**
Name: HERCULES WHARF
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 1.4' N**
USGS Quad: MARE ISLAND **Longitude: 122° 17.5' W**

T I D A L   D A T U M S

Tidal datums at HERCULES WHARF based on:

LENGTH OF SERIES:	4 MONTHS
TIME PERIOD:	October 1986 - January 1987
TIDAL EPOCH:	1983-2001
CONTROL TIDE STATION:	9414290 SAN FRANCISCO, SAN FRANCISCO BAY

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

MEAN HIGHER HIGH WATER (MHHW)	=	1.854
MEAN HIGH WATER (MHW)	=	1.673
MEAN TIDE LEVEL (MTL)	=	0.984
MEAN SEA LEVEL (MSL)	=	0.981
MEAN LOW WATER (MLW)	=	0.295
MEAN LOWER LOW WATER (MLLW)	=	0.000

National Geodetic Vertical Datum (NGVD 29)

Bench Mark Elevation Information In METERS above:

Stamping or Designation	MLLW	MHW
2 1921	3.196	1.523
4 1921	4.294	2.621
5 1936	3.538	1.865
5074 F 1976	5.079	3.406
5074 G 1976	2.789	1.116

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415074 **PUBLICATION DATE: 05/01/2003**
Name: HERCULES WHARF
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 1.4' N**
USGS Quad: MARE ISLAND **Longitude: 122° 17.5' W**

D E F I N I T I O N S

Mean Sea Level (MSL) is a tidal datum determined over a 19-year National Tidal Datum Epoch. It pertains to local mean sea level and should not be confused with the fixed datums of North American Vertical Datum of 1988 (NAVD 88).

NGVD 29 is a fixed datum adopted as a national standard geodetic reference for heights but is now considered superseded. NGVD 29 is sometimes referred to as Sea Level Datum of 1929 or as Mean Sea Level on some early issues of Geological Survey Topographic Quads. NGVD 29 was originally derived from a general adjustment of the first-order leveling networks of the U.S. and Canada after holding mean sea level observed at 26 long term tide stations as fixed. Numerous local and wide-spread adjustments have been made since establishment in 1929. Bench mark elevations relative to NGVD 29 are available from the National Geodetic Survey (NGS) data base via the World Wide Web at National Geodetic Survey.

NAVD 88 is a fixed datum derived from a simultaneous, least squares, minimum constraint adjustment of Canadian/Mexican/United States leveling observations. Local mean sea level observed at Father Point/Rimouski, Canada was held fixed as the single initial constraint. NAVD 88 replaces NGVD 29 as the national standard geodetic reference for heights. Bench mark elevations relative to NAVD 88 are available from NGS through the World Wide Web at National Geodetic Survey.

NGVD 29 and NAVD 88 are fixed geodetic datums whose elevation relationships to local MSL and other tidal datums may not be consistent from one location to another.

The Vertical Mark Number (VM#) and PID# shown on the bench mark sheet are unique identifiers for bench marks in the tidal and geodetic databases, respectively. Each bench mark in either database has a single, unique VM# and/or PID# assigned. Where both VM# and PID# are indicated, both tidal and geodetic elevations are available for the bench mark listed.

The NAVD 88 elevation is shown on the Elevations of Tidal Datums Table Referred to MLLW only when two or more of the bench marks listed have NAVD 88 elevations. The NAVD 88 elevation relationship shown in the table is derived from an average of several bench mark elevations relative to tide station datum. As a result of this averaging, NAVD 88 bench mark elevations computed indirectly from the tidal datums elevation table may differ slightly from NAVD 88 elevations listed for each bench mark in the NGS database.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Datums Page

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

To reach the tidal bench marks from Berkeley, proceed north on Highway 80 to El Cerrito, then proceed west on Cutting Boulevard to 23rd Street, then turn right and proceed north on 23rd Street/San Pablo Avenue for 8.9 km (5.5 mi) to Richmond Parkway, then turn left and proceed west on Richmond Parkway for 400 m (1300 ft), then turn right and proceed NW on Atlas Road to the Point Pinole Regional Park, and continue to the paved road in the park to where there is a fishing pier and ruins of the Atlas Powder Company pier. The bench marks are located in the park, along the road leading to the pier. The tide gage and staff were located 137 m (450 ft) from the shore on a piling among the ruins of the powder company pier.

T I D A L B E N C H M A R K S

PRIMARY BENCH MARK STAMPING: 5056 A 1976
DESIGNATION: 941 5056 A TIDAL

MONUMENTATION:	Tidal Station disk	VM#:	8514
AGENCY:	National Ocean Survey (NOS)	PID:	
SETTING CLASSIFICATION:	Copper-clad steel rod		

The primary bench mark is a disk located 183 m (600 ft) east of a magazine, 23 m (75 ft) SW of Sandy Beach, 21 m (69 ft) SE of the concrete at the south end of Point Pinole pier, 6 m (21 ft) NE of the top of an embankment overlooking the mark, and 1 m (4 ft) ENE of a witness post. The bench mark is set 0.21 m (0.7 ft) above the grade, crimped to the top of a copper-clad steel rod driven 12.2 m (40 ft) to substantial resistance and encased in a PVC pipe.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 5056 B 1976
DESIGNATION: 941 5056 B TIDAL

MONUMENTATION: Tidal Station disk VM#: 8515
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Copper-clad steel rod

The bench mark is a disk located 123 m (405 ft) NNE of a square concrete slab, 122 m (400 ft) NE of a magazine, 77 m (253 ft) NE of chemical toilets on a concrete slab, 62 m (205 ft) SSE of bench mark 5056 A 1976, 20 m (66 ft) WSW of the inshore end of the beach, and 1.04 m (3.4 ft) WSW of a witness post. The bench mark is set 0.21 m (0.7 ft) above grade, crimped to the top of a copper-clad steel rod driven 7.3 m (24 ft) to substantial resistance and encased in a PVC pipe.

BENCH MARK STAMPING: 5056 C 1976
DESIGNATION: 941 5056 C TIDAL

MONUMENTATION: Tidal Station disk VM#: 8516
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Concrete foundation slab

The bench mark is a disk set horizontally in the NE corner of a square concrete foundation slab, 122 m (400 ft) SSW of bench mark 5056 B 1976, 46 m (150 ft) south of the chemical toilets, 26 m (84 ft) west from the centerline of the paved road leading from the pier to the pair gate, 19 m (61 ft) north from the gravel road in the direction of the magazine, and 0.52 m (1.7 ft) down from the top of the slab.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 5056 D 1976
DESIGNATION: 941 5056 D TIDAL

MONUMENTATION: Tidal Station disk VM#: 8517
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Copper-clad steel rod

The bench mark is a disk located 229 m (750 ft) SE of a water tank on a knoll above a magazine, 137 m (450 ft) SSE of bench mark 5056 C 1976, 102 m (336 ft) WNW of yellow brick kilns in a brick wall, 45 m (148 ft) WSW of a paved road, 1.37 m (4.5 ft) SE of a witness post, and 0.24 m (0.8 ft) above the grade. The bench mark is crimped to the top of a copper-clad steel rod driven 7.6 m (25 ft) to substantial resistance and encased in a PVC pipe.

BENCH MARK STAMPING: 5056 E 1976
DESIGNATION: 941 5056 E TIDAL

MONUMENTATION: Tidal Station disk VM#: 8518
AGENCY: National Ocean Survey (NOS) PID:
SETTING CLASSIFICATION: Concrete wall

The bench mark is a disk set horizontally in concrete on a section of wall projecting 0.76 m (2.5 ft) WNW from a main concrete wall containing two yellow brick kilns running north-south, 122 m (400 ft) SSE of a rusted underground conveyor, 102 m (336 ft) ENE of bench mark 5056 D 1976, 61 m (200 ft) WSW of the dirt road at a culvert, 26 m (84 ft) north of the southern end of the wall, 23 m (76 ft) east from the centerline of a paved road, 6 m (19 ft) south of kilns, and 0.70 m (2.3 ft) above grade.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

T I D A L   B E N C H   M A R K S

BENCH MARK STAMPING: P 556 1956
DESIGNATION: P 556

MONUMENTATION: Bench Mark disk VM#: 8519
AGENCY: US Coast and Geodetic Survey (USC&GS) PID#: HT0904
SETTING CLASSIFICATION: Concrete post

The bench mark is a disk 0.8 km (0.5 mi) north of the parking lot in Point Pinole Regional Park, 0.5 km (0.3 mi) NW along Sobrante Avenue from the intersection with Atlas Road, 40 m (131 ft) west of the junction of the paved and dirt road in the park, 12 m (41 ft) SW of the centerline of a paved road, 2.90 m (9.5 ft) NE of the first powerline pole NW of the park gate, 0.46 m (1.5 ft) SE of a wooden witness post, and 0.46 m (1.5 ft) above the road.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

T I D A L D A T U M S

Tidal datums at POINT PINOLE, SAN PABLO BAY based on:

LENGTH OF SERIES:	5 MONTHS
TIME PERIOD:	June 1977 - October 1977
TIDAL EPOCH:	1983-2001
CONTROL TIDE STATION:	9414290 SAN FRANCISCO, SAN FRANCISCO BAY

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

MEAN HIGHER HIGH WATER (MHHW)	= 1.822
MEAN HIGH WATER (MHW)	= 1.636
MEAN TIDE LEVEL (MTL)	= 0.974
MEAN SEA LEVEL (MSL)	= 0.966
MEAN LOW WATER (MLW)	= 0.312
MEAN LOWER LOW WATER (MLLW)	= 0.000

National Geodetic Vertical Datum (NGVD 29)

Bench Mark Elevation Information In METERS above:

Stamping or Designation	MLLW	MHW
5056 A 1976	2.176	0.540
5056 B 1976	6.371	4.735
5056 C 1976	10.593	8.957
5056 D 1976	12.102	10.466
5056 E 1976	5.953	4.317
P 556 1956	18.324	16.688

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service

Station ID: 9415056 **PUBLICATION DATE: 02/26/2004**
Name: POINT PINOLE, SAN PABLO BAY
CALIFORNIA
NOAA Chart: 18654 **Latitude: 38° 0.9' N**
USGS Quad: SAN QUENTIN **Longitude: 122° 21.8' W**

D E F I N I T I O N S

Mean Sea Level (MSL) is a tidal datum determined over a 19-year National Tidal Datum Epoch. It pertains to local mean sea level and should not be confused with the fixed datums of North American Vertical Datum of 1988 (NAVD 88).

NGVD 29 is a fixed datum adopted as a national standard geodetic reference for heights but is now considered superseded. NGVD 29 is sometimes referred to as Sea Level Datum of 1929 or as Mean Sea Level on some early issues of Geological Survey Topographic Quads. NGVD 29 was originally derived from a general adjustment of the first-order leveling networks of the U.S. and Canada after holding mean sea level observed at 26 long term tide stations as fixed. Numerous local and wide-spread adjustments have been made since establishment in 1929. Bench mark elevations relative to NGVD 29 are available from the National Geodetic Survey (NGS) data base via the World Wide Web at National Geodetic Survey.

NAVD 88 is a fixed datum derived from a simultaneous, least squares, minimum constraint adjustment of Canadian/Mexican/United States leveling observations. Local mean sea level observed at Father Point/Rimouski, Canada was held fixed as the single initial constraint. NAVD 88 replaces NGVD 29 as the national standard geodetic reference for heights. Bench mark elevations relative to NAVD 88 are available from NGS through the World Wide Web at National Geodetic Survey.

NGVD 29 and NAVD 88 are fixed geodetic datums whose elevation relationships to local MSL and other tidal datums may not be consistent from one location to another.

The Vertical Mark Number (VM#) and PID# shown on the bench mark sheet are unique identifiers for bench marks in the tidal and geodetic databases, respectively. Each bench mark in either database has a single, unique VM# and/or PID# assigned. Where both VM# and PID# are indicated, both tidal and geodetic elevations are available for the bench mark listed.

The NAVD 88 elevation is shown on the Elevations of Tidal Datums Table Referred to MLLW only when two or more of the bench marks listed have NAVD 88 elevations. The NAVD 88 elevation relationship shown in the table is derived from an average of several bench mark elevations relative to tide station datum. As a result of this averaging, NAVD 88 bench mark elevations computed indirectly from the tidal datums elevation table may differ slightly from NAVD 88 elevations listed for each bench mark in the NGS database.

The NGS Data Sheet

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DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.42
1        National Geodetic Survey,   Retrieval Date = MARCH 26, 2007
 JT0557 ***********************************************************************
 JT0557  TIDAL BM      -  This is a Tidal Bench Mark.
 JT0557  DESIGNATION -  TIDAL 5 1936
 JT0557  PID         -  JT0557
 JT0557  STATE/COUNTY-  CA/CONTRA COSTA
 JT0557  USGS QUAD   -  MARE ISLAND (1980)
 JT0557
 JT0557                         *CURRENT SURVEY CONTROL
 JT0557  ___________________________________________________________________
 JT0557* NAD 83(1986)-  38 01 04.     (N)    122 17 24.     (W)     SCALED
 JT0557* NAVD 88     -         3.58   (+/-2cm)       11.7   (feet)  VERTCON
 JT0557  ___________________________________________________________________
 JT0557  GEOID HEIGHT-        -32.27  (meters)                      GEOID03
 JT0557
 JT0557  VERT ORDER  -  FIRST     CLASS II (See Below)
 JT0557
 JT0557.The horizontal coordinates were scaled from a topographic map and have
 JT0557.an estimated accuracy of +/- 6 seconds.
 JT0557
 JT0557.The NAVD 88 height was computed by applying the VERTCON shift value to
 JT0557.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 JT0557.The vertical order pertains to the NGVD 29 superseded value.
 JT0557
 JT0557.This Tidal Bench Mark is designated as VM 8532
 JT0557.by the Center for Operational Oceanographic Products and Services.
 JT0557
 JT0557.The geoid height was determined by GEOID03.
 JT0557
 JT0557;                   North         East     Units  Estimated Accuracy
 JT0557;SPC CA 3     -   669,950.    1,842,840.      MT  (+/- 180 meters Scaled)
 JT0557
 JT0557                          SUPERSEDED SURVEY CONTROL
 JT0557
 JT0557  NGVD 29 (??/??/92)    2.77   (m)            9.1    (f) COMPUTED    1 2
 JT0557
 JT0557.Superseded values are not recommended for survey control.
 JT0557.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 JT0557.See file dsdata.txt to determine how the superseded data were derived.
 JT0557
 JT0557_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEH623080(NAD 83)
 JT0557_MARKER: DJ = TIDAL STATION DISK
 JT0557_SETTING: 30 = SET IN A LIGHT STRUCTURE
 JT0557_SP_SET: SEMAPHORE BASE
 JT0557_STAMPING: 5 1936
 JT0557_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 JT0557
 JT0557  HISTORY     - Date     Condition        Report By
 JT0557  HISTORY     - 1936     MONUMENTED       CGS
 JT0557  HISTORY     - 1956     GOOD             NGS
 JT0557  HISTORY     - 1961     GOOD             NGS
 JT0557  HISTORY     - 1990     MARK NOT FOUND   USPSQD
 JT0557
 JT0557                          STATION DESCRIPTION
 JT0557
 JT0557'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 JT0557'1 MI N FROM PINOLE.
 JT0557'0.5 MILE NORTHWEST ALONG TENNENT AVENUE FROM THE FIRST WESTERN
 JT0557'BANK AT PINOLE, THENCE 0.5 MILE NORTHEAST ALONG THE SOUTHERN
 JT0557'PACIFIC COMPANY RAILROAD, IN R4W T2N, IN THE TOP OF THE EAST
 JT0557'CORNER OF THE EAST CONCRETE BASE OF DOUBLE SEMAPHORE 234-235,
 JT0557'18.6 FEET EAST OF THE EAST RAIL OF THE EAST MAIN TRACK, AND ABOUT
 JT0557'1/2 FOOT HIGHER THAN THE TRACK.
```

```
JT0557
JT0557                          STATION RECOVERY (1961)
JT0557
JT0557'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1961
JT0557'RECOVERED IN GOOD CONDITION.
JT0557
JT0557                          STATION RECOVERY (1990)
JT0557
JT0557'RECOVERY NOTE BY US POWER SQUADRON 1990 (TM)
JT0557'MARK NOT FOUND.

*** retrieval complete.
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The NGS Data Sheet

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1        National Geodetic Survey,   Retrieval Date = MARCH 26, 2007
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 JT0558  TIDAL BM     -  This is a Tidal Bench Mark.
 JT0558  DESIGNATION -  TIDAL 4 1921
 JT0558  PID         -  JT0558
 JT0558  STATE/COUNTY-  CA/CONTRA COSTA
 JT0558  USGS QUAD    -  MARE ISLAND (1980)
 JT0558
 JT0558                        *CURRENT SURVEY CONTROL
 JT0558  ___________________________________________________________________
 JT0558* NAD 83(1986)-  38 01 14.    (N)    122 17 18.     (W)     SCALED
 JT0558* NAVD 88     -         4.33  (+/-2cm)      14.2    (feet)  VERTCON
 JT0558  ___________________________________________________________________
 JT0558  GEOID HEIGHT-         -32.26  (meters)                     GEOID03
 JT0558
 JT0558  VERT ORDER  -  FIRST     CLASS II (See Below)
 JT0558
 JT0558.The horizontal coordinates were scaled from a topographic map and have
 JT0558.an estimated accuracy of +/- 6 seconds.
 JT0558
 JT0558.The NAVD 88 height was computed by applying the VERTCON shift value to
 JT0558.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 JT0558.The vertical order pertains to the NGVD 29 superseded value.
 JT0558
 JT0558.This Tidal Bench Mark is designated as VM 8531
 JT0558.by the Center for Operational Oceanographic Products and Services.
 JT0558
 JT0558.The geoid height was determined by GEOID03.
 JT0558
 JT0558;                    North         East     Units  Estimated Accuracy
 JT0558;SPC CA 3     -   670,250.    1,842,990.      MT  (+/- 180 meters Scaled)
 JT0558
 JT0558                         SUPERSEDED SURVEY CONTROL
 JT0558
 JT0558  NGVD 29 (??/??/92)    3.53   (m)           11.6    (f) COMPUTED    1 2
 JT0558
 JT0558.Superseded values are not recommended for survey control.
 JT0558.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 JT0558.See file dsdata.txt to determine how the superseded data were derived.
 JT0558
 JT0558_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEH624083(NAD 83)
 JT0558_MARKER: DJ = TIDAL STATION DISK
 JT0558_SETTING: 30 = SET IN A LIGHT STRUCTURE
 JT0558_SP_SET: BUILDING FOUNDATION
 JT0558_STAMPING: 4 1921
 JT0558_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 JT0558
 JT0558  HISTORY     - Date     Condition        Report By
 JT0558  HISTORY     - 1921     MONUMENTED       CGS
 JT0558  HISTORY     - 1956     GOOD             NGS
 JT0558  HISTORY     - 1961     GOOD             NGS
 JT0558
 JT0558                         STATION DESCRIPTION
 JT0558
 JT0558'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 JT0558'1.2 MI N FROM PINOLE.
 JT0558'0.5 MILE NORTHWEST ALONG TENNENT AVENUE FROM THE FIRST WESTERN
 JT0558'BANK AT PINOLE, THENCE 0.7 MILE NORTHEAST ALONG THE SOUTHERN
 JT0558'PACIFIC COMPANY RAILROAD, IN R4W T2N, AT THE HERCULES POWDER
 JT0558'COMPANY POWERHOUSE (BUILDING 101), IN THE TOP OF THE WEST
 JT0558'CORNER OF THE CONCRETE FOUNDATION, AND 2.7 FEET ABOVE THE GROUND.
 JT0558
 JT0558                         STATION RECOVERY (1961)
```

```
JT0558
JT0558'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1961
JT0558'RECOVERED IN GOOD CONDITION.

*** retrieval complete.
Elapsed Time = 00:00:01
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The NGS Data Sheet

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DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.42
1        National Geodetic Survey,   Retrieval Date = MARCH 26, 2007
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 JT0560  TIDAL BM     -  This is a Tidal Bench Mark.
 JT0560  DESIGNATION -  TIDAL 2 1921
 JT0560  PID         -  JT0560
 JT0560  STATE/COUNTY-  CA/CONTRA COSTA
 JT0560  USGS QUAD   -  MARE ISLAND (1980)
 JT0560
 JT0560                       *CURRENT SURVEY CONTROL
 JT0560  ___________________________________________________________________
 JT0560* NAD 83(1986)-  38 01 16.    (N)    122 17 22.     (W)     SCALED
 JT0560* NAVD 88     -         3.25  (+/-2cm)      10.7    (feet)  VERTCON
 JT0560  ___________________________________________________________________
 JT0560  GEOID HEIGHT-         -32.26  (meters)                     GEOID03
 JT0560
 JT0560  VERT ORDER  -  FIRST     CLASS II (See Below)
 JT0560
 JT0560.The horizontal coordinates were scaled from a topographic map and have
 JT0560.an estimated accuracy of +/- 6 seconds.
 JT0560
 JT0560.The NAVD 88 height was computed by applying the VERTCON shift value to
 JT0560.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 JT0560.The vertical order pertains to the NGVD 29 superseded value.
 JT0560
 JT0560.This Tidal Bench Mark is designated as VM 8530
 JT0560.by the Center for Operational Oceanographic Products and Services.
 JT0560
 JT0560.The geoid height was determined by GEOID03.
 JT0560
 JT0560;                   North         East     Units  Estimated Accuracy
 JT0560;SPC CA 3     -   670,320.    1,842,890.      MT  (+/- 180 meters Scaled)
 JT0560
 JT0560                        SUPERSEDED SURVEY CONTROL
 JT0560
 JT0560  NGVD 29 (??/??/92)    2.45   (m)            8.0    (f) COMPUTED    1 2
 JT0560
 JT0560.Superseded values are not recommended for survey control.
 JT0560.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 JT0560.See file dsdata.txt to determine how the superseded data were derived.
 JT0560
 JT0560_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEH623083(NAD 83)
 JT0560_MARKER: DJ = TIDAL STATION DISK
 JT0560_SETTING: 30 = SET IN A LIGHT STRUCTURE
 JT0560_SP_SET: DRAIN TILE
 JT0560_STAMPING: 2 1921
 JT0560_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 JT0560
 JT0560  HISTORY     - Date     Condition        Report By
 JT0560  HISTORY     - 1921     MONUMENTED       CGS
 JT0560  HISTORY     - 1961     GOOD             NGS
 JT0560
 JT0560                        STATION DESCRIPTION
 JT0560
 JT0560'DESCRIBED BY NATIONAL GEODETIC SURVEY 1961
 JT0560'1.3 MI N FROM PINOLE.
 JT0560'0.5 MILE NORTHWEST ALONG TENNENT AVENUE FROM THE FIRST WESTERN
 JT0560'BANK AT PINOLE, THENCE 0.7 MILE NORTHEAST ALONG THE SOUTHERN
 JT0560'PACIFIC COMPANY RAILROAD TRACK, THENCE 0.1 MILE NORTHWEST ALONG A
 JT0560'GRAVELED ROAD, IN R4W T2N, AT THE HERCULES POWDER COMPANY, NEAR
 JT0560'THE SOUTHEAST END OF THE HERCULES WHARF, 6 FEET WEST OF THE FIRST
 JT0560'IRON FIRE HYDRANT ON SOLID GROUND, AND SET IN THE TOP OF AN 8-INCH
 JT0560'DRAIN TILE FILLED WITH CONCRETE PROJECTING 0.3 FOOT ABOVE THE
 JT0560'GROUND.
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*** retrieval complete.
Elapsed Time = 00:00:00
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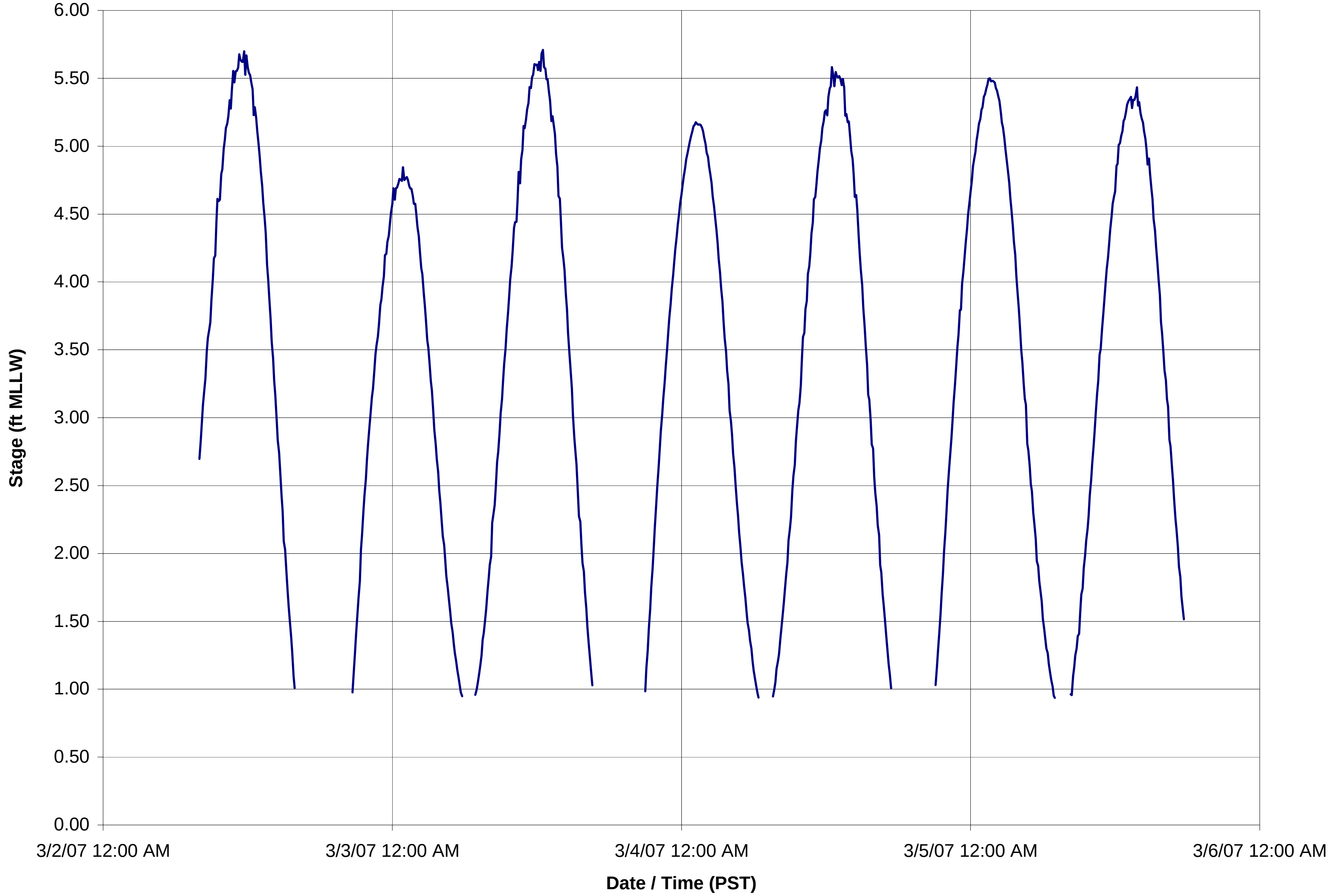
Appendix C
Water Surface Elevation Time Series
(bathymetric survey)



Environmental Data Solutions

Hercules Multimodal Transit Facility Project

Water Surface Elevation Time Series

March 1 - March 5, 2007

1110_WSE_timeseries_bathy_survey_26march07

EELGRASS SURVEY SUMMARY-HERCULES INTERMODAL TRANSIT CENTER PROJECT

City of Hercules ***May 26, 2010***

Reviewed by: SERGE STANICH

Prepared by: STEPHEN STRINGER, M.S.

Introduction:

This technical memorandum summarizes the results of eelgrass (*Zostera marina*) surveys that have been conducted for the Hercules Intermodal Transit Center Project (ITC). The Project will include activities within an intertidal area of San Pablo Bay that could contain eelgrass beds. The purpose of the surveys was to determine if eelgrass is present in intertidal areas in San Pablo Bay within the Project area. An assessment of potential habitat for eelgrass in the project area was also conducted. Areas outside of the intertidal portions of San Pablo Bay that occur within the project site were not surveyed due to their lack of potential to support eelgrass.

The proposed project is in the City of Hercules (Hercules), Contra Costa County, California. The project is located on the "Mare Island, California" 7.5 minute U.S. Geological Survey quadrangle (USGS quad). The project site is on the southeastern shoreline of San Pablo Bay, a part of San Francisco Bay (Bay), approximately one mile northwest of Interstate 80 (I-80). The proposed project is within Hercules Waterfront District, which is planned for transit oriented development. A project location map is included as **Figure 1**.

Site History and Project Description:

Hercules originated in 1881 as a company town for the Hercules Powder Company, and was incorporated in 1900. The company produced dynamite at its plant on Hercules Point until the early 1960s, when it transitioned to fertilizer production. The project site is located on land that was formerly part of the manufacturing plant. The plant closed in 1977 and Hercules Properties, Ltd. purchased the land in 1979. The site has undergone extensive remediation with oversight from the California Department of Toxic Substances Control (DTSC).

The proposed ITC project involves the redevelopment of Brownfield Area and the construction of an ITC on the Hercules waterfront in Contra Costa County. The ITC would include a new passenger railroad station including center platform on the existing Capitol Corridor line, a transit bus terminal, associated parking facilities, and will be designed to facilitate connection to future ferry service between Hercules and San Francisco.

Improvements will be made to the Union Pacific Railroad Company (UPRR) facilities to meet current safety standards, and will include separation of grade from the UPRR track to adjacent commercial and residential areas. Track realignment to increase allowable rail speeds will be implemented, and the trestle across Refugio Creek will be replaced to reduce flooding and improve the stream channel. To promote alternative transportation, the ITC project will also complete a portion of the San Francisco Bay Trail within Hercules to encourage bicycle use and provide connection to the ITC. Project related roadway improvements would include the extension of John Muir Parkway to the San Pablo Bay waterfront, the completion of Bayfront Boulevard, including a bridge across Refugio Creek, and the construction of Transit Loop Road across Refugio Creek.

Refugio Creek is a perennial stream that flows northwesterly through the project area and discharges into San Pablo Bay. It would also be realigned and enhanced as part of the ITC project. In its current configuration, the creek is largely man made, as the Hercules Powder Company property owners had the channel deepened and straightened in the early 20^{th} century. Large areas of the creek banks have been stabilized with concrete bags and do not contain vegetation. Immediately before crossing under the UPRR tracks, the creek makes two ninety degree turns before discharging into the bay. The UPRR trestle across Refugio Creek limits channel capacity and constricts stormwater flows resulting in occasional flooding of low lying areas along the south side of the tracks. Realignment of the creek is necessary to improve hydraulic conveyance and improve flood protection. Additionally, restoration and enhancement of the floodway is also proposed. Portions of the straightened channel will be realigned with meanders to provide diversity in the channel geometry. The Refugio Creek corridor will be restored to support native vegetation communities including tidal and freshwater marsh. A map of the preliminary project design is included as **Figure 2**.

Eelgrass Background

Eelgrass is a marine vascular plant that grows in clear, well-lit, shallow coastal waters in soft bottom regions of bays and estuaries in the Northern Hemisphere. Eelgrass typically occurs on muddy or sandy bottoms in shallow, subtidal areas and can occur within inter-tidal areas (Wyllie-Echeverria and Fonseca, 2003). Eelgrass spreads by underground roots, referred to as rhizomes, with its active growth season during the spring and summer reaching a maximum growth in fall (March 1 to October 31). Eelgrass dies back to underground stems in late fall and is dormant until spring. Within the southern portion of its range (including San Francisco Bay), eelgrass growth is generally limited at the shoreward edge by desiccation stress at low tides and along its deeper fringe by the limited availability of sunlight (Merkel and Associates, 2001).

In San Francisco Bay, eelgrass beds occur within shallow bay habitats (in a narrow depth range typically below 0.0 meter (0.0 foot) MLLW, and in the more saline brackish-water interfaces of the estuary (Merkel and Associates, 2001, 2009). The beds are considered to be a valuable shallow-water habitat, providing shelter, feeding, and breeding habitats for many species of invertebrates, fishes, and some waterfowl (NOAA 2003). Eelgrass beds supply organic material to nearshore environments, and their root systems stabilize area sediments. These plants grow in relatively few locations within the Bay and require special conditions to flourish (NOAA 2003). Threats to eelgrass beds include:

- Dredging is one of the greatest threats to eelgrass. Not only are the plants removed, but the entire physical, biological, and chemical structure of the ecosystem is changed. Plumes of silt bury plants, smother animals and reduce light penetration.
- Shoreline or over-water construction changes the shoreline in ways that can alter the absorption of wave energy, erode the bottom, or increase turbidity. Structures built over the water also prevent eelgrass from getting enough sunlight.
- Pollution causes increased nutrient-loading, which causes excessive epiphyte growth on eelgrass blades, blocking out light; herbicide run-off can kill or damage eelgrass plants.
- Oil spills cause eelgrass plants to lose their leaves.
- Species invasion by plants introduced from other areas by humans will crowd and displace native plants.
- Electricity plants and other power generators that use seawater as a coolant, pump warm water back into the sea where it can kill eelgrass.
- Land disturbance activities causing sedimentation and turbidity in estuaries far downstream.

A major focus of protection of eelgrass beds in the Bay is on light availability. Actions increasing turbidity, shading and deepening areas or that otherwise reduce light penetration are of primary concern to agencies regulating activities in the Bay.

Eelgrass is designated as Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act. The National Marine Fisheries Service (NMFS) considers eelgrass a significant habitat within San Francisco Bay and its protection and restoration is a primary goal of their San Francisco Bay Subtidal Habitat program discussed in the San Francisco Bay Watershed Database and Mapping Project (NMFS 2005). Eelgrass beds are considered a Special Aquatic Site by the US Army Corps of Engineers (USACE) and are regulated under Section 404 of the Clean Water Act. Eelgrass beds are also subject to the San Francisco Bay

Conservation and Development Commission (BCDC) jurisdiction under Section 66605 of the McAteer-Petris Act and are afforded special management considerations by the California Department of Fish and game (CDFG) and the US fish and Wildlife Service (USFWS).

Eelgrass Survey Methods

Surveys for eelgrass can be conducted by physical methods such as diving or beach walking, by off water remote sensing methods, or by on water remote sensing methods. Off water remote sensing methods include the interpretation of aerial photography or satellite imagery either by a human interpreter or by computer. On water remote sensing methods interpret geo referenced underwater videographic or hydroacustic methods (Whatcom 2004). Physical methods (diving or beachwalking) can be useful when precise mapping of a relatively small study area is needed (Whatcom 2004). In the San Francisco Bay estuary, a combination of physical (divers) and on water remote sensing (side scan and down looking sonar surveys) survey methods are often used (Merkel and Associates 2001; WWR 2007).

Methods:

Eelgrass beds in the San Francisco Bay typically occur below 0.0 meter (0.0 foot) MLLW (Merkel and Associates, 2001, 2009). Previous surveys for eelgrass beds in the San Francisco Bay focused on areas with depths from +0.5m MLLW to -3.0 MLLW (Merkel and Associates, 2001) to cover the range of potential habitat. Within the ITC project boundary, the intertidal mudflats occur at depths of +0.3m to > +0.6 m MLLW (WWR, 2007), which is above the typical upper limit of eelgrass occurrence in the San Francisco Bay estuary.

2007 Eelgrass Surveys of the Project Site

In 2007, Wetlands and Water Resources, Inc (WWR) conducted field surveys for sensitive aquatic habitats, particularly Eelgrass (*Zostera marina*) and widgeongrass (*Ruppia maritima*) beds, for the Hercules Multimodal Transit Facility Project (WWR 2007). The survey also included a Class 1 hydrographic survey of the San Pablo Bay seafloor to provide current bathymetric data for the project area and vicinity. The survey footprint covered the larger, project footprint that has sense been reduced and no longer includes construction of the ferry terminal and dredging operations to provide a channel for ferry access from San Pablo Bay. The survey footprint included all areas within the current project boundary and included approximately 650 acres between the shoreline and -6.6 ft (-2 m) Mean Lower Low Water (MLLW)[1] in the area where the proposed navigation channels were planned to be dredged and where ferry wake wash could be a factor. No eelgrass or widgeongrass beds or individual shoots were detected within the survey footprint.

[1] The average of the lowest tide recorded at a tide station each day during the recording period.

2010 Eelgrass Surveys of the Project Site

Eelgrass surveys were re-conducted in 2010 to determine whether eelgrass had expanded into the project area since the 2007 surveys. Due to the small area of intertidal mudflats in the current study area and the elevation of the intertidal mudflats (+0.3m to > +0.6 m MLLW), visual survey methods (pedestrian surveys) were utilized.

HDR biologists Stephen Stringer and Tish Burnaugh conducted a visual inspection survey for eelgrass in the mudflats adjacent to the mouth of Refugio Creek on April 23, 2010 during the active period of growth for eelgrass (March 1 to October 1). The visual inspection survey consisted of walking meandering transects of all areas of intertidal mudflats within the project boundary. The visual inspection included a search of the intertidal mudflats and adjacent shallow water areas for the presence/absence of eelgrass beds, patches, or individual shoots. The visual inspection was conducted from approximately 12:30pm to 1:30 pm, during a receding tide. Adjacent shallow water areas were searched using binoculars.

Results:

All areas of the intertidal mudflats within the project boundary were accessible by foot at the time of the survey due to low tide conditions. Intertidal mudflats above approximately +0.5m MLLW were completely exposed with no surface inundation. Intertidal mudflats in the lower elevation limits of the survey (+0.3m MLLW) were inundated to a depth of approximately 0.05 m (2 inches). In the vicinity of the Refugio Creek outfall channel, the substrate in the intertidal mudflats is composed primarily of sand and rocks presumably deposited from upstream portions of Refugio Creek and remaining from historic development and remediation activities at the site. Thus these areas are best referred to simply as “intertidal areas” rather than “intertidal mudflats.” Green algae were observed growing on the rocks in the intertidal areas. No eelgrass or any other vascular plants were observed growing on the intertidal areas adjacent to the Refugio Creek outfall channel or adjacent intertidal mudflats. Site photos are included as **Figure 3**.

Summary:

No eelgrass was observed in the Hercules Intermodal Transit Center Project site during the 2007 side scan sonar and diver surveys and during the 2010 visual inspection surveys in 2010. The habitat quality for eelgrass in the project site is low to non-existent because the intertidal mudflats and other intertidal areas in the project site occur at or above the upper elevational range of eelgrass in the San Francisco Bay estuary.

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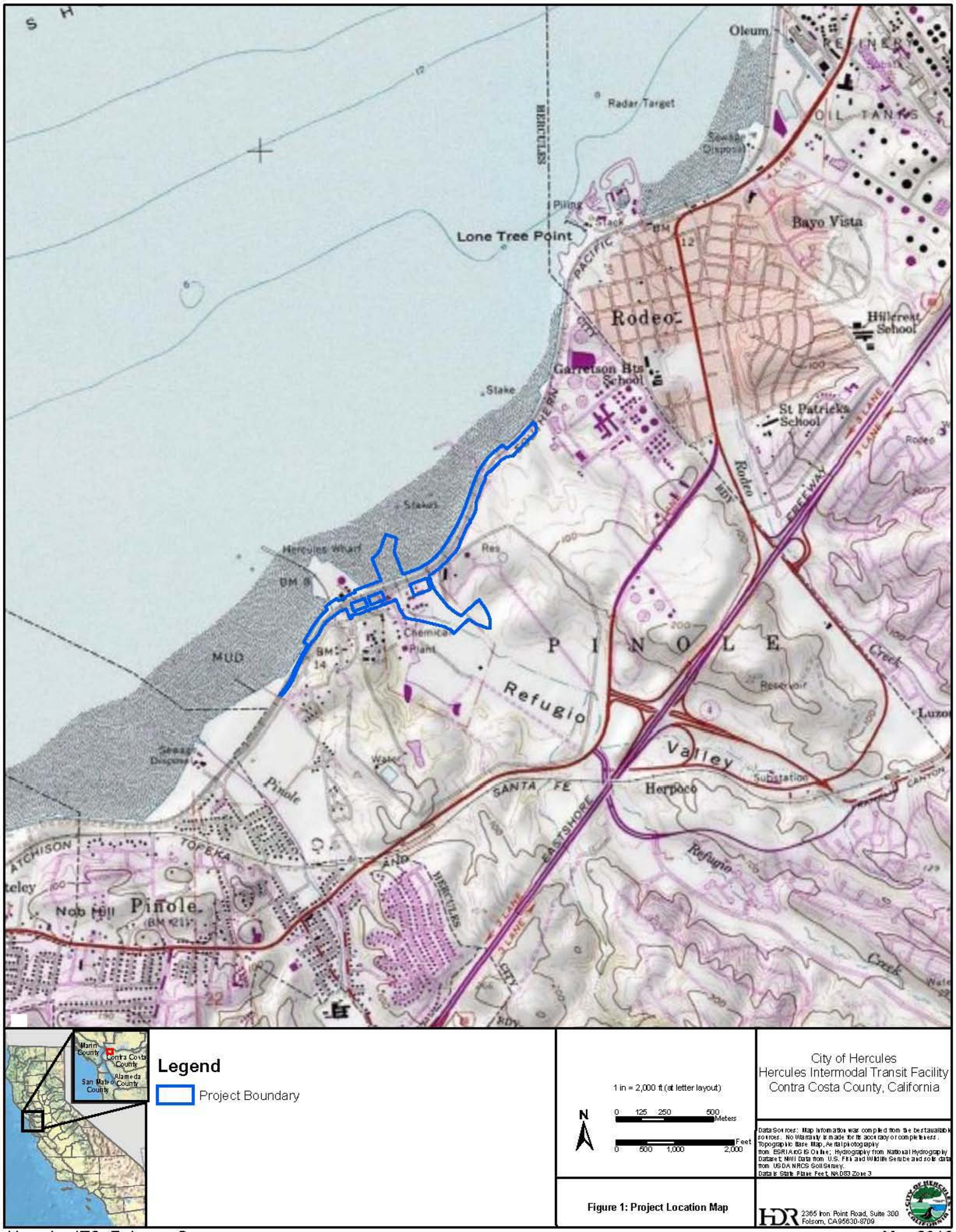

Figure 1: Project Location Map

Hercules ITC: Eelgrass Survey

May 2010

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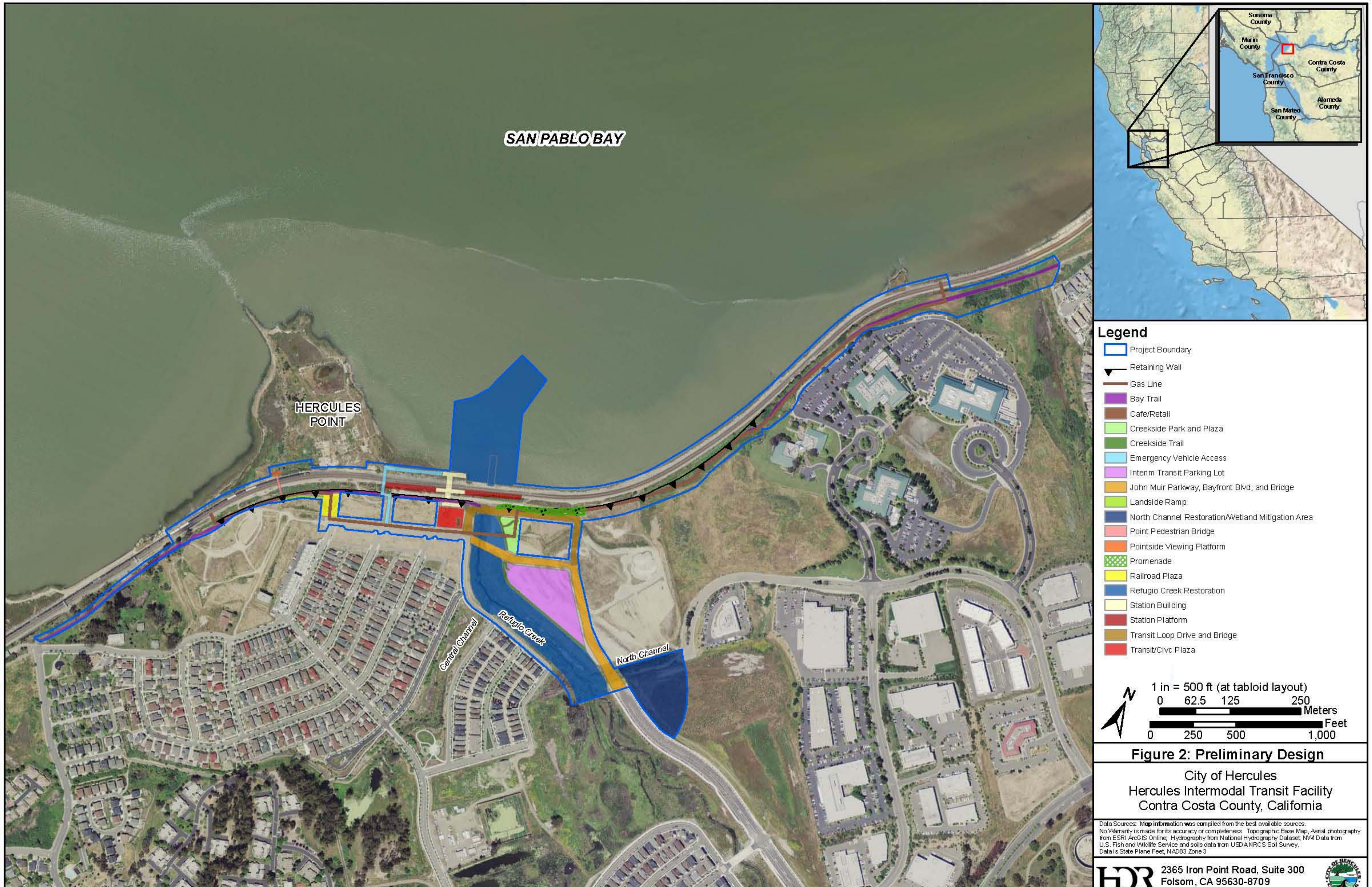

Hercules ITC: Eelgrass Survey

May 2010

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Figure 3. Site Photographs

Looking northeast of the mudflats just beyond the existing Refugio Creek channel extending into San Pablo Bay in the project site.

Looking north of the mudflats just beyond the existing Refugio Creek channel extending into San Pablo Bay in the project site.

Looking southeast of the mudflats just beyond the existing Refugio Creek channel extending into San Pablo Bay in the project site.

View looking east toward the mouth of Refugio Creek showing the mudflats.