Final

Technical Memorandum to Supplement the Administrative Record for Installation Restoration Site 28, Todd Shipyards

Alameda Point, Alameda, California

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PREPARED FOR:

U.S. DEPARTMENT OF THE NAVY

REVIEW AND APPROVAL

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ACRONYMS AND ABBREVIATIONS

µg/L	Microgram per liter
AWQC	Ambient water quality criteria
B(a)P	Benzo(a)pyrene
Basin Plan	Water Quality Control Plan for the San Francisco Bay Basin
BEI	Bechtel Environmental, Inc.
CCC	Criterion continuous concentration
CMC	Criterion maximum concentration
COC	Chemical of Concern
CTR	California Toxics Rule
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FWBZ	First water-bearing zone
GW	Groundwater
HHRA	Human health risk assessment
IR	Installation Restoration
K_d	Distribution coefficient
mg/kg	Milligram per kilogram
mL/g	Milliliter per gram
Navy	U.S. Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PAH	Polycyclic aromatic hydrocarbon
POE	Point of exposure
POM	Point of measurement
PP	Proposed Plan
ppm	Part per million
PRG	Preliminary Remediation Goal
R-factor	Retardation factor
RAO	Remedial action objective
RD	Remedial Design
RI	Remedial Investigation

ROD	Record of Decision
S	Soil
TDS	Total Dissolved Solids
Tetra Tech	Tetra Tech EM Inc.
TM	Technical Memorandum
VOC	Volatile organic compound
Water Board	San Francisco Bay Regional Water Quality Control Board

EXECUTIVE SUMMARY

The purpose of this Technical Memorandum (TM) is to describe the resolution of issues identified by the regulatory agencies during the Remedial Investigation (RI) Report, Feasibility Study (FS) Report, and Proposed Plan (PP) for Installation Restoration (IR) Site 28. The inclusion of this TM in the U.S. Department of the Navy's (Navy) Administrative Record is intended to contribute to completion of the Record of Decision (ROD) for IR Site 28. This TM is based on all investigations and analyses completed to date at IR Site 28 and addresses the following:

a. The groundwater remediation goal for Copper

b. The groundwater remediation goal for Arsenic

c. The evaluation of the Storm Sewer System

d. The soil remediation goal for Lead

GROUNDWATER REMEDIATION GOAL FOR COPPER

The preliminary remediation goal (PRG) for copper in groundwater at the point of exposure (POE) is 3.1 micrograms per liter (μg/L). This PRG is based on the California Toxics Rule criterion continuous concentration (CCC) for the protection of aquatic life in saltwater. Because the CCC of 3.1 μg/L for copper is a surface water criterion, it does not apply explicitly to groundwater. Therefore, the proposed groundwater remediation goal of 3.1 μg/L for copper will be applied at the POE where groundwater discharges from IR Site 28 to the Oakland Inner Harbor. A point of measurement (POM) trigger level for copper in groundwater will be established utilizing the groundwater modeling approach presented conceptually in this TM which will be further refined during the Remedial Design (RD) phase. The calculated trigger level will be applied at the POM to determine if the groundwater remediation goals will be achieved at the POE.

GROUNDWATER REMEDIATION GOAL FOR ARSENIC

The PRG for arsenic in groundwater is 2,000 μg/L. This PRG is based on the protection of agricultural water supplies in the inland areas. The maximum arsenic concentrations detected in groundwater from April 2002 to May 2006 in the inland areas at IR Site 28 ranged from 260 to 440 μg/L. This is well below the PRG for arsenic in groundwater of 2,000 μg/L. Additional groundwater monitoring will be conducted to confirm that arsenic concentrations do not exceed 2,000 μg/L.

Arsenic has not been identified as a chemical of concern for ecological receptors at the point of discharge or POE at IR Site 28. The Navy plans to conduct a limited data gaps investigation in early 2007 to further characterize the extent of arsenic contamination in groundwater at IR Site 28. The field investigation will include the installation of an additional monitoring well and the collection of groundwater samples by direct-push technologies. This will allow the Navy to draw more definitive conclusions regarding the environmental fate of arsenic at IR Site 28.

EVALUATION OF STORM SEWER SYSTEM

The Navy evaluated the construction of two storm sewers owned by the City of Alameda (known as the East and West Storm Sewers). The Navy reviewed City of Alameda construction documents to determine if the storm sewers would influence groundwater flow or act as preferential migration pathways for groundwater. Based on the results of the evaluation, the Navy has concluded that neither storm sewer is likely to act as a preferential migration pathway for chemicals associated with IR Site 28.

SOIL REMEDIATION GOAL FOR LEAD

In the RI, soil at IR Site 28 was found to contain lead at elevated concentrations. Unacceptable risk was calculated in the RI Report using the LeadSpread 7 model for a resident child with 7 days per week of exposure (Bechtel Environmental, Inc. [BEI] 2004; Department of Toxic Substances Control 1999). However, because the current and future land use of IR Site 28 is recreational, the 7-day exposure scenario is an overly conservative assumption. Risk posed to a recreational visitor from lead was not calculated in the RI Report (BEI 2004) therefore, risks for a recreational child with 5 and 2 days of exposure were calculated for this TM based on the original parameters presented in the RI Report.

Based on the newly-calculated site-specific risks for a recreational child at IR Site 28, the Navy PRG for lead in soil presented in the FS report of 800 milligrams per kilogram (mg/kg) is appropriate for use in the IR Site 28 ROD. This PRG is bounded by the range of the more conservative 5-day and the more realistic 2-day recreational exposure calculations and is considered protective of recreational visitors.

1.0 INTRODUCTION

The purpose of the this Technical Memorandum (TM) is to describe the resolution of issues identified by the regulatory agencies during the Remedial Investigation (RI) Report, Feasibility Study (FS) Report, and Proposed Plan (PP) for Installation Restoration (IR) Site 28. Resolution in this technical memorandum of the issues will complete the administrative record for the IR Site 28 Record of Decision (ROD). The issues involve:

- Groundwater Remediation Goal for Copper
- Groundwater Remediation Goal for Arsenic
- Evaluation of Storm Sewer System
- Soil Remediation Goal for Lead

This TM is based on all investigations and analyses completed to date at IR Site 28. The inclusion of this TM into the U.S. Department of the Navy's (Navy) Administrative Record is intended to contribute to completion of the ROD for IR Site 28.

The organization of the TM, site description, history, and previous investigations at IR Site 28 are discussed below.

1.1 REPORT ORGANIZATION

The remainder of this TM is organized into the sections summarized below.

- Section 2.0, Achievement of Groundwater Remediation Goals – discusses the groundwater-related quality standards, summarizes existing groundwater data, and presents a groundwater modeling approach that can be used to determine achievement of the remediation goal for copper. This section also provides an evaluation of the Preliminary Remediation Goal (PRG) for arsenic in groundwater in the inland area of IR Site 28.
- Section 3.0, Evaluation of Storm Sewer System – presents an evaluation of the east and west storm sewers within IR Site 28 to demonstrate that they do not provide a preferential pathway for migration of groundwater to surface water.
- Section 4.0, Soil Remediation Goal for Lead – presents new site-specific remediation goal from the LeadSpread model to determine acceptable levels of exposure to lead.
- Section 5.0, Conclusions – presents the conclusions of this TM based on the evaluation results.
- Section 6.0, References – lists the references used to prepare this TM.

Figures and tables are presented after their first mention in the text of this TM. In addition, the following appendices are included in this TM.

- Appendix A provides the illustrative BIOSCREEN model calculations
- Appendix B provides the LeadSpread model calculations

1.2 IR SITE 28 DESCRIPTION AND HISTORY

The following sections provide background information, including a description of IR Site 28 and its history and a summary of previous investigations conducted at the site.

1.2.1 IR Site 28 Description

Alameda Point is located on the western tip of Alameda Island, which is on the eastern side of San Francisco Bay (see Figure 1). IR Site 28 consists of 2.9 acres located in the northeastern portion of Alameda Point on the Oakland Inner Harbor (see Figure 2). IR Site 28 includes a dog park and a parking lot (see Figure 3). The site is 900 feet long (east to west) and wedge-shaped, increasing in width (north to south) from 35 feet at the western boundary to 300 feet at the eastern boundary. To the north, the site is bounded by Oakland Inner Harbor. The southern boundary parallels Main Street (approximately 100 feet to the south), extending through the fenced dog park and the paved parking lot used by Alameda/Oakland ferry riders. The eastern boundary also runs through the parking lot and the short western boundary lies in a vacant area.

IR Site 28 comprises the land portion of Parcel 215. Parcel 215 covers approximately 4.63 acres, 2.9 acres of which is dry land (IR Site 28), with the remainder being a subaqueous portion of Oakland Inner Harbor, known as IR Site 20. Two access ramps located partially within the northern site boundary lead out to a wharf, which is part of Pier 5. The pier provides separate areas for docking of deep-sea and smaller vessels. IR Site 28 is currently used for recreational use only.

1.2.2 IR Site 28 History

During the late 1800s, construction of railroad causeways, dikes, and levees contributed to the formation of marshland in the area of IR Site 28. Between 1930 and the late 1960s, IR Site 28 continued to be developed through a series of fill episodes. IR Site 28 was owned by the Navy from 1936 to 1970. The Todd Shipyards Corporation acquired the property in 1970, and it was then transferred back to the Navy in 1995. The dog park and parking lot were both constructed on the site in 1993.

Past uses at IR Site 28 included shipbuilding, repair and maintenance of commercial and military marine vessels, and equipment storage and staging. Railroad causeways, railroad tracks, and spurs existed on the site from 1883 to the mid-1960s. Constructed in 1947 and demolished in 1988, Building 63 was used for storage of materials related to shipbuilding and maintenance.

Approximately 12,000 square feet of former Building 63 was located within the boundary of IR Site 28.

1.2.3 IR Site 28 Previous Investigations

The following sections describe the relevant findings and conclusions of the RI Report (Bechtel Environmental, Inc. [BEI] 2004) and the FS Report (BEI 2005) prepared for IR Site 28. Other investigations conducted at IR Site 28 include the Initial Assessment Study, Environmental Baseline Survey Investigation, Storm Drain Investigation, Sediment Screening Study, polycyclic aromatic hydrocarbon (PAH) Investigation, and the ongoing Basewide Groundwater Monitoring Program. These other investigations are summarized in the RI Report and the FS Report, thus they are not described further in this TM.

1.2.3.1 Remedial Investigation Report

The RI included the collection and analysis of soil and groundwater samples to evaluate the nature and extent of contamination and provide data for the risk assessments (BEI 2004). Soil and groundwater samples were collected from 30 soil borings and 4 newly installed monitoring wells. Samples collected from these locations were analyzed for metals, volatile organic compounds (VOC), PAHs, pesticides, polychlorinated biphenyls, and organotins. The RI Report identified the following potential concerns at IR Site 28 (BEI 2004):

- Soil throughout the site contained arsenic, iron, and PAHs at concentrations exceeding the Environmental Protection Agency (EPA) Region IX industrial PRGs and Alameda Point background concentrations
- Soil within 100 feet of the shoreline (north of the dog park) contained metals, PAHs, pesticides, polychlorinated biphenyls, and organotins at concentrations exceeding the EPA Region IX industrial PRGs, and Alameda Point background concentrations
- Soil containing chemicals at concentrations that may leach to groundwater
- Groundwater containing metals at concentrations that may contaminate the surface water of the Oakland Inner Harbor/San Francisco Bay
- Groundwater containing metals at concentrations exceeding drinking water criteria

The following two potential sources of chemicals in soil and groundwater were identified at IR Site 28: (1) former railroads that crossed the site between 1883 and the mid-1960s, with associated activities; and (2) undocumented historical shipyard activities, including welding, paint stripping, paint application, equipment storage, and weed suppression or pest control conducted at the adjoining property to the east of IR Site 28.

Data collected during the RI were used to conduct a site-specific baseline human health risk assessment (HHRA) and a Tier 1 screening-level ecological risk assessment. These risk assessments characterized the current and potential threats of chemicals remaining in the soil that may migrate to groundwater or surface water, release to air, or bioaccumulate in the food chain.

The HHRA calculated cancer risk and noncancer Hazard Index (HI) associated with exposure to chemicals at IR Site 28 for residential, occupational, construction, and recreational scenarios. The current and planned future use of IR Site 28 is recreational. Cancer risk for the recreational scenario is within the cancer risk management range (10^{-4} to 10^{-6}) and the HI is equal to 1. The construction scenario cancer risk is within the risk management range; however, the HI is equal to 2 which was evaluated as unacceptable. The HHRA results for residential use for IR Site 28 fall above the cancer risk management range and far exceed an HI of 1; however, the site is not planned for residential use. The unacceptable risks to the construction worker and residential user at IR Site 28 are from PAHs, arsenic, and lead in soil and arsenic in groundwater. These chemicals were identified as chemicals of concern (COC) at IR Site 28 and recommend for further evaluation.

The ecological risk assessment concluded that the absence of current or future substantial terrestrial habitat at IR Site 28 indicated a small current or potential likelihood for ecological receptors to use the site. Therefore, no further investigation or assessment of ecological risk for soil at IR Site 28 was recommended. However, based on the modeling of groundwater discharge and chemical concentrations in groundwater from the monitoring wells, a potential exists for future copper concentrations in groundwater at the point of discharge to exceed water quality criteria in the benthic habitat offshore of IR Site 28 (BEI 2004). Due to the potential ecological risk to individual benthic aquatic organisms occurring in the area of the groundwater discharge, copper in groundwater was recommended for further evaluation.

1.2.3.2 Feasibility Study Report

In June 2005, BEI prepared a Final FS Report (BEI 2005) which summarized the results of the IR Site 28 RI Report (BEI 2004), developed remedial action objectives (RAO), PRGs, and remedial alternatives, and evaluated the remedial alternatives against the National Oil and Hazardous Substances Pollution Contingency Plan ([NCP] Title 40 *Code of Federal Regulations* § 300 et seq.) criteria.

The RAOs presented in the FS Report are to (1) reduce concentrations of arsenic, lead, and PAHs in soil to levels that are protective of recreational visitors and construction workers; (2) reduce exposure to arsenic in groundwater in the inland area to levels that are protective of the agricultural water supply; and (3) prevent potential exposure to copper in surface water adjacent to the sediments along the shoreline area for aquatic offshore receptors (in the Oakland Inner Harbor).

The PRGs for soil at IR Site 28 identified in the FS Report and PP were as follows:

- Arsenic: 9.1 milligrams per kilogram (mg/kg)
- Lead: 800 mg/kg
- PAHs: 2.1 mg/kg

The PRG for arsenic in soil was based on background concentrations at Alameda Point and the PRG for lead in soil was based on the construction worker exposure scenario. The PRG for PAHs in soil was based on the EPA Region IX industrial PRG, which was adjusted for total risk (EPA 2004). Section 4.0 presents new calculations of site-specific risks using the LeadSpread 7 model (Department of Toxic Substances Control 1999) with results indicating that the PRG for lead (800 mg/kg) in soil as selected in the FS remains protective of a recreational child.

The PRGs for groundwater at IR Site 28 identified in the FS Report were as follows:

- Arsenic: 2,000 micrograms per liter (µg/L) (inland area of groundwater)
- Copper: 3.1 µg/L (shoreline area of groundwater)

The PRG for arsenic in the inland area groundwater was based on the agricultural water supply objective from the San Francisco Bay Regional Water Quality Control Board (Water Board 1995). The PRG presented in the FS Report for copper in the shoreline area groundwater was derived from the California Toxics Rule (CTR) and values from the Water Board (as discussed further in Section 2.1). The PRG presented in the FS report for copper (3.1 µg/L) is the remediation goal at the point of exposure (POE) that will be used in the IR Site 28 ROD.

Based on the RAOs and PRGs identified for soil and groundwater, the FS Report evaluated potential remedial alternatives to clean up soil and groundwater at IR Site 28. Various technologies and associated process options were screened based on their effectiveness, implementability, cost, compliance with EPA guidance and the NCP, and ability to meet IR Site 28 RAOs for soil and groundwater. Those technologies and associated process options retained after screening were assembled into eight remedial alternatives for soil and five remedial alternatives for groundwater (arsenic for the inland area and copper for the shoreline area).

2.0 GROUNDWATER REMEDIATION GOALS

Establishment of groundwater remediation goals for COCs in groundwater must take into consideration the current and future designated beneficial uses of groundwater for IR Site 28. Current and future beneficial uses of the first water-bearing zone (FWBZ) and the Oakland Inner Harbor include agricultural water supply, estuarine and marine habitat, and freshwater replenishment in the Oakland Inner Harbor. Groundwater at IR Site 28 is not currently used as a source of drinking water, and the Navy does not consider groundwater at IR Site 28 to be a current or potential drinking water source due to high concentrations of total dissolved solids and other factors. Drinking water is supplied to IR Site 28 and the rest of Alameda Point by the East Bay Municipal Utilities District.

The Water Board (2006) concurred with the technical rationale presented by the Navy in previously-submitted letters and Comprehensive Environmental Response, Compensation and Liability Act documents that the FWBZ overlying IR Site 28 is not a potential drinking water source due to:

- The high potential for sea water intrusion to raise total dissolved solids levels above 3,000 milligrams/liter within a matter of weeks of pumping, due to the close proximity (200 feet) of the well to the Oakland Inner Harbor (California State Water Resources Board Resolution 88-63 defines drinking water source as having less than 3,000 milligrams/liter total dissolved solids, [California State Water Resources Control Board 1988]).

- No known vertical conduits to the underlying Alameda Aquifer, which is considered a potential drinking water source, have been discovered on-site or in the vicinity of IR Site 28.

- Institutional controls are currently in place that restrict extraction of groundwater from wells at IR Site 28 and no other supply wells are currently in existence near- or down-gradient of groundwater at IR Site 28.

Based on this conclusion, the Water Board granted an exemption to State Board Resolution 88-63 criteria for the groundwater within 200 linear feet of the Oakland Inner Harbor at IR Site 28. The determination of beneficial uses of groundwater at Alameda Point was also documented in a January 2000 letter from Anna-Marie Cook, U.S. EPA (EPA 2000b). In this letter, U.S. EPA clarified the conditions under which the groundwater underlying the central region of Alameda Point would not be considered a drinking water source. The U.S. EPA states, "Based on the shallow depth of the aquifer in this area, the likelihood of saltwater intrusion (based on groundwater flow directions) if any significant pumping takes place, and the fact that no wells currently exist within or close to this area, it seems unlikely that groundwater in this area will be a potential source of drinking water in the future. U.S. EPA would concur with non-MCL cleanup levels for this area [which includes IR Site 28] on the condition that any contaminated groundwater .... is remediated to levels such that the threats posed by such exposures as inhalation (groundwater vapors into soils and from soils into residences), dermal contact, and those associated with irrigation use are eliminated, and any significant ongoing degradation of the groundwater from contamination is prevented."

Other beneficial uses of groundwater such as the protection of aquatic receptors and agricultural resources are applicable for IR Site 28 groundwater. A PRG for arsenic in groundwater of 2,000 µg/L would protect agricultural resources in the inland area. Arsenic has not been identified as a chemical of concern for ecological receptors at the point of discharge or POE at IR Site 28. The Navy plans to conduct a limited data gaps investigation in early 2007 in order to draw more definitive conclusions regarding the environmental fate of arsenic at IR Site 28.

The following subsections discuss the PRG for copper in groundwater at the point of discharge to the Oakland Inner Harbor. In addition, updated data for arsenic in groundwater at IR Site 28 are also presented.

2.1 COPPER IN GROUNDWATER

This TM proposes a conceptual model for estimating a trigger level for copper concentration at the point of measurement (POM) which would prevent exceedances of the CTR criterion continuous concentration (CCC) for the protection of aquatic life in saltwater of 3.1 µg/L at the POE. The POE is the groundwater/surface water interface where biota would be exposed (also known as the discharge area). At IR Site 28 the discharge area is the shoreline of the Oakland Inner Harbor (see Figure 3). The POM is the location (monitoring well) where groundwater samples are collected to determine if the remediation goal for copper is being met. Groundwater modeling will be used to calculate trigger levels at the POM to determine if the groundwater remediation goal will be achieved at the POE.

The PRG for copper in groundwater at the POE is based on the potential exposure to benthic aquatic organisms in surface water at IR Site 28 at the POE. The following sections summarize (1) the surface water-related quality standards related to determining if copper in groundwater at the POE will meet the remediation goal; (2) existing data for copper concentrations in groundwater, and (3) the conceptual site model, as well as a proposed groundwater modeling approach, for use in determining compliance with the remediation goal for copper in groundwater.

2.1.1 Surface Water-Related Quality Standards for Copper

This section presents the established standards relevant to the remediation goal for copper in groundwater at the POE at IR Site 28, which is based on exposures of benthic aquatic organisms in surface water.

Water quality criteria have been established for the protection of aquatic organisms in surface waters. Protectiveness is typically differentiated by estimates of acute and chronic exposure scenarios which specify magnitude, duration, and frequency to be met in order to provide protection of aquatic life. Acute exposure is generally defined as less than 96 hours, while chronic exposure is a period of time longer than acute exposure including durations up to the entire lifetime of the organism.

Surface water quality criteria are not directly applicable to groundwater, however, can apply to estuarine waters in the Oakland Inner Harbor. Selection of appropriate water quality criteria for a given site requires that an exposure scenario be defined. Normally, acute exposure would be applicable to groundwater at the point of discharge prior to dilution in the receiving waters. The more conservative chronic water quality criteria along with the assumption of no dilution of groundwater within the Oakland Inner Harbor will be applied at the POE at this site, although some mixing of groundwater and surface water would occur during the time required for chronic exposure.

Ambient Water Quality Criteria (AWQC). The U.S. Environmental Protection Agency (EPA) has established water quality criteria for copper for the protection of aquatic life and human health in surface water (EPA 2006). Published pursuant to Section 304(a) of the Clean Water Act, AWQC provide guidance for states in adopting water quality standards. The concentrations for copper in surface saltwater are 4.8 µg/L for acute exposure (criterion maximum concentration [CMC]) and 3.1 µg/L for chronic exposure (CCC).

California Toxics Rule (Title 40 *Code of Federal Regulations* Part 131). According to the saltwater copper criteria for aquatic life, the CTR values are 4.8 µg/L CMC and 3.1 µg/L CCC in the dissolved form. As specified in the FS Report (BEI 2005), the PRG for copper in groundwater at the POE is 3.1 µg/L, which is based on the CCC for surface water (Oakland Inner Harbor) where groundwater discharges from IR Site 28. Because the CCC of 3.1 µg/L for copper is a surface water criterion, it does not apply explicitly to groundwater. However, the CCC of 3.1 µg/L will be used as the PRG for copper at the POE because it is the most conservative water quality standard and is protective of aquatic life in surface water.

Water Quality Control Plan for the San Francisco Bay Basin (the Basin Plan) (Water Board 1995). The Basin Plan dictates the effluent limitations for point discharges of selected toxic pollutants discharged under National Pollutant Discharge Elimination System permit to surface waters in the San Francisco Bay Basin. The effluent limitation for copper discharged to surface waters is 20 µg/L.

2.1.2 Summary of Existing Groundwater Data

Between April 2002 and May 2006, groundwater samples were collected during quarterly monitoring events at IR Site 28. Copper concentrations were detected in samples collected from four monitoring wells (28SW01, 28SW02, 28SW03, and 28SW04) (see Table 1). During each quarterly groundwater sampling event, monitoring well 28SW03 consistently yielded maximum copper concentrations compared with the other wells at IR Site 28. Copper concentrations at well 28SW03 ranged from 40 µg/L in April 2002 to 210 µg/L in August 2005. In the other three wells, all copper concentrations either decreased or remained below the Alameda Point maximum background level (27.3 µg/L). Notably, during sampling events between November 2004 and May 2006, monitoring wells 28SW01, 28SW02, and 28SW04 yielded either no detections of copper or detected copper concentrations below 10 µg/L.

TABLE 1: ANALYTICAL RESULTS FOR COPPER IN GROUNDWATER
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	Monitoring Well Identification			
Sampling Date	**28SW01**	**28SW02**	**28SW03**	**28SW04**
April 2002	3.2	10.2	40.0[a]	19.9
May 2002	ND	22.7	57.8[a]	24.8
June 2002	5.9	7.5	61.8[a]	30.6[a]
June 2004	43.0[a]	5.2	93.0[a]	ND
November 2004	3.3	3.8 J	130[a]	ND
February 2005	ND	6.8 J	98.0[a]	ND
August 2005	ND	6.9 J	210.0[a]	ND
May 2006	5.7 J	10.0	120[a]	1.1 J

Notes:
All results are presented in micrograms per liter (µg/L).
a Site concentrations exceeded maximum background concentration (27.3 µg/L) for Alameda Point.
J Copper concentration estimated.
ND Not detected

2.1.3 Groundwater Modeling

A groundwater modeling approach was developed for IR Site 28 to: (1) establish a conceptual model to be used in the Remedial Design (RD) phase, which would determine the maximum allowable copper concentration in a groundwater monitoring well; (2) protect benthic aquatic organisms from exposure to elevated copper concentrations; and (3) to establish a trigger level within the groundwater monitoring well that would prompt additional remedial action (such as metals immobilization compound treatment).

Direct application of CTR criteria to groundwater at the POM is inappropriate for various reasons including the fact that it does not consider the tendency for the chemical concentrations in groundwater to attenuate as it migrates towards a point of discharge. Typically, three discrete zones exist along the groundwater migration pathway: (1) the zone of groundwater transport from the source area to the tidal mixing zone; (2) the tidal mixing zone; and (3) the zone of groundwater discharge to the surface water body. Attenuation within the first of these zones occurs due to hydrodynamic dispersion, adsorption, and biological and chemical transformation. Attenuation within the second of these zones occurs due to the aforementioned processes in combination with dilution due to mixing of seawater with groundwater as high tides cause seawater to move inland into the groundwater aquifer. Attenuation within the third of these zones is due to dilution with the much larger volume of water present in the surface water body.

Fresh groundwater usually grades into saline seawater with a resulting steady increase in the content of total dissolved solids (TDS) (Fetter, C.W. 2001). The zone in which there is a salinity gradient is created from this mixture of fresh groundwater with saltier seawater. High levels of

TDS may result from seawater intrusion possibly located within a tidal mixing zone, high TDS levels in groundwater are a common phenomenon in San Francisco Bay Area reclaimed land created using dredge spoils. When dredge spoils are drained and dried to form reclaimed land all the salt water that was either in the pore space, or used to transport dredge via pipelines (i.e., as at Mare Island) is evaporated, concentrated and precipitated within the sediment. Further characterization of the site to determine the extent of the tidal mixing zone is needed before conclusions can be drawn with respect to seawater intrusion or dilution of groundwater as a result of mixing with seawater.

Sections 2.1.3.1 and 2.1.3.2 summarize the conceptual model for groundwater and the illustrative groundwater model for IR Site 28. The final groundwater model to be used will be determined during the RD phase. Use of two-dimensional and three-dimensional numerical models were considered in general but rejected on the basis of limited site data and significant additional cost and level of effort for no reduction in model uncertainty. The following one-dimensional advection-dispersion models have been considered:

- BIOSCREEN – provides a one-dimensional analytical solution to the advection-dispersion equation.

- SOLUTE – a Microsoft-DOS-based model with no graphical output. It is not a widely used model.

- FORTRAN-based program used to perform the RI modeling (written by Bechtel).

- PRINCE – a set of analytical models developed for the EPA at Princeton University by Dr. Robert Cleary and Dr. Michael Ungs. These models were initially developed as tools for testing the validity of more complex numerical modeling results. These models provide a level of modeling similar to BIOSCREEN.

- BIO1D – a one-dimensional modeling code which simulates biodegradation and sorption in contaminant transport. BIO1D provides an interactive software package to serve as an educational tool for understanding the relative importance of various physiochemical and biochemical processes. The BIO1D code is especially useful for analyzing laboratory data from column experiments.

2.1.3.1 Conceptual Model

Achievement of groundwater remediation goals will be determined by modeling groundwater from POM to POE (see Figure 3). In this TM, the POE specifically refers to the discharge point that is closest to the POM (see Figure 4). Representing minimum attenuation, this definition of POE creates a conservative conceptual model for use in the RD phase. Therefore, this conceptual model determines the maximum allowable copper concentration for the POM in an existing groundwater monitoring well. The conceptual model for IR Site 28 was created to organize existing field data and literature-derived parameter values so the groundwater flow system could be analyzed.

As shown in cross-sectional view on Figure 4, groundwater flows from the POM through the subsurface sandy fill material to the surface water at Oakland Inner Harbor. Copper concentrations are known at the POM. Copper concentrations at the POE can be determined by groundwater models using attenuation and groundwater movement scenarios. Development of a conceptual model is necessary before constructing a computerized groundwater flow or contaminant transport model (EPA 1992).

The assumptions and parameters used to develop the conceptual model are summarized below.

Physical and chemical-specific assumptions and parameters used to develop the conceptual model at IR Site 28 are listed below.

Physical Assumptions

- The maximum amount of time for exposure is 100 years.
- The aquifer is homogeneous and isotropic.
- The POM is the well (28SW03) with the highest copper concentration (210 µg/L) with a detection level greater than its respective comparison criterion.
- Groundwater flow is horizontal, unidirectional, and at steady rate.
- Groundwater flow is in the direction of shortest travel from the assumed location of the source area to the POE.
- The effective porosity is equal to the total porosity, which for more permeable materials where contaminant transport takes place is assumed to be 0.34.

Chemical-Specific Assumptions

- The source of contamination and source release is continuous and at a steady-state.
- The simulated source release is through a vertical plane defined by the width of the area of concern (source width) and the saturated thickness, where the vertical plane is perpendicular to the groundwater flow direction (EPA 2000a).

Groundwater Model Parameters

Parameters used in groundwater modeling such as hydraulic conductivity, plume size, copper soluble mass, and retardation factor (R-factor) will be determined during the RD phase. The following parameters are needed to complete the groundwater modeling at IR Site 28.

- **Groundwater Level.** The August 2005 groundwater levels of 6.37, 4.16, 3.72, and 4.88 feet above mean sea level will be used for monitoring wells 28SW01, 28SW02, 28SW03, and 28SW04, respectively. Groundwater level measurements are collected quarterly.

- **pH.** During the 2004-2005 sampling year, pH levels ranged from 6.09 to 8.01 at all monitoring well sites.

- **Hydraulic Gradient.** The slope of the potentiometric surface was calculated using the August 2005 static water level data obtained from IR Site 28 monitoring wells (0.020 feet per feet). The gradient will be calculated from the groundwater level data obtained during the RD phase.

- **Saturation Thickness.** The estimated thickness of permeable materials in the aquifer for 28SW03 is 15.0 feet.

- **Hydraulic Conductivity.** As outlined in the RI Report (BEI 2004), hydraulic conductivity data through slug tests were not available for well 28SW03 at IR Site 28. Therefore, the hydraulic conductivity was calculated to be 65.0 feet per day (BEI 2004). It is assumed that the aquifer is isotropic and homogenous at IR Site 28; therefore, the hydraulic conductivity is more likely closer to the values obtained from slug tests at the other shoreline monitoring wells, 28SW01 (5.47 feet per day) and 28SW02 (2.39 feet per day). Hydraulic conductivity for well 28SW03 will be measured during pumping or slug tests during the RD phase.

- **Plume Size.** Currently, the size and shape of the copper contaminant plume is unknown. Based on the groundwater monitoring program at IR Site 28, elevated copper concentrations occur only at well 28SW03 and the plume size is constrained maximally by wells 28SW02 (~400 feet to the west) and 28SW04 (~200 feet to the south). During the RD phase, the lateral and vertical extent of the groundwater plume will be delineated. Geochemical analysis will also be conducted to determine the plume stability.

- **Copper Soluble Mass.** The source soluble copper mass for IR Site 28 is currently unknown. Of the 36 soil samples for IR Site 28 with detections of copper, 3 samples had copper concentrations exceeding both Alameda Point background levels (3.12 to 49.1 mg/kg) and the EPA Region IX residential PRG (3,100 mg/kg) (BEI 2004, 2005). Two of the three soil samples were located within 100 feet to the east and west of well 28SW03. Delineation of the source is still uncertain, and more information is necessary to determine the soluble copper mass. This parameter will be further defined during the RD phase.

- **Porosity.** The effective porosity is the ratio of the volume of the interconnected voids to the bulk volume of the aquifer matrix (sand), while total porosity includes those voids not connected. Typical values for effective porosity of coarse sand range from 0.31 to 0.46 (Domenico and Schwartz 1990). As designated in the RI Report (BEI 2004) and the FS Report (BEI 2005), the effective porosity for IR Site 28 is 0.34.

- **R-factor.** Estimation of the R-factor (unitless) requires an assumption of the value of the distribution coefficient (K_d); for example, when K_d is zero there is no sorption.

Values of K_d for copper can span several orders of magnitude. Strenge and Peterson (1998) recommended K_d values based on the pH; the content of clay, iron, and aluminum oxyhydroxide (soil chemistry and particle size); and the organic matter in the soil (fraction of organic content). For soil, pH values range from 5 to 9, and where the content of the above listed soil constituents is less than 10 percent by weight, the K_d is 41.9 milliliters per gram (mL/g). If the sediments are either 10 percent to 30 percent by weight or greater than 30 percent by weight, the recommended K_d values are 92.2 mL/g and 336 mL/g, respectively. Other ranges for copper K_d values include 1.3 to 3,981 mL/g (HydroGeoLogic 1999) and 1.5 to 648 mL/g (Sheppard and others 2003).

K_d and R-factors are site-specific. During the RD phase, grain size and fraction of organic content measurements will need to be made on soil samples; and an interpretation concerning the environment of deposition will need to be completed, with the results compared with the results from other sites so an appropriate K_d value may be chosen to calculate the R-factor for copper in groundwater at IR Site 28.

The Navy plans to conduct a limited data gaps investigation at IR Site 28 in early 2007. As part of this field investigation, the Navy will further characterize the extent of copper and arsenic concentrations in groundwater. The field investigation will include the installation of an additional monitoring well and the collection of groundwater samples by direct-push technologies. Additional field data will also be collected during the RD phase to establish the input parameters for the final groundwater model. After the collection of these additional field data, the Navy will determine the appropriate location of the POM and use groundwater modeling to determine the actual trigger level at the POM, which would yield 3.1 μg/L at the POE.

When modeling is conducted during the RD phase the overall modeling approach will include (1) establishing the "best case" set of parameter values based upon site characterization, (2) performing a sensitivity analysis by sequential variation of input parameters and running model simulations using the new input parameter value, (3) calculating the relative influence of each input parameter on the output of the model and use the sensitivity coefficient to identify controlling parameters, and (4) performing a series of model runs wherein only the controlling parameters are varied.

2.1.3.2 *Illustrative Groundwater Model*

As noted previously, the final groundwater model to be used will be determined during the RD phase. This TM used the BIOSCREEN model (EPA 1996) as an example modeling approach for establishing a trigger level for copper at the POM based on the remediation goal for copper in groundwater at the POE. Justification for selecting the BIOSCREEN model in this TM for the modeling approach includes the following:

- The BIOSCREEN model was developed and has been approved by the EPA.
- BIOSCREEN provides a one-dimensional analytical solution to the advection-dispersion equation as did the model used in the RI Report (Bechtel 2004).
- BIOSCREEN is public domain software, easy and fast to run, which produces a report-ready output, making it a highly cost effective modeling tool.
- Use of BIOSCREEN for this modeling task is consistent with the principle of parsimony, which dictates that models with the smallest number of parameters are preferred as each parameter introduced into a model adds uncertainty.
- BIOSCREEN has been used for metals modeling at IR Program Sites 4 and 9 at Construction Battalion Center Port Hueneme (SulTech 2006) and at Investigation Area F1 and F2 at the Former Mare Island Naval Shipyard (Sullivan Consulting Group and Tetra Tech EM Inc. 2005, 2006).

BIOSCREEN is a mathematical computer model used to evaluate natural attenuation scenarios based on the analytical solute transport model from Domenico and Schwartz (1990). Using BIOSCREEN as the model framework results in a purely illustrative groundwater model based on hypothetical values for copper migration parameters. Using hypothetical parameters as inputs, with an initial simulation time of 100 years for copper attenuation, preliminary results for BIOSCREEN established a trigger level for copper at the POM that is based upon the PRG (3.1 μg/L) for surface water and the POE, as described in Section 2.1.

Hypothetical values for hydrogeology, dispersion, adsorption, plume dimensions, and soluble mass were used for input parameters in BIOSCREEN (see Appendix A). These inputs are only an illustrative attempt for determining copper concentrations at the POM. For illustrative purposes, the model presented in Appendix A has a source area (or POM) at 100 feet from the point of discharge (or POE). With a source concentration of 650 μg/L and a soluble mass of 1,000 kilograms, the model shows that the surface water criteria (3.1 μg/L) will be exceeded (POE = 4.0 μg/L or 0.004 milligram per liter) at the POE after 100 years from the time of release (see Appendix A). The centerline function in BIOSCREEN is the output for the screening model. The crucial parameters for a realistic and meaningful centerline output in the BIOSCREEN model are R-factor (controlled by appropriate K_d values), copper source soluble mass, and plume size.

2.2 ARSENIC IN GROUNDWATER

The PRG for arsenic in groundwater is 2,000 µg/L. This PRG is based on the protection of the beneficial use of agricultural water supplies in the inland areas. As shown in Table 2, the maximum arsenic concentrations detected in groundwater from April 2002 to May 2006 in the inland areas at IR Site 28 ranged from 260 to 440 µg/L. Although arsenic concentrations in the inland areas exceed the Alameda Point background concentration of 40.7 µg/L, this is well below the PRG for arsenic in groundwater of 2,000 µg/L.

Arsenic has not been identified as a COC for ecological receptors at the point of discharge or POE at IR Site 28. As shown in Table 2, arsenic concentrations have not exceeded the CTR criterion of 36 µg/L (EPA 2006) in the shoreline wells (28SW01, 28SW02, and 28SW03). The Navy plans to conduct a limited data gaps investigation in early 2007 to further characterize the extent of copper and arsenic contamination in groundwater at IR Site 28. The field investigation will include the installation of an additional monitoring well and the collection of groundwater samples by direct-push technologies. This will allow the Navy to draw more definitive conclusions regarding the environmental fate of arsenic at IR Site 28.

TABLE 2: ANALYTICAL RESULTS FOR ARSENIC IN GROUNDWATER
Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards
Alameda Point, Alameda, California

Sampling Date	Monitoring Well Identification			
	28SW01	28SW02	28SW03	28SW04
April 2002	27.8	27.2	ND	298 [a]
May 2002	27.2	18.7	ND	352 [a]
June 2002	20	12.4	8.2	353 [a]
June 2004	6.2	ND	ND	420 [a]
November 2004	18.0	8.6	6.9	280 [a]
February 2005	18.0	19.0	2.9 J	260 [a]
August 2005	21.0	33.0	ND	440 [a]
May 2006	28.0 J	31.0 J	13.0 J	350 J [a]

Notes:

All results are presented in micrograms per liter (µg/L).

a Site concentrations exceeded maximum background concentration (40.7 µg/L) for Alameda Point.

J Arsenic concentration estimated.

ND Not detected.

3.0 EVALUATION OF THE STORM SEWER SYSTEM

Currently, two storm sewers owned by the City of Alameda traverse the site in a north-south orientation (see Figure 5). The storm sewers (also known as outfalls) have no formal name and are hereinafter referred to as the East Storm Sewer and the West Storm Sewer. Another storm sewer, Outfall E, is located west of the western boundary of IR Site 28 (see Figure 5). The East and West Storm Sewers were evaluated to determine whether they act as preferential pathways for groundwater migration to surface water. The storm sewer setting at IR Site 28 and the results of the evaluation of each storm sewer are discussed below.

3.1 Storm Sewer Setting

The East Storm Sewer connects an open storm drain, which runs along the northern side of Main Street, to the Oakland Inner Harbor. A sluice gate, located adjacent to the open storm drain, controls the water flow through the East Storm Sewer (see Figure 5). The East Storm Sewer consists of two 24-inch-diameter pipes, which appear to be installed 7 to 8 feet below ground surface; the construction material of these pipes is unknown. The East Storm Sewer was presumably constructed in 1993, when the dog park and parking area for the Alameda/Oakland Ferry terminal were constructed. A review of aerial photographs indicated the open storm drain channel on the north side of Main Street has been present since 1946 (aerial photographs are presented in Attachment A of the RI Report [BEI 2004]).

The West Storm Sewer connects a pump station, located south of Main Street, with the Oakland Inner Harbor. This storm sewer, consisting of two 28-inch-diameter high-density polyethylene pipes, was constructed as part of the City of Alameda's Main Street Pump Station Improvements Project (City of Alameda 1998), which was part of the Main Street Improvements and Greenway Project completed in March 2000 (BEI 2005).

Several different storm sewer investigations have been performed by the Navy, including the following:

- "Final Project Closure Report for Site 18 – Storm Drain System, Naval Air Station, Alameda, California" (International Technology Corporation 1997)
- "Storm Sewer Study Report, Alameda Point, Alameda, California" (Tetra Tech EM Inc. [Tetra Tech] 2000)
- "Draft Final Storm Sewer Study Report, Total Petroleum Hydrocarbon Addendum, Alameda Point, Alameda, California" (Tetra Tech 2001)

None of these reports identified or discussed storm sewers located within IR Site 28. The Navy never constructed a building at IR Site 28; therefore, the Navy would have no reason to construct storm sewers at this site. The area of Alameda Point south of IR Site 28 and Main Street, which has been used for residential purposes, contains a storm sewer system that drains to outfall E without crossing IR Site 28.

3.2 Evaluation of the East Storm Sewer

The design and construction of the East Storm Sewer were evaluated to determine the potential for this storm sewer to act as a preferential migration pathway for groundwater. Storm sewers discharging into a tidal water body are designed and constructed to minimize the amount of water movement outside the sewer, which could lead to sewer undermining. The City of Alameda's Standard Storm Sewer Outfall Structure drawing, dated June 1952, calls for a wingwall extending 1.5 feet to either side of the pipe, 1.5 feet beneath the pipe, and 1 foot above the pipe (see Figure 6). Behind the wing wall, for a minimum of 6 feet, a reinforced concrete cradle extends from the bottom of the trench to the spring line (half the height) of the pipe. This reinforcement is tied into the wing wall, creating a structure designed to minimize movement of the pipe and water along the length of the pipe.

The City of Alameda's Excavation of Trenches for Pipe Sewers drawing, dated December 1961, illustrates two alternatives: one showing a concrete cradle and encasement, and the other showing a pipe trench without the cradle or encasement (see Figure 6). Neither of these details calls for the pipe to be laid on bedding material such as sand.

The City of Alameda indicated material from the excavation, if deemed suitable, may be used for backfill (City of Alameda 1965). The RI Report described the near-surface geology of IR Site 28 as Artificial Fill consisting of poorly graded, fine to medium coarse sand with interbedded lean clay and sandy clay (BEI 2004). Sand is a common material used as pipe bedding and backfilling around utilities; therefore, it is likely excavated material was used as backfill material to reduce costs. If so, the sewer trench would have hydrogeologic properties similar to the adjoining surface materials. The soil immediately adjacent to the storm trenches at IR Site 14, located west of IR Site 28 and adjacent to the Oakland Inner Harbor, was tested and determined to have similar properties. Therefore, the sewer trench is not likely to influence groundwater flow or act as a preferential pathway.

3.3 EVALUATION OF THE WEST STORM SEWER

The design and construction of the West Storm Sewer were evaluated to determine the potential for this sewer to act as preferential migration pathway for groundwater. The West Storm Sewer was built from plans prepared in 1998 for a project completed in March 2000 (see Figure 7). The plans for the Main Street Pump Station Improvements indicate the existence of a reinforced concrete wing wall extending approximately 8.5 feet from the centerline of the nearest pipe (City of Alameda 1998). The West Storm Sewer was installed on sand bedding, with compacted, imported fill surrounding the pipes to 1 foot above the top of the pipe. The profile of the West Storm Sewer indicated the sewer invert is approximately at sea level and slopes down to the harbor at a 0.31-percent grade. At Oakland Inner Harbor, the invert elevation of the sewer is approximately 1 foot below mean sea level.

The West Storm Sewer contains two reinforced concrete restrainer blocks along its 330-foot run from the pumping station. The restrainer blocks extend the full width of the trench and are set on undisturbed soil. These blocks should effectively prevent the bedding material from acting as a preferred pathway for the length of the storm sewer. The furthest downgradient concrete retainer is about 160 feet from the outfall. The sand bedding material downstream of the outfall is potentially in hydraulic communication with Oakland Inner Harbor. However, sand bedding material and imported fill material surrounding the pipe are likely to have similar geotechnical properties to the native Artificial Fill material at IR Site 28. Therefore, the West Storm Sewer is not likely to be a preferential pathway.

Since the West Storm Sewer pipes are 6 years old, they are likely in good condition and not leaking. Furthermore, because the West Storm Sewer is located partially below mean sea level and inverts below sea level through IR Site 28, it is likely to contain seawater much of the time, which fluctuates with tidal influence. The West Storm Sewer is located west of the portion of IR Site 28 where remedial action is proposed, and west of the area where copper-affected groundwater is located. The West Storm Sewer was constructed after the former Naval Air Station Alameda was closed and after ship building activities were conducted at IR Site 28 by the Navy and Todd Shipyards Corporation. No storm drains are connected to the West Storm Sewer from IR Site 28. As a result, the West Storm Sewer is unlikely to act as a preferential migration pathway for chemicals associated with IR Site 28.

4.0 SOIL REMEDIATION GOAL FOR LEAD

In the RI, soil at IR Site 28 was found to contain lead at elevated concentrations. Unacceptable risk was calculated in the RI Report using the LeadSpread 7 model for a resident child with 7 days per week of exposure (Bechtel Environmental, Inc. [BEI] 2004; Department of Toxic Substances Control 1999). However, because the current and future land use of IR Site 28 is recreational, the 7-day exposure scenario is an overly conservative assumption. Risk posed to a recreational visitor from lead was not calculated in the RI Report (BEI 2004) therefore, risks for a recreational child with 5 and 2 days of exposure were calculated for this TM based on the original parameters presented in the RI Report. Five days of exposure is conservative, while 2 days of exposure per week is realistic because it is unlikely a recreational child would be at the site for 5 days of every week. These two exposure frequencies likely bracket the actual exposure that would be expected for a recreational child at IR Site 28. Therefore, the PRG for lead at the site was based on the conservative 5-day exposure per week and the more realistic 2-day exposure per week (see Appendix B). Calculated site-specific PRGs for 5 days of recreational child exposure are 455 parts per million (ppm) and 707 ppm in soil, resulting in a 99th and 95th percentile estimate, respectively, of blood lead of 10 micrograms per deciliter, respectively (see Appendix B). Calculated site-specific PRGs for 2 days of recreational child exposure were 1,152 ppm and 1,784 ppm in soil, resulting in a 99th and 95th, respectively, percentile estimate of blood lead of 10 micrograms per deciliter, respectively (see Appendix B).

Based on the new calculated site-specific risks for a recreational child at IR Site 28, the PRG for lead in soil presented in the FS report of 800 mg/kg will be used in the IR Site 28 ROD. The PRG is bounded by the range of the more conservative 5-day and the more realistic 2-day recreational exposure calculations and is considered protective of recreational visitors and occupational workers.

5.0 CONCLUSIONS

A conceptual groundwater modeling approach was developed for IR Site 28, which includes establishing a trigger level for copper at the POM based on the remediation goal for copper in groundwater at the POE of (3.1 μg/L). This conceptual groundwater modeling approach will be further refined during the RD phase. Additional data needed to calculate the R-factor, copper source soluble mass, and groundwater plume size will be collected during the RD phase.

The PRG for arsenic in groundwater is 2,000 μg/L is based on the protection of agricultural water supplies in the inland areas.

Based on the review of City of Alameda construction documents, the East and West Storm sewers will not likely influence the groundwater flow or act as a preferential pathway for groundwater to the Oakland Inner Harbor. No further evaluation of the East and West Storm sewers will be required in the IR Site 28 ROD.

The PRG for lead from the FS will stand because it is protective and appropriate for the current and future land use.

Based on the above conclusions, the following PRGs from the FS Report (BEI 2005) will be used in the IR Site 28 ROD:

- Lead in soil: 800 mg/kg
- Arsenic in groundwater: 2,000 μg/L
- Copper at the POE: 3.1μg/L

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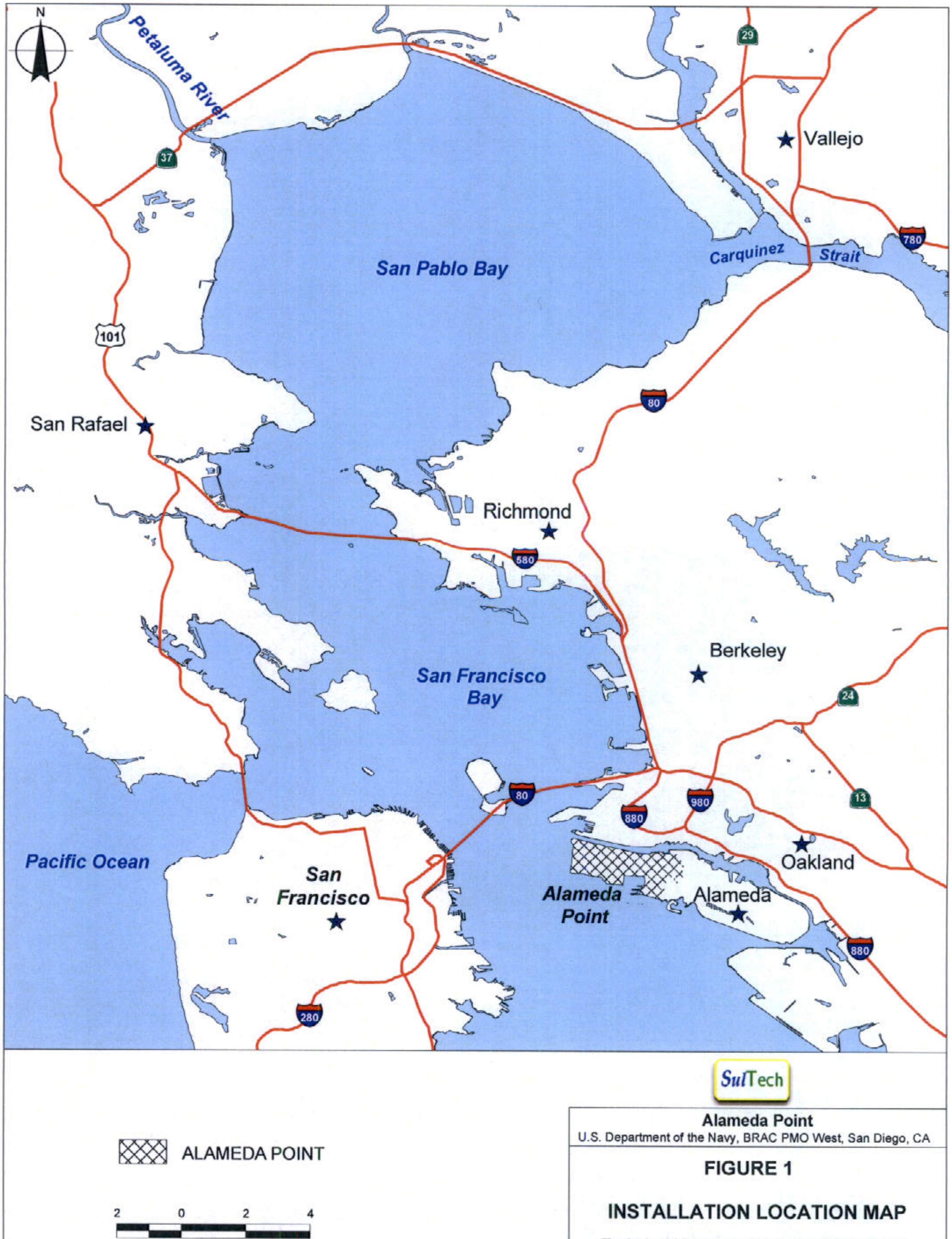
FIGURES



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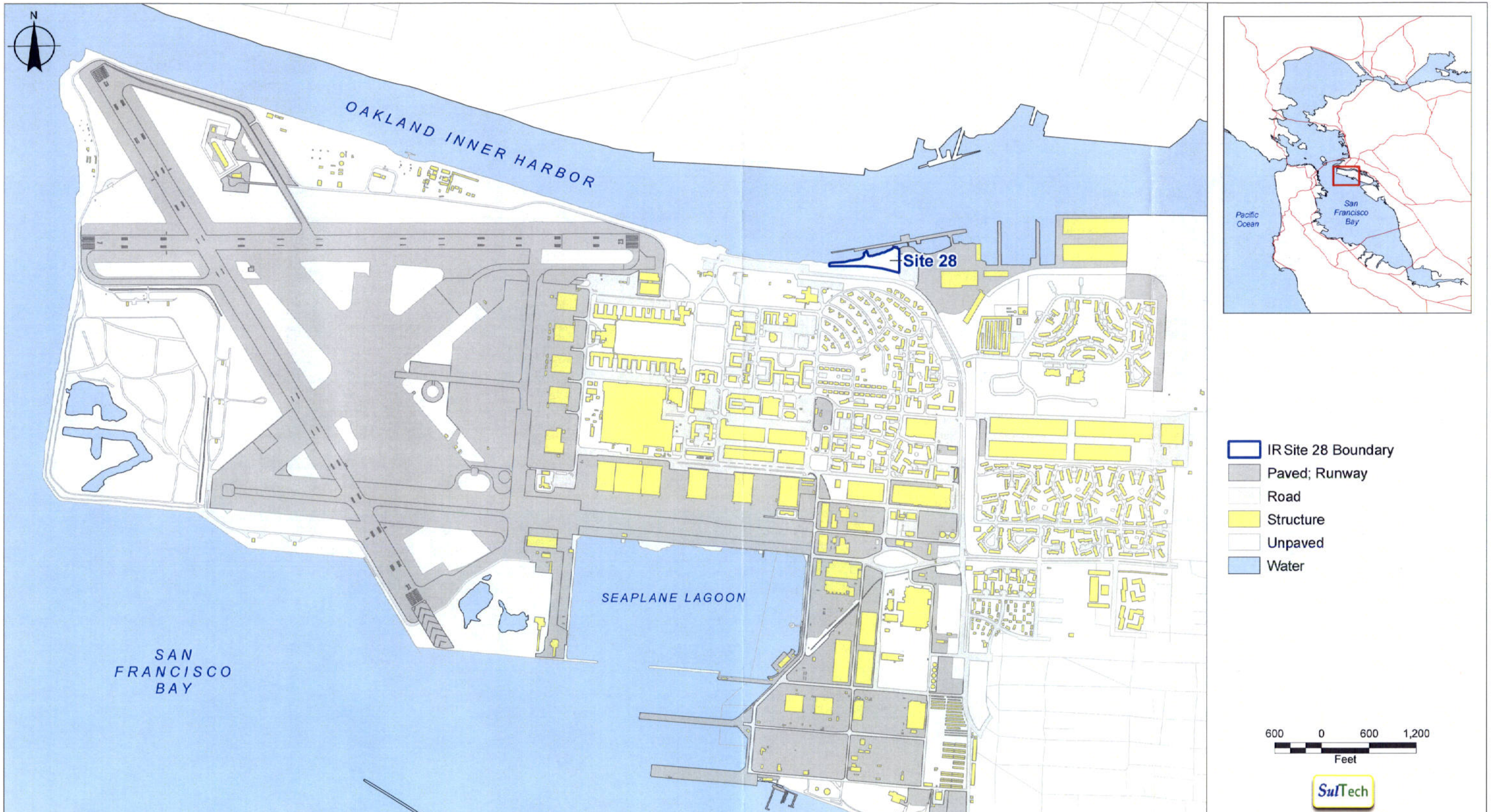
Alameda Point
U.S. Department of the Navy, BRAC PMO West, San Diego, CA

FIGURE 1

INSTALLATION LOCATION MAP

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

02/07/2006 V:\Projects\8115 - Alameda\Tech Memo\Figure 1.mxd SULLIVAN - SD D. Wise



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U.S. Department of the Navy, BRAC PMO West, San Diego, CA

FIGURE 2

SITE LOCATION MAP

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

2006/05/09 V:\Projects\B115_Alameda\Tech Memo\Figure 2.mxd SULLIVAN - SD D. Wise

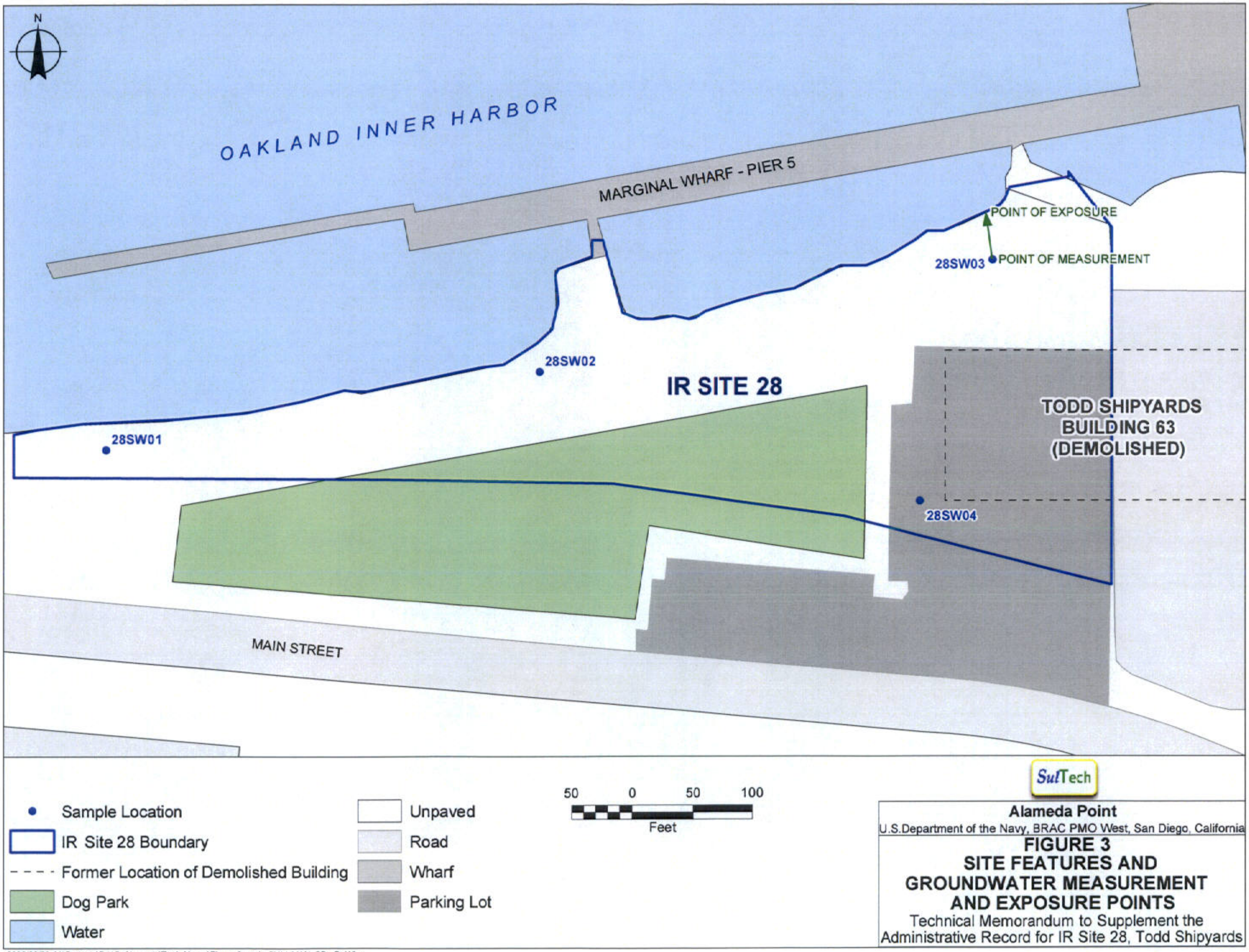

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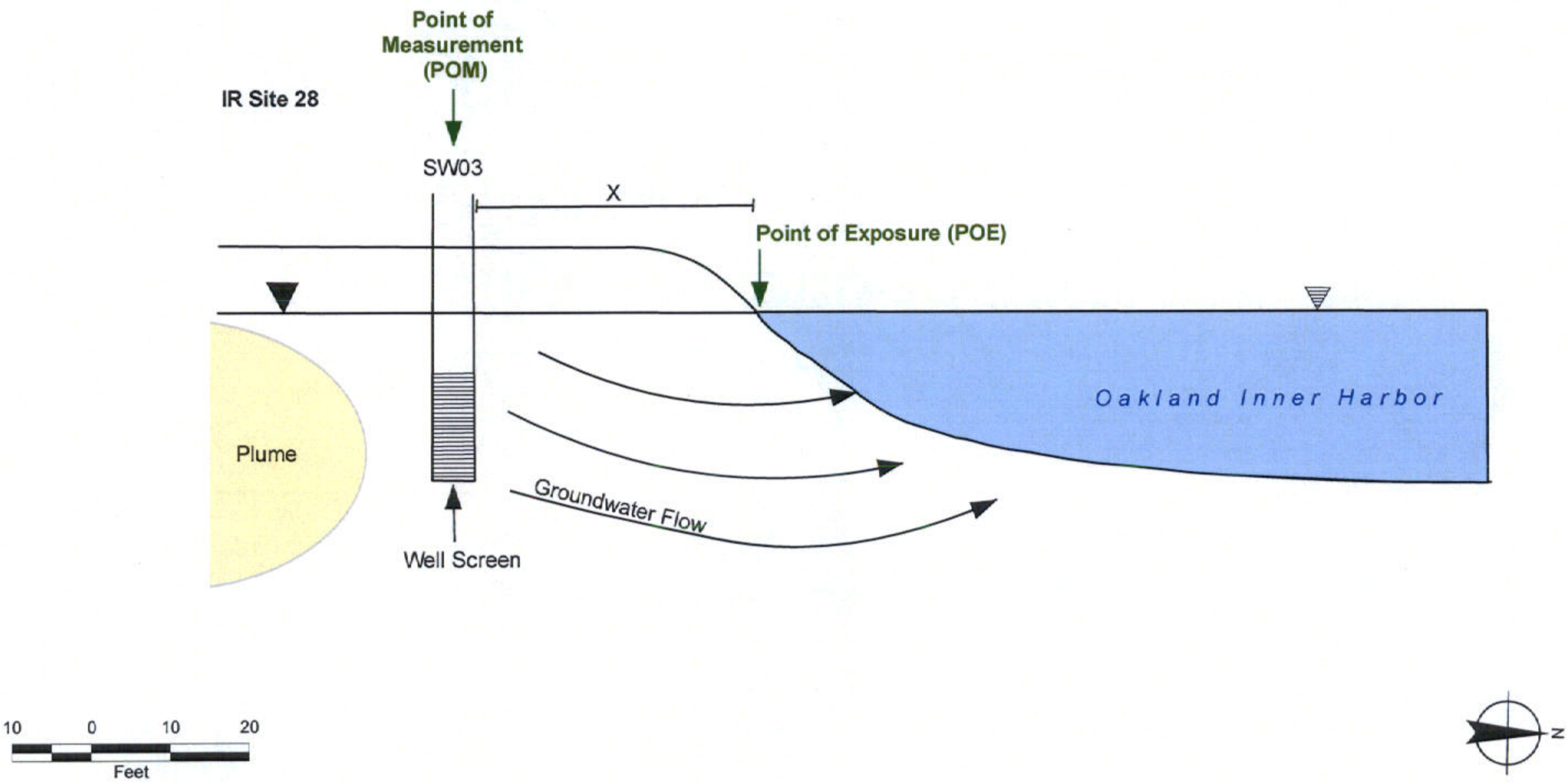
FIGURE 3
SITE FEATURES AND GROUNDWATER MEASUREMENT AND EXPOSURE POINTS

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

2006/06/29 V:\Projects\B115_Alameda\Tech Memo\Figure 3.mxd SULLIVAN SD D. Wise



Groundwater Table

Surface Water

X Distance Between POE and POM

Note: Plume front position reflects assumed post metals remediation compound injection condition.

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FIGURE 4

GROUNDWATER CONCEPTUAL MODEL

IR SITE 28

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

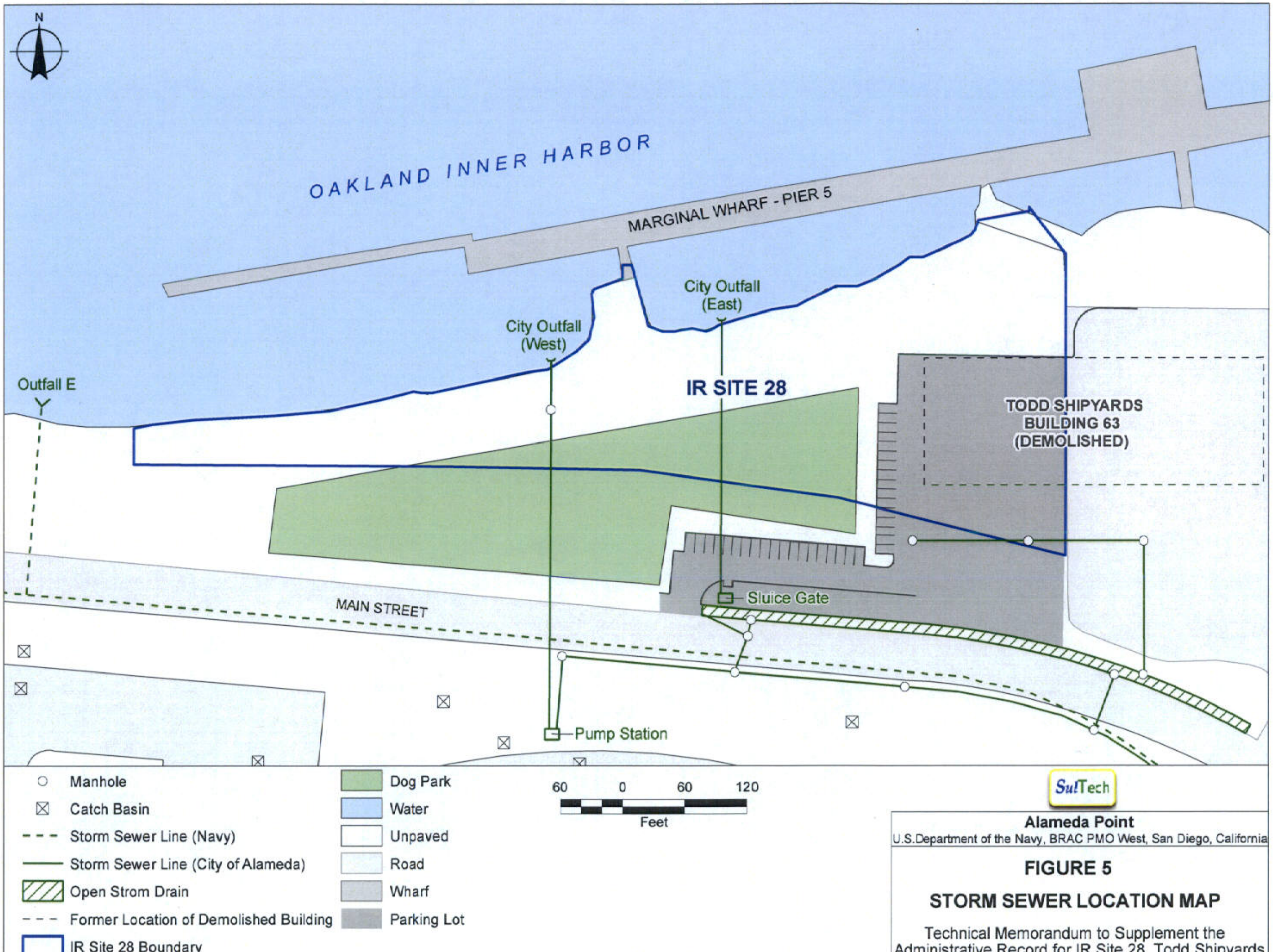

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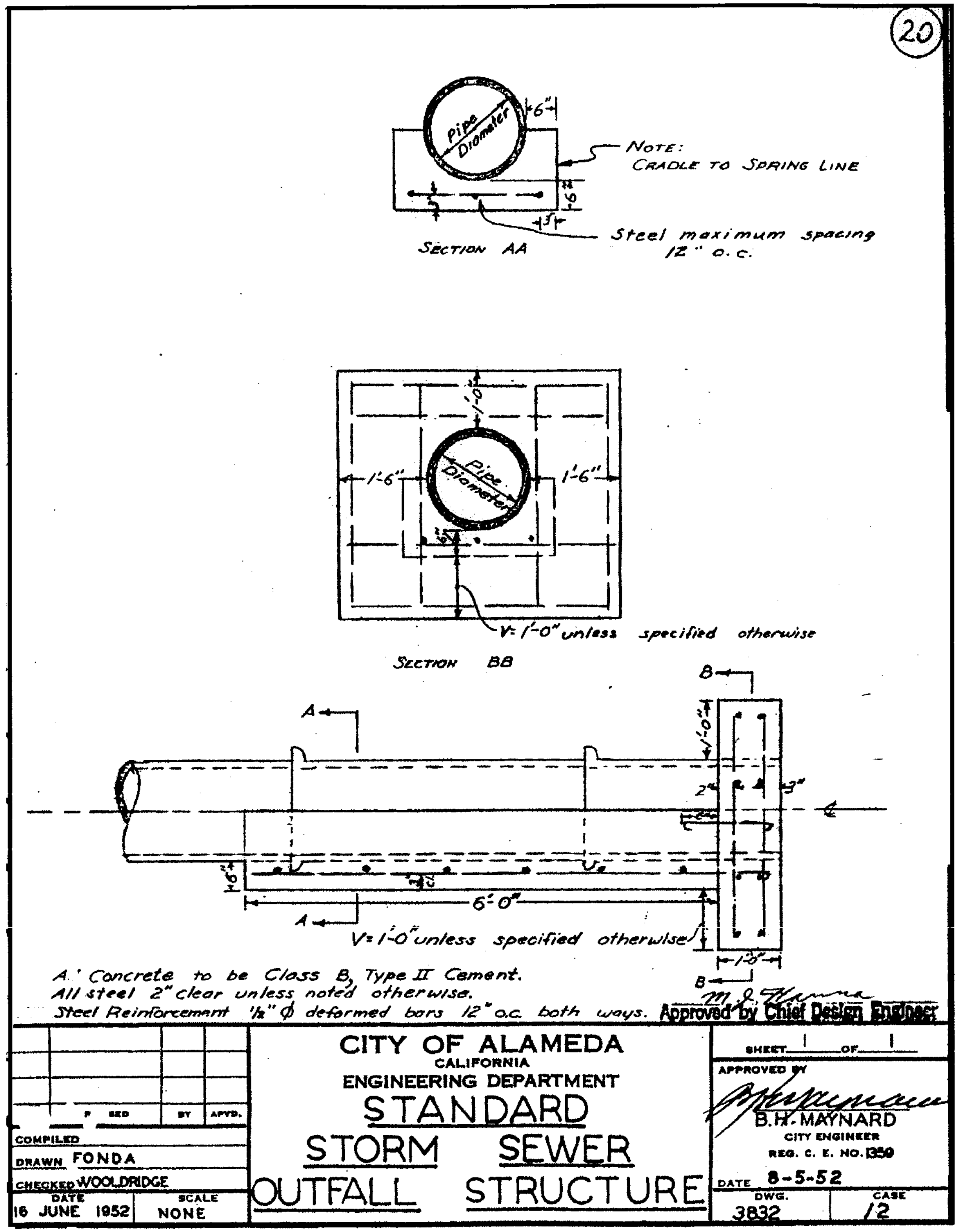
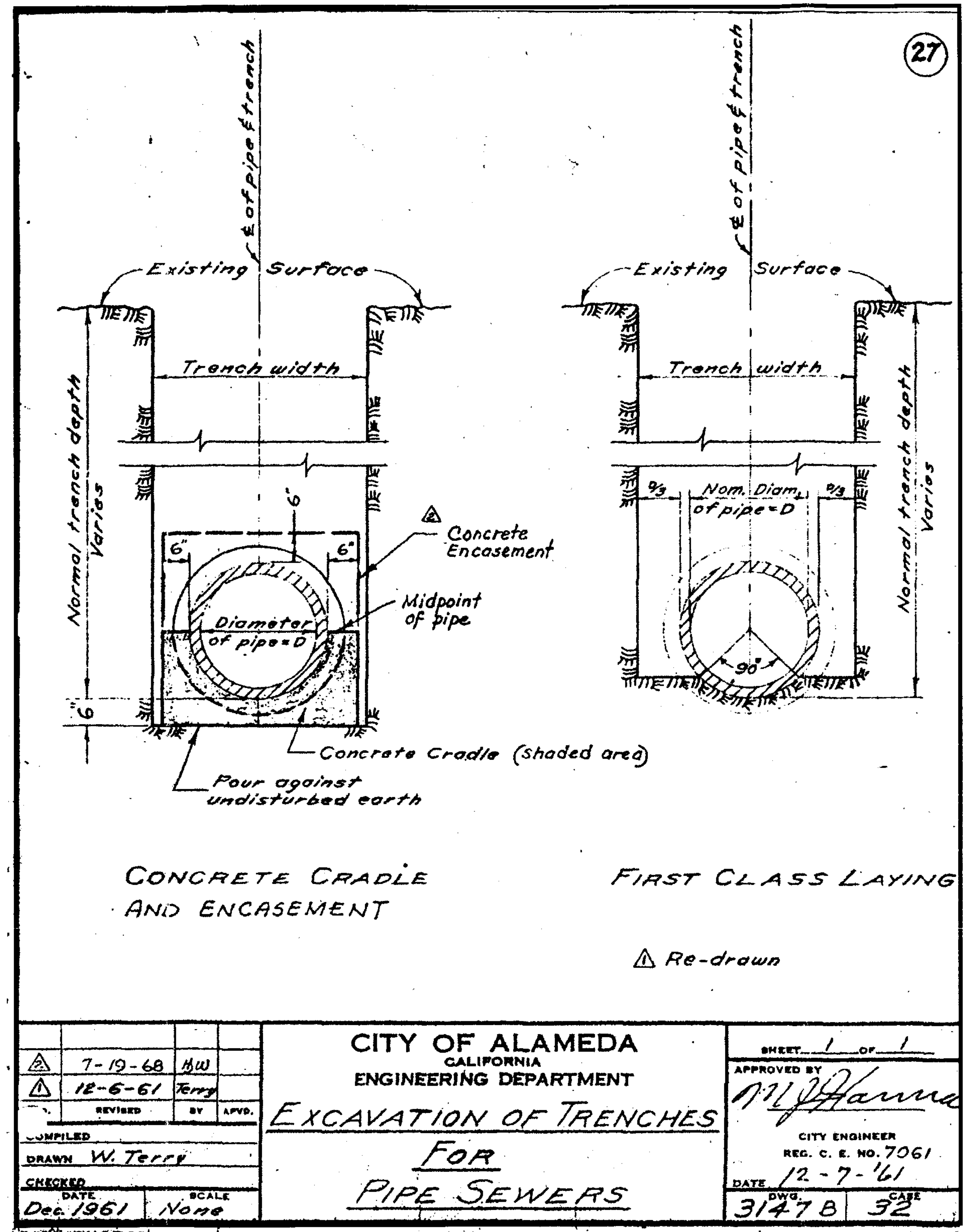
FIGURE 5

STORM SEWER LOCATION MAP

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

2006/06/29 V:\Projects\B115_Alameda\Tech Memo\Figure 5.mxd SULLIVAN SD D. Wise





Source; City of Alameda Standard Plans, as retrieved on June 28, 2006.

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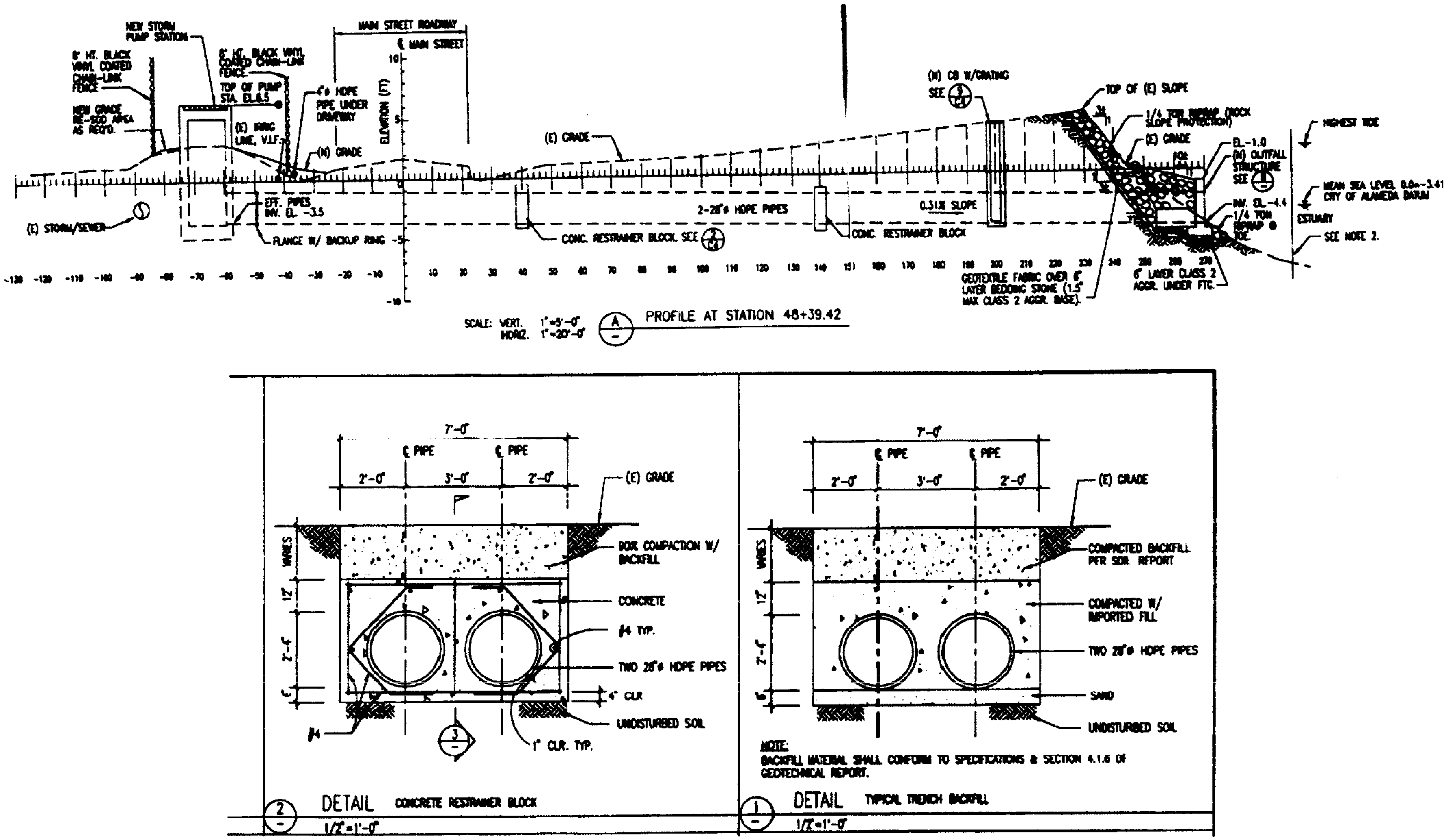
FIGURE 6

EAST STORM SEWER DETAILS

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

2006/05/09 V:\Projects\B115_Alameda\Tech Memo\Figure 6.mxd SULLIVAN - SD D. Wise



Source: Main Street Pump Station Improvements , dated June 16, 1998, prepared by Baseline Engineering for the City of Alameda.

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FIGURE 7

WEST STORM SEWER DETAILS

Technical Memorandum to Supplement the Administrative Record for IR Site 28, Todd Shipyards

2006/06/29 V:\Projects\B115_Alameda\Tech Memo\Figure 7.mxd sullivan sd d. wISE

APPENDIX A
ILLUSTRATIVE BIOSCREEN MODEL CALCULATIONS

2 pages.

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Hypothetical Site

Run Name

Data Input Instructions:

115	1. Enter value directly....or
or	2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02	
Variable*	Data used directly in model.
20	Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	96.6	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.4E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.02	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	11.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.1	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	500	*(ft)*

3. ADSORPTION

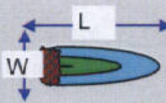
Retardation Factor*	*R*	300.0	*(-)*
or		or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*		*(per yr)*
or		or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	100	*(ft)*
Modeled Area Width*	600	*(ft)*
Simulation Time*	100	*(yr)*



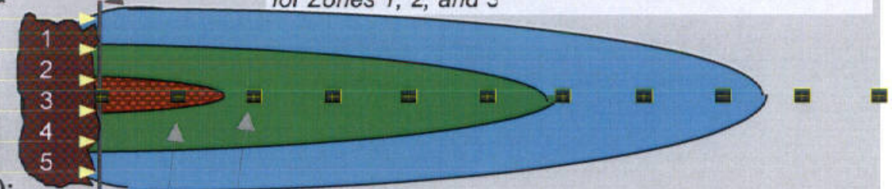
6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
600	0.65
0	0
0	0



View of Plume Looking Down

Source Halflife (see Help):

		(yr)
Inst. React.	1st Order	
Soluble Mass	1000	*(Kg)*

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	10	20	30	40	50	60	70	80	90	100

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

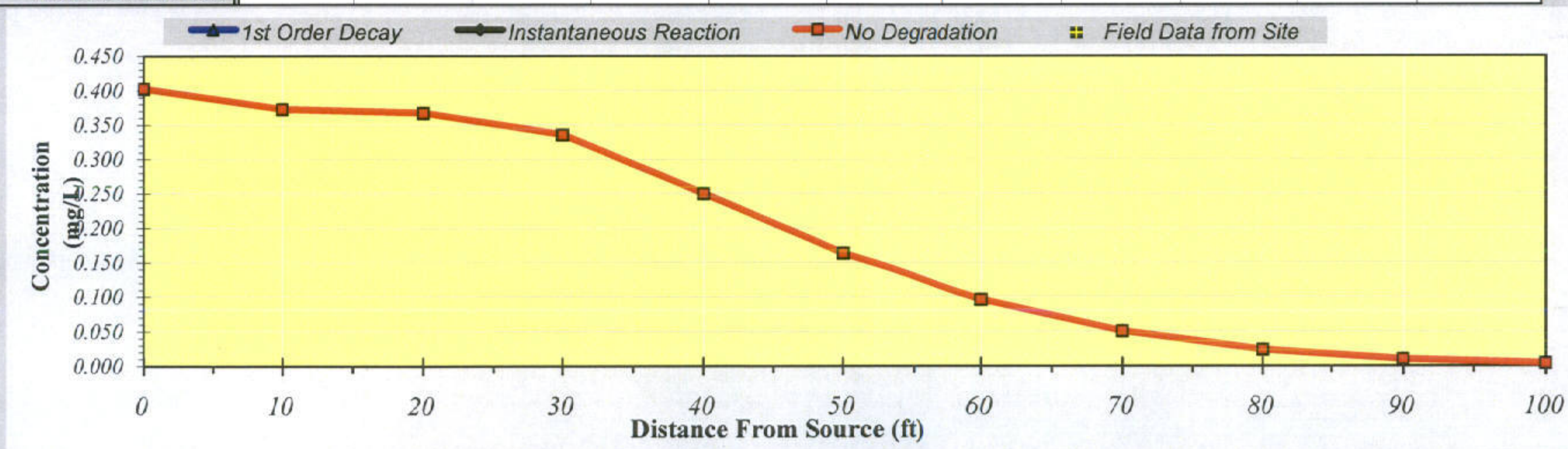
Restore Formulas for Vs, Dispersivities, R, lambda, other

HYPOTHETICAL DISSOLVED COPPER CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Starting concentration at T = 0 is 0.65 mg/L

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.402	0.373	0.367	0.335	0.250	0.164	0.096	0.050	0.024	0.010	0.004
1st Order Decay	0.402	0.373	0.367	0.335	0.250	0.164	0.096	0.050	0.024	0.010	0.004
Inst. Reaction	0.402	0.373	0.367	0.335	0.250	0.164	0.096	0.050	0.024	0.010	0.004
Field Data from Site											



Calculate Animation

Time:

100 Years

Return to Input

Recalculate This Sheet

APPENDIX B
LEADSPREAD MODEL CALCULATIONS

3 pages.

LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.055
Lead in Soil/Dust (ug/g)	449.0
Lead in Water (ug/l)	7
% Home-grown Produce	0%
(ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.1	2.4	3.0	3.4	2844	4230
BLOOD Pb, CHILD	4.2	7.8	9.2	11.2	12.7	322	502
BLOOD Pb, PICA CHILD	7.4	13.5	16.0	19.5	22.2	162	252
BLOOD Pb, OCCUPATIONAL	1.0	1.8	2.1	2.6	2.9	4113	6097

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	202.1	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	4.2E-5	0.02	2%	1.5E-5	0.01	1%
Soil Ingestion	8.8E-4	0.40	35%	6.3E-4	0.28	29%
Inhalation1		0.09	8%		0.06	7%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.39	35%		0.39	40%
Food Ingestion1		0.23	21%		0.23	24%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	6.1E-5	0.03	1%		0.03	0%
Soil Ingestion	7.0E-3	3.16	74%	1.4E-2	6.32	85%
Inhalation1	1.5E-6	0.00	0%		0.00	0%
Inhalation		0.07	2%		0.07	1%
Water Ingestion		0.45	11%		0.45	6%
Food Ingestion, child		0.54	13%		0.54	7%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

REFERENCES

California Department of Toxic Substances Control Website: www.dtsc.ca.gov/AssessingRisk/index.cfm

LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.055
Lead in Soil/Dust (ug/g)	449.0
Lead in Water (ug/l)	7
% Home-grown Produce	0%
(ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.0	1.8	2.1	2.6	2.9	4021	5961
BLOOD Pb, CHILD	3.3	6.1	7.2	8.8	10.0	450	703
BLOOD Pb, PICA CHILD	5.6	10.2	12.1	14.7	16.7	226	353
BLOOD Pb, OCCUPATIONAL	1.0	1.8	2.1	2.6	2.9	4113	6097

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	5	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	202.1	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.0E-5	0.01	1%	1.5E-5	0.01	1%
Soil Ingestion	6.3E-4	0.28	29%	6.3E-4	0.28	29%
Inhalation1		0.06	7%		0.06	7%
Inhalation	1.8E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.39	40%		0.39	40%
Food Ingestion1		0.23	24%		0.23	24%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	4.4E-5	0.02	1%		0.02	0%
Soil Ingestion	5.0E-3	2.26	68%	1.0E-2	4.52	81%
Inhalation1	1.1E-6	0.00	0%		0.00	0%
Inhalation		0.07	2%		0.07	1%
Water Ingestion		0.45	13%		0.45	8%
Food Ingestion, child		0.54	16%		0.54	10%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

REFERENCES

California Department of Toxic Substances Control Website: www.dtsc.ca.gov/AssessingRisk/index.cfm

LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.055
Lead in Soil/Dust (ug/g)	449.0
Lead in Water (ug/l)	7
% Home-grown Produce	0%
(ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	0.8	1.4	1.7	2.0	2.3	10198	15048
BLOOD Pb, CHILD	2.0	3.6	4.3	5.2	5.9	1126	1757
BLOOD Pb, PICA CHILD	2.9	5.3	6.2	7.6	8.6	565	883
BLOOD Pb, OCCUPATIONAL	1.0	1.8	2.1	2.6	2.9	4113	6097

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	2	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	202.1	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.2E-5	0.01	1%	1.5E-5	0.01	1%
Soil Ingestion	2.5E-4	0.11	15%	6.3E-4	0.28	29%
Inhalation1		0.03	3%		0.06	7%
Inhalation	7.0E-7	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.39	51%		0.39	40%
Food Ingestion1		0.23	30%		0.23	24%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.7E-5	0.01	0%		0.01	0%
Soil Ingestion	2.0E-3	0.90	46%	4.0E-3	1.81	63%
Inhalation1	4.3E-7	0.00	0%		0.00	0%
Inhalation		0.07	4%		0.07	2%
Water Ingestion		0.45	23%		0.45	16%
Food Ingestion, child		0.54	27%		0.54	19%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

REFERENCES

California Department of Toxic Substances Control Website: www.dtsc.ca.gov/AssessingRisk/index.cfm

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Southwest Division
1230 Columbia Street, Suite 870
San Diego, CA 92101-8517

DATE: 01/16/07
CTO: 0093
LOCATION: Alameda Point, Alameda, California

FROM: [signature]

Steven Bradley, Contract Manager

DOCUMENT TITLE AND DATE:

Technical Memorandum to Supplement the Administrative Record for Installation Restoration Site 28, Todd Shipyards; Alameda Point, Alameda, California

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