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ALAMEDA POINT
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Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

FINAL

IMPLEMENTATION MEMORANDUM FOR BENCH SCALE TEST OF ZERO-VALENT IRON AT OU-2B

January 24, 2007

ALAMEDA POINT
ALAMEDA, CALIFORNIA

Base Realignment and Closure
Program Management Office West
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CONTRACT NO. N62473-06-D-2201
CTO NO. 0020

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IMPLEMENTATION MEMORANDUM FOR BENCH SCALE TEST OF ZERO-VALENT IRON AT OU-2B

January 24, 2007

ALAMEDA POINT
ALAMEDA, CALIFORNIA

DCN: ECSD-RACIV-07-0316

TETRA TECH

1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

June Yi, PE
Project Manager

TETRA TECH EC, INC.

TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N62473-06-D-2201 (RAC IV)

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Naval Facilities Engineering Command SW
Ms. Beatrice Appling, AQE.BA
Building 127, Room 108
1220 Pacific Highway
San Diego, CA 92132-5190

DATE: 01/24/07
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LOCATION: Alameda, California

FROM: **A. N. Bolt**, Program Manager

DESCRIPTION: Final Implementation Memorandum for Bench Scale Test of Zero-Valent Iron at OU-2B, January 24, 2007

Response to Comments on Pre-Draft Implementation Memorandum of Bench Scale Test of Zero-Valent Iron at OU-2B, Dated Dec. 19, 2006 (DCN: 07-0064) Included with Final.

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D. Silva (EVR.DS) 3C/3E	G. Clark	
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RESPONSE TO COMMENTS
ON PRE-DRAFT IMPLEMENTATION MEMORANDUM FOR BENCH SCALE TEST OF ZERO-VALENT IRON AT OU-2B DATED DECEMBER 19, 2006 ALAMEDA POINT ALAMEDA, CALIFORNA

Comments dated: December 22, 2006

Comments by: Kofi Asante-Duah, PhD, Remedial Technical Manager

GENERAL COMMENTS

Comment a: *Considering all the fairly extensive investigations at the case-project and nearby sites, it seems quite surprising that another geophysical survey is being considered for same area? Note that elimination of any unnecessary DFW could bring some cost savings to this project.*

Response a: The intent of the geophysical survey is to locate potential underground utilities or obstructions prior to any intrusive work, which protects the health and safety of the workers and is TtEC policy. No change in text or DFW is proposed.

Comment b: *Suggest that document very clearly/explicitly identify the specific contaminant(s) [and target media] of interest very early on in the presentation – as this is quite important in any attempts to bring realistic focus to the discussions. Also, the project RAOs and/or key contaminant remediation goals might as well be stated in this document.*

Response b: Concur. The following text has been added in the first paragraph of Section 1.0 to identify the contaminants of interest, and better provide focus to the following discussions:

> **A field pilot test is being planned to assess several zero-valent iron (ZVI)-based technology options for treating trichloroethene (TCE) in groundwater at Operable Unit (OU)-2B at Alameda Point, Alameda, California.** This Implementation Memorandum (Memo) describes work associated with: (1) collection of soil and groundwater samples for a bench scale test; and (2) conducting a bench scale test to evaluate several types of ~~Zero-Valent Iron (~~ZVI~~)~~ **materials.**~~for use in a field pilot scale implementation as part of the ZVI Treatability Study at Operable Unit (OU) 2B at Alameda Point, Alameda, California.~~ **The**

purpose of the bench-scale test is to aid in selection of ZVI materials to be used in the field pilot test. Soil and groundwater samples will be collected from two areas of OU-2B: a source reduction area north of Building 360 and a plume interception area west of Building 162 (Figure 1-1). The bench scale test will be conducted by Dr. Greg Lowry at Carnegie Mellon University (CMU). This Memo has been prepared on behalf of the Navy Base Realignment and Closure (BRAC) Project Management Office West under Contract Task Order No. 0020, issued under Remedial Action Contract No. N62473-06-D-2201.

Comment c: *Apparently the maximum TCE concentration within the so-called "plume interception area" is only 3.6ppb (and average of only 1.3ppb) [as noted, e.g., in Attachment 1, Section 1.0, para2] – i.e.,* versus *a MCL of 5ppb for TCE; that said, why is this study designed to include 'contaminant reduction' assessment within this area?*

Response c: The intent of the study in the plume interception area is to create a barrier to minimize contaminant migration to the Seaplane Lagoon. Although nearby monitoring wells indicate TCE concentrations below the MCL, they are completed in the uppermost portion (5-15 feet below ground surface [bgs]) of the First Water Bearing Zone (FWBZ). There are no monitoring wells completed at the target depth interval of 20 to 40 feet bgs in the plume interception area. However, historic Hydropunch® data in the plume interception area indicates TCE concentrations of up to 2,300 µg/L at this target depth interval as indicated on Figures 1-2 through 1-4.

For clarity, Attachment 1, Section 1.0, paragraph 2, will be revised as follows:

> Soil and groundwater impacted with chloroethenes (CEs) have been targeted for treatment using zero valent iron (ZVI)~~—at Building 360~~ at Alameda Point (the site). Accordingly, a bench-scale treatability study will be conducted to preliminarily assess treatment performance of several ZVI materials, and to obtain data for field-scale implementation. Two separate treatment applications will be ~~required~~**employed** to address contaminants at the site, including: (i) a source reduction application, and (ii) a plume interception application. The main contaminant is trichloroethene (TCE), which, based on recent data taken from the Summer 2005 Quarterly Groundwater Monitoring Data Report, is present near the source reduction area (well MW360-1 **near Building 360**) at a maximum concentration of 2,400 micrograms per liter (µg/L) (average of 2,050 µg/L) and near the plume interception area (well M11-06 **near Building 162**) at a maximum concentration of 3.6 µg/L (average of 1.3 µg/L). **However,** ~~B~~both

monitoring wells are completed in the **uppermost portion of the** First Water Bearing Zone (FWBZ).~~and~~ **There are** no monitoring wells **completed at the target contaminant depth interval of 20 to 40 feet below ground surface**~~were present at ideal locations in the Second Water Bearing Zone (SWBZ)~~. Historical Hydropunch data taken from the Remedial Investigation Report (see Figures 1-2 through 1-4 of the Implementation Memo) indicate a maximum concentration of 200,000 μg/L in the source reduction area and a maximum concentration of 2,300 μg/L in the plume interception area. ~~This historical data also indicates that TCE has impacted the SWBZ in both the source reduction and plume interception areas.~~

Comment d: *For the proposed metals analyses, perhaps we should consider both filtered and unfiltered analyses – especially if the incremental project costs would not be significant.*

Response d: Concur. Section 1.6.3, step 6h, will be modified as follows:

h. After collection of the VOA vials, sample collection will continue by increasing the purge rate to 0.2 to 0.5 L/min. A 500-mL plastic container will **be** filtered with a 0.45 micron filter and filled for soluble metals analysis. **An additional 500-mL plastic container will be filled (no filter) for total metals analysis.**

Comment e: *The selected boring locations [e.g., as shown in Figure 1-1] may not quite be 'coincident' with the occurrence of maximum concentrations [especially for the so-called "plume interception area", as inferred from Figures 1-2 through 1-4]? Anyhow, it might be quite useful to include a brief but adequate and explicit discussion of the reasoning behind the choice of the specific sampling locations and configuration indicated for this project – i.e., include a design rationale that supports the viability of the proposed sampling program to meet the specific project goals.*

Response e: Please see response to general comment c. In addition, Section 1.5, second paragraph, describes the rationale for selected borehole locations.

Comment f: *Although it may be apparent for the most part, suggest that the predominant groundwater flow direction(s) are indicated on* all appropriate figures *in this document (even if rough approximations only). This should indeed be relevant to the discussion and conceptualization of any contaminant plume configurations/movements vis-à-vis the sampling network design for this project.*

Response f: Concur. Predominant groundwater flow direction toward the Seaplane Lagoon will be indicated on all figures.

Comment g: *Carefully check for miscellaneous minor errors/typos/etc. throughout document.*

Response g: An additional edit for minor errors/typos/etc. will be conducted prior to submittal of the final document.

SPECIFIC COMMENTS

Comment a: *Attachment 1, Section 2.3.1, para2: It might help to discuss/explain why completely different types of ZVI's are to be used for the two designated 'application areas'?*

Response a: The following text has been inserted after the first paragraph of Section 2.3.1, to explain the rationale for the materials being considered for each area:

> **It is currently envisioned that two areas will require treatment: a plume interception area, and a source reduction area. These applications may likely require a different type of ZVI material. Treatment for the plume interception area will involve emplacing a material in pathway of the plume to generate a continual treatment zone, or barrier, where contaminated water would be treated as it flows through the zone. For this application, a material with a relatively long lifetime will likely be required (i.e. larger iron grain sizes, or iron which incorporates a slow-release carbon source to stimulate biological process). For the source reduction area, treatment would ideally be more rapid, and success will largely be a function of getting the material distributed throughout the contaminated area as efficiently as possible. Thus, smaller iron particles (nano-scale), which are more reactive and are depleted faster, but have been shown to be more mobile in groundwater systems, are potentially appropriate for this application.**

Comment b: *Attachment 1, Section 2.4, Item #1: What might be the likely effects of 'compositing' several soil sub-samples on the target contaminant levels, and thus the possibility of false reporting of initial contaminant concentrations, etc. – i.e., possible loss of volatiles occurring from exactly the indicated sampling approach, and its implication on the study outcome?*

Response b: It is possible that contaminant levels would be averaged and thus lowered if a composite sample becomes necessary. A composite sample will only be collected if required to provide the 20 liter volume specified for bench scale testing. The goal of bench-scale testing is to determine the best substrate for in-situ remediation, and thus does not require the maximum concentration. Maximum concentration will impact the amount of substrate for final in-situ remediation. These data will be collected during the data-gap investigation, which is part of another Contract Task Order.

Comment c: *Attachment 1, Table 2: Apparently, TCE is the main/primary contaminant of interest [see, e.g., Section 1.0, para2] – and yet this table fails to directly/explicitly list this key parameter? Also, what about the LOD's?*

Response c: The table was revised to more explicitly show that TCE will be among the analytes to be measured, and to explain that the limits of detection will be established for relevant analytes following finalization of analyte list and determination of the specific analytical methodology.

Comment d: *Attachment 2: I understand there is a designated 'HSP person' at NAVFAC–SWDIV [Jan Corbett, at 1220 Pacific Hwy?] who has to review/approve this section; as such, no review is provided here in this memo.*

Response d: Don Coons with the Navy Environmental Health Center (NEHC) completes the review of Site Health and Safety Plans (SHSPs) for Jan Corbett. The SHSPs referenced in this Memo have already been reviewed by NEHC; therefore, this Memo will not be forwarded to Jan Corbett or the NEHC for additional review.

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ABBREVIATIONS AND ACRONYMS

ACPWA	Alameda County Public Works Agency
AHA	Activity Hazard Analysis
bgs	below ground surface
BRAC	Base Realignment and Closure
CE	chloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMU	Carnegie Mellon University
COC	chain of custody
DFW	Definable Feature of Work
DO	dissolved oxygen
DoD	Department of Defense
DOT	Department of Transportation
EMI	electromagnetic induction instrument
FID	flame ionization detector
GPR	ground-penetrating radar
ISB	in-situ bioremediation
ISCO	in-situ chemical oxidation
L/min	liters per minute
Memo	Implementation Memorandum
mL	milliliter
NZVI	nanoscale ZVI
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCB	polychlorindated biphenyls
PPE	personal protective equipment

ABBREVIATIONS AND ACRONYMS
(Continued)

PVC	polyvinyl chloride
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
SVOC	semivolatile organic compound
TCE	trichloroethene
TPH-e	total extractable petroleum hydrocarbon
TPH-p	total purgeable petroleum hydrocarbon
TtEC	Tetra Tech EC, Inc.
USACE	U.S. Army Corps of Engineers
VOA	volatile organic analysis
VOC	volatile organic compound
ZVI	Zero-Valent Iron

1.0 SCOPE OF WORK

A field pilot test is being planned to assess several zero-valent iron (ZVI)-based technology options for treating trichloroethene (TCE) in groundwater at Operable Unit (OU)-2B at Alameda Point, Alameda, California. This Implementation Memorandum (Memo) describes work associated with: (1) collection of soil and groundwater samples for a bench scale test; and (2) conducting a bench scale test to evaluate several types of ZVI materials. The purpose of the bench-scale test is to aid in selection of ZVI materials to be used in the field pilot test. Soil and groundwater samples will be collected from two areas of OU-2B: a source reduction area north of Building 360 and a plume interception area west of Building 162 (Figure 1-1). The bench scale test will be conducted by Dr. Greg Lowry at Carnegie Mellon University (CMU). This Memo has been prepared on behalf of the Navy Base Realignment and Closure (BRAC) Project Management Office West under Contract Task Order No. 0020, issued under Remedial Action Contract No. N62473-06-D-2201.

1.1 DEFINABLE FEATURES OF WORK

A definable feature of work (DFW) is defined as an activity or task that is separate and distinct from other activities and that requires separate control activities. The following DFWs have been identified and will be implemented as described herein:

- Geophysical Survey
- Sonic Drilling and Sample Determination
- Sample Collection
- Bench Scale Test

1.2 SCHEDULE

Field activities include a geophysical survey and collection of samples for the bench scale test. Approximately four to five days are proposed for the fieldwork. The samples will be shipped to CMU for use in the bench scale test and split samples will be sent to an independent laboratory for analysis. The bench scale test will require approximately 6 weeks initially and may be expanded. However, it is assumed that basic data will be available after the initial 6 weeks to proceed with preparation of *Work Plan for ZVI Treatability Study at OU-2B* (which will include a Sampling and Analysis Plan) for the field pilot scale test. Any subsequent experimentation, if deemed appropriate, may be conducted in conjunction with the work plan preparation, and results would be incorporated accordingly.

1.3 SCOPE OF WORK SUMMARY

The scope of work includes using a sonic drill rig with a support truck to advance two boreholes to approximately 50 below ground surface (bgs). Soil cores will be collected, continuously logged, and field screened to determine the relative zone of highest concentrations. Soil and groundwater samples will be collected from this zone prior to sealing the borehole with cement grout.

The soil and groundwater samples will be shipped to CMU for use in a bench scale test to select the appropriate type of ZVI for field implementation, which will be described in the *Work Plan for ZVI Treatability Study at OU-2B*. The seven-step data quality objective process is not directly applicable to this project. The intended use of the data generated from CMU will be for comparison purposes to evaluate the effectiveness and performance of different ZVI materials. In addition, data generated from split sample analysis at an independent laboratory will be used to ascertain the concentration for the contaminants of concern (volatile organic compounds [VOCs] and metals) and also be compared with CMU's results.

1.4 GEOPHYSICAL SURVEY

Prior to intrusive activities, a geophysical survey will be conducted using ground-penetrating radar (GPR) and/or an electromagnetic induction (EMI) instrument. The GPR and EMI instrument produce an image of the subsurface and identify discontinuities in the soil column that may indicate the presence of buried utility lines or other obstructions near the existing wells. In addition to a geophysical survey, Underground Service Alert will be contacted at least two (2) days prior to the commencement of work.

1.5 SONIC DRILLING AND SAMPLE INTERVAL DETERMINATION

An Alameda County Public Works Agency (ACPWA) drilling permit application will be completed and submitted for approval prior to the commencement of work. A Tetra Tech EC, Inc. (TtEC) field representative will coordinate with ACPWA on scheduling and inspections, if necessary.

Soil and groundwater samples will be collected from two areas of OU-2B: a source reduction area north of Building 360 and a plume interception area west of Building 162 (Figure 1-1). Historical HydroPunch® sample results provided in the Final OU-2B Remedial Investigation Study Report (SulTech, 2005) indicate that concentrations of TCE are highest from approximately 10 to 40 feet bgs (Figures 1-2 through 1-4). The proposed borehole locations were selected based on these concentrations.

The boreholes will be hand-augered for the first 5 feet to minimize the potential of encountering underground utilities and/or obstructions. A continuous soil core will be collected to approximately 50 feet bgs using the sonic drill method. This method consists of advancing a 10-foot-long nominal 6-inch core barrel using high-frequency resonant energy. After the core barrel is advanced, a 10-foot-long nominal 8-inch override casing is advanced. The core barrel is retrieved and the soil core is extruded into a plastic core bag. A clean core barrel is lowered into the override casing and advanced the next 10 feet. The process is repeated until the desired depth of 50 feet bgs is reached. The borehole locations will be surveyed for horizontal and vertical coordinates during the implementation of the Work Plan for ZVI Treatability Study at OU-2B.

The soil cores will be logged in accordance with the Unified Soil Classification System visual manual procedure (Howard, 1986) and using a Munsell® (GretagMacbeth, 1994) soil chart. Information will be recorded in the field logbook and/or on a boring log form. Soil core samples will be collected and field screened for organic vapors using a flame ionization detector (FID) headspace analysis in accordance with the following procedures:

1. The plastic core bag will be sliced open using a utility knife to expose the soil core. The core will be initially screened by passing an FID approximately 1 inch from the surface of the core.
2. Headspace field screening of the cores will be based on initial FID readings, lithology, color change, odor, or staining. A portion of the core sample will be placed in a clean, plastic resealable bag. The bag will be half-filled with soil, leaving half empty for head space field screening. The bag will then be placed in a location with a constant temperature (i.e., car, bed of pickup, room). After a minimum of 5 minutes, the bag will be pierced with the probe of the FID to sample the headspace.
3. Field screening readings will be recorded in the field logbook and on the boring log at the appropriate interval.

After core logging and field screening, soil and groundwater samples will be collected as described in Section 1.6 from the interval with the highest FID headspace reading. All drill cutting materials will be collected, profiled, and disposed of in accordance with waste management procedures described in Section 4.0 of this Memo.

After the drilling and sampling is complete, the boreholes will be backfilled with an ACPWA-approved sealing material. Bentonite chips or pellets will not be used as backfill material for the boreholes. Up to 5 percent of bentonite clay may be added to a cement-bentonite grout mixture. The sealing material will be placed with a tremie pipe, proceeding upward from the bottom of the borehole to prevent free fall and bridging of the sealing material. The sealing material will be placed in one continuous operation from the bottom to the top of the boring. The sealing material will be given sufficient time to set and cure in the borehole before completing the surface seal. Additional sealing material will be pumped/poured into the boring to near ground surface if settling occurs. Surface sealing will be consistent with the surrounding surface features (i.e., asphalt, concrete, or native soil).

All non-disposable drilling and sampling equipment will be decontaminated as described in Section 4.0 of this Memo.

1.6 SAMPLE COLLECTION AND ANALYSIS

Soil and groundwater samples will be collected from the interval with the highest FID headspace reading at each borehole location. Analyses, containers, holding times, and preservatives are detailed on Table 1-1.

1.6.1 Soil Sampling Procedure for Independent Laboratory Analysis

The following procedure will be used to collect the soil samples for independent laboratory analysis.

1. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting soil samples at each location.
2. At the interval with the highest FID headspace reading (as described in Section 1.5), samples will be collected from the soil core.
3. Three En Core® samplers will be collected directly from the soil core for VOC analysis as follows:
    a. Holding the coring body, the plunger rod will be pushed down until the small o-ring rests against the tabs. This will ensure that the plunger will move easily.
    b. The locking lever on the En Core T-handle will be depressed. The coring body, with the plunger end first, will be placed into the open end of the T-handle, aligning the slots of the coring body with the locking pins in the T-handle. The coring body will be twisted clockwise to lock the pins in the slots. The sampler will be checked to ensure that it is locked in place. The sampler will now be ready for use.
    c. By holding the T-handle, the coring body will be pushed into the soil until the coring body is full. When full, the small o-ring will be centered in the T-handle viewing hole. The sampler will then be removed from the soil and any excess soil will be wiped from the coring body exterior.
    d. The coring body will be capped while it is still on the T-handle. The cap should be pushed over the flat area of the ridge. To lock the cap in place, the cap will be pushed and twisted so that it seals the sampler.
    e. The capped sampler will be removed by depressing the locking lever on the T-handle while twisting and pulling the sampler from the T-handle.

f. The En Core sampler will be placed in its aluminum-sealed bag. The sample label on the outside of the bag will be completed.

g. This procedure will be performed two more times for a total collection of three En Core samplers for VOC analysis. All three En Cores will be placed in one aluminum bag.

h. A label will be placed on the outside of the aluminum bag.

i. The sample number (using a sequential numbering system such as 20-001), date, and time collected will be recorded on the label, field logbook, and chain-of-custody (COC). Clear tape will be placed over the label.

j. The aluminum bag will be placed in a plastic bag, a custody seal will be placed over the bag, the bag placed in another plastic bag, and then that bag will be placed in a cooler filled with ice.

4. After collection of En Cores, soil will be placed in an 8-ounce glass jar for metals analysis using a new, individually packaged, disposable plastic scoop.
5. The jar will be labeled as described above in Step 3h.
6. A custody seal will be placed over the jar lid, the jar placed in two plastic bags, and then that bag will be placed in a cooler filled with ice.
7. Samples will be shipped via FedEx for overnight delivery. The original copy of the COC will be placed in a plastic bag and taped to the underside of the cooler lid.

1.6.2 Soil Sampling Procedure for CMU

Following collection of soil samples for the independent laboratory, soil samples will be collected as follows for CMU.

1. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting soil samples at each location.
2. At the interval with the highest FID reading from each boring location (as described in Section 1.5), the soil core will be placed in 5 acetate-lined 1-gallon buckets.
3. Each container will be labeled as described in Step 3.i in Section 1.6.1.
4. Each container will be custody sealed and packaged by securing the lid of the bucket and placing the custody seal over it. Clear packing tape will be used to secure the custody seal and lid of the bucket, and the buckets will be placed in a cooler filled with ice.
5. Sample containers will be shipped to CMU via FedEx for overnight delivery as described in Section 1.6.4.

1.6.3 Groundwater Sampling Procedure

A two-inch polyvinyl chloride (PVC) pipe will be placed inside the sonic drill rig override casing to the depth of the boring. A 5 foot (0.010 slot size) screen will be placed at the approximate interval of the highest headspace reading determined during soil sampling (see Section 1.5). The override casing will then be pulled back enough to expose the PVC screen and the following procedures will be used to collect the groundwater samples for both CMU and the independent laboratory:

1. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting groundwater samples at each location.
2. Groundwater sampling will be conducted using a low-flow bladder pump. The pump will be lowered into the temporary well to the midpoint of the screen interval. Discharge tubing from the pump will be placed such that purge water will be collected in a 5-gallon bucket.
3. The water level in the temporary well will be checked with a water level meter, and the water level will be recorded in the field logbook.
4. Personnel will start pumping at 0.2 to 0.5 liters per minute (L/min). Pumping rate will be measured using a graduated cylinder and a stopwatch. There should be no more than 1 foot of drawdown during pumping. If necessary, pumping rates will be reduced to the minimum capability of the pump (0.1 to 0.2 L/min) to avoid drawdown. If drawdown occurs, a minimum of two tubing volumes will be removed from the temporary well prior to the sample collection.
5. After purging is complete, oxidation-reduction potential (ORP), dissolved oxygen (DO), and pH will be measured with a calibrated water quality meter, and the measurements will be recorded in the field logbook. Final readings will be recorded once the parameters have stabilized for three consecutive readings, as follows:
    - Consecutive readings within ± 10 millivolts for ORP
    - Consecutive readings within ± 0.3 for DO (in units of milligrams per liter)
    - Consecutive readings within ± 0.1 standard units for pH
6. Samples for the independent laboratory will be collected first as follows: three 40-milliliter (mL) volatile organic analysis (VOA) vials and one filtered 500-mL poly bottle for soluble metals analysis will be collected from each borehole for the independent laboratory analysis. Samples to be submitted for independent laboratory analysis will be transferred from the tubing to sample containers from each temporary well location as follows:
    a. The pump flow rate will be set at 0.1 to 0.2 L/min to collect VOC samples.
    b. Water will be collected from the discharge tubing into a 40-mL VOA vial to minimize aeration by allowing the water to flow down the inside of the vial

instead of directly into the bottom of the vial. Tubing should not touch the inside of the vial.

c. The vial will be filled up to the lid until a positive meniscus is formed.

d. The vial will be capped immediately, but slowly.

e. The sample will be checked for the presence of air bubbles by inverting the vial and gently tapping the side of the vial.

f. If an air bubble is present, then the collected sample will be discarded and resampled using a new vial.

g. The previous steps will be repeated until three air-bubble-free vials are collected.

h. After collection of the VOA vials, sample collection will continue by increasing the purge rate to 0.2 to 0.5 L/min. A 500-mL plastic container will be filtered with a 0.45 micron filter and filled for soluble metals analysis. An additional 500-mL plastic container will be filled (no filter) for total metals analysis.

7. After collection of containers for the independent laboratory, samples will be collected for CMU. Five 1-gallon glass bottles will be collected from each location for CMU. The bottles will be filled so there is minimal headspace.

8. Each container will be labeled as described in Step 3.i of Section 1.6.1.

9. Each container will be custody sealed by placing a custody seal over the lid except for VOA vials, which will be placed in a plastic bag first and then the outside of the bag will be custody sealed.

10. Containers will be placed in double plastic bags and placed in coolers half full of ice to keep samples cooled.

11. Samples will be shipped via FedEx for overnight delivery as described in Section 1.6.4. The original copy of the COC will be placed in a plastic bag and taped to the underside of the cooler lid.

12. All non-disposable equipment will be decontaminated between each sample acquisition.

1.6.4 Sample Packaging and Shipping

Samples will be shipped to the independent laboratory in coolers as follows:

- Each cooler will be shipped with a temperature blank. A temperature blank is a vial filled with tap water and stored in the cooler during sample collection and transportation.
- Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage of ice.
- The original copy of the COC signed by the sampler to relinquish custody will be placed in a plastic bag and taped to the underside of the cooler lid.

- Two custody seals will be taped across the cooler lid.
- Clear tape will be placed over the custody seals, and the cooler will be wrapped with tape around the lid and top to bottom to secure the cooler shut.
- The original airbill will be placed on the cooler in a pouch with the original COC. A copy of the same airbill will be placed on subsequent coolers. The airbill will be completed for priority overnight delivery and placed in a pouch. The number of coolers should be included on the airbill (1 of 2, 2 of 2, etc.).

1.6.5 Sample Analysis

The independent laboratory that will provide analytical services for this project will be a Department of Health Services Environmental Laboratory Accreditation Program (ELAP)-certified analytical laboratory and have successfully completed the Naval Facilities Engineering Service Center (NFESC) Laboratory Evaluation Program.

Table 1-2 listed the reporting limits for soil and groundwater analysis by the independent laboratory. The laboratory must be capable of meeting all the requirements listed in Table 1-2 and the quality control (QC) requirements in the *Navy Installation Restoration Chemical Data Quality (IR CDQM) Manual* (NFESC, 1999) and the *Quality Systems Manual (QSM) for Environmental Laboratories* (Department of Defense [DoD], 2006).

The bench scale testing using the samples collected for CMU will be conducted by Dr. Greg Lowry at CMU, a technical expert in the field of ZVI applications.

1.7 BENCH SCALE TEST

The objective of the bench scale test is to screen ZVI and ZVI-based materials to select one or more materials for use in the field treatability study for the source reduction and the plume interception areas of OU-2B at Alameda Point. This will involve microcosm testing, and possibly focused column testing. Each area (source reduction and plume interception) will be assessed separately. A detailed scope of work, which includes the type of ZVI materials selected and experimental details, is provided as Attachment 1 to this Memo.

1.8 DELIVERABLES

The results from the bench scale test from the initial phase (approximately 6 weeks) will be presented as soon as available for use in preparing the *Work Plan for the ZVI Treatability Study at OU-2B*. CMU will submit a draft report to TtEC for review and comment, and following resolution of any issues, a final report. The field pilot scale implementation may be executed concurrently with the second phase of the bench scale test. The final bench test report will be included as an appendix in the *ZVI Treatability Study Report at OU-2B*.

The results from the independent laboratory will be presented in a hard-copy, Level III-equivalent analytical data package comprised of a table of contents referencing individual sections in the data package, the original, white copy of COC records, a copy of all corrective action reports, a narrative documenting the resolution of all corrective actions and non-conformances, analytical results, associated QC results, sample preparation and analysis logs, and calibration information. Results from the independent laboratory will not require third-party data validation.

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2.0 HEALTH AND SAFETY

All field activities as part of this Memo will follow the applicable sections of the *Final Site Health and Safety Plan for Pre-Design Field Activities* (TtEC, 2006a) and the *Draft Site Health and Safety Plan for OU-1, OU-2A, and OU-2B Data Gap Sampling* (TtEC, 2006b). A copy of these Site Health and Safety Plans will be available on site during the field activities. Additional health and safety practices applicable to this Memo are described below.

All field personnel will wear the appropriate personal protective equipment (PPE) at all times during the field work. This includes a hard hat, safety glasses, high-visibility vest, and steel-toe boots. Hearing protection and a first aid kit will also be available on site. A Site Health and Safety Specialist will be on site and is responsible for overseeing that the appropriate PPE is used and will monitor conformance with safety and emergency-response procedures. In the case of an emergency or injury, the route to the nearest hospital is shown on Figure 2-1. Emergency contact information is provided in Table 2-1.

All equipment shall be operated, inspected daily, and maintained as specified in the manufacturer's operating manual. A copy of the manual, provided by the drilling subcontractor, will be available at the job site. All machinery and mechanized equipment operation shall be inspected and operated by qualified personnel. All qualified persons shall provide or possess proper documentation and/or certificates prior to the start of work. All soil and concrete drilling operations shall meet the requirements of U.S. Army Corps of Engineers (USACE), Safety and Health Requirements Manual, EM 385-1-1 (USACE, 2003). This includes drilling equipment that must be equipped with two easily accessible and functional emergency shutdown devices (not including the ignition key).

All field personnel and drivers must possess and carry valid 40-hour Occupational Safety and Health Administration (OSHA) training certifications, a current 8-hour Hazardous Waste Operations refresher training certificate, and current medical certification that meets all of the applicable OSHA regulations to include 29 Code of Federal Regulations (CFR) 1910.120 (Title 8 California Code of Regulations, 5192).

Activity Hazard Analyses (AHAs) for the specific tasks are provided as Attachment 2 and will be reviewed and discussed by field personnel prior to any field activities. A daily safety tailgate meeting will be held prior to the field work.

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3.0 TRAFFIC CONTROL

Traffic control will be addressed for vehicular traffic, vehicular parking, and pedestrian control during the field activities. Traffic controls and signs will be used in accordance with the California Department of Transportation's *Manual of Traffic Control for Construction and Maintenance Work Zones* (California State Department of Transportation, 1996) to provide for the effective completion of the work activities in a safe manner while minimizing the impact of the normal traffic flow. Any sidewalk or parking areas will have proper signage and construction areas barricaded for pedestrian safety. In addition, field crews will wear appropriate highly visible clothing when working in traffic areas. No fire apparatus will be barricaded or blocked during the field activities.

Figure 1-1 illustrates the borehole locations. Traffic controls will be required during activities close to or on a roadway, or that block or intrude on a sidewalk or parking area. Traffic control measures will include:

- Traffic cones will be set up around the drill rig while mobilizing, drilling, and demobilizing.
- Warning signs will be placed to alert traffic of the construction area.
- A flagman, when required, will be used to control traffic flow.
- On-street parking will be limited to vehicles associated with construction activities throughout the project in order to maintain normal access and clear lanes. When possible, vehicles associated with the project will be parked off the roadway.
- Off-street and on-street parking that will be affected by field activities will have a 48-hour notification posting. In addition, the work area will be barricaded and taped off the day before mobilizing the drill rig.

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4.0 WASTE MANAGEMENT

All drill cutting material will be contained on site in labeled 55-gallon drums and characterized for off-site disposal. The drilling subcontractor will be responsible for managing the cuttings as they exit the boring until they are deposited in a 55-gallon drum. If the subcontractor operates any large equipment (i.e., a forklift), they are required to possess the proper operators license. Water generated (displaced and/or decontamination water) during drilling will be containerized on site in labeled 55-gallon drums and characterized for appropriate disposal. All drums containing free liquid shall be placed in secondary containment for storage prior to disposal; 55-gallon drums will be staged near Building 112 until properly disposed of. Any free liquid present in slurry will be solidified at the disposal facility prior to landfill.

All non-disposable equipment will be decontaminated prior to entry on site and between borehole locations. Decontamination will consist of high-pressure, hot-water cleaning with phosphate-free detergents followed by a potable water rinse and a deionized water rinse. The drilling subcontractor will provide all decontamination equipment such as a high-pressure/hot-water washer, detergents, clean 5-gallon buckets, deionized water, and a trailer with self-contained wastewater reservoirs. Decontamination will be conducted within a polyethylene-lined secondary containment area to capture the water and prevent unintended discharge. All decontamination wastewater will be transferred into labeled 55-gallon drums.

Wastes that may potentially be hazardous waste will be labeled "POTENTIALLY HAZARDOUS – ANALYSIS PENDING." The contents of the container and the accumulation start date will also be indicated on the outside of the drum upon generation. Wastes may only be stored on site for less than 90 days.

Each waste stream requiring off-site disposal will be sampled and analyzed, as necessary, to ensure that it is properly characterized and profiled and meets the waste acceptance criteria and packaging requirements for the proposed treatment, storage, and disposal facility or recycling facility prior to transport. Soil and waste water will be sampled at a frequency determined by the disposal facility and analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), Title 22 metals, total purgeable petroleum hydrocarbons (TPH-p), and total extractable petroleum hydrocarbons (TPH-e). Soluble Threshold Limit Concentration and Toxic Characteristic Leaching Procedure analyses will be conducted as required.

Prior to shipping, drums of hazardous waste will be properly labeled using the designated yellow hazardous waste label. If wastes are regulated under the Department of Transportation (DOT), the appropriate hazard class labels will be used. Green and white non-hazardous waste labels will be used for all containers of non-hazardous waste.

Hazardous and non-hazardous wastes will be transported off site for recycling or disposal. Used PPE will generally be managed and disposed of as non-hazardous waste unless generator knowledge indicates that it should be managed as hazardous waste.

Each waste stream requiring off site disposal will be sampled and analyzed, as necessary, to ensure that it is properly characterized and profiled and meets the waste acceptance criteria and packaging requirements for the proposed treatment, storage, and disposal facility or recycling facility prior to transport. Soil and wastewater will be stored in containers and sampled as follows:

1. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting samples.
2. The top of the drum or other approved container will be carefully opened.
3. Using a new, individually packaged, disposable plastic scoop, grab soil samples will be collected into sample containers listed in Table 1-1. Additional sample containers may be collected to ensure sufficient sample quantity for analyses. En Cores will be collected as described in Section 1.6.1 directly from the drum or approved container.
4. Wastewater samples will be collected using disposable bailers into containers listed in Table 1-1. Samples will be transferred from the bailers to sample containers as follows:
    a. Once the bailer is retrieved from the container, the small diameter emptying tube (that is supplied with the bailer) will be placed in the bottom of the bailer to dislodge the ball holding the water in the bailer.
    b. As water begins to flow from the tube, it will be carefully collected into a 40-mL VOA vial to minimize aeration by allowing the water to flow down the inside of the vial instead of directly into the bottom of the vial.
    c. The vial will be filled up to the lid until a positive meniscus is formed.
    d. The vial will be capped immediately, but slowly.
    e. The sample will be checked for the presence of air bubbles by inverting the vial and gently tapping the side of the vial.
    f. If an air bubble is present, then the collected sample will be discarded and resampled using a new vial.
    g. The previous steps will be repeated until three air-bubble-free vials are collected for VOCs and three for TPH-p.
    h. After collection of the VOA vials, sample collection will continue by placing the larger diameter emptying tube (that is also supplied with the bailer) into the bottom of the bailer.
    i. As the water begins to flow from the tube, glass containers will be collected for SVOCs, pesticides, PCBs, and TPH-e. Then, a plastic container will be collected for metals. Container size and preservation requirements are listed in Table 1-1.

5. Each container will be labeled and clear packing tape will be placed over the label to secure it. Samples will be uniquely designated using a sequential numbering system (20-001). The sample number, date, and time collected will be recorded in the field logbook, on the labels, and on the COC.
6. Samples will be custody sealed, packaged, and stored on ice as described in Section 1.6.1 for soil samples and Section 1.6.3 for water samples.

All waste will be transported using a hazardous waste manifest (for Hazardous Waste) or a non-hazardous waste manifest or bill of lading (for non-hazardous waste). Waste will be transported in accordance with all 49 CFR Part 142 regulations, including containerization, labeling and placarding. Wastes disposed of off site may only be sent to Resource Conservation and Recovery Act (RCRA) Subtitle C or RCRA Subtitle D facilities that meet the requirements of 40 CFR, Part 300.440 (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Off-site Policy). Waste containing hazardous substances may only be disposed of at facilities approved to accept CERCLA waste, under the off-site rule. Additionally, all transporters and disposal facilities must be prequalified by TtEC prior to use.

Table 4-1 presents a matrix summarizing applicable waste characterization, containment, storage, transportation, and disposal requirements.

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5.0 REFERENCES

California State Department of Transportation. 1996. *Manual of Traffic Control for Construction and Maintenance Work Zones.*

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U.S. Army Corps of Engineers (USACE). 2003. *Safety – Safety and Health Requirements.* EM 385-1-1. November 3.

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TABLES

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TABLE 1-1

ANALYTICAL METHODS, CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIREMENTS

Matrix	Analytical Group	Analytical and Preparation Method	Container (number, size, type)	Preservation Requirements (chemical, temperature, etc.)	Maximum Holding Time (preparation/analysis)
Soil	VOC	EPA Method 5035A/8260B	Three 5-g En Core	4±2°C	48 hours/14 days
Soil	TPH-purgeable	EPA Method 5035A/8015B	Three 5-g En Core	4±2°C	48 hours/14 days
Soil	SVOCs	EPA Method 3550B/8270C	One or two 8-ounce glass jars (depending)	4±2°C	14 days/40 days
Soil	TPH extractable	EPA Method 3550B/8015B		4±2°C	14 days/40 days
Soil	Pesticides	EPA Method 3550B/8081A		4±2°C	14 days/40 days
Soil	PCBs	EPA Method 3550B/8082		4±2°C	14 days/40 days
Soil	Title 22 Metals	EPA Method 3050B/6010B/6020		4±2°C	180 days
Soil	Mercury	EPA Method 7471A		4±2°C	28 days
Water	VOCs	EPA Method 8260B	Three 40-mL VOA Vials	pH ≤2 w/HCL, 4±2°C	14 days
Water	TPH-purgeable	EPA Method 8015B	Three 40-mL VOA Vials	pH ≤2 w/HCL, 4±2°C	14 days
Water	SVOCs	EPA Method 3510C/8270C	Two 1-L amber bottles	4±2°C	7 days/40 days
Water	TPH-extractable	EPA Method 3510C/8015B	Two 1-L amber bottles	4±2°C	7 days/40 days
Water	Pesticides	EPA Method 3510C/8081A	Two 1-L amber bottles	4±2°C	7 days/40 days
Water	PCBs	EPA Method 3510C/8082	Two 1-L amber bottles	4±2°C	7 days/40 days
Water	Title 22 Metals	EPA Method 3010A/6010B/6020	One 500-mL Poly bottle	pH ≤ 2 w/HNO_3	180 days
Water	Mercury	EPA Method 7470A			28 days

TABLE 1-1

ANALYTICAL METHODS, CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIREMENTS

Abbreviations and Acronyms:

°C – degrees Celsius
EPA – U.S. Environmental Protection Agency
g – gram
HCL – hydrochloric acid
HNO_3 – nitric acid
L – liter
mL – milliliter
PCB – polychlorinated biphenyl
pH – hydrogen (ion) potential
TPH – total petroleum hydrocarbon
VOA – volatile organic analysis
VOC – volatile organic compound

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
VOC/8260B	1,1,1-Trichloroethane	NE	5	µg/kg	NE	NE	2	µg/L
	1,1,2,2-Tetrachloroethane	NE	5	µg/kg	NE	NE	1	µg/L
	1,1,2-Trichloroethane	NE	5	µg/kg	NE	NE	5	µg/L
	1,1-Dichloroethane	NE	5	µg/kg	NE	NE	5	µg/L
	1,1-Dichloroethene	NE	5	µg/kg	NE	700	5	µg/L
	1,2-Dichloroethane	NE	5	µg/kg	NE	500	0.5	µg/L
	1,2-Dichloropropane	NE	5	µg/kg	NE	NE	5	µg/L
	2-Hexanone	NE	50	µg/kg	NE	NE	50	µg/L
	Acetone	NE	50	µg/kg	NE	NE	50	µg/L
	Benzene	NE	5	µg/kg	NE	500	1	µg/L
	Bromodichloromethane	NE	5	µg/kg	NE	NE	5	µg/L
	Bromoform	NE	5	µg/kg	NE	NE	5	µg/L
	Bromomethane	NE	10	µg/kg	NE	NE	5	µg/L
	Carbon tetrachloride	NE	5	µg/kg	NE	500	0.5	µg/L
	Chlorobenzene	NE	5	µg/kg	NE	100,000	5	µg/L
	Chloroethane	NE	5	µg/kg	NE	NE	5	µg/L
	Chloroform	NE	5	µg/kg	NE	6,000	5	µg/L
	Chloromethane	NE	10	µg/kg	NE	NE	5	µg/L
	cis-1,2-Dichloroethene	NE	5	µg/kg	NE	NE	5	µg/L
	cis-1,3-Dichloropropene	NE	5	µg/kg	NE	NE	0.5	µg/L
	Dibromochloromethane	NE	5	µg/kg	NE	NE	5	µg/L
	Ethylbenzene	NE	5	µg/kg	NE	NE	5	µg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	2-Butanone	NE	50	μg/kg	NE	NE	5	μg/L
	Methyl tert-butyl ether	NE	5	μg/kg	NE	NE	5	μg/L
	Methylene chloride	NE	10	μg/kg	NE	200,000	50	μg/L
	Methyl isobutyl ketone	NE	50	μg/kg	NE	NE	5	μg/L
	Styrene	NE	5	μg/kg	NE	NE	5	μg/L
	Tetrachloroethene	NE	5	μg/kg	NE	NE	50	μg/L
	Toluene	NE	5	μg/kg	NE	NE	5	μg/L
	trans-1,2-Dichloroethene	NE	5	μg/kg	NE	NE	5	μg/L
	trans-1,3-Dichloropropene	NE	5	μg/kg	NE	NE	10	μg/L
	Trichloroethene	2,040,000	5	μg/kg	NE	700	5	μg/L
	Vinyl chloride	NE	5	μg/kg	NE	NE	5	μg/L
	Xylenes (Total)	NE	5	μg/kg	NE	NE	5	μg/L
SVOC/8270C	1,2,4-Trichlorobenzene	NE	330	μg/kg	NE	NE	0.5	μg/L
	1,2-Dichlorobenzene	NE	330	μg/kg	204,000	500	5	μg/L
	1,3-Dichlorobenzene	NE	330	μg/kg	NE	200	0.5	μg/L
	1,4-Dichlorobenzene	NE	330	μg/kg	NE	NE	5	μg/L
	2,4,5-Trichlorophenol	NE	330	μg/kg	NE	NE	5	μg/L
	2,4,6-Trichlorophenol	NE	330	μg/kg	NE	NE	10	μg/L
	2,4-Dichlorophenol	NE	330	μg/kg	NE	NE	10	μg/L
	2,4-Dimethylphenol	NE	330	μg/kg	NE	7,500	5	μg/L
	2,4-Dinitrophenol	NE	660	μg/kg	NE	400,000	10	μg/L
	2,4-Dinitrotoluene	NE	330	μg/kg	NE	2,000	10	μg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	2,6-Dinitrotoluene	NE	330	µg/kg	NE	NE	10	µg/L
	2-Chloronaphthalene	NE	330	µg/kg	NE	NE	10	µg/L
	2-Chlorophenol	NE	330	µg/kg	NE	NE	50	µg/L
	2-Methylphenol	NE	330	µg/kg	NE	130	10	µg/L
	2-Nitroaniline	NE	330	µg/kg	NE	NE	10	µg/L
	2-Nitrophenol	NE	330	µg/kg	NE	NE	10	µg/L
	3,3-Dichlorobenzidine	NE	330	µg/kg	NE	NE	10	µg/L
	3-Nitroaniline	NE	330	µg/kg	NE	200,000 [a]	10	µg/L
	4,6-Dinitro-2-methylphenol	NE	660	µg/kg	NE	NE	20	µg/L
	4-Bromophenyl-phenylether	NE	330	µg/kg	NE	NE	20	µg/L
	4-Chloro-3-methylphenol	NE	330	µg/kg	NE	NE	20	µg/L
	4-Chloroaniline	NE	330	µg/kg	NE	NE	20	µg/L
	4-Chlorophenyl-phenylether	NE	330	µg/kg	NE	NE	50	µg/L
	4-Methylphenol	NE	330	µg/kg	NE	NE	10	µg/L
	4-Nitroaniline	NE	330	µg/kg	NE	NE	10	µg/L
	4-Nitrophenol	NE	660	µg/kg	NE	NE	10	µg/L
	bis(2-Chloroethoxy)methane	NE	330	µg/kg	NE	NE	10	µg/L
	bis(2-Chloroethyl)ether	NE	20	µg/kg	NE	200,000 [a]	10	µg/L
	bis(2-Chloroisopropyl)ether	NE	330	µg/kg	NE	NE	20	µg/L
	bis(2-Ethylhexyl)phthalate	NE	330	µg/kg	NE	NE	20	µg/L
	Butylbenzylphthalate	NE	330	µg/kg	NE	NE	10	µg/L
	Di-n-butylphthalate	NE	330	µg/kg	NE	NE	10	µg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	Di-n-octylphthalate	NE	330	µg/kg	NE	NE	10	µg/L
	Dibenzofuran	NE	330	µg/kg	NE	NE	10	µg/L
	Diethylphthalate	NE	330	µg/kg	NE	NE	10	µg/L
	Dimethyl phthalate	NE	330	µg/kg	NE	NE	10	µg/L
	Hexachlorobenzene	NE	330	µg/kg	NE	NE	10	µg/L
	Hexachlorobutadiene	NE	330	µg/kg	NE	NE	10	µg/L
	Hexachlorocyclopentadiene	NE	330	µg/kg	NE	NE	10	µg/L
	Hexachloroethane	NE	330	µg/kg	NE	500	10	µg/L
	n-Nitrosodiphenylamine	NE	330	µg/kg	NE	NE	50	µg/L
	Nitrobenzene	NE	330	µg/kg	NE	3,000	10	µg/L
	Pentachlorophenol	17,000	330	µg/kg	NE	NE	10	µg/L
	n-Nitrosodinpropylamine	NE	330	µg/kg	NE	NE	10	µg/L
	Benzo(a)pyrene	NE	330	µg/kg	NE	2,000	10	µg/L
	Dibenz(a,h)anthracene	NE	330	µg/kg	NE	NE	10	µg/L
	Acenaphthene	NE	330	µg/kg	NE	5,000	10	µg/L
	Acenaphthylene	NE	330	µg/kg	NE	NE	10	µg/L
	Anthracene	NE	330	µg/kg	NE	NE	10	µg/L
	Benzo(a)anthracene	NE	330	µg/kg	NE	NE	10	µg/L
	Benzo[b]fluoranthene	NE	330	µg/kg	NE	NE	10	µg/L
	Benzo[g,h,i]perylene	NE	330	µg/kg	NE	NE	10	µg/L
	Benzo[k]fluoranthene	NE	330	µg/kg	NE	NE	10	µg/L
	Chrysene	NE	330	µg/kg	NE	NE	10	µg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	Fluoranthene	NE	330	µg/kg	NE	NE	10	µg/L
	Fluorene	NE	330	µg/kg	NE	NE	10	µg/L
	Indeno[1,2,3-cd]pyrene	NE	330	µg/kg	NE	NE	10	µg/L
	Naphthalene	NE	330	µg/kg	NE	NE	10	µg/L
	Phenanthrene	NE	330	µg/kg	NE	NE	10	µg/L
	Pyrene	NE	330	µg/kg	NE	NE	10	µg/L
Pesticides/8081A	4,4-DDD	1,000 [e]	4	µg/kg	NE	NE	10	µg/L
	4,4-DDE	1,000 [e]	4	µg/kg	NE	NE	10	µg/L
	4,4-DDT	1,000 [e]	4	µg/kg	100 [c]	NE	0.2	µg/L
	alpha-BHC	NE	2	µg/kg	100 [c]	NE	0.2	µg/L
	Aldrin	1,400	2	µg/kg	100 [c]	NE	0.2	µg/L
	beta-BHC	NE	2	µg/kg	NE	NE	0.2	µg/L
	delta-BHC	NE	2	µg/kg	140	NE	0.1	µg/L
	Chlordane (technical)	2,500	2	µg/kg	NE	NE	0.1	µg/L
	Dieldrin	8,000	4	µg/kg	NE	NE	0.1	µg/L
	Endosulfan sulfate	NE	4	µg/kg	250	30	0.1	µg/L
	Endosulfan I	NE	2	µg/kg	800	NE	0.2	µg/L
	Endosulfan II	NE	4	µg/kg	NE	NE	0.2	µg/L
	Endrin	200	4	µg/kg	NE	NE	0.1	µg/L
	Endrin Aldehyde	NE	4	µg/kg	NE	NE	0.2	µg/L
	Endrin Ketone	NE	4	µg/kg	20	20	0.2	µg/L
	Lindane	4,000	2	µg/kg	NE	NE	0.2	µg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	Heptachlor	4,700 [f]	2	µg/kg	NE	NE	0.2	µg/L
	Heptachlor epoxide	4,700 [f]	2	µg/kg	400	400	0.1	µg/L
	Methoxychlor	100,000	20	µg/kg	470 [c]	8 [c]	0.1	µg/L
	Toxaphene	5,000	50	µg/kg	470 [c]	8 [c]	0.1	µg/L
PCBs/8082	Aroclor 1016	50,000 [g]	50	µg/kg	10,000	10,000	1	µg/L
	Aroclor 1221	50,000 [g]	50	µg/kg	500	500	2	µg/L
	Aroclor 1232	50,000 [g]	50	µg/kg	5,000 [d]	NE	1	µg/L
	Aroclor 1242	50,000 [g]	50	µg/kg	5,000 [e]	NE	1	µg/L
	Aroclor 1248	50,000 [g]	50	µg/kg	5,000 [e]	NE	1	µg/L
	Aroclor 1254	50,000 [g]	50	µg/kg	5,000 [e]	NE	1	µg/L
	Aroclor 1260	50,000 [g]	50	µg/kg	5,000 [e]	NE	1	µg/L
TPH-purgeable/8015B	Gasoline (C_6-C_{10})	NE	1	mg/kg	NE	NE	25	pg/L
TPH-extractable/8015B	Diesel (C_{10}-C_{24}) Motor Oil (C_{24}-C_{36})	NE	10 20	mg/kg	NE	NE	50	pg/L
Metals/6010B/6020/7000	Antimony	500	3	mg/kg	NE	NE	0.1	mg/L
	Arsenic	500	0.2	mg/kg	NE NE	NE NE	0.5 0.5	mg/L
	Barium	10,000	0.5	mg/kg	15,000	NE	1	µg/L
	Beryllium	75	0.5	mg/kg	5,000	5,000	1	µg/L
	Cadmium	100	0.5	mg/kg	100,000	100,000	1	µg/L
	Chromium	2,500	0.5	mg/kg	750	NE	1	µg/L
	Cobalt	8,000	1	mg/kg	1,000	1,000	1	µg/L

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Analytical Group/Method	Analyte	Regulatory Limit for Soil Waste	Reporting Limits	Units	STLC Limit for Wastewater	TCLP Limit for Wastewater	Reporting Limits	Units
	Copper	41,000	0.5	mg/kg	5,000	5,000	1	µg/L
	Lead	1,000	0.5	mg/kg	80,000	NE	1	µg/L
	Mercury	20	0.1	mg/kg	25,000	NE	1	µg/L
	Molybdenum	3,500	1	mg/kg	5,000	5,000	1	µg/L
	Nickel	2,000	1	mg/kg	200	200	0.5	µg/L
	Selenium	100	0.5	mg/kg	350,000	NE	2	µg/L
	Silver	500	0.5	mg/kg	20,000	NE	1	µg/L
	Thallium	700	0.5	mg/kg	1,000	1,000	1	µg/L
	Vanadium	2,400	0.5	mg/kg	5,000	5,000	1	µg/L
	Zinc	5,000	1	mg/kg	7,000	NE	1	µg/L

Notes:

[a] Levels listed are based on EPA Region 9 Industrial PRGs. For analytes that do not have established values, the Navy and regulators will be consulted to provide guidance on acceptable levels.
[b] Levels listed are based on Total Threshold Limit Concentration (TTLC) values.
[c] Values listed are from validated analytical methods.
[d] Value listed is for total 1,3-dichloropropene.
[e] Value listed is for the sum of 4,4- DDD, 4,4- DDE, and 4,4- DDT.
[f] Value listed is for the sum of heptachlor and heptachlor epoxide.
[g] Value listed is for total PCBs.

TABLE 1-2

PROPOSED REPORTING LIMITS FOR INDEPENDENT LABORATORY ANALYSIS

Abbreviations and Acronyms:

µg/kg – micrograms per kilogram
µg/L – micrograms per liter
DON – Department of the Navy
mg/kg – milligrams per kilogram
N/A – not applicable
NE – none established
PCB – polychlorinated biphenyl
PRG – Preliminary Remediation Goal
STLC – Soluble Threshold Limit Concentration
SVOC – semi-volatile organic compound
TCLP – Toxicity Characteristic Leaching Procedure
TTLC – Total Threshold Limit Concentration
VOC – volatile organic compound

TABLE 2-1

EMERGENCY INFORMATION

REPORT ALL FIRES, SERIOUS INJURY, OR UNCONTROLLED SPILLS IMMEDIATELY: 911 (CALL WILL ROUTE TO CALIFORNIA HIGHWAY PATROL IN VALLEJO ON A CELL PHONE)

Hospital:	Alameda Hospital (510) 522-3700 2070 Clinton Avenue Alameda, CA 94501			
Directions:	Starting at the front of the base, turn left on Ranger Avenue. Turn right on Lexington and left on Navy Way. Take Navy Way to Main Street and turn right. Continue to Central Avenue. Central Avenue becomes CA/61. Continue on to CA/61 to Chestnut Street and turn left onto Clinton.			
Clinic:	Concentra Medical Center (510) 465-9565 384 Embarcadero W Oakland, CA 94607			
Directions:	From Atlantic, turn left onto SR-61 (Webster Street) for 0.6 miles. Bear right onto Posey Tube for 0.6 miles and continue north on Harrison Street for about 150 yards. Turn left onto 6th Street for about 200 yards, left onto Broadway Street for 0.3 miles, and right onto West Embarcadero for 80 yards to Concentra Medical Clinic.			
Fire/Police/EMS:	911 This number will connect you to emergency dispatch. ***911 calls from a cell phone do not go directly to Base emergency services, but through the California Highway Patrol.*** **If using a cell phone, call Alameda Fire Dispatch directly at (925) 447-4257.**			
TtEC Contacts:	Project Manager June Yi (949) 756-7559	PESM (CIH) Roger Margotto (619) 471-3503 cell: (619) 988-0520	Project SHSS TBD	
RPM:	Steve Peck, (619) 532-0786			
ROICC:	Gregory Grace, (510) 749-5940			
Poison Control Center:	California Poison Control System, Central Office University of California, San Francisco School of Pharmacy, Box 1262 San Francisco, CA 94143 Emergency Phone: (800) 876-4766 [All of CA]			

TABLE 2-1

EMERGENCY INFORMATION

CHEMTREC:	(800) 424-9300
National Response Center:	(800) 424-8802
RCRA Hotline:	(800) 424-9346

Abbreviations and Acronyms:

CIH – Certified Industrial Hygienist
EMS – Emergency Medical Services
PESM – Project Environmental Safety Manager
RCRA – Resource Conservation and Recovery Act
ROICC – Resident Officer in Charge of Construction
RPM – Remedial Project Manager
SHSS – Site Health and Safety Specialist
TBD – to be determined
TtEC – Tetra Tech EC, Inc.

TABLE 4-1

SUMMARY OF WASTE MANAGEMENT, TRANSPORTATION, AND DISPOSAL REQUIREMENTS

Waste Types	Characterization Requirements	Containment Requirements	Storage Requirements	Transportation Requirements	Disposal Requirements
Soil	Unless a waste determination (such as RCRA hazardous, non-RCRA hazardous, or non-hazardous) can be made based on generator knowledge, soil (including soil cuttings from sampling activities) will be sampled in accordance with Section 4.0. Samples will be run for potential contaminants including: VOCs, SVOCs, TPH, total metals, pesticides, PCBs, and STLC or TCLP, as needed.	Contain within 55-gallon metal drums (1A2).	Unless predetermined to be hazardous or known to be non-hazardous, containers will be marked with the following information: **"POTENTIALLY HAZARDOUS WASTE – ANALYSIS PENDING."** Container labeling will also include the accumulation start date and the contents of the container. Containers will be sealed/covered when not being loaded/unloaded, and they will be elevated to prevent contact with any ponded precipitation and/or liquids. Containers will be stored within a designated hazardous waste storage area, within secondary containment. Hazardous waste may only be stored on site for less than 90 days.	If material is a hazardous waste, the container must be labeled with the appropriate labels. A hazardous waste manifest and DOT vehicle placarding are required. Must use a Cal/EPA-permitted transporter. Must have LDR certifications as necessary. Hazardous waste manifest will be signed by the Navy. Individuals involved in overseeing or shipping hazardous materials must meet DOT training requirements.	All soil will be sent off site for disposal at an appropriate TSDF approved under the CERCLA Off-site Rule. Prior to transport, the soil will be segregated as RCRA hazardous, non-RCRA hazardous, and/or non-hazardous. An ESQ scientist must prequalify any TSDF and/or transporter prior to shipment of waste.
Non-hazardous waste (trash, inert construction debris, clean polyethylene liners, and so forth)	Materials generated during the investigation activities and not contaminated with any waste or waste residue may be characterized as a non-hazardous solid waste.	Wastes to be stored in non-hazardous roll-off bins or stockpiles.	Non-hazardous waste will be stored separately from hazardous waste and labeled accordingly to prevent commingling of hazardous and non-hazardous wastes.	There are no special transporter requirements for wastes determined to be non-hazardous. A contracted solid waste management company will collect the material.	Non-hazardous waste will be disposed of off site at an approved Class III solid waste landfill. An ESQ scientist must prequalify any TSDF and/or transporter prior to shipment of waste.

TABLE 4-1

SUMMARY OF WASTE MANAGEMENT, TRANSPORTATION, AND DISPOSAL REQUIREMENTS

Waste Types	Characterization Requirements	Containment Requirements	Storage Requirements	Transportation Requirements	Disposal Requirements
Wastewater (decontamination water, displaced groundwater)	Unless a waste determination (such as RCRA hazardous or non-hazardous) can be made based on generator knowledge, the material will be sampled to determine appropriate management and disposal procedures. Samples will be run for potential contaminants including VOCs, SVOCs, TPH, PCBs, pesticides, and metals analysis.	DOT-approved 55-gallon metal drums (1A1) or aboveground tank.	Unless predetermined to be hazardous or known to be non-hazardous, containers will be marked as follows: **"POTENTIALLY HAZARDOUS WASTE -ANALYSIS PENDING"** Container labeling will also include the accumulation start date and the contents of the container. Containers will be sealed/covered when not being loaded/unloaded, and they will be elevated to prevent contact with any ponded precipitation and/or liquids. Containers will be stored within a designated hazardous waste storage area, within secondary containment. Hazardous waste may only be stored on site for less than 90 days.	If material is a hazardous waste, a hazardous waste manifest and DOT vehicle placarding are required. Must use a Cal/EPA-permitted transporter. Must also have LDR certifications as necessary. Hazardous waste manifest will be signed by the Navy. Individuals involved in overseeing or shipping hazardous materials must meet DOT training requirements.	The waste will be containerized and sent off site for disposal at an appropriate TSDF approved under the CERCLA Off-site Rule. An ESQ Scientist must prequalify any TSDF and/or transporter prior to shipment of waste.
PPE and sampling equipment	Use process knowledge to make a waste determination. PPE and decontaminated sampling equipment can be managed as a non-hazardous solid waste.	Use double-plastic bags at point of generation to transport to the 90-day accumulation area. DOT-approved 55-gallon, metal, (open top) drums (1A2).	Each container of PPE and sampling equipment will be labeled with a green non-hazardous waste label. The container will be labeled as **"NON-HAZARDOUS WASTE - PERSONAL PROTECTIVE EQUIPMENT/SAMPLING EQUIPMENT"** Containers will be sealed/covered when not being loaded/unloaded, and they will be elevated to prevent contact with any ponded precipitation and/or liquids. Containers will be stored within a designated hazardous waste storage area, within secondary containment.	There are no special transporter requirements for wastes determined to be non-hazardous. A contracted solid waste management company will collect the material.	Decontaminated PPE may be disposed at an approved Class III solid waste landfill. An ESQ scientist must prequalify any TSDF and/or transporter prior to shipment of waste.

TABLE 4-1

SUMMARY OF WASTE MANAGEMENT, TRANSPORTATION, AND DISPOSAL REQUIREMENTS

Waste Types	Characterization Requirements	Containment Requirements	Storage Requirements	Transportation Requirements	Disposal Requirements
Unidentified Waste Streams (that is, waste streams that may be generated during site activities, but have yet to be identified)	Unless a waste determination (for example, RCRA hazardous, non-RCRA hazardous, or non-hazardous) can be made based on generator knowledge, the material will be sampled to determine appropriate management and disposal procedures. Samples will be run for potential contaminants including: VOCs, SVOCs, TPH, total metals analysis, and STLC or TCLP, as appropriate.	DOT-approved 55-gallon metal drums (1A1 or 1A2) depending on whether a liquid or solid.	Unless predetermined to be hazardous or known to be non-hazardous, containers will be marked as follows: **"POTENTIALLY HAZARDOUS WASTE -ANALYSIS PENDING"** Container labeling will also include the accumulation start date and the contents of the container. Containers will be sealed/covered when not being loaded/unloaded, and they will be elevated to prevent contact with any ponded precipitation and/or liquids. Containers will be stored within a designated hazardous waste storage area, within secondary containment. Hazardous waste may only be stored on site for less than 90 days.	If material is a hazardous waste, a hazardous waste manifest and DOT vehicle placarding are required. A Cal/EPA permitted transporter must be used. Individuals involved in overseeing or shipping hazardous materials must also have LDR certifications as necessary. Hazardous waste manifest will be signed by the Navy. Individuals involved in overseeing or shipping hazardous materials must meet DOT training requirements.	Non-hazardous waste will be disposed off site at an approved Class III solid waste landfill An ESQ scientist must prequalify any TSDF and/or transporter prior to shipment of waste.

Abbreviations and Acronyms:

Cal/EPA – California Environmental Protection Agency
CERCLA – Comprehensive Response, Compensation, and Liability Act
DOT – Department of Transportation
ESQ – Environmental Safety and Quality
LDR – land disposal restriction
PCB – polychlorinated biphenyl
PPE – personal protective equipment
RCRA – Resource Conservation and Recovery Act
STLC – Soluble Threshold Limit Concentration
SVOC – semivolatile organic compound
TCLP – Toxicity Characteristic Leaching Procedure
TPH – total petroleum hydrocarbons
TSDF – treatment, storage, and disposal facility
VOC – volatile organic compound

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FIGURES

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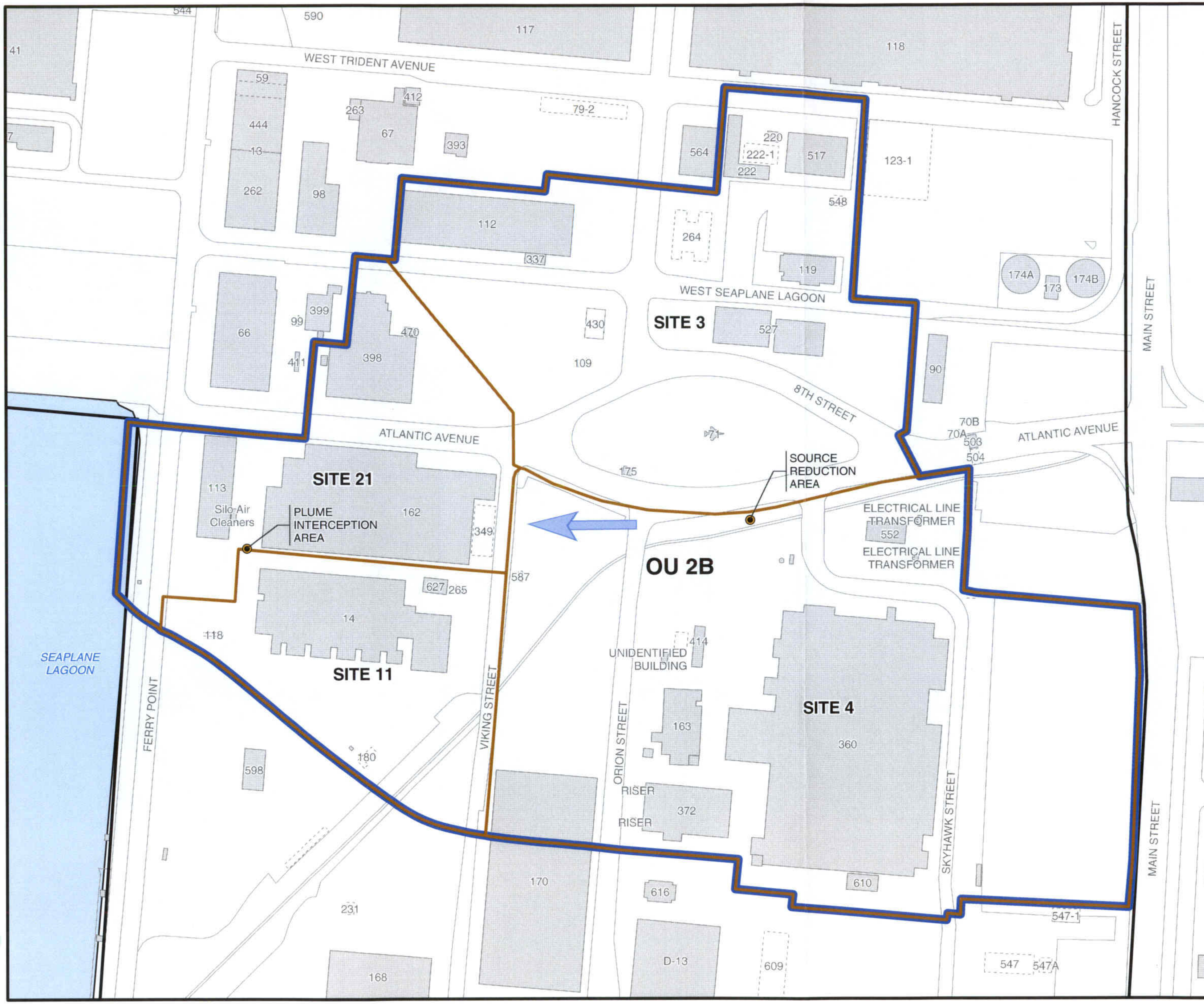
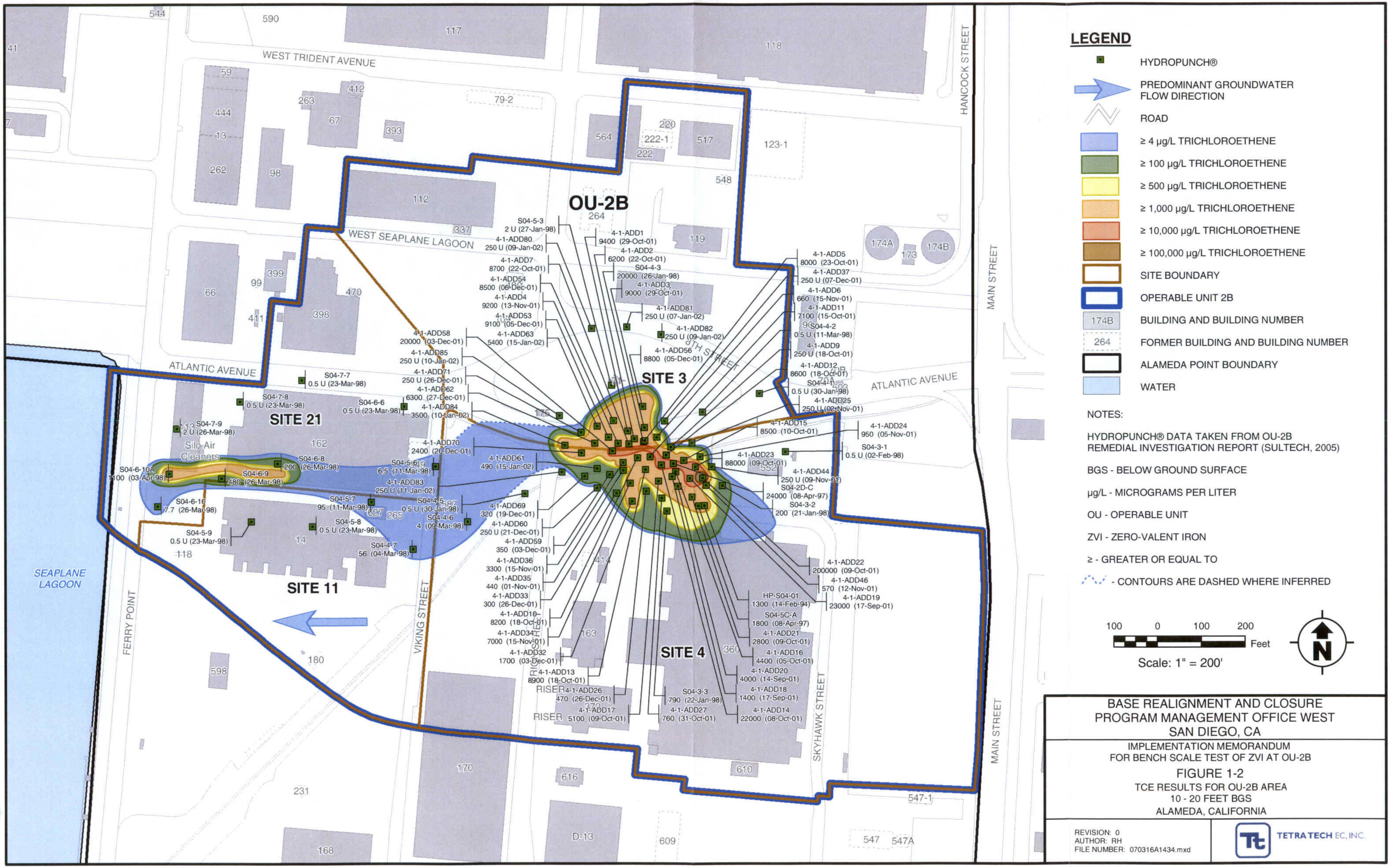


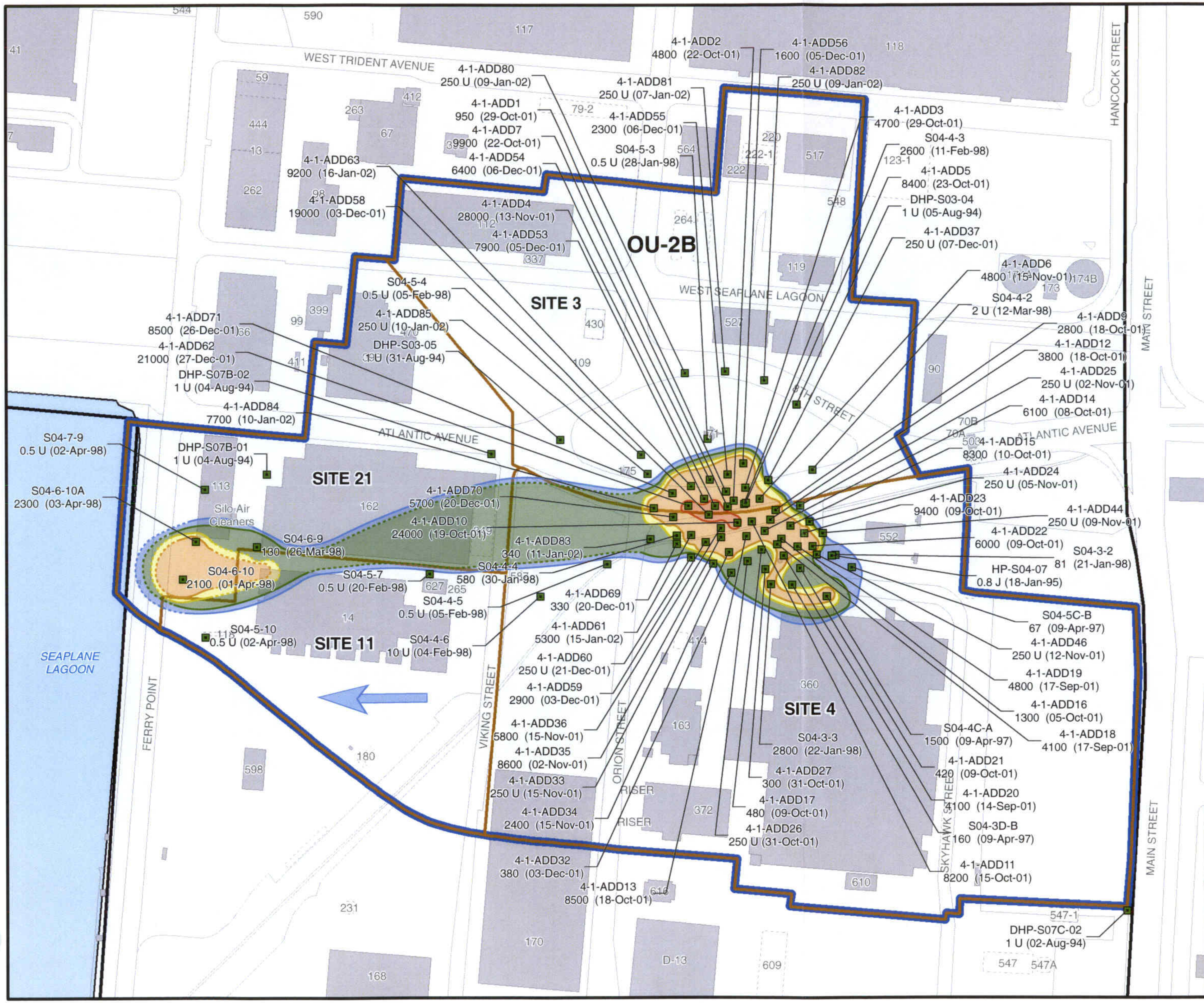
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CA

IMPLEMENTATION MEMORANDUM
FOR BENCH SCALE TEST OF ZVI AT OU-2B

FIGURE 1-1
BORING LOCATION MAP
ALAMEDA, CALIFORNIA

REVISION: 0
AUTHOR: RKH
FILE NUMBER: 070316L1433.mxd


OU-2B
SITE 3
SITE 21
SITE 11
SITE 4
SEAPLANE LAGOON
WEST TRIDENT AVENUE
WEST SEAPLANE LAGOON
ATLANTIC AVENUE
HANCOCK STREET
MAIN STREET
FERRY POINT
VIKING STREET
SKYHAWK STREET
5TH STREET
LEGEND
HYDROPUNCH®
PREDOMINANT GROUNDWATER FLOW DIRECTION
ROAD
≥ 4 µg/L TRICHLOROETHENE
≥ 100 µg/L TRICHLOROETHENE
≥ 500 µg/L TRICHLOROETHENE
≥ 1,000 µg/L TRICHLOROETHENE
≥ 10,000 µg/L TRICHLOROETHENE
≥ 100,000 µg/L TRICHLOROETHENE
SITE BOUNDARY
OPERABLE UNIT 2B
BUILDING AND BUILDING NUMBER
FORMER BUILDING AND BUILDING NUMBER
ALAMEDA POINT BOUNDARY
WATER
NOTES:
HYDROPUNCH® DATA TAKEN FROM OU-2B REMEDIAL INVESTIGATION REPORT (SULTECH, 2005)
BGS - BELOW GROUND SURFACE
µg/L - MICROGRAMS PER LITER
OU - OPERABLE UNIT
ZVI - ZERO-VALENT IRON
≥ - GREATER OR EQUAL TO
- CONTOURS ARE DASHED WHERE INFERRED
100 0 100 200 Feet
Scale: 1" = 200'
N
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CA
IMPLEMENTATION MEMORANDUM
FOR BENCH SCALE TEST OF ZVI AT OU-2B
FIGURE 1-2
TCE RESULTS FOR OU-2B AREA
10 - 20 FEET BGS
ALAMEDA, CALIFORNIA
REVISION: 0
AUTHOR: RH
FILE NUMBER: 070316A1434.mxd
TETRA TECH EC, INC.



LEGEND

- HYDROPUNCH®
- PREDOMINANT GROUNDWATER FLOW DIRECTION
- ROAD
- ≥ 4 μg/L TRICHLOROETHENE
- ≥ 100 μg/L TRICHLOROETHENE
- ≥ 500 μg/L TRICHLOROETHENE
- ≥ 1,000 μg/L TRICHLOROETHENE
- ≥ 10,000 μg/L TRICHLOROETHENE
- SITE BOUNDARY
- OPERABLE UNIT 2B
- 174B BUILDING AND BUILDING NUMBER
- 264 FORMER BUILDING AND BUILDING NUMBER
- ALAMEDA POINT BOUNDARY
- WATER

NOTES:

HYDROPUNCH® DATA TAKEN FROM OU-2B REMEDIAL INVESTIGATION REPORT (SULTECH, 2005)

BGS - BELOW GROUND SURFACE

μg/L - MICROGRAMS PER LITER

OU - OPERABLE UNIT

ZVI - ZERO-VALENT IRON

≥ - GREATER OR EQUAL TO

- CONTOURS ARE DASHED WHERE INFERRED

100 0 100 200 Feet

Scale: 1" = 200'

N

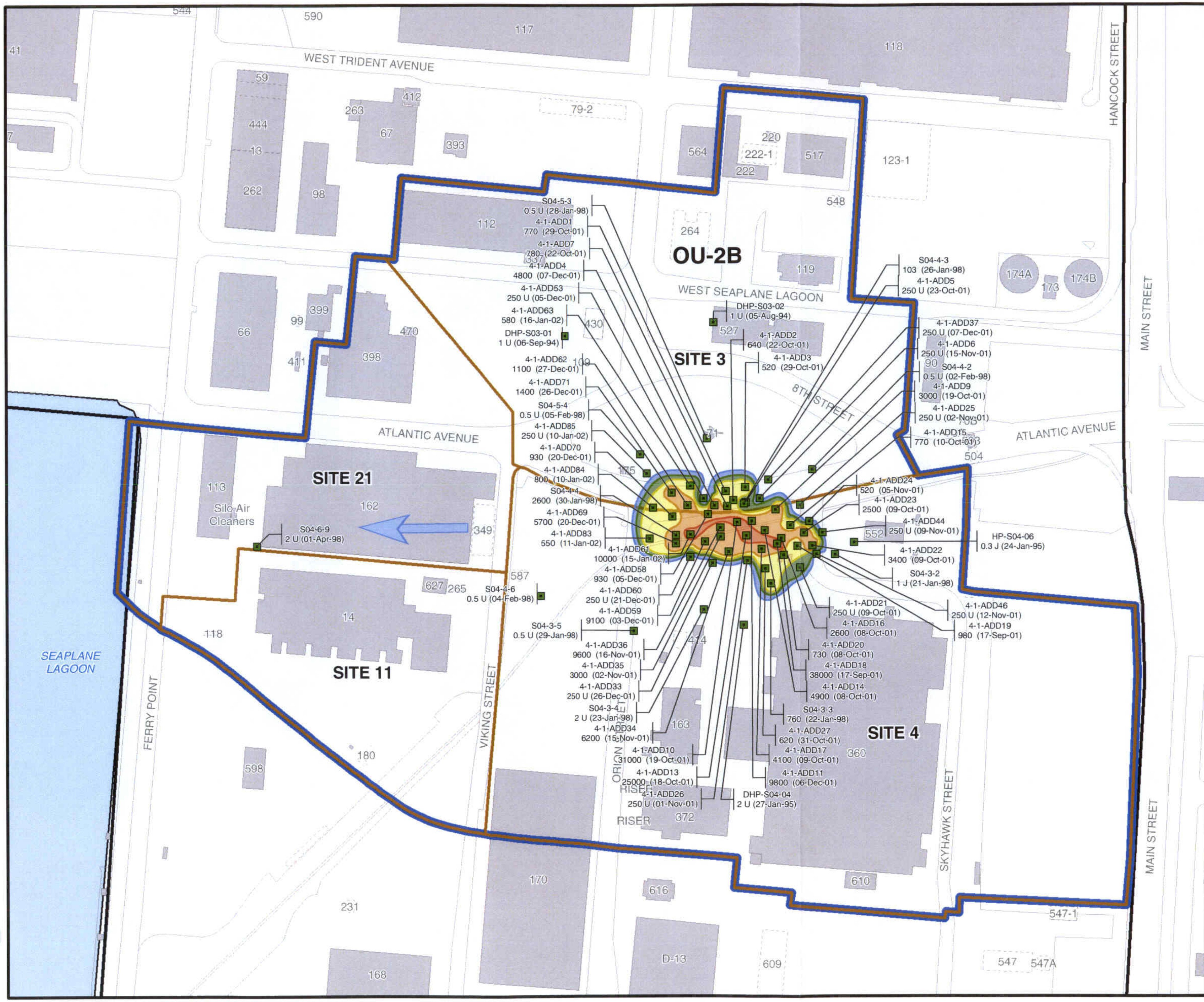
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CA

IMPLEMENTATION MEMORANDUM
FOR BENCH SCALE TEST OF ZVI AT OU-2B

FIGURE 1-3
TCE RESULTS FOR OU-2B AREA
20 - 30 FEET BGS
ALAMEDA, CALIFORNIA

REVISION: 0
AUTHOR: GFG
FILE NUMBER: 070316A1435.mxd

TETRA TECH EC, INC.



LEGEND

- HYDROPUNCH®
- PREDOMINANT GROUNDWATER FLOW DIRECTION
- ROAD
- ≥ 4 μg/L TRICHLOROETHENE
- ≥ 100 μg/L TRICHLOROETHENE
- ≥ 500 μg/L TRICHLOROETHENE
- ≥ 1,000 μg/L TRICHLOROETHENE
- ≥ 10,000 μg/L TRICHLOROETHENE
- SITE BOUNDARY
- OPERABLE UNIT 2B
- 174B BUILDING AND BUILDING NUMBER
- 264 FORMER BUILDING AND BUILDING NUMBER
- ALAMEDA POINT BOUNDARY
- WATER

NOTES:

HYDROPUNCH® DATA TAKEN FROM OU-2B REMEDIAL INVESTIGATION REPORT (SULTECH, 2005)

BGS - BELOW GROUND SURFACE

μg/L - MICROGRAMS PER LITER

OU - OPERABLE UNIT

ZVI - ZERO-VALENT IRON

≥ - GREATER OR EQUAL TO

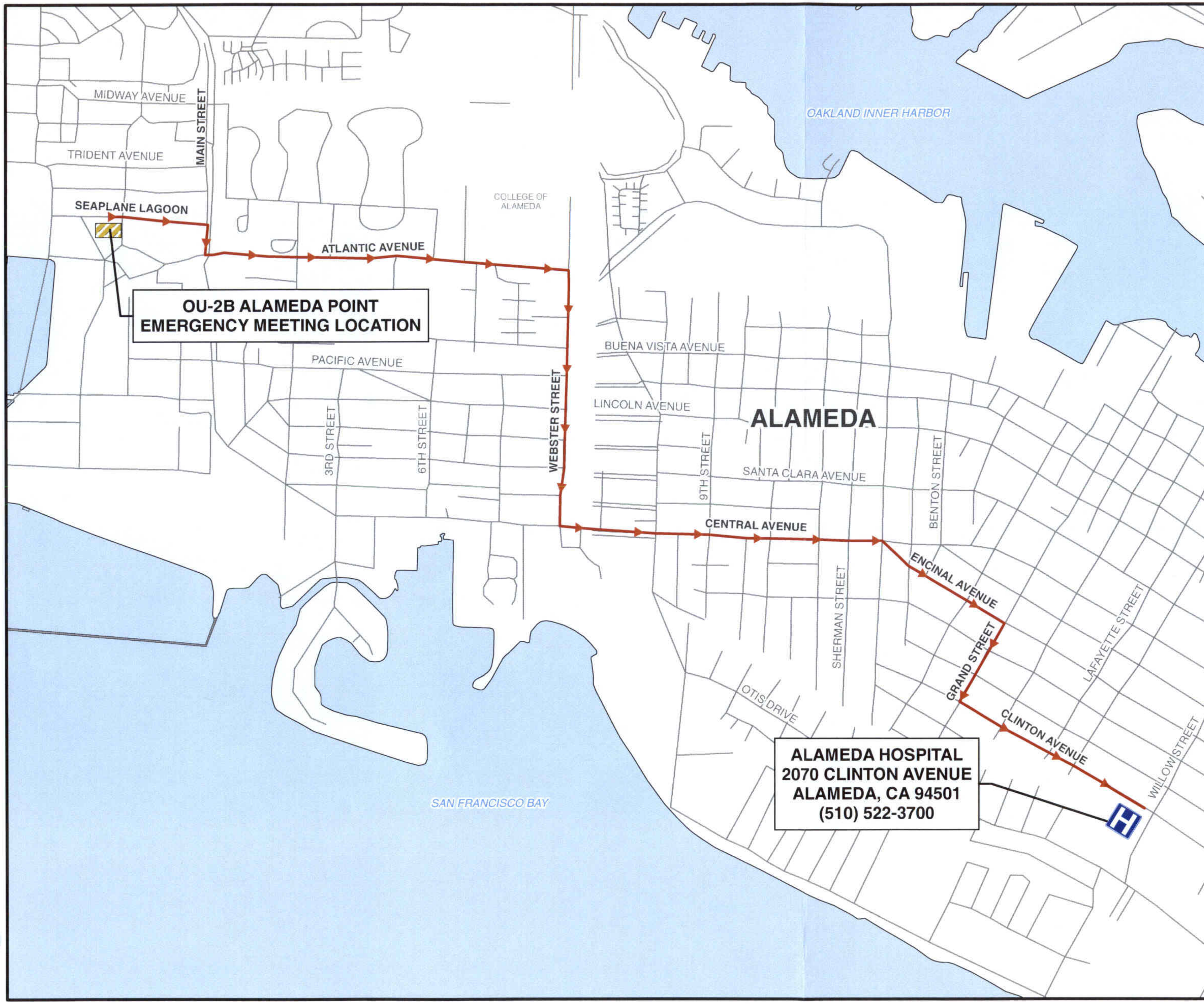
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CA

IMPLEMENTATION MEMORANDUM
FOR BENCH SCALE TEST OF ZVI AT OU-2B

FIGURE 1-4
TCE RESULTS FOR OU-2B AREA
30 - 40 FEET BGS
ALAMEDA, CALIFORNIA

REVISION: 0
AUTHOR: GFG
FILE NUMBER: 070316A1436.mxd

TETRA TECH EC, INC.



LEGEND

- ROAD
- HOSPITAL ROUTE
- BUILDING 112/EMERGENCY LOCATION

NOTE:

OU - OPERABLE UNIT

HOSPITAL DIRECTIONS:

EXIT EAST OUT OF SITE TRAVELING ON SEAPLANE LAGOON TOWARDS MAIN STREET. TURN RIGHT ON MAIN STREET HEADING SOUTH. TURN LEFT ONTO ATLANTIC AVENUE. TURN RIGHT ONTO WEBSTER STREET HEADING SOUTH TO CENTRAL AVENUE. TURN LEFT ONTO CENTRAL AVENUE HEADING EAST TO ENCINAL AVENUE. MAKE SLIGHT RIGHT ONTO ENCINAL AVENUE HEADING SOUTHEAST TO GRAND STREET. TURN RIGHT ON GRAND STREET HEADING SOUTHWEST TO CLINTON AVENUE. TURN LEFT ONTO CLINTON AVENUE HEADING SOUTHEAST TO ALAMEDA HOSPITAL (2070 CLINTON AVENUE).

600 0 600 1,200 Feet

Scale: 1" = 1200'

N

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CA

IMPLEMENTATION MEMORANDUM
FOR BENCH SCALE TEST OF ZVI AT OU-2B

FIGURE 2-1

HOSPITAL ROUTE MAP

ALAMEDA, CALIFORNIA

REVISION: 0
AUTHOR: RKH
FILE NUMBER: 070316L1437.mxd

TETRA TECH EC, INC.

ATTACHMENT 1

SCOPE OF WORK FOR ZVI BENCH SCALE TEST

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Zero Valent Iron (ZVI) Treatability Study at OU-2B
Contract Task Order (CTO) 0020
Alameda Point
Alameda, California

SCOPE OF WORK

Prepared by:
Tetra Tech EC, Inc.

Prepared Under:
Contract N62473-06-D-2201
U.S. Navy, Southwest Division
Naval Facilities Engineering Command, Southwest (NAVFAC SW)
Remedial Action Contract

Prepared	Reviewed	Approved	Date	Pages Affected
M. Losi	D. Goldman	J. Yi	1/24/07	All

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

1.0 GENERAL INFORMATION

Tetra Tech EC, Inc. (TtEC) is soliciting bids in order to place a subcontract with Carnegie Mellon University (CMU) to conduct a bench-scale treatability study.

Soil and groundwater impacted with chloroethenes (CEs) have been targeted for treatment using zero valent iron (ZVI) at Alameda Point (the site). Accordingly, a bench-scale treatability study will be conducted to preliminarily assess treatment performance of several ZVI materials, and to obtain data for field-scale implementation. Two separate treatment applications will be employed to address contaminants at the site, including: (i) a source reduction application, and (ii) a plume interception application. The main contaminant is trichloroethene (TCE), which, based on recent data taken from the Summer 2005 Quarterly Groundwater Monitoring Data Report, is present near the source reduction area (well MW360-1 near Building 360) at a maximum concentration of 2,400 micrograms per liter (μg/L) (average of 2,050 μg/L) and near the plume interception area (well M11-06 near Building 162) at a maximum concentration of 3.6 μg/L (average of 1.3 μg/L). However, both monitoring wells are completed in the uppermost portion of the First Water Bearing Zone (FWBZ). There are no monitoring wells completed at the target contaminant depth interval of 20 to 40 feet below ground surface. Historical Hydropunch data taken from the Remedial Investigation Report (see Figures 1-2 through 1-4 of the Implementation Memo) indicate a maximum concentration of 200,000 μg/L in the source reduction area and a maximum concentration of 2,300 μg/L in the plume interception area. In addition, a preliminary review of the CE data reveals evidence of some anaerobic degradation of TCE (dichloroethene [DCE] and vinyl chloride [VC] are present). Because oxygen can impair use of ZVI, evidence of anaerobicity suggests that the site may be favorable for use of ZVI.

Nothing contained herein relieves the Subcontractor from fulfilling the requirements stipulated in the Subcontract in its entirety.

The TtEC Technical Points of Contact for this Project are:

Mark Losi (949) 756-7516 (Project Technical Lead)

June Yi (949) 756-7559 (Project Manager)

The TtEC Contractual/Procurement Point of Contact is:

Will Paty (619) 471-352

2.0 SCOPE OF WORK

Recent technological advances have led to the development of a number of products that are comprised of or contain various preparations of ZVI for in-situ treatment applications. The laboratory bench-scale tests will be used to evaluate several ZVI materials for treating CEs via in-situ reductive dechlorination. The work will be conducted at CMU under the direction of Dr. Greg Lowry, who is a renowned expert in testing various nano-scale ZVI (NZVI) particles.

2.1 OBJECTIVES

The overall objective of the laboratory work is to screen and test ZVI and ZVI-based materials to select one or more materials for use in the field treatability study for the source reduction and the plume interception applications via direct injection. This will involve microcosm testing (soil/groundwater/headspace systems), and possibly focused column testing as well. Initially, microcosm tests will be conducted to determine the most effective ZVI material(s) in removing CEs from site soil and groundwater for the source reduction application and/or plume interception application. The following specific aspects will be addressed:

- The mass of TCE reduced/mass of ZVI added
- The rate of dechlorination
- The propensity for formation of chlorinated byproducts

Depending on the results of the microcosm studies, focused column testing may be conducted to assess mobility of one or possibly two types of ZVI selected.

2.2 SUMMARY OF WORK

This document presents a general scope of work that will be conducted at CMU to address the objectives outlined above. The major tasks involved in executing the work are outlined as follows:

Task 1: Work Plan Development/Finalization: Develop and finalize a focused laboratory study work plan. This may include review of site data to preliminarily assess the potential for success of this approach, and development and/or modification of the experimental details, including the objectives, basic approach, and procedures/methodologies. Final experimental details will consider Dr. Lowry's in-house capabilities, laboratory equipment, and preferred methodologies. The laboratory study work plan will be prepared in draft and final versions and submitted to Tetra Tech EC, Inc. (TtEC) for review and approval before proceeding with Task 2. This task will require coordination with TtEC and manufacturers of ZVI materials.

Task 2: Microcosm Experiments: Conduct microcosm experiments separately for source reduction and plume interception to compare a variety of potentially applicable ZVI materials. These will likely include several ZVI preparations and other materials that incorporate ZVI along with an organic substrate.

Task 3: Column Experiments: Conduct column experiments under simulated aquifer conditions on the most promising materials (no more than two) identified in the microcosm tests. Column experiments will be conducted only for the source reduction application. The main objective of the column experiments would be to estimate the mobility and expected radius of influence of the selected materials.

Task 4: Reporting: Generate a report containing detailed discussions of procedures, results, interpretations, and recommendations for field pilot-scale implementation. Submit draft and final versions. Submit a draft report after completion of Task 2. Prepare the final report after completion of Task 3 and include results from Task 2 and Task 3.

Each treatment application (source reduction and plume interception) will be assessed separately. The plume interception application will only require microcosm testing, as mobility of the material is not of primary importance. However (as noted), for the source reduction application, the most effective materials identified in the microcosm test will likely be tested in the column experiments to estimate and compare mobility. The methods for conducting such tests will depend highly on the injection method used to inject the particles. This may vary for each material, and will be determined once the materials are selected.

2.3 WORK ELEMENTS DETAILS

Development and finalization of the work plan (Task 1) will be conducted immediately after the contract with CMU is in place. Microcosm and column tests (Tasks 2 and 3, respectively) will be conducted thereafter, based on the protocols established for the work plan under Task 1. The draft report (Task 4) will be due no later than 3 weeks following completion of microcosm experiments (Task 2). The final report will be due no later than 3 weeks following completion of Task 3. The following subsections discuss each task in further detail.

2.3.1 Task 1: Work Plan Development/Finalization

ZVI injection is an in-situ technology that destroys CEs via abiotic reductive processes. Basically ZVI is injected within the subsurface in CE-impacted groundwater, where it undergoes chemical oxidization. Through this process, electrons are transferred to CEs, thereby causing reduction to innocuous end products. The major advantages of ZVI over comparable technologies (in-situ chemical oxidation [ISCO] and in-situ bioremediation [ISB]) are that the material has the potential to remain active over relatively long time periods, (compared with ISCO), depending on the pH at the point of application, reductive dechlorination is rapid (compared with ISB), and the process brings about complete reduction of CEs without significant generation of daughter products (as is observed with ISB). In field applications, however, chlorinated byproducts have been observed after ZVI injection, possibly due to biostimulation and increased biodegradation of TCE, which leads to chlorinated byproducts. In addition, several available amendments incorporate ZVI along with an organic substrate, which essentially takes advantage of both abiotic and biological processes. Brief descriptions of materials that may be relevant to this study and general characteristics are presented in Table 1.

It is currently envisioned that two areas will require treatment: a plume interception area, and a source reduction area. These applications may likely require a different type of ZVI material. Treatment for the plume interception area will involve emplacing a material in the pathway of the plume to generate a continual treatment zone, or barrier, where contaminated water would be treated as it flows through the zone. For this application, a material with a relatively long lifetime will likely be required (i.e., larger iron grain sizes, or iron that incorporates a slow-release carbon source to stimulate biological process). For the source reduction area, treatment would ideally be more rapid, and success will largely be a function of getting the material distributed throughout the contaminated area as efficiently as possible. Thus, smaller iron particles (nano-scale), which are more reactive and are depleted faster, but have been shown to be more mobile in groundwater systems, are potentially appropriate for this application. It is noted, however, that micro scale iron may also be applicable and cost-effective for treating the source area due to recent advances in injection technology, and will thus be included as such.

For the current study, we anticipate testing the following materials in the respective applications:

Plume Interception Application

- Microscale ZVI
- Emulsified ZVI (EZVI)or EHC™[1]

Source Reduction Application

- Catalyzed NZVI
- Surface Modified NZVI
- Microscale ZVI

It is noted that several different types of microscale ZVI and NZVI are commercially available, that may differ significantly in terms of various aspects of applicability and costs. Final selection of materials will be based on potential for success in the field from both technical and economic perspectives. As noted, the laboratory study work plan will be prepared in draft and final versions and submitted to TtEC for review and approval before proceeding with Task 2. Coordination with TtEC and manufacturers of ZVI materials will be required.

2.3.2 Task 2: Microcosm Experiments

Microcosm experiments will be performed to assess and compare the propensity for selected materials to stimulate CE reduction. Selected materials will be tested using contaminated water and soils from the respective location where they would potentially be implemented. TtEC will be responsible for collecting and shipping representative samples from the site to CMU. Following field sampling, soil and groundwater subsamples will be sent to an independent laboratory for initial analyses of CEs and other selected water quality parameters (Table 2). TtEC will also coordinate with the manufacturers to ship the selected ZVI materials to CMU.

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[1] EHC™ is a product consisting of a controlled-release, integrated carbon (plant based) and ZVI source.

Prior to setting up the microcosms, groundwater CE concentrations will be measured at CMU, Microcosms (flasks or serum bottles) containing the groundwater and/or soil will be set up in triplicate, and spiked with selected ZVI amendments. If CE levels in the samples are not representative of site conditions (results of analyses following field sampling), appropriate CEs will also be spiked into microcosms). Blanks and controls will also be set up. Details of the microcosm set up (soil/water ratio, mass of amendments, etc.) will be specified as part of Task 1.

Microcosms will be sealed and incubated at room temperature and samples will periodically be withdrawn and analyzed as described below. The microcosm studies should yield one or two preferred amendments to be considered for use in the plume interception application, and one or two preferred amendments for source reduction application (the latter may be subjected to further column tests to assess mobility).

The microcosm experiments are expected to run a total of approximately 6 to 8 weeks; the actual time will depend on the rate of TCE dechlorination observed and the amount of time required to develop methods and validate quality assurance/quality control (QA/QC) protocols for the microcosms. Sampling and analysis will be conducted prior to addition of the respective amendments and at 2 days, 1 week, 2 weeks, and 1 month (subject to adjustment pending initial results). Analytes to be regularly measured will include CEs and non-chlorinated reaction products (e.g. acetylene, ethene, and ethane). Secondary parameters such as Fe(II), nitrate, pH, dissolved oxygen (DO), oxidation/reduction potential (ORP), and others as applicable, may be assessed to a limited extent if needed to ensure that the systems are behaving as predicted.

2.3.3 Task 3: Column Experiments

The field test will provide some data on mobility that cannot be evaluated in the laboratory scale because it is difficult to simulate injection conditions in the laboratory. However, bench scale column studies comparing the mobility of the different particle types in the groundwater and aquifer materials from the site will allow for an assessment of which particles have the best chance for mobility in the field test. The column studies will be conducted to determine the mobility of selected particle types (no more than two) under identical conditions (conditions as close as possible to those expected at the field site) so the relative mobility of each type can be compared. This information along with the reactivity studies will be used to determine which particles have the highest potential for success in the field for the source reduction application.

Following the microcosm experiments, the Work Plan will be updated accordingly to specify which materials will be tested in the column experiments. We anticipate running 4 columns (two treatments, two controls), but additional columns may be required. The apparatus will consist of columns that are used as part of a standard protocol designed by Dr. Lowry to assess ZVI materials. Details regarding the apparatus will be provided in the Work Plan.

The study will focus on particle migration, but may also include an assessment (as applicable, and to the extent possible) of destruction of CEs, various metabolites, secondary groundwater quality parameters (e.g., Fe(II), nitrate, pH, DO, ORP), and the leaching of other naturally-occurring metals as a result of the modified aquifer conditions). Microbiological analyses may be conducted as well (although this will significantly increase the length and cost of the study.

2.3.4 Task 4: Reporting

A draft report consisting of detailed explanations of all procedures, results, interpretations, conclusions, and recommended design parameters will be generated by CMU after completion of Task 2. The draft report will be submitted for review and comment, and a revised, final report, incorporating comments, will be issued at the conclusion of Task 3. The work in progress final report will be submitted for an interim review. Results, conclusions, and recommendations will include, at a minimum, graphs of CE concentrations over time, graphs or tables of other analytical results (ORP, pH, other anions, etc.), discussions of the effects of the amendment on all measured parameters, recommended loading rates for each amendment tested, and kinetic information (calculated rate constants) addressing reaction rates for comparing materials and for predicting general remediation time frames in the field. All raw analytical data (internally generated data, and outside laboratory reports) will be included as an attachment.

2.4 ASSUMPTIONS

1) Approximately 20 liters (L) of saturated soil and 20 L of contaminated groundwater will be collected from each of the two locations. These will be collected by TtEC. The soil samples may be composited from several subsamples collected from the zone where treatment is most likely to occur. Subsample aliquots will be sent to an independent analytical laboratory for initial analysis of CEs and other relevant parameters.

2) Samples collected and sent to the laboratory for bench tests are subject to variability. Efforts will be made to collect samples from the most contaminated zones where treatment will be targeted, although the available data are limited and somewhat outdated and conditions have likely changed.

3) It is understood that data from microcosm studies be made available as soon as possible for evaluation and selection of materials for the field pilot-scale implementation (i.e. before conducting any column studies). A draft report will be submitted containing the results of microcosm studies. In the interest of expediting the current schedule, preparation of the field work plan can thus be conducted concurrently with column study work and reporting.

4) In general, a thorough assessment of ZVI amended with organic substrates (EHC and EZVI) may require more time than the 6-week time frame planned for the microcosm tests. Biological reduction of CEs requires growth, evolution, and maintenance of an integrated microbial community and the process involves generation and subsequent degradation of daughter products. Thus, biological reduction of CEs is generally considered slower and less predictable than reduction via ZVI. It is therefore acknowledged that, based on schedule constraints, it may be necessary to end the experiment prior to fully determining the results of organic-amended treatments. If

this is the case, results will be interpreted to the extent possible based on the data collected.

5) The work will be conducted at room temperature (20 - 22 °C).

6) Sacrificial batch microcosm solutions will be analyzed periodically as needed to assess contaminant levels and trends during the respective tests. Although the main objective of the column test is to assess ZVI migration, influent and effluent samples may be analyzed for CEs as well. The frequency of the analyses may vary based on previous results and the operations being conducted.

7) The analytical work for CEs will be performed in house at CMU. Inorganic analysis (e.g. general water quality [WQ] parameters) will be conducted by an EPA-certified commercial laboratory (Severn Trent Laboratories, Pittsburgh, PA). Microbial parameters (if assessed), will likely be analyzed at an outside laboratory as well.

8) The experiments will be conducted with the goal of simulating field conditions as closely as possible. However, it is acknowledged that considerable uncertainty exists in translating laboratory batch microcosm studies to the field. Therefore, it is understood that any data from the experiments described herein will be subject to variation in the field.

3.0 SCHEDULE

To be determined.

4.0 MEASUREMENT AND PAYMENT

Subcontractor shall submit a single invoice to TtEC at the completion of all work elements incorporated in the Schedule of Values (Attachment A) and Subcontractor's cumulative progress against each Pay Item based on actual progress of work, as reported to and validated by TtEC. TtEC shall evaluate Subcontractor's status of all work completed. The basis for establishing level of progress shall include, but is not limited to: TtEC's review of Subcontractor's submittals. In the event that invoice adjustments are required by TtEC based on the evaluation of work performed, Subcontractor shall make such adjustments and submit a revised invoice to TtEC.

Measurement of work performed shall be based on the progress of the work and the amount of work completed. The lump sum and unit prices provided by the Subcontractor for each pay item in the Schedule of Values shall cover Subcontractor's full and complete compensation, satisfaction, and discharge for all work done and all costs and expense incurred, damages sustained, and for each and every matter, thing or act performed, furnished or suffered in the full and complete performance and completion of the work of this Subcontract, except as may be modified pursuant to the General Terms and Conditions.

TABLE 1

INFORMATION REGARDING ZERO VALENT IRON AND ZERO VALENT IRON -BASED AMENDMENTS UNDER CONSIDERATION

PRODUCT	SUPPLIER	COST	CONTACT	ESTABLISHED METHODS?	COMMENTS
"Catalyzed" BNP, or "NanoFe"	PARS Environmental	$40-$65/lb, depending on quantity	Harch Gill 800 959 1119	No	Will provide samples Would need signed NDA Catalyst is palladium Wants to review protocol Affiliated with Zhang of Lehigh Claims to be only vendor that can provide large quantities
"Catalyzed" Z-loy	OnMaterials, Inc.	$23/lb, low teens for large quantities	Clint Bickmore, Ph.D. 303 952 4520	Maybe	Will provide samples Would need signed NDA Propylene glycol coated to protect/activate Can provide large quantities 200 nm Does not like to think of in terms of moving w/groundwater, possibly viewed as a contaminant
"Catalyzed" PolyMetallix™	Crane Company (Polyflon)	$72-$77/lb, depending on quantity Cheaper w/large quantities	Will LaRusso 203 840 7555	No	Will provide samples for bench-scale Would need signed NDA Can produce large quantities
Polymer-Modified Nanoiron	Toda America	$34-$45/lb, depending on quantity	Andy Jazdanian, PhD 847 525 3097	Greg Lowry has worked extensively with this material	70 nm Can provide large quantities – need 2-3 months lead time Doesn't provide injection services or technical help Biodegradable polymer - coated to enhance dispersion and longevity
Microscale ZV)	ARS Technologies	$1-$1.70/lb	John Poulson 415 828 1177		Will supply powder No issues with large quantity

TABLE 1

INFORMATION REGARDING ZERO VALENT IRON AND ZERO VALENT IRON -BASED AMENDMENTS UNDER CONSIDERATION

PRODUCT	SUPPLIER	COST	CONTACT	ESTABLISHED METHODS?	COMMENTS
					H200: 70-80 μm May want to try HC15 15 μm (more experimental), $3/lb)
Granular Iron	Peerless Metal Products, Master Builders	$0.40/lb			**NOT TO BE TESTED**
Emulsified ZVI (micro or nano)	Terra Systems	Add $2 - $5/lb to ZVI material cost	Mike Lee 302 798 9553	Sent Protocol	Will be able to provide large quantities w/in 6 months Can provide sample for lab testing
EHC™	Adventus	$1.50/lb	Alan Seech 905 273 5374 x221	No contact yet	No contact yet, but can likely provide material for test, and they can provide large quantities if selected for the field test

Abbreviations and Acronyms:
BNP – Bi-metallic Nano Particles
lb – pound
NDA – Non-Disclosure Agreement
nm – nanometers
μm – micrometers
ZVI – zero-valent iron

TABLE 2

PRELIMINARY ANALYTE LIST FOR BENCH-SCALE STUDY

Parameter[1,2]	Matrix	Method	LOD[3]	Frequency	Comment
PCE, TCE, DCE, VC	Water	GC/MS	- -	(A)	Identify contaminant removal/trends/mechanisms
Ethene/Ethane	Water	GC/MS	- -	(A)	Identify contaminant removal/trends
ORP	Water	Probe	- -	(A)	Need to achieve -400 mV for chemical reductive dechlorination, -200 mV for biological reductive dechlorination. Measure in the field during sample collection as well as during experimentation
pH	Water	Probe	- -	(A)	Generally increases in the ZVI ZOI. Measure in the field during sample collection as well as during experimentation
DO	Water	Probe	- -	(A)	If present, should be removed rapidly by ZVI. Measure in the field during sample collection as well as during experimentation; can be measured less frequently
Fe(II)	Water	Kit	- -	(B)	Produced abiotically (predominantly) w/in the zone of influence, typically forms precipitate within the zone of influence. Measure in the field during sample collection as well as during experimentation
Chloride	Water	IC	- -	(B)	Increases indicative of dechlorination
Sulfate	Water	IC	- -	(B)	Typically reduced through biological reactions in the ZOI
Nitrate	Water	IC	- -	(B)	Reduced to ammonia/ammonium w/in ZOI.
Major Cations	Water	IC	- -	(B)	CMU may want to track
Soluble Metals	Water	ICP/MS	- -	(C)	May increase or decrease in the ZOI
Total Biomass	Water	qPCR	- -	(C)	Potentially applicable to treatments with a biological component
DHC	Water	qPCR	- -	(C)	Potentially applicable to treatments with a biological component
DOC	Water		- -	(C)	High background concentrations may affect degradation rate of CEs with iron; should reflect organic-amended treatments; initially, there may be elevated levels of DOC for polymer-treated ZVI.
PCE, TCE, DCE, VC	Soil	GC/MS	- -	(D)	Assess sorbed phase; use in mass balance
Ethene/Ethane	Soil	GC/MS	- -	(D)	Assess sorbed phase; use in mass balance

TABLE 2

PRELIMINARY ANALYTE LIST FOR BENCH-SCALE STUDY

Parameter[1,2]	Matrix	Method	LOD[3]	Frequency	Comment
TOC	Soil		- -	(D)	Potentially applicable to treatments with a biological component
Total Biomass	Soil	qPCR	- -	(D)	Potentially applicable to treatments with a biological component
Total Metals	Soil	ICP/MS	- -	(D)	May increase or decrease in the ZOI; Assess remaining iron

Notes:

(1) This list includes potential analytes to be measured during the bench test. This list is preliminary and is subject to change pending consultation with Greg Lowry. Adjustments may be made based on establishment of experimental methodology (i.e. flask set up) and analytical capabilities at CMU. Analytical methodology at CMU will be specified at a later date.

(2) TtEC will also send split samples to a commercial laboratory for baseline analysis. Details regarding methodology (etc.) are included in Tables 1-1 and 1-2 of the Memo.

(3) Limits of detection will be established for relevant analytes following finalization of analyte list and determination of the specific analytical methodology.

(A) Baseline, periodically during test (immediately after addition of amendments, 2 days, 1 week, 2 weeks, 4 weeks, and 6 weeks)
(B) Baseline, periodically during test (i.e. immediately after addition of amendments, 2 weeks and 6 weeks)
(C) Baseline, immediately after addition of amendments, 6 weeks
(D) Baseline, extract after study complete

Assumptions:

1. Baseline parameters are analyzed at the commercial laboratory to ensure that parameters measured at CMU are representative of field conditions.
2. Study duration assumed to be 6 weeks.

Abbreviations and Acronyms:

CE – chloroethene
CMU – Carnegie Mellon University
DCE – dichloroethene
DHC – *Dehalococcoides* spp.
DO – dissolved oxygen
DOC – dissolved organic carbon
Fe(II) – Ferrous iron
GC/MS – gas chromatography/mass spectrometry

TABLE 2

PRELIMINARY ANALYTE LIST FOR BENCH-SCALE STUDY

IC – ion chromatography
ICP/MS – ion coupled plasma/mass spectrometry
qPCR – quantitative polymerase chain reaction
LOD – limit of detection
mV - millivolts
ORP – oxidation/reduction potential
PCE - tetrachloroethene
TCE - trichloroethene
TOC – total organic carbon
VC – vinyl chloride
ZOI – zone of influence
ZVI – zero valent iron

Reference:

Interstate Technology Regulatory Council. 2005. Permeable Reactive Barriers: Lessons Learned, New Directions. February, http://www.itrcweb.org/Documents/PRB-4.pdf

ATTACHMENT 2

ACTIVITY HAZARD ANALYSES

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ACTIVITY HAZARD ANALYSIS (AHA) #1

Geophysical Survey

Analyzed By/Date: R. Margotto, CSP 10/31/06

Job Steps	Possible Hazards	Protection Against Hazards
1. Park contractor vehicle at site.	Vehicle could hit someone or something.	Use spotters when positioning vehicle if needed. Ensure that spotters know how to communicate with driver of vehicle.
	Location could create a traffic hazard.	Locate vehicle in an area that will not obstruct traffic.
2. Unload equipment from vehicle.	Lifting of instruments from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
3. Move equipment to designated survey location.	Handling of instruments could cause strain to workers.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause the workers to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded. Work area will be kept neat and in an orderly state of housekeeping.
4. Survey and mark utilities.	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with vehicle operators. Post an observer, as needed, when surveyor is using instruments (a surveyor is often focused on the task and may not be aware of nearby traffic). Use traffic controls or barricades, if necessary, to keep traffic away from workers.
	Use of spray paint to mark underground utilities and anomalies could expose employees to paint fumes or paint itself.	Follow manufacturers' instructions on use of paint. Review MSDSs. Never point spray paint canisters at another person.
	Mis-marking utilities could create unknown hazards.	Use the following universal color codes for utilities: Blue – Water; Red – Electrical; Yellow – Gas; Green – Sewer.
	When carrying stakes, workers could trip and impale the body.	Carry stakes in a puncture-proof leather or canvas bag, and carry the bag to the side of the body. Ensure that all tips are pointed toward the ground at all times.
	Installation of wooden stakes presents puncture and splinter hazards.	Keep the stake tip pointed at the ground. Wear leather gloves. Use caution when using tools to pound in the stake.

ACTIVITY HAZARD ANALYSIS (AHA) #1
Geophysical Survey

Analyzed By/Date: R. Margotto, CSP 1031/06

Equipment to be Used	Inspection Requirements	Training Requirements
Vehicles- pickup trucks	Daily and before use. Use the equipment safety checklist found in the SHSP.	Only Department of Motor Vehicles-licensed personnel will operate vehicles
Equipment- underground utility meters	Inspect equipment before each use following manufacturers' requirements. Document inspection on an inspection form or in a logbook.	Specific training for use of equipment.

Abbreviations and Acronyms:

MSDS – Material Safety Data Sheets
SHSP – Site Health and Safety Plan

ACTIVITY HAZARD ANALYSIS (AHA) #2
Sonic Drilling and Sample Collection

Analyzed By/Date: R. Margotto, CSP 10/12/06

Principal Steps	Potential Safety/Health Hazards	Recommended Control
1. Visually survey the site prior to drill rig placement.	Failure to properly survey the site could cause exposure and/or damage to underground and overhead utilities, and cause slips, trips, and falls from various agents.	Ensure that the ground has no hazards such as unstable soil, underground utilities (marked per utility survey), overhead utilities, or pre-existing slip, trip, and fall hazards. Mark or eliminate all hazards as feasible.
2. Verify that drillers have certification of OSHA HAZWOPER training and medical release records on site.	Untrained workers or workers without annual physicals cannot work on potential hazardous waste sites.	Allow only trained personnel to operate and work on the drill rig. Also, operators shall meet the physical requirements listed in EM 385-1-1 Appendix G.
3. Inspect the drill rig.	Improper inspection of the rig could cause workers to be exposed to hazards associated with failure of various mechanical devices including wire lines and hydraulic lines.	The rig and all associated equipment will be inspected by a competent person before use and at the beginning of each day. Ensure that an operator's manual for the drill rig is available. Verify that the emergency shutdown system is well marked to allow anyone involved in the drilling operation to perform an emergency shutdown. There must be a minimum of two kill switches. Ensure that a first aid kit is readily available to treat injured workers, ensure that a 20-pound, dry-chemical, ABC fire extinguisher is readily available, and ensure that a spill control kit consisting of shovel, absorbent material, and disposal drum is available.

ACTIVITY HAZARD ANALYSIS (AHA) #2

Sonic Drilling and Sample Collection

Analyzed By/Date: R. Margotto, CSP 10/12/06

Principal Steps	Potential Safety/Health Hazards	Recommended Control
4. Place the drill rig.	Unstable soil or uneven conditions could cause rig instability. Rig could hit someone or something (overhead utilities, and so forth). Workers can be exposed to traffic hazards.	The rig must only be moved when the mast has been lowered. Use spotters when positioning the rig. Ensure that spotters know how to communicate with driver. Ensure that the weight of the rig is evenly distributed on the ground, brakes are set, and wheel chocks are in place. Extend stabilizer jacks and ensure that the rig is level to the vertical and horizontal planes. Rigs must have at least a 15-foot clearance from any overhead power lines 50kV or less. Ensure that workers are wearing high-visibility vests or shirts. Set up traffic control per Section 3.0 of the Implementation Memo that flagmen are trained and that the work area is posted. Barricade and limit access to work areas. Always use spotters to keep people and vehicles away from the rig as it is moved. All backing up requires a spotter.
5. Start up the drill rig.	Air hoses or hydraulic lines under pressure could suddenly release, whipping and hitting workers and causing severe injury.	Only C-57 qualified operators shall operate drill rigs. Confirm that visual inspection of all pressurized hose connections was completed. Acknowledge that all personnel are ready before starting the drill rig.
6. Lift the drill rig mast.	Pinch points and mast could contact, or be in proximity to overhead utilities.	The mast must be at least 15 feet from overhead utility lines if voltage is less than 50 kV. Clearance must be larger if voltage is higher (refer to EM 385-1-1, Section 11). When any part of the rig is in motion, workers must be far enough away to avoid being pinned. Do not manually guide any moving part and avoid placing hands close to moving machinery. The sonic rig does not use rotating external drill bits to drill; therefore, the number of moving parts is significantly less of a hazard. However, all rotating parts must be guarded.

ACTIVITY HAZARD ANALYSIS (AHA) #2
Sonic Drilling and Sample Collection

Analyzed By/Date: R. Margotto, CSP 10/12/06

Principal Steps	Potential Safety/Health Hazards	Recommended Control
7. Hand auger the first 5 feet of the borehole to verify that no underground utilities are present.	Hand augering could cause back and muscle strain to workers.	Hand tools shall be selected to minimize the following stressors: chronic muscle contraction or steady force, extreme or awkward finger, hand, or arm positions, repetitive forceful motions, excessive gripping, pinching, and/or pressing with hand and fingers. Avoid prolonged repetitive motion. Rotate job task with other workers.
8. Drill the borehole with the drill rig.	Pressurized hydraulic lines could rupture, causing a release of hot fluids. Hot fluids could cause burns to workers or ignite if they come into contact with the engine.	Only authorized and trained personnel shall be allowed in the area where the drilling is performed. Ensure that the first aid kit, fire extinguisher, and spill-control kit are readily available.
	Back and muscle strains could result from manually moving heavy materials, equipment, drums, and so forth.	Do not lift more than 50 pounds without assistance. Personnel will be directed to use proper lifting techniques such as keeping the back straight, lifting with the legs, and limiting twisting. Use mechanical equipment, such as a drum dolly, and so forth, whenever possible.
	When performing sonic drilling, workers must avoid working close to the rotating shaft; however, there is less likelihood of entanglement since the shaft is smooth.	Workers will not wear any jewelry or loose clothing, or long hair (long hair must be totally under the hard hat.) during operation of the rig.
	Workers could injure themselves at pinch points or by slips, trips, and falls near the borehole.	The drill rig must have two kill switches. Set up barricade near rotating shaft. Avoid placing hands close to moving machinery, wear gloves as appropriate, and keep constantly alert. Cap and flag open boreholes and protect them as an open excavation.
	Workers could be exposed to noise above the 84 dBA limit.	Ensure that workers are using hearing protection. Monitor noise with a sound level meter; set up barriers.
	Workers could be exposed to atmospheric and contact hazards from chemical agents released during drilling.	Monitor breathing zone for potentially harmful volatile organic vapors with field instruments and wear required PPE pursuant to the SHSP.
	Without a communication system in place, workers could get injured or property could get damaged.	There will be constant communication between the driller, laborers, and the site geologist. Ensure that phone communications for emergency contacts are functioning.

ACTIVITY HAZARD ANALYSIS (AHA) #2

Sonic Drilling and Sample Collection

Analyzed By/Date: R. Margotto, CSP 10/12/06

Principal Steps	Potential Safety/Health Hazards	Recommended Control
9. Collect soil and groundwater samples.	Collecting samples over long periods of time could cause muscle strain.	Maintain a steady pace and follow rest periods given on the job. Select a position during sampling to minimize the following stressors: chronic muscle contraction or steady force; extreme or awkward positions; repetitive forceful motions; or excessive gripping, pinching, or pressing.
	Workers could be exposed to chemical contaminants.	Wear required PPE. The intent of PPE is to prevent contact with groundwater that may have low levels of contaminants (although these contaminants are low in concentration, they still can be absorbed by skin or cause irritation to skin). Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Decontaminate exteriors of sample containers. Avoid spills. Ensure that spill cleanup supplies are available.
10. Mix grout.	Lifting of materials could cause strain to workers.	Use proper lifting techniques such as keeping the back straight, lifting with the legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use a hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Workers could come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands. Avoid generating dust. If grout is high in silica content, wear a dust mask when handling dry grout.
	Workers could be exposed to dust from bags of material.	Wear proper PPE for skin, eye, and breathing protection. An MSDS for dry grout must be reviewed by all workers.
11. Pour or pressure-fill grout into the borehole to seal.	Lifting of materials could cause strain to workers.	Use proper lifting techniques such as keeping the back straight, lifting with the legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use a hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Workers could come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands.
	Grout could cause probe rods to be slippery.	Wear gloves, as appropriate. Use extra caution while removing rods and handling them, as they are prone to slip.

ACTIVITY HAZARD ANALYSIS (AHA) #2
Sonic Drilling and Sample Collection

Analyzed By/Date: R. Margotto, CSP 10/12/06

Principal Steps	Potential Safety/Health Hazards	Recommended Control
	Air hoses or hydraulic hoses under pressure could suddenly release, whipping and hitting workers and causing severe injury.	Do not disconnect air hoses and compressors until the hose line has been bled. Visually inspect all connections of any lines under pressure. Use safety clamps (whip checks) to connect each side of the connection to the other if the connection breaks (safety clamps will keep hoses from whipping under sudden release of pressure). Tie back or attach hoses wherever possible to minimize the length of hose that could whip around if there is a sudden release of pressure.
12. Finish boring at the surface with concrete or asphalt, as necessary.	Workers could come into contact with concrete or asphalt.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands.
13. Decontaminate sample equipment between wells	Failure to decontaminate could cause erroneous analyses on subsequent sampling.	Ensure that equipment has been decontaminated between each sample taken. Develop a method to ensure that it is clear that equipment has been decontaminated.
	Improper collection of decontamination solution could cause a release to the environment.	Be sure to collect all decontamination solution into approved containers and label the containers for subsequent disposal.

Equipment to be Used	Inspection Requirements	Training Requirements
Hand tools, power tools, and sampling equipment	Daily or before use. Discard defective tools.	Only trained equipment operators may operate heavy equipment; only DMV-licensed personnel will operate trucks.
Sonic drill rig	Equipment inspections as required by operators' manuals	Specific training on the use of the drill rig. Operator's manuals must be reviewed and available on site.

Abbreviations and Acronyms:

DMV – Department of Motor Vehicles
EM – Engineering Manual
HAZWOPER – Hazardous Waste Operations and Emergency Response
kV – kilovolts
MSDS – Material Safety Data Sheet
PPE – personal protective equipment
SHSP – Site Health and Safety Plan

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