PORT OF OAKLAND

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February 15, 1994

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Ms. Jennifer Eberle
Hazardous Materials Specialist
Hazardous Materials Division
Alameda County Health
Care Services Agency
80 Swan Way, Rm 200
Oakland, CA 94621

Subject: ***Work Plan for Additional Site Investigation Activities, Transbay Container Terminal (TBCT), 707 Ferry Street, Port of Oakland, Oakland, California***

Dear Ms. Eberle:

Enclosed, you will find the Work Plan for Additional Site Investigation Activities, Transbay Container Terminal (TBCT), 707 Ferry Street, Port of Oakland, Oakland, California.

One 10,000 gallon diesel UST was removed on 3 December 1993. The work plan addresses the installation of one well in the down gradient direction from the tank removal site. We feel that due to the proximity to the Bay and an extensive investigation in the neighboring property (Mobil Oil Site), that the groundwater gradient at this site is known and one well is appropriate for monitoring.

Please call me at 272-1184 if you have any questions or comments.

Sincerely,

Jon Amdur
Port Environmental Scientist

CC: Rich Hiett, San Francisco Regional Water Quality Control Board, 2101 Webster Street, Suite 500 Oakland, CA 94612

Neil Werner (Environmental Department)

enclosure

Work Plan for
Additional Site Investigation Activities

Berth 25, 707 Ferry Street,
Oakland, California

January 28, 1994

Prepared for
Port of Oakland
Oakland, California

Prepared by
Uribe & Associates
Oakland, California

Certification

Work Plan for Additional Site Investigation Activities Berth 25, 707 Ferry Street, Oakland, California

I certify that to the best of my knowledge, the information presented in this document was produced in accordance with professional standards, and that data contained here are true and accurate. The field program will be conducted under the supervision of a California Registered Geologist.

2/15/94

Gerard L. Slattery — Date

California Registered Geologist No. 5038

REGISTERED GEOLOGIST
GERARD L. SLATTERY
No. 5038
STATE OF CALIFORNIA

Work Plan for Additional Site Investigation Activities
Berth 25, 707 Ferry Street, Oakland, California

Table of Contents

Introduction

Uribe & Associates (U&A) has prepared this work plan to direct the installation of one groundwater monitoring well at 707 Ferry Street, Oakland, California (Figure 1). The work is to be completed as part of a subsurface investigation performed for compliance with underground storage tank (UST) closure requirements for one former UST (CF-04), which was removed on December 3, 1993. The UST was a 10,000-gallon UST used for diesel storage. The tank was located approximately 300 feet south of the shoreline, adjacent to a building between the trackways of the 'transtainer' overhead cranes used to move shipping containers.

After the tank removal and soil excavation, samples from the excavation had a maximum of 18 mg/kg of TPH-diesel left in place. Samples collected from adjacent to the tank directly after removal had a maximum of 2 mg/kg TPH-diesel. A slight sheen was observed on groundwater in the excavation directly after the UST removal. After groundwater was purged from the excavation during soil excavation, no sheen was observed on the groundwater that refilled the excavation. The excavation was only extended enough to place a new 10,000-gallon UST.

U&A proposes to install the groundwater monitoring well within 10 feet in the assumed down-gradient direction of the removed UST location. Figure 2 illustrates the location of the former UST and proposed monitoring well location. The site is in the Marine Terminals area of the Port of Oakland. The site is currently a container shipping terminal operated by Transbay Container Corporation (TBCT).

Project Background

Regional and Site Geology/ Hydrogeology

The Marine Terminals area of the Port is constructed on a fill peninsula on the east side of San Francisco Bay. The fill consists of material dredged from the estuary, and material brought from other areas. In some areas, the fill contains a large percentage of debris. The topography is flat; the elevation is approximately 10 feet above mean sea level. Beneath the fill are the silts, sands, and clayey silts of the original tidal marsh. These sediments are commonly called Bay Mud.

Below the Bay Mud is the Merritt Sand formation, which contains a fresh water aquifer that is a potential source of irrigation water in both Oakland and Alameda.

The soils encountered at the site during the UST removal consisted of aggregate fill in the upper two feet, and silty sand to the base of the excavation. The silty sand is a fine-grained to medium-grained sand with between 25 and 40 percent silt. The backfill material for the tank was pea gravel. The groundwater depth at the site is approximately 10.5 below ground surface.

Tank Removal

one crack in the rib

The UST was removed on December 3, 1993. There were no obvious holes or other damage to the tank. The tank was a 10,000-gallon, single-wall fiberglass tank. There was only obvious contamination in the area of the pump island. A slight sheen was observed on groundwater in the excavation directly after the UST removal. After groundwater was purged from the excavation during soil excavation, no sheen was observed. The complete tank removal and sampling activities are discussed in *Underground Storage Tank Removal and Soil Excavation at Berth 25, 707 Ferry Street, Oakland, California* (U&A, 1994).

The UST was located adjacent to a building between the trackways of the 'transtainer' overhead cranes used to move shipping containers. Containers were also stacked to the north and south of the tank location, within about 20 feet of the excavation. Due to the proximity of the terminal operations and the potentially hazardous working conditions during ship loading, access to the job site was limited, and the extent of excavation was constrained.

A total of approximately 200 cubic yards of soil was excavated. In the pump island area, soil was excavated to a depth of five feet below ground surface (bgs) to remove apparent contamination. The removed soil under the pump island was discolored and registered up to 400 parts per million (ppm) on a photo-ionization detector (PID). Four soil samples were collected from the tank pit and from the pump island area. Only one of the samples had detected concentrations of benzene, toluene, ethyl benzene, and xylenes (BTEX), and all of the soil associated with that sample was excavated. After the excavation, a maximum of 18 mg/kg TPH-diesel is left in place. Figure 2 shows the extent of the excavation and soil sample locations from the tank pit and pump island area.

Project Approach

Introduction

At the request of the Port, U&A will install one groundwater monitoring well, adjacent to the former UST excavation, at the location shown in Figure 2 to evaluate subsurface conditions. The well location will be within 10 feet of the former UST in the assumed down-gradient direction, to the west-southwest. This gradient is based on information from groundwater monitoring wells approximately 600 to 800 feet to the northeast of the site at the former Mobil Bulk Plant at Berth 24.

Exploratory Soil Boring

U&A will install one soil boring at the location shown in Figure 2. The boring will be drilled to a total depth of approximately 20 feet bgs and completed as a groundwater monitoring well. Soil samples for chemical analysis will be collected every three feet, or more frequently if field screening by a U&A field geologist warrants. Field screening will consist of visual observations and response to a photo-ionization detector (PID).

Soil samples from the borings will be analyzed for TPH-diesel (EPA Method 8015, modified) and benzene, toluene, ethyl benzene, and xylenes (BTEX, EPA Method 8020).

Groundwater Monitoring Well

The boring will be converted into a groundwater monitoring well using 2-inch diameter PVC casing. The well will be developed using a surge block and bailer. The well will be surveyed to the Port of Oakland datum (3.2 feet below mean sea level).

Groundwater Sampling

Quarterly groundwater monitoring will be initiated once the well is installed. Prior to sampling, a water level measurement will be collected, and then the well will be purged of standing groundwater.

Samples will be transported to a State-certified laboratory under chain of custody. Groundwater samples will be analyzed for TPH-diesel, BTEX, and total dissolved solids.

Report of Activities

U&A will prepare a report of the well installation activities, including a review of the soil and groundwater sampling data. The need for additional site investigation activities will be determined after the results of the monitoring well installations and quarterly groundwater sampling have been reviewed.

Project Tasks

Task 1: Project Planning and Management

U&A will review the project file and other information provided by the Port. U&A will prepare the site safety plan to include the additional well installation activities, groundwater gradient measurements, and groundwater monitoring activities (Appendix A).

Task 2: Well Installation and Soil Sampling

U&A staff will supervise the drilling of one soil boring for completion as a groundwater monitoring well to evaluate soil and groundwater conditions at the site. The boring location will be checked for underground utilities by the Port maintenance and construction crew. The boring will be logged by a U&A geologist. Soil samples for chemical analysis will be collected at three-foot intervals or more frequently if field observations warrant. Field screening will consist of visual observations and response to a photo-ionization detector. Soil samples from the borings will be analyzed for TPH-Diesel (EPA Method 8015, modified), and BTEX (EPA Method 8020).

The monitoring well will be completed using 2-inch diameter PVC casing, with 10 feet of screen. Well design will depend on the nature of soils encountered and the occurrence of groundwater. Groundwater is anticipated to be 8 to 10 feet bgs. The gravel filter pack and screen will be set to reach at least one foot above the groundwater level. All purged groundwater, decontamination water, and soil cuttings will be placed in drums, pending proper disposal.

Task 3: Well Development and Groundwater Sampling

U&A will develop and sample the monitoring well after the water level measurements have been collected in accordance with the U&A standard operating procedure for groundwater sampling

(Appendix B). Groundwater samples will be analyzed for TPH-diesel, BTEX, and total dissolved solids. Groundwater sampling will continue on a quarterly basis.

Task 4: Elevation Survey

U&A will supervise the survey of the well elevation by a licensed land surveyor. The top of the well casing and the ground surface (lip of the road cover) will be surveyed to the Port of Oakland datum (3.2 feet below mean sea level).

Task 5: Report of Investigation Activities

U&A will prepare a report of well installation activities to summarize the sampling data at the site. U&A will also prepare letter reports of quarterly groundwater monitoring results.

References

Uribe & Associates, U&A, 1994, *Underground Storage Tank Removal and Soil Excavation at Berth 25, 707 Ferry Street, Oakland, California.* Prepared for the Port of Oakland.

Figures

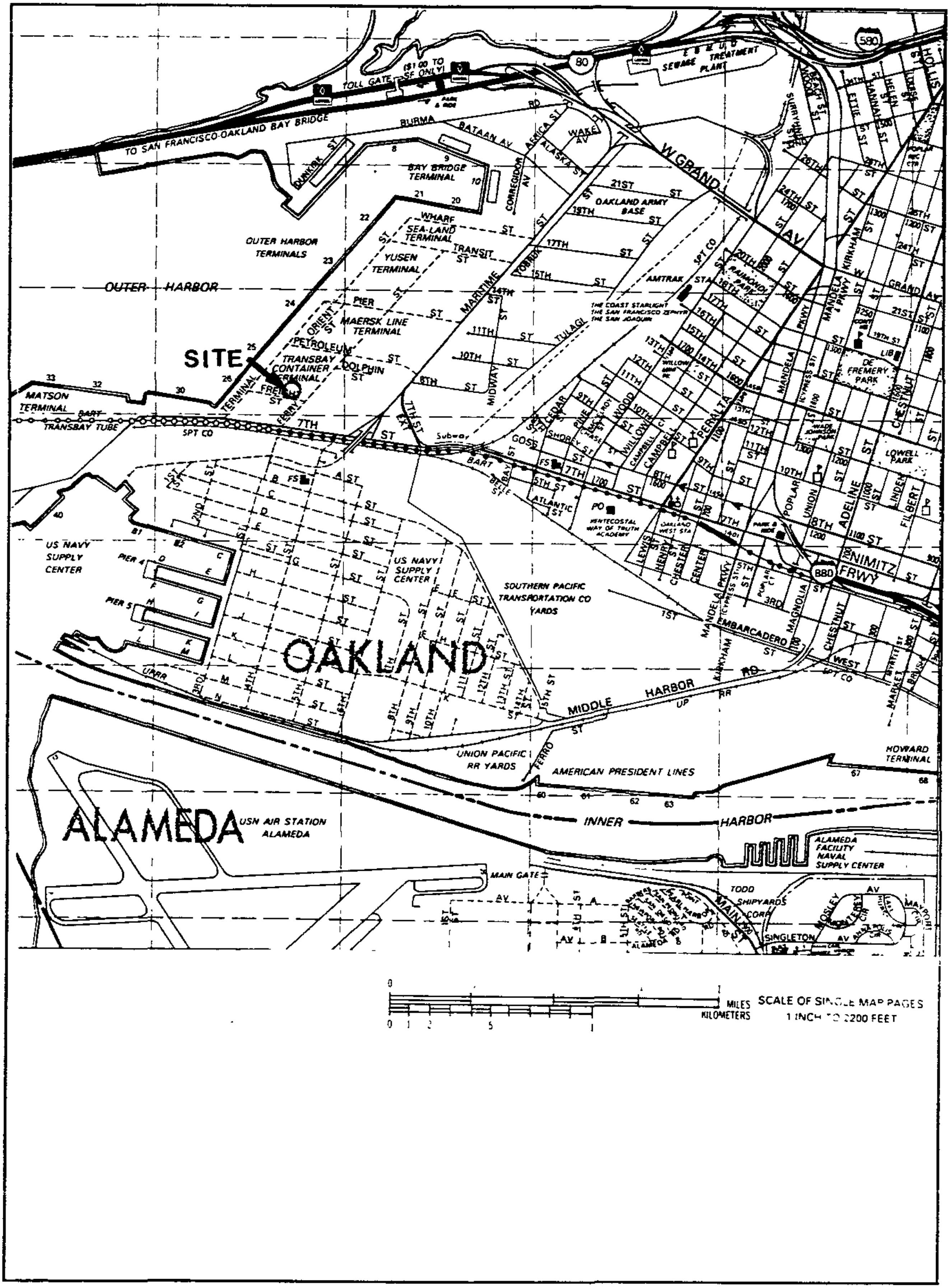

Figure 1: Site Location Map, Berth 25, 707 Ferry Street, Oakland, California

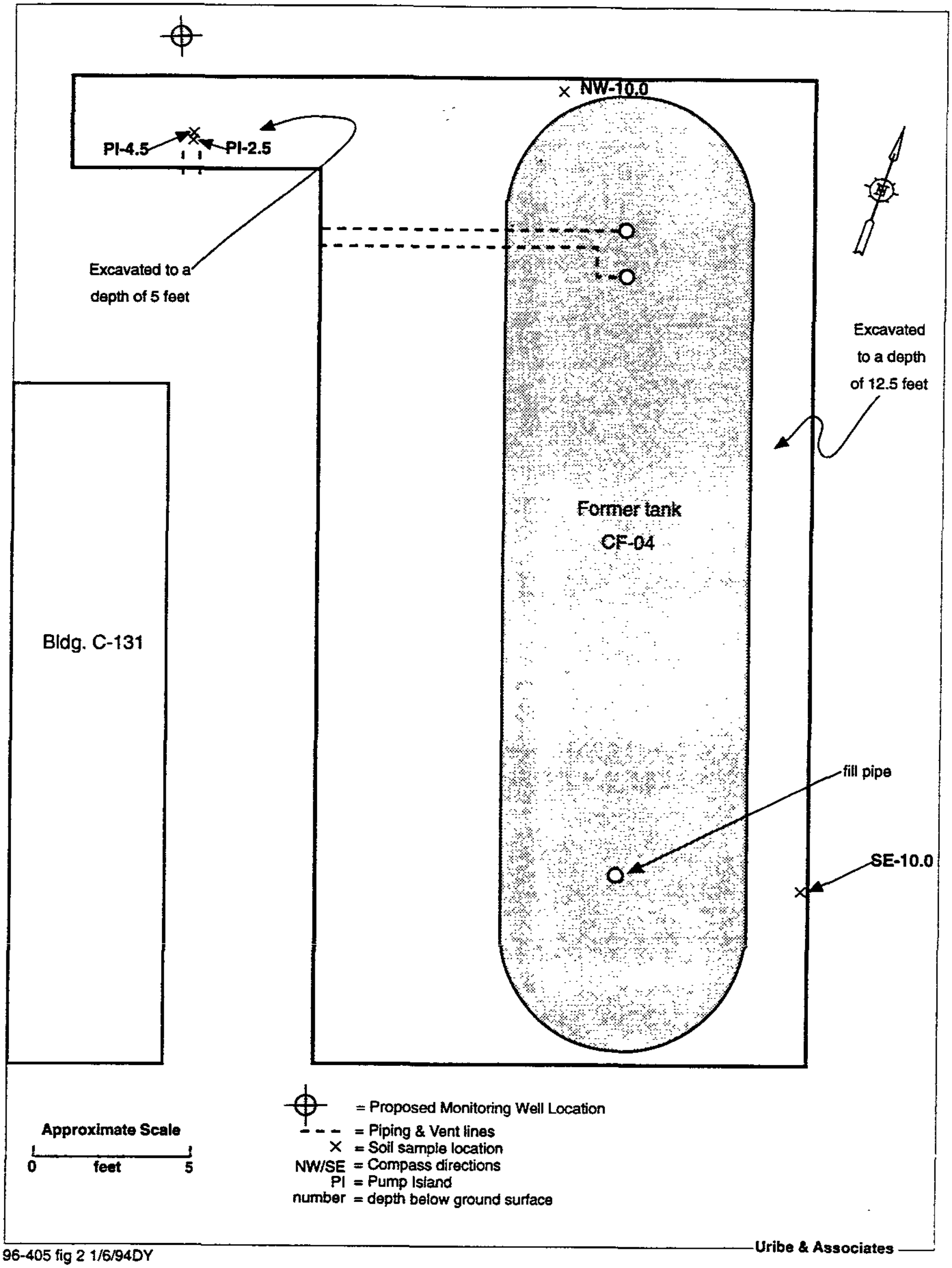

Figure 2: Site Plan with Sample Locations and Proposed Monitoring Well Location
Berth 25, 707 Ferry Street, Oakland, California

Appendix A

Health and Safety Plan for Groundwater Monitoring Well Installation and Sampling

SITE SAFETY PLAN FOR Berth 25, 707 Ferry Street

A. SITE DESCRIPTION

Date: ______________________ Location: ______________________

Hazards: Drilling rig, traffic, Container Cranes, Diesel, Engine Solvents

Area Affected: Immediate area arround drilling rig

Surrounding Population: Container yard, Parking lot

Topography: flat

Weather Conditions: Expect overcast, temps in 50's, Wind up to 15 mph constantly

Additional Information: ______________________

B. ENTER OBJECTIVES - The objectives of the initial entry to the contaminated area is to

This is not an initial entry - Not Applicalble

C. ONSITE ORGANIZATION AND COORDINATION - The following personnel are designated to carry out the stated job functions on site.

Project Team Leader:	Gerald Slattery
Scientific Advisor:	John Borrego
Site Safety Officer:	John Borrego
Public Information Officer:	John Borrego
Field Team Leader:	John Borrego
Field Team Members:	John Borrego
	Gregg Drilling Crew (2 people)
Local Agency Reps:	Jennifer Eberle, ACDEH,
Contractor(s):	Gregg Drilling

All personnel arriving or departing the site should log in and out with the Recordkeeper. All activities on site must be cleared through the Project Team Leader.

D. HAZARD EVALUATION

The following substance(s) are known or suspected to be on site. The primary hazards of each are identified.

Substances Involved	Concentration (If known)	Primary Hazards
Gasoline		Inhalation
Diesel		Inhalation
Solvents		Inhalation

The following additional hazards are expected on site: Drilling rig physical hazards

E. PERSONAL PROTECTIVE EQUIPMENT

Based on evaluation of potential hazards, the following levels of personal protection have been designated for the applicable work areas or tasks:

Location	Job Function	Level of Protection
All Staff		A B C **D** Other
		A B C D Other
		A B C D Other
		A B C D Other

Specific protective equipment for each level of protection is as follows:

Level A: Fully-encapsulation suit SCBA (disposable coveralls)
Level B: Splash gear (type) SCBA
Level C: Splash gear (type) Full-face canister respirator
Level D: Hard hat, steel toed shoes/boots, appropriate work gloves
Other:

The Following protective clothing materials are required for the involved substances:

Substance	Material

If air-purifying respirators are authorized, Yellow is the appropriate canister for use with the involved substances and concentrations. A competent individual has determined that all criteria for using this type of respiratory protection have been met.

No changes to the specified levels of protection shall be made with the approval of the Site Safety Officer and the Project Team Leader!

F. ONSITE WORK PLANS

Work party(s) consisting of 3 persons will perform the following tasks:

Project Team Leader	Tasks
John Borrego	collect samples, log cuttings, direct drilling activities
Work Party #1 Gregg Drilling	Operation of Drilling Rig, decontamination of sampling equipment
Work Party #2	
Rescue Team (for IDLH sites)	
Decontamination Team	

The work party(s) were briefed on the contents of this plan at date: . time: ______

G. COMMUNICATION PROCEDURES

Hand gripping throat........................... Out of air, can't breathe
Grip partner's writs or
both hands around waist .... Leave area immediately
Hands on top of head.......................... Need assistance
Thumbs up .... OK, I'm all right, I understand
Thumbs down .... No, negative

Telephone communication to the Command Post should be established as soon as practicable. The phone number is ________ 415-519-0947 or Page 510-382-4250

H. DECONTAMINATION PROCEDURES

Personnel and equipment leaving the site shall be thoroughly decontaminated. The standard level decontamination protocol shall be used with the following decontamination stations:

(1) Soapy water (2) rinse (3) rinse (4) ________ (5) ________
(6) ________ (7) ________ (8) ________ (9) ________ (10) ________
Other ________

The following decontamination equipment is required: ________

____

________ will be used as the decontamination solution.

I. SITE SAFETY AND HEALTH PLAN

1. John Borrego ________ is the designated Site Safety Officer and is directly responsible to the Project Team Leader for safety recommendations on site.

2. Emergency Medical Care

________ at ________, phone ________ is located _____ minutes from this location. ________ was contacted at ________ ________ and briefed on the situation, the potential hazards, and the substances involved. A map of alternative routes to this facility is available at __.

Local ambulance service is available from 911 ______ at phone 911.

Their response time is 10 minutes. Whenever possible, arrangements should be made for onsite standby.

First-aid equipment is available is available on site at the following locations:

First-aid kit	John's Truck
Emergency eye wash	Drilling rig
Emergency shower	na
(other)	

Emergency medical information for substances present:

Substance	Exposure Symptoms	First-Aid Instructions

List of Emergency phone numbers:

Agency/Facility	Phone #	Contact
Police	911	
Fire	911	
Hospital	911	
Airport		
Public Health Advisor		

3. Environmental Monitoring

The following environmental monitoring instruments shall be used on site (cross out if not applicable) at the specified intervals.

Combustible Gas Indicator	**Continuous**	hourly	daily	other
CO_2 Monitor	Continuous	hourly	daily	other
Colormetric Tubes	Continuous	hourly	daily	other
(type)				
HNU/OVA	**Continuous**	hourly	daily	other

Other _____________________________Continuous hourly daily other

____________________________________Continuous hourly daily other

4. Emergency Procedures (should be modified as required for incident)

The following standard emergency procedures will be used by onsite personnel. The Site Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedures are followed.

Personnel Injury: Upon notification of an injury the designated emergency signal Horn Blast shall be sounded. The Site Safety Officer will call an ambulance. The rescue team will remove the injured person to the hotline. The Site Safely Officer and Project Team Leader should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The onsite EMT shall initiate the appropriate first aid, and contact should be made for an ambulance and with the designated medical facility (if required).

Personnel Injury in the Support Zone: Upon notification of an injury, the Project Team Leader and Site Safety Officer will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of site personnel, operations may continue.

Fire/Explosion: Upon notification of a fire or explosion on site, the designated emergency signal shall be sounded. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Personal Protective Equipment Failure: If any site worker experiences a failure or alternation of protective equipment that affects the protection factor, that person and his/her buddy shall immediately leave the site. Re-enter shall not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure: If any other equipment on site fails to operate properly, the Project Team Leader and Site Safety Officer shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan Tasks, all personnel shall leave the site until the situation is evaluated and appropriate actions taken.

The following emergency escape routes are designated for use in those situations where egress from the site cannot occur through the main exit.

In all situations, when an onsite emergency results in evacuation, personnel shall not re-enter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. The Site Safety Plan has been reviewed.
4. Site personnel have been briefed on any changes in the Site Safety Plan.

5. Personal Monitoring

The following personal monitoring will be in effect on site: Personal exposure sampling:

Medical monitoring: The expected air temperature will be 50's. If it is determined that heat stress monitoring is required (mandatory if over 70 degrees F) the following procedures shall be followed:

____

____

All site personnel have read the above plan and are familiar with its provisions.

	Name	Signature
Site Safety Officer	____________________	__________
Project Team Leader	____________________	____________________
Other Site Personnel	____________________	____________________
	____________________	____________________
	____________________	____________________
	____________________	____________________
	____________________	____________________
	____________________	____________________
	____________________	____________________

Appendix B

U&A Standard Operating Procedures

HOLLOW-STEM AUGER DRILLING, LOGGING AND SOIL SAMPLING

Introduction:

For environmental investigations of sites underlain by most unconsolidated formations, anticipated total depths (TDs) of less than 100 feet, and especially when wells or piezometers will be installed, hollow-stem augers are the preferred method of drilling. Borings are drilled with augers of a sufficient diameter to allow sampling and if necessary, the completion a monitoring well. Typically, 8-inch diameter augers are used. These allow for a minimum two-inch annulus, as required by most regulatory agencies, when a 4-inch casing is used.

Procedure for Clearing Boring Locations:

Prior to drilling any borehole, a drilling objective and program for each boring, including possible variations, will be determined by the supervising professional (registered geologist or civil engineer) and project manager, and defined in the scope of work. This will include a review of the anticipated formations, depth to first water, sampling frequency and anticipated total depth (TD). All locations will be cleared for subsurface utilities, by Underground Service Alert (USA), a utilities locating contractor. At a minimum, the upper five feet of the subsurface will be hand augered, to verify the absence of any unidentified utilities. Hand augering may continue at the discretion of the field geologist. If any obstructions are encountered the project manager will be notified. A new location will be determined and cleared.

Drilling Program:

Borings will be drilled to meet drilling objectives described in the scope of work, i.e., characterization of the vadose zone and the first water-bearing zone. Because of the extreme heterogeneity of most unconsolidated formations, continuous sampling is performed to ensure complete hydrogeologic characterization. In some instances continuous sampling may not be desirable, or practical, and an alternative sampling frequency will be determined. Borings may be extended to deeper depths, if obvious contamination is encountered at the drilling objective TD. Furthermore, drilling program objectives may be modified in consideration of information obtained during drilling. All drilling and sampling equipment which enters the borehole, will be thoroughly steam cleaned and/or decontaminated with Tri-sodium phosphate (TSP) and rinsed with distilled water prior to drilling.

Borehole Logging:

All boreholes will be logged by a registered geologist or civil engineer, or a geologist trained with logging procedures and working under the direct supervision of a registered geologist or civil engineer. All materials encountered in the borehole will be described according to the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ASTM D 2488-90. All fluids encountered in the borehole will be described and liquid levels will be determined according to ASTM procedure 4750-87. To determine the depth and nature of fluid occurrence in the borehole, drilling may be stopped at the direction of the drilling program or the field geologist, and the borehole will be allowed to stand open while fluid-level measurements are taken. The fluid content of all materials encountered will be described. If necessary, a grab sample of fluids for chemical analysis may be collected with a bailer. The depth drilled, date and time of sample collection will be noted.

Geophysical Logging:

If necessary, boreholes will be logged with geophysical equipment as determined by the project manager and supervising professional. All geophysical logging equipment will be cleaned prior to entering the borehole(s).

GROUNDWATER MONITORING WELL AND PIEZOMETER CONSTRUCTION

Introduction:

Groundwater monitoring well and piezometer design will be determined by the supervising professional and project manager. Wells or piezometers will be designed to satisfy the requirements of the drilling objective and provide the information needed for the investigation. Generally, it is desirable to complete wells in water-bearing formations (i.e., those which will produce some minimal amount of water such that a representative samples can be collected from the well in a reasonable amount of time). Typically water-bearing zones are of moderate- or higher-estimated permeability. However, because of the requirements of the investigation, it may be necessary to set well screens in low-estimated permeability formations, such as clays and silts.

Borehole Design:

Boreholes for wells or piezometers will be a minimum of 6 inches in diameter to allow for a minimum annulus of 2 inches.

Monitoring Well Construction Materials:

Monitoring wells will be generally constructed with flush thread, schedule 40 PVC casing: blank and slotted. Casing lengths are typically 5 or 10 feet. The bottom of the casing string will be fitted with a PVC endcap. Slotted intervals and sand packs will be set adjacent to the appropriate water-bearing formation or saturated formation, depending on the goal(s) of the investigation. In all instances, no well will be constructed so as to permit cross contamination between water-bearing units or between uncontaminated water and contaminated soils.

Slot openings will generally be 0.020 inch. Sand for sand packs will be matched to screen slot size and formation to the extent possible. Only new, factory washed sand will be used. Generally some settling of the sand pack will occur during development. As a countermeasure, depending on borehole conditions and formation characteristics, sand packs will generally extend 1 foot above the top of the well screen, prior to well development.

A bentonite seal will be placed above the sand pack. Generally, one 5 gallon bucket of bentonite pellets is sufficient to create a 2 foot seal above the sand pack. The purpose of the seal is to prevent grout in the annulus from permeating the sand pack, and thus reduce or eliminate the flow of water into the well.

Annular space above the sand pack and bentonite seal will be sealed with a mixture of Portland cement and up to 5 % bentonite powder (grout).

<u>Well Design</u>:

For hydrocarbon investigations, generally the uppermost saturated formation is the target of the investigation. It may be necessary to complete wells in low-estimated permeability formations, where groundwater first occurs. If the zone of interest is unconfined (i.e., the water table can fluctuate freely) and/or free product may be encountered, the well screen will extend from the anticipated high water level, from unsaturated formation to saturated formation, to a maximum of twenty feet below the first occurrence of water (i.e., the water level at the time of well completion).

For shallow, confined water-bearing zones (i.e., groundwater is prevented from rising by an overlying aquitard) the borehole will be advanced through the water-bearing zone to a competent aquitard (at least 3 feet of low permeability materials) or a maximum of 20 feet below the top of the water-bearing zone (the bottom of the overlying confining aquitard). The screen will generally be set from the top of the water-bearing formation to the top of the bottom confining aquitard or a maximum of 20 feet below the top of the water-bearing formation, whichever is less. If the borehole is overdrilled, it will be backfilled back to a depth of 20 feet below the top of the water-bearing zone, before the well is completed. Under no circumstances, will the screen interval and/or sand pack extend across aquitard(s).

For deep, confined water-bearing zones the borehole will be advanced to the water-bearing zone of interest, and if necessary beyond to allow for complete geophysical logging. Once logging is completed, excess borehole will be backfilled. Generally, deeper zone wells will be drilled with rotary drilling techniques, and may involve setting surface casing through upper aquifers.

However, hollow-stem augers may be used to drill deeper wells, as the augers act as a casing during drilling. As with shallow completions, well screen interval will match the thickness of the confined water-bearing zone and not exceed twenty feet. Under no circumstances, will the screen interval and/or sand pack extend across aquitard(s).

Well Completion:

Well construction materials will be used uncontaminated from straight of the factory box or decontaminated by steam cleaning or cleaned with TSP and clean water. The casing string will be assembled one piece at a time and lowered through the hollow stem augers. The casing will be held under tension to the degree possible to ensure straightness. Once in position, the augers will be lifted up, a few feet at a time, and the sand for the sand pack will be added, slowly, to avoid bridging in the open borehole and/or locking the casing in the augers. The sand pack will be followed by the bentonite seal, and finally grout. Grout will be emplaced by lowering a tremmie pipe to a foot above the bentonite seal, and then pumping grout until it rises to the ground surface and displaces any borehole fluids and/or cuttings. The top of the casing will be trimmed, and a water tight, lockable cap will be fitted.

Generally, some settling of the grout will occur, and depending on the amount of settlement, more grout may be added. The remaining annular space will be filled with concrete and a well cover will be set. Flush mounted covers will be set slightly above ground level and the concrete finished so that surface fluids will move away from the well. If a stove pipe cover is used, traffic barriers will be installed to prevent damage to the cover and well. The well will be identified on its' casing and a survey mark will be inscribed on the top, northern side of the casing. All well-sites will be secured and cleaned to their previous condition or better.

Piezometer Design and Completion:

Piezometer design will be determined by the project manager and the supervising professional. Piezometers will be constructed with short screen well points or PVC casing, both 2-inch diameter, and will not exceed 5 feet in length. Piezometers will generally be temporary and will therefore not be set with grout. Instead, fine sand will be used instead of grout as annular fill. Piezometer screens will be set following the same guidelines for the various well completion scenarios. Piezometers will be fitted with water-tight, locking caps, and generally will not have well head protection cemented in place, instead a protective stove pipe may be set in place, temporarily. Piezometers will be identified and marked with a reference point for surveying.

SOIL SAMPLING:

During boring activities, soil samples for chemical analysis will be collected at 5-foot intervals, as required by regulations, and more frequently if warranted. Samples will be collected in decontaminated brass sleeves inserted into the sampler. Upon recovery, the sampler will be opened, and the sleeves separated and immediately covered with Teflon tape and plastic end-caps. Samples will be placed in a cooler, chilled to 4°C, and transported to the analytical laboratory under chain-of-custody. Each sample will be labelled with an identification number appropriate for the project written in indelible ink. The sample label will also include the date, company name, project number, preservative used, and sampler's initials. The number will be included on the chain-of-custody form along with any special information necessary to identify the sample.

Grab samples will also be collected in brass sleeves and capped with Teflon and plastic end caps. Grab sample frequency and distribution will vary according to the project. Generally, a minimum of one discreet grab sample will be collected from each 20 cubic yards of soil. Sample locations will be determined using a nine-point random grid system. Transportation and chain-of-custody procedures will be identical to boring samples.

All sampling equipment will be decontaminated after each use with simple green™ or Tri-Sodium Phosphate.

CHAIN-OF-CUSTODY PROCEDURES

Sample Handling:

All soil and water samples will be labelled with the sample number, date, company name, preservative used, and sampler's initials. A chain-of-custody form will then be filled out including the time and date of the sample, the sample number, the number of containers for each sample, the analysis required and any distinguishing comments or laboratory notifications. The chain-of-custody form will remain with the samples at all times during transportation and storage.

Transfer of Custody to Laboratory

The chain-of-custody will be signed and dated by the sampler when relinquished to the laboratory. The laboratory courier or sample receiver will also sign and date the chain-of-custody.

Organic Compound Monitor (OVA or PID or HNU)

Equipment Preparation

1. Ensure that the battery in the Organic Compound Monitor is fully charged.

2. Recharge the hydrogen gas cylinder in the Century OVA.

3. Ensure that the Organic Compound Monitor has been calibrated within the last week.

4. Follow manufacturer's instructions.

Monitoring Activities

1. Once an hour, record the instrument reading on the data sheet.

Post-Monitoring Activities

Maintenance, care, and calibration of Organic Compound Monitors should be carried out in accordance with the instrument's instruction manual.

WELL DEVELOPMENT

Introduction:

Once monitoring wells or piezometers are installed, it is desirable, and generally required by regulations, to develop the well to improve or restore the hydraulic conductivity of the formation and the sand pack; both may have been impaired during drilling and well construction. The goal of development is to dislodge fines and draw them into the well casing, and once there remove them from the casing. Generally, well development activities will improve the flow rate of the well. Typically, wells will be developed for 4 hours and/or until the well no longer yields sediment and water is clear. This may not be possible for wells completed in fine-grained or extremely heterogeneous formations.

Development Methods:

Methods of choice are surging, bailing, jetting and pumping. Surging consists of moving a tightly fitting surge block or disc up and down in the well casing, which creates suction in the casing, below the surge block. Bailing consists of removing fluids with a bailer, which is simply a tube or pipe with a check valve fixed to the bottom of it. Both of these methods are accomplished by using the sand line winch on the drill or development rig. Jetting consists of lowering a special tool into the well which will direct compressed air against the well screen slots. Jet-air lifting is a method of pumping and also uses compressed air. It has the advantage of directing suction locally against the well screen. Pumping can be accomplished with a bladder pump or electric submersible.

For wells completed in fine grained or clayey formations, it may be necessary to add a fluid to assist in development; clean water is not recommended as it may hydrate clays and further reduce porosity and permeability. If necessary an engineered development fluid will be obtained.

Generally, the most rapid improvements from development are noted when development is performed as soon as possible, shortly after the sand pack and bentonite seal have been set.

Development Procedures:

All development equipment will be decontaminated prior to use. Development will usually begin by noting fluid-level measurements, and then proceeding slowly, so as to not impact the formation or damage the well screen. Next, a bailer may be used to remove fines which have probably settled in the casing, through the screen during well construction. Typically, a surge block, which is capable of creating significant suction may be used for low flow rate wells. If development is proceeding, or if the formation is of moderate- or high-estimated permeability, pumping may be sufficient to complete development. Development will proceed for 4 hours or until produced groundwater is clear and sand free. All fluids and materials added to and removed from the well will be noted. An initial estimate of the well flow rate will be made, based on well recovery rates or pumping rates. Temperature, conductivity and pH will be monitored during development.

All fluids and materials removed from the well will be stored on-site in drums, pending sampling and analysis. All fluids and materials used and generated by the well installation and development activities will be properly disposed of.

GROUNDWATER SAMPLING

Groundwater samples for chemical analysis will be collected following this procedure:

All purging and sampling equipment will be decontaminated prior to use.

Upon arrival at the site, the wells will be located and opened up, to allow for equilibration with the atmosphere. The monitoring well is first checked for floating product with a dual interface probe. Water or liquid-level measurements will be collected, to the nearest one hundredth of a foot (0.01 foot). If a probe is not available, a clear plastic bailer may be used to check for product. The volume of water in the well casing will be calculated and three to five casing volumes of water will be evacuated. The well will be bailed or pumped to remove the correct volume of water. Stabilization parameters, temperature, conductivity and pH, will be monitored. For wells with extremely low flow rates, i.e. less than 0.01 gallon per minute (GPM), the well will be bailed dry and allowed to recover overnight, and then sampled.

Once the well has been purged, samples will be collected with a bailer and transferred to appropriate sampling vials or bottles. Samples will be labeled and placed in a cooler, cooled to 4 ° C and transported to the analytical laboratory under chain-of-custody. Purge water will be stored on-site pending analytical results, and then properly disposed of.