PORT OF OAKLAND

November 7, 2014

Mr. Keith Nowell
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502-6540

Subject: **ACEH SCP Case File RO470**
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Berths 60-63 Redevelopment Project
1395 Middle Harbor Road, Oakland, CA

Dear Mr. Nowell:

Attached please find a *Post-Construction Work Plan* ("Work Plan") prepared by AMEC Environment & Infrastructure, Inc. ("AMEC") on behalf of the Port of Oakland ("Port"). The purpose of this Work Plan is to assess the extent of contamination identified during previous construction work at the former American President ("APL") Terminal, Berths 60-63 at 1395 Middle Harbor Road, Port of Oakland. The scope of work described in this Work Plan is based on recommendations presented in the Post-Construction Closure Report ("PCCR") dated August 13, 2013 and comments on the PCCR prepared by Alameda County Department of Environmental Health ("ACEH") presented in the ACEH SCP Case File RO470 letter dated June 4, 2014.

I declare under penalty of perjury, that the information contained in the attached document is true and correct to the best of my knowledge.

Sincerely yours,

John Prall

John Prall, PG
Port Associate Environmental Scientist
Port Environmental Programs & Planning Division

Cc: David Nanstad, AMEC
Anne Whittington, Port of Oakland
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November 6, 2014

Project OD14170810.02

Mr. Keith Nowell
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502-6540

Subject: **Post-Construction Work Plan**
Former APL Terminal, Port of Oakland
Oakland, California

Dear Mr. Nowell:

On behalf of the Port of Oakland, AMEC Environment & Infrastructure, Inc. (AMEC), has prepared this *Post-Construction Work Plan* (Work Plan) for an investigation to assess the extent of contamination identified during previous construction work at the former American Presidents Line (APL) Terminal at Berths 60–63 at 1395 Middle Harbor Road, Port of Oakland (Port), Oakland, California (the site; Figure 1). The scope of work described in this Work Plan is based on recommendations presented in the Post-Construction Closure Report (PCCR) for the site prepared by Baseline Environmental Consulting (Baseline) dated August 13, 2013 and comments on the PCCR prepared by Alameda County Department of Environmental Health (ACEH) presented in the ACEH SCP Case File RO470 letter (Letter) dated June 4, 2014.

1.0 BACKGROUND

Research conducted as part of environmental planning prior to redevelopment indicated that the site was historically occupied by various industries, including lumberyards, rail yards, shipbuilding, ship repair, and garbage handling operations. Soil and groundwater investigations conducted at the site indicated that these past uses had resulted in releases of organic and inorganic contaminants to soil and groundwater.

In 2006, the APL Terminal was redeveloped to enlarge the terminal area and to construct new facilities. Redevelopment was performed as described in the *Revised Soil Management and Contingency Plan APL Terminal Redevelopment Project, Port of Oakland, Oakland, California* (ETIC Engineering, Inc., 2006). The PCCR included documentation of excavation activities, soil handling, sampling, observations during earthwork, and discoveries of locations with soil and groundwater contamination encountered during redevelopment. These locations were identified as “Cases” or “Other Samples” in the PCCR. The PCCR included recommendations that four of these locations (Cases 002, 004, 009, and Oily/Water by Building E-221) receive further investigation.

The ACEH presented technical comments on the PCCR recommendations in a letter to the Port (ACEH, 2014). The ACEH concurred with the PCCR recommendations and requested collection and analysis of additional soil and groundwater samples from additional soil borings. The ACEH

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also requested that other locations be investigated in addition to the four investigation locations identified in the PCCR (ACEH, 2014); these additional locations included Case areas 005 and 010. Therefore, investigation is planned in the following locations (Figure 2) as described within this Work Plan:

- **Case 002** – Solvent odor was detected in a trench excavated for a fire line in the upper middle portion of the site. Volatile organic compounds (VOCs) were detected in soil samples from the trench at concentrations exceeding commercial/industrial environmental screening levels (ESLs; CalEPA, 2013).
- **Case 004** – Staining was observed and petroleum odor was detected in a trench excavated near queuing lanes in the northeastern portion of the site. Total petroleum hydrocarbons (TPH) quantified as diesel (TPHd) and polynuclear aromatic hydrocarbons (PAHs) were detected at concentrations exceeding commercial/industrial ESLs.
- **Case 005** – Staining was observed and odors were detected in stockpiled soil excavated near Building E-224.
- **Case 009** – Soil excavated from an area west of boring B-20 contained TPHd at a concentration that exceeded the commercial/industrial ESL.
- **Case 010** – Stockpiled soil from a trench excavated for a water line in the northern central portion of the site contained elevated levels of TPH and PAHs.
- **Building E-221** – Oily water was encountered and removed from a sump by Building E-221, and stained soil was removed from beneath the building footprint. TPHd and TPH quantified as motor oil (TPHmo) were detected in these samples at concentrations exceeding commercial/industrial ESLs.

1.1 Case 011 and Boring B97

ACEH also requested additional explanation regarding investigation performed at Case 011 in the vicinity of an oil/water separator near Building E-127 and to provide the location of Boring B97 on a figure within the Work Plan.

The 1,500-gallon-capacity oil/water separator near Building E-127 (Figure 2) was inspected on May 24, 2007. The oil/water separator consisted of two compartments. At the time of inspection, 4 feet of oil overlying water was present in one of the compartments and water containing dissolved petroleum hydrocarbons was present in the other compartment. A sample collected for laboratory analyses showed that the water contained elevated concentrations of petroleum hydrocarbons (Baseline, 2013).

On June 5, 2007, the contents of the oil/water separator were removed and disposed of off-site. The oil/water separator was removed on June 6, 2007 and inspected. No visible cracks were observed and the oil/water separator was reported to be “intact.” No odor was reported from within the oil/water separator excavation and no staining of soils was reportedly observed. Two soil samples (PIA012 and PIA013) were collected from the bottom of the oil/water separator excavation and analyzed for TPH purgeables, TPH extractables, VOCs, semivolatile organic compounds (SVOCs), and metals. These two samples were designated as Case 012 and Case 013, respectively, and collectively represent Case 014. Because analytical results for the two samples indicated that soil beneath the oil/water separator met re-use criteria; no over-excavation was performed and no additional investigation was recommended (Baseline, 2013). No additional investigation for Case 011 is planned.

The location of Boring B97 is shown on Figure 2 *Proposed Boring and Monitoring Well Locations*.

2.0 FIELD INVESTIGATION SCOPE AND APPROACH

This section outlines the tasks to be performed for the proposed field investigation for each of the areas described above. Protocols for field documentation and sample handling described in Standard Operating Procedure (SOP) 3.0 Field Documentation and Sample Handling, provided in Attachment A, will be followed during the field investigation.

2.1 Borehole Clearance and Permitting

Drilling locations will be marked in the field after Port-provided utility drawings have been reviewed and it has been verified that no known subsurface utilities are present in the area. Once the locations are marked in the field, a private geophysical subsurface utility locator will check each proposed drilling location to ensure that the areas are free of utilities. AMEC will notify Underground Service Alert a minimum of 48 hours prior to subsurface utility location. In addition, AMEC will obtain drilling permits from Alameda County before subsurface investigation work begins. After the borings have been cleared and prior to the start of drilling, photographs will be taken of each of the boring/well locations.

2.2 Soil Boring Advancement and Soil Sampling

Eighteen soil borings will be drilled and temporary wells installed and sampled at the five case areas listed below. The proposed boring locations have been selected to characterize the vertical and lateral extent of chemicals of concern in soil and groundwater at each of the case areas. Groundwater samples will be collected from the first water bearing unit encountered. The locations are illustrated on Figures 2 thru 7.

- **Case 002 – (four borings: APLB-1 through APLB-4)** – Four borings will be located approximately 15 feet north, south, east, and west of the previous Case 002 confirmation sample location (designated Phase 1A-007-East-5ft). Figure 3 illustrates the proposed boring locations.
- **Case 004 – (three borings: APLB-5 through APLB-7)** – One boring will be located downgradient, approximately 34 feet south of the Case 004 confirmation sample location (designated P1A-004-N4); one boring will be drilled cross-gradient, approximately 15 feet east of the previous confirmation sampling location; and one boring will be drilled approximately 15 feet north of the original confirmation sampling location. Figure 4 illustrates the proposed boring locations.

- **Case 005 – (four borings: APLB-8 through APLB-11)** – Four borings will be located approximately 15 feet north, south, east, and west of the original Case 005 confirmation sample location (designated P1A-005-E4). Figure 4 illustrates the proposed boring locations.
- **Case 009 – (three borings: APLB-12 through APLB-14)** – Two borings will be located downgradient, approximately 15 feet south of the of the original Case 009 trench excavation; and one boring will be drilled approximately 15 feet north of the former trench. Figure 6 illustrates the proposed boring locations.
- **Case 010 – (four borings: APLB-15 through APLB-18)** – One boring will be located approximately 15 feet from the southwest end of the former Case 010 trench location; one boring will be located approximately 15 feet from the northeast end of the former Case 010 trench location; and two borings will be drilled approximately 75 feet apart between the eastern edge of the former Case 010 trench location and an adjacent subsurface storm drain line. Figure 3 illustrates the proposed boring locations.

Cases 004 and 005 are in proximity to the former Union Pacific Railroad (UPRR) Roundhouse Area which is under a Covenant and Environmental Restriction on Property (Deed Restriction). The northwest corner of the Roundhouse Area is approximately 23 feet south of sample location P1A-004-N4 and the western boundary of the Roundhouse area is approximately 57 feet east of sample location P1A-005-E4. The western boundary of the Roundhouse Area and the location of Cases 004 and 005 are shown on Figures 2 and 4. Investigation activities conducted at the Roundhouse Area indicate that separate-phase hydrocarbons are present in the subsurface near former UPRR structures and elevated concentrations of lead are present in soil across the area. The *Revised Site Management Plan Former Union Pacific Roundhouse Area,* dated January 9, 2009 (SMP; AMEC Geomatrix, 2009) describes required soil management measures for activities that would disturb soil within the Roundhouse Area. Because proposed Case 004 and 005 boring locations are outside of the Roundhouse Area, it is not anticipated that the measures described in the SMP will need to be implemented. However, the SMP is included with this Work Plan as Attachment B should field conditions require moving a boring inside the limits of the Roundhouse Area.

The borings will be advanced to approximately 4 feet below the soil/groundwater interface using a direct-push drill rig equipped with clear acetate liners. Drilling procedures are described in SOP 13.0, Drilling, which is provided in Attachment A. Groundwater has been encountered between 5 and 9 feet below ground surface (bgs) in borings previously drilled in the area; therefore, it is planned that the borings will extend to depths between 9 and 14 feet bgs. The borings will be lithologically logged in accordance with the American Society for Testing and Materials (ASTM) Standard ASTM D2487-06 by a geologist or engineer working under the supervision of a California-licensed professional geologist. Soil logging procedures are described in SOP 11.0, Soil and/or Rock Logging, which is provided in Attachment A. Three soil samples will be collected from targeted sample depths by cutting approximately 6-inch-long sections of the acetate liner at depths of approximately 2 and 5 feet bgs and at the soil/groundwater interface (expected between 5 and 9 feet bgs). The cut acetate liner sections will be capped with Teflon-lined plastic caps, after which the liners will be labeled, placed in re-closable zipper-top plastic bags, and stored in an cooler with ice. The labels will record the site name and sample identification number, the sample collection date and time, the sampler's initials, and the AMEC project number. Soil samples will be collected in accordance with SOP 14.0, Soil Sampling, which is provided in Attachment A.

2.3 Installation of Temporary Wells and Groundwater Sampling

After the borings have been advanced and soil samples have been collected, temporary wells consisting of 5 feet of slotted 1-inch polyvinyl chloride (PVC) casing and blank 1-inch PVC casing[1] will be lowered into the borehole to a depth consistent with occurrence of first water (soil/groundwater interface) in the borehole. The wells will be sampled after sufficient groundwater enters the casing to allow sampling via low-flow sampling methods. Protocols for groundwater sampling are provided in SOP 17, Groundwater Sampling, which is provided in Attachment A. It is anticipated that a peristaltic pump with polyethylene tubing will be used to purge and sample the temporary wells and that the wells will be purged at a rate of approximately 200 milliliters per minute. The water from the temporary well will be purged, and field indicator parameters (pH, temperature, turbidity, and specific conductance) will be monitored. After these parameters have stabilized, three casing volumes have been removed, or the well has been purged until dry and allowed to recover to 80 percent of the original volume, samples will be collected by filling laboratory-supplied sample containers with water directly from the purge tubing. Sample containers will be labeled and then placed in re-closable zipper-top plastic bags in a cooler with ice. Purge water will be temporarily contained in labeled drums or a portable poly tank designated for this investigation derived waste and then transferred to a secure staging area at the APL Terminal, pending profiling and disposal.

2.4 Borehole and Temporary Well Abandonment

After the groundwater samples have been collected, the temporary well casings will be removed from the boreholes, and the boreholes will be backfilled with bentonite/cement grout using a tremie pipe. In areas where asphalt pavement is present, the surface of the grouted borehole will be covered with a cold-asphalt patch. SOP 13.0, Drilling (Attachment A) further describes procedures for borehole abandonment.

2.5 Monitoring Well Installation

Three groundwater monitoring wells (APLMW-1 through APLMW-3) will be installed in the vicinity of Building E-221 to replace three wells that were abandoned during site redevelopment. These wells were originally installed to assess groundwater impacts from former underground storage tanks at Building E-221. The proposed well locations are shown on Figure 5. SOP 13, Drilling, and SOP 16.0, Well Installation, are provided in Attachment A.

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[1] The length of the blank casing will be cut and fitted onto the slotted casing such that once the casing has been introduced into the borehole, the slotted screen extends approximately 4 feet below and 1 foot above the soil/water interface.

The well boreholes will be drilled to depths of up to 8 feet below the soil/groundwater interface (estimated to be between 5 and 9 feet bgs) using a hollow-stem auger drill rig equipped with 8-inch-diameter augers. The boreholes will be continuously sampled and logged by driving California-modified style split-spoon samplers from the ground surface to the groundwater interface and then to depths of 4 and 8 feet below the soil/groundwater interface. Soil samples will be collected for laboratory analyses from each well borehole at depths of approximately 4 feet bgs and at the soil/groundwater interface.

The wells will be constructed using 2-inch-diameter Schedule 40 PVC casing consisting of 0.010-inch slotted screen, and blank casing (such that the screen extends approximately 2 feet above the soil/groundwater interface). Annular materials will consist of 2/12 sand or equivalent filter pack that will extend 2 feet above the screen, hydrated bentonite pellets extending 2 feet above the sand, and grout from the top of the bentonite to approximately 0.5 foot bgs. The wells will be completed within a below-grade watertight utility box and fitted with a locking cap.

2.6 Well Development and Groundwater Sampling

The three wells installed at Building E-221 (APLMW-1 through APLMW-3) will be developed and sampled a minimum of three days following installation. Well development and groundwater sampling procedures are described in SOP 16.0, Well Installation, and SOP 17.0, Groundwater Sampling, respectively. These SOPs are included in Attachment A. The wells will be developed by surging, bailing, and pumping. The well purge water will be monitored for field indicator parameters during development. The wells will be purged until field indicator parameters stabilize or a minimum of 10 casing volumes of water have been pumped from the wells.

Water levels in the three wells will be measured and the wells sampled using low-flow techniques two days following development. The same procedures used to sample the temporary wells will be followed when collecting samples from wells APLMW-1 through APLMW-3.

2.7 Quality Control Sampling

A duplicate sample will be collected for every ten groundwater samples. Duplicate samples will be identified by assigning the date and duplicate designation; e.g., DUP20141102 for a duplicate sample collected on November 2, 2014. Field notes will designate the corresponding primary sample for each duplicate sample. If multiple duplicate samples are collected on a given day, they will be designated with a “-1”, “-2”, etc. In addition, a field rinsate blank will be collected for each day of sampling to evaluate potential cross-contamination during sampling. The total number of rinsate samples will not exceed 10 percent of the total of the primary samples collected for analysis. Field rinsate blanks will be collected by pouring laboratory-supplied blank water over the sampling equipment and collecting the rinse water in laboratory-supplied sample containers. Field rinsate blanks will be analyzed for the analytical suite associated with the sampling event. Rinsate blanks will be designated as RB plus the date; e.g., RB20141102 for a rinsate sample collected on November 2, 2014.

In addition, if samples are collected for VOCs or TPH as gasoline (THPg), a trip blank will be submitted for VOC analysis. The trip blank will be a vial of laboratory blank water provided by the laboratory and will be analyzed to ascertain if there is VOC cross-contamination at the laboratory or during shipment or handling of the samples. The trip blanks will be designated as TB and the date; e.g., TB20141102. Quality control samples are listed on Table 1.

2.8 Decontamination and Investigation-Derived Waste (IDW) Management

Protocols for equipment decontamination are provided in SOP 7.0, Equipment Decontamination, which is provided in Attachment A. Drilling equipment and reusable sampling equipment will be decontaminated with a steam cleaner or low-phosphate soap solution and clean water rinse between borings and before leaving the site. PVC casing removed from the boreholes will be steam cleaned and then disposed as trash. The decontamination rinsate will be contained and transferred to 55-gallon drums.

Soil cuttings will be placed in 55-gallon drums. Well development and sampling purge water will be containerized in a portable poly tank or 55-gallon drums. The soil and waste water containers will be labeled and moved to a secure location identified by the Port. The drums with soil cuttings will be labeled with the boring identification numbers and date of drilling. The water containers will also be labeled as to contents and date of generation. Once the sampling program has been completed, a composite sample of the wastewater (well development, purge and decontamination rinsate) will be collected for waste characterization. Analytical results for soil samples collected from the borings will be used to characterize the soil cuttings. Based on analytical results, the soil cuttings and waste water will be profiled and disposed off site at a licensed facility.

2.9 Laboratory Analyses

Soil and groundwater samples collected as part of this investigation will be transported and submitted under chain of custody control to a Port-contracted laboratory. Samples will be analyzed by Curtis & Tompkins, Inc. (a California-state certified, ISO/IEC 17025:2005 and NELAC 2003 Accredited Environmental Testing Laboratory) or Test America, (a California state certified and NELAC accredited laboratory). Soil and groundwater samples from each of the case locations will be analyzed for the following chemicals of concern using the indicated United States Environmental Protection Agency (EPA) test method:

- **Case 002** – VOCs (EPA 8260B) and SVOCs (EPA 8270C).
- **Case 004** – TPHd and TPHmo (EPA 8015M); VOCs (EPA 8260B); SVOCs (8270SIM).
- **Case 005** –TPHg, TPHd, and TPHmo (EPA 8015M); VOCs (EPA 8260B); and SVOCs (EPA 8270SIM).
- **Case 009** – TPHd and TPHmo (EPA 8015M).

- **Case 010** – TPHg, TPHd, and TPHmo (EPA 8015M); VOCs (EPA 8260B); and SVOCs (EPA 8270SIM).
- **Building E-221** – TPHg, TPHd, and TPHmo (EPA 8015M); benzene, toluene, ethylbenzene, and xylenes (BTEX) (EPA 8021B); PAHs (EPA 8270SIM).

IDW wastewater samples will be analyzed for chemicals of concern identified for the case areas including TPHg, TPHd, and TPHmo (EPA 8015M); VOCs (including BTEX) (EPA 8260B); and SVOCs (including PAHs) (EPA 8270SIM).

Table 1 presents the proposed sampling and analysis plan.

The laboratory will generate Level III data packages, which will include chromatographs. The Level III data packages will be consistent with Level III laboratory deliverable requirements described in Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use, EPA-540-R-08-005, January 2009 (EPA, 2009).

2.10 Data Management and Data Validation

Analytical data will be provided as electronic deliverables from the laboratory, which will be loaded into AMEC's Structured Query Language database. Database reports in the form of summary tables will then be generated for data reporting and evaluation.

Level II cursory data review will be performed according to the principles presented in the United States EPA National Functional Guidelines for Inorganic Superfund Data Review (EPA, 2010), and the principles presented in the EPA National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2008). Level II cursory data review will include review of chain-of-custody, sample preservation, holding times, surrogate recoveries, blanks, laboratory control and laboratory control sample duplicates, matrix spike and matrix spike duplicate samples, serial dilution, field duplicate samples and laboratory reporting limits, as applicable. Data validation qualifiers will be applied to the analytical results, as applicable, and a validation summary report will be prepared summarizing results of the data review.

2.11 Surveying

Horizontal and vertical position of the 18 borings and three wells will be surveyed by a California-licensed surveyor. Horizontal position will be surveyed to an accuracy of 0.1 foot relative to the North American Datum of 1983 (NAD83) and vertical position to an accuracy of 0.01 foot relative to the North American Vertical Datum of 1988 (NAVD88) and the Port of Oakland Vertical Datum (3.20 feet below Mean Sea Level). A small notch or other survey mark will be established on the rim of the top of each casing where the elevation of each monitoring well is measured to serve as a reference mark for measuring depth to groundwater.

3.0 REPORTING

After completion of the field investigation, a draft report will be prepared describing the field program, presenting observations during drilling, and results of the soil and groundwater analyses. The report will also provide figures showing sample locations, boring logs, well completion details, and tables summarizing soil and groundwater analytical results. The final report will be submitted to the Alameda County Department of Environmental Health.

Analytical results will be screened against current commercial/industrial ESLs. The report will provide an analysis of whether results show that the areas of contamination are adequately characterized and whether chemical concentrations are at levels that pose risk based on commercial/industrial land uses.

We trust that this Work Plan provides sufficient detail concerning the proposed soil and groundwater sampling program at the former APL Terminal. Please contact the undersigned if you have questions or comments.

Sincerely yours,
AMEC Environment & Infrastructure, Inc.

William Feller
Senior Geology Professional

Mary Jo Heassler

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Attachments:

Table 1	Sampling and Analysis Plan
Figure 1	Site Location Map
Figure 2	Proposed Boring and Monitoring Well Locations
Figure 3	Proposed Boring Locations – Cases 002 and 010
Figure 4	Proposed Boring Locations – Cases 004 and 005
Figure 5	Proposed Monitoring Well Locations – Building 221
Figure 6	Proposed Boring Locations – Case 009
Attachment A	Standard Operating Procedures
Attachment B	Revised Site Management Plan Former UP Roundhouse Area

REFERENCES CITED

Alameda Country Environmental Health (ACEH), 2014. ACEH *SCP Case File RO470, Port of Oakland / APL / Berths 60-63, 1395 Middle Harbor Road, Oakland*. Letter from Keith Nowell of ACEH to John Prall, Port of Oakland. June 4.

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TABLE

TABLE 1

SAMPLING AND ANALYSIS PLAN

Former APL Terminal, Port of Oakland

Case Area	Boring/ Well	Matrix	Sample Numbers [a]	Approximate Sample Depth	Sample Type	Date	Lab ID	Test Method	VOCs (8260B)	BTEX (8021B)	SVOCs (8270C)	PAHs (8270 SIM)	TPHd, TPHmo (8015M)	TPHg (8015M)	Comments
								Soil Containers	One liner						
								Aqueous Containers	3 x 40 mL VOA	3 x 40 mL VOA	2 x 1 L Amber	2 x 1 L Amber	1 x 1 L Amber	3 x 40 mL VOA	
002	APLB-1	soil	APLB-1(2.0)	2	Primary				X		X				
		soil	APLB-1(5.0)	5	Primary				X		X				
		soil	APLB-1(TBD)	TBD	Primary				X		X				
		water	APLB-1(GW)	NA	Primary				X		X				
	APLB-2	soil	APLB-2(2.0)	2	Primary				X		X				
		soil	APLB-2(5.0)	5	Primary				X		X				
		soil	APLB-2(TBD)	TBD	Primary				X		X				
		water	APLB-2(GW)	NA	Primary				X		X				
	APLB-3	soil	APLB-3(2.0)	2	Primary				X		X				
		soil	APLB-3(5.0)	5	Primary				X		X				
		soil	APLB-3(TBD)	TBD	Primary				X		X				
		water	APLB-3(GW)	NA	Primary				X		X				
	APLB-4	soil	APLB-4(2.0)	2	Primary				X		X				
		soil	APLB-4(5.0)	5	Primary				X		X				
		soil	APLB-4(TBD)	TBD	Primary				X		X				
		water	RBDATE	NA	QC				X		X				Rinsate blank
		water	TBDATE	NA	QC				X						Trip blank
		water	APLB-4(GW)	NA	Primary				X		X				
004	APLB-5	soil	APLB-5(2.0)	2	Primary				X		X		X		
		soil	APLB-5(5.0)	5	Primary				X		X		X		
		soil	APLB-5(TBD)	TBD	Primary				X		X		X		
		water	APLB-5(GW)	NA	Primary				X		X		X		
	APLB-15	soil	APLB-15(2.0)	2	Primary				X		X		X		
		soil	APLB-15(5.0)	5	Primary				X		X		X		
		soil	APLB-15(TBD)	TBD	Primary				X		X		X		
		water	APLB-15(GW)	NA	Primary				X		X		X		
	APLB-7	soil	APLB-7(2.0)	2	Primary				X		X		X		
		soil	APLB-7(5.0)	5	Primary				X		X		X		
		soil	APLB-7(TBD)	TBD	Primary				X		X		X		
		water	APLB-7(GW)	NA	Primary				X		X		X		
005	APLB-8	soil	APLB-8(2.0)	2	Primary				X		X		X	X	
		soil	APLB-8(5.0)	5	Primary				X		X		X	X	
		soil	APLB-8(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-8(GW)	NA	Primary				X		X		X	X	
	APLB-9	soil	APLB-9(2.0)	2	Primary				X		X		X	X	
		soil	APLB-9(5.0)	5	Primary				X		X		X	X	
		soil	APLB-9(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-9(GW)	NA	Primary				X		X		X	X	

TABLE 1

SAMPLING AND ANALYSIS PLAN

Former APL Terminal, Port of Oakland

Case Area	Boring/ Well	Matrix	Sample Numbers [a]	Approximate Sample Depth	Sample Type	Date	Lab ID	Test Method	VOCs (8260B)	BTEX (8021B)	SVOCs (8270C)	PAHs (8270 SIM)	TPHd, TPHmo (8015M)	TPHg (8015M)	Comments
								Soil Containers	One liner						
								Aqueous Containers	3 x 40 mL VOA	3 x 40 mL VOA	2 x 1 L Amber	2 x 1 L Amber	1 x 1 L Amber	3 x 40 mL VOA	
005	APLB-10	soil	APLB-10(2.0)	2	Primary				X		X		X	X	
		soil	APLB-10(5.0)	5	Primary				X		X		X	X	
		soil	APLB-10(TBD)	TBD	Primary				X		X		X	X	
		water	RBDATE	NA	QC				X		X		X	X	Rinsate blank
		water	TBDATE	NA	QC				X					X	Trip blank
		water	APLB-10(GW)	NA	Primary				X		X		X	X	
		water	DUPDATE-2	NA	Duplicate				X		X		X	X	
	APLB-11	soil	APLB-11(2.0)	2	Primary				X		X		X	X	
		soil	APLB-11(5.0)	5	Primary				X		X		X	X	
		soil	APLB-11(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-11(GW)	NA	Primary				X		X		X	X	
009	APLB-12	soil	APLB-12(2.0)	2	Primary								X		
		soil	APLB-12(5.0)	5	Primary								X		
		soil	APLB-12(TBD)	TBD	Primary								X		
		water	APLB-12(GW)	NA	Primary								X		
	APLB-13	soil	APLB-13(2.0)	2	Primary								X		
		soil	APLB-13(5.0)	5	Primary								X		
		soil	APLB-13(TBD)	TBD	Primary								X		
		water	APLB-13(GW)	NA	Primary								X		
	APLB-14	soil	APLB-14(2.0)	2	Primary								X		
		soil	APLB-14(5.0)	5	Primary								X		
		soil	APLB-14(TBD)	TBD	Primary								X		
		water	APLB-14(GW)	NA	Primary								X		
010	APLB-15	soil	APLB-15(2.0)	2	Primary				X		X		X	X	
		soil	APLB-15(5.0)	5	Primary				X		X		X	X	
		soil	APLB-15(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-15(GW)	NA	Primary				X		X		X	X	
	APLB-16	soil	APLB-16(2.0)	2	Primary				X		X		X	X	
		soil	APLB-16(5.0)	5	Primary				X		X		X	X	
		soil	APLB-16(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-16(GW)	NA	Primary				X		X		X	X	
	APLB-17	soil	APLB-17(2.0)	2	Primary				X		X		X	X	
		soil	APLB-17(5.0)	5	Primary				X		X		X	X	
		water	RBDATE	NA	QC				X		X		X	X	Rinsate blank
		water	TBDATE	NA	QC				X					X	Trip blank
		soil	APLB-17(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-17(GW)	NA	Primary				X		X		X	X	
010	APLB-18	soil	APLB-18(2.0)	2	Primary				X		X		X	X	
		soil	APLB-18(5.0)	5	Primary				X		X		X	X	
		soil	APLB-18(TBD)	TBD	Primary				X		X		X	X	
		water	APLB-18(GW)	NA	Primary				X		X		X	X	

TABLE 1

SAMPLING AND ANALYSIS PLAN

Former APL Terminal, Port of Oakland

Case Area	Boring/ Well	Matrix	Sample Numbers [a]	Approximate Sample Depth	Sample Type	Date	Lab ID	Test Method	VOCs (8260B)	BTEX (8021B)	SVOCs (8270C)	PAHs (8270 SIM)	TPHd, TPHmo (8015M)	TPHg (8015M)	Comments
								Soil Containers	One liner						
								Aqueous Containers	3 x 40 mL VOA	3 x 40 mL VOA	2 x 1 L Amber	2 x 1 L Amber	1 x 1 L Amber	3 x 40 mL VOA	
Former Building E-221	APLMW-1	soil	APLMW-1(4.0)	4	Primary					X		X	X	X	
		soil	APLMW-1(TBD)	TBD	Primary					X		X	X	X	
		water	APLMW-1(GW)	NA	Primary					X		X	X	X	
	APLMW-2	soil	APLMW-2(4.0)	4	Primary					X		X	X	X	
		soil	APLMW-2(TBD)	TBD	Primary					X		X	X	X	
		water	APLMW-2(GW)	NA	Primary					X		X	X	X	
		water	DUPDATE	NA	Duplicate					X		X	X	X	
	APLMW-3	soil	APLMW-3(4.0)	4	Primary					X		X	X	X	
		soil	APLMW-3(TBD)	TBD	Primary					X		X	X	X	
		water	APLMW-3(GW)	NA	Primary					X		X	X	X	
IDW water		water	RWDATE	NA	Primary				X		X		X	X	Decontamination rinsate and purge water

[a] The sample depth is entered in parentheses at the end of the sample number. Date will correspond to the date the sample was collected.

Abbreviations

BTEX = collective term for benzene, toluene, ethylbenzene, and xylenes
GW = groundwater
IDW = Investigation derived waste
L = liter
mL = milliliter
PAHs = polynuclear aromatic hydrocarbons
SVOCs = semivolatile organic carbons
TBD = to be determined
TPHd = total petroleum hydrocarbons quantified as diesel
TPHg = TPH quantified as gasoline
TPHmo = TPH quantified as motor oil
VOCs = volatile organic carbons
VOA = volatile organic analysis

FIGURES

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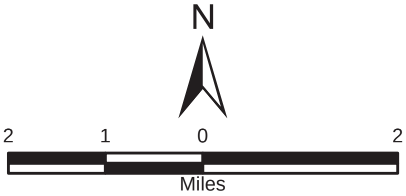

Source: Oakland West
(USGS 1:24,000 sheets)

SITE LOCATION MAP
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH	Date: 09/19/2014	Project No. OD14170810
	amec	Figure 1

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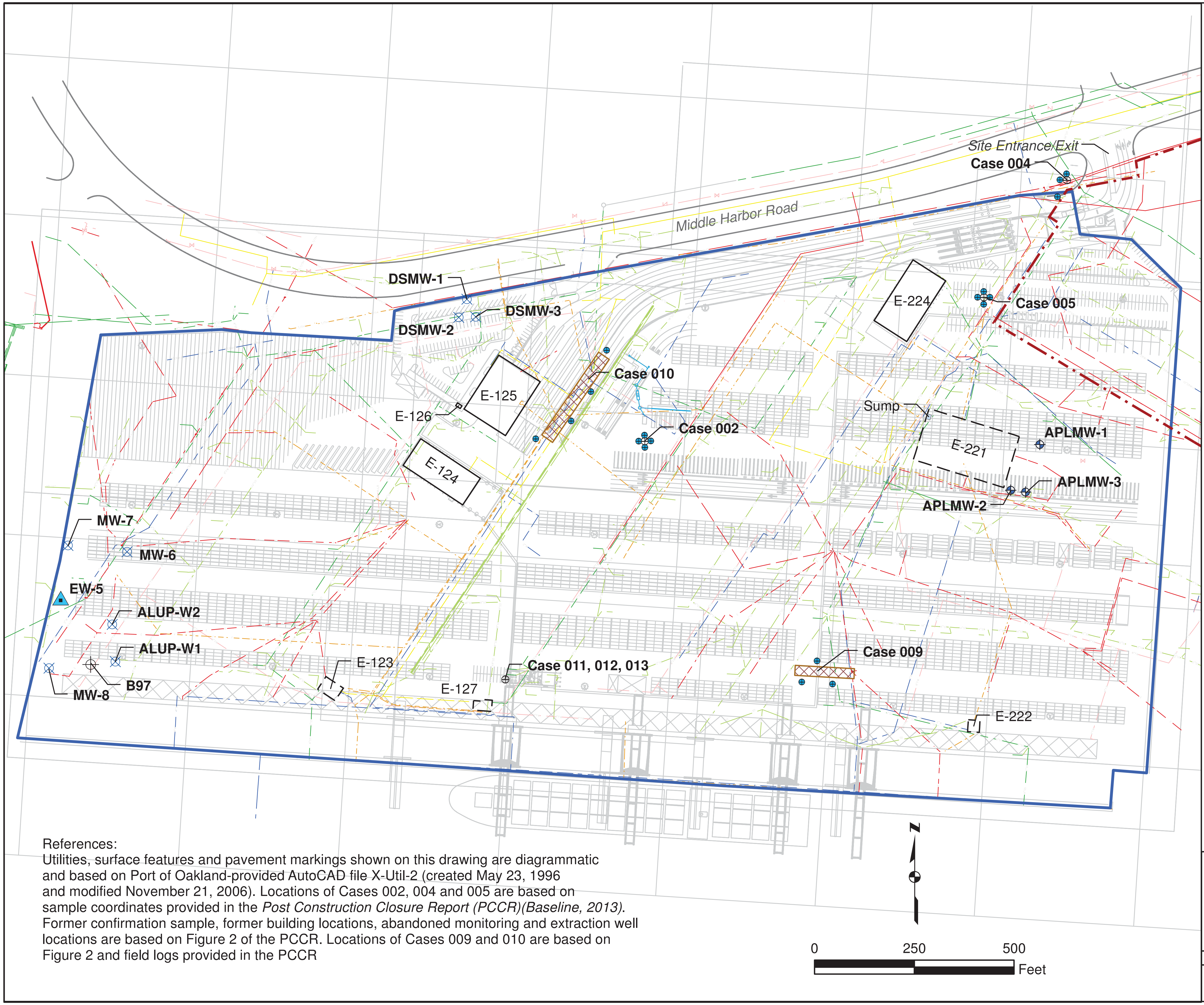

References:
Utilities, surface features and pavement markings shown on this drawing are diagrammatic and based on Port of Oakland-provided AutoCAD file X-Util-2 (created May 23, 1996 and modified November 21, 2006). Locations of Cases 002, 004 and 005 are based on sample coordinates provided in the *Post Construction Closure Report (PCCR)(Baseline, 2013)*. Former confirmation sample, former building locations, abandoned monitoring and extraction well locations are based on Figure 2 of the PCCR. Locations of Cases 009 and 010 are based on Figure 2 and field logs provided in the PCCR

EXPLANATION

- ⊕ Proposed Monitoring Well Location
- ● Proposed Boring Location
- ⊕ Former Confirmation Sample
- ☒ Abandoned Monitoring Well Location
- ▲ Extraction Well Location
- ⊕ Boring Location
- ☐ Existing Building Location
- ⬚ Former Building Location
- ▨ Former Trench Location
- ☐ Redevelopment Boundary
- -·- Deed Restriction Boundary, Former UP Roundhouse Area

Subsurface Utilities

—W—	Water Supply
—SS—	Sanitary Sewer
-T-	Communications
-E-	Electrical
—FW—	Fire Service
—G—	Gas
—SD—	Storm Drain

Notes:
The information shown on this figure, including utility locations, is diagrammatic and not to scale. This figure is not intended to locate existing utilities. All utility Locations will be field verified. Screened back lines represent existing surface features and pavement markings at the site as shown by Port of Oakland provided information. Existing surface features, and pavement markings may not match the figure.

PROPOSED BORING AND
MONITORING WELL LOCATIONS
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH	Date: 11/03/2014	Project No. OD14170810
amec	Figure	2

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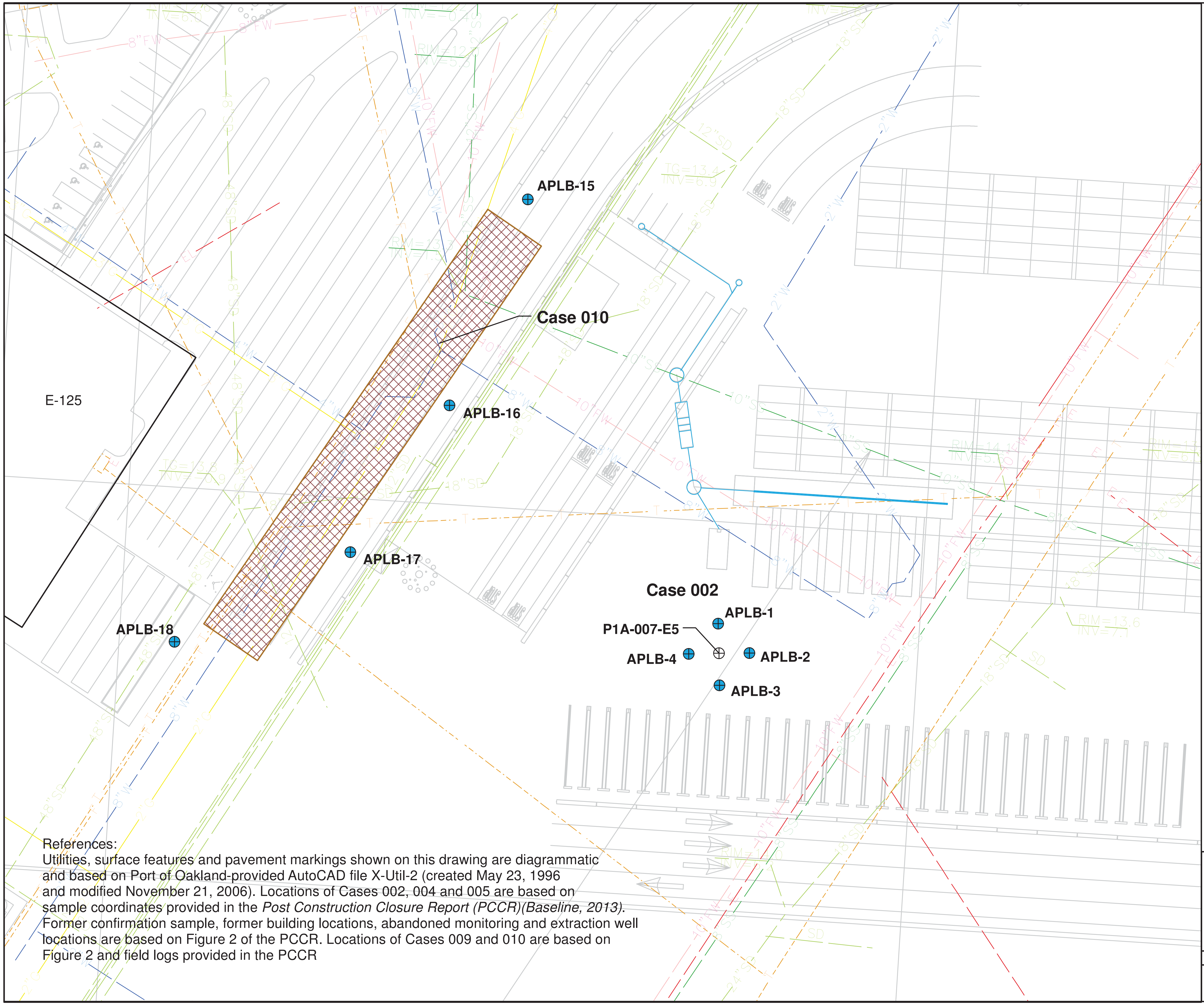

References:
Utilities, surface features and pavement markings shown on this drawing are diagrammatic and based on Port of Oakland-provided AutoCAD file X-Util-2 (created May 23, 1996 and modified November 21, 2006). Locations of Cases 002, 004 and 005 are based on sample coordinates provided in the *Post Construction Closure Report (PCCR)(Baseline, 2013)*. Former confirmation sample, former building locations, abandoned monitoring and extraction well locations are based on Figure 2 of the PCCR. Locations of Cases 009 and 010 are based on Figure 2 and field logs provided in the PCCR

EXPLANATION

⊕	Proposed Boring Location
⊕	Former Confirmation Sample
☐	Existing Building Location
▨	Former Trench Location

Subsurface Utilities

—W—	Water Supply
—SS—	Sanitary Sewer
–·T·–	Communications
–·E·–	Electrical
—FW—	Fire Service
—G—	Gas
—SD—	Storm Drain

Notes:
The information shown on this figure, including utility locations, is diagrammatic and not to scale. This figure is not intended to locate existing utilities. All utility Locations will be field verified. Screened back lines represent existing surface features and pavement markings at the site as shown by Port of Oakland provided information. Existing surface features, and pavement markings may not match the figure.

N

0 50 100
Feet

PROPOSED BORING
LOCATIONS – CASES 002 AND 010
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH	Date: 09/18/2014	Project No. OD14170810
amec	Figure	3

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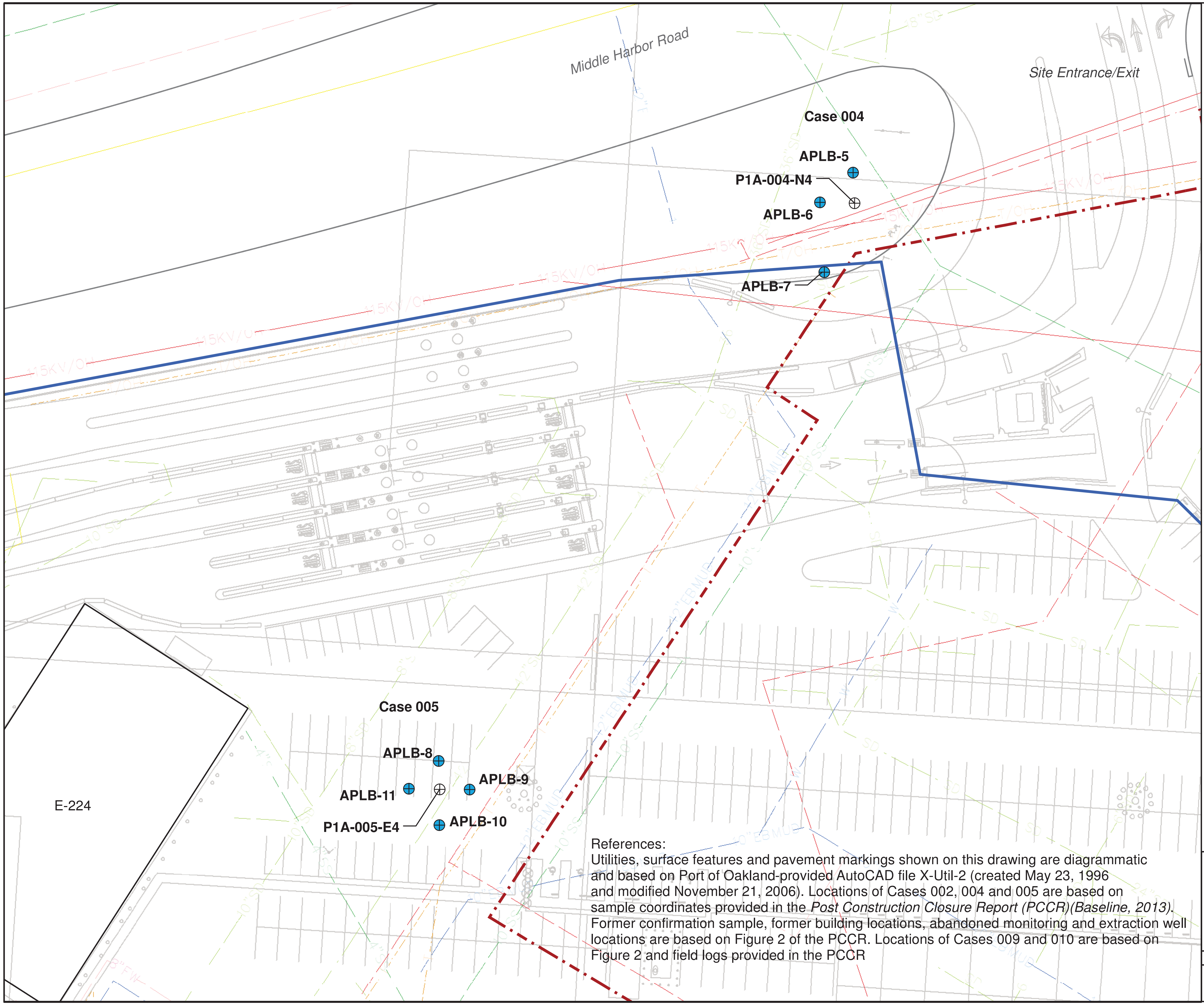

References:
Utilities, surface features and pavement markings shown on this drawing are diagrammatic and based on Port of Oakland-provided AutoCAD file X-Util-2 (created May 23, 1996 and modified November 21, 2006). Locations of Cases 002, 004 and 005 are based on sample coordinates provided in the *Post Construction Closure Report (PCCR)(Baseline, 2013).* Former confirmation sample, former building locations, abandoned monitoring and extraction well locations are based on Figure 2 of the PCCR. Locations of Cases 009 and 010 are based on Figure 2 and field logs provided in the PCCR

EXPLANATION

⊕	Proposed Boring Location
⊕	Former Confirmation Sample
▭	Redevelopment Boundary
▭	Existing Building Location
- · - ·	Deed Restriction Boundary, Former UP Roundhouse Area

Subsurface Utilities

—W—	Water Supply
—SS—	Sanitary Sewer
- -T- -	Communications
—E—	Electrical
—FW—	Fire Service
—G—	Gas
—SD—	Storm Drain

Notes:
The information shown on this figure, including utility locations, is diagrammatic and not to scale. This figure is not intended to locate existing utilities. All utility Locations will be field verified. Screened back lines represent existing surface features and pavement markings at the site as shown by Port of Oakland provided information. Existing surface features, and pavement markings may not match the figure.

N

0 50 100
Feet

PROPOSED BORING
LOCATIONS – CASES 004 AND 005
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH	Date: 11/06/2014	Project No. OD14170810
amec		Figure 4

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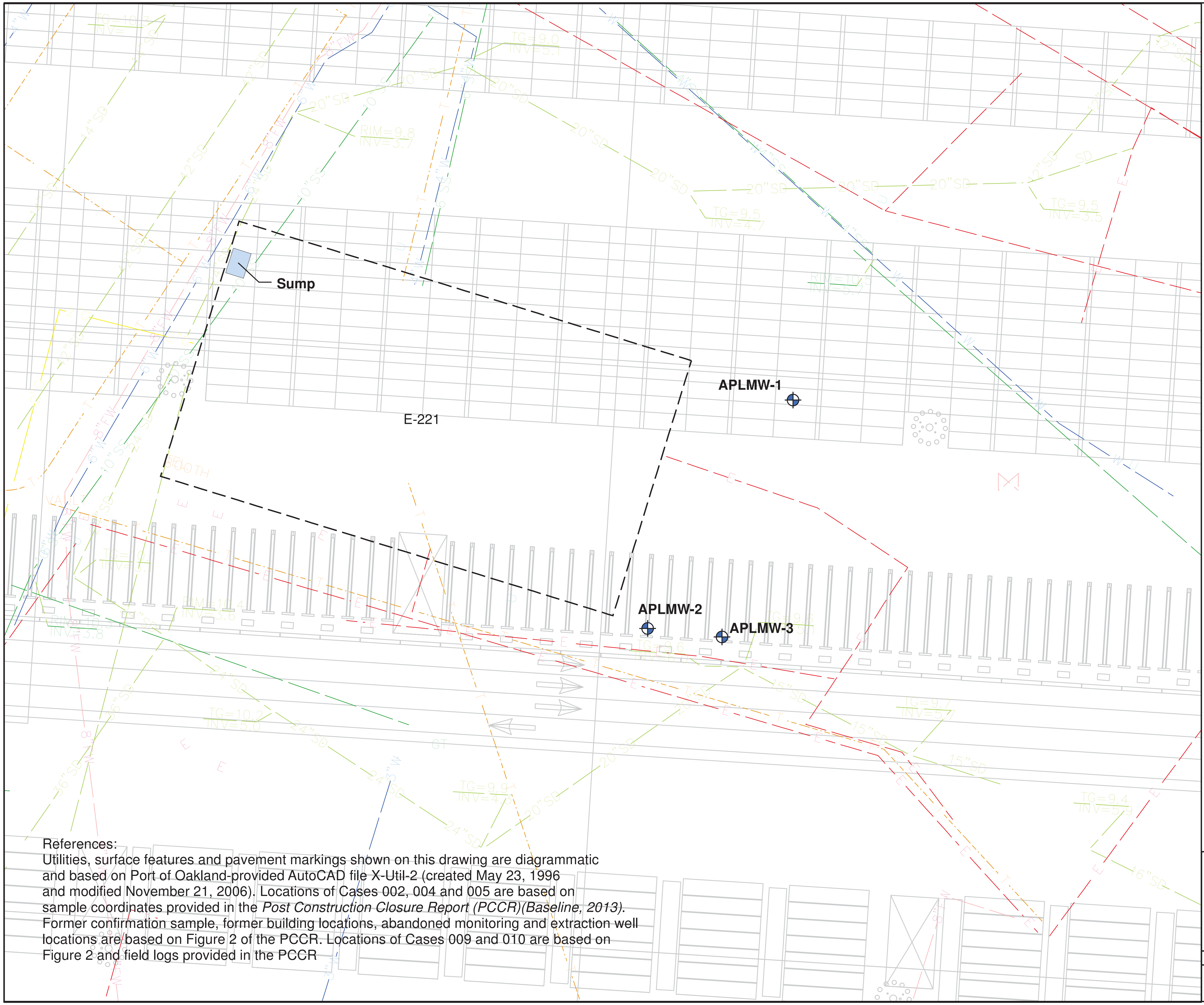


References:
Utilities, surface features and pavement markings shown on this drawing are diagrammatic and based on Port of Oakland-provided AutoCAD file X-Util-2 (created May 23, 1996 and modified November 21, 2006). Locations of Cases 002, 004 and 005 are based on sample coordinates provided in the *Post Construction Closure Report (PCCR)(Baseline, 2013)*. Former confirmation sample, former building locations, abandoned monitoring and extraction well locations are based on Figure 2 of the PCCR. Locations of Cases 009 and 010 are based on Figure 2 and field logs provided in the PCCR

EXPLANATION

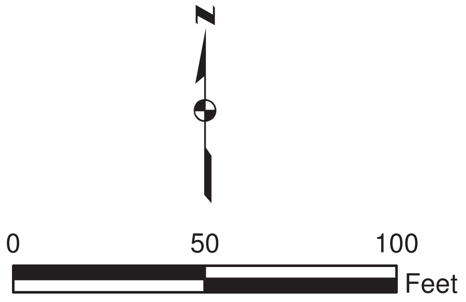
⊕ Proposed Monitoring Well Location

┌ ┐ Former Building Location

Subsurface Utilities

—W— Water Supply
—SS— Sanitary Sewer
- - T - - Communications
— E — Electrical
—FW— Fire Service
—G— Gas
—SD— Storm Drain

Notes:
The information shown on this figure, including utility locations, is diagrammatic and not to scale. This figure is not intended to locate existing utilities. All utility Locations will be field verified. Screened back lines represent existing surface features and pavement markings at the site as shown by Port of Oakland provided information. Existing surface features, and pavement markings may not match the figure.



PROPOSED MONITORING
WELL LOCATIONS – BUILDING 221
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH | Date: 09/18/2014 | Project No. OD14170810
amec | Figure 5

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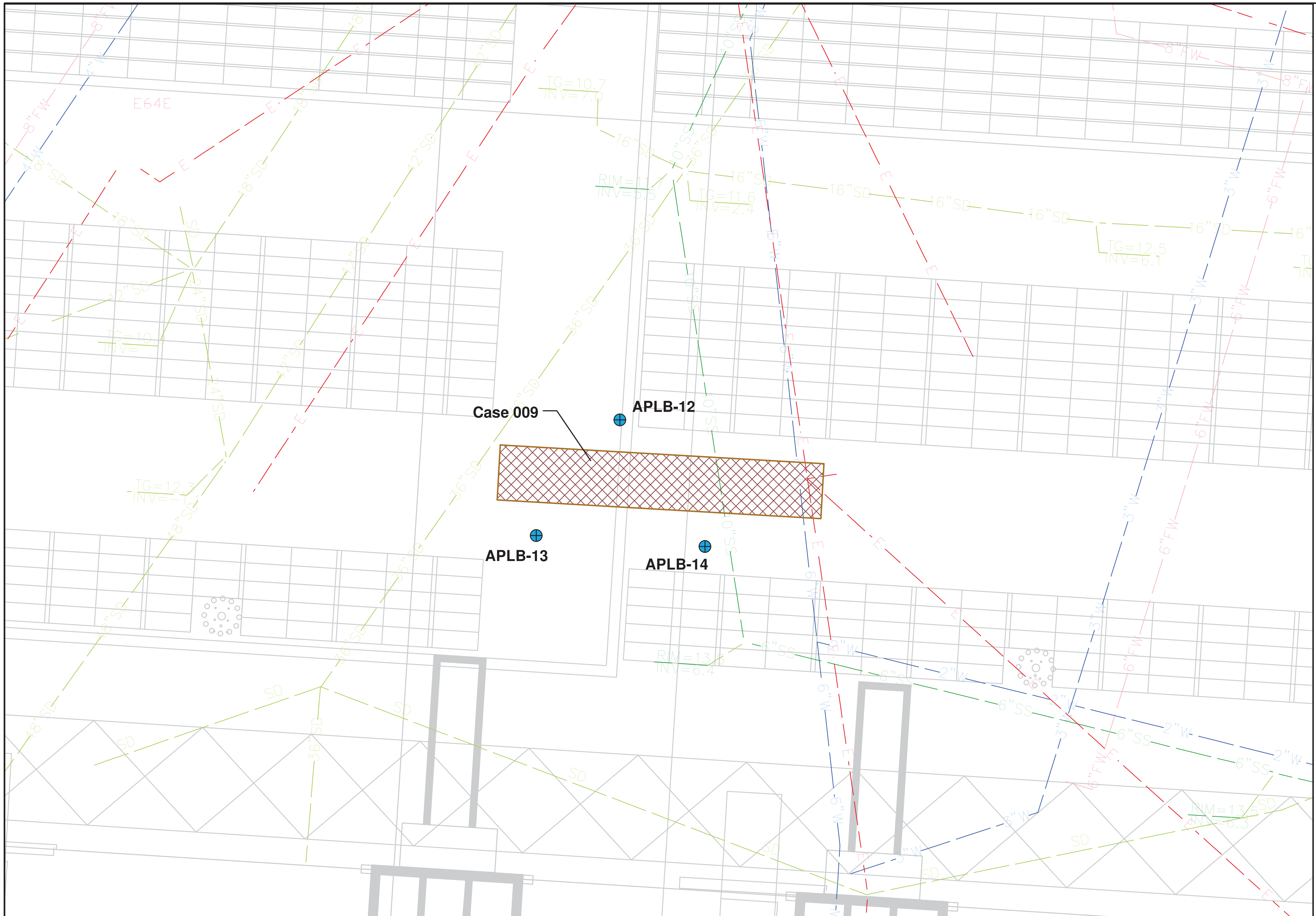


References:
Utilities, surface features and pavement markings shown on this drawing are diagrammatic and based on Port of Oakland-provided AutoCAD file X-Util-2 (created May 23, 1996 and modified November 21, 2006). Locations of Cases 002, 004 and 005 are based on sample coordinates provided in the *Post Construction Closure Report (PCCR)(Baseline, 2013)*. Former confirmation sample, former building locations, abandoned monitoring and extraction well locations are based on Figure 2 of the PCCR. Locations of Cases 009 and 010 are based on Figure 2 and field logs provided in the PCCR

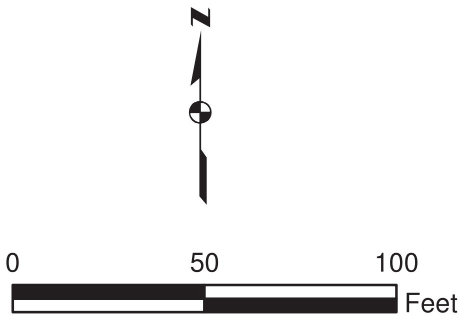
EXPLANATION

⊕	Proposed Boring Location
▨	Former Trench Location

Subsurface Utilities

—W—	Water Supply
—SS—	Sanitary Sewer
- -T- -	Communications
- -E- -	Electrical
—FW—	Fire Service
—G—	Gas
—SD—	Storm Drain

Notes:
The information shown on this figure, including utility locations, is diagrammatic and not to scale. This figure is not intended to locate existing utilities. All utility Locations will be field verified. Screened back lines represent existing surface features and pavement markings at the site as shown by Port of Oakland provided information. Existing surface features, and pavement markings may not match the figure.



PROPOSED BORING
WELL LOCATIONS – CASE 009
Post-Construction Work Plan
Former APL Terminal, Port of Oakland
Oakland, California

By: TJH	Date: 09/19/2014	Project No. OD14170810
amec	Figure	6

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ATTACHMENT A

Standard Operating Procedures

A3.0 – FIELD DOCUMENTATION AND SAMPLE HANDLING

Purpose and Scope: The purpose of this document is to present procedures for field documentation and sample handling. It includes a description of how to fill out a Daily Field Record (DFR), Sample Control Log, and Chain-of-Custody (COC). It also describes procedures for sample labeling, handling, preservation, packaging, and shipping.

Equipment: The following equipment will be needed depending on specific task and will be used, as appropriate, when packing or shipping samples:
Sample Bottles;
Sample Labels;
Custody Seals;
Fine Tipped Permanent Markers;
Nitrile gloves or other appropriate gloves;
Sealable storage bags;
Bubble wrap or appropriate packing materials;
Blue ice or double bagged ice;
Coolers suitable for sample shipment and holding ice;
Strapping/packaging tape and shipping labels, if needed; and
Hand-Held Global Positioning System (GPS) device;
Camera with spare memory chip and batteries.

Documentation: DFR;
Sample Control Log;
Chain of Custody Form (COC);
Maps/plot plan; and
Camera.

This Standard Operating Procedure (SOP) is to be used in conjunction with work plans.

A3.1 FIELD AND SAMPLE DOCUMENTATION

Documentation of the conditions and procedures used to collect, treat, and handle samples and field data is one of the most important aspects of any monitoring program. Proper documentation provides sources to determine the integrity and applicability of the data. Carefully document all field activities in a field logbook or on data sheets. Field logbooks shall be bound with consecutively numbered pages and shall be written in with permanent black ink. Field activities shall be recorded in sufficient detail so that field activities can later be reconstructed from the notes. Any changes to the notes in the field logbook shall be made by drawing a single line through the incorrect material and initialing and dating the mark-out.

A3.1.1 Daily Field Record (DFR)

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, and a permanent record of field activities. Record field observations and data collected during the investigation with waterproof ink on DFR sheets. A new DFR should be completed for each day or when a separate phase of work is initiated.

The DFRs will include the following information, as appropriate.

- Project and Task Number;
- Project Name;
- Location of sample (if samples are collected);
- Date;
- Time;
- Field Activity;
- Weather Conditions;
- Personnel Onsite, Company Name, and Time Onsite;
- Personal Safety Checklist;
- Drum Identification (if drums are used); and
- Description of Work Performed.

Information written within the area delineated “Description of Work Performed” should include the following:

- Sample identification number(s);
- Description of sample;
- Sample depth;
- Number and volume of samples;
- Sample methods used, or reference to the appropriate SOP;
- Sample handling, including filtration and preservation, as appropriate, for separate sample aliquots;
- Field observations;
- Photo documentation;

- Results of any field measurements, such as depth to water, pH, temperature, specific electrical conductivity, and discharge; or
- Decontamination procedures.

Photographs should be taken of pertinent activities that occur during the investigation. These should include capturing images that clearly demonstrate that the goals of the project are being met. They should also be taken of any changes in procedures or unexpected findings that occur in the field. Items of scale should be included in the view of the photograph (i.e., ruler, clipboard, etc.). A running log of the photographs with a description of each photograph should be included on a photo log attached to the DFR.

Strike out changes or deletions in the field book or on the data sheets with a single strike mark and be sure that the original information remains legible. Each page should be completely filled without any blank lines, if necessary write “Not Applicable” or “NA” on blank lines. The field logbook or field data sheets should be signed daily by the author of the entries.

A3.1.2 Sample Control Log

If samples are collected during the field investigation, a sample control log must be filled out documenting the sampler name, date, time, COC number, analyses requested, duplicates collected and naming designation, additional notes, the date that the samples were sent to the laboratory, and the expected date that the results are due.

A3.1.3 Chain of Custody (COC)

During sampling activities, a “paper trail” of sample custody must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples should be recorded by the sampling personnel on an Atlantic Richfield COC form. If an Atlantic Richfield COC form is not available, an equivalent form provided by the destination laboratory can be used instead. A COC form will be completed for each set of samples collected daily. At a minimum, every COC will contain the following information:

- Sampling Personnel’s name and signature;
- Project name;
- Date and time of collection;

- Sample identification number and matrix;
- Analyses requested;
- Number of containers;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times;
- Method of shipment; and
- Shipping papers/waybill identification number (as appropriate).

A3.2 SAMPLE LABELING

After sample collection, the samples will be labeled with self-adhesive labels with all necessary information added using waterproof ink. Make sure the labels are completed so that the information is legible and consistent. At a minimum, each sample label will contain the following information:

- Project name;
- Sample identification code;
- Date (mmddyy) and military time (tt:tt) of sample collection;
- Analyses required;
- Method of preservation, if used; and
- Sampler's initials.

The information on the sample label should match the COC.

Each sample, including quality assurance/quality control samples, will be assigned a unique identification code according to sample location and date for use in the project database. Each sample will be assigned a unique identification code according to sample location and date. Sample containers will be sealed in sealable plastic bags and immediately placed on ice in an insulated cooler and chilled. Insulated coolers will be provided by the contract laboratories. Samples will be placed right side up in a cooler with blue or double bagged ice for delivery to the laboratory.

A3.3 SAMPLE HANDLING

General sample handling procedures shall include the following:

- Always make field measurements on a separate sub-sample, not on the sample that is sent to the laboratory for analysis. Discard the sub-sample after the measurements have been made.
- Do not use containers that have been used in the laboratory to store concentrated reagents or have been previously used as sample containers. Use only new containers that are certified clean by the manufacturer or laboratory for sample collection.
- For water samples, do not allow the inner portion of sample containers and caps to come into contact with bare hands, gloves, or other objects.
- Keep sample containers in a clean environment away from dust, dirt, and fumes. Field personnel shall wear disposable nitrile gloves when collecting water samples. Gloves must be changed out between each water sample collected.
- Do not let any samples, including water, vegetation, or invertebrate samples, stand in the sun. Store all samples in coolers with blue or double bagged ice;
- COC procedures will be strictly adhered to during sample collection, transportation, and laboratory handling to assure the identity of the samples. Improper sample and data handling and inadequate COC procedures affect the credibility and acceptability of analytical results, regardless of their accuracy or precision. COC documentation will document processing of the sample from the time of collection to the time of analysis.

If overnight storage of collected water samples is required prior to shipment to a laboratory, the samples will be stored in accordance to procedures described in Section A3.6.

A3.4 SAMPLE PRESERVATION

Sample preservation will depend on the analytical method to be performed and the sample matrix. Preservation methods and preservatives for each analytical method and matrix will be presented in the work plans. The planned sample preservation activities, sample container size and type, and analytical methods should be confirmed with the laboratory well in advance of collecting samples.

For all water samples, the laboratory will supply clean, unused, and pre-preserved sample containers as appropriate. If containers are preserved, the type of preservative should be clearly labeled on each bottle. Do not rinse out sample containers. The preservative will be documented on the sample labels, COC, and in the project DFRs. For soil samples, the laboratory does not typically provide the sample containers (e.g. stainless steel sample tubes, acetate liners, etc.). Sample containers used for soil samples will be decontaminated prior to use in accordance to procedures described in Section D7.1.1.

A3.5 SAMPLE PACKAGING AND SHIPPING

If samples are required by the laboratory to be chilled, they will be stored during the day in ice-cooled containers. Samples collected during the morning may be temporarily stored in a refrigerator (if available) until shipment in the afternoon. All samples stored in the coolers or the refrigerator will be documented on the sample tracking form. When samples are being packaged for shipment, the procedures listed below will be followed.

1. Field personnel will visually screen each sample in the cooler for loose surface contamination, and confirm that each sample is listed on the sample tracking form and the COC.

2. Samples will be packed with abundant packaging material to minimize the potential for damage during shipment. Samples will be packaged with either double bagged "wet" ice or "blue-ice," as necessary, to maintain an appropriate temperature within the cooler.

3. The completed COC will be signed and placed in a plastic sealable storage bag which will be taped to the inside cover of the cooler. The COC form will be shipped with the cooler to confirm transfer; the carrier waybill number will be recorded on the original COC. Commercial carriers are not required to sign the COCs.

4. If samples are to be transported overnight via Federal Express or United Parcel Service, all ice must be double bagged to prevent leakage. The lid of the cooler must be taped shut with custody seals and labeled with stickers indicating “Fragile” and arrows pointing to the lid. The cooler will then be taped shut using clear shipping tape. Failure to seal all potential leaks may result in rejection of delivery by the courier. If samples are shipped on a Friday then Saturday delivery stickers must be attached to the coolers on all four sides as well as the top. Make sure to check the overnight delivery space on the shipping papers. Affix the label on the top or side of the cooler.

5. Samples will typically be shipped to the laboratory daily. Copies of the completed COC will be kept in the field office by the field manager.

6. Sample shipment will be scheduled to prevent exceeding any required holding period. Failure to conduct analyses within the required holding times may potentially

require the qualification of associated analytical results and will prompt appropriate corrective and preventive action measures.

A3.6 OVERNIGHT STORAGE

Samples stored overnight require storage at no more than 4°C or 39°F, but above freezing. Samples will be kept in a locked and secured cooler or refrigerator and shipped the following day.

A6.0 – FIELD MEASUREMENTS - WATER

Purpose and Scope: The purpose of this document is to provide procedures for measuring the water levels from wells and collecting field parameters in surface water and groundwater. It includes instructions on the setup, field procedures, and how to fill out the associated field forms.

Equipment:

pH Meter and electrode;
Specific Electrical Conductivity (SEC) Meter;
Dissolved Oxygen (DO) Meter;
Oxygen Reduction Potential (ORP) (Eh) Meter;
Thermometer;
Turbidity Meter;
Water Level Indicator;
HACH DR/890 Portable Colorimeter;
Iron Ferrous Reagent, 1,10 Phenanthroline Powder Pillows or AccuVac® Ampules;
Iron Reagent, FerroVer Powder Pillows or AccuVac® Ampules;
Sulfate Reagent, SulfaVer® Powder Pillows or AccuVac® Ampules;
Ferrous Ammonium Sulfate, Hexahydrate (pre-measured by a lab);
Sulfate Standard Solution, 50 mg/L;
100 mL graduated cylinder;
1,000 mL graduated cylinder,
1mL pipette and bulb;
Peristaltic Pump
0.45 Micron Filter Cartridges
Silicone tubing
Teflon tubing
Distilled Water;
Deionized Water;
Spray water bottle;
Sample cup or beaker;
Calibration standards for each meter;
Miscellaneous Field Tools;
Extra batteries; and
Safety Equipment.

Documentation:

Daily Field Record (DFR);
Water Level Monitoring Record;
Well Development Record;
Well Sampling Record;
Field Instrument Calibration Sheet.

This Standard Operating Procedure (SOP) describes the general methodology for water level measurement from wells and measuring field parameters in water. Field parameters include pH, specific electric conductivity (SEC), turbidity, oxidation-reduction potential (ORP), temperature, dissolved oxygen (DO), ferrous iron, total iron, and sulfate. Refer to the manufacturers recommendations for specific operational procedures and calibration requirements for each type of meter described in this SOP.

All field measurements of water will be performed by appropriately trained field staff under the guidance of a California-licensed Professional Geologist or Professional Engineer.

This SOP is to be used in conjunction with work plans.

A6.1 SET-UP AND EQUIPMENT CALIBRATION

Prior to taking any field measurements, sampling personnel will assemble all necessary equipment and calibration standards. All instruments to be used will be checked and calibrated per the manufactures instructions and as often as recommended by the manufacturer to ensure they are in proper working condition. Calibration data including the record of the concentration of the calibration standard, record of the calibration reading for the check standard, and acceptance range for readings from the check standard will be recorded on a Field Instrument Calibration Sheet.

A6.2 WATER LEVEL MEASUREMENT

This SOP focuses on taking water level measurements from wells. Open the well by removing the lid on the well box and remove the well cap. When opening the well box and removing the cap, be sure to keep your head away from the top of the open casing to avoid inhaling any fumes that may reside within the well.

Decontaminate all water level measurement equipment as described in SOP 7.0 – Equipment Decontamination prior to inserting any instruments into the well.

Water level measurements will be referenced to a known elevation datum. The measuring point at the top of the well casing (generally the north side of the casing) will be permanently marked and surveyed. Measurements will be consistently taken from the same marked point. Water levels will be measured with an electrical sounding device, a hydrocarbon interface measuring device, or equivalent device. A hydrocarbon interface measuring device may be used as the primary instrument if the presence of light non-aqueous phase liquids (LNAPLs) or dense non-aqueous phase liquids (DNAPLs) is suspected.

The static water level will be measured in each monitoring well or supply well using an electronic water level indicator. Measurements will be made by recording the depth-to-water

(DTW) and repeating the measurement until at least two consecutive depth readings within 0.01-foot are measured. The final water level measurement for each well will be recorded in the field on a Water Level Monitoring Record.

When attempting to collect a DTW measurement, if a vacuum or a pressure buildup is detected upon opening the airtight well cap, an initial depth to water level will be obtained and the well will be allowed to equilibrate for approximately 20-minutes. After the field geologist or engineer has used good judgment to determine that the water table is stable, another DTW measurement within the well and determined will be obtained. Additional measurements will be obtained at 20-minute intervals until at least two consecutive depth readings are within 0.01-foot.

The field geologist or engineer may also measure the depth-to-bottom (DTB), or the depth to the bottom of the well by lowering a measuring device (e.g., sounding device) to the bottom of the well.

At the completion of the DTW and possible DTB measurements, the field geologist or engineer will wipe down the down-hole equipment with a new paper towel to remove excess water or debris from the tool and decontaminate, as appropriate.

A6.3 FIELD PARAMETERS

Generally, a multiparameter water quality meter (YSI is the brand that is commonly used) will be used to measure field parameters. The following describes measuring field parameters of pH, SEC, temperature, turbidity, ORP, and DO using an YSI meter or similar equipment.

A6.3.1 pH

The general procedures for the operation, calibration, and maintenance of the field pH meter and its accessories are included in the instruction manual provided with the equipment. In addition, the instruction manual provides information regarding specific calibration requirements and user recommendations. Manufacturer's specifications and recommendations should be followed when using the pH meter.

Prior to use each day, the pH meter should be examined for cleanliness, for defects, and for any possible need of repair. The examination should include the battery and electrode. Once the pH meter is observed to be in correct operating condition, it should be calibrated using a minimum of a three-point calibration using 4.0, 7.0, and 10.0 pH standard solutions (purchased from a reputable vendor). Prior to beginning the calibration, the expiration date for each of the calibration standards will be checked. Standard solutions that have expired will not be used and will be properly disposed. A record of the pH reading and a record of acceptance limit for each concentration of standard and any calibration notes will be denoted on the Field Instrumentation Calibration Sheet.

A6.3.2 Electrical Conductivity

The general operation, calibration, and maintenance for use of the conductivity meter are included in the instruction manual provided with the equipment. In addition, the instruction manual provides information regarding specific calibration requirements and user recommendations. Manufacturer's specifications and recommendations should be followed when using the conductivity meter.

Prior to use each day, the conductivity meter should be examined for cleanliness, for defects, and for any possible need of repair. The examination should include the battery and the probe. Once the conductivity meter is observed to be in correct operating condition, it should be calibrated using a minimum standard solution of 1,000 micro-mhos (µmhos) at 25 degrees Celsius (° C) (purchased from a reputable vendor). Prior to beginning the calibration, the expiration date for the calibration standard will be checked. Standard solutions that have expired will not be used and will be properly disposed of in accordance with SOP9.0.. A record of electrical conductivity reading and a record of acceptance limit for calibration and any calibration notes will be denoted on the Field Instrumentation Calibration Sheet.

A6.3.3 Temperature

The operation procedure of the thermometer for use in the field is included in the instruction manual provided with the equipment. Prior to use each day, examine the thermometer for cleanliness, defects, and any possible need of repair.

A6.3.4 Turbidity

The general procedures for the operation, calibration, and maintenance of a field turbidity meter are included in the instruction manual provided with the equipment. In addition, the instruction manual provides information regarding specific calibration requirements and user recommendations.

Prior to use each day, the turbidity meter should be examined for cleanliness, for defects, and for any possible need of repair. The examination should include the battery. Once the turbidity meter is observed to be in correct operating condition, it should be calibrated using a minimum two-point calibration using a minimum of 0.0 and 10.0 NTU standard solutions (purchased from a reputable vendor).. Prior to beginning the calibration, the expiration date for each of the calibration standards will be checked. Standard solutions that have expired will not be used and will be properly disposed. Acceptance limits for each standard and any calibration notes will be denoted on the Field Instrumentation Calibration Sheet.

A6.3.5 Oxidation-Reduction Potential

The general procedures for the operation, calibration, and maintenance of the field ORP are included in the instruction manual provided with the equipment. In addition, the instruction manual provides information regarding specific calibration requirements and user recommendations.

Prior to use, examine the ORP meter for cleanliness, defects, and any possible need of repair. The examination should include the battery and probe. Once the ORP meter is observed to be in correct operating condition, it should be calibrated using a minimum standard solution of 100 milliVolts (mV) (purchased from a reputable vendor). Prior to beginning the calibration, the expiration date for the calibration standard will be checked. Standard solutions that have expired will not be used and will be properly disposed. A record of the ORP reading and a record of acceptance limit for calibration and all calibration notes will be denoted on the Field Instrumentation Calibration Sheet.

A6.3.6 Dissolved Oxygen

The general procedures for the operation, calibration, and maintenance of a field DO meter are included in the instruction manual provided with the equipment. In addition, the instruction manual provides information regarding specific calibration requirements and user recommendations.

Prior to use, examine the DO meter for cleanliness, defects, and any possible need of repair. The examination should include the battery and probe. Once the DO meter is observed to be in correct operating condition, it should be calibrated using distilled or de-ionized water and the barometric pressure of the atmosphere where the DO is being collected. All calibration notes must be recorded on the Field Instrumentation Calibration Sheet.

A6.3.7 Lockout/Tagout

If any of the above water quality meters are found to be above or below the range of concentration for check standard, the equipment must be locked out and tagged out so it will not be used inadvertently. A replacement meter shall be obtained and properly calibrated while the out of range equipment is repaired.

A6.3.8 Procedures for Testing a Sample

Samples will be tested for the above water quality parameters by triple rinsing a small container with the sample water before filling the container with the sample to be tested. Once the container is filled to the level in which all the appropriate probes will be submerged the probe shall be inserted into the container and the parameters shall be allowed to stabilize. If more than one meter is used then a second container shall be filled in order to submerge the second probe.

In some cases a flow through cell may be used while collecting water quality parameters. If a flow through cell is used it must be decontaminated in between each sample location.

Once the water quality readings have stabilized, the values for each parameter will be recorded on a Well Development Record or a Well Sampling Record.

A6.4 HACH FIELD TEST KITS FOR IRON AND SULFATE

Field measurement of total dissolved iron, ferrous iron, and sulfate will be made with a HACH Portable Colorimeter (DR/890 or similar) using FerroVer® Powder Pillows or AccuVac® ampoules (HACH Method 8008), 1,10 Phenanthroline Powder Pillows or AccuVac® ampoules (HACH Method 8146), and Sulfa Ver 4® Powder Pillows or AccuVac® ampoules (HACH Method 8051) respectively. Prior to use each day, the colorimeter should be examined for cleanliness, for defects, and for any possible need of repair. The examination should include the battery.

Colorimeters not manufactured by HACH should be operated and calibrated according to the manufacturer’s instructions.

A6.4.1 TOTAL DISSOLVED IRON

A6.4.1.1 ANALYSIS

To measure dissolved iron, the sample will be field filtered prior to analysis. The glass sample cells will then be first rinsed with the sample and discarded. A 10 ml aliquot will be transferred to the 10 mL mark in two separate glass sample cells. To analyze the sample, select stored Program 33 when using the HACH Portable Colorimeter (or other similar program depending on the instrument manufacturer). Wipe off one of the glass sample cells with a soft clean cloth to remove finger prints or smudges which can interfere with the meter reading, insert it into the colorimeter, and press “zero” to zero the meter. Add the contents of one FerroVer powder pillow to the second sample cell and secure the cap. The container will be inverted for three minutes using a timer (samples containing visible rust will be allowed to react for five minutes). At the conclusion of three minutes, wipe off the glass sample cell with a soft clean cloth to remove finger prints or smudges which can interfere with sample reading. Insert the sample into the spectrophotometer and press “read”. If using the FerroVer AccuVac® ampoules, follow the procedures included in the instruction manual provided with the equipment.

A6.4.1.2 CALIBRATION/ACCURACY CHECK

According to HACH, the colorimeter is pre-calibrated for the total dissolved iron measurement; however, at a minimum, an accuracy check should be performed at least once a week. To run an accuracy check, a 1.0 mg/L iron solution will be prepared by diluting 1.0 mL of Iron Standard Solution (100 mg/L Fe [purchased]) to 100 mL with deionized water.

To prepare the 1.0 mg/L total dissolved iron standard solution:

- Rinse a 100 mL graduated cylinder with the dilute hydrochloric or nitric acid solution followed by a triple rinse with deionized or distilled water.
- Using a graduated pipette, measure 1.0 mL of the purchased 100 mg/L Fe solution and add it to the clean graduated cylinder.
- Carefully, bring the 100 mL graduated cylinder to volume with deionized or distilled water and mix.

The solution will need to be prepared each time an accuracy check is run.

Once the solution has been prepared, the analysis procedure described in Section D6.4.1.1 will be used to test the accuracy of the instrument. Results should be between 0.9 mg/L and 1.1 mg/L Fe. All accuracy check results must be recorded on a Field Instrumentation Calibration Sheet.

A6.4.2 FERROUS IRON

A6.4.2.1 ANALYSIS

To measure ferrous iron, the sample will be field filtered prior to analysis. The glass sample cells will then be first rinsed with the sample and discarded. A 25 ml aliquot will be transferred to the 25 mL mark in two separate glass sample cells. To analyze the sample, select stored Program 33 when using the HACH Portable Colorimeter (or other similar program depending on the instrument manufacturer). Wipe off one of the glass sample cells with a soft clean cloth to remove finger prints or smudges which can interfere with the meter reading, insert it into the colorimeter, and press “zero” to zero the meter. Add the contents of one 1,10 Phenanthroline powder pillow to the second sample cell and secure the cap. The container will be inverted for three minutes using a timer. At the conclusion of three minutes, wipe off the glass sample cell with a soft clean cloth to remove finger prints or smudges which can interfere with sample reading. Insert the sample into the spectrophotometer and press “read”. If using the 1,10 Phenanthroline AccuVac® ampoules, follow the procedures included in the instruction manual provided with the equipment.

A6.4.2.2 CALIBRATION/ACCURACY CHECK

According to HACH, the colorimeter is pre-calibrated for the ferrous iron measurement; however, at a minimum, an accuracy check should be performed at least once a week. To run an accuracy check, a 1.0 mg/L ferrous iron standard solution will be made.

To prepare the 1.0 mg/L ferrous iron standard solution:

- Rinse a 1.0 Liter graduated cylinder with the dilute hydrochloric or nitric acid solution followed by a triple rinse with deionized or distilled water.

- Add the pre-measured ferrous ammonium sulfate, hexahydrate provided by the lab to the clean graduated cylinder. If the pre-measured standard is not available, weigh out 0.7022 grams of the purchased ferrous ammonium sulfate, hexahydrate and add it to the clean graduated cylinder.

- Carefully, bring the 1.0 Liter graduated cylinder to volume with deionized or distilled water and mix.

- Rinse a 100 mL graduated cylinder with the dilute hydrochloric or nitric acid solution followed by a triple rinse with deionized or distilled water.

- Using a graduated pipette, measure 1.0 mL of the ferrous ammonium sulfate, hexahydrate solution to the cleaned 100 mL graduated cylinder.

- Carefully, bring the 100 mL graduated cylinder to volume with deionized or distilled water and mix.

The solution will need to be prepared each time an accuracy check is run.

Once the solution has been prepared, the analysis procedure described in Section A6.4.2.1 will be used to test the accuracy of the instrument. Results should be between 0.9 mg/L and 1.1 mg/L ferrous iron. All accuracy check results must be recorded on the Field Instrumentation Calibration Sheet.

A6.4.3 SULFATE

The following sections describe the analysis and calibration/accuracy check procedures.

A6.4.3.1 ANALYSIS

To measure sulfate, the sample does not need to be field filtered prior to analysis unless the sample is highly turbid (< 25 NTU) or colored. The glass sample cells will then be first rinsed with the sample and discarded. To analyze the sample, select stored Program 91, if using Sulfa Ver 4 powder pillows, or Program 92, if using Sulfa Ver 4 AccuVac ampuls, when using the HACH Portable Colorimeter (or other similar program depending on the instrument manufacturer). A 10 ml aliquot will be transferred to the 10 mL mark in two separate glass sample cells. Wipe off one of the glass sample cells with a soft clean cloth to remove finger prints or smudges which can interfere with the meter reading, insert it into the colorimeter, and press “zero” to zero the meter. Add the contents of one Sulfa Ver 4 powder pillow to the second sample cell and secure the cap. The container will be shaken for five minutes using a timer. At the conclusion of five minutes, wipe off the glass sample cell with a soft clean cloth to remove finger prints or smudges which can interfere with sample reading. Insert the sample into the spectrophotometer and press “read”. If using the Sulfa Ver 4 AccuVac® ampoules, follow the procedures included in the instruction manual provided with the equipment.

A6.4.3.2 CALIBRATION/ACCURACY CHECK

For sulfate, a new calibration conducted by the user is recommended for each new lot of reagent; however the Standard Adjust feature is typically sufficient for field purposes. According to HACH, a standard adjust is recommended when using the stored programs 91 or 92. To adjust the calibration curve using the reading obtained with the 50-mg/L standard solution, press the “setup” key and scroll to the STD setup option. Press “enter” to activate the standard adjust option. Then enter “50” to edit the standard concentration to match that of the standard used. Press “enter” to complete the adjustment.

To establish a user entered calibration, standards of 10, 20, 30, 40, 50, 60, and 70 mg/L sulfate will be prepared by pipetting 1, 2, 3, 4, 5, 6, and 7 mL of a purchased 1,000 mg/L sulfate standard into 100 mL graduated cylinders. Dilute to the mark with deionized water and mix well. Zero the instrument with water. For the instrument, the user-entered settings for sulfate are:

Program Number: #101-105
Wavelength: 520 nm
Resolution: 0 mg/L

Refer to instrument calibration instructions for all other instrument manufacturers. If a new calibration is performed using the HACH colorimeter then an accuracy check is not required. All calibration results must be recorded on the Field Instrumentation Calibration Sheet.

A6.4.4 SAMPLE DILUTION

Each analysis has an upper concentration limit which is listed in the manufacturer’s instructions. If the initial sample reading is greater than the upper concentration limit, a dilution of the sample will be completed. A dilution of 1 part sample to 100 parts deionized water (1:100) will be conducted first. If the resulting value is less than half the detection limit, a dilution of 1 part sample to 50 parts deionized water (1:50) will be conducted. Fill both sample cells to the desired level (10 mL or 25 mL) with the diluted sample. Wipe off one of the glass sample cells with a soft clean cloth to remove finger prints or smudges which can interfere with the meter reading, insert it into the colorimeter, and press “zero” to zero the meter. After the meter has been zeroed, run the test following the desired analysis procedures as outlined above. The resultant value will be multiplied by 100 or 50, based on the respective dilution completed to determine an actual concentration. All dilution notes must be recorded on the Well Sampling Record.

A7.0 – EQUIPMENT DECONTAMINATION

Purpose and Scope: The purpose of this document is to describe procedures for equipment decontamination. It includes a discussion on decontaminating sampling equipment, drilling and excavation equipment, and collecting equipment blanks to verify that the decontamination procedures were adequately performed.

Equipment:
Steam Cleaner;
Four 5-gallon buckets;
Bottle brushes;
Distilled water;
Potable water;
Non-Phosphate Cleaning Solution (Liquinox); and
4-ml plastic sheeting.

Documentation:
Daily Field Record (DFR); and
Chain-of-Custody (COC) Form.

This Standard Operating Procedure (SOP) is to be used in conjunction with work plans.

A7.1 DECONTAMINATION PROCEDURES

Decontamination procedures described in this section are applicable to non-dedicated, non-disposable equipment.

A7.1.1 Sampling Equipment

Prior to use and after each sample is collected, all soil and water sampling equipment will be decontaminated either using a steam cleaner or washed using a three step system. The three step decontamination system will include washing the sampling equipment: (1) in soapy water using a non-phosphate (Liquinox) solution, (2) rinsed with potable water and (3) rinsed again with distilled water. Equipment will be washed in a row of three buckets. Hard bristle bottle brushes may be used to remove mud and debris prior to the three step system with an optional fourth bucket. Sample equipment should be allowed to drain dry after the final distilled water rise.

A7.1.2 Drilling and Excavation Equipment

Drilling and excavating equipment, including backhoe buckets, drill bits, casing, augers, and tools or other equipment that have come in contact with potentially impacted soils or water will be steam cleaned between each location, as appropriate. The steam cleaner will be capable of generating a working pressure of approximately 2,000 pounds per square inch (psi), a discharge rate of 5 gallons per minute (gpm), and an operating temperature of at least 130 degrees Fahrenheit (˚F).

Drilling and excavation equipment will be decontaminated using a portable decontamination station or a decontamination area constructed onsite. If constructed, the onsite decontamination area will be lined and bermed with two layers of 10 mil visqueen to contain rinsate from steam cleaning operations. If appropriate, the decontamination area will be designed to allow a backhoe, drilling rig, and support vehicles to drive onto the visqueen. After completion of each boring, drill casing or augers, drill bits and drill rods will be transported by truck to the steam cleaning area, as appropriate. Rinsate collected in the decontamination area will be collected as appropriate.

In addition to the drilling equipment, if not already pre-cleaned, all monitoring-well casing, well screen, and centralizers will be steam cleaned prior to installation. Cleaned well materials will be covered with 4 mil visqueen, and transported to the well location.

A7.1.3 Submersible Pumps

If a non-dedicated submersible pump is necessary to properly evacuate a well, it will be cleaned prior to use and between sampling locations using a three step wash. First, the pump intake device will be submersed into non-phosphate cleaning solution and run until the bucket is empty. Second, the pump will be submersed into a bucket containing potable water and run until the bucket is empty. The second step can be repeated twice in order to sufficiently rinse the pump. The third step involves rinsing the pump with distilled water using the same method as Steps 1 and 2.

A7.1.4 Equipment Blanks

As appropriate, equipment blanks will be collected after decontamination of the sampling equipment during soil sampling activities to provide an additional check on possible sources of contamination related to field sampling instruments. To collect an equipment blank, laboratory supplied distilled or deionized water is passed through or over clean sampling equipment and collected directly into empty sample containers for analysis. Equipment blanks will be handled and transported in the same manner as the samples acquired that day. Equipment blanks will be analyzed according to all water analytical methods. Equipment blanks will be labeled and handled as described in the QAPP and SOP 3.0 – Field Documentation and Sample Handling.

A11.0 – SOIL AND/OR ROCK LOGGING

Purpose and Scope:	The purpose of this document is to describe procedures for soil and/or rock logging. It describes the required equipment and forms, the information necessary to complete a boring log, and methods for describing drill cuttings and soil cores.
Equipment:	Hand Lens; Dilute hydrochloric acid (HCl); Soil Knife; Water level indicator; Rock Hammer; Hand-Held Global Positioning System (GPS) device; Measuring Tape; Compass; Core Boxes; Sharpie Markers; Adhesive Labels; Camera; Tables; White Erase Board and Markers; Wooden Pallets; Plastic Tarp; Wooden/Foam Blocks; Hack Saw; and Plastic Bags.
Documentation:	Daily Field Record; Soil Boring Log; and Rock Boring Log.

This Standard Operating Procedure (SOP) is to be used in conjunction with work plans. All logging activities must be performed by appropriately trained field staff under the guidance of a California-licensed Professional Geologist or Hydrogeologist.

A11.1 BORING LOG PREPARATION

On the first page of the log for each boring, the sampler will record the following information:

- Project information including Job Number, Client Name; and Site Location;
- Borehole identifier;
- Drilling subcontractor;

- Date started and date finished;
- Drilling method;
- Drilling equipment including rig model, sampling equipment, and rig number, if more than one on site;
- Sampling method including hammer weight in pounds and drop height in feet;
- Name of Person Conducting the Logging and the responsible geologist or engineer;
- Elevation and location datum collected from a GPS; and
- Complete and accurate location sketch with dimensions to landmarks. Significant and relatively permanent features such as road intersections, corners of large buildings, or other man-made structures are best used. The sketch must include a north arrow.

Each succeeding page of the boring log should contain at a minimum:

- Job Number;
- Client Name;
- Borehole identifier;
- Any water level measurements; and
- Page numbers (marked as page x of x)

On the DFR for the day, the following details must be recorded: Water levels will be recorded each day prior to drilling start-up and as appropriate. Maps indicating the location of the boring log should be attached to the DFR. The casing depth must be noted for each water level reading. Drilling mud use must be noted, if applicable. Water levels will be referenced to ground surface, unless otherwise noted. At the conclusion of drilling, a final static water level will be measured. The field personnel will note on the log any remarks relative to the measurement, such as relatively rapid fluctuations. When more than one boring is drilled, the elevations of the water levels will be tabulated and the measurements will be compared to evaluate the consistency of readings between boreholes.

Surface conditions will be noted, including vegetation or ground cover and land use, general topography (rolling, level, etc.), and physical features (hillside, river bottom, etc.). The time and date of the commencement and conclusion of the drilling, down time, and the end and start of each shift should also be noted on the log.

Upon completion of each boring, a standard completion note will be placed at the bottom of the last page of the boring log. The note will include:

- Boring completed at (depth) feet on (date);
- Casing used to a depth of (depth) feet on (date);
- Ground water level recorded at (depth) feet on (date);
- Hole backfilled to ground surface on (date); and
- Casing diameter and length will be recorded.

All depths will be recorded in decimals, not fractions.

A11.2 GENERAL LOGGING PROCEDURES

The left side of the boring log will be filled out accurately and completely for each boring and sampling attempt. The following information will be included:

- In the depth column each hash mark will represent a 0.5' interval.
- In the sample number column, write the sample number in sequential whole numbers for each boring (i.e., 1, 2, 3). Restart the numbering for each boring.
- In the sample column, indicate the interval that the sample was collected and the sampler type. The abbreviations for sampler types are TW for thin-wall, P for piston, ST for Shelby Tube, SS for standard split spoon, CC for continuous core, and GS for grab samples. These abbreviations, or notations as to other sampler types, will be used in the sampler type column. Other types of sampler types may be used depending on the type of drilling equipment used and will be noted on the boring logs (as appropriate).
- Depending on the type of investigation, blow counts may be recorded. If recorded, the blow count for each 6-inch interval will be recorded opposite the appropriate interval on the depth scale. This will be used to later calculate the number of blows to advance the sampler tube one foot.
- Record the depth of each sample attempt, if applicable.

- Record the sample number and depth. The sample depth is always measured to the top of the sample. A sample attempt where no sample is recovered will not be numbered, but the attempt must be noted.

- Mark the sampling attempts in the depth in feet column.

Record a detailed description of the soil or rock strata encountered and all pertinent information regarding drilling operations and estimated soil, rock, and groundwater properties. The description will include the geologic and/or geotechnical descriptions.

- The geotechnical description includes classifying the soil or rock units to the soil or rock classification systems as described in Section A11.3 and A11.4, respectively. The key terms used to describe soil and rock are presented on Tables A11-1 and A11-2, respectively.
  - Table A11-1 presents the key terms to describe the geotechnical physical properties of soil. This table was adapted from the *AMEC Geotechnical Manual for Employees of AMEC Earth and Environmental* dated June 6, 2008 and the Unified Soil Classification System (USCS) as described in ASTM A2487-06.
  - Table A11-2 presents the key terms to describe the geotechnical physical properties of rock. This table was also adapted from *AMEC Geotechnical Manual for Employees of AMEC Earth and Environmental* dated June 6, 2008, U.S. Bureau of Reclamation, 1998, Engineering Geology Field Manual, Volume 1 (second edition), and Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core as described in ASTM D6032-08.

- Mark abrupt soil or rock changes by a solid horizontal line at the appropriate depth in the soil or rock graph column. Mark gradational by a dashed line. Do not use diagonal lines.

- Note any changes in hydrogeologic conditions (i.e., dry, saturated).

- Abbreviations may be used to save space for editing purposes; where used, a list of abbreviations must be provided.

Comments or remarks are extremely important and should be included. Some important aspects of the drilling operation that will be recorded are as follows:

- The organic content of the soil and the depth of topsoil and roots;

- Any sudden change in the speed, sound, or penetration rate of the drill rig;

- Whether continuous samples or drill cuttings have been used log the boring; and

- Whether a sample is suspected of having been disturbed, contaminated, or chemically or physically altered during the drilling process.

Field personnel will make specific arrangements for scanning and sending completed boring logs to the Project Manager, or someone designated by the Project Manager. Field personnel will retain one copy of the boring log in the field for reference throughout the job.

A11.3 SAMPLING AND DESCRIPTION OF SOIL

This section presents the descriptive term and general procedures that will be used to classify soil sampled in exploratory borings, test pits or trenches, and the general format for presenting the soil data that are recorded in the field. The classification terms for soil descriptions are presented in Table A11-1.

The following data are considered to be the minimum information that should be recorded in the field when logging soil. The various components of the soil sample are listed below:

USCS Classification Group Name or Symbol[1]
Indicate the soil type (gravel, sand, silt, or clay), grading (well or poor), and grain size (coarse or fine).

Moisture Content[1]
Indicate the moisture in the sample

Relative Density/Consistency[1]
Indicate if the soil is loose, soft dense, or hard.

Cementation[1]
Indicate if the soil is cemented.

Grain Size[1]
Indicate the size of the grains in the soil.

Maximum Particle Size[1]
Indicate the largest observed particle size.

Odor (if present)
Indicate if an odor is present.

Lithologic Descriptions (which are to include the following):

1. First Line: ALL CAPITAL LETTERS

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[1] Values and definitions are listed in Table C11-1 of this Section.

a) Geologic Unit Type and Soil Type [and Formation name if known]

2. Second Line, Third Line, etc. (in the following order): all lower case letters
   - a) Color. Use the Munsell Color Chart for rock color descriptions. Describe color when the rock is moist or wet. The Munsell number is recorded after the color. The color of mottling or conspicuous zones of weathering or alteration also should be noted.
   - b) Moisture Content
   - c) Relative Density/Consistency
   - d) Cementation
   - e) Grain size
   - f) Maximum particle size
   - e) odor
   - g) Any other distinctive geologic features that will aid in correlation or interpretation of the geologic conditions (e.g., the type and size of voids, fossils, cementation, reaction to HCl, etc).

Graphic Log

Depicts the core as sketched in the field.

TABLE A11-1
TERMS USED TO DESCRIBE THE GEOTECHNICAL PHYSICAL PROPERTIES OF SOIL

USCS Soil Classification System For Coarse-Grained Soils (<50% passes #200 sieve)

GW	Well Graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly-Graded gravels, gravel-sand mixtures. Little or no fines
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures

USCS Soil Classification System for Fine-Grained Soils (>50% passes #200 sieve)

ML	Inorganic silts &very fine sands, silty or clayey fine sands, clayey silts with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts & clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high plasticity
PT	Peat, humus, swamp soils with high organic content

COLOR

Use the Munsell Color Chart for soil color descriptions. Describe color if the soil is moist or wet. The Munsell number is recorded after the color. The color of mottling or conspicuous zones of weathering or alteration also should be noted.

MOISTURE CONTENT

Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet or Saturated	Visible free water, usually soil is below water table

APPARENT/RELATIVE DENSITY – COARSE-GRAINED SOIL

Very loose	Easily penetrated with ½-inch reinforcing rod pushed by hand.
Loose	Difficult to penetrate with½-inch reinforcing rod pushed by hand
Medium Dense	Easily penetrated a foot with ½-inch reinforcing rod driven with 5-lb. hammer
Dense	Difficult to penetrate a foot with ½-inch reinforcing rod driven with 5-lb. hammer
Very Dense	Penetrated only a few inches with ½-inch reinforcing rod driven with 5-lb. hammer

CONSISTENCY – FINE-GRAINED SOIL

Very soft	Easily penetrated several inches by thumb. Excludes between thumb and fingers when squeezed in hand
Soft	Easily penetrated 1-inch by thumb. Molded by light finger pressure
Medium Stiff	Penetrated over ½-inch by thumb with moderate effort.
Stiff	Indented about ½-inch by thumb but penetrated only with great effort.
Very Stiff	Readily indented by thumbnail
Hard	Indented with difficulty by thumbnail

CEMENTATION

Weakly – Crumbles or breaks with handling or slight finger pressure
Moderately – Crumbles or breaks with considerable finger pressure
Strongly – Will not crumble or break with finger pressure

GRAIN SIZE

Boulders	Larger than basketball-sized
Cobbles	Fist-sized to basketball-sized
Coarse Gravel	Thumb-sized to fist-sized
Fine Gravel	Pea-sized to thumb-sized
Coarse Sand	Rock salt-sized to pea-sized
Medium Sand	sugar-sized to rock salt-sized
Fine Sand	Flour-sized to sugar-sized
Fines	Flour sized and smaller

A11.4 SAMPLING AND DESCRIPTION OF ROCK

This section presents the descriptive terms and general procedures that will be used to classify rock core sampled in exploratory borings, test pits or trenches, and the general format for presenting the rock core in the field. The classification terms for rock descriptions are presented in Tables A11-2 and A11-3.

The following data are considered to be the minimum information that should be recorded in the field when logging rock core. The various components (columns) of the field log are described below, in order from left to right as they appear on the log:

Core Run
Indicate the run number, or sampling interval.

Core Recovery
Indicate the percent core recovery for a specific run. Recovery can be expressed as a ratio and/or a percentage.

Rock Quality Designation (RQD)
Indicate summation of run (i.e. fresh to only moderately weathered) core pieces over 4 inches in length (measured along the axis of the core) divided by the total length of the core run. RQD can be expressed as a ratio and/or a percentage.

Fracturing[2]
Indicate the fracture spacing within a run.

Hardness[2]
Indicate the hardness of the core within a run.

Strength[2]
Indicate the strength of the core within a run.

Weathering[2]
Indicate the degree of weathering of the core within the run.

Lithologic Descriptions (which are to include the following):

1. First Line: ALL CAPITAL LETTERS
    a) Rock Type

2. Second Line, Third Line, etc. (in the following order): all lower case letters

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[2] Values and definitions are listed in Table D11-2 of this Section.

a) Color. Use the Munsell Color Chart for rock color descriptions. Describe color when the rock is moist or wet. The Munsell number is recorded after the color. The color of mottling or conspicuous zones of weathering or alteration also should be noted.
b) Grain size and texture. Note grain roundness, shape, and sorting.
c) Lithology. Predominant minerals identifiable in hand specimen should be noted.
d) Bedding/Foliation/Flow Texture. Note attitude(s) and describe any depositional features or structures (e.g., planar or cross bedding, laminated bedding, etc.).
e) Contacts. Contacts should be identified and their nature described.
f) Any other distinctive geologic features that will aid in correlation or interpretation of the geologic conditions (e.g., the type and size of voids, fossils, cementation, reaction to HCl, etc).

Examples:

SANDSTONE
dark gray (10 YR 5/2) with yellowish brown mottling (10YR 5/4), medium to coarse sub angular sand, well sorted, mostly quartz and lithics, no bedding apparent, contacts not exposed, has local veinlets of quartz.

CLAYSTONE
Grayish brown (7.5 YR 3/3), has thin (< 1 inch thick) sand stringers and fossiliferous beds (up to 1 foot thick), exposed contacts appear depositional.

Graphic Log

Depicts the core as sketched in the field.

Discontinuity Descriptions[3] (which are to include the following in order):

1. Discontinuity type (i.e., bedding plane, joint, foliation, shear/fault, mechanical break, or vein) and dip angle.

2. Aperture (i.e., tight, open, filled, or healed). Note presence and type of staining or coatings on fracture surfaces, fracture surface moisture conditions, amount of separation/filling, and type and hardness of filling.

3. Surface shape (i.e., irregular, planar, and wavy or undulating)

4. Roughness (i.e., stepped, rough, moderately rough, slightly rough, smooth, polished). Note the presence of slickensides or striations.

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[3] See Table C11-3 for additional information.

Remarks

Records information pertaining to the drilling operation. Some of the information that may be recorded includes:

Drilling methods
Drilling rate
Loss of circulation
Casing used and reasons
Driller's comments
Samples and sampling methods
Drilling difficulties
Color of return water
Cement or drilling mud used
Water pressure test intervals

Core box numbers and boundaries between boxes will be noted in this column.

The reason for stopping the hole is recorded at the bottom of the column, using the following terms:

<u>Terminated hole:</u> hole stopped by geologist because sufficient information and depth was attained.

<u>Abandoned hole:</u> stopped hole because of coring difficulties.

<u>Refusal:</u> stopped by rock too hard for drilling equipment.

TABLE A11-2

TERMS USED TO DESCRIBE THE GEOTECHNICAL PHYSICAL CONDITION OF ROCKS[4]

FRACTURING	**SPACING (True spacing)**
(VC) Very closely spaced (crushed)	Less than 0.1 ft (< 30 mm)
(Cl) Closely spaced	0.1 ft to 0.3 ft (30 to 100 mm)
(Mo) Moderately spaced	0.3 ft to 1.0 ft (100 to 300 mm)
(Wi) Widely spaced	1.0 ft to 3.0 ft (300 mm to 1 m)
(VW) Very widely spaced	3.0 ft to 10.0 ft (1 to 3 m)
(Ex) Extremely wide	Greater than 10 ft (> 3 m)

BEDDING OR FLOW TEXTURE	**THICKNESS/SPACING**
(La) Laminated	Less than 0.03 ft (3/8 in) (< 10 mm)
(VTn) Very thinly	0.03 (3/8 in) to 0.1 ft (10 to 30 mm)
(Tn) Thinly	0.1 to 0.3 ft (30 to 100 mm)
(Mo) Moderately	0.3 to 1 ft (100 to 300 mm)
(Tk) Thickly	1.0 to 3.0 ft (300 mm to 1 m)
(VTk) Very thickly	3.0 to 10.0 ft (1 to 3 m)
(Ma) Massive	Greater than 10 ft (> 3 m)

HARDNESS - a measure of the resistance of a rock surface to scratching/abrasion.

(So) Soft – can be grooved or gouged easily with a knife, can be scratched with fingernail
(Lo) Low Hardness - can be grooved 1/16 inch (2 mm) deep with a knife with moderate or heavy pressure
(Mo) Moderately Hard - can be scratched with a knife with light or moderate pressure
(Ha) Hard - can be scratched with a knife with difficulty
(VH) Very Hard - cannot be scratched with a knife

STRENGTH - a measure of crushing resistance of rock.

(Fr) Friable – breaks with light to moderate manual pressure
(We) Weak – core or fragment breaks with light hammer blow or heavy manual pressure
(Mo) Moderately Strong – core or fragment breaks with moderate hammer blow
(St) Strong – heavy hammer blow required to break specimen
(VS) Very Strong – core or fragment breaks only with repeated heavy hammer blows
(Ex) Extremely Strong – core or fragment can only be chipped with repeated heavy hammer blows

WEATHERING - a measure of the physical and chemical alteration of a rock from its original "fresh" condition.

	DECOMPOSITION	**DISCOLORATION**	**FRACTURES**
(Fr) Fresh	Unaltered; cleavage surfaces glistening	No discoloration	No stains or coatings
(Sl) Slight	No megascopic alteration of minerals; no grain separations	Slight and localized	Few stains on fracture surfaces
(Mo) Moderate	Slight alternation of minerals; cleavage surfaces lusterless/stained; partial separation of grains visible	Moderate discoloration, usually throughout	Thin coatings or stains
(Se) Severe	Moderate to complete alteration of minerals; feldspars to clay, etc.; rock is friable	Discolored throughout	Extensively coated with oxides, carbonates, or clay

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[4] Based on US Bureau of Reclamation, 1998, Engineering Geology Field Manual, Second Edition, Vol.1.

TABLE A11-3

KEY TO TERMS USED TO DESCRIBE DISCONTINUITES IN ROCK[5]

DISCONTINUITY TYPE (and dip angle)

(Be) Bedding plane	(Jo) Joint
(Fo) Foliation	(Sh) Shear or Fault
(Me) Mechanical break (dip angle not recorded)	(Ve) Vein

APERTURE

(Ti) Tight – No visible separation
(Op) Open – (Note amount of separation; note staining or coatings on fracture surfaces; note fracture surface moisture conditions)
(He) Healed – (Note degree of healing, i.e., partial or complete, thickness and mineralogy/hardness)
(Fi) Filled – (Note degree of filling, i.e., partial or complete, thickness and type of filling)

SURFACE SHAPE

(Ir) Irregular
(Pl) Planar
(Wa) Wavy or undulating

ROUGHNESS (note presence of slickensides or striations)

(St) Stepped – Near normal steps and ridges occur on fracture surface
(Ro) Rough – Large, angular asperities can be seen
(Mo) Moderately rough – Asperities are clearly visible and fracture surface feels abrasive
(Sl) Slightly rough – Small asperities on the fracture surface visible and can be felt
(Sm) Smooth – No asperities, smooth to touch
(Po) Polished – Extremely smooth and shiny

Where appropriate during field mapping, the following discontinuity characteristics also should be noted:

Discontinuity orientations (strike and dip)
Prominent joint sets, cleavages, foliations, etc.
Fracture continuity
Fracture cross-cutting relationships
Moisture/seepage conditions

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[5] Based on US Bureau of Reclamation, 1998, Engineering Geology Field Manual, Second Edition, Vol. 1.

A11.5 ROCK CORE COLLECTION

If rock is encountered during drilling, the geologist should record the time required for each core run, drill gauge readings for rotation and down-feed pressure, and drill fluid and rock cutting recovery and conditions. Where deemed appropriate by the geologist, soft or highly deformed rock can be sampled using a modified California sampler without sleeves, Shelby or Pitcher tubes, or 94 mm core. If specified by the work plan, all recovered core may be stored in core boxes supplied by the drilling company. When core is sensitive to changes in moisture content, the core may be wrapped in plastic or shrink wrap to protect the core. Rock cores will be photographed in the core boxes. Movement and transportation of core boxes should be minimized to reduce disturbance of the core. Rock core shall be described in the field according to Field Logging and Classification of Rock.

Marking Core Boxes – The first core run shall be placed in the box beginning in the upper left corner (hinge side), continuing to the right. Subsequent core runs shall be placed in the box with the top of the core run at the left end of the core box and the bottom of the run at the right end of the box until the box is full. At the top of the first core run, an adhesive label with the boring number, core run number, and the starting depth will be placed in the upper left-hand corner of the core box side wall. At the bottom of the last core run, a similar label with the boring number, core run number, and ending depth will be placed in the upper right-hand corner of the core box divider wall. Wooden or foam divider blocks should be put between the core from different runs, with the run number and depth of the run marked on each block. If foam blocks are used, a hack saw may be used to cut the foam to the appropriate size. Blocks also will be placed to mark intervals where there is no recovery for a specific run and will be labeled with the run number and depth. The core may have to be broken to store it. Unless someone is studying the core, the lid of the core box should be fastened into place. Adhesive labels with the project and task number, boring number, core run numbers, core depths, and date shall be applied to the outside of the core boxes on the core box lid, the front of the core box (side opposite the hinges), and the top of the core box (left end). If the box in use has been used before, place new adhesive labels on top of the existing old labels.

Storing Core Boxes – During drilling activities, core boxes may be stored on a wooden pallet within the work area as long as they do not present a hazard (i.e. trip hazard, road block, tipping hazard, etc.). Core boxes should not be stored in direct contact with the ground surface to reduce exposure to moisture and must be stored on a level surface. If core is collected over a period of several days, the core boxes should be covered with a plastic tarp at the end of each day to prevent the accumulation of moisture (i.e. dew or frost) or exposure to rainstorms. If a rainstorm occurs during drilling activities, the boxes shall be closed and covered with a plastic tarp for the duration of the rainfall event.

Core Left in the Hole - Core sometimes is left in the hole when a run is pulled. This core is referred to as “stick up” and should be recovered during the next run. The procedure is to log the entire core in a given run. Thus, if 1.5 m (5 feet) are drilled and 300 mm (1 foot) is left in the hole (not ground up), the run is considered a 1.5-meter run, and all logging, percent of core recovery, etc., are computed on that basis. The next run may recover the 300 mm (1 foot) previously drilled, but this 300 mm (1 foot) properly belongs with the previous run.

This procedure may seem to be a minor item, but unless properly handled it can cause serious confusion. For example, suppose a 1.5 m (5 foot) core barrel is being used and the run begins at a depth of 15.2 m (50 feet). At 16.8 m (55 feet), the barrel is removed from the hole, and instead of 1.5 m (5 feet) of core, only 1.2 m (4 feet) of core is in the barrel. Drilling starts again at 16.8 m (55 feet) and the coring is stopped at 17.1 (56 feet). The barrel contains 610 mm (2 feet) of core when the run is pulled. If properly recorded there is 100 percent recovery for this 300 mm (1 foot) run and for the previous 1.5 m (5 foot) run.

There are other techniques for determining “stick up”. The stick up typically can be distinguished by excessive “tool marks” where the core barrel fit over the stick up. Care should be taken to ensure that the driller isn’t “washing away” core at the tip.

Core Photographs – Prior to wrapping cores for testing, cores will be photographed using a high resolution digital camera. A white erase board presenting the project name, the project and task number, boring number, core run number, core depth, and date will be placed behind the core being photographed. Core photographs will be cropped and placed in a Microsoft Word template showing 5 feet (one core run) per page. Photos will be documented as described in SOP 3.0 – Field Documentation and Sample Handling.

A13.0 – DRILLING

Purpose and Scope:	The purpose of this document is to describe procedures for drilling soil borings. It describes the required equipment and forms, the set-up procedures, drilling procedures, various types of drilling technologies, and borehole abandonment procedures.
Equipment:	Drill rig, drilling tools, and support truck with clean water storage tanks; Steam cleaner; Grout pump and tremie pipe; Portland cement, Types I through V; Powdered bentonite; Plastic sheeting; Hand-Held Global Positioning System (GPS) device; Dust meters Miscellaneous tools; and Safety equipment.
Documentation:	Daily Field Record; Soil Boring Log; Maps/plot plan; and Camera.

This Standard Operating Procedure (SOP) describes setup procedures that will be performed by the field geologist or engineer while observing the drilling activities performed by others. This SOP does not include procedures for operating the drilling equipment. It is expected that the drilling operations will be subcontracted to a third party that is appropriately qualified and specializes in such investigations. This SOP is to be used in conjunction with work plans. All drilling activities will be subcontracted to a third party that has a current California drilling license. All drilling activities will be performed under the oversight of appropriately trained field geologist under the guidance of a California-licensed Professional Geologist or Professional Engineer.

A13.1 PRE-DRILLING ACTIVITIES

The following activities must be performed prior to the start of any drilling activities:

- Provide subcontractors with the applicable scope and necessary access information.
- Prepare schedules and coordinate with the staff, client, and regulatory agencies.
- Obtain appropriate permits according to Federal, State, and local regulations.

- Confirm the drilling locations with the Project Manager and mark the locations with white spray paint. Additional markings with flags, wooden stakes, or other methods may be used to ensure that the locations can be easily found at the time of drilling.

- While marking the drilling locations, perform a preliminary review of potential overhead or underground utilities and hazards that may interfere with the drilling program.

- Obtaining proper clearance for potential above- and below-ground hazards. This may include some or all of the following:

    - reviewing As-Built Utility diagrams;

    - notifying Underground Services Alert,

    - subcontracting to a utility clearance specialist; and

    - physically verifying that utilities do not exist by hand digging or using an “air knife” to vacuum out surface sediments.

- If relocation is necessary due to the presence of a utility line, then new location must be at least 2 feet away from the outermost edge of the obstruction. Confirm any relocated borings with the Project Manager.

- Verify that equipment has been decontaminated and is in good working order prior to its arrival onsite.

A13.2 DRILLING PROCEDURES

The following activities must be performed on the day of drilling:

- Perform a Health and Safety tailgate meeting with all personnel performing the drilling activities. Secure the work zone with traffic cones and barricade tape. Verify that the appropriate Personal Protective Equipment (PPE) is worn within the work zone. .

- Decontaminate all down-hole drilling and sampling tools. Set up a decontamination station for sampling equipment.

- Set up a soil logging and note taking area.

- If the location is near utilities, then an air knife or hand digging equipment will be used to excavate the first 6.5 feet of material. Observe for potential backfill material that might accompany a buried utility line. In some cases, utility lines can be buried at depths greater than 6.5 feet deep. If such a case is suspected, continue excavating to the appropriate depth before drilling.

- Perform drilling and sampling activities. Drilling methods are described in Section D13.3 of this SOP. Refer to SOP 14.0 – Soil Sampling for procedures on how to collect soil samples.

- Perform the appropriate air monitoring for health and safety during drilling. This may include the use of a photoionization detector (PID), flame ionization detector (FID), or personal air monitoring devices.

- Document the drilling activities. SOP 3.0 – Field Documentation and Sample Handling, presents field documentation and sample handling procedures and SOP 11.0 – Soil and/or Rock Logging, presents procedures for logging soil and or rock and completing a boring log. Soil cores will be classified and stored. Note any drill rig chatter, or a change in down-hole drilling rate on the boring log.

- Once all drilling activities are completed at a location, the boring location will be surveyed using a GPS. Then the boring may be surveyed with borehole geophysical equipment, converted into a monitoring well or piezometer, or abandoned. Refer to SOP 16.0 – Installation and Construction of Groundwater Monitoring Wells and Piezometers for procedures on how to install monitoring wells and piezometers. Refer to Section A13.4 of this SOP for procedures on how to abandon a borehole.

- Decontaminate all equipment prior to moving to the next boring location. Properly containerize, label, and document the location of all waste such as soil cuttings and decontamination water.

A13.3 TYPES OF DRILLING METHODS

This section provides a brief description of the drilling methods that may be used at the site, including dual tube percussion and casing hammer, hollow-stem auger, rotary, direct push, and sonic. The method actually used will depend on the use and anticipated depth of the boring, and the material anticipated to be encountered.

A13.3.1 Dual Tube Percussion and Casing Hammer Methods

The dual tube percussion and air rotary casing hammer methods are used in cases where boreholes penetrate unconsolidated material containing intervals of cobbles or boulders.

Where dual tube percussion methods are specified, ten-foot-long dual flush-threaded casing sections fitted with O-rings will be used. The outer diameter is approximately 10-inches, the inner diameter is approximately 9-inches. Compressed air is used to circulate drill cuttings up the inner tube. Water-level measurements and drive samples can be collected from within the inner tube.

Where casing hammer methods are specified, ten-foot-long flush threaded drive casing sections fitted with hollow drill rod will be used. The outer diameter of the drive casing is approximately 10-inches. Compressed air is forced down the drill stem and out the drill bit to circulate drill cuttings up the annulus. Drill cuttings will be collected at least every five feet and stored in plastic bags. Water level measurements may be collected with the drill rods in place; however, depth discrete “drive samples” can be collected only after the drill bit and rod have been removed from the borehole. A boring log based upon drive samples and observed cuttings must be prepared.

A13.3.2 Hollow-stem Auger Method

The hollow-stem auger method is used in cases where shallow boreholes will penetrate unconsolidated sediment.

Where hollow-stem auger drilling methods are specified, hollow-stem augers, with lock bolt jointed 5-foot sections, and drill rod, plug, and bit assembly will be used. The auger diameter will be selected based upon auger availability, drilling rig capacity, anticipated boring depth, sampler type, and intended boring use.

Drilling fluids may be used with hollow-stem augers only in cases where flowing sands require maintenance of a positive hydraulic potential between the inside and outside of the augers. In such cases, potable water will be pumped directly to the inside of the augers. If the drill rod assembly within the auger should become bound by flowing sands, potable water will be pumped to the top of the drill rod assembly and the assembly will be raised and lowered through the augers until the assembly becomes unbound. The source, time, duration of use, rate of flow of drilling water, as well as justification for water use, will be recorded on the boring log.

A13.3.3 Rotary Drilling Methods

Rotary drilling methods using drilling fluids other than air are used in cases where deep penetrative work is to be conducted in unconsolidated sediments or shallow penetrative work is to be conducted in soft rock and other deposits containing boulders.

Where rotary drilling methods are specified, a drill pipe fitted with a roller, drag bit, or drive shoe will be used. The type and diameter of the bit or shoe will be specified based upon availability, formation characteristics, drilling rig capacity, anticipated boring depth, sampler type, and intended boring use.

Temporary surface casing may be installed to prevent migration of ground water through the borehole. Sealing of the surface casing will be specified based upon site geology and aquifer characteristics.

Potable water mixed with bentonite may be used as a drilling fluid. In such cases, a portable, steel, two-stage drilling mud pit with steel gate will be used. The mud pit base will be fitted with a rubber, bentonite, or cloth gasket to prevent circulation loss at the ground surface. Make-up drilling water will be added directly to the mud pit. Settled fines will be removed periodically from the first stage of the pit. The rate and volume of necessary drilling water make-up will be recorded on the boring log.

A13.3.4 Direct Push Method

The direct push method is used for shallow penetrative work in unconsolidated sediments where it is beneficial to minimize the volume of cuttings. Continuous core, discrete soil drive samples, soil vapor or groundwater samples can be collected with this method. Only small diameter monitoring wells or piezometers can be installed with the direct push method.

The push rig advances steel casing hydraulically to reach the desired termination depth. Samples are collected as the drilling tool advances. Cone penetrometer testing (CPT) is a type of direct push method that is used to estimate soil stratigraphy, density, strength and hydrogeologic information by measuring sleeve friction, cone bearing and pore water pressure. The tool can be modified to measure soil resistivity or detect the presence and concentration of aromatic hydrocarbons.

Hydropunch™ tools have an inlet screen that can be exposed at a desired depth to sample groundwater in direct push borings. Refer to SOP 17.0 – Groundwater Sampling for procedures on Hydropunch™ sampling.

A13.3.5 Sonic Drilling (Sonic Coring)

The sonic method of drilling is used where it is beneficial to collect continuous cores; use no air, mud, water, or other medium for penetration; drill through most types of formation; drill at any angle from horizontal to vertical; and yield no cuttings (other than core) in the drilling process. The sonic drill head is a hydraulically-activated unit that imparts high frequency sinusoidal wave vibrations into a drill string to effectuate a cutting action at the bit face. The resultant cutting action forces a circular continuous core of the formation up into the drill string. Due to the high forces developed by the resonant head and the external flush nature of the specialized drill string, excess formation material generated by the cutting face of the bit is forced into the borehole wall thus resulting in the generation of no cuttings in the drilling process.

A13.4 BOREHOLE ABANDONMENT

All soil borings will be permanently sealed to prevent vertical migration of contaminants. Soil borings shall be destroyed by backfilling, from bottom to the surface, with Holeplug™, Enviroplug™, Volclay™, or a cement-bentonite grout slurry (cement grout), and in accordance with appropriate Federal, State, and local regulations. Boreholes that extend below the water table or extend below 30 feet deep will be backfilled by tremie method. For boreholes shallower than 30 feet that do not penetrate the water table, the grout material may be poured from the surface.

Holeplug™ and Enviroplug™ bentonite do not require mixing but are poured into the borehole dry and charged with clean water.

Volclay™ and cement-bentonite grout (herein termed cement grout) require mixing with clean, potable water. The cement-bentonite mix should not contain more than 5 percent bentonite.

Approximately 24 hours after initial grouting, the borehole shall be checked for settlement. If a settlement depression has formed, the depression shall be filled with grout and checked again 24 hours later. This process shall be repeated until grout remains at the ground surface.

A14.0 – SOIL SAMPLING

Purpose and Scope:	The purpose of this document is to provide procedures for collecting soil samples. It includes a discussion of general procedures, various sampler devices, surface soil sampling, bulk soil sampling, and soil sample compositing.
Equipment:	Stainless steel spatulas; Stainless steel spades; Stainless steel hand auger buckets and hand auger accessories; Power auger/drilling rig; Split spoon samplers; Continuous core samplers; Shelby tubes; Teflon sheets; Plastic sheeting; Stainless steel sampling rings; Plastic ring caps; Stainless steel measuring cup; Stainless steel trowel; Hand bucket auger; Driver sampler; Hand-Held Global Positioning System (GPS) device; Cleaning and decontamination equipment; Sample labels; Ice chest; "Blue" or double bagged “wet” ice; Sealable plastic storage bags; Miscellaneous tools; and Safety equipment.
Documentation:	Daily Field Record (DFR); Soil Boring Log; Chain of Custody (COC) form; Maps/plot plan; and Camera.

This Standard Operating Procedure (SOP) is to be used in conjunction with work plans.

A14.1 GENERAL PROCEDURES

All soil sampling activities must be performed by appropriately trained field staff under the guidance of a California-licensed Professional Geologist or Professional Engineer.

The following is a list of general procedures that should be adhered to during soil sampling:

- Record relevant data on a Daily Field Record prior to sampling (SOP 3.0 – Field Documentation and Sampling Handling);

- Decontaminate all sampling equipment prior to sampling;

- Clear surface vegetation, rocks, and other material not designated for sampling from the sampling point;

- Reach the desired sampling depth by drilling a soil boring (SOP 13.0 - Drilling);

- Collect the soil sample and transfer it to the appropriate container;

- Record the soil sample lithology (SOP 11.0 – Soil and/or Rock Logging);

- Affix an appropriate label to the sample container, being sure to provide required information. Place the properly labeled sample container in an appropriate carrying container and maintain the sample at the required temperature. Add information pertaining to the sample to the COC, Daily Field Record, and Field Record of Soil Sampling forms. Package and ship samples at end of the day to the appropriate laboratory following the sample handling procedures described in SOP 3.0 – Field Documentation and Sample Handling;

- Document the surface location of the soil sample using a GPS; and

- Either discard or decontaminate all items which contact the sample such as trowel, split-spoon sampler, and gloves before proceeding to the next sampling location.

Specific procedures for the various methods that may be used to collect soil samples are described in the following sections.

A14.2 SAMPLER DEVICES AND METHODS

Several drilling methods may be used to reach desired depths for soil sampling. When the desired sampling depth has been reached and the borehole has been prepared, the following sampler devices and methods may be used to collect samples:

- Penetration Test and Split-Barrel Sampler (split-spoon);

- Thin Wall Sampler;

- Continuous Sampling System;

- Collection of Cuttings; and

- Shelby Tube.

A14.2.1 Penetration Test and Split-Barrel Sampling

Penetration test and split-barrel sampling are methods used to collect representative undisturbed soil samples. Samples collected by these methods will be used for description and identification, chemical analysis, and in some cases physical analysis. A split-barrel sampler consists of a section of pipe that splits into two pieces along its axis. A driving shoe and waste barrel screwed to the ends hold the split section together during driving. Aids for sample retention may also be incorporated into the split-barrel sampler. These include catchers, spring or gravity traps (in the lower end), and check valves (in the top end). The standard sampler has an outside diameter of 2-inches and an inside diameter of 1-3/8 inches.

The penetration test samplers have been used to develop an empirical relationship between driving resistance and the relative density of soil. The procedure for determining and interpreting penetration resistance or relative density is the Standard Penetration Test (SPT), which is described as follows:

- After the boring has been advanced to the desired sampling depth and extracted drill cuttings have been suitably removed, a split-barrel sampler attached to drill rods is lowered to the bottom of the cleaned-out borehole.
- Once the sampler is on the bottom of the borehole, three 6-inch increments are marked on the drill rods above a convenient fixed datum.
- The sampler is driven by a 140-pound hammer free falling a distance of 30-inches onto a collar or drive head attached to the top of the drill rods. The sampler is driven a total of 18-inches into the undisturbed soil, and the number of blows required to advance each 6-inch increment is recorded.
- The standard penetration test should be terminated if one of the following occurs:
  - A total of 50 blows has been applied during any one of the three 6-inch increments;
  - A total of 100 blows has been applied;
  - There is no observed advance of the sampler during the application of 10 successive blows of the hammer.
- After the total penetration of the sampler has been achieved, the sampler is retrieved to the surface and opened.

The sample is logged and removed from the sampler, the sampler is decontaminated and then re-assembled. If the samples are to be retained for future reference, they will be placed in sealable plastic bags and labeled as to depth and location according to standard procedures. Typically, samples are taken at each lithologic change and at intervals not greater than 5 feet (unless otherwise stipulated by the field engineer or geologist).

Where relatively undisturbed samples are to be collected, soil samples are obtained with a “California” or similar split-barrel (split-spoon) sampler fitted with dry decontaminated 2.5-inch diameter, 3 or 4-inch long stainless steel rings. Procedures for sampling with the “California” sampler are similar to procedures described for the standard penetration test. Soil samples will be collected by driving the split-barrel sampler 18-inches (or until refusal) into undisturbed soil at the bottom of the borehole. The drill rig is equipped with a 140-pound hammer to drive the sampler. Hammer blows required to drive the sampler in 6-inch increments will be recorded on the Boring Log.

Upon retrieval from the borehole, the sampler will be dismantled, and the sample tubes removed and placed on clean plastic. These tubes will be separated with a clean steel knife, then logged by the field geologist. After logging, the exposed ends of the rings will be covered with 2-mil Teflon sheets, and plastic end caps. Sample labels will be affixed to the end caps and will contain the following information: boring number; sample location; sample number; sample depth; date of sampling; time of sampling; sample collector's name; soil type; and name of client or facility owner. Depending on the length of each tube, three to six tubes will be retained from each sample interval.

A14.2.2 Thin Walled Sampler

A thin wall sampler is a one-piece metal tube, of thing gauge, which is forcefully driven into the soil to collect an undisturbed sample. The tube is the sample container and cannot be reused. Thin walled samplers cannot be used in extremely hard soil. Thin wall sampling tube methods are used where undisturbed samples of fine-grained materials are to be obtained for chemical analysis, saturated vertical hydraulic conductivity testing or other geotechnical analysis. Other larger diameter samples (3- to 6-inches in diameter) are helpful in sampling gravel deposits and retrieving samples of sufficient volume to perform compaction tests. The size of the sampler should be documented on all penetration records.

The thin wall sampling method is conducted by attaching a sampling tube to the nose-end of the “California” sampler and pushing the tube, in one continuous motion, into the material to be sampled. Once the tube is retrieved, slough material will be removed from the tube and the actual sample length will be measured. If the sample is to be retained for future reference or analysis, it will be trimmed, logged, capped, sealed, and labeled.

A14.2.3 Continuous Core Sampling System Methods

Continuous core sampling system methods may be specified where continuous soil cores are to be recovered by hollow-stem auger, direct push, or sonic drilling methods. The continuous sampling system utilizes a core barrel, which recovers a soil core from the interval drilled. The core barrel is recovered after each interval is drilled.

Soil samples may be cut directly from continuous cores of soil cores or transferred into laboratory supplied containers. In some cases, the entire length of the soil cores will be placed in lined core boxes so that the logged conditions can be confirmed by a geologist tasked with the responsibility of review.

A14.2.4 Cuttings Collection Methods

Cuttings brought to the surface during drilling activities may be collected as grab samples for laboratory or physical analysis. Cuttings will be collected at a minimum of every five feet and at changes in lithology. Samples will be placed in a container marked with a unique designation that includes the borehole identification and the sample depth.

A14.3 SURFACE SOIL SAMPLING

Methods to be used for collection of surface soil samples include taking a grab sample with either a scoop or trowel, hand bucket auger, or the hand drive sample method. The scoop or trowel samplers are used to collect shallow soil samples, up to 6-inches in depth. The sampler will transfer the sample into a laboratory-supplied glass jar or pre-cleaned stainless steel tube and seal the end(s). In the case of the hand drive-sampler method, samples will be collected directly into stainless steel tubes. If collecting a sample in a stainless steel tube, the sampler will seal the ends with a sheet of Teflon and a cap on both ends of the tube. The sampler will document the soil type on a boring log and label the sample container with sample number, depth, date, time, and study area.

A14.4 BULK SOIL SAMPLING

Bulk soil samples for some physical and mineralogical tests will be collected from test pits and soil borings. Samples will be collected from test pits less than 5-feet deep from the wall of the pit with a stainless steel trowel. In test pits deeper than 5-feet, samples will be collected out of the backhoe bucket. Bulk samples from soil borings will be collected from the cuttings produced during drilling or retrieved from a sampler.

Samples of sand, silt, and clay-size material will be collected into gallon-sized plastic bags or in sample sleeves. Coarse-grained gravels will be collected into 5-gallon buckets. In general, the size of the bulk sample will be at least 10 times greater than the size of the largest class or material. Samples will be labeled with the sample number, date, time, location, depth, and test pit or borehole.

A14.5 SOIL SAMPLE COMPOSITING

Soil sample compositing is used to combine soil from two or more samples so that the composite that is submitted for analysis is representative of the entire mass of soil sampled. Soil samples can be composited in the laboratory or in the field.

Individual samples to be composited will be identified on their labels by their own sample identification and by the sample identification for the composite sample. Samples to be composited also will be identified clearly on the COC and on the Field Record of Soil Sampling by both identifications. In the case of bulk samples, mineralogical samples, or any other soil samples to be composited for archiving or non-chemical analysis, the procedure is described below. In general, compositing consists of the following steps:

- Take an approximately equal in weight sub-sample from each sample to be composited;
- Combine and homogenize the sub-samples; and
- Take a sample of homogenized soil for analysis.

Grab samples are disturbed samples obtained by shovel, hand trowel, bucket auger, or similar means. A grab sample can be sub-sampled by taking a smaller grab sample if the material is relatively homogeneous or if the grab sub-sample will contain the various types of materials in approximately the proportions present the larger sample. Otherwise, the material should be homogenized and subdivided as described below.

Split-spoon and similar samples may be more easily subdivided by splitting the sample lengthwise with a spatula into halves or smaller fractions. Another approach is to cut a vshaped channel from the side of the sample and use the material from the channel for compositing.

Sub-samples should be the same volume. A measuring cup is satisfactory for determining size. The size of each sub-sample should be chosen in advance on the basis of the final sample volume and the amount of material available. Make the size of the sub-sample after quartering or splitting larger than the desired volume, then mix the sub-sample thoroughly in the measuring cup with a spatula and discard the excess. Combine the sub-samples on a tray covered with aluminum foil or plastic sheeting. Chop cohesive materials into pieces considerably smaller than the final sample size with a trowel or spatula. Mix the composite sample until it appears homogeneous. If the composite sample is too large, subdivide it as follows: Pile the soil in a cone. Flatten the cone to a uniform thickness. Draw two lines across the pile, dividing it into quarters. Discard two opposite quarters re-mix the remaining quarters, and repeat the process until the sample is slightly larger than the sample container. Fill the container and discard the excess. Label the container and document the sample as described in SOP 3.0 – Field Documentation and Sample Handling. The sampler must identify the sample as a composite and to identify the number and locations of samples that were composited.

Some soil samples will be composited using Incremental sampling. IS is a structured sampling protocol that reduces sampling error associated with compositional and distributional heterogeneity of the analyte of interest in soil or sediments. The IS protocol consists of defining sampling or decision units, collecting a minimum of 30 individual soil samples from randomly selected locations within each unit, and submitting the samples to the laboratory for processing (drying, compositing, sieving, and sub-sampling) in a specified manner prior to laboratory analysis.

A14.6 ADDITIONAL SAMPLING METHODS

The selection of sampling methods presented above is not all inclusive of the soil sampling devices that may be used at the Site. The use of additional or alternative sampling devices may be required to adequately characterize the Site.

A16.0 – INSTALLATION AND CONSTRUCTION OF GROUNDWATER MONITORING WELLS AND PIEZOMETERS

Purpose and Scope: The purpose of this document is to describe procedures for constructing, installing, and developing groundwater monitoring wells, extraction wells, recharge wells, and piezometers. This document includes a discussion on well design, well installation, well surface completion, well development, and well construction summary diagrams.

Equipment:
Drilling rig, drilling tools, and support truck with water tanks;
Steam cleaner;
Grout plant and tremie pipe;
Portland cement, Types I through V;
Powdered bentonite;
Well casing and screen, cap and bottom plug (screen slot size based upon target geologic formation);
Stainless steel centralizers;
Bentonite pellets;
Washed, graded sand (grain size based on formation and screen slot size utilized);
Protective well box or monument and padlock;
Concrete mix;
Plastic sheeting; and
Safety Equipment.
Hand-Held Global Positioning System (GPS) device;

Documentation:
Daily Field Record (DFR);
Soil Boring Log;
Field Well Construction Summary which includes:
- Well Casing Installation
- Annular Materials Volume Calculations Worksheet
- Grouting Form
- Surface Completion Details for Wells

Well Sampling and/or Development Record
Maps/plot plan; and
Camera.

This Standard Operating Procedure (SOP) describes setup procedures that may be performed by the field geologist or engineer that will observe the well installation activities performed by others. This SOP does not include procedures for conducting a well installation. It is expected that the well installation activities will be subcontracted to a third party that is appropriately qualified and specializes in such investigations.

This SOP is to be used in conjunction with work plans.

A16.1 PREPARATION AND SET-UP

All necessary drilling/well permits and utility clearances shall be obtained prior to the start of drilling operations. Well installation will be performed under the oversight of a geologist experienced in design and construction of monitoring wells. All decisions regarding well design and installation will be completed under the guidance of a California-licensed Professional Geologist. Unless otherwise arranged, well construction supplies and equipment will be supplied by the drilling subcontractor. Prior to drilling and well construction, all drilling equipment, tools, and well materials (unless new) to be used in well construction will be cleaned thoroughly with a portable steam cleaning system supplied by the drilling subcontractor. Between well installations, drilling equipment and tools will be cleaned at the designated contaminant reduction zone.

A16.2 MONITORING WELL DESIGN

During advancement of the soil boring, the geologist will prepare a boring log and keep a time log of significant events during each working day. Logs will indicate field classification of soils, sampling depths, first encountered and static groundwater levels, progress of drilling, final completion depth, and the nature and resolution of any problems encountered. Based on data gathered from the borehole, the desired purpose of the well, and previously collected information from other boreholes and monitoring wells, the geologist and Project Manager will determine the well specifications. Well specifications include the following:

- Total depth of well;
- Screened interval placement;
- Screen slot size;
- Location of centralizers;
- Filter pack size;
- Filter pack interval;
- Thickness and placement of bentonite seal; and
- Grouting method.

Wells installed will typically be constructed of either 2 or 4-inch Schedule 40 PVC blank and screen. In the case of wells deeper than 150 feet, 2 or 4-inch Schedule 80 PVC will be used to minimize the potential for casing blistering when the grout cures. The diameter of the screen and casing will be a minimum of 4-inches less than the diameter of the borehole. Stainless steel centralizers will be placed at the top and bottom of the screen and every 40 feet along the blank casing. The bottom of each well will consist of a slip cap mounted with stainless steel screws to a flush-threaded end cap. Holes of 1/16-inch diameter will be drilled through both caps prior to installation to prevent water from sitting in the bottom of the well if the static water level drops below the bottom of the well. A locking cap will be used to secure the top of the well.

A16.3 WELL INSTALLATION

Wells will be installed in accordance with applicable Federal, State, and local laws and regulations. This section describes the well installation procedures for unconsolidated material. Once the desired depth of the borehole has been reached, the borehole will be prepared for installation of the well casing. The well casing/screen assembly will be inserted into the borehole. The casing/screen assembly will be installed as follows:

- The well casing, including the bottom cap and screen, will be suspended in the borehole at the desired depth.
- The primary filter pack will be decided based on what is appropriate for the formation and slot size of the screen. The filter pack will be poured from the surface or placed by tremie method to the bottom of the annulus between the well casing and the borehole. The filter pack will extend at least 2 feet above the top of the screen. The level of filter pack in the annulus will be verified by tag-line measurement during emplacement. The volume of sand will be compared to the calculated annular volume to verify proper placement of the filter pack.
- When the primary filter pack is installed to the desired depth, the screened interval will be surged to settle the sand around the well screen (preliminary development). During surging, the well casing will be secured at the surface to prevent settling of the casing. Surging will continue until the filter pack stops settling. Upon completion, sand will be added to bring the filter pack up to the desired depth.
- A bentonite seal at least three feet thick will be placed immediately above the primary filter pack. If bentonite is to be placed below standing water, a high-solids bentonite grout will be pumped by tremie method. The level of the top of the bentonite seal will be verified by tag-line measurement. If pellets are used, adequate time for hydration (at least 30 minutes) of the pellets will be allowed before grouting the remaining annulus.

- Boring cuttings will not be used as backfill. The borehole annulus will be grouted with a cement-bentonite grout mix, which will extend to within approximately 2 feet of the ground surface. The grout must be tremied if there is standing water above the bentonite seal.

- The top 2 feet will be filled with a concrete mix used to make the concrete pad and secure the protective well box or monument.

- The grout will then be allowed to settle. If significant settlement of grout occurs, additional grout will be added to the prescribed depth of approximately 2 feet below ground surface prior to the installation of the protective casing and the concrete pad.

A16.4 WELL SURFACE COMPLETION

For wells completed above ground surface, steel security pipe with a hinged, lockable cover will be installed in the grout to a depth of 1 to 2 feet and equipped with a padlock. For flush-mount wells a steel protector and cover with watertight seal will be installed. The integrity of the well will be protected with a lockable sanitary sealing well cap with an expandable O-ring, which forms an airtight seal. All locks will be keyed alike.

For wells completed above ground surface, the drilling subcontractor will construct a concrete apron generally (3ft x 3ft x 0.5ft) around each well. Concrete aprons will be crowned to provide positive runoff away from the well. Concrete pads may be constructed within 3 days after wells have been installed. If necessary, steel guard posts 2-inches in diameter and filled with concrete will be installed around the pads. Posts will be five feet long and will have a stickup of 2.5 feet above ground surface and 2.5 feet below ground surface. For flush mounts, the space around the protective casing will be filled with concrete and rounded to provide positive runoff away from the well.

A16.5 WELL CONSTRUCTION SUMMARY DIAGRAMS

Upon completion of well construction and development, a standard Field Well Construction Summary and Well Casing Installation Form (Attached) will be completed. The following information will be included:

- Project name and number;

- Job location;

- Well ID;

- Permit number (if applicable);
- Land-surface elevation and datum;
- Date of installation;
- Drilling method (i.e., hollow-stem auger, air hammer, air rotary, or mud-rotary);
- Drilling contractor;
- Drilling fluids (where applicable);
- Amount of fluids lost during drilling;
- Well construction details, such as: Type of well (i.e., flush-mount or stick-up); borehole diameter; well casing diameter, material, and amount; final well depth; depth and type of filter pack; depth of bentonite seal; and depth and type of grout mixture; and
- Well purpose (i.e., monitoring, production, or recovery).

A16.6 WELL DEVELOPMENT

Well development consists of preliminary and final development. Preliminary well development will be conducted after installation for the well screen, casing, and primary filter pack, but prior to installation of seals and grout. Additional filter pack will be added, as needed, after completion of preliminary well development to bring the filter pack up to the desired depth.

Final well development will begin no earlier than 24 hours after the grout has been placed. Typically, well development will be performed using one more of these methods: surging, over-pumping, or bailing. The method to be used will be selected based on specific hydrogeologic conditions at the site but will generally consist of a sequence of bailing, surging, bailing, and then pumping. Approximately ten casing volumes of water will be removed. Water exiting the well will be collected and properly disposed. Well development will continue until the water is relatively free of sand, fines, and the turbidity is reduced. Generally, development will continue until turbidity values are less than 5 NTU. Measurements of pH, specific conductance, and temperature will also be collected every 5 minutes during pumping. When these parameters have stabilized, the well is considered developed and the water in the well is considered to be representative of the groundwater for that location.

Measurement of development parameters will be recorded on the Well Development Form (Attached) and will include the time of each measurement, approximate volume of water removed prior to each measurement, and the time intervals during which development is conducted.

- Well development method;
- Date of well development;
- Amount of water removed during development;
- Static depth to water;
- Pumping depth to water;
- Duration of pumping;
- Yield; and
- Specific capacity.

A16.7 EXTRACTION AND RECHARGE WELL CONSTRUCTION AND INSTALLATION

Recharge wells to be installed during remedial activities will be constructed according to the procedures outlined for Monitoring Well Installation and Construction with the following exceptions. Boreholes for recharge wells will be at least 16-inches in diameter and will be drilled by either casing hammer or tri-tube (similar to dual tube) methods. Well casing will be between 8- and 10-inches in diameter. Casing material, diameter and thickness, screen slot sizes, and filter pack design will be determined based on design criteria and on material encountered during drilling. In addition, extraction and recharge wells may have yield criteria that require specifications for well development that are designed specifically for the well.

A16.8 PIEZOMETER INSTALLATION

Piezometers installed during investigation or remedial activities will be constructed according to procedures outlined for Monitoring Well Installation and Construction, with the following exceptions:

- Boreholes for piezometers may be as small as 8-inches in diameter;
- Well piezometer casing will generally be 2-inches in diameter; and

- Piezometer screen may be constructed of either PVC or stainless steel.

Exact specifications for each piezometer, including screen material, casing diameter, screen slot size and filter pack design will be based on material encountered during drilling.

A16.9 WELL AND PIEZOMETER SURVEY

The location of all wells and piezometers will be initially surveyed using a hand held GPS. After completion of the well or piezometer the top of casing and the ground surface elevation will be surveyed by a California-licensed Land Surveyor to the nearest 0.01 foot (ft) in the vertical and 0.1 ft in the horizontal.

A17.0 – GROUNDWATER SAMPLING

Purpose and Scope: The purpose of this document is to present procedures for collecting a groundwater sample for chemical analysis.

Equipment:

Bailer (Teflon, Polyvinyl Chloride (PVC), polyethylene, or equivalent);
Bailer reel with twine;
A tarp or plastic sheet;
Water level indicator;
pH meter;
Specific Electrical Conductivity (SEC) meter;
Thermometer;
Oxygen-reduction potential (ORP) (Eh) meter;
Dissolved oxygen (DO) meter;
Turbidity meter;
Flow through cell (for ORP and DO measurements);
Sample containers (laboratory cleaned and provided);
Electric generator;
Electric submersible pump control box;
Oil-less compressor;
Groundwater pump (e.g., submersible pump, peristaltic pump, bladder pump, etc.);
Filter equipment (0.45 micron, inline, disposable);
Tubing (Teflon orPVC);
Ice chests and ice;
Zip lock bags
Blue or double bagged "wet" ice;
5-gallon buckets;Miscellaneous tools; and
Safety Equipment.

Documentation:

Daily Field Record (DFR);
Sample Control Log;
Chain of Custody (COC) form;
Field Instrument Calibration Sheet;
Well Sampling and/or Development Record;
Fedex Shipping labels;
Maps/plot plan; and
Camera.

Water sampling activities generally are performed after water table elevations have been measured and stagnant water within the wells has been purged. This Standard Operating Procedure (SOP) describes the purging and groundwater sampling procedures to be performed in monitoring wells, piezometers and open boreholes.

All groundwater sampling will be performed by appropriately trained field staff under the guidance of a California-licensed Professional Geologist or Professional Engineer. This SOP is to be used in conjunction with work plans.

A17.1 PREPARATION AND SET-UP

Preparation and set-up for water sampling will include the following:

- Review the above listed SOPs and obtain, prepare, and maintain all applicable field forms;
- Review the scope of work and take note of the proposed sample locations, number of samples, and list of analytes to be collected. Verify the proposed samples with the Project Manager.
- Plan the sampling order when using non-dedicated equipment. The order of sampling is based on the results of the previous sampling event, where sampling proceeds from the lowest to highest detectable concentrations.
- Notify the laboratory 2-3 weeks in advance of sampling of the number of samples and types of analyses. Confirm preservation and handling requirements with the laboratory. Arrange for the laboratory to ship appropriate containers and sample coolers to the office prior to mobilization to the site, and upon receipt, inspect sample containers, and notify laboratory of any missing or damaged containers
- Coordinate and provide notification of the sampling schedule to the Project Manager and other affected individuals, and clear access to wells and/or surface water sampling locations.
- Calibrate in accordance with manufacturer's instructions, pH, SEC, temperature, ORP, DO, and turbidity meters to ensure the meters are in good working condition and providing accurate measurements. Document the results of each calibration on a Field Instrument Calibration Sheet.
- Assemble all other required equipment and check that it is in proper working condition.
- Ensure all sampling equipment has been decontaminated. If dedicated or disposable sampling equipment is used, decontamination activities will not be needed.

A17.2 PROCEDURE

Document general field activities on a Daily Field Record (SOP 3.0 – Field Documentation and Sampling Handling).

Prior to purging, the field technician will visually check the well for damage and begin to prepare the Well Sampling Record.

The static water level and depth-to-bottom will then be measured according to the procedures outlined in SOP 6.0 – Field Measurements - Water. Depth-to-water measurements will be recorded to the nearest 0.01-foot and recorded on the Water Level Monitoring Record and Well Sampling Record. Monitoring well construction logs, along with available water level data, will be reviewed to determine the volume of water to be purged.

Each well will then be purged to allow collection of a representative sample. Monitoring wells will be purged using bailers or submersible pumps. If a submersible pump is used the purge rate will be determined for the well by the purge volume and as approved by the Project Manager. The purge method may be dependent on the chemical of potential concern, physical constraints, and available equipment. Extracted purged water will be properly contained and managed. Purging of each monitoring well will continue until the following two minimum conditions are met:

- Three casing volumes are removed from the well or piezometer.
- The field pH, electric conductivity, temperature, ORP, DO, and turbidity measurements of the discharged water have stabilized to three consecutive readings that are taken at least 1 minute apart that are within 10% of each other. Measurements of ORP and DO require the use of a flow through cell for accurate measurements.

Wells that are pumped or bailed dry prior to removing three casing volumes of water will be allowed to recover at least 5 minutes and then pumped or bailed dry a second time. Field measurements of temperature, pH, electrical conductivity, ORP, DO, and turbidity will then be collected as the well fills again. If a well is purged dry a third time, all water within the filter pack material is considered to have been removed and purging can be stopped.

If any of the field measurements are suspect, instruments will be re-calibrated. Calibration information will be recorded on the Instrument Calibration Form and noted on Daily Field Records. Samples will be collected when the well has recharged a minimum of 80% of the pre-purge volume, as verified by measuring the depth to water.

Prior to collecting any samples, the field technician will put on new gloves. Water will then be pumped or bailed, filtered (if necessary), and decanted into laboratory supplied containers. A submersible pump or a disposable bailer will be used to obtain the groundwater samples from the well. When using a submersible pump for sampling, if a flow through cell was used during purging it must be removed. When using a bailer for sample collection, the bailer will be lowered with minimum splash to just below the water surface. If multiple types of analyses will be performed, the sample containers will be filled in the following order:

- Metals; and
- Other Chemical Constituents.

Samples collected for metals and other inorganic analysis will be filtered and preserved in the field according to laboratory instruction. Samples that require filtering will be filtered using a disposable filter with a filter screen size of 0.45 micrometers (µm) (micron filter). A description of the odor or physical appearance of the sample including color, clarity, suspended solids, etc. will be reported on the Well Sampling Record.

Labels will be affixed to each sample bottle recording the sample identification number, date, time (military time), analysis required, preservative used, and collector’s initials. A COC will accompany each sample to establish the required documentation necessary to trace sample possession. All collected samples, including any duplicates and blanks, will be recorded on a Sample Control Log. Refer to SOP 3.0 – Field Documentation and Sample Handling for details.

Non-dedicated and non-disposable bailers, pumps, meters, reels, water levels meters, and Teflon tubing will be decontaminated prior to first use and upon completion of sampling (SOP 7.0 – Equipment Decontamination).

A17.3 PIEZOMETER SAMPLING

Piezometers are a permanent or temporary well that may be designed similar to a monitoring well. This type of well is primarily used to collect water-level elevation data to aid in determining the direction of groundwater flow.

Piezometers may be sampled periodically to evaluate water quality, in which case, piezometers will be sampled according to procedures outlined above for the sampling of monitoring wells.

A17.4 GRAB GROUNDWATER SAMPLING

Grab groundwater samples may be collected during or immediately after drilling if water from the formation is freely flowing into an open boring.

Grab groundwater samples will be collected according to the procedures outlined above for sampling of monitoring wells with the exception that purging and monitoring of field parameters may not be performed prior to sample collection.

A17.5 HYDROPUNCH^{TM} GROUNDWATER SAMPLING

A Hydropunch^{TM} (HP) sampler is a grab groundwater sampling device is screened over a short interval (generally less than two feet) that can be used to collect a water sample at a relatively discrete interval when compared to traditional wells. If the depths of potential groundwater bearing zones are identified, a HP sampler may be lowered into the open borehole and driven into undisturbed soil by a hammer or direct push (described in SOP 13.0 - Drilling). Once the HP sampler is driven into soil, the outer shell of the sampler is retracted to expose a screen. If groundwater is present it will flow into the sampler through the screen.

If a discrete water sample is desired at a depth already reached by the boring, an adjacent borehole can be installed with a HP sampler to collect groundwater samples at the desired sample depth.

Groundwater samples will be collected from the HP in the same manner as discussed in Section A17.1 with the exception that no purging or monitoring of field parameters will be performed prior to sample collection.

A17.6 MICROPURGE OR LOW FLOW SAMPLING METHOD

This method assumes the water within the screened interval is not stagnant, and a small change of the natural flow rate in the screened interval will result in samples with particulates and colloidal material representative of groundwater.

To micropurge and sample:

- Place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a pre-determined location within the screen interval. The placement of the pump intake should be positioned with a calibrated sampling pump hose, sounded with a weighted tape, or using a pre-measured hose. Record the pump intake location on the groundwater sampling log.
- Measure the water level to the nearest 0.01 feet and record information on the groundwater sampling log, leave water level indicator probe in the monitoring well.

- Connect the discharge line from the pump to a flow-through cell. A “T” connection may be needed prior to the flow through cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the monitoring well.

- Start pumping the well at a low flow rate (0.2 to 0.5 liter per minute) and slowly increase the speed. Check the water level. Maintain a steady flow rate while maintaining the drawdown of less than 0.33 feet (Puls and Barcelona, 1996).

- Measure the discharge rate with a graduated cylinder and a stop watch. Also, measure the water level and record both flow rate and water level on the groundwater sample log. Continue purging, monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at a minimal flow to ensure minimal drawdown in the monitoring well.

- During the purging, a minimum of one tubing volume (including the volume of water in the pump and flow cell) must be purged prior to recording the water-quality parameters. Then monitor and record the water –quality-indicator field parameters every three to five minutes. The water-quality indicator field parameters are turbidity, DO, SEC, pH, ORP, and temperature. Once the criteria have been successfully met indicating that the water quality indicator parameters have stabilized, then sample collection can take place.

- If a stabilized drawdown in the well can’t be maintained at 0.33 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump of and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then the sampling can proceed next time the pump is turned on. This information should be noted on the groundwater sampling log with a recommendation for a different purging and sampling procedure.

- Maintain the same purging rate or reduce slightly for sampling (0.2 to 0.5 liter per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell.

A17.7 REFERENCES

Puls, R.W. and M.J. Barcelona, 1996, Groundwater Issue Paper: Low-Flow (Minimal Draw-down) Groundwater Sampling Procedures; U.S. Environmental Protection Agency, EPA/540/S-95/504, 12pp.

ATTACHMENT B

Revised Site Management Plan Former UP Roundhouse Area

REVISED SITE MANAGEMENT PLAN
FORMER UNION PACIFIC ROUNDHOUSE AREA
1407 MIDDLE HARBOR DRIVE
OAKLAND, CALIFORNIA

Submitted to:

Port of Oakland, California

Submitted by:

AMEC Geomatrix, Inc., Oakland, California

January 9, 2009

Project 8207.016

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REVISED SITE MANAGEMENT PLAN
Former UP Roundhouse Area
1407 Middle Harbor Drive
Oakland, California

1.0 INTRODUCTION

AMEC Geomatrix, Inc. (AMEC)[1], has prepared this Revised Site Management Plan (SMP), on behalf of the Port of Oakland (Port), for the former UP Roundhouse Area (the site; Figure 1). This document updates and supersedes the November 30, 2005 SMP based on the completion of monitoring activities conducted by the Port between 2006 and 2008.[2]

The site was refurbished in 2005 to be incorporated into the Port's marine terminal operations. Based on investigation activities conducted at the site, separate-phase petroleum hydrocarbon product (petroleum product) is present in the subsurface, and soil at the site contains elevated concentrations of lead. This SMP has been prepared based on existing known conditions and the intended use of the site as a container terminal. The SMP is incorporated by reference into the environmental deed restriction for the site.

The objectives of the SMP are to:

- summarize existing conditions at the site;
- present protocols and measures to protect construction workers at the site from potential exposures to product that is present in the subsurface and lead that is present in soil; and,
- provide a plan for management of soil and groundwater disturbed during operations, maintenance, or development activities in a manner that protects human health and the environment; and

Terms used in this SMP include the following:

- Tenant – current leaseholder;
- Contractor – party conducting on-site activities as engaged by the Port or other parties; and

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[1] AMEC Geomatrix, Inc, formerly Geomatrix Consultants, Inc. For purposes of this report, investigations and remediation completed prior to June 20 will be attributed to Geomatrix.

[2] Further, this SMP also supersedes the March 15, 1999 *Remediation and Risk Management Plan* and June 14, 1999 *Supplement to Remediation and Risk Management Plan* (Kleinfelder, 1999a and 1999b) prepared for the site by Kleinfelder, Inc. (Kleinfelder).

- Consultant – engineer/consultant engaged by the Port or Tenant to assist in implementing this SMP.

This document describes site background and environmental site conditions, soil and construction dewatering management activities, maintenance of the SMP, representations and limitations of the SMP, and lists the references used in preparing the SMP, including those that provide information about known environmental conditions at the site.

2.0 BACKGROUND

This section provides information regarding site setting, historical uses, regulatory status, and environmental investigation and remediation activities that have been conducted at the site.

2.1 SITE SETTING, PAST USES, AND CONDITIONS

The approximately 44-acre site is bounded by Port property and the Oakland Inner Harbor to the south, Port marine terminal operations to the west (currently occupied by Eagle Marine Services, Ltd.), and the Union Pacific Railroad Company (UPRR) yard to the north. A scrap metal facility operated by Schnitzer Steel, Inc., is located directly east of the site.

The site previously was owned by UPRR and was purchased by the Port in 1996. Historically, the site was used as a railroad maintenance facility and contained a roundhouse and associated turntable, fueling facilities, and associated structures (Figure 2). Railroad operations discontinued at the site in the 1960s, and the site facilities were demolished by the 1970s. Since that time, the paved site was used as a staging area for various tenants since the Port purchased the property. Remedial measures were completed at the site in October 2005 (as described in Section 2.4). The site was incorporated for use as part of the Port's marine terminal operations in mid-2006.

Based on environmental work conducted at the site, the site is underlain by artificial fill (consisting primarily of sand, gravel, and/or asphalt) extending to depths of 5 to 8 feet below ground surface (bgs). The fill typically is underlain by dark gray clay and water-bearing silts and fine- to medium-grained sand to depths of 8 to 10 feet bgs, which may be Young Bay Mud (YBM) or similar dredged material from the bay. These units reportedly are underlain by YBM (clay and silty clay rich in organic material) at a depth of 10 to 14 feet bgs. The YBM is underlain by the Merritt Sand that can reach a maximum thickness of 65 feet. Shallow groundwater generally is encountered at a depth of less than 10 feet bgs throughout the site and surrounding area.[3] The presumed hydraulic gradient is generally toward the south and the Oakland Inner Harbor.

2.2 REGULATORY OVERSIGHT

Regulatory agency oversight was initiated at the site in 1991 upon the removal of six underground storage tanks (USTs; as described in Section 2.3). Broadly, this oversight has been provided as follows:

Agency	Description	Date
Alameda County Health Care Services Agency (ACHCSA)	Removal of USTs	1991-1997
California Regional Water Quality Control Board, San Francisco Bay Region (Water Board)	Site characterization and monitoring	1996-present
U.S. Environmental Protection Agency (USEPA)	Remediation of petroleum discharge under a Notice of Federal Interest	2004-2005

2.3 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Various investigations have been conducted at the site since 1991. These investigations have included collection of soil, grab groundwater, and soil vapor samples from throughout the site. The findings of these investigations are summarized below based on information provided in the October 1998 and March 1999 reports by Kleinfelder (Kleinfelder, 1998 and 1999a), the UST case closure summary from the ACHCSA (ACHCSA, 1997), and the August 2005 investigation report by Geomatrix (Geomatrix, 2005a). Additionally, information from the product monitoring program, conducted between 2006 and 2008, also is presented herein. Tables and figures that document analytical testing results are presented in Appendix A. Analytical data summaries and figures for various phases of investigation included in Appendix A are from the October 1999 Kleinfelder report (Kleinfelder, 1999a), Geomatrix's August 2005 investigation report (Geomatrix, 2005a), and the 2005 groundwater monitoring report (Geomatrix, 2005b). No data tables or figures are available from the UST removal and monitoring efforts conducted by UPRR from 1991 to 1997.

2.3.1 Petroleum Product in the Subsurface

Soil analytical results and field observations indicate that separate-phase petroleum product is present in the subsurface and is distributed primarily near historical structures such as oil

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[3] Previous groundwater monitoring at the site has indicated that depth to groundwater generally ranges from approximately 2 to 10 feet bgs across the site.

tanks and pipelines, within the area shown on Figure 2. Within this area, the petroleum product is laterally discontinuous, and product migration, where observed, appears to have been through preferential pathways, such as the storm drain system prior to improvements (Section 2.4).

Analytical testing indicates that the petroleum product is characterized in the diesel and motor oil hydrocarbon ranges.

Outside of the defined product area, the presence of petroleum hydrocarbons in soil, where detected, has been reported as concentrations less than 100 milligrams per kilogram (mg/kg). Consistent with varying quality of fill material, the presence of petroleum hydrocarbons in soil outside of the areas where product has been identified is random across the site. Remedial measures were implemented at the site under the direction of the USEPA to remove preferential pathways within the product area. These remedial measures are discussed in Section 2.4.

2.3.2 Other Constituents in Soil

Soil samples collected from the site have been analyzed for metals, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), including polynuclear aromatic hydrocarbons (PAHs). Based on analytical results, the following analytes have been detected in site soil:

- Metals: Elevated concentrations of antimony and lead were reported at select locations during site investigations (Kleinfelder, 1999a). However, results of sampling conducted on excavated soil during site remediation activities suggest that elevated lead is distributed in fill material across the site.

- VOCs: No benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected in soil samples.

- SVOCs, including PAHs: PAHs were detected in some soil samples; of these, fluorene and phenanthrene appeared most frequently detected. No other SVOCs were detected.

2.3.3 Volatile Constituents in Soil Vapor

No BTEX or chlorinated hydrocarbons were detected in soil gas samples. Low concentrations of undifferentiated petroleum hydrocarbons and elevated concentrations of methane (up to 27 percent by volume) were detected at some locations within the product area.

2.3.4 Dissolved Constituents in Groundwater

Analytical results indicate that no VOCs, including BTEX, have been detected in groundwater beneath the site. Metals, where detected, are present at concentrations below Maximum Contaminant Levels (MCLs) in filtered groundwater samples (Geomatrix, 2005a). Additionally, with the exception of some PAHs, no SVOCs have been detected in groundwater. PAHs and extractable petroleum hydrocarbons primarily are detected in samples within the area where product is present in soil; however, petroleum hydrocarbons have been detected at low concentrations in some groundwater samples collected outside of the product area (AMEC, 2008). No significant dissolved phase plume associated with product exists at the site.

2.4 REMEDIAL MEASURES

Based on the results of the investigative activities conducted by AMEC in response to an oily discharge from the site through the storm drain system in July 2004 and the resulting Notice of Federal Interest (NFI) issued by the USEPA, remedial measures were implemented at the site to prevent migration of petroleum product through subsurface utility lines and discharge to the Oakland Inner Harbor. Remedial measures that were implemented at the site included the following:

- The storm drain line extending from catch basin DI-21 to catch basin DI-14A, and selected laterals to this trunk line, was decommissioned in October and November 2004. Impermeable barriers were placed in the backfill of the decommissioned storm drain line to remove preferential pathways through the storm drain backfill. A new, water-tight storm drain line was installed, as shown on Figure 3.

- In February 2005, the storm drain network in the vicinity of catch basin DI-7 was decommissioned using subsurface barriers and by demolishing catch basins.

- The entire storm drain network at the site was redesigned and replaced. This work consisted of shallow trench drains that are not in contact with product (where possible), water-tight storm drain pipelines and sealed catch basins in areas of known or suspected product, backfilling storm drain pipe trenches with low-permeability controlled density fill in areas of known or suspected product, and installation of subsurface barriers along storm drains and other subsurface utilities (e.g., fire water and electrical conduit). These remedial measures were completed at the site in October 2005.

The locations of the remedial measures are shown on Figure 3.

2.5 PRODUCT MONITORING PROGRAM

As approved by the Water Board in its September 23, 2005 letter to the Port, a petroleum product monitoring program was implemented at the site. To monitor whether product is moving in the direction of the Oakland Inner Harbor, four wells (PMW-6, PMW-7, PMW-8, and

PMW-9) were installed in January 2006 between the maximum known extent of the petroleum product in the subsurface and the Oakland Inner Harbor.

Product monitoring activities were conducted quarterly from February 2006 through November 2007. Product monitoring consisted of observing the surface of the groundwater in the four wells for the possible presence of product; field methods consisted of visual observation by shining a flashlight into the well and lowering a clean disposable bailer into the well to observe the possible presence of sheen on the water surface. In addition to visual observation, field personnel used an oil/water interface probe to monitor for product in wells PMW-6 through PMW-9. During the 2 years of quarterly monitoring, neither sheen nor free product were observed and the oil/water interface probe did not register the presence of product in any of the monitoring wells.

The absence of product in the monitoring wells re-affirmed that the primary mechanism for product migration at the site was by way of preferential pathways and that engineering controls have been successful in preventing migration. Based on these results, the Water Board approved the proposed well destruction on October 21, 2008 in a meeting with the Port and AMEC, followed by e-mail correspondence to the Port on October 24, 2008. The product monitoring wells subsequently were destroyed on November 17, 2008.

3.0 SOIL MANAGEMENT ACTIVITIES

This section outlines soil management measures that should be implemented during site construction activities. This SMP is written to specifically address issues that may arise during construction and maintenance activities at the site.

3.1 SITE MANAGEMENT MEASURES

The purpose of the site management measures is to provide guidelines to be followed during potential future earthwork activities at the site. These site management measures are to be used by parties involved in construction and maintenance activities at the site, including the Port and Tenant, their designated Consultants and Contractors, and utility contractors accessing subsurface utilities (e.g., electrical, sewer). Activities may include, but are not limited to, excavation, demolition, new construction, rehabilitation/new construction/site development [in some combination], construction grading, landscaping, geotechnical studies, and utility repair. Parties engaged in soil handling during future earthwork activities shall be provided a copy of this SMP.

3.1.1 Regulatory Requirements

Earthwork activities may be subject to federal, state, and local laws and regulations, including those promulgated by USEPA, California Environmental Protection Agency (Cal-EPA), the Bay Area Air Quality Management District (BAAQMD), the City of Oakland, and the California Occupational Safety and Health Administration (Cal-OSHA). These laws address issues such as health and safety, dust generation, hazardous waste, storm water, and community right-to-know. While some of these issues are discussed in this SMP, it is the responsibility of the Contractor to ensure that all earthwork activities comply with current applicable laws and regulations.

3.1.2 Site-Specific Health and Safety Plan

A site-specific Health and Safety Plan shall be prepared prior to initiating subsurface activities at the site. Each Contractor shall prepare its own separate site Health and Safety Plan in compliance with federal and state law to address worker safety measures, including personal protective equipment, monitoring, and appropriate notifications, during construction activities.

3.1.3 Access Control

Vehicle and personnel access to areas where soil will be disturbed shall be controlled. Caution tape, cones, fencing, steel plates, or other measures shall be used to clearly designate the active work area and to prevent access by the public. Stockpiles of excavated soil shall be covered as described in Section 3.1.4 and secured by temporary fences or other means to prevent unauthorized access.

3.1.4 Soil Handling Guidelines

Based on soil sampling and analytical testing that has been conducted at the site, elevated concentrations of lead are present in soil across the site, and petroleum product is present in the subsurface in the central portion of the site (Figure 2). Therefore, excavated soil should be tested prior to disposal and the following guidelines should be undertaken:

1. **Handling of soil during excavation.** All excavated soil shall be stockpiled on site. Soil that will not be used on site shall be sampled and chemically tested prior to off haul. No soil shall be exported for off-site reuse. Soil shall be visually observed for the presence of petroleum product, including evidence of discoloration, staining, and/or noticeable chemical odors. Soil observed to contain petroleum product shall be segregated and stockpiled or contained separately from other soil. Access to stockpile areas shall be controlled to prevent unauthorized persons accessing exposed soil (Section 3.1.3).

2. **Securing soil piles.** At the end of each workday, stockpiled soil shall be secured with a cover consisting of a minimum of 10-mil plastic sheeting to prevent erosion

or run-off. Stockpiles shall be secured by temporary fences or other means to prevent unauthorized access. Covered drums or secured roll-off bins would provide substantially similar control.

3. **Disposal of soil.** Excavated soil that will not be reused on site shall be sampled and analyzed for disposal characterization by the Port. Soil shall be profiled based on requirements of the disposal facility selected by the Port and in accordance with all applicable state and federal laws. Soil shall, at a minimum, be analyzed for Title 22 metals, petroleum hydrocarbons, and benzene, toluene, ethylbenzene, and xylenes at a frequency consistent with the disposal facility's requirements. Depending on the results for metals and the disposal facility requirements, soluble metals analyses also may be necessary. Soil determined to be hazardous waste shall be disposed off site within 90 days of generation. The soil must be properly manifested and transported by a registered transporter under applicable U.S. and California Department of Transportation regulations. Current federal and state requirements should be reviewed prior to disposal of soil.

4. **Fill material.** Soil brought to the site as fill material shall be characterized to assess whether chemicals may be present in the soil. Characterization may be based on knowledge of the source (e.g., material directly from a quarry). Analyses may include, but are not limited to, metals, petroleum hydrocarbons, pesticides, and polycyclic aromatic hydrocarbons. The Port or its representative should be consulted to define criteria (e.g., number of samples) appropriate for use at the time of the activity.

3.1.5 Management of Open Excavations

For excavations that must be left open after the end of a work day, dust control measures shall be implemented to prevent dust generation while the excavation is unattended, as described in Section 3.1.7. In addition, public access to the excavation shall be controlled by implementation of access controls as described in Section 3.1.3.

3.1.6 Dust Control

Chemicals of concern identified in the subsurface at the site include lead in soil and petroleum product. When earthwork activities occur, dust control measures shall be implemented to minimize dust generation. These will include dust control measures recommended by the BAAQMD (1999) and other recommended practices, such as:

- sprinkling water to maintain soil moisture,[4] as necessary;
- covering all trucks hauling soil, sand, or other loose materials or requiring all trucks to maintain at least 2 feet of freeboard;[5]

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[4] BAAQMD recommends at least twice daily.

[5] Trucks hauling soil off site must secure the load in accordance with California and U.S. Departments of Transportation regulations.

- paving, applying water three times daily, or applying soil stabilizers (non-toxic) on all unpaved roadways, parking areas, or staging areas;
- sweeping all paved access roads, parking areas, and staging areas daily;
- sweeping streets daily if visible soil material is carried onto adjacent public streets;
- restricting non-essential traffic to compacted roadways and capped portions of the site;
- limiting vehicle speeds to 5 miles per hour on unpaved portions of the site;
- minimizing drop heights while loading transportation vehicles; and
- covering exposed soil or stockpiles and securing with fencing or other means.

Additional control measures developed by the BAAQMD (1999) in its California Environmental Quality Act Guidelines may be applicable if the construction area is greater than 4 acres in size.

3.1.7 Equipment Decontamination

In addition to the presence of product in the subsurface, soil at the site has been shown to contain elevated concentrations of lead. Therefore, construction equipment used for construction or maintenance activities shall be decontaminated prior to working in other areas of the site or leaving the site. If vehicles are exposed to affected soil and/or product, decontamination procedures should include removing loose soil from the vehicle exterior with brooms or brushes. Soil and product not removed by brushing should be removed by washing with soap and water, pressure washing, or steam cleaning.

Water from the cleaning processes shall be collected and containerized, and sampled prior to proper disposal. Small equipment can be cleaned directly in a container that will be used for storing the water before disposal (e.g., bucket or drum). For larger equipment or vehicles that must be washed, a temporary decontamination area should be set up for collecting and containerizing wash water. Access to the decontamination area should be restricted. Other methods for handling decontamination water (e.g., disposal to sewer or storm drain, on-site use for dust control in lead-affected soil areas) may be used if approved by Water Board or the appropriate agency.

3.1.8 Storm Water Management

Storm water pollution controls will be implemented to minimize runoff of sediment in storm water, which could include lead-affected sediment. Storm water pollution controls at construction sites greater than 1 acre in size are regulated using the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (99-08-DWQ; General Permit).

In advance of mobilization for the site, the Port will file a Notice of Intent (NOI) to comply with the General Permit for earthwork activities disturbing greater than 1 acre of the site. Prior to mobilization, the Contractors also shall prepare storm water pollution prevention plans (SWPPPs) consistent with the Port's model SWPPP as well as the Port's standard construction specifications to address requirements for erosion prevention and storm water management.

Storm water pollution controls implemented at the site will be based on Best Management Practices (BMPs), such as those described in the "Information on Erosion and Sediment Controls for Construction Projects: A Guidebook," Erosion and Sediment Control Field Manual (Water Board, 2002), and the Storm Water Best Management Practices Handbook (CSQA, 2003). Specific practices that shall be implemented to reduce the sediment load of storm water runoff from the site include grading the site to prevent storm water from running off site, installing storm water control devices (earth berms, silt fences, or hay bale barriers) around the perimeter of unpaved portions of the site until final paving has been completed, and protecting existing catch basins with silt fences, hay bales, or gravel bags. In addition, all Contractors shall store fuel and chemicals in such a manner that prevents accidental spills from impacting storm water.

3.1.9 Methane Monitoring

As noted in Section 2.3.3, methane concentrations up to 27 percent by volume have been measured in the petroleum product area during soil vapor sampling. Prior to construction within a utility or subsurface vault, methane concentration measurements shall be collected within the subsurface feature to evaluate the presence of potentially explosive vapors, and Cal-OSHA confined space entry requirements shall be followed. Similarly, caution and monitoring shall be undertaken during general excavation activities. Specific vapor monitoring procedures shall be outlined in the Contractor's Health and Safety Plan.

Prior to construction of buildings on the site, the possible presence of methane shall be assessed. If necessary, methane mitigation measures shall be incorporated into the building design.

3.2 UNANTICIPATED SUBSURFACE CONDITIONS

It is possible that unknown, historical subsurface features and structures of potential environmental concern (such as underground vaults or piping) may remain at the site. If present, these structures or features may be encountered during construction or maintenance activities. In addition, chemicals other than those previously identified may be present in site soil. Unanticipated subsurface conditions may include, but not be limited to, the following:

- underground storage tank;
- concrete vault;
- underground piping; and
- other chemical impact, as evidenced by stained soil or odors.

Whenever unanticipated conditions are encountered, the Contractor shall stop work in that area, secure the work area, and evaluate the situation before any further action is taken. Further action may include removal or in-place abandonment of subsurface structures, or characterization and appropriate handling of soil potentially affected by chemicals. Further action will be taken in consultation with appropriate regulatory agencies.

The following provides some general guidelines for addressing below-grade structures.

- The Contractor shall cease work in the area of the below-grade structure and notify the Port or its Consultant if a below-grade structure is discovered. If the structure is of environmental concern (e.g., petroleum-containing UST), the Port will notify the appropriate regulatory agency.
- Residual liquid or sludge, if present in the encountered below-grade structure or pipeline, shall be removed by an appropriately-licensed contractor, placed in sealed storage containers, characterized as required by applicable laws and regulations and by the permitted disposal facility, and appropriately disposed.
- The below-grade structure shall be removed or closed in place as required by applicable laws and regulations. Contaminated soil surrounding the below-grade structure shall be addressed under appropriate regulatory oversight.

4.0 WATER MANAGEMENT ACTIVITIES

Only low concentrations of petroleum hydrocarbons have been detected in groundwater at some locations at the site. However, if construction or maintenance activities require dewatering, the procedures presented below shall be followed.

Construction de-watering water shall be pumped into holding tanks, and the water in the tanks shall be sampled by the Port and analyzed in accordance with characterization requirements for off-site disposal. Water shall be stored on site in accordance with applicable laws and regulations. The water shall be disposed of off site (or treated on site as appropriate) within 90 days of generation and must be properly manifested and transported by a registered transporter under applicable U.S. and California Department of Transportation regulations. Current federal and state requirements shall be reviewed prior to disposal of water. Should long-term dewatering be necessary, the Contractor shall work with the Port to determine disposal options and requirements for additional sampling of water generated during excavation.

5.0 MANAGEMENT OF SMP

This section discusses the responsibilities for managing this SMP and the circumstances under which this SMP may be modified.

5.1 RESPONSIBILITIES

The Port and its Tenant shall oversee implementation of this SMP at the site. In addition, the Port and Tenant shall include a copy of this SMP in all contracts signed with Contractors and shall provide a copy of this SMP to all third party contractors working in the subsurface at the site, such as utility contractors. The Contractor shall be responsible for adhering to this SMP, following project specifications, and job and site safety. The Contractor also is responsible for providing a copy of this SMP to its subcontractors. The Consultant, on behalf of the Port, may observe construction activities but is not responsible for directing/supervising the Contractor’s operations/work.

5.2 MODIFICATIONS OF SMP

This SMP was developed based on AMEC’s understanding of current conditions at the site and applicable regulations. It may be necessary to modify this SMP from time to time for any of several reasons, including:

- change in property use (e.g., addition of buildings to the site);
- change in understanding of environmental conditions (e.g., newly identified chemicals);
- intrusive activity that is not addressed by this SMP;
- new chemical toxicity information for chemicals present at the site, such as lead; or
- new legal requirements.

The Port is responsible for providing a modified SMP to the Water Board when substantial changes to the assumptions or conditions documented in the SMP occur.

6.0 SCOPE, REPRESENTATIONS, AND LIMITATIONS

This SMP was developed exclusively to address lead in soil and petroleum product present in the subsurface at the site. This SMP does not address issues related to other chemicals or media that may be encountered during construction projects, including but not limited to, demolition and construction debris, asphalt, concrete, asbestos-containing materials, and lead-based paint. If such materials are encountered during a construction project, Contractors and workers are responsible for complying with all applicable laws pertaining to the handling and disposal of these materials.

This SMP is based on current known site conditions and current laws, policies, and regulations. No representation is made with respect to future site conditions, other than those specifically identified within this report.

AMEC disclaims any responsibility for any unintended or unauthorized use of this SMP. It is expressly understood that while this SMP is intended to provide guidance and establish a framework for the management of residual product in the subsurface and lead in soil to protect human health and the environment, this SMP shall not create any warranties or obligations to AMEC as to implementation, adequacy, or success of protective measures under this SMP.

7.0 REFERENCES

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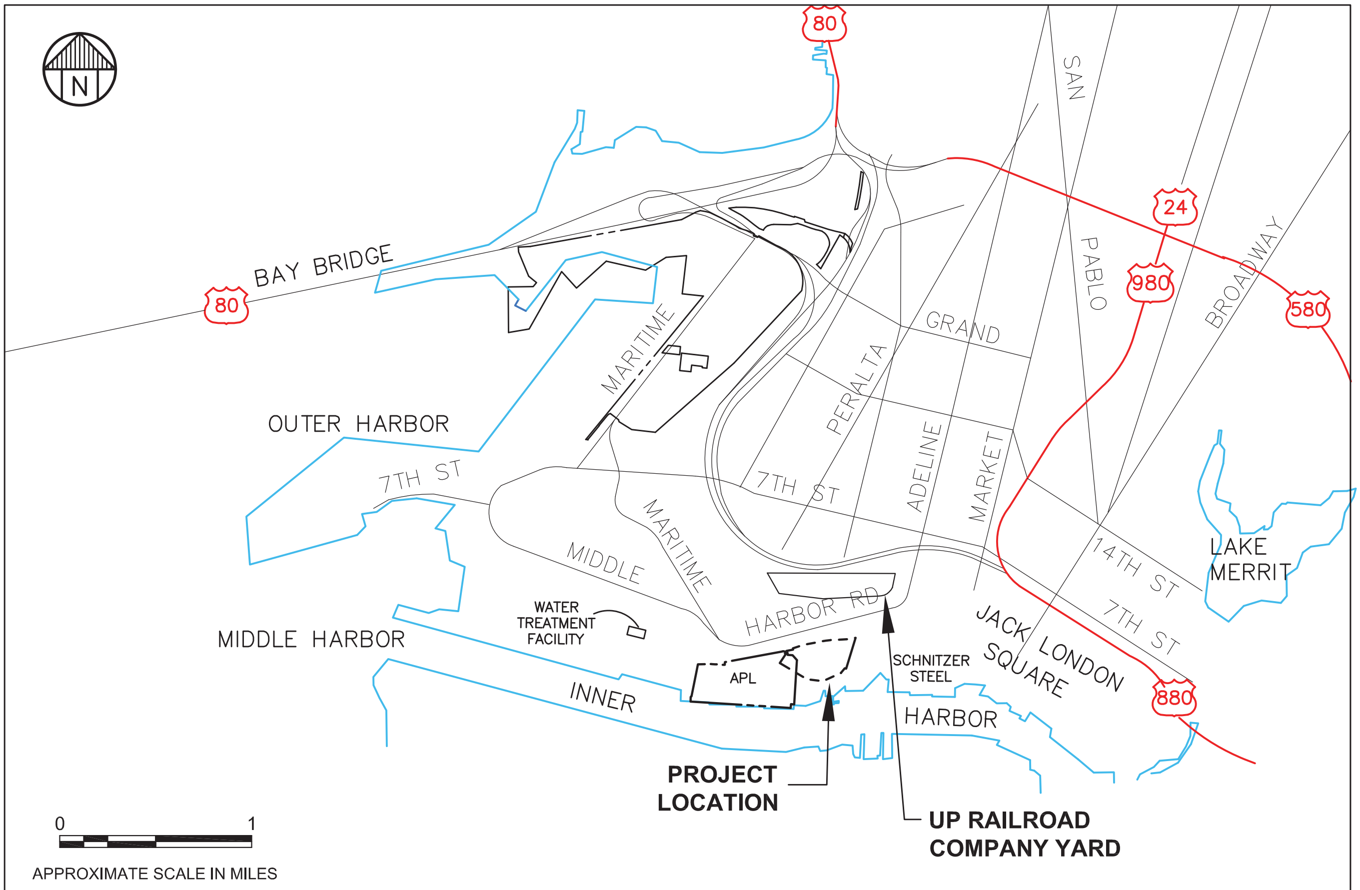
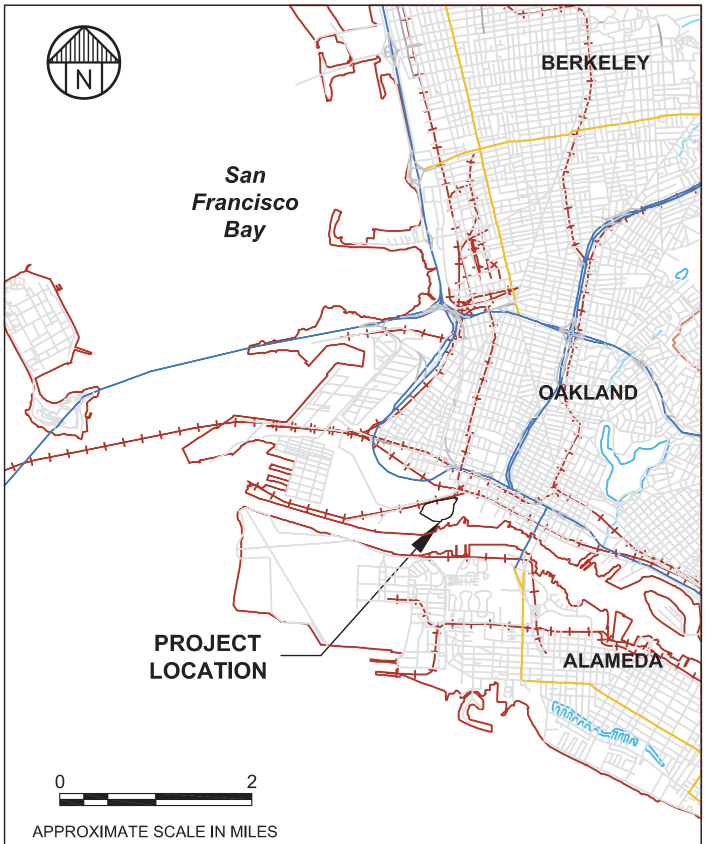
Kleinfelder, Inc., 1999a, Remediation and Risk Management Plan, Former Union Pacific Roundhouse Site, Oakland, California, March 15.

Kleinfelder, Inc., 1999b, Supplement to Remediation and Risk Management Plan, Former Union Pacific Roundhouse Site, 1407 Middle Harbor Road, Oakland, California, June 14.

FIGURES



SITE VICINITY MAP



REGIONAL MAP

REGIONAL AND VICINITY MAPS
Former UP Roundhouse Site
1407 Middle Harbor Road
Oakland, California

By: ---	Date: 12/19/08	Project No. 8207.016
AMEC Geomatrix		Figure 1

Plot Date: 12/19/08 - 10:13am, Plotted by: ann.mcglibery
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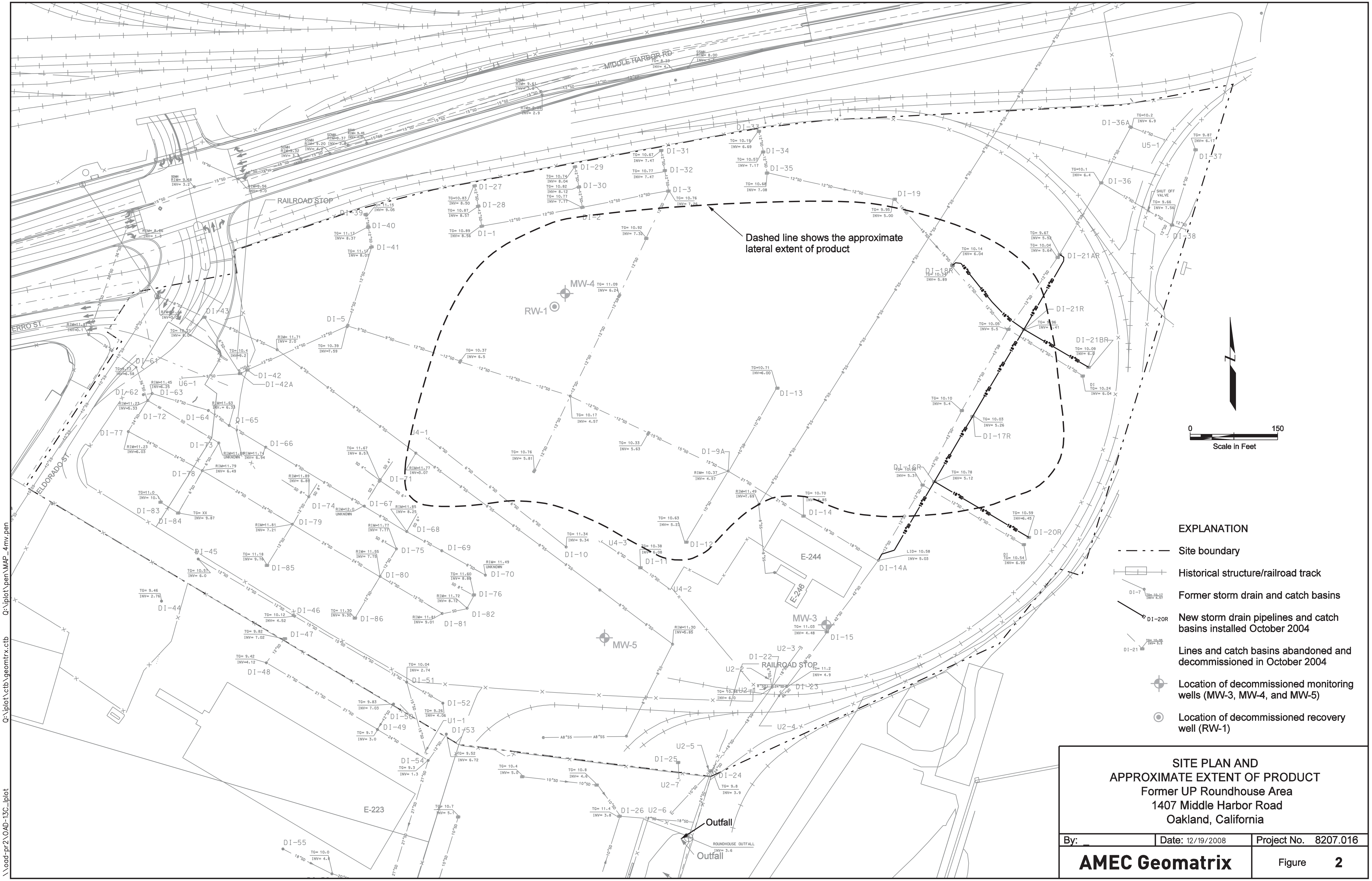

EXPLANATION

- Site boundary
- Historical structure/railroad track
- Former storm drain and catch basins
- New storm drain pipelines and catch basins installed October 2004
- Lines and catch basins abandoned and decommissioned in October 2004
- Location of decommissioned monitoring wells (MW-3, MW-4, and MW-5)
- Location of decommissioned recovery well (RW-1)

SITE PLAN AND
APPROXIMATE EXTENT OF PRODUCT
Former UP Roundhouse Area
1407 Middle Harbor Road
Oakland, California

By: _	Date: 12/19/2008	Project No. 8207.016
AMEC Geomatrix		Figure 2

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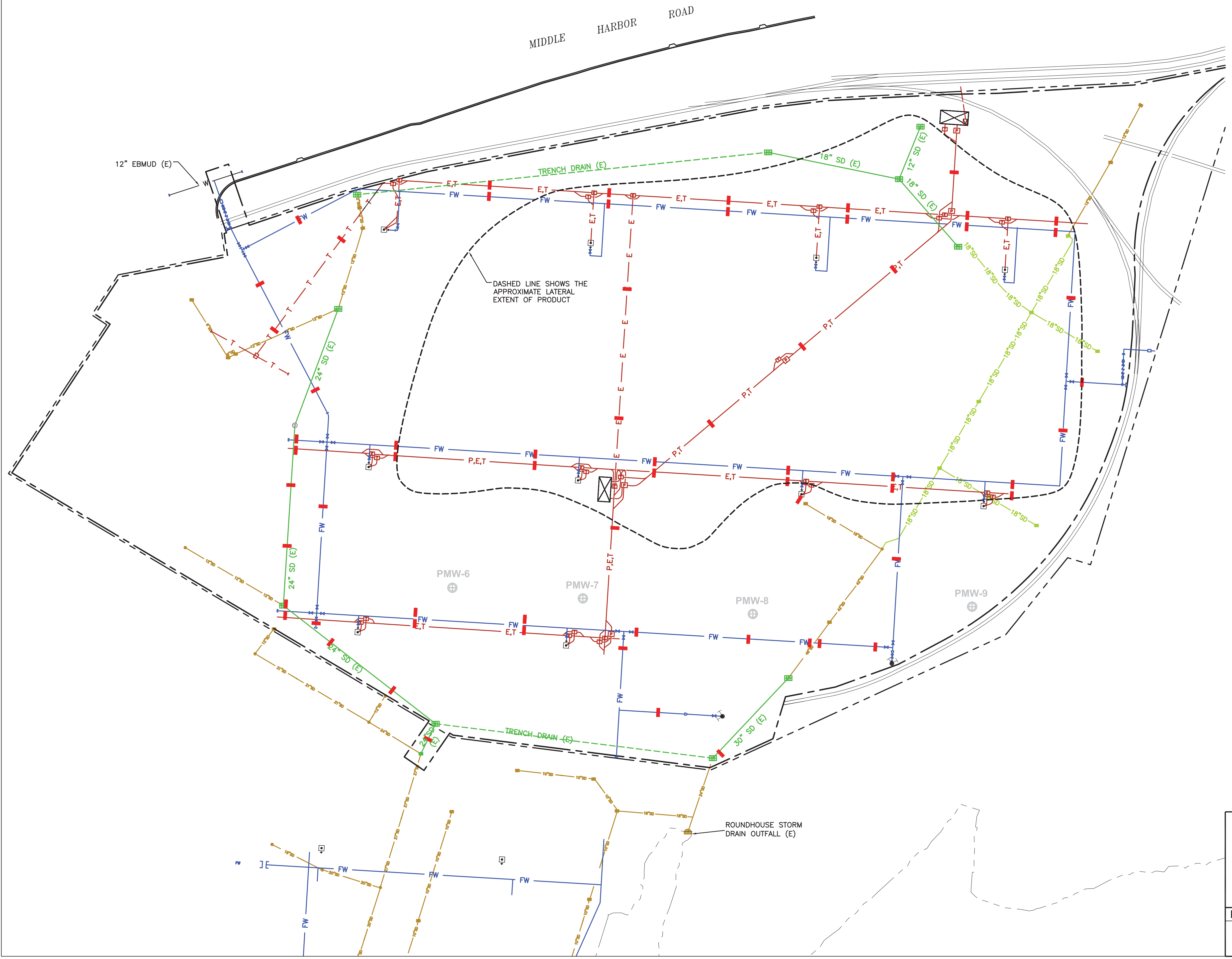

LEGEND

— — —	Limits of site
—P,E,T—	Power, electrical, telecommunication lines - installed 10/05
—FW—	Firewater line - installed 10/05
—SD—	Storm drain - (e)
—SD—	Storm drain - installed 10/04-11/04
—12" SD—	Storm drain - installed 10/05
- - - -	Trench drain - installed 10/05
—▮—	Control density fill backfill barrier
⌒	Approximate extent of product
⊕	Location of decommissioned product monitoring wells

NOTE

1. Actual control density fill barrier locations may vary slightly from locations shown on figure.

APPROXIMATE SCALE IN FEET
0 80 160
0 24 48
APPROXIMATE SCALE IN METERS

LOCATIONS OF REMEDIAL MEASURES AND
DECOMMISSIONED PRODUCT MONITORING
WELL NETWORK
Former UP Roundhouse Site
1407 Middle Harbor Road
Port of Oakland, California

By: ---	Date: 12/19/08	Project No. 8207.016
AMEC Geomatrix		Figure 3

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APPENDIX A

Analytical Testing Results

① 110 FT DIA. TURNTABLE
② ROUNDHOUSE
③ MACHINE SHOP
④ CONC. WASHING STAND
⑤ MOTOR CAR REPAIR

⑦ PAINT AND REPAIR
⑧ PIPING MILL
⑨ PAINT SHOP
⑩ DIESEL LOCOMOTIVE BLDG.
⑪ WASTE HO

⑬ 2,000 GAL TANK
⑭ OIL HOUSE
⑮ 75,000 GAL OIL TANK
⑯ WATER TANK
⑰ SEPARATOR AND SURGE

⑲ 20,000 GAL SETTLING TANK
⑳ OIL TRAP
㉑ HOT WATER TANK
㉒ OIL SUMP
㉓ INCINERATOR (ONE OF TWO)

PORT OF OAKLAND

U.P. ROUNDHOUSE
PHASE II SITE ASSESSMENT

TABLE 1A

UP Roundhouse Phase II Site Assessment

Laboratory Analytical Results-Groundwater, Metals

All results in micrograms per liter (ug/L)

Sample ID	Date	antimony	arsenic	barium	beryllium	cadmium	chromium	cobalt	copper	lead	mercury	molybdenum	nickel	selenium	silver	thallium	vanadium	zinc
3.0	7/30/96	ND	289	12900	6.89	42.4	1060	195	4390	13100	10.9	48.4	2260	ND	35.3	608	1530	8870
4.0	7/31/96	ND	460	6560	51.9	ND	4880	1130	4910	6780	30	ND	5270	ND	75.4	3060	4020	8720
5.0	7/31/96	ND	475	6260	18.2	ND	2070	384	1940	1470	6.76	ND	2200	ND	ND	1280	1680	2290
6.0	7/30/96	644	ND	3150	8.57	19.1	1210	248	11100	67200	7.68	46.2	2270	ND	22.8	719	1970	10200
7.1	7/31/96	ND	7450	5700	16.9	ND	2220	404	1510	707	2.36	ND	2740	ND	ND	1390	1620	2660
8.0	7/30/96	ND	262	3580	7.82	7.43	960	180	1740	9110	8.73	42.4	1070	ND	15.3	691	780	3580

Footnotes

ND=Not Detected

ug/L=micrograms per liter

Sample 1 not collected - no water in boring

Sample 2 not collected - boring terminated due to obstructions

Sample 7.1 contained a separate phase observed as small dark globules

Antimony, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, silver, thallium, vanadium, and zinc analyzed by EPA 6010

Mercury analyzed by EPA 7471

Arsenic analyzed by EPA 7060

Selenium analyzed by EPA 7740

TABLE 1B

UP Roundhouse Phase II Site Assessment

Laboratory Analytical Results-Groundwater, Organics

[illegible] < 3ppm

All results in micrograms per liter (ug/L)

Sample ID	Date	TPH-gas	TPH-diesel	8080	8240	8270
3.0	7/30/96	470	150~~000~~	ND	ND	[1]
4.0	7/31/96	ND	1600	ND	ND	ND
5.0	7/31/96	82	10000	ND	ND	[2]
6.0	7/30/96	ND	22000	ND	ND	[3]
7.1	7/31/96	1,200	800000	ND	ND	[4]
8.0	7/30/96	630	28000	ND	ND	[5]

Footnotes
ND=Not Detected
ug/L=micrograms per liter
Sample 1 not collected - no water in boring
Sample 2 not collected - boring terminated due to obstructions
Sample 7.1 contained a separate phase observed as small dark globules
[1]=12 ug/L phenanthrene
[2]=52 ug/L 2-methylnaphthalene, 11 ug/L acenaphthene, 11 ug/L dibenzofuran, 25 ug/L fluorene, 33 ug/L phenanthrene, 88 ug/L anthracene, 17 ug/L di-n-butylphthalate, 12 ug/L bis(2-ethylhexyl)phthalate
[3]=11 ug/L naphthalene, 12 ug/L 2-methylnaphthalene, 43 ug/L fluoranthene, 55 ug/L pyrene, 12 ug/L benzo(a)anthracene, 17 ug/L chrysene, 13 ug/L benzo(k) fluoranthene, 11 ug/L benzo(a)pyrene
[4]=6,200 ug/L 2-methylnaphthalene, 530 ug/L fluorene, 1,400 ug/L phenanthrene, 74 ug/L pyrene
[5]=11 ug/L naphthalene, 1,200 ug/L 2-methylnaphthalene, 22 ug/l acenaphthene, 58 ug/L phenanthrene, 17 ug/L fluoranthene, 26 ug/L pyrene

TABLE 2A

UP Roundhouse Phase II Site Assessment

Laboratory Analytical Results-Soil, Metals

All results in milligrams per kilogram (mg/kg)

Sample ID	Date	antimony	arsenic	barium	beryllium	cadmium	chromium	cobalt	copper	lead	mercury	molybdenum	nickel	selenium	silver	thallium	vanadium	zinc
1.1 at 5.5	7/30/96	ND	49.1	60.6	0.24	ND	6.37	3.27	35.3	12.6	0.122	ND	4.47	ND	1.02	12.3	9.34	96.8
1.1 at 10	7/30/96	ND	4.78	23.1	0.312	ND	40.3	5.82	140	7.23	0.107	2.39	37.3	ND	ND	33.3	32	86
1.1 at 15	7/30/96	ND	2.61	20.1	0.183	0.667	20.7	13.6	85.1	ND	ND	6.75	37.8	ND	ND	16.9	33.1	56.7
3.0 at 2.5	7/30/96	ND	5.68	54.2	0.186	ND	36.3	7.51	36.1	39	0.28	ND	66.2	ND	ND	26.7	30.6	71.9
3.0 at 4.5	7/30/96	ND	5.27	248	0.244	0.691	47.8	14.2	83.8	82.6	1.19	ND	54.9	ND	0.894	42	42.5	109
3.0 at 10	7/30/96	ND	3.23	132	0.194	ND	58.5	15.3	42.1	7.13	0.0705	ND	52	ND	ND	47.6	45.5	63.8
4.0 at 3	7/31/96	ND	1.4	53.1	0.204	ND	24.5	3.7	15.3	19	0.134	ND	15	ND	ND	14.1	17.7	35.8
4.0 at 5	7/31/96	ND	ND	24.1	0.267	ND	37.1	4.38	30.3	27.7	0.098	ND	29.1	ND	ND	28.9	29	58.1
4.0 at 7.5	7/31/96	ND	1.75	63.1	0.0868	ND	19.2	2.9	14.3	ND	ND	ND	14.4	ND	ND	7.12	11.3	18
4.0 at 9.5	7/31/96	ND	1.16	36.1	0.341	0.439	40.3	6.89	413	51.2	0.312	ND	39.3	ND	ND	31.3	35	191
5.0 at 3	7/31/96	ND	3.83	68.8	0.209	ND	38.2	7.35	37.9	8.13	0.125	ND	54.7	ND	ND	26.4	23.4	53.7
5.0 at 5.5	7/31/96	ND	13.6	66	0.174	ND	44.2	6.67	51	17.7	0.485	ND	43.3	ND	0.555	20.8	22.1	52.8
5.0 at 10	7/31/96	ND	21.6	12.2	0.215	1.11	29	5.33	64.9	6.84	ND	16.9	35.8	ND	ND	22.5	35.3	49.8
6.0 at 3	7/30/96	ND	6.85	136	0.106	0.643	83.2	4.28	136	11200	0.0985	ND	41.2	ND	ND	32.5	46.3	59.3
6.0 at 5	7/30/96	1010	8.19	60.8	0.128	0.552	11.4	3.56	418	13600	0.318	ND	64.8	ND	1.06	31.3	57.9	264
6.0 at 9.5	7/30/96	11.8	2.55	26.5	0.123	ND	30.3	4.4	45.5	259	0.0371	ND	30.1	ND	ND	14.4	22.2	55.1
7.1 at 2.5	7/31/96	ND	16.9	69.4	0.157	ND	16.1	5.02	17.8	6.61	0.0475	ND	18.1	ND	ND	14.7	24.6	31.2
7.1 at 4.5	7/31/96	ND	115	82.2	0.216	ND	44.2	7.9	16.3	8.61	0.101	ND	52	ND	ND	27.2	25.4	38.3
7.1 at 9.5	7/31/96	ND	2.17	18	0.288	ND	39.4	5.33	475	6.69	0.0272	3.09	35.8	ND	ND	29.6	31.6	230
8.0 at 5	7/30/96	ND	4.89	81.6	0.25	ND	63.4	9.8	38	10.3	0.0394	ND	82.4	ND	0.636	35.6	27.1	56.7
8.0 at 10	7/30/96	ND	1.79	35.1	0.176	ND	34.5	4.89	45.3	13.2	0.0702	ND	31.8	ND	ND	21	23	42.4

Footnotes

ND=Not Detected
NA=Not Analyzed
No samples collected at Location 2 due to obstructions during boring operations
mg/l=milligrams per liter
Antimony, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, silver, thallium, vanadium, and zinc analyzed by EPA 6010
Mercury analyzed by EPA 7471
Arsenic analyzed by EPA 7060
Selenium analyzed by EPA 7740

TABLE 2B

UP Roundhouse Phase II Site Assessment
Laboratory Analytical Results-Soil, Organics
All results in milligrams per kilogram (mg/kg)

Sample ID	Date	TPH-gas	TPH-diesel	8080	8150	8240	8270
1.1 at 5.5	7/30/96	ND	8.1	ND	ND	ND	ND
1.1 at 10	7/30/96	ND	18	ND	NA	[1]	ND
1.1 at 15	7/30/96	ND	110	ND	NA	ND	ND
3.0 at 2.5	7/30/96	ND	140	ND	ND	ND	ND
3.0 at 4.5	7/30/96	ND	250	ND	NA	ND	ND
3.0 at 10	7/30/96	ND	160	ND	NA	ND	ND
4.0 at 3	7/31/96	ND	6.4	ND	ND	ND	ND
4.0 at 5	7/31/96	ND	26	ND	NA	ND	ND
4.0 at 7.5	7/31/96	ND	ND	ND	NA	ND	ND
4.0 at 9.5	7/31/96	ND	6.2	ND	NA	[2]	ND
5.0 at 3	7/31/96	ND	16	ND	ND	ND	ND
5.0 at 5.5	7/31/96	12	4800	[3]	NA	[4]	[5]
5.0 at 10	7/31/96	ND	30	ND	NA	[6]	ND
6.0 at 3	7/30/96	ND	330	ND	ND	[7]	ND
6.0 at 5	7/30/96	ND	240	ND	NA	ND	ND
6.0 at 9.5	7/30/96	ND	190	ND	NA	ND	ND
7.1 at 2.5	7/31/96	37	7300	ND	ND	ND	[8]
7.1 at 4.5	7/31/96	84	5300	ND	NA	ND	[9]
7.1 at 9.5	7/31/96	ND	38	ND	NA	[10]	ND
8.0 at 5	7/30/96	81	1800	ND	ND	[11]	[12]
8.0 at 10	7/30/96	29	5000	ND	NA	[13]	[14]

Footnotes ND=Not Detected
NA=Not Analyzed
No samples collected at Location 2 due to obstructions during boring operations
mg/l=milligrams per liter
[1]=0.10 mg/kg acetone
[2]=0.0067 mg/kg carbon disulfide
[3]=0.041 mg/kg PCB-1260
[4]=0.068 mg/kg total xylenes
[5]=5.5 mg/kg 2-methylnaphthalene, 1.6 mg/kg acenaphthene, 2.0 mg/kg dibenzofuran, 5.3 mg/kg fluorene, 9.8 mg/kg phenanthrene, 30 mg/kg anthracene
[6]=0.0082 mg/kg carbon disulfide
[7]=0.19 mg/kg acetone
[8]=26 mg/kg 2-methylnaphthalene, 3.0 mg/kg fluorene, 7.2 mg/kg phenanthrene
[9]=30 mg/kg 2-methylnaphthalene, 0.68 mg/kg acenaphthene, 2.6 mg/kg fluorene, 6.7 mg/kg phenanthrene, 0.57 mg/kg anthracene, 0.36 mg/kg pyrene
[10]=0.0072 mg/kg carbon disulfide
[11]=0.096 mg/kg total xylenes
[12]=50 mg/kg 2-methylnaphthalene, 0.43 mg/kg acenaphthene, 8.5 mg/kg phenanthrene, 0.76 mg/kg pyrene
[13]=0.13 mg/kg total xylenes
[14]=9.4 mg/kg 2-methylnaphthalene, 0.66 mg/kg phenanthrene

Compound	Det Limit (ug/L)	SG-1	SG-2	SG-3	SG-4	SG-5	SG-6	SG-7	SG-8	SG-9	SG-10	SG-11
carbon tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichloromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	0.1	ND	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
acetone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
toluene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-/p-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cyclohexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 3 Soil Gas Analytical

Compound	Det Limit (ug/L)	SG-12	SG-13	SG-14	SG-15	SG-16	SG-17	SG-18	SG-19	SG-20	SG-21	SG-22
carbon tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichloromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
acetone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
toluene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-/p-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cyclohexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	Det Limit (ug/L)	SG-23	SG-24	SG-25	SG-26	SG-27	SG-28	SG-29	SG-30	SG-31	SG-32	SG-33
carbon tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichloromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
acetone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
toluene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-/p-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cyclohexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	Det Limit (ug/L)	SG-34	SG-35	SG-36	SG-37	SG-38	SG-39	SG-40	SG-41	SG-42
carbon tetrachloride	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	1.0	NA	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	1.0	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-dichloroethene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
dichlorofluoromethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
dichloromethane	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-tetrachloroethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
trichloro-trifluoroethane	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	1.0	NA	ND	ND	ND	ND	ND	ND	ND	ND
acetone	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
toluene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
m-/p-xylene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
o-xylene	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
cyclohexane	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone	0.5	NA	ND	ND	ND	ND	ND	ND	ND	ND

SOIL GAS SAMPLE RESULTS

E NAME: Union Pacific Yard - Port of Oakland
LAB NAME: Optimal Technology Inc.
DATE: 8-13 to 8-15-96
ALYST: Timothy L. Thelsen
INSTRUMENT ID: HP5890-2
LLECTOR: Timothy L. Theisen
DETECTORS: ECD and PID
PAGE: 1 of 6

ple ID	N/A	BLANK	SG-1	SG-2	SG-3	SG-3 DUP	SG-4	SG-5	SG-6	BLANK	SG-7
pling Depth (ft.)	N/A	NA	3.5	3.5	3.5	3.5	3.5	3.5	3.5	NA	3.5
Volume (ml)	N/A	NA	1,000	1,000	1,000	1,000	1,000	1,000	1,000	NA	1,000
um (in. of Water)	N/A	NA	0	0	0	0	0	0	0	NA	0
tion Volume PID/ECD	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500
on Factor PID/ECD	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
on Tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
oethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
oform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
-1,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
orofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
oromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
-Trichloroethane	0.1	ND	ND	ND	1.6	1.5	ND	ND	ND	ND	ND
-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
oroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
orofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
oro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
one	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ne	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
obenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
anone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
thyl-2-Pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Unknown Mix Area)	N/A	ND	*332,000	*707,000	ND	ND	ND	*163,000	ND	ND	*1,115,000

SOIL GAS SAMPLE RESULTS

TE NAME: Union Pacific Yard - Port of Oakland
LAB NAME: Optimal Technology Inc.
DATE: 8-13 to 8-15-96
JALYST: Timothy L. Theisen
INSTRUMENT ID: HP5890-2
)LLECTOR: Timothy L. Theisen
DETECTORS: ECD and PID
PAGE: 2 of 6

ple ID	N/A	SG-8	SG-9	SG-10	SG-11	SG-12	SG-13	SG-14	SG-15	BLANK	SG-16
pling Depth (ft.)	N/A	3.5	3.5	3.5	3.5	3.5	3.0	3.5	3.5	NA	4.0
e Volume (ml)	N/A	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	NA	1,000
uum (in. of Water)	N/A	0	0	0	25	0	20	0	0	NA	10
ction Volume PID/ECD	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500
tion Factor PID/ECD	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
on Tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
s-1,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
achloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
on	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
en	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ne	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
obenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
anone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
thyl-2-Pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Unknown Mix Area)	N/A	*659,000	*1,298,000	ND	ND	*40,000	ND	ND	ND	ND	ND

SOIL GAS SAMPLE RESULTS

TE NAME: Union Pacific Yard - Port of Oakland

IALYST: Timothy L. Theisen

LLECTOR: Timothy L. Theisen

LAB NAME: Optimal Technology Inc.

INSTRUMENT ID: HP5890-2

DETECTORS: ECD and PID

DATE: 8-13 to 8-15-96

PAGE: 3 of 6

ple ID	N/A	SG-17	SG-18	SG-19	SG-19 DUP	SG-20	SG-21	SG-22	SG-23	SG-24	BLANK
pling Depth (ft.)	N/A	3.5	3.5	3.0	3.0	3.5	3.0	3.5	3.5	3.5	NA
e Volume (ml)	N/A	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	NA
uum (In. of Water)	N/A	0	15	0	0	0	10	0	10	0	NA
tion Volume PID/ECD	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500
lon Factor PID/ECD	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
on Tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
s-1,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
achloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
on	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
robenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
-Xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
tanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethyl-2-Pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
H (Unknown Mix Area)	N/A	ND	ND	*1,677,000	*1,625,000	*1,223,000	ND	ND	ND	ND	ND

SOIL GAS SAMPLE RESULTS

TE NAME: Union Pacific Yard - Port of Oakland
NALYST: Timothy L. Thelsen
OLLECTOR: Timothy L. Thelsen

LAB NAME: Optimal Technology Inc.
INSTRUMENT ID: HP5890-2
DETECTORS: ECD and PID

DATE: 8-13 to 8-15-96
PAGE: 4 of 6

nple ID	N/A	SG-25	BLANK	SG-26	SG-27	BLANK	SG-28	SG-29	SG-30	BLANK	SG-31
npling Depth (ft.)	N/A	3.5	NA	3.5	3.5	NA	3.5	3.5	3.5	NA	3.5
ge Volume (ml)	N/A	1,000	NA	1,000	1,000	NA	1,000	1,000	1,000	NA	1,000
uum (in. of Water)	N/A	0	NA	30	0	NA	55	0	0	NA	0
ction Volume PID/ECD	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500	500/500
tion Factor PID/ECD	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
on Tetrachloride	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
roform	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
s-1,2-Dichloroethene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loromethane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
achloroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-Tetrachloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Trichloroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loroethene	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
loro-trifluoroethane	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
one	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ne	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
obenzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexane	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
anone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
thyl-2-Pentanone	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Unknown Mix Area)	N/A	ND	ND	*79,000	ND	ND	ND	ND	ND	ND	*540,000

SOIL GAS SAMPLE RESULTS

TE NAME: Union Pacific Yard - Port of Oakland
LAB NAME: Optimal Technology Inc.
DATE: 8-13 to 8-15-96
NALYST: Timothy L. Theisen
INSTRUMENT ID: HP5890-2
OLLECTOR: Timothy L. Theisen
DETECTORS: ECD and PID
PAGE: 5 of 6

nple ID	N/A	SG-32	SG-32-DUP	SG-33	SG-34	SG-35	SG-36	SG-37	SG-38	SG-39	SG-39-DUP
npling Depth (ft.)	N/A	3.5	3.5	3.5	NS	3.5	3.5	3.5	3.5	3.5	3.5
ge Volume (ml)	N/A	1,000	1,000	1,000	NS	1,000	1,000	1,000	1,000	1,000	1,000
uum (in. of Water)	N/A	0	0	0	NS	0	0	0	40	0	0
ction Volume PID/ECD	500/500	500/500	500/500	500/500	NS	500/500	500/500	500/500	500/500	500/500	500/500
tion Factor PID/ECD	1/1	1/1	1/1	1/1	NS	1/1	1/1	1/1	1/1	1/1	1/1

COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
bon Tetrachloride	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
roethane	1.0	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
roform	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
Dichloroethane	1.0	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
Dichloroethane	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
Dichloroethene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
s-1,2-Dichloroethene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
loromethane	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
achloroethene	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
1,2-Tetrachloroethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
2,2-Tetrachloroethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
1-Trichloroethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
2-Trichloroethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
loroethene	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
lorofluoromethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
loro-trifluoroethane	0.1	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
l Chloride	1.0	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
one	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
ene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
robenzene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
lbenzene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
-Xylene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
lene	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
ohexane	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
tanone	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
thyl-2-Pentanone	0.5	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
(Unknown Mix Area)	N/A	ND	ND	*188,000	NS	ND	ND	ND	ND	ND	ND

SOIL GAS SAMPLE RESULTS

TE NAME: Union Pacific Yard - Port of Oakland
LAB NAME: Optimal Technology Inc.
DATE: 8-13 to 8-15-96
NALYST: Timothy L. Theisen
INSTRUMENT ID: HP5890-2
OLLECTOR: Timothy L. Theisen
DETECTORS: ECD and PID
PAGE: 6 of 6

nple ID	N/A	SG-40	SG-41	SG-42							
npling Depth (ft.)	N/A	3.5	3.5	3.5							
ge Volume (ml)	N/A	1,000	1,000	1,000							
uum (In. of Water)	N/A	0	0	0							
ction Volume PID/ECD	500/500	500/500	500/500	500/500							
tion Factor PID/ECD	1/1	1/1	1/1	1/1							

COMPOUND	DET. LIMIT	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)	CONC. (ug/L)
bon Tetrachloride	0.1	ND	ND	ND							
roethane	1.0	ND	ND	ND							
roform	0.1	ND	ND	ND							
Dichloroethane	1.0	ND	ND	ND							
Dichloroethane	0.5	ND	ND	ND							
Dichloroethene	0.5	ND	ND	ND							
1,2-Dichloroethene	0.5	ND	ND	ND							
s-1,2-Dichloroethene	0.5	ND	ND	ND							
lorofluoromethane	0.1	ND	ND	ND							
loromethane	0.5	ND	ND	ND							
achloroethene	0.1	ND	ND	ND							
1,2-Tetrachloroethane	0.1	ND	ND	ND							
2,2-Tetrachloroethane	0.1	ND	ND	ND							
1-Trichloroethane	0.1	ND	ND	ND							
2-Trichloroethane	0.1	ND	ND	ND							
loroethene	0.1	ND	ND	ND							
lorofluoromethane	0.1	ND	ND	ND							
loro-trifluoroethane	0.1	ND	ND	ND							
l Chloride	1.0	ND	ND	ND							
tone	0.5	ND	ND	ND							
zene	0.5	ND	ND	ND							
ene	0.5	ND	ND	ND							
robenzene	0.5	ND	ND	ND							
lbenzene	0.5	ND	ND	ND							
-Xylene	0.5	ND	ND	ND							
lene	0.5	ND	ND	ND							
ohexane	0.5	ND	ND	ND							
tanone	0.5	ND	ND	ND							
ethyl-2-Pentanone	0.5	ND	ND	ND							
[illegible]	N/A	ND	ND	[illegible]							

ATTACHMENT 2

Table 1-UP Roundhouse Phase II Task 3 Site Assessment

Laboratory Analytical Results-Soil

All results in milligrams per kilogram (mg/kg)

Sample ID	Date	TPH-Diesel	TPH-Bunker C	lead	chromium +6	Napthlalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	PLyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benao(k)fluoranthene	Benzo(a)pyrene	Dibenz(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
9 @3	11/13/96	14000	ND	ND	ND	ND	ND	ND	8.8	13000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9 @5	11/13/96	690	ND	37.2	ND	ND	ND	ND	0.65	0.93	ß	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9 @8	11/13/96	21	ND	8.07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9 @12	11/13/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10 @ 3	11/11/96	ND	540	40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10 @ 5	11/11/96	18	ND	8.52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10 @ 10	11/11/96	18	ND	5.55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10 @ 14.5	11/11/96	21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11 at 1.5	11/11/96	3800	ND	9.14	ND	ND	ND	ND	4.9	8.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11 at 5.5	11/11/96	120	550	6.61	ND	ND	ND	ND	0.04	0.091	0.075	0.48	0.65	0.19	ND	0.29	0.11	0.45	ND	0.39	0.35
11 at 9.5	11/11/96	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11 at 10.5	11/11/96	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11 @ 14.5	11/11/96	22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12 @ 3	11/13/96	3500	ND	78.7	ND	ND	ND	ND	1.2	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12 @ 5	11/13/96	4300	ND	497	ND	ND	ND	ND	3.8	7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12 @ 8	11/13/96	38	ND	ND	ND	ND	ND	0.25	0.18	0.78	1.6	0.45	0.38	0.075	ND	0.048	0.028	0.049	ND	0.04	ND
12 @ 12.5	11/13/96	36	ND	ND	ND	ND	ND	ND	ND	ND	0.033	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13 @ 2.5	11/12/96	79	350	6.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13 @ 5.5	11/12/96	8300	ND	10.4	ND	ND	ND	ND	7	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13 @ 8.5	11/12/96	53	210	10.2	ND	ND	ND	ND	ND	0.05	0.035	0.3	0.38	0.098	0.18	0.21	0.072	0.26	ND	0.25	0.19
13 @ 12.5	11/12/96	ND	ND	4.94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14 @ 2.5	11/12/96	ND	130	16.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14 @ 5	11/12/96	3100	ND	23.5	ND	ND	ND	ND	1.8	2.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14 @ 8.5	11/12/96	ND	ND	11.7	ND	ND	ND	ND	ND	0.036	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14 @ 12.5	11/12/96	ND	ND	10.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14 @ 14	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15 @ 2.5	11/13/96	1300	ND	33.1	ND	ND	ND	ND	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15 @ 4.5	11/13/96	1500	ND	60.4	ND	ND	ND	ND	0.068	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 1-UP Roundhouse Phase II Task 3 Site Assessment

Laboratory Analytical Results-Soil

All results in milligrams per kilogram (mg/kg)

Sample ID	Date	TPH-Diesel	TPH-Bunker C	lead	chromium +6	Napthlalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	PLyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benao(k)fluoranthene	Benzo(a)pyrene	Dibenz(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
15 @ 8	11/13/96	ND	17	4.91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15 @ 12.5	11/13/96	29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16 @ 2.5	11/12/96	12000	ND	448	ND	ND	ND	ND	11	27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16 @ 5	11/12/96	2800	11000	8.6	ND	ND	ND	0.34	1.2	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16 @ 8.5	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16 @ 12.5	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16 @ 14.5	11/12/96	ND	ND	6.96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 @ 3	11/11/96	9100	ND	12.7	ND	ND	ND	ND	4.2	8.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 @ 5	11/11/96	13000	ND	34.6	ND	ND	ND	ND	13	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 @ 8.5	11/11/96	26	ND	83.5	ND	ND	ND	ND	13	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 @ 12.5	11/11/96	ND	ND	4.85	ND	ND	ND	ND	13	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 @ 14	11/11/96	ND	ND	4.56	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18 @ 3	11/12/96	ND	620	981	ND	ND	ND	ND	ND	0.26	ND	0.3	0.26	ND	ND	0.28	ND	0.23	ND	ND	0.29
18 @ 5.5	11/12/96	ND	ND	4.09	ND	ND	ND	ND	ND	0.018	ND	ND	0.017	ND	ND	ND	ND	0.02	ND	ND	0.024
18 @ 7.5	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18 @ 13	11/12/96	ND	80	9.49	ND	ND	ND	ND	0.055	0.16	ND	0.17	0.13	0.021	ND	0.019	ND	0.018	ND	ND	ND
18 @ 14	11/12/96	ND	54	8.53	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19 @ 2.5	11/11/96	17	ND	13.6	ND	ND	ND	ND	ND	0.019	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19 @ 5	11/11/96	22	ND	3.79	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19 @ 8.5	11/11/96	23	ND	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19 @ 12.5	11/11/96	19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20 @ 3	11/11/96	ND	310	13.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.092	ND	ND	ND	ND	ND
20 @ 5	11/11/96	ND	1900	23.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20 @ 9.5	11/11/96	23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20 @ 14	11/11/96	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Footnotes

ND=Not Detected
mg/l=milligrams per liter
[1]=The result for Bunker C is elevated due to the presence of diesel

ATTACHMENT 2

Table 2-UP Roundhouse Phase II Task 3 Site Assessment

Laboratory Analytical Results-Water

All results in micrograms per Liter (μg/L) u.o.n.

Sample ID	Date	TPH-Diesel (mg/L)	TPH-Bunker C (mg/L)	Lead	chromium +6 (mg/L)	Napthlalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	PLyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benao(k)fluoranthene	Benzo(a)pyrene	Dibenz(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
9	11/13/96	0.4	ND	ND	0.0636	ND	ND	ND	2.7	ND	ND	0.088	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	11/11/96	ND	ND	ND	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	11/13/96	1.3	ND	5600	ND	ND	ND	27	29	33	33	12	8.5	1.3	4.3	0.79	ND	0.78	ND	ND	ND
13	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18	11/12/96	0.3	ND	358	ND	10	ND	8.9	8.9	8.6	0.91	0.4	0.24	ND	ND	ND	ND	ND	ND	ND	ND
20	11/11/96	ND	ND	0.18	ND	ND	ND	ND	0.17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Footnotes

ND=Not Detected
mg/L=milligrams per liter
u.o.n. = unless otherwise noted
All water samples were filtered by Pace

Table 3. Analytical Results of Reconnaissance Groundwater Samples
Supplemental Remedial Investigation
Former U.P. Roundhouse
Port of Oakland
Oakland, California

Boring	TPH-d [1] (mg/L) unfiltered	TPH-d [2] (mg/L) filtered	TDS (mg/L)	Pb (mg/L)	Sb (mg/L)
K1B	24	0.20 Y	--	--	--
K2B	64	0.97 Y	--	--	--
K3B	9.4	0.97 Y	--	--	--
K4	140	0.94 Y	--	--	--
K5	2.1	0.46 Y	--	--	--
K6	<0.05	<0.064	4,100	--	--
K7	95	0.56 Y	--	--	--
K8	<0.05	0.054	--	<0.003	--
K9	<0.05	<0.094	--	<0.003	<0.060
K10	--	--	--	<0.003	--

Notes:

TPH-d [1]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with silica gel cleanup.
TPH-d [2]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with 0.7-micron glass fiber filtering and silica gel cleanup.
TDS	Total dissolved solids; EPA Method 160.1
Pb	Lead; EPA Method 6010
Sb	Antimony; EPA Method 6010
mg/L	Milligrams per liter
Y	Sample exhibits fuel pattern which does not resemble standard.
--	Not analyzed

Table 4. Analytical Results from Monitoring Well Sampling, July 1998
Supplemental Remedial Investigation
Former U.P. Roundhouse
Port of Oakland
Oakland, California

Boring	TPH-d [1] (mg/L) unfiltered	TPH-d [2] (mg/L) filtered	BTEX (mg/L)	TDS (mg/L)	Pb (mg/L)	pH SU
MW3	<0.05	<0.05	<0.0005	1760	<0.003	7.1
dup	--	--	<0.0005	--	--	--
MW4	8.2	1.8 Y	--	600	<0.003	6.7

Notes:

TPH-d [1]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with silica gel cleanup.
TPH-d [2]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with 0.7-micron glass fiber filtering and silica gel cleanup.
BTEX	Benzene, toluene, ethylbenzene, xylenes; EPA Method 8021B
TDS	Total dissolved solids; EPA Method 160.1
Pb	Lead; EPA Method 6010
pH	Hydrogen ion index; EPA Method 150.1
mg/L	Milligrams per liter
SU	Standard units
Y	Sample exhibits fuel pattern which does not resemble standard.
--	Not analyzed
dup	Duplicate

Table 2. Analytical Results from Monitoring Well Sampling, January 13 and 14, 1999
Former UP Roundhouse Site
Port of Oakland
Oakland, California

Boring	TPH-d [1] (mg/L) unfiltered	TPH-d [2] (mg/L) filtered	BTEX (mg/L)	TDS (mg/L)	Pb (mg/L)	pH SU
MW-3	<0.05	<0.05	<0.001	1,620	0.003	7.2
MW-4	85	1.5	<0.001	900	<0.003	6.7
MW-4 dup.	100	1.5	<0.001	920	<0.003	6.8

Notes:

TPH-d [1]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with silica gel cleanup.
TPH-d [2]	Total petroleum hydrocarbons quantified as diesel (extractables); modified EPA Method 8015 with 0.7-micron glass fiber filtering and silica gel cleanup.
BTEX	Benzene, toluene, ethylbenzene, xylenes; EPA Method 8260
TDS	Total dissolved solids; EPA Method 160.1
Pb	Lead; EPA Method 6010
pH	Hydrogen ion index; EPA Method 150.1
mg/L	Milligrams per liter
SU	Standard units
Y	Sample exhibits fuel pattern which does not resemble standard.
--	Not analyzed
dup.	Duplicate sample

TABLE 1
ANALYTICAL RESULTS OF SOIL GAS SAMPLING FORMER UNION PACIFIC ROUNDHOUSE SITE OAKLAND, CALIFORNIA

Soil Gas Probe	Methane (%)	Oxygen (%)	Nitrogen (%)	Carbon dioxide (%)
KG-1	3.0	14	80	2.5
KG-2	23	14	57	5.7
KG-3	27	7.4	58	7.6
KG-4	6.9	19	73	1.1
KG-4 (duplicate)	6.8	18	74	1.1
KG-5	<0.001	21	79	0.049
KG-6	7.9	16	74	2.2
KG-7	3.7	13	80	2.8
KG-8	<0.001	20	80	0.047
KG-9	<0.001	20	80	0.2
KG-10	0.005	19	80	1.0
KG-11	<0.001	21	79	0.047

Notes

Samples collected January 14, 1999.

Analyzed by ASTM D-1945.

SUMMARY OF LABORATORY ANALYTICAL RESULTS FOR SOIL SAMPLES [1]

Former UP Roundhouse Site
1407 Middle Harbor Road
Oakland, California

Boring	Date Sampled	Sample Identification	Depth (ft bgs)	TPHd (mg/kg)	TPHmo (mg/kg)
B-1	3/31/2005	B-1-3.0	3.0	8.0 HY	19
		B-1-5.0	5.0	2.0 HY	7
B-2	3/31/2005	B-2-2.5	2.5	3,500 HY	15,000
		B-2-5.0	5.0	960 HY	4,000
B-3	4/7/2005	B-3-3.5	3.5	1.5 HY	5.9
		B-3-7.5	7.5	23 HY	52 L
B-4	4/7/2005	B-4-4.5	4.5	2.3 HY	9.9
		B-4-7.0	7.0	1.3 HY	<5.2
B-5	4/7/2005	B-5-4.5	4.5	<1.0	<5.0
		B-5-7.5	7.5	63 HY	230
B-6	4/7/2005	B-6-4.5	4.5	70 HY	270
		B-6-6.5	6.5	8.2 HY	25
B-7	4/7/2005	B-7-5.5	5.5	1.1 HY	<5.0
B-9	4/7/2005	B-9-3.0	3.0	370 HY	4,100
		B-9-5.0	5.0	8.7 HY	16 L
B-10	4/7/2005	B-10-3.0	3.0	17 HY	71 L
		B-10-5.0	5.0	2.0 HY	13
B-11	4/8/2005	B-11-3.0	3.0	5.8 HY	16
		B-11-5.0	5.0	<1.0	<5.0
B-12	4/8/2005	B-12-5.0	5.0	160 HY	760

Notes:

[1] Samples collected by Geomatrix Consultants, Inc. and analyzed at Curtis & Tompkins, Ltd., a California-certified analytical laboratory located in Berkeley, California

Abbreviations:

TPHd = Total petroleum hydrocarbons quantified as diesel using U.S. Environmental Protection Agency (EPA) Method 8015B
TPHmo = Total petroleum hydrocarbons quantified as motor oil using EPA Method 8015B
ft bgs = depth measured in feet below the surrounding ground surface
mg/kg = concentrations reported in milligrams per kilogram
< = target analyte not detected at or above the laboratory reporting limit shown.
H = Result qualified by the analytical laboratory; heavier hydrocarbons contributed to the quantitation
Y = Result qualified by the analytical laboratory; lighter hydrocarbons contributed to the quantitation
S = Result qualified by the analytical laboratory; sample exhibits chromatographic pattern which does not resemble standard

SUMMARY OF LABORATORY ANALYTICAL RESULTS FOR GRAB GROUNDWATER SAMPLES [1]

Former UP Roundhouse Site
1407 Middle Harbor Road
Oakland, California

Boring	Sample Identification	Date Sampled	TPHd (µg/L)	TPHmo (µg/L)	BTEX (µg/L)	VOCs (µg/L)	SVOCs[2] (µg/L)	PAHs (µg/L)	TDS (mg/L)
B-1	B-1-033105	3/31/2005	71 Y	<300	ND (<0.50)	--	ND (<9.3 to <46)	ND (<0.95)	1,360
B-2	B-2-033105	3/31/2005	1000 HY	320 LY	ND (<0.50)	--	ND (<9.6 to <48)	ND (<4.9)	770
B-3	B-3-0405	4/7/2005	<50	<300	--	ND (<0.5 to <10)	ND (<9.6 to <48)	ND (<0.98)	590
B-4	B-4-0405	4/7/2005	<50	<300	--	ND (<0.5 to <10)	ND (<9.6 to <48)	ND (<1.0)	4,000
B-5	B-5-0405	4/7/2005	<50	<300	--	ND (<0.5 to <10)	ND (<9.6 to <48)	ND (<0.95)	550
B-6	B-6-0405	4/7/2005	<50	<300	ND (<0.50)	--	ND (<9.5 to <48)	ND (<0.96)	1,580
dup	B-60-0405	4/7/2005	<50	<300	ND (<0.50)	--	ND (<9.6 to <48)	ND (<0.97)	2,020
B-7	B-7-0405	4/7/2005	<50	<300	ND (<0.50)	--	ND (<9.4 to <47)	ND (<0.98)	240
B-8	B-8-0405	4/7/2005	<50	<300	ND (<0.50)	--	ND (<9.6 to <48)	ND (<0.95)	2,260
B-9	B-9-0405	4/7/2005	74 Y	<300	ND (<0.50)	--	ND (<9.9 to <50)	ND (<1.0)	670
B-10	B-10-0405	4/7/2005	<50	<300	ND (<0.50)	--	ND (<9.9 to <50)	ND (<1.2)	340
B-11	B-11-0405	4/8/2005	<50	<300	ND (<0.50)	--	ND (<10 to <50)	ND (<1.3)	860
B-12	B-12-0405	4/8/2005	<50	<300	ND (<0.50)	--	ND (<11 to <56)	ND (<1.0)	490

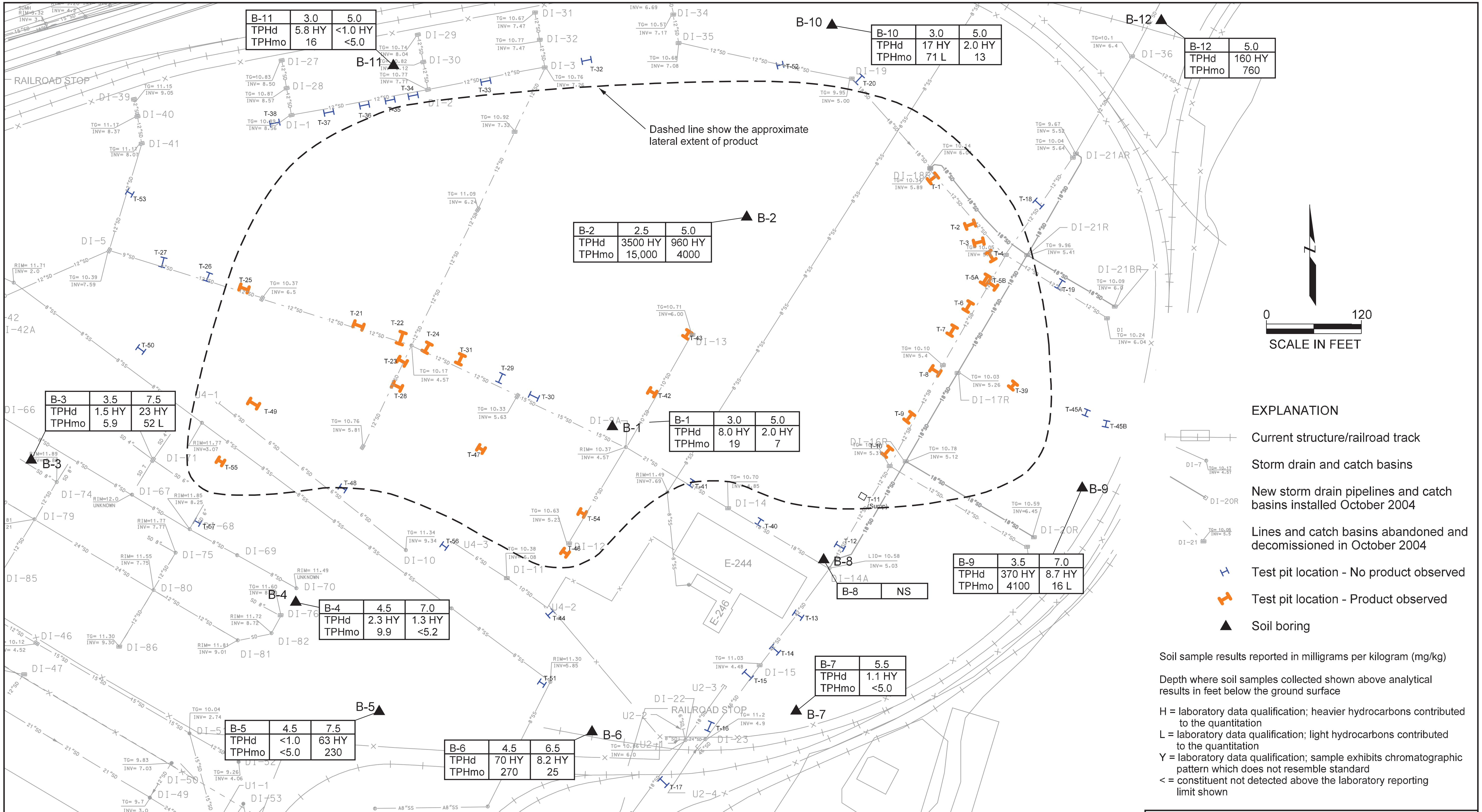
Notes:

[1] Samples collected by Geomatrix Consultants, Inc. and analyzed at Curtis & Tompkins, Ltd., a California-certified analytical laboratory located in Berkeley, California

[2] SVOCs analyzed outside of sample holding time. Results should be considered approximate.

Abbreviations:

TPHd = Total petroleum hydrocarbons quantified as diesel using U.S. Environmental Protection Agency (EPA) Method 8015B after silica gel preparation (EPA Method 3630C) and filtration through a 0.7-micron, glass fiber filter.
TPHmo = Total petroleum hydrocarbons quantified as motor oil using EPA Method 8015B after silica gel preparation (EPA Method 3630C) and filtration through a 0.7-micron, glass fiber filter.
BTEX = Benzene, toluene, ethylbenzene, and total xylenes using EPA Method 8021B analysis
VOCs = volatile organic compounds (including BTEX) using EPA Method 8260B
SVOCs = Semi-Volatile Organic Compounds using EPA Method 8270 following filtration through 0.7-micron, glass fiber filter
PAHs = polycyclic aromatic hydrocarbons using EPA Method 8270 SIM following filtration through 0.7-micron, glass fiber filter
TDS = Total dissolved solids using EPA Method 160.1
µg/L = concentrations reported in micrograms per liter
mg/L = concentrations reported in milligrams per liter
ND = target analytes not detected at or above laboratory reporting limit, or range limit range, shown in parentheses.
< = target analyte not detected at or above the laboratory reporting limit shown.



Dashed line show the approximate lateral extent of product

B-11	3.0	5.0
TPHd	5.8 HY	<1.0 HY
TPHmo	16	<5.0

B-10	3.0	5.0
TPHd	17 HY	2.0 HY
TPHmo	71 L	13

B-12	5.0
TPHd	160 HY
TPHmo	760

B-2	2.5	5.0
TPHd	3500 HY	960 HY
TPHmo	15,000	4000

B-3	3.5	7.5
TPHd	1.5 HY	23 HY
TPHmo	5.9	52 L

B-1	3.0	5.0
TPHd	8.0 HY	2.0 HY
TPHmo	19	7

B-9	3.5	7.0
TPHd	370 HY	8.7 HY
TPHmo	4100	16 L

B-8	NS

B-4	4.5	7.0
TPHd	2.3 HY	1.3 HY
TPHmo	9.9	<5.2

B-7	5.5
TPHd	1.1 HY
TPHmo	<5.0

B-5	4.5	7.5
TPHd	<1.0	63 HY
TPHmo	<5.0	230

B-6	4.5	6.5
TPHd	70 HY	8.2 HY
TPHmo	270	25

EXPLANATION

- Current structure/railroad track
- Storm drain and catch basins
- New storm drain pipelines and catch basins installed October 2004
- Lines and catch basins abandoned and decomissioned in October 2004
- Test pit location - No product observed
- Test pit location - Product observed
- ▲ Soil boring

Soil sample results reported in milligrams per kilogram (mg/kg)

Depth where soil samples collected shown above analytical results in feet below the ground surface

H = laboratory data qualification; heavier hydrocarbons contributed to the quantitation
L = laboratory data qualification; light hydrocarbons contributed to the quantitation
Y = laboratory data qualification; sample exhibits chromatographic pattern which does not resemble standard
< = constituent not detected above the laboratory reporting limit shown

APPROXIMATE EXTENT OF PRODUCT RESULTS OF SOIL SAMPLING AND TEST PIT OBSERVATIONS

Former UP Roundhouse Site
1407 Middle Harbor Road
Port of Oakland, California

GEOMATRIX

Project No.	Figure
8207.012.3	3

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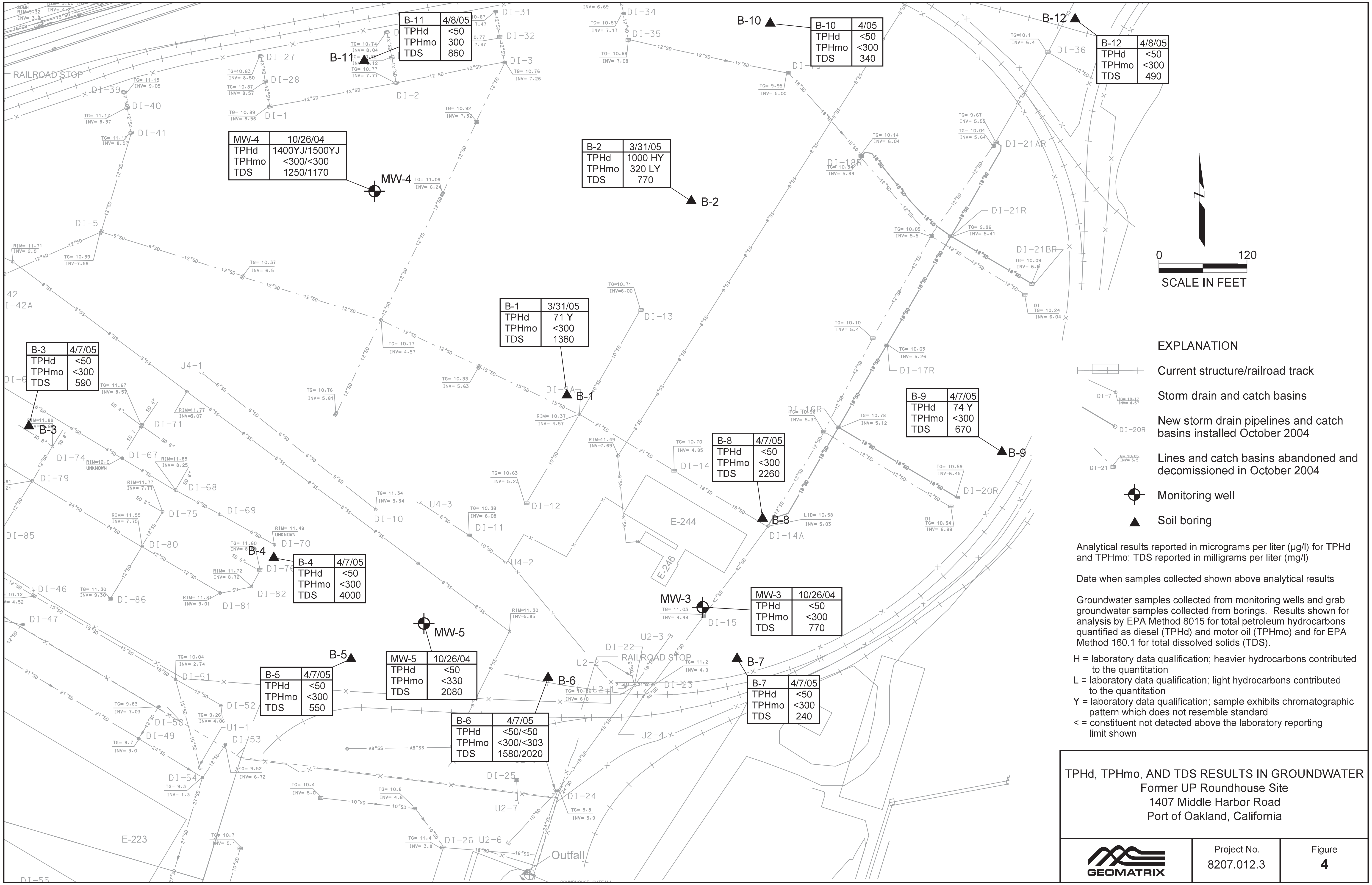

B-11	4/8/05
TPHd	<50
TPHmo	300
TDS	860

B-10	4/05
TPHd	<50
TPHmo	<300
TDS	340

B-12	4/8/05
TPHd	<50
TPHmo	<300
TDS	490

MW-4	10/26/04
TPHd	1400YJ/1500YJ
TPHmo	<300/<300
TDS	1250/1170

B-2	3/31/05
TPHd	1000 HY
TPHmo	320 LY
TDS	770

B-1	3/31/05
TPHd	71 Y
TPHmo	<300
TDS	1360

B-3	4/7/05
TPHd	<50
TPHmo	<300
TDS	590

B-9	4/7/05
TPHd	74 Y
TPHmo	<300
TDS	670

B-8	4/7/05
TPHd	<50
TPHmo	<300
TDS	2260

B-4	4/7/05
TPHd	<50
TPHmo	<300
TDS	4000

MW-3	10/26/04
TPHd	<50
TPHmo	<300
TDS	770

MW-5	10/26/04
TPHd	<50
TPHmo	<330
TDS	2080

B-5	4/7/05
TPHd	<50
TPHmo	<300
TDS	550

B-7	4/7/05
TPHd	<50
TPHmo	<300
TDS	240

B-6	4/7/05
TPHd	<50/<50
TPHmo	<300/<303
TDS	1580/2020

EXPLANATION

Current structure/railroad track

Storm drain and catch basins

New storm drain pipelines and catch basins installed October 2004

Lines and catch basins abandoned and decomissioned in October 2004

Monitoring well

Soil boring

Analytical results reported in micrograms per liter (µg/l) for TPHd and TPHmo; TDS reported in milligrams per liter (mg/l)

Date when samples collected shown above analytical results

Groundwater samples collected from monitoring wells and grab groundwater samples collected from borings. Results shown for analysis by EPA Method 8015 for total petroleum hydrocarbons quantified as diesel (TPHd) and motor oil (TPHmo) and for EPA Method 160.1 for total dissolved solids (TDS).

H = laboratory data qualification; heavier hydrocarbons contributed to the quantitation
L = laboratory data qualification; light hydrocarbons contributed to the quantitation
Y = laboratory data qualification; sample exhibits chromatographic pattern which does not resemble standard
< = constituent not detected above the laboratory reporting limit shown

TPHd, TPHmo, AND TDS RESULTS IN GROUNDWATER
Former UP Roundhouse Site
1407 Middle Harbor Road
Port of Oakland, California

GEOMATRIX

Project No.	Figure
8207.012.3	4

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APPENDIX B

Photographs

APPENDIX B
PHOTOGRAPHS

Former Union Pacific Roundhouse Area
1407 Middle Harbor Drive
Oakland, California

Photograph B-1 – Repaving of Former UP Roundhouse site, facing north.

Photograph B-2 – Following Phase 2 Engineering Activities, facing west.

Photograph B-3 – Following decommissioning of PMW-7, facing west.

Photograph B-4 – Following decommissioning of PMW-8, facing north.

Photograph B-5 Facing east at Former UP Roundhouse.–