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Alameda County Department of Environmental Health
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Oakland CA 94621

31 August 90

P12

Workplan for Soil Investigation and Groundwater Monitoring
2801 MacArthur Boulevard
Oakland CA

Dear Mr. Seto:

We are transmitting the subject workplan on behalf of A.P.A. Fund Limited (c/o Nicholas Molnar, CaliFrance Corporation). The workplan was prepared in response to your correspondence of 8 March 1990 and 23 May 1990 and CaliFrance Corporation's correspondence of 5 June 1990 and 10 August 1990. The results of your workplan review may be transmitted to Mr. Molnar or myself.

If you have any questions, please call.

Sincerely,

Streamborn

Gregory J. Reller
Geologist

cc: Lester Feldman, San Francisco Bay Regional Water Quality Control Board, Oakland CA

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Workplan
Soil Investigation and Groundwater Monitoring
2801 MacArthur Boulevard
Oakland CA

Prepared For:

A.P.A. Fund Limited
(a California Limited Partnership)
c/o Nicholas Molnar
CaliFrance Corporation
1904 Franklin Street
Oakland CA 94612

Prepared By:

Streamborn
Berkeley CA

30 August 1990

Contents

INTRODUCTION

This work-plan describes soil sampling and groundwater monitoring procedures for the property located at 2801 MacArthur Boulevard, Oakland CA (Figure 1). Soil sampling and groundwater monitoring will be performed pursuant to mandates of the Alameda County Department of Environmental Health to: (1) further define the extent of soil contamination and (2) determine whether groundwater contamination exists. As described in this workplan, groundwater monitoring should consist of one 2-inch diameter monitoring well installed near the location of petroleum release, and two 2-inch diameter piezometers located to better define the local hydraulic gradient. Groundwater samples should be collected from the monitoring well after installation and development, and for three subsequent quarters. During piezometer and well installation, soil samples should be collected, subsequently analyzed, and then combined with the existing soil data to document the extent of soil contamination.

BACKGROUND

The subject property previously operated as a service station. Three underground gasoline storage tanks (3,500-gallon leaded, 3,500-gallon unleaded, and 7,500-gallon unleaded) and associated product and vent lines were removed on 3 May 1989 by Riedel Environmental Services. One underground waste oil storage tank (1,000-gallon) was removed on 3 July 1989 and associated piping was removed in July and August 1989, with the work performed by Riedel. Verification samples (Figure 2) collected during tank and piping removal showed localized areas with petroleum-containing soil (Table 1). Nine borings (Figure 4) were subsequently performed on 12 June 1989 (B1), 13-14 July 1989 (B2 through B4), and 24-28 August 1989 (B5 through B9), with the work performed by Riedel. Soil analytical results from the borings (Table 2) again revealed localized areas with petroleum-containing soil. Stockpiles of excavated soil were also sampled (Figure 3), with the analytical results (Table 3) confirming previous measurements of petroleum-containing soil. Soil sampling and analysis to date has not revealed detectable concentration of purgeable halocarbons (halogenated volatile organic compounds by EPA Method 8010) nor elevated concentrations of lead.

The boring data show elevated residual concentrations of total petroleum hydrocarbons as gasoline (TPH-gasoline) in soil from borings B4, B7, and B9 (Figure 4). To the east, southeast, and south of borings B4, B7, and B9 are borings B1, B2, B3, B5, B6, and B8 in which contaminants were not detected. Also, borings B4, B7, and B9 each "bottomed" in uncontaminated material. Furthermore, the residual elevated concentrations measured in borings B4 and B7 are confined to a depth of 30 to 35 feet, with non-detectable concentrations above and below. This contrasts with boring B9, wherein elevated concentrations were measured over most of the sampled depth shallower than 35 feet. Preliminary interpretation of the available data may indicate the following:

Incorrect, see Table 2

- Contaminants detected in soil at the subject property (TPH-gasoline, benzene, toluene, ethylbenzene, and xylenes) have resulted primarily from historic releases of gasoline
- B9 data are likely indicative of a near-surface onsite release (tank, piping, or surface spill), with an as-yet unexplained zone of concentrated contamination at the 20- to 25-foot depth.
- B4 and B7 data are likely indicative of lateral petroleum hydrocarbon migration from release locations near the gasoline tanks or piping, possibly through a sand seam coincident with the water table
- Ground surface topography and regional hydrogeologic data suggest groundwater may flow toward the west or southwest in the vicinity of the subject property

The property is located on the Oakland upland and rests upon Quaternary older alluvium. Soil descriptions contained in the Riedel boring logs indicate that the property is underlain by silt, sandy clay, and scarce sand layers. Groundwater was observed during on-site drilling by Riedel at depths ranging from approximately 28 to 42 feet below grade in some of the borings, while other borings were drilled to depths of approximately 40 feet without encountering noticeable water. As yet, static water levels have not been determined using accurate measurements (such as measurements from wells or piezometers).

PURPOSE

The investigation described by this workplan is intended to gather data necessary to address selected objectives of the Alameda County Department of Environmental Health:

- Better definition of the horizontal and vertical extent of soil contamination
- Evaluation of the likelihood of the presence of contaminants in groundwater

To characterize the lateral and vertical extent of soil contamination, data gathered by Riedel should be integrated with the results of this investigation. Existing data documents the vertical extent of contamination, as well as the lateral limits of contamination to the east, southeast, and south of the release locations. These existing data should be supplemented with additional soil sampling to the west of borings B4 and B7 (Figure 4). The sampling locations are somewhat remote from the existing borings to account for the hypothesized groundwater-aided migration. This workplan also supplements the existing data with another boring located north of boring B9 (Figure 4). This sampling location is somewhat close to the existing boring to account for the hypothesized limited vadose zone migration.

If these two additional borings do not encounter elevated petroleum concentrations, the documented release locations will have been encircled with "clean" explorations and the project objective regarding definition of the extent or soil contamination will be satisfied. Soil samples will be collected from the two borings and the borings will be completed as piezometers. Using the groundwater levels initially measured in the piezometers, albeit of limited accuracy, a single groundwater monitoring well should be sited. The proposed monitoring well should be located within 10 feet of the former gas tanks excavation, in the interpreted downgradient direction. A likely location is shown on Figure 4.

Questionable — need more soil borings

Soil sampling and groundwater monitoring should comply with 'Regional Board Staff Recommendations for the Initial Evaluation and Investigation of Underground Tanks, Tri-Regional Recommendations (2 June 1988, Revised 9 November 1989)'.

CONTINGENCY CONDITIONS

On the basis of the Riedel borings, groundwater - if encountered - is expected between depths of approximately 28 and 45 feet. During drilling for the piezometers and monitoring well, if a depth of 50 feet is reached without observable groundwater, then then the piezometers and well will be completed with screened intervals extending from 50 to 40 feet below grade. The piezometers and well should then be monitored quarterly and if groundwater is observed during any quarterly monitoring, a sample should be collected and analyzed. Otherwise, water level and water quality data will not be collected during the proposed field work.

According to 'Regional Board Staff Recommendations for the Initial Evaluation and Investigation of Underground Tanks, Tri-Regional Recommendations (2 June 1988, Revised 9 November

1989)', performance of groundwater monitoring at locations where groundwater occurs deeper than 50 feet is not necessarily required, subject to determination on a site-specific basis. Thus, the appropriate response to lack of groundwater within 50 feet of the ground surface at the subject property will be a reevaluation of the need for groundwater monitoring.

SCOPE OF WORK

Drilling and Soil Sampling The piezometers and groundwater monitoring well should be constructed using hollow-stem auger drilling. Drilling and soil sampling should be performed in accordance with Standard Operating Procedure 1A: Hollow-Stem Auger Drilling and Split-Spoon Soil Sampling (Appendix A). The borehole should be intermittently sampled and logged, with samples from several depths retained for potential chemical and physical testing. Soil sampling and testing requirements are summarized in Table 4.

Soil samples should be collected and retained for potential testing at maximum 5-foot intervals or discernable changes in material type, whichever is more frequent. Samples should be screened in the field using an organic vapor monitor and if field observations indicate the presence of soil contamination, then additional samples may be collected from the contaminated horizon.

If field observations do not indicate the presence of soil contamination, then approximately 4 representative soil samples from each boring should be analyzed and the remaining samples should be archived. If soil or groundwater contamination is detected, then the archived soil samples may be selectively analyzed to provide additional data. An attempt will be made to collect a sample of aquifer material suitable for grain size analysis to provide more accurate well design criteria in the event contaminants are detected and additional wells are required. The grain size sample should be archived pending results of groundwater analysis.

Soil samples should be analyzed for Total Petroleum Hydrocarbons as Gasoline (extraction by EPA Method 5030 with analysis by GCFID), and Benzene, Toluene, Xylenes, and Ethylbenzene (EPA Method 8020)

Well and Piezometer Completion Two 2-inch diameter piezometers and one 2-inch diameter groundwater monitoring well should be constructed following the practices outlined in Standard Operating Procedure 2A: Completion of Borings as Wells (Appendix A), the schematic shown on Figure 5, and the specifications contained in Table 5.

Piezometers and groundwater monitoring wells should be installed with 10 feet of .010 slotted PVC screen and a filter pack of #2/12 clean sand due to the anticipated fine grained soils. Since the detection of either dissolved or floating contaminants is desired, the well screen should straddle the water table.

The conditions anticipated during preparation of this workplan may not be encountered and modifications to the well completion specification may be appropriate. For example, if an aquitard or non-water bearing soil horizon is encountered at a depth of 5 feet below the water table, then drilling should stop and the well screen should extend to only 5 feet below the water table. Such field design modifications preserve the natural integrity of the aquifer system thus reducing concerns about cross contamination.

Well Development The groundwater monitoring well should be developed in accordance with Standard Operating Procedure 3A: Well Development (Appendix A). Well development should produce relatively non-turbid formation water, subject to reasonable time limitations. Due to the fine-grained nature of the soils at the property, sufficient water may not be produced by the formation to develop the monitoring well according to the desired criteria.

Well Sampling Groundwater monitoring well sampling should be performed as described in Standard Operating Procedure 4A: Well Purging and Sampling (Appendix A). Groundwater sampling requirements are summarized in Table 6. The first sampling event will be conducted immediately after well development, with subsequent sampling events planned for three quarters. Groundwater sampling should consist of initial purging to draw fresh formation water into the well. If the well does not provide sufficient recharge, the purge step may be abbreviated.

Groundwater samples should be analyzed for TPH-gasoline (GCFID EPA 3550), Benzene, Toluene, Xylenes, and Ethylbenzene (EPA 8020). These analytes were selected based upon their detection in soil samples collected by Riedel at the property.

Investigation-Derived Wastes Soil sampling and groundwater monitoring activities will generate the following wastes:

- Soil cuttings and excess soil samples
- Development and purge water
- Decontamination wastewater

These wastes should be containerized in clean, steel 55-gallon DOT 17H removable-top drums pending receipt of analytical results.

Wastes represented by chemical measurements in soil and groundwater where chemicals are not detected may be treated as inert. Limited quantities of inert waters may be discharged to sanitary sewers, subject to sanitary district approval. Inert soils may be disposed of at a local Class III landfill or may be reused as fill material.

Non-inert wastes require specific interpretation with respect to current regulations. These regulations require classification of the waste by the generator; accordingly, it will be the responsibility of A.P.A. Fund Limited to classify and arrange for disposal of these wastes.

Reporting One report and three updates should be submitted. The initial report should document the completion of piezometers and groundwater monitoring well construction, soil sampling, disposition of investigation-derived wastes, well development, and initial groundwater analytical results. The initial report should describe any variations from the procedures outlined in this workplan.

A quarterly update should be prepared upon receipt of the results of analysis of the quarterly groundwater samples. Each of the quarterly updates should compare the most recent analytic results with results of earlier sampling rounds. The quarterly updates should discuss any changes in chemistry or water level. A quarterly update report need not be prepared is groundwater is not encountered in the monitoring well.

QUALITY ASSURANCE/QUALITY CONTROL

Specific quality control procedures are discussed in the standard operating procedures of Appendix A. Quality control samples should consist of the following:

- Replicate samples of soil and groundwater (both field and laboratory)
- Laboratory spikes
- Cross-contamination blanks (both field and laboratory)

Field-Generated Quality Control Samples One soil replicate and one soil cross-contamination blank should be collected during drilling and soil sampling. The replicate and blank should be analyzed only if contamination is detected in the natural soil samples and quality control problems are suspected with the soil data. Analytical parameters for the soil replicate and soil cross-contamination blank should correspond to the detected compounds.

A travel blank for analysis by EPA Method 8020 should be submitted for analysis with each groundwater sample. If concentrations of any analytes are detected during one of the quarterly events, a cross-contamination blank and duplicate groundwater sample should be collected on subsequent quarterly sampling rounds. The cross-contamination blank should be collected by passing deionized water through and around the decontaminated sample-contacting equipment. Analytical parameters for the groundwater duplicate and groundwater cross-contamination blank should correspond to the detected compounds

Laboratory-Generated Quality Control Samples The laboratory should report results of laboratory blank, laboratory replicate, and laboratory spike analyses conducted during soil and groundwater analysis. The results of laboratory-generated quality control samples should be provided in addition to the field quality control samples.

Field Meter Quality Control Procedures Meters for measurement of field parameters (pH, specific conductance, and temperature) should be calibrated daily. Calibration standards should generally approximate or span the anticipated range of measurements. Recalibration may be appropriate if unusual measurements are noticed. Calibration data should be documented on the instrument calibration log.

The field organic vapor monitor (used for site safety and to screen soil samples during drilling) should be calibrated using a standard gas prior to the beginning of each field day. Recalibration may be appropriate if unusual measurements are noticed. Calibration data should be documented on the instrument calibration log.

HEALTH AND SAFETY

The Site Safety Plan in Appendix B presents the procedures which should be followed to protect the safety of on-site workers during planned field work at the subject property. Physical and chemical hazards such, as working around heavy equipment and exposure to chemicals, are addressed. Work is planned in a previously investigated area, with existing data suggesting minimal chemical hazards. Although the proposed investigation does not necessarily require adherence to safety protocols for hazardous waste site, the procedures in the Site Safety Plan are intended to comply with the pertinent sections of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

TABLES

Table 1

Soil Results from Verification Samples Collected During Tank and Piping Removal

Sample Designation	Sample Location	Depth (feet)	Sample Date	Sample Type	Lead (mg/kg)	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)				Oil & Grease (mg/kg)		Purgeable Halocarbons (mg/kg)
						Gasoline	Diesel	Motor Oil	Benzene	Toluene	Ethyl-benzene	Xylenes	Non-Polar	Total	
1771-A	7,500-gallon Unleaded Gasoline Tank	11	5/7/89	Grab	NM	<10	NM	NM	0.005	<0.003	<0.003	<0.003	NM	NM	NM
1771-B	7,500-gallon Unleaded Gasoline Tank	11	5/7/89	Grab	NM	<10	NM	NM	0.011	0.008	<0.003	0.007	NM	NM	NM
1772-A	3,500-gallon Unleaded Gasoline Tank	11	5/7/89	Grab	NM	<10	NM	NM	0.004	<0.003	<0.003	0.010	NM	NM	NM
1772-B	3,500-gallon Unleaded Gasoline Tank	11	5/7/89	Grab	NM	<10	NM	NM	0.021	0.012	0.003	0.014	NM	NM	NM
1773-A	3,500-gallon Leaded Gasoline Tank	11	5/7/89	Grab	11	480	NM	NM	0.120	1.200	0.910	5.200	NM	NM	NM
1773-B	3,500-gallon Leaded Gasoline Tank	11	5/7/89	Grab	10	<10	NM	NM	<0.003	<0.003	<0.003	<0.003	NM	NM	NM
Waste Oil Vt	1,000-gallon Waste Oil Tank	NA	7/3/89	Grab	NM	27	<10	<10	<0.0025	<0.0025	<0.003	<0.003	<100	<50	<0.002 to <0.050
73	Waste Oil Piping	NA	8/30/89	Grab	NM	<10	NM	NM	<0.025	0.310	0.088	0.180	NM	NM	NM
74	Waste Oil Piping	NA	8/30/89	Grab	NM	<10	NM	NM	<0.025	0.160	<0.075	0.130	NM	NM	NM
75	Waste Oil Piping	NA	8/30/89	Grab	NM	<10	NM	NM	<0.025	0.053	<0.075	<0.075	NM	NM	NM
76	Waste Oil Piping	NA	8/31/89	Grab	NM	180	NM	NM	<0.025	0.420	0.660	1.800	NM	NM	NM

General Notes

(a) NM indicates parameter not analyzed

(b) < indicates parameter below detection limit

(c) NA indicates information not available

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Table 2

Soil Results from Borings

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sample Type	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)			
					as Gasoline	as Diesel	as Motor Oil	Benzene	Toluene	Ethylbenzene	Xylenes
B1	B1-20	20.0-20.5	6/12/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B1	B1-25	25.0-25.5	6/12/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B1	B1-30	30.0-30.5	6/12/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-5.0	5.0-5.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-10.0	10.0-10.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-15.0	15.0-15.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-20.0	20.0-20.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-25.0	25.0-25.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-30.0	30.0-30.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B2	B-2-35.0	35.0-35.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-5.0	5.0-5.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-10.0	10.0-10.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-15.0	15.0-15.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-20.0	20.0-20.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-25.0	25.0-25.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-30.0	30.0-30.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-35.0	35.0-35.5	7/14/89	SS-Liner	72	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-38.0	38.0-38.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-39.5	39.5-40.0	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-41.0	41.0-41.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B3	B-3-42.0	42.0-42.5	7/13/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sample Type	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)			
					as Gasoline	as Diesel	as Motor Oil	Benzene	Toluene	Ethylbenzene	Xylenes
B4	B-4-5.0	5.0-5.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-10.0	10.0-10.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-15.0	15.0-15.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-20.0	20.0-20.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-25.0	25.0-25.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-30.0	30.0-30.5	7/14/89	SS-Liner	150	NM	NM	<0.25	<0.5	<0.5	<0.5
B4	B-4-35.0	35.0-35.5	7/14/89	SS-Liner	5,300	NM	NM	<5.0	<10.0	<10.0	<10.0
B4	B-4-36.5	36.5-37.0	7/14/89	SS-Liner	7.9	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-38.0	38.0-38.5	7/14/89	SS-Liner	<1.0	NM	NM	<0.05	<0.1	<0.1	<0.1
B4	B-4-39.0	39.0-39.5	7/14/89	SS-Liner	71	NM	NM	<0.25	<0.5	<0.5	<0.5
B4	B-4-40.5	40.5-41.0	7/14/89	SS-Liner	15	NM	NM	<0.05	<0.1	<0.1	<0.1
B5	B-5-20	20.0-20.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B5	B-5-25	25.0-25.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B5	B-5-30	30.0-30.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B5	B-5-35	35.0-35.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B5	B-5-40	40.0-40.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B5	B-5-45	45.0-45.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B6	B-6-20	20.0-20.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B6	B-6-25	25.0-25.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B6	B-6-30	30.0-30.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B6	B-6-35	35.0-35.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B6	B-6-40	40.0-40.5	8/24/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sample Type	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)			
					as Gasoline	as Diesel	as Motor Oil	Benzene	Toluene	Ethylbenzene	Xylenes
B7	B-7-15	15.0-15.5	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-20	20.0-20.5	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-25	25.0-25.5	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-30	30.0-30.5	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-33	33.0-33.5	8/25/89	SS-Liner	380	NM	NM	0.130	3.00	1.00	3.50
B7	B-7-36	36.0-36.5	8/25/89	SS-Liner	65	NM	NM	<0.025	0.120	0.190	0.440
B7	B-7-41	41.0-41.5	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-45.5	45.5-46.0	8/25/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B7	B-7-51.0	51.0-51.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B8	B-8-15	15.0-15.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	0.097	<0.075	<0.075
B8	B-8-20	20.0-20.5	8/28/89	SS-Liner	21	NM	NM	<0.025	0.190	0.360	0.630
B8	B-8-25	25.0-25.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	0.050	<0.075	<0.075
B8	B-8-30	30.0-30.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B8	B-8-35.5	35.5-36.0	8/28/89	SS-Liner	<10	NM	NM	<0.025	0.130	0.150	0.260
B8	B-8-40.5	40.5-41.0	8/28/89	SS-Liner	<10	NM	NM	<0.025	0.056	<0.075	<0.075
B8	B-8-45	45.0-45.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B8	B-8-50	50.0-50.5	8/28/89	SS-Liner	<10	NM	NM	<0.025	0.220	<0.075	<0.075
B9	B-9-6.5	6.5-7.0	8/28/89	SS-Liner	20	NM	NM	0.026	0.046	<0.075	0.200
B9	B-9-9.5	9.5-10.0	8/30/89	SS-Liner	<10	NM	NM	<0.025	<0.025	<0.075	<0.075
B9	B-9-16.5	16.5-17.0	8/30/89	SS-Liner	490	NM	NM	0.700	0.610	2.000	15.000
B9	B-9-21.0	21.0-21.5	8/30/89	SS-Liner	1,500	NM	NM	4.1	3.4	14.0	62.0
B9	B-9-26.5	26.5-27.0	8/30/89	SS-Liner	1,100	NM	NM	3.0	28.0	13.0	68.0

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sample Type	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)			
					as Gasoline	as Diesel	as Motor Oil	Benzene	Toluene	Ethylbenzene	Xylenes
B9	B-9-31.5	31.5-32.0	8/30/89	SS-Liner	79	NM	NM	0.350	0.800	0.610	2.0
B9	B-9-35.0	35.0-35.5	8/30/89	SS-Liner	<10	NM	NM	0.390	0.130	<0.075	0.200
B9	B-9-40.5	40.5-41.0	8/30/89	SS-Liner	<10	NM	NM	<0.025	0.043	<0.075	<0.075
B9	B-9-45.5	45.5-46.0	8/30/89	SS-Liner	<10	NM	NM	<0.025	0.066	<0.075	<0.075
B9	B-9-51.0	51.0-51.5	8/30/89	SS-Liner	<10	NM	NM	0.310	0.046	<0.075	<0.075

<u>General Notes</u>

(a) NM indicates parameter not measured

(b) < indicates parameter below detection limits

(c) SS-Liner indicates sample collected using split-spoon sampler fitted with liners

Table 3
Soil Results from Stockpiles

Sample Number	Sample Location	Sample Depth	Sample Date	Sample Type	Total Petroleum Hydrocarbons (mg/kg)			Nonhalogenated Volatile Aromatic Organic Compounds (mg/kg)				Oil & Grease (mg/kg)		Approximate Origin of Stockpiled Material that Sample Represents
					Gasoline	Diesel	Motor Oil	Benzene	Toluene	Ethyl-benzene	Xylenes	Non-Polar	Total	
77	E-1	NA	8/31/89	Grab	27	37	130	0.370	0.960	0.530	1.500	NM	NM	Upper part of gasoline tank excavation
78	E-2	NA	8/31/89	Grab	<10	12	130	<0.025	0.190	<0.075	<0.075	NM	NM	Upper part of gasoline tank excavation
79	E-3	NA	8/31/89	Grab	<10	11	110	<0.025	0.170	<0.075	<0.075	NM	NM	Upper part of gasoline tank excavation
80	S-1	NA	8/31/89	Grab	550	11	<10	0.064	1.50	1.20	5.20	NM	NM	Deeper part of gasoline tank excavation
81	S-2	NA	8/31/89	Grab	25	13	<10	<0.025	<0.025	<0.075	<0.075	NM	NM	Upper part of gasoline tank excavation
82	S-3	NA	8/31/89	Grab	17	<10	<10	<0.025	<0.025	<0.075	<0.075	NM	NM	Upper part of gasoline tank excavation
83	S-4	NA	8/31/89	Grab	<10	<10	<10	<0.025	0.054	<0.075	<0.075	NM	NM	Upper part of gasoline tank excavation
84	S-5	NA	8/31/89	Grab	<10	150	370	<0.025	0.24	<0.075	<0.075	290	670	Upper part of waste oil tank and piping excavations
85	S-6	NA	8/31/89	Grab	<10	170	380	<0.025	0.32	<0.075	<0.075	560	1,100	Upper part of waste oil tank and piping excavations

General Notes

(a) NM indicates parameter not analyzed

(b) < indicated parameter below detection limit

(c) NA indicates information not available

Table 4

Soil Sampling and Testing Requirements

Item	Requirement
Sampling Interval and Sample Type	Collect split-spoon samples every 5 feet or at detectable changes in strata, whichever is more frequent. Beginning at 5-foot depth and at approximate 5-foot intervals thereafter, collect samples in liners for potential chemical or physical testing. Also, collect samples in liners for potential chemical testing if elevated organic vapor readings are observed. Remaining samples may be collected without liners for classification purposes.
Sampler	Split-spoon sampler, 1.4-inch ID without liners, 2-inch ID with liners.
Liners	2-inch diameter by 6-inch length, brass or stainless.
Sampler and Liner Decontamination	Pressure wash or steam clean, wash with soap, rinse with tap water, rinse with distilled water.
Field Observations and Measurements	Screen samples with field organic vapor monitor. Visually classify samples according to ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Measure penetration resistance (blows/foot) during driving of split-spoon.
Hollow-Stem Auger	Approximate 4-inch inside diameter (approximate 8-inch flight diameter)
Samples Retained for Physical Testing	Archive one sample (liner) from the formation material encountered within the screened interval. Analyze this sample for grain size distribution (ASTM D 422) if groundwater sampling discloses contamination and additional wells are needed.
Sample Handling for Physical Testing	Cap liner with plastic end caps, label, and store at room temperature.
Samples Retained for Chemical Testing	Retain samples (liners) at approximate 5-foot intervals for potential chemical testing. Analyze up to 4 samples per boring (selection based on results of field organic vapor screening) for Total Petroleum Hydrocarbons as Gasoline (extraction by EPA Method 5030 with analysis by GCFID), and BTXE (EPA Method 8020). If compounds are below detection limits, archive remaining samples for possible future analysis pending results of groundwater sampling and testing. If compounds are detected, make selective determination of need for additional soil analyses.
Sample Handling for Chemical Testing	Cap liner with Teflon sheet, plastic cap, and duct tape (do not use electrical tape). Label liner, place in ziplock bag, and store on ice in cooler until delivery to the laboratory. Log chemical samples on chain-of-custody form and maintain sample security.
Quality Control Samples for Chemical Testing	Collect one sequential replicate and one cross-contamination blank. If detectable concentrations are measured in natural soil samples, analyze blank and replicate samples for detected compounds. Otherwise archive samples.

Table 5

Piezometer and Well Completion Specifications

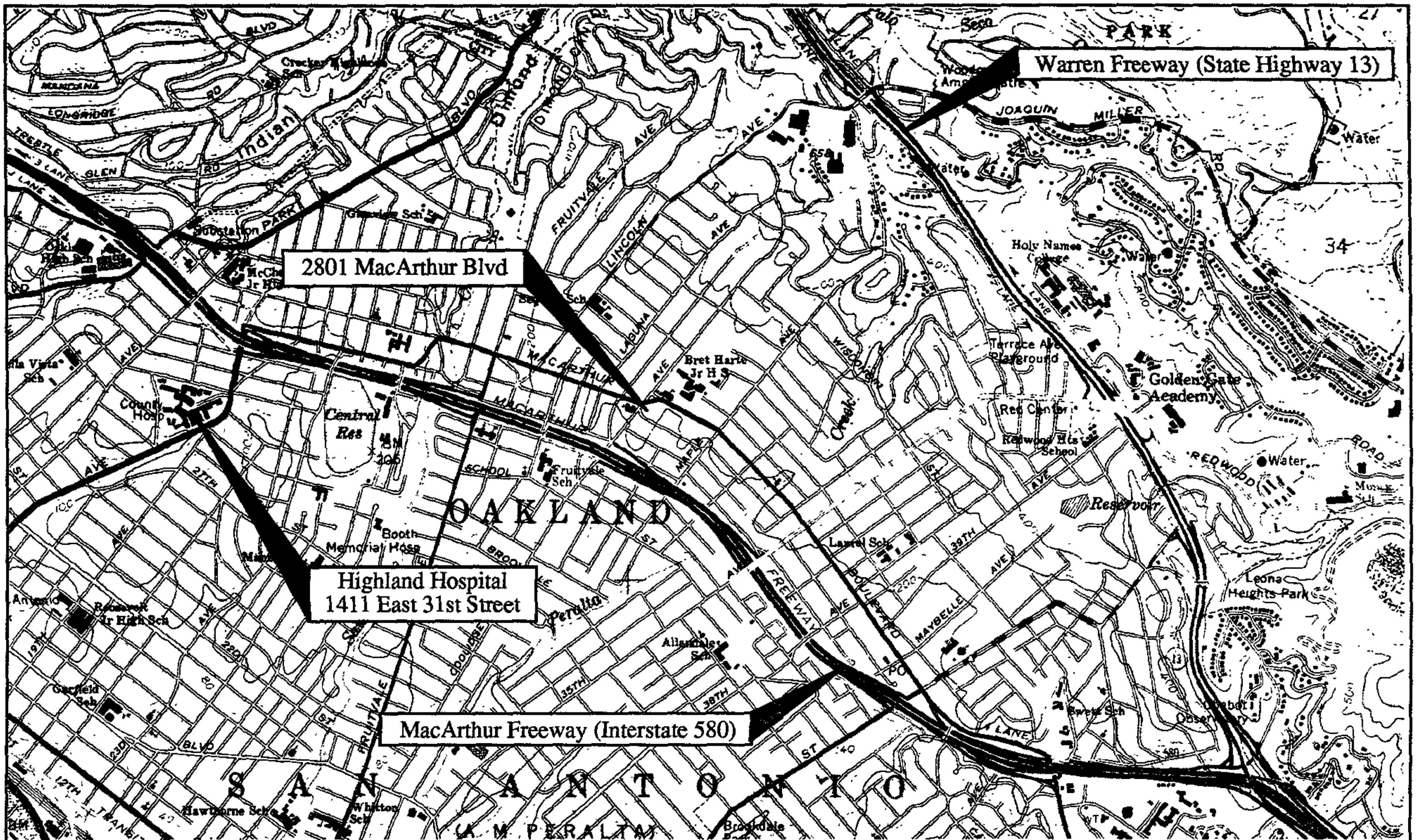
Item	Requirement
Casing Type	Schedule 40 PVC, flush-threaded couplings
Casing Diameter	Nominal 2-inch Inside Diameter
Centralizers	None
Bottom Cap	Threaded or Slip-On (use stainless steel screws for slip-on cap, do not use glue)
Sediment Trap	None
Screen Length	10 feet
Slots	0.01-inch, factory-slotted
Casing and Screen Decontamination	Steam clean or pressure wash prior to installation
Filter Pack	#2/12 or similar clean silica sand
Filter Pack Interval	6 inches below bottom cap to approximately 1.5 feet above top of screened interval
Bentonite Seal	Natural bentonite, minimum 2-foot layer above filter pack
Grout	Cement-bentonite (approximately 5% bentonite)
Surface Completion	8-inch diameter flush-mounted traffic-rated box with locking top cap

Table 6

Groundwater Sampling and Testing Requirements

Item	Requirement
Sampling Frequency	Quarterly for 1 year (4 events, every 3 months)
Purge Equipment	Submersible pump or bailer
Purge Equipment Decontamination	Pressure wash or steam clean, wash with soap, rinse with tap water, rinse with distilled water
Field Measurements and Observations	Water level prior to purge, turbidity (qualitative clarity and color), pH, temperature, specific conductivity, purge volume
Sampler	Teflon bailer with bottom-emptying device
Sampler Decontamination	Pressure wash or steam clean, wash with soap, rinse with tap water, rinse with distilled water
Natural Sample Collection	Lower bailer to midpoint of standing water column to collect sample, discharge sample from bottom of bailer to bottom of sample containers without aeration
Sample Containers	One 100-milliliter glass bottle for Total Petroleum Hydrocarbons as Gasoline and three 40-milliliter glass vials for BTXE
Sample Handling and Preservation	Verify no headspace, acidify BTXE with HCl to pH<2. Label containers, place in ziplock bags, store on ice in cooler, enter onto chain-of-custody, maintain sample custody until sent to laboratory.
Quality Control Samples	One travel blank per sampling event for BTXE. Collect cross-contamination blanks and duplicates during subsequent sampling events if detectable concentrations of analytes are measured in natural samples.

FIGURES



Basemap Reference: U.S. Geological Survey, 7.5 Minute Topographic Quadrangle, Oakland East CA

0 0.5 1.0

Approximate Scale in Miles

0 5,000

Approximate Scale in Feet

N

Figure 1

Location Map

2801 MacArthur Blvd
Oakland CA

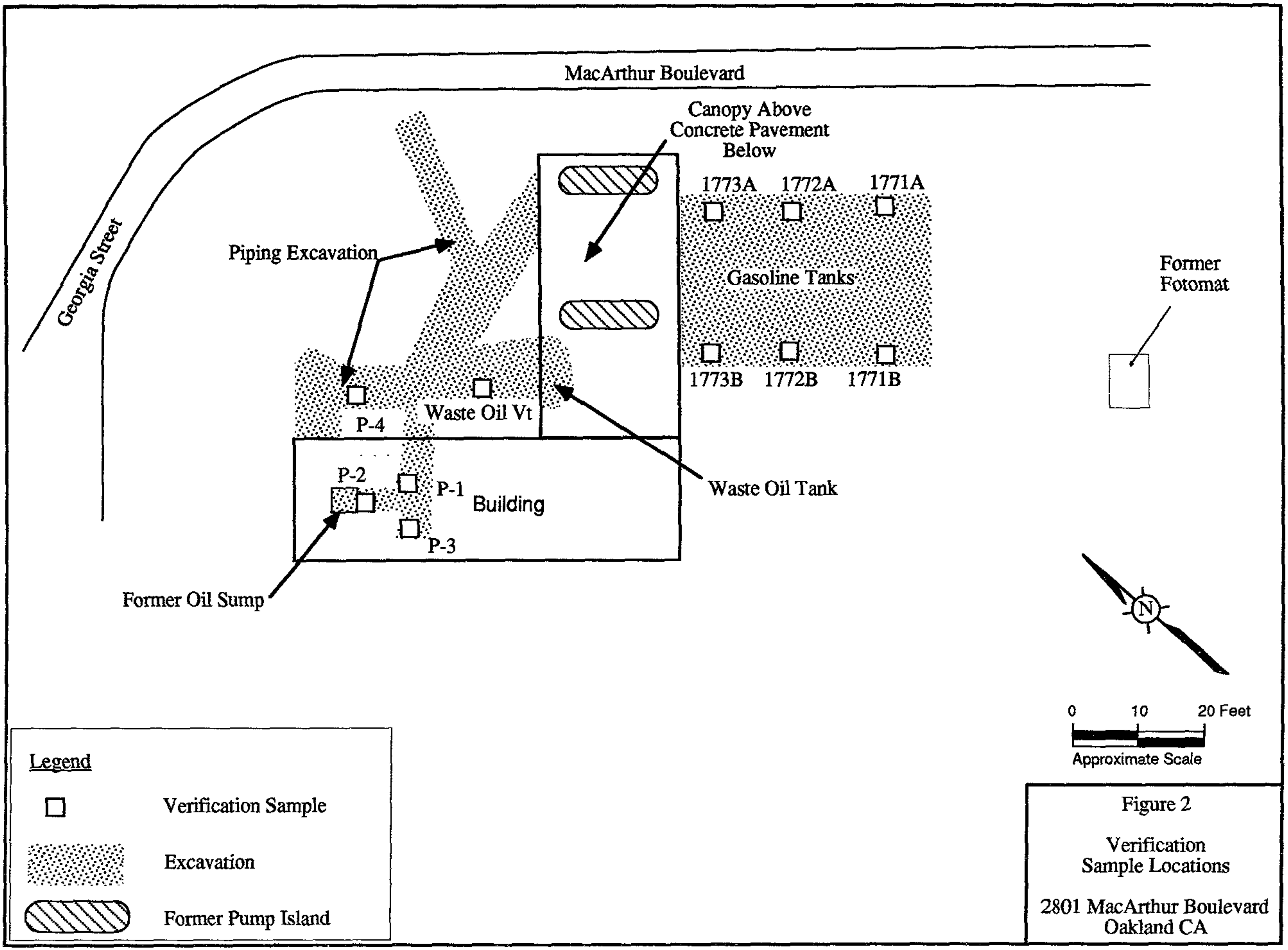


Figure 2

Verification Sample Locations

2801 MacArthur Boulevard
Oakland CA

STREAMBORN

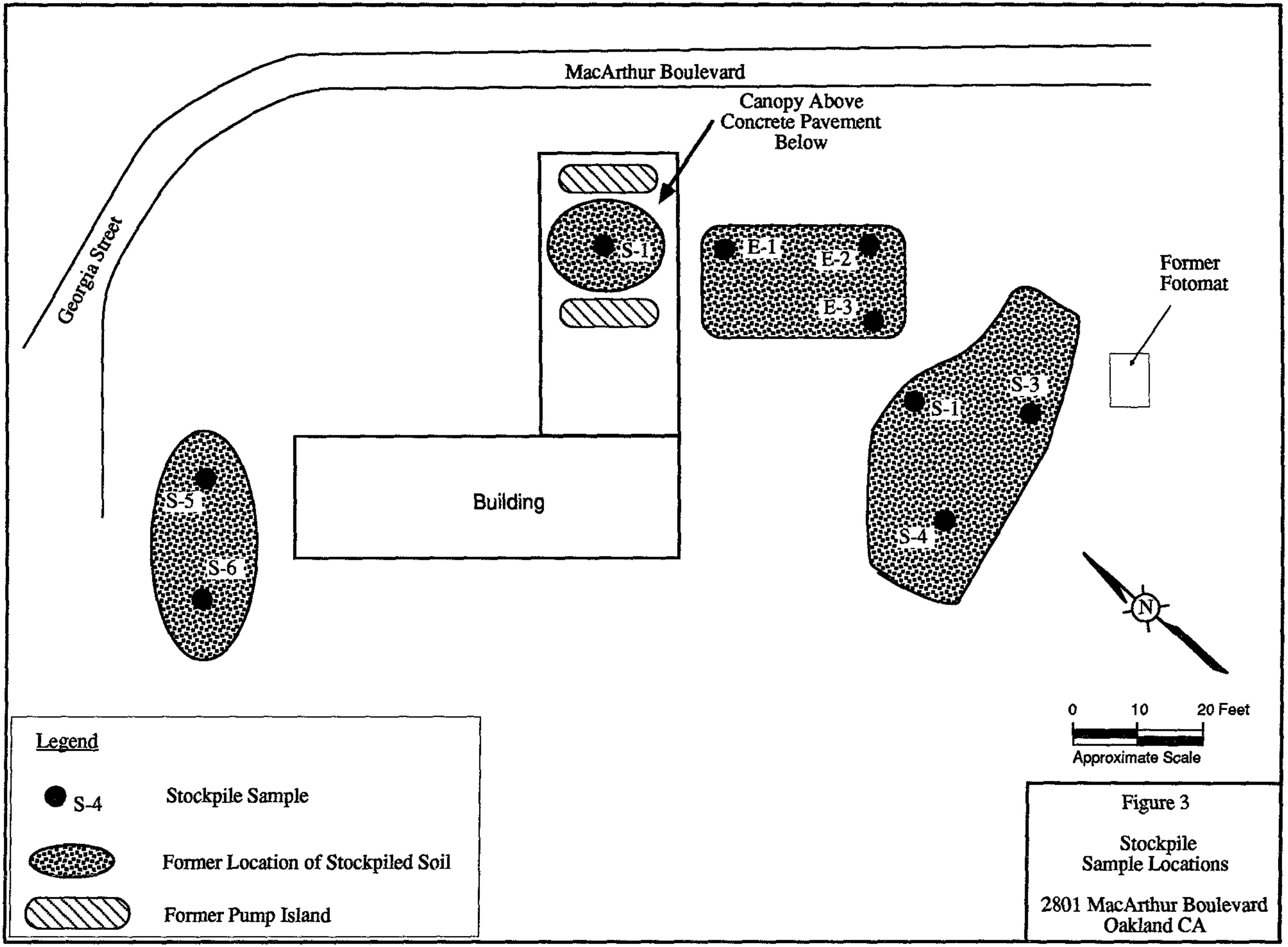


Figure 3

Stockpile
Sample Locations

2801 MacArthur Boulevard
Oakland CA

STREAMBORN

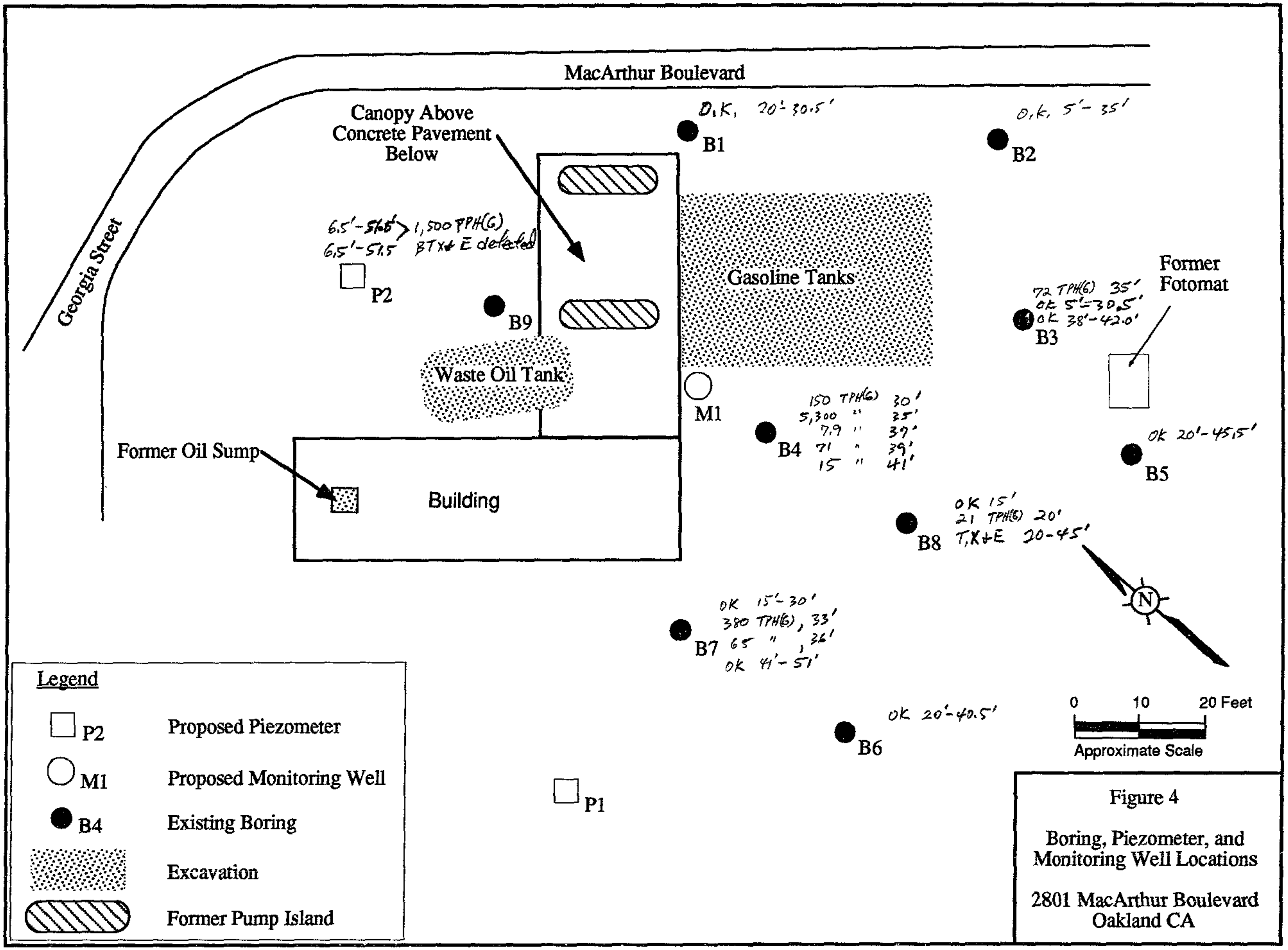
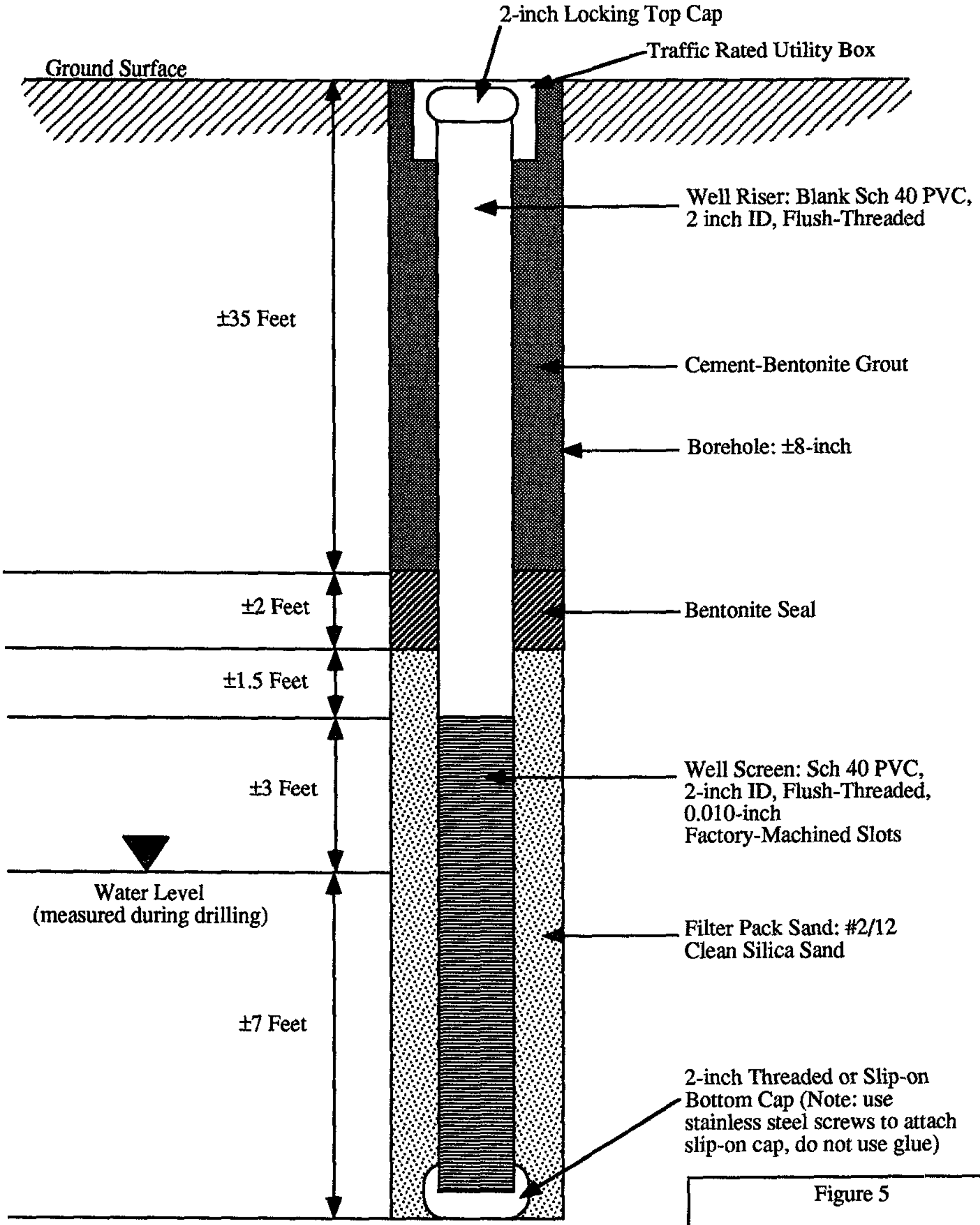


Figure 4

Boring, Piezometer, and Monitoring Well Locations

2801 MacArthur Boulevard
Oakland CA

STREAMBORN



Note: This design should be modified to suit site-specific conditions

Figure 5

Piezometer /Well Schematic

2801 MacArthur Blvd
Oakland CA

APPENDIX A
Standard Operating Procedures

1A: Hollow StemAuger Drilling and Split Spoon Sampling
2A: Completion of Borings as Wells or Piezometers
3A: Well Development
4A: Well Purging and Sampling

STANDARD OPERATING PROCEDURE (SOP) 1A
HOLLOW-STEM AUGER DRILLING AND SPLIT-SPOON SOIL SAMPLING

1.0 INTRODUCTION AND SUMMARY

This SOP describes methods for drilling with the use of hollow-stem augers and soil sampling with the use of spilt-spoon samplers. Drilling activities covered by this SOP may be conducted to obtain soil samples or to create a borehole within which a well may be constructed. Soil samples may be obtained to log subsurface materials, to collect samples for chemical characterization, or to collect samples for physical parameter characterization.

The soil sampling techniques described in this SOP are generally suitable for chemical characterization and physical classification tests; because a driven split-spoon sampler is employed, the resulting soil samples should generally be considered "disturbed" with respect to physical structure and may not be suitable for measuring sensitive physical parameters, such as strength and compressibility. The augering techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the auger flights, a relatively small annulus of remoulded soil surrounding the outside diameter of the auger flights, and limited capability for cross-contamination between subsurface strata as the leading flights of the augers pass from contaminated strata to uncontaminated underlying strata. However, should conditions require strict measures to help prevent cross-contamination or maintain the integrity of an aquitard, consideration should be given to augmenting the procedures of this SOP, for example, by using pre-drilled and grouted isolation casing.

The procedures for hollow-stem auger drilling and split-spoon soil sampling generally consist of initial decontamination, advancement of the augers, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon, and continued augering and sampling until the total depth of the borehole is reached. Withdrawal of the augers upon reaching the total depth requires completion of the borehole by grouting, by constructing a well, or other measures; borehole completion is not covered in this SOP.

2.0 EQUIPMENT AND MATERIALS

- Drill rig, drill rods, hollow-stem augers, and drive-weight assembly (for driving the split-spoon sampler) should conform to ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) hollow-stem augers may exceed 6.5 inches inside diameter as may be necessary for installing 4-inch diameter well casing, (2) hollow-stem augers should have a center bit assembly (end plug), (3) alternative drive-weight assemblies or downhole hammers are acceptable as long as the type, weight, and equivalent free fall are noted on the boring log.
- Split-spoon sampler should conform to ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) split-spoon should be fitted with liners for collection of chemical characterization sample, and (2) allowable split-spoon diameters include nominal 1-1/2-inch inside diameter by nominal 2-inch outside diameter (Standard Penetration Test split-spoon), nominal 2-inch inside diameter by nominal 2-1/2-inch outside diameter (California Modified split-spoon),

or nominal 2-1/2-inch inside diameter by nominal 3-inch outside diameter (Dames & Moore split-spoon). The split-spoon type and length of the split-barrel portion of the sampler should be noted on the boring log, as should the use of a sample catcher if employed.

- Liners should be 6-inch length, fitted with plastic end-caps, brass or stainless steel, with a nominal diameter corresponding to that of the inside diameter of the split-spoon sampler. The boring log should note whether brass or stainless steel liners were used.
- Teflon sheets, approximate 6-mil thickness, precut to a diameter or width of the liner diameter plus approximately 1 inch
- 1/2-pint widemouth glass jars, laboratory cleaned
- Kimwipes, certified clean silica sand, or deionized water (for blank sample preparation)
- Duct tape
- Sample labels, boring log forms, chain-of-custody forms, hazardous waste labels, and daily report forms
- Ziploc plastic bags of size to accommodate a liner
- Stainless steel spatula and knife
- Cooler with ice or dry ice (do not use blue ice)
- Field organic vapor monitor such as Foxboro GC 128 (flame ionization detector) or Thermo-Analytical OVM (photoionization detector). The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be noted on the boring log.
- Aluminum foil, and rubber bands
- Pressure washer or steam cleaner
- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of hollow-stem augers, drill rod, and end plug
- Buckets and bristle brushes for decontamination of liners, split-spoon sampler, and other small gear
- Low residue, organic free soap such as Liqui-nox or Alconox
- Distilled water
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following typical procedures are intended to cover the majority of drilling and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected subsurface conditions. Deviations from the following typical procedures may be expected and should be noted on the boring log.

1 Decontaminate drill rig, drill rods, hollow-stem augers, split-spoon sampler and other drilling equipment immediately prior to mobilization to the site.

2 Investigate the location of the proposed boreholes for buried utilities and obstructions. At least 48 hours before drilling, contact known or suspected utility services individually or through collective services such as "USA" and "Underground Alert". As appropriate, retain private buried utility location services or geophysical investigation services to search for buried utilities and obstructions. Also as appropriate, pothole suspect utility locations prior to drilling or relocate boreholes. During initial advancement of each borehole, drill cautiously and have the driller pay particular attention to the "feel" of the hollow-stem auger. The suspected presence of an obstruction, buried pipeline or cable, utility trench backfill, or similar may be cause for suspension of drilling, subject to further investigation.

3 Advance the hollow-stem auger, fitted with end plug, to the desired sampling depth. Note depth interval, augering conditions, and driller's comments on boring log. Samples should be taken at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.

4 Remove drill rod and end plug from the hollow stem and note presence of water mark on drill rod, if any. If below the groundwater table in clean sand, allow water level in hollow-stem to equilibrate prior to removing end plug and remove plug slowly so as to minimize suction at the base of the plug. Also, monitor top of hollow-stem using field organic vapor monitor, as appropriate.

5 Decontaminate split-spoon, liners, spatulas and knives, and other equipment that may directly contact the chemical characterization sample. Fit split-spoon with liners and attach to drill rod.

6 Lower split-spoon sampler through hollow-stem of auger until sampler is resting on soil. Note discrepancy between elevation of tip of sampler and leading edge of augers, if any. If more than 6-inches of slough exists inside the hollow-stem augers, consider the conditions unsuitable and re-advance the hollow-stem augers and end plug to a new sampling depth.

7 Drive and recover the split-spoon according to the requirements of ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Record depth interval, hammer blows for each 6-inches, and sample recovery on boring log. Monitor the recovered split-spoon with the field organic vapor monitor, as appropriate.

8 Remove either bottom-most or second-from-bottom liner (or both) from split-spoon for purposes of chemical characterization and physical parameter testing. Observe soil at each end of liner(s) for purposes of completing sample description. Place teflon sheet at each end of liner, cover with plastic caps, and tape plastic caps with duct tape (do not use

electrical tape) to further minimize potential loss of moisture or volatile compounds. Label liner(s) and place in ziploc bag on ice or dry ice inside cooler.

9 Extrude soil from remaining liner(s) and subsample representative 1-inch cube (approximate dimensions). Place subsample in widemouth glass jar, cover jar with aluminum foil and seal foil to jar with rubber band. Allow jar to equilibrate at ambient conditions for approximately 5 minutes and screen for organic vapors by inserting the probe of the field organic vapor monitor through the aluminum foil. Record depth interval, observed sample reading, and ambient (background) reading on the boring log. Glass jars may be reused by discarding the soil subsample and wiping any residue from the jar using a paper towel.

10 Visually classify soil sample in approximate accordance with ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Descriptions should include moisture content, color, textural information, group symbol, group name, and odor. Optional descriptions, especially if classification is performed with protective gloves, include particle angularity and shape, clast composition, plasticity, dilatancy, dry strength, toughness, and reaction with HCl. Add notes on geologic structure of sample, as appropriate. Record depth interval, visual classification, and other notes to the boring log.

11 Repeat steps 3 through 10 until total depth of borehole is reached.

12 Complete borehole according to the requirements specified elsewhere.

13 Decontaminate hollow-stem augers, drill rod, and end plug between boreholes and after finishing last borehole prior to drill rig leaving site.

14 Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.

15 Containerize soil cuttings, excess soil sample, and decontamination wastewaters in steel drums. Affix hazardous waste labels to the drums.

16 Complete pertinent portion of the chain-of-custody form and daily activity report.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality control sampling consists of sequential replicates, collected at an approximate frequency of 1 sequential replicate for every 10 natural samples. Sequential replicates are collected by packaging two adjacent liners of soil from a selected split-spoon drive. Each sample is labeled according to normal requirements. The replicate samples obtained in such a manner are suitable for assessing the reproducibility of both chemical and physical parameters. Interpretations of data reproducibility should recognize the potential for significant changes in soil type, even over 6-inch intervals. Accordingly, sequential replicates do not supply the same information as normally encountered duplicate or split samples. Duplicate or split samples are better represented by the laboratory performing replicate analyses on adjacent subsamples of soil from the same liner.

Optional quality control samples may be collected to check for cross-contamination using field blanks. Field blanks may be prepared by (1) swipe sampling decontaminated liners and split-spoon with kimwipes, (2) pouring clean silica sand into a decontaminated split-spoon sampler that has been fitted with liners, or (3) pouring deionized water over the decontaminated liners and split-spoon and collecting the water that contacts the sampling implements for aqueous analysis. Field blanks may be prepared at the discretion of the field staff given reasonable doubt regarding the efficacy of the decontamination procedures.

The comparability of the field visual classification may be checked by conducting laboratory classification tests. Requests for laboratory testing verification of the field classification should be left to the discretion of the field staff.

Field decisions that may also affect the quality of collected data include the frequency of sampling and the thoroughness of documentation. Subject to reasonable limitations of budget and schedule, the completeness, comparability, and representativeness of data obtained using this SOP will be enhanced by decreasing the sampling interval (including collecting continuous samples with depth) and increasing the level of detail for sample classification and description of drilling conditions. More frequent sampling and more detailed documentation may be appropriate in zones of chemical concentration or in areas of critical geology (for example, zones of changing strata or cross-correlation of confining strata).

5.0 DOCUMENTATION

Observations, measurements, and other documentation of the drilling and soil sampling effort should be recorded on the following:

- Daily Report
- Field Notebook
- Boring Log
- Sample Label
- Chain-of-Custody

Documentation should include any deviations from this SOP, notations of unusual or unexpected conditions, and documentation of the containerization and disposition/disposal of investigation-derived waste. Specific instructions for selected forms are provided below.

5.1 Sample Label

- Project name and project number
- Boring or well number
- Sample depth interval (feet below ground surface), record the depth interval using notation similar to "19.2-19.7", generally do not record just one depth "19.2" because of uncertainty regarding the location such depth corresponds to (midpoint, top, etc.)
- Sample date and sample time
- Sampler
- Optional designation of orientation of sample within the subsurface, for example, an arrow with "up" or "top" designated

5.2 Boring Log

- Project name and project number
- Boring number
- Description of boring location, including taped or paced measurements to noticeable topographic features (a location sketch should be considered)
- Date and time drilling started and completed
- Drilling company and name of drilling supervisor, optional names and responsibilities of drillers helpers
- Manufacturer and model number of drill rig
- Inside diameter of the hollow stem and outside diameter of the auger flights of the hollow-stem augers, optional description of type of bit on end plug and leading edge of auger, optional description of the size of drill rod
- Depth at which groundwater was first encountered with the notation "during drilling"
- Method of borehole completion
- Other notations and recordings described previously in 2. EQUIPMENT AND MATERIALS and 3. TYPICAL PROCEDURES

6.0 DECONTAMINATION

Prior to entering the site, the drill rig and appurtenant items (drill rod, hollow-stem augers, end plug, split-spoon sampler, shovels, troughs and buckets, drillers stand, etc.) should be decontaminated by steam cleaning or pressure washing. Between each borehole, appurtenant items that contacted downhole soil (essentially all appurtenant items including drill rod, hollow-stem augers, end plug, split spoon sampler, shovels, troughs and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. Prior to leaving the site, the drill rig and appurtenant items should be decontaminated by steam cleaning and pressure washing. Onsite decontamination should be conducted within the confines of a trough or lined pit to temporarily contain the wastewater. Between each borehole and prior to demobilization, the trough or lined pit should be decontaminated by steam cleaning or pressure washing. If a rack or other support is used to suspend appurtenant items over the trough or lined pit during decontamination, only the rack or other support needs to be decontaminated between boreholes.

Prior to each sample, the split-spoon sampler, liners, sample catcher, spatulas and knives, and other equipment or materials that may directly contact the sample should be decontaminated. Decontamination for these items should consist of a soap wash (Alconox, Liqui-nox, or other organic free - low residue soap), followed by a tap water rinse, followed by a distilled water rinse. Wastewater from the soap wash should be temporarily contained. Wastewater from the tap water and distilled water rinses may be discharged to the ground surface or a sanitary sewer.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before each borehole, fresh decontamination solutions should be prepared.

7.0 INVESTIGATION-DERIVED WASTE

Wastes resulting from the activities of this SOP may include soil cuttings, excess soil sample, decontamination wastewaters, and miscellaneous waste (paper, plastic, gloves, jars, aluminum foil, etc.) Unless otherwise prohibited by the Site Safety Plan, miscellaneous waste should be double-bagged in plastic garbage bags and disposed of as municipal waste.

Soil cuttings and excess soil sample from each borehole should be placed in individual steel drums with hazardous waste labels affixed. Solids from multiple boreholes may be combined within a single drum if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the solids are similarly uncontaminated or similarly contaminated. Given sufficient drums and reasonable doubt, separate drums should be used for each borehole.

Decontamination wastewaters for each borehole should be placed in individual steel drums with hazardous waste labels affixed. Wastewaters from multiple boreholes may be combined, subject to the same limitations as solids.

8.0 SAFETY

Normal and special safety precautions are described in the Site Safety plan. The Site Safety plan should be reviewed periodically during drilling to keep mindful of important safety measures. Physical hazards typically prevail because the drill rig contains exposed rotating and hammering equipment and because drill rod and augers are heavy material with sharp edges.

Chemical hazards are typically discovered upon withdrawal of the end plug or withdrawal of the soil-filled split-spoon sampler from the hollow-stem auger, as well as removal of the soil-filled liners from the split-barrel. Opportune monitoring for volatile chemicals may be conducted at these times. Splash protection and direct contact protection are also essential measures to minimize the potential for chemical exposure.

9.0 REFERENCES

American Society for Testing and Materials, 1989. 1989 Annual Book of ASTM Standards, Section 4 - Construction, Volume 4.08 - Soil and Rock, Building Stones; Geotextiles. ASTM, Philadelphia, PA. 1989.

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.

U.S. Environmental Protection Agency, 1989a. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

U.S. Environmental Protection Agency, 1989b. Soil Sampling Quality Assurance User's Guide - Second Edition. National Technical Information Service, PB 89-189 864/AS, Springfield, VA. 1989.

STANDARD OPERATING PROCEDURE (SOP) 2A
COMPLETION OF BORINGS AS WELLS

1.0 INTRODUCTION AND SUMMARY

This SOP describes methods for installation of a monitoring well within an existing borehole. The well construction techniques discussed in this SOP are generally suitable for construction of wells screened in one groundwater zone which will be used for water quality sampling and/or observations of groundwater elevation. Typically, 2- or 4-inch diameter wells, with total depths less than 80 feet will be installed using this SOP. Large diameter or deep wells may require modification of the methods described herein. Discussion of specific well casing and screen material is beyond the scope of this SOP, and well casing and screen material should be selected on a site specific basis. The permitting activities of this SOP apply in California and different permits are needed in other locations.

The procedures for construction of wells generally consist of well permitting, well design, decontamination of well casing and screen, simultaneous assembly and lowering of casing and screen into the borehole, placement of the filter-pack around the screen, installation of a bentonite seal above the filter pack, sealing of the remaining annular space with grout, and surface completion. The procedures described below are intended to conform to practices outlined in Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells (Aller, et al., 1989); A Compendium of Superfund Field Operations Methods (U. S. EPA, 1989); and California Well Standards (Final Draft), (California Department of Water Resources, 1990) .

2.0 EQUIPMENT AND MATERIALS

- Drill rig, steam cleaner, water supply, cement mixing equipment
- Hand tools (pipe wrenches, chain wrenches, pipe vise, shovels, rubber mallet, etc.)
- Tape measure long enough to reach the bottom of the boring
- Well casing, screen, and end caps
- Centralizers (if required)
- Brushes, detergent, and rags for decontamination
- Clean sand
- Bentonite pellets (or powder) for seal above filter pack, unaltered sodium bentonite
- Cement for grout
- Locking hasp
- Protective surface casing
- Well construction log and daily report forms
- Calculator

Site specific conditions may require other specialized equipment, thus great care should be taken to anticipate conditions reasonably expected to occur during well installation.

3.0 TYPICAL PROCEDURES

The following procedures apply to most well installations. However, normal field practice requires re-evaluation and modification of these procedures upon encountering unexpected situations during well construction. Deviations from the following procedures are to be expected and should be documented.

1 Determine local jurisdiction charged with regulation of wells and apply for required local permits. Local jurisdictions may include county, water district, or city. Determine special design considerations (such as minimum length of grout seal) and inspection requirements (such as witnessing the placement of the grout seal). Also file notice of intent to construct well with the California Department of Water Resources using its standardized form.

2 Well design begins with the conception of the specific purpose for the well, and should include consideration of the specific analytes of interest, anticipated subsurface conditions at the intended well location, and the soil conditions encountered during drilling and recorded on the boring log.

   Design considerations discussed in this SOP are limited to portions of the well subject to modification by information gathered during drilling. Such information includes depth to groundwater, thickness of water bearing strata, and grain size distribution of the water bearing strata. Conceptual well designs should be modified as required in the field to prevent connection of naturally separate groundwater zones, to allow an adequate surface seal to be installed, and to maximize the chance for detection of the contaminants of concern. Modifications of conceptual designs should be discussed with the project supervisor prior to implementation whenever possible.

3 Prior to installation in the borehole, well casing and screen should be decontaminated and inspected to help minimize cross-contamination which may affect subsequent water quality samples.

   Decontamination should comprise steam cleaning, pressure washing, or equivalent. Of oil or grease contamination is suspect, decontamination should also include a soap wash and tap water rinse. This procedure should be applied to both the outside and the inside of well casing and screen immediately before assembly and well installation.

4 Assembly of the well screen and blank casing is accomplished simultaneously with insertion into the boring. Initially a bottom plug is attached to the bottom of the screen and the screen is lowered into the boring. The next length of screen or blank casing (depending on the specific well design) is attached and the process is repeated until the well extends from the surface to the bottom of the boring. Various types of mechanical clamps are used to prevent dropping of the well screen into the well during assembly. It is useful to leave surplus blank casing extending above grade at this point to facilitate subsequent construction activities.

   Measure the length of well screen and blank casing inserted into the boring and record the quantities on the well construction log. The total length of well screen and casing should be confirmed by taping from the surface.

5 Install the filter pack by pouring filter pack material into the annulus between the casing and borehole. Install filter pack from (1) an elevation approximately 6 inches beneath the elevation of the bottom cap of the well casing to (2) approximately 2 feet above the top of the screened interval.

If augers or drill casing remain in the ground during well construction, the annulus between the well material and the casing may be used as a tremie If the well is constructed in an open borehole, then the filter pack should be placed using a tremie pipe. The filter pack should be poured slowly into the borehole and the depth to the top of the filter pack should be "tagged" periodically with a tape. Adequate time should be allowed for the sand to settle through standing water prior to tagging or the tape may be lost by burial. Tagging is time consuming, however it provides reasonable checks of filter pack bridging during installation.

If augers or other temporary casing are being used as a tremie, they should be withdrawn as the filter pack is placed. During placement, the elevation of the tip of the augers/temporary casing should be kept slightly above the top of the filter pack. Minimizing the separation between the top of the filter pack and tip of the augers/temporary casing during filter pack placement will help prevent inclusions of formation material within the filter pack. However, if the tip of the augers/temporary casing is not kept above the top of the filter pack and the filter pack is allowed to settle within the augers/temporary casing, a filter pack bridge may occur and the well casing may become "locked" inside the augers/temporary casing.

The quantity of filter pack material required to fill the annulus should be calculated. The quantity of filter pack material actually installed in the well should be measured and compared to the calculated quantity. Both quantities should be recorded on the well construction log.

6 The bentonite seal is installed by pouring bentonite pellets or slurried bentonite powder onto the top of the filter pack. The bentonite seal should extend approximately two feet above the top of the filter pack. The quantity and type of bentonite used should be recorded on the well construction log. The top of the bentonite seal should be measured by taping. If bentonite pellets are used and the seal exists above the groundwater table, water should be poured on top of the pellets after their installation and the pellets should be allowed to hydrate for approximately 10 minutes before proceeding with installation of the grout seal.

7 The grout seal should be tremied into the well to prevent inclusions of formation material or slough in the annular seal. Typically, grout seal should consist of neat cement grout, using 1 sack (94 pounds dry weight) of Type I/II Portland cement to 5 gallons of water. The type of seal may need to be designed on a site specific basis to conform to applicable regulatory requirements. Also, local requirements may require inspection of grout seal placement by the regulating authority.

If augers or temporary casing remain in the borehole during grouting, the level of the grout should be kept above the tip of the augers or casing to help prevent inclusions of formation material in the grout seal.

The volume of the grout actually used should be recorded on the well construction log and compared to the calculated annular volume of the sealed interval. Any discrepancies should be noted on the well construction log.

8 Complete the surface of the well by installing a protective surface casing and locking mechanism around the top of the well casing. The protective casing should be anchored approximately 3 feet into the grout annulus.

9 The completed well should be protected from disturbance while bentonite seal hydrates and grout cures. Further well activities, such as development or sampling, should be withheld for a period of 3 to 7 days to allow these materials to obtain an initial set.

10 Complete and file form DWR 188 plus reports or forms required by local agencies.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance checks for well completion include comparison of theoretical versus actual volumes of filter pack, bentonite seal, and grout seal. Discrepancies that indicate actual "take" was less than theoretical may indicate inclusions of formation material or slough within the annulus. Specific attention to such discrepancies is necessary if the bentonite seal and grout seal are needed to separate contaminated from uncontaminated zones that may be penetrated by the well.

Other quality assurance details include accurate measurement and documentation of the lengths and types of materials used to complete the well.

5.0 DOCUMENTATION

Observations, measurements, and other documentation of the well completion effort should be recorded on the following:

- Daily Report
- Field Notebook
- Well Completion Log
- DWR 188

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Materials used for filter pack, bentonite seal, and grout seal should be new at the beginning of each project. Typically, damaged or partially-used containers of material that are brought onsite by drillers or other material suppliers should not be used for well completion. If there is sufficient question regarding contamination of materials, obtain representative samples for later laboratory testing.

Well casing and screen should be decontaminated immediately prior to insertion within the borehole. Casing and screen with oil or grease staining may be rejected or decontaminated by washing with soap, rinsing with tap water, and then steam cleaning, pressure washing or equivalent. New and visually clean casing and screen should be decontaminated by steam cleaning, pressure washing, or equivalent.

If augers or temporary casing are removed during well construction, these materials should be decontaminated by steam cleaning, pressure washing, or equivalent.

7.0 INVESTIGATION-DERIVED WASTE

Wastewater from casing and screen decontamination may be discharged to the ground surface near the well subject to the landowner's permission. Otherwise, these wastewaters may be discharged to the sanitary sewer.

Borehole fluids displaced during well completion, excess grout, and decontamination wastes from the cleaning of augers or temporary casing should be placed in steel drums. The drums should be labeled with a hazardous waste label indicating the generator's name and accumulation date. The drums should also be labeled with a description of contents and well number from which the wastes originated.

8.0 SAFETY

Primary chemical hazards during well completion are associated with dermal exposure to borehole fluids that may be displaced during completion. Primary protection against dermal exposure includes splash protection and gloves.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.

U.S. Environmental Protection Agency, 1989. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

STANDARD OPERATING PROCEDURE (SOP) 3A
WELL DEVELOPMENT

1.0 INTRODUCTION AND SUMMARY

This SOP describes procedures to develop wells that have been properly installed. Typically, fine soil particles are entrained within the filter pack and adjacent formation during well installation. The well development procedures described herein are intended to help remove the fine soil particles, resulting in enhanced hydraulic response of the well and increased representativeness of water quality samples collected from the well.

Typically, this SOP will be used to develop 2- or 4-inch diameter monitoring wells and occasionally
larger diameter monitoring or pumping wells; all screened within a single groundwater zone. The procedures described herein should be modified for domestic wells. The procedures described herein may also need modification if product is observed in the well.

Well development activities generally include decontaminating the downhole equipment, repetitive combinations of surging or swabing followed by overpumping or bailing, measurement and observation of well yield, turbidity, and field parameters, and containerizing the development wastewater. Development is typically conducted until no further improvement in well response and turbidity is observed or until a reasonable time has been devoted to development.

2.0 EQUIPMENT AND MATERIALS

- Pressure washer or steam cleaner
- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- Tap water
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H
- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be documented.
- Beaker, glass, ±250 milliliter for measurement of field parameters. A similar flow-through cell may also be used.
- Water level meter
- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters.
- Vented surge block or swab of appropriate diameter for the screened interval of the well casing.
- Bailing and/or overpumping equipment consisting of one or a combination of the following:

  <u>Bailer</u>: Steel or PVC. Dedicated or new bailer rope. Generally as large a diameter as will fit down well.

Surface Centrifugal Pump: Limited to water lift of approximately 20 feet. Dedicated or new flexible plastic suction hose. Foot valve and flow control valve optional.

Air-Lift Pump: Dual-casing assembly with eductor casing (outer casing) to extend at least 2 feet beyond inner casing. Foot valve should be provided at the bottom of the eductor casing to prevent release of aerated water into the well when the air lift pump is turned off. Air from compressor should be dual-filtered to remove oil.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following procedures are intended to cover the majority of well development conditions. However, normal field practice requires re-evaluation of these procedures upon encountering unusual or unexpected conditions such as observation of free product, measuring elevated pH in the development water, or observing dramatic increases in turbidity as development progresses. Deviations from the following procedures may be expected and should be documented.

1. Development should generally be initiated after the well sealing materials (grout) have obtained an initial cure. Typically, development may begin 3 to 7 days after well completion.
2. Remove top cap and perform field organic vapor monitoring of well casing.
3. Measure static water level and total depth of well. Compare total depth to well completion diagram. Calculate volume of standing water in casing.
4. Decontaminate downhole equipment (see section DECONTAMINATION in this SOP).
5. Begin bailing or overpumping using as high an evacuation rate as possible. Record the following at the beginning of development and during each bail/overpump cycle:
   - Volume removed and time
   - pH, temperature, and specific conductance
   - Turbidity (clarity and color)
   - Approximate drawdown and well yield
   - Whether well was bailed/pumped dry
   - Other observations (such as presence of product) as appropriate

   Bail/overpump until at least one casing volume of standing water has been removed. Continue bailing/overpumping if the removed water remains very turbid, indicating removal of fines from the screened interval. Terminate bailing/overpumping upon improvement of clarity.
6. Surge/swab the well to loosen fines from the screened interval. Position vented surge block several feet above the screened interval and surge/swab with upward motion. Lower the surge/swab several feet and repeat, keep surging/swabing progressively lower intervals until the

bottom of the screened interval is reached. For each interval, surge/swab for several minutes or as indicated by field experimentation.

7. Repeat items 5 and 6 until evacuated water at the end of the bailing/overpumping cycle is low or non-turbid, field parameters are representative of natural groundwater conditions, and well yield has stabilized at a value representative of the intercepted groundwater zone. Terminate development after a reasonable period of time even if these conditions are not observed. Unless otherwise specified in the Quality Assurance Project Plan or Sampling Plan, 4 hours may typically be taken as a reasonable time effort.
8. Terminate development by bailing or overpumping for an extended period of time to remove fines that have been loosened by the last cycle of surging/swabing. Record final observations.
9. Containerize development water and decontamination wastewater in steel drum(s). Label drum(s) with hazardous waste label, description of contents, and well number from which waste originated.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Meters for measurement of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented on the instrument calibration log.

Quantitative turbidity measurements may be taken with a turbidity meter (both field and laboratory versions are available). If qualitative descriptors of turbidity are used, these terms (very-, moderate-, low-turbidity) may be further defined on the development log. Representative samples may also be collected and returned to the laboratory for measurement with a turbidity meter.

Because well development is typically the first activity of a newly completed well and because the activity is fairly vigorous, the following precautions may be appropriate:

- If product is observed but not anticipated within the groundwater zone intercepted by a well, and the well penetrated a contaminated overlying groundwater zone, well development may be interrupted subject to further consideration or study. Faulty well sealing may result in migration of product from overlying to underlying groundwater zones, which is exacerbated during development.
- If elevated pH is observed but not anticipated, and the well is being developed soon after completion, well development may be interrupted subject to further consideration or study. Elevated pH may originate from grout that has not yet cured, or from grout contamination of the filter pack.
- If turbidity increases dramatically after surging/swabing and does not return to previously observed levels, the cause may be a broken well casing, broken screen, or dislodged end cap, which allows soil to enter the casing unretarded by the filter pack. Probing the well may disclose a break or faulty joint. Consider interrupting well development if this condition is suspected.

5.0 DOCUMENTATION

The well completion schematic should be taken into the field to serve as reference information. Observations, measurements, and other documentation of the development effort should be recorded on the following:

- Daily Report
- Field Notebook
- Instrument Calibration Log
- Well Development Log

Documentation should include any deviations from this SOP, as well as the documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Prior to entering the site, well development equipment should be decontaminated by steam cleaning, pressure washing, or equivalent.

Prior to development of each well, down-well equipment should be decontaminated by steam cleaning or pressure washing, washing with soap, and rinsing with tap water, or equivalent.

Prior to leaving the site, equipment should be steam cleaned, pressure washed, or equivalent.

7.0 INVESTIGATION-DERIVED WASTE

Development water and decontamination wastewater should be containerized in steel drums. Drums should be labeled with hazardous waste labels, including: generator's name and accumulation date. The drums should also be labeled with a description of contents and well number of waste origination. Waste from different wells may be combined in single drums, but chemically-affected and clean wastes should not be mixed.

8.0 SAFETY

Primary chemical hazards during well development are associated with dermal exposure. Primary protection against dermal exposure includes splash protection and gloves. Air-lift pumping may also exacerbate the release of volatile organic compounds from groundwater to air, thus increasing the risk of exposure; frequent monitoring with the field organic vapor monitor may be employed to mitigate this risk.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.

U.S. Environmental Protection Agency, 1989. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

STANDARD OPERATING PROCEDURE (SOP) 4A
WELL PURGING AND SAMPLING

1.0 INTRODUCTION AND SUMMARY

This SOP describes procedures to purge and sample wells that have been properly installed and developed. Typically, this SOP will be used for sampling monitoring wells with 2- or 4-inch diameter casing. The sampling described herein is appropriate for a variety of groundwater analyses, including: total and dissolved metals, volatile and semi-volatile organic compounds, and general minerals. For newly installed and developed well, the purging and sampling described in this SOP is typically performed at least 7 days after well development to allow ambient groundwater conditions to re-establish in the vicinity of the well.

The procedures described in this SOP should be modified for domestic wells or wells with dedicated sampling equipment. The procedures should also be modified if product is observed in the well.

Typical well sampling and purging activities include decontaminating the purging and sampling equipment, purging the stagnant water from the well casing and filter pack by pumping or bailing, measuring field parameters and evacuated volume of groundwater during purging, terminating the purging process when field parameters stabilize, collecting groundwater samples by pumping or bailing, and labeling and preserving the collected samples.

2.0 EQUIPMENT AND MATERIALS

- Pressure washer or steam cleaner
- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- If sampling is to be performed for metals, dilute (10%) reagent-grade nitric acid for decontamination
- Tap water
- Distilled water
- Deionized water for cross-contamination blanks
- Cooler with ice or dry ice (do not use blue ice)
- Ziplock bags of size to accommodate sample containers
- Steel, 55-gallon, open-top drums, DOT 17H
- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be documented.
- Laboratory-cleaned containers of proper type and size for the analytical parameters (refer to Table 1)
- Reagent-grade chemicals for sample preservation, as required for the analytical parameters (refer to Table 1)

- If dissolved metals analyses are required, 45-micron cellulose acetate filters and filtering device. Alternate filter type and size (cellulose nitrate, Teflon, or glass-fiber pre-filters) may be required as specified in the Quality Assurance Project Plan or Sampling Plan. The make, type, and size of filter, including disposable filters, should be documented.
- Beaker, glass, ±250 milliliter for measurement of field parameters. A similar flow-through cell may also be used.
- Water level meter
- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters. As specified in the Quality Assurance Project Plan or Sampling Plan, oxidation-reduction potential (ORP) or dissolved oxygen meters may also be required.
- Purging equipment consisting of one of the following:

  Bailer: Steel, PVC, Teflon, or stainless steel. Dedicated or new bailer rope.

  Bladder Pump: Plastic or Teflon bladder. 4-inch or 6-inch diameter by ±4-foot long decontamination chambers.

  Submersible Electric Pump: Normally used where relatively large quantities of purge water are expected from wells with quick recharge. Pump should have flow control valve and foot valve. 6-inch diameter by ±4-foot long decontamination chambers.

  Surface Centrifugal Pump: Limited to water lift of approximately 20 feet. Dedicated or new flexible plastic suction hose. Foot valve. Flow control valve.
- Sampling device consisting of one of the following:

  Bailer: Teflon or stainless steel. Dedicated or new bailer rope. If samples are collected for volatile organic compound analysis, bailer should also be fitted with bottom-emptying device.

  Bladder Pump: Teflon bladder. Dedicated or new Teflon or tygon tubing for sample discharge line. 4-inch or 6-inch diameter by ±4-foot long decontamination chambers.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following procedures are intended to cover the majority of purging and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected conditions. Deviations from the following procedures may be expected and should be documented.

1. Remove top cap and perform field organic vapor monitoring of well casing
2. Measure static water level and total depth and compare to historic measurements. Remeasure if discrepancies are noted with historic data.

Document observations of product, if appropriate. Calculate volume of standing water in casing.

3. Decontaminate purging and sampling equipment (see section DECONTAMINATION in this SOP)

4. Begin purging and if possible, adjust purge rate to expose as little of the screened interval as possible (subject to reasonable time constraints). Record the following observations at the beginning of purge, periodically during purge, and during sampling:

   - Purge volume and time
   - pH, temperature, and specific conductivity
   - Turbidity (clarity and color)
   - Approximate drawdown and well yield during purge
   - Whether well was purged dry
   - Other observations (such as presence of product) as appropriate

5. Terminate purging when one of the following conditions is observed:

   Quick Recharge Wells: Well shows stabilized field parameters and at least 3 casing volumes of standing water have been removed - ready for sampling. If field parameters have not stabilized after removal of 5 casing volumes of standing water, terminate purging anyway. Wells should be allowed to recover to at least 1/2 the original standing water depth prior to sampling.

   Slow Recharge Wells: Wells that are initially purged dry, and do not recover to 1/2 the original standing water depth within 4 hours, should be purged dry again and then sampled when sufficient recovery has occured to submerge the sampling bailer or pump. Generally, 3 feet of recovery may be considered sufficient recovery for normal bailer or pump submergence.

6. If possible, sample from mid-depth of screened interval. Otherwise, sample from mid-depth of water column at time of sampling.

7. If dissolved metals analyses are to be performed, filter sample. Also if dissolved metals analyses are to be performed and the sample is moderately turbid or very turbid, collect companion filtered and unfiltered samples.

8. For parameters other than dissolved metals, do not filter sample. Fill sample containers directly and preserve according to the requirements of Table 1. Containers should generally filled to capacity. 40 milliliter glass vials should be filled from the bottom using a sample discharge tube (bottom-emptying device for bailer or discharge tube of bladder pump). 40 milliliter vials should not have headspace.

9. Label sample containers, place in ziplock bag, and place on ice in cooler.

10. Log samples onto chain-of-custody form and maintain sample custody until shipped to laboratory.

11. Containerize purge water, excess sample, and decontamination wastewater in steel drum(s). Label drum(s) with hazardous waste label, contents, and well number from which waste originated.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality control samples should consist of the following:

- Duplicate samples at a frequency of 1 per 10 natural samples
- Cross-contamination blank (also known as a sampler rinsate blank) at a frequency of 1 per 10 natural samples. Cross-contamination blanks are prepared by passing deionized water over and through decontaminated sampling equipment (including sample filter if used).
- If analyses require collection of samples in 40 milliliter vials, travel blanks should also be included at a frequency of 1 per day of sampling.
- Optional quality control samples include standard reference materials and natural matrix spikes.

Meters for measurement of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented on the instrument calibration log.

5.0 DOCUMENTATION

The following information should be collected prior to sampling and taken into the field for reference:

- Well completion schematic
- Summary of historic water level, total depth, and field parameter measurements

Observations, measurements, and other documentation of the purging and sampling effort should be recorded on the following:

- Daily Report
- Field Notebook
- Instrument Calibration Log
- Well Purge and Sample Log
- Chain-of-Custody

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Prior to entering the site, purging and sampling equipment should be decontaminated by steam cleaning, pressure washing, or equivalent.

Prior to sampling each well, down-well equipment and equipment that will contact the sample (except sample containers) should be decontaminated according to the following procedure:

- Steam clean or pressure wash (optional unless oily contamination covers equipment)
- Wash with soap

- Rinse with tap water
- Double rinse with distilled water

If metals are included in the analytical parameters, the decontamination procedures should include:

- Steam clean or pressure wash (optional unless oily contamination covers equipment)
- Wash with soap
- Rinse with tap water
- Rinse with dilute nitric acid (skip for pumps containing metal parts)
- Rinse with tap water
- Double rinse with distilled water

Suction or discharge hoses from purge pumps need external decontamination only. Purge or sampling pumps should be decontaminated by filling the decontamination chamber with the aforementioned solutions and pumping the solutions from the chamber to the waste drum.

Prior to leaving the site, purging and sampling equipment should be steam cleaned, pressure washed, or equivalent.

7.0 INVESTIGATION-DERIVED WASTE

Purge water, excess sample, and decontamination wastewater should be containerized in steel drums. Drums should be labeled with hazardous waste labels, including: Generator's name and accumulation date. Wastes from different wells may be combined, but wastes that are anticipated to contain chemical should not be mixed with waste that are not thought to be contaminated.

8.0 SAFETY

Primary chemical hazards during well purging and sampling are associated with dermal exposure. Acids used for decontamination and sample preservation may also present chemical hazards. Primary protection against dermal exposure includes splash protection and gloves. Special chemical hazards may be associated with the presence of product, if discovered during sampling. Water quality samples are not generally considered representative in the presence of product. Accordingly, it may be appropriate to abandon sampling efforts if product is discovered.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.

U.S. Environmental Protection Agency, 1989a. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

U.S. Environmental Protection Agency, 1989b. USEPA Method Study #39, Method 504, 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP) in Water, Pb 89-119 580/AS. National Technical Information Service, Springfield VA. 1989.

Table 1

Sampling and Preservation for Groundwater Samples

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Purgeable Halocarbons by GC	EPA 8010	Two 40 ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	14 days after collection
Purgeable Aromatics by GC	EPA 8020	Two 40 ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	14 days after collection
Organochlorine Pesticides and PCB's	EPA 8080	Two 1 liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Organophosphorus Pesticides	EPA 8140	Two 1 liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Chlorinated Herbicides (Phenoxy Herbicides)	EPA 8150	Two 1 liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Volatile Organic Compounds by GC/MS	EPA 8240	Two 40 ml glass vials	Cool to 4 degrees Celsius	14 days after collection
Semi-Volatile Organic Compounds by GC/MS (Base/Neutral/Acid Extractable Organics)	EPA 8270	Two 1 liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP)	EPA 504	Two 1 liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Total Petroleum Hydrocarbons as Deisel	Extract by EPA 3550 and analyze by GCFID	Two 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	Extract 7 days after collection Analyze 7 days after extraction
Oil & Grease	SM 503	One 1-liter glass with aluminum foil-lined cap	H_2SO_4 to pH<2, cool to 4 degrees Celsius	28 days after collection
Total Metals	EPA 7000 Series	One 1/2 liter poly	HNO3 to pH<2, cool to 4 degrees Celsius	6 months after collection (28 days for mercury)
Dissolved Metals	EPA 7000 Series	One 1/2 liter poly	HNO3 to pH<2, cool to 4 degrees Celsius	6 months after collection (28 days for mercury)
General Minerals	Various	Two 1 liter poly	Cool to 4 degrees Celsius	7 days after collection

APPENDIX B
Site Safety Plan

SITE SAFETY PLAN

The contents of this site safety plan are based in part upon experience and judgement and in part on known features of the site. This plan should not be used as a substitute for good judgement if unanticipated conditions are encountered during field work.

Anticipated Field Work The field work anticipated during preparation of this plan includes: drilling, soil sampling, piezometer and monitoring well construction, and monitoring well sampling.

Chemical Hazard Evaluation Chemicals detected in soil underlying the site during previous work were gasoline, benzene, toluene, ethylbenzene, xylenes, and lead. Table B1 compares the maximum reported concentration of these chemicals in soil from the subject site with applicable exposure standards. The comparison presented in Table B1 demonstrates a moderate likelihood for the presence of concentrations of these chemicals at levels of concern.

Physical Hazard Evaluation Physical hazards which may be be encountered while working on this project are anticipated to include: work around heavy machinery, heavy lifting, slip-trip-fall, loud noise, and exposure to the weather.

Health and Safety Responsibilities This site safety plan will be implemented by the site safety officer under the supervision of the project manager, and in coordination with appropriate client representatives. Safety personnel and their responsibilities are presented in Table B2.

Work Zone A work zone will be established around the drilling rig and monitoring well during the work. The work zone is an area of sufficient size to allow safe completion of the work while maintaining control of access to the work area. The work zone will be maintained by requesting people not directly involved in the drilling operation to stay out of the immediate work area, or other suitable means.

No smoking or chewing of tobacco, eating, or drinking will be allowed in the work zone. An area will be designated onsite for short breaks, if necessary.

Personal Protective Equipment Since available chemistry data do not indicate a likelihood for worker exposure to the contaminants of concern, field work will begin in modified Level-D personal protection. Modified Level-D health and safety requirements are summarized in Table B3.

If monitoring results obtained during drilling exceed the action levels specified below, then personal protective equipment will be upgraded to modified Level-C (Table B3).

Monitoring Visual monitoring is the responsibility of everybody on the work site. Onsite workers should evaluate themselves for signs of fatigue as the work progresses. Work breaks should be taken as reasonably required to maintain worker efficiency. Modifications to work schedules should be made as required to promote worker safety.

Atmospheric monitoring of the work area will involve use of a photo-ionization device (PID) capable of detecting organic vapors such as benzene, toluene, ethylbenzene, and xylenes. The PID should allow quantification of organic vapors to 1 part per million in air (volume/volume). Atmospheric monitoring will focus on the breathing zone of workers within the work zone. If continual readings greater than 5 ppm above background are detected in the breathing zone on the PID, then personal protective equipment will be upgraded to modified Level-C from modified Level-D. 5 ppm was selected as a conservative upgrade criteria as this is one-half the 8-hour time weighted average exposure limit for benzene (Table B1). If continual readings greater than 100 ppm above background are recorded in the breathing zone then work will stop. Work will be resumed upon consultation with the project manager and client, and may include additional safety precautions.

Emergency Procedures. These procedures are designed to allow rapid treatment of workers for injuries or exposure to hazardous substances ocurring on the worksite. A secondary purpose of these procedures is to allow documentation of emergencies which occur on the job. As in other aspects of this workplan, good judgement and logic should prevail in an emergency. Modifications to these procedures may be required in response to unanticipated conditions encountered in the field.

Emergency information is summarized in Table B4 and Figure B1.

If required, first aid should be provided for the injured worker.

The site safety officer should be notified immediately of an emergency. It is the site safety officers responsibility to document the emergency, and report it to the project manager and client representative in a timely manner.

Documentation Documentation specific to the Site Safety Plan consists of the tail gate safety meeting form. A copy of the tailgate safety meeting form is included as Attachment B1. Health and safety issues not addressed on the tailgate safety meeting form should be recorded in the field notebook.

Decontamination Decontamination refers to removal of possible chemicals from workers and monitoring equipment. In many instances removal and thorough cleaning of work clothing is adequate for worker decontamination. However if skin contact with chemical containing material occurs during field work, the affected area should be scrubbed thoroughly with soap and water.

Monitoring equipment should be kept clean by wiping as required with a paper towel or other suitable material.

Health and Safety Wastes Wastes generated by health and safety practices are disposable protective equipment such as gloves, tyvek-coveralls, and boot covers. These items may be disposed of by placing them in a garbage bag and then a garbage dumpster.

Table B1

Maximum Residual Environmental Concentrations and Relevant Exposure Criteria

Chemical	Maximum Residual Concentration in Soil (mg/kg)	Permissible Exposure Limit (ppm v/v)	8 Hour Time Weighted Average (ppm v/v)	Immediately Dangerous to Life and Health (ppm v/v)
Benzene	4.1	NA	10	NA
Toluene	28	100	100	2000
Ethylbenzene	14	100	100	2000
Xylenes	68	100	100	10,000
Gasoline	5,300	500	300	NA
Oil and Grease	<100	NA	NA	NA
Lead	11	0.15 mg/m^3	<0.1 mg/m^3 (10 hour time weighted Average)	NA

General Notes

(a) Exposure criteria from American Conference of Governmental Industrial Hygienists, *Threshold Limit Values and Biological Exposure Indices for 1988-1989*, and National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards*, 1985

(b) NA indicates no applicable value listed in cited references

(c) < indicates parameter below detection limit

(d) Maximum residual concentrations do not include contamination that has been treated or removed form the site

Table B2

Safety Personnel and Responsibilities

Personnel	Responsibilities
Project Manager (Doug Lovell)	Enforcement of Site Safety Plan, provide properly trained onsite personnel to complete the work, coordination of safety issues with client.
Site Safety Officer (Greg Reller)	Enforcement of Site Safety Plan, coordination and documentation of field safety procedures, communication of safety issues to project manager, delineate work zone, atmospheric monitoring, review site safety procedures with subcontractors (drillers), conduct tailgate site safety meeting (form presented in Attachment B1), contact Underground Service Alert, clear underground utilities, maintain adequate supply of safety equipment onsite
Subcontractor's (Drillers) Site Safety Officer	Understand and obtain subcontracting crews' compliance with Site Safety Plan, maintain onsite supply of safety equipment for subcontractor's personnel, relay safety concerns to Site Safety Officer

Table B3

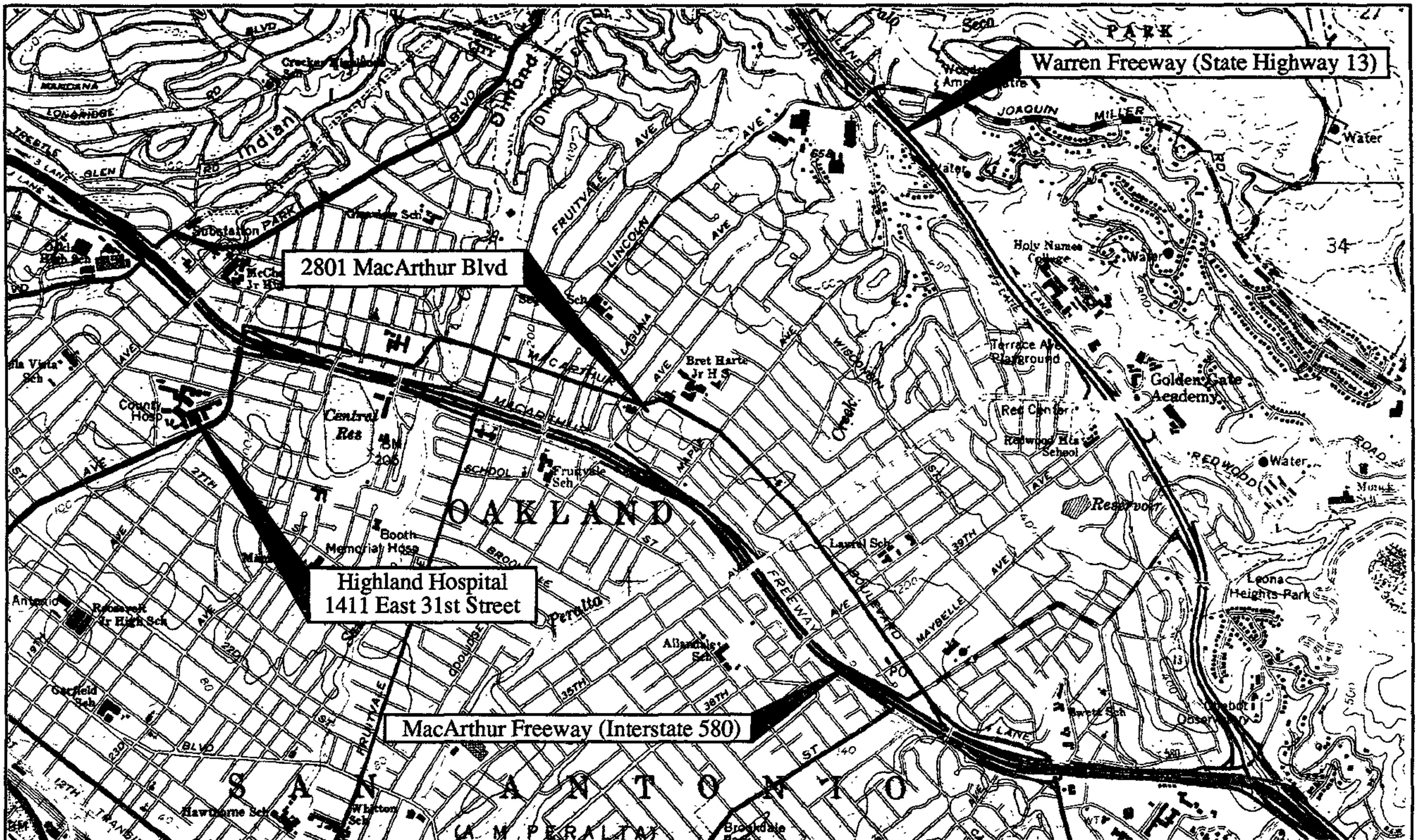
Personnel Protective and Monitoring Equipment

Item	Requirement
Modified Level-D Personal Protective Equipment	Hardhat, dedicated work clothing (cotton coveralls or tyveks), chemical resistant steel toed boots, work gloves or chemical resistant gloves (as appropriate), first aid kit, fire extinguisher, optional eye and hearing protection.
Modified Level-C Personal Protective Equipment	Add Half-face respirator with OV-HEPA cartridges and required tyveks to modified Level-D protective equipment. Change respirator cartridges upon detection of breakthrough (by smell), increase in breathing resistance, or daily (whichever is more frequent)
Atmospheric Monitoring	PID capable of detecting organic vapor concentrations of 1 ppm. PID to be calibrated to known reference gas daily. Action levels (measurement in the breathing zone of work area): >10 ppm for 10 minutes: upgrade to modified Level C >100 ppm: stop work, consult with project manager and client
Visual Monitoring	Evaluate co-workers for signs of fatigue and visual signs of distress due to physical labor and possible chemical exposure.

Table B4

Emergency Information

Emergency Service or Contact	Telephone	Address and Directions
Hospital	(415)534-8055	Highland Hospital 1411 East 31st Street Oakland CA • Drive northwest (towards Berkeley) from the site on MacArthur Boulevard • Turn left on 14th Street • Turn right on 31 st Street, the hospital is located on the left • Refer to Figure B1
Ambulance	911	
Fire Department	911	
Police Department	911	
On-site Telephone	To be determined	
Streamborn Site Safety Officer	Greg Reller 415/528-4234 (work)	
Streamborn Project Manager	Doug Lovell 415/528-4234 (work) 415/528-2613 (home)	
CaliFrance	Nicholas Molnar 415/452-4711 (work)	
Subcontractors	To be determined	



Basemap Reference: U.S. Geological Survey, 7.5 Minute Topographic Quadrangle, Oakland East CA

0 0.5 1.0

Approximate Scale in Miles

0 5,000

Approximate Scale in Feet

N

Figure B-1

Hospital Location Map

2801 MacArthur Blvd
Oakland CA

STREAMBORN

Attachment B1
Tailgate Safety Meeting

Client: ______________________________ Date: ____________________

Address: ______________________________ Time: ____________________

______________________________ Work Site: ____________________

______________________________ ____________________

Work Description: ____

____

Potential Chemical Hazards: ____

____

Physical Hazards: ____

____

____

Protective Clothing/Equipment: ____

____

Conditions for Upgrade of Protective Equipment: ____

____

Nearest Emergency Hospital: ______________________________ Telephone: ____________________

Route To Hospital: ____

____

____

Attendees

Printed Name	Signature
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

Meeting Conducted By:

____________________ ____________________