STREAMBORN

510/528-4234
Fax 528-2613

STID 23

Larry Seto
Alameda Department of Environmental Health
80 Swan Way, Room 200
Oakland CA 94621

31 January 1992

Project No. P67

Workplan
Supplemental Soil and Groundwater Investigation
2801 MacArthur Boulevard 94602
Oakland CA

Dear Mr. Seto:

On behalf of Nicholas Molnar of A.P.A. Fund Limited, we are transmitting the subject workplan. Please contact Mr. Molnar at 510/452-4711 with any questions or comments.

Sincerely,

STREAMBORN

Mark W. Buscheck
Geologist

Attachment

Mail: P.O. Box 9504, Berkeley CA 94709-0504 Office: 900 SantaFe Avenue, Albany CA 94706

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Supplemental Soil and Groundwater Investigation
2801 MacArthur Boulevard
Oakland CA

Prepared For:
A.P.A. Fund Limited
Oakland CA

Prepared By:
STREAMBORN
Berkeley CA

Project No. P67

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Mail: P.O. Box 9504, Berkeley CA 94709-0504 Office: 900 SantaFe Avenue, Albany CA 94706

CONTENTS

Introduction 1

Background 1

Purpose and Rationale 2

Scope of Work 2
- Drilling, Soil Sampling, and Soil Analysis 2
- Well Completion 3
- Surveying 3
- Well Development 3
- Well Purging, Sampling, and Groundwater Analysis 3
- Investigation-Derived Waste 4
- Reporting 4

Quality Assurance/Quality Control 4
- Field-Generated Quality Control Samples 5
- Laboratory-Generated Quality Control Samples 5
- Field Meter Quality Control Procedures 5

Schedule 5

Health and Safety 5

Tables (following text)
- 1 - Chronology of Field Work
- 2 - Soil Results from Borings
- 3 - Results of Groundwater Analyses
- 4 - Groundwater Elevation Measurements
- 5 - Soil Sampling and Testing Requirements
- 6 - Well Completions Specifications
- 7 - Groundwater Sampling and Testing Requirements

Contents (continued)

Figures (following tables)

1 - Location Map

2 - Facility Plan

3 - Summary of Soil Analyses for Total Petroleum Hydrocarbons as Gasoline

4 - Summary of Soil Analyses for Benzene, Toluene, Ethylbenzene, and Xylenes

5 - Summary of Groundwater Analyses

6 - Groundwater Elevations (May 1991 and January 1992)

7 - Proposed Boring and Monitoring Well Locations

8 - Monitoring Well Completion Schematic

Appendices (following figures)

A - Standard Operating Procedures

B - Site Safety Plan

INTRODUCTION

This workplan describes drilling of 3 borings and completion of 2 of the borings as monitoring wells at 2801 MacArthur Boulevard, Oakland CA, (Figure 1). The workplan was prepared in response to the Alameda County Department of Environmental Health's letter dated 16 December 1991, requesting further definition of the extent of soil and groundwater contamination.

As described in the workplan, 3 soil borings will be advanced to a depth of approximately 45-feet. During drilling, soil samples will be collected at 5-foot centers or noticeable changes in strata, and approximately three selected samples from each boring will be analyzed for total petroleum hydrocarbons as gasoline (TPH-gasoline) and benzene, toluene, ethylbenzene, and xylenes. Two of the borings will be completed as 2-inch diameter monitoring wells. The new monitoring wells will be developed and sampled for four quarters. Two existing monitoring wells will also be sampled fro four quarters. Groundwater samples will be analyzed for TPH-gasoline and benzene, toluene, ethylbenzene, and xylenes. Analytical data will be combined with the existing soil and groundwater database and interpreted with respect to the nature and extent of contamination.

BACKGROUND

A chronology of environmental activity is summarized in Table 1.

The subject property was operated as a service station for numerous years. In May 1989, three underground gasoline tanks and petroleum-contaminated soil were removed from a single (common) excavation. In June 1989, a boring (B1) was drilled adjacent to the former gasoline tanks excavation. In July 1989, a waste oil tank and petroleum-contaminated soil were removed. Eight additional soil borings (B2 through B9) were drilled in July and August 1989. Two additional soil borings (B10 and B11), two piezometers (P1 and P2) and one monitoring well (M1) were installed in October 1990. An additional piezometer (P3) and monitoring well (M2) were installed in March and April 1991. Water levels have been periodically monitored and groundwater samples have been collected and analyzed. Excavation, boring, piezometer, and well locations are shown on Figure 2. Analytical results from borings are contained in Table 2 and summarized on Figures 3 and 4. Groundwater analytical measurements are presented in Table 3 and summarized on Figure 5. Groundwater elevation measurements are presented in Table 4 and summarized on Figure 6. The aforementioned work was performed by Riedel Environmental Services (reports dated 9 June 1989, 20 June 1989, and 14 December 1989) and Streamborn (reports dated 20 August 1991 and 31 January 1992).

These investigations indicate the presence of a zone of soil with elevated concentrations of TPH-gasoline located in the central portion of the property (Figure 3). This zone of soil contamination is found at a depth of approximately 30 to 35 feet which is approximately coincident with the groundwater table. To the north, east, and south of the former tanks, the lateral limits of this gasoline-contaminated soil zone are defined using data from the 16 borings/piezometers/wells The westerly limits of soil contamination are not as well defined.

The groundwater sampling results reveal elevated concentrations of dissolved gasoline and associated compounds (benzene, toluene, ethylbenzene, and xylenes). M2 and P2 have been sampled twice and P1 sampled once.

Groundwater analytical results reveal a dramatic decrease in concentrations from (1) M2 and P2, located near the former source areas, to (2) P1, located approximately 70-feet downgradient of the former source areas (Figure 5). Because P1 (which was originally constructed as a piezometer and not a monitoring well) intercepts (only) the upper ±2-feet of the saturated zone, we suspect the measured concentrations are unrepresentatively elevated; were P1 to intercept the upper ±10-feet of groundwater (like "normal" monitoring wells), lower concentrations would result. Despite this hypothesis, the most downgradient monitoring location (P1) shows contamination and the downgradient limits of chemically-affected groundwater have yet to be determined.

The subject property is located on the Oakland upland and rests upon Quaternary older alluvium. Soil observed during installation of piezometers and monitoring wells indicate the property is underlain by mixtures and layers of clay, silt, silty-sand, clayey-sand, silty-gravel, clayey-gravel, sand, and gravel. The sand and gravel deposits appear to be discontinuous across the property. Groundwater movement is probably limited by fine-grained strata which envelope the more-permeable, coarse-grained lenses.

The direction of groundwater gradient is south to southeast (Figure 6).

PURPOSE AND RATIONALE

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

- Better definition of the lateral extent of soil contamination toward the western edge of the property.
- Determination of the downgradient extent of groundwater contamination.

To further characterize the lateral extent of soil contamination toward the west, soil boring (only) B12 is proposed (Figure 7). B12 is sidegradient of existing piezometer P2, where elevated soil concentrations have been measured (Figure 3). Additionally, soil results from proposed monitoring well M4 will augment the database in the western portion of the property. Proposed well M4 is downgradient of boring B11, where elevated concentrations have been measured.

The proposed soil boring (only) and proposed wells will be advanced to a depth of ±45-feet. Both the proposed soil boring (only) and proposed wells are located at the property boundary.

To define the extent of groundwater contamination downgradient of the former source areas, monitoring wells M3 and M4 are proposed (Figure 7). The proposed locations are: (1) positioned 100- to 200-feet downgradient of the former source areas, (2) abutting the property boundary, and (3) positioned to account for the measured variance in the direction of groundwater gradient. The wells will be screened within the upper 10-feet of the saturated zone (Figure 8).

After development, new wells M3 and M4 will be sampled quarterly for 1 year. The quarterly monitoring will also include existing well M2 and existing piezometer P2. The proposed monitoring program should serve to document groundwater quality in the source area and attenuation to the downgradient boundary of the property.

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)'.

SCOPE OF WORK

Drilling, Soil Sampling, and Soil Analysis

The three soil borings (including two to be completed as monitoring wells) 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 Sampling (Appendix A). Soil sampling and testing requirements are delineated in Table 5.

Soil samples should be collected and retained for potential testing at maximum 5-foot intervals or discernable changes in subsurface 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.

Approximately three samples from each boring should be analyzed and the remaining samples should be archived. In the event of soil or groundwater contamination, 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, for possible future well installations.

Soil samples should be analyzed for TPH-Gasoline (GCFID EPA 5030) and benzene, toluene, ethylbenzene, and xylenes (EPA 8020). These analytes were selected based upon their detection in historic soil and groundwater sampling at the property.

Well Completion

Two 2-inch diameter groundwater monitoring wells should be constructed in accordance with guidelines outlined in Standard Operating Procedure 2A: Completion of Borings as Wells (Appendix A), the schematic contained in Figure 8, and specifications delineated in Table 6 .

The conditions anticipated during preparation of this workplan may not be encountered and modifications to the well completion specifications 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 be terminated 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 the possibility of cross contamination.

Surveying

The monitoring well elevations should be surveyed relative to an assumed site-specific datum (Temporary Bench Mark #1, top of concrete, western edge of the northernmost pump island, assumed Elevation = 1,000.00 feet, Figure 7).

Our elevation data should not be confused with the ground surface topographic contours contained on the basemap for the property. Two different datums were used. At the time of our original (survey) work, we were not aware of the existence of the basemap and its elevation data.

Well Development

The groundwater monitoring wells 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 wells according to the desired criteria.

Well Purging, Sampling, and Groundwater Analysis

New wells M3 and M4, as well as existing wells M2 and existing piezometer P2, should be sampled quarterly for a complete hydrogeologic cycle. Groundwater monitoring well sampling should conform to Standard Operating Procedure 4A: Well Purging and Sampling (Appendix A). Groundwater sampling should include purging to draw fresh formation water into the wells. If the wells do not provide sufficient recharge, the purge step may be abbreviated. Groundwater sampling requirements are summarized in Table 7.

The first sampling event will be conducted approximately 1 week after well development of the new wells, with subsequent sampling events every quarter.

Groundwater samples should be analyzed for TPH-Gasoline (GCFID EPA 3550) and and benzene, toluene, ethylbenzene, and xylenes (EPA 8020). These analytes were selected based upon their detection in historic soil and groundwater sampling at the property.

Investigation-Derived Waste

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 drilling, soil sampling, completion of groundwater monitoring well construction, well development, initial groundwater analytical results, and disposition of investigation-derived waste. 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 analytical results with results of earlier sampling rounds. The quarterly updates should discuss any changes in chemistry or water level.

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 the representativeness of the natural samples is suspect. 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.

SCHEDULE

The following schedule is anticipated:

- Notify underground alert and file well permit - 1 week.
- Drilling, soil sampling, and well installations - 2 field days (subject to driller availability).
- Survey and develop 2 new wells (M3 and M4) - 1 field day, 1 week between well development and sampling.
- Sample wells (P2, M2, and 2 new wells - M3 and M4) - 1 field day, 2 weeks for analytical results.
- Initial report - 1 week.
- Purge and sample wells, quarterly updates - 3 quarters.

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.

Table 1

Chronology of Field Work

Date	Performed By	Field Activity
May 1989	Riedel	Three underground gasoline tanks removed from a single excavation; verification soil sampling conducted.
12 June 1989	Riedel	Drilling and soil sampling of boring B1.
3 July 1989	Riedel	Underground waste oil tank and associated petroleum-stained soil removed, verification soil sampling conducted.
13 and 14 July and 25, 28, and 30 August 1989	Riedel	Drilling and soil sampling of borings B2 through B9.
18 October 1990	Streamborn	Drilling and soil sampling of borings B10 and B11. Measurement of water levels.
19 October 1990	Streamborn	Drilling and soil sampling of P1. Partial drilling and soil sampling of P2. Completion of P1 as a piezometer. Surveying of ground surface at B10, B11, P1, and P2. Measurement of water levels.
20 October 1990	Streamborn	Complete drilling and soil sampling of P2. Partial completion of P2 as a piezometer. Drilling, soil sampling, and partial completion of M1 as a monitoring well. Measurement of water levels.
21 October 1990	Streamborn	Completion of M1 and P2. Grouting of B10 and B11. Measurement of water levels.
25 October 1990	Streamborn	Surveying of measuring points for M1, P1, and P2. Measurement of water levels.
26 October 1990	Streamborn	Measurement of water levels. Bailing of P1, P2, and M1 to allow recovery and verification of water levels.
2 November 1990	Streamborn	Measurement of water levels. Monitoring for floating product at P1, P2, and M1 using an interface probe (no product detected).
6 November 1990	Streamborn	Development and sampling of P2.
16 November 1990	Streamborn	Measurement of water levels.
23 November 1990	Streamborn	Measurement of water levels.
28 November 1990	Streamborn	Measurement of water levels.
5 December 1990	Streamborn	Measurement of water levels.
18 March 1991	Streamborn	Drilling, soil sampling, and completion of P3 as a piezometer. Measurement of water levels.
29 March 1991	Streamborn	Measurement of water levels.
3 April 1991	Streamborn	Measurement of water levels.
9 April 1991	Streamborn	Measurement of water levels.
16 April 1991	Streamborn	Measurement of water levels.
18 April 1991	Streamborn	Drilling, soil sampling, and completion of M2 as a monitoring well. Measurement of water levels.
30 April 1991	Streamborn	Development of M2. Measurement of water levels.
7 May 1991	Streamborn	Purging and sampling of M2. Measurement of water levels.
16 January 1992	Streamborn	Measurement of water levels, purging and sampling of P1, P2, and M2.
23 January 1992	Streamborn	Measurement of water levels.

General Notes

(a) Riedel = Riedel Environmental Services, Richmond CA.

(b) Streamborn = Streamborn, Berkeley CA.

Table 2

Soil Results from Borings

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sampler	Sample Type	TPH - Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Oil & Grease (mg/kg)	Field Screening (ppm v/v)
B1	B1-20	20.0-20.5	12 June 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B1	B1-25	25.0-25.5	12 June 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B1	B1-30	30.0-30.5	12 June 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-5.0	5.0-5.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-10.0	10.0-10.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-15.0	15.0-15.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-20.0	20.0-20.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-25.0	25.0-25.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-30.0	30.0-30.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B2	B-2-35.0	35.0-35.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-5.0	5.0-5.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-10.0	10.0-10.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-15.0	15.0-15.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-20.0	20.0-20.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-25.0	25.0-25.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-30.0	30.0-30.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-35.0	35.0-35.5	14 July 1989	Riedel	SS-Liner	72	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-38.0	38.0-38.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-39.5	39.5-40.0	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-41.0	41.0-41.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B3	B-3-42.0	42.0-42.5	13 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-5.0	5.0-5.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-10.0	10.0-10.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-15.0	15.0-15.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-20.0	20.0-20.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-25.0	25.0-25.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-30.0	30.0-30.5	14 July 1989	Riedel	SS-Liner	150	<0.25	<0.5	<0.5	<0.5	NM	NA

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sampler	Sample Type	TPH - Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Oil & Grease (mg/kg)	Field Screening (ppm v/v)
B4	B-4-35.0	35.0-35.5	14 July 1989	Riedel	SS-Liner	5,300	<5.0	<10.0	<10.0	<10.0	NM	NA
B4	B-4-36.5	36.5-37.0	14 July 1989	Riedel	SS-Liner	7.9	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-38.0	38.0-38.5	14 July 1989	Riedel	SS-Liner	<1.0	<0.05	<0.1	<0.1	<0.1	NM	NA
B4	B-4-39.0	39.0-39.5	14 July 1989	Riedel	SS-Liner	71	<0.25	<0.5	<0.5	<0.5	NM	NA
B4	B-4-40.5	40.5-41.0	14 July 1989	Riedel	SS-Liner	15	<0.05	<0.1	<0.1	<0.1	NM	NA
B5	B-5-20	20.0-20.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B5	B-5-25	25.0-25.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B5	B-5-30	30.0-30.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B5	B-5-35	35.0-35.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B5	B-5-40	40.0-40.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B5	B-5-45	45.0-45.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B6	B-6-20	20.0-20.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B6	B-6-25	25.0-25.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B6	B-6-30	30.0-30.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B6	B-6-35	35.0-35.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B6	B-6-40	40.0-40.5	24 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-15	15.0-15.5	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-20	20.0-20.5	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-25	25.0-25.5	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-30	30.0-30.5	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-33	33.0-33.5	25 August 1989	Riedel	SS-Liner	380	0.130	3.00	1.00	3.50	NM	NA
B7	B-7-36	36.0-36.5	25 August 1989	Riedel	SS-Liner	65	<0.025	0.120	0.190	0.440	NM	NA
B7	B-7-41	41.0-41.5	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-45.5	45.5-46.0	25 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B7	B-7-51.0	51.0-51.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B8	B-8-15	15.0-15.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	0.097	<0.075	<0.075	NM	NA
B8	B-8-20	20.0-20.5	28 August 1989	Riedel	SS-Liner	21	<0.025	0.190	0.360	0.630	NM	NA
B8	B-8-25	25.0-25.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	0.050	<0.075	<0.075	NM	NA

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sampler	Sample Type	TPH - Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Oil & Grease (mg/kg)	Field Screening (ppm v/v)
B8	B-8-30	30.0-30.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B8	B-8-35.5	35.5-36.0	28 August 1989	Riedel	SS-Liner	<10	<0.025	0.130	0.150	0.260	NM	NA
B8	B-8-40.5	40.5-41.0	28 August 1989	Riedel	SS-Liner	<10	<0.025	0.056	<0.075	<0.075	NM	NA
B8	B-8-45	45.0-45.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B8	B-8-50	50.0-50.5	28 August 1989	Riedel	SS-Liner	<10	<0.025	0.220	<0.075	<0.075	NM	NA
B9	B-9-6.5	6.5-7.0	28 August 1989	Riedel	SS-Liner	20	0.026	0.046	<0.075	0.200	NM	NA
B9	B-9-9.5	9.5-10.0	30 August 1989	Riedel	SS-Liner	<10	<0.025	<0.025	<0.075	<0.075	NM	NA
B9	B-9-16.5	16.5-17.0	30 August 1989	Riedel	SS-Liner	490	0.700	0.610	2.000	15.000	NM	NA
B9	B-9-21.0	21.0-21.5	30 August 1989	Riedel	SS-Liner	1,500	4.1	3.4	14.0	62.0	NM	NA
B9	B-9-26.5	26.5-27.0	30 August 1989	Riedel	SS-Liner	1,100	3.0	28.0	13.0	68.0	NM	NA
B9	B-9-31.5	31.5-32.0	30 August 1989	Riedel	SS-Liner	79	0.350	0.800	0.610	2.0	NM	NA
B9	B-9-35.0	35.0-35.5	30 August 1989	Riedel	SS-Liner	<10	0.390	0.130	<0.075	0.200	NM	NA
B9	B-9-40.5	40.5-41.0	30 August 1989	Riedel	SS-Liner	<10	<0.025	0.043	<0.075	<0.075	NM	NA
B9	B-9-45.5	45.5-46.0	30 August 1989	Riedel	SS-Liner	<10	<0.025	0.066	<0.075	<0.075	NM	NA
B9	B-9-51.0	51.0-51.5	30 August 1989	Riedel	SS-Liner	<10	0.310	0.046	<0.075	<0.075	NM	NA
B10	B10, 15.5-16	15.5-16	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
B10	B10, 21-21.5	21-21.5	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	1-47
B10	B10, 30.5-31	30.5-31	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	4.5-31
B10	B10, 45.5-46	45.5-46	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
B11	B11, 21-21.5	21-21.5	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
B11	B11, 31-31.5	31-31.5	18 October 1990	Streamborn	SS-Liner	230	0.15	0.47	0.88	1.60	<10	420-430
B11	B11, 36-36.5	36-36.5	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	12-225
B11	B11, 46-46.5	46-46.5	18 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
P1	P1, 25.5-26	25.5-26	19 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	NM	<1
P1	P1, 35-35.5	35-35.5	19 October 1990	Streamborn	SS-Liner	7.4	0.011	<0.005	<0.005	<0.005	NM	48-50
P1	P1, 40.5-41	40.5-41	19 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	NM	133
P1	P1, 49.7-50.3	49.7-50.3	19 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	NM	1-39
P2	P2, 20.5-21	20.5-21	19 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1

See notes on last page

Table 2 (continued)

Sample Location	Sample Designation	Sample Depth (feet)	Sample Date	Sampler	Sample Type	TPH - Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Oil & Grease (mg/kg)	Field Screening (ppm v/v)
P2	P2, 30-30.5	30-30.5	19 October 1990	Streamborn	SS-Liner	20	0.018	<0.005	<0.005	0.013	<10	276-296
P2	P2, 35.5-36	35.5-36	19 October 1990	Streamborn	SS-Liner	95	0.21	0.20	0.14	0.33	<10	328-422
P2	P2, 55.5-56	55.5-56	19 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
P3	P3, 35.5-36	35.5-36	18 March 1991	Streamborn	SS-Liner	990	5.8	24	11	20	NM	69-132
P3	P3, 40.5-41	40.5-41	18 March 1991	Streamborn	SS-Liner	<1	<0.005	<0.005	<0.005	<0.005	NM	<1
M1	M1, 20.5-21	20.5-21	20 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
M1	M1, 25.5-26	25.5-26	20 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	2
M1	M1, 35.5-36	35.5-36	20 October 1990	Streamborn	SS-Liner	82	<0.005	0.019	0.028	0.026	<10	86-294
M1	M1, 45.5-46	45.5-46	20 October 1990	Streamborn	SS-Liner	<2.5	<0.005	<0.005	<0.005	<0.005	<10	<1
M2	M2, 26-26.5	26-26.5	18 April 1991	Streamborn	SS-Liner	1.3	0.32	<0.005	0.04	0.036	NM	18-19
M2	M2, 31-31.5	31-31.5	18 April 1991	Streamborn	SS-Liner	490	<0.005	0.41	3.4	7.5	NM	95-138
M2	M2, 36-36.5	36-36.5	18 April 1991	Streamborn	SS-Liner	33	<0.005	0.072	0.099	0.094	NM	135-151
M2	M2, 41-41.5	41-41.5	18 April 1991	Streamborn	SS-Liner	25	0.17	0.079	0.13	0.12	NM	112-116
M2	M2, 46-46.5	46-46.5	18 April 1991	Streamborn	SS-Liner	<1	<0.005	<0.005	<0.005	<0.005	NM	<1

General Notes

(a) NM indicates parameter not measured.

(b) NA indicates data not available.

(b) < indicates parameter below detection limits.

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

(d) Riedel = Riedel Environmental Services, Richmond CA.

(e) Streamborn = Streamborn, Berkeley CA.

Table 3

Results of Groundwater Analyses

Sample Location	Sample Designation	Sample Date	Sample Collection Method	Total Petroleum Hydrocarbons As Gasoline (µg/l)	Benzene (µg/l)	Toluene (µg/l)	Ethyl-benzene (µg/l)	Xylenes (µg/l)	Comments
P2	P2	6 November 1990	Purge and Sample with Bailer	33,000	4,700	2,100	380	630	Elevated specific conductance and pH were measured during sampling. These elevated measurements reflect the effect of grout seal abutting the base of the filter-pack.
P2	16Jan92P2	16 January 1992	Purge and Sample with Bailer	99,000	6,500	12,000	2,000	16,000	Elevated pH and partially elevated specific conductance measured during sampling. The elevated measurements relect the effect of grout seal abutting the base of the filter-pack. Approximately 1/16-inch of free product was initially observed in bailer and a product sheen was observed in the sample container.
M2	M2-GW1	7 May 1991	Purge and Sample with Bailer	16,000	1,300	950	170	890	
M2	16Jan92M2	16 January 1992	Purge and Sample with Bailer	22,000	960	570	370	1,800	
P1	16Jan92P1	16 January 1992	Purge and Sample with Bailer	6,700	500	4.4	80	40	

General Note

(a) Laboratory analyses by Chromalab, San Ramon CA

Table 4

Groundwater Elevation Measurements

Location	B10		B11		M1		M2		P1		P2		P3	
Measuring Point	Ground Surface-N Side, Elevation 998.6		Ground Surface-N Side, Elevation 997.8		Top of PVC Casing-N Side, Elevation 1,000.0 (Ground Surface-N Side, Elevation 1,000.3)		Top of PVC Casing-N Side, Elevation 999.6 (Ground Surface-N Side, Elevation 999.9)		Top of PVC Casing-N Side, Elevation 999.6 (Ground Surface-N Side, Elevation 999.8)		Top of PVC Casing-N Side, Elevation 997.8 (Ground Surface-N Side, Elevation 998.1)		Top of PVC Casing-N Side, Elevation 999.1 (Ground Surface-N Side, Elevation 999.3)	
	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
Intercepted Interval	0.0 to 50.0	948.6 to 998.6	0.0 to 51.5	946.3 to 997.8	32.5 to 45.9	954.4 to 967.8	35 to 45	954.9 to 964.9	27.5 to 38.8	961.0 to 972.3	33 to 43	955.1 to 965.1	35 to 45	964.3 to 954.3
18 October 1990 (18:45 hrs)	45.6	953	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
19 October 1990 (10:00 hrs)	37.8	960.8	32.0	965.8	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
19 October 1990 (13:20 hrs)	37.2	961.4	31.6	966.2	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
20 October 1990 (8:00 hrs)	35.0	963.8	32.2	965.6	NM	NM	NM	NM	38.0 (1)	961.8 (1)	NM	NM	NM	NM
21 October 1990 (9:00 hrs)	34.5	964.1	32.4	965.4	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
24 October 1990	NM	NM	NM	NM	36.1	963.9	NM	NM	37.9	961.7	41.1	956.7	NM	NM
25 October 1990	NM	NM	NM	NM	36.1	963.9	NM	NM	38.0	961.6	40.6	957.2	NM	NM
2 November 1990 (2)	NM	NM	NM	NM	36.4	963.6	NM	NM	38.4	961.2	38.4	959.4	NM	NM
6 November 1990	NM	NM	NM	NM	36.8	963.2	NM	NM	38.7	960.9	37.0	960.8	NM	NM
16 November 1990	NM	NM	NM	NM	36.8	963.2	NM	NM	38.3	961.3	37.4	960.4	NM	NM
23 November 1990	NM	NM	NM	NM	36.9	963.1	NM	NM	38.1	961.5	35.9	961.9	NM	NM
28 November 1990	NM	NM	NM	NM	37.0	963.0	NM	NM	38.3	961.3	35.4 (3)	962.4 (3)	NM	NM
5 December 1990	NM	NM	NM	NM	37.2	962.8	NM	NM	38.2	961.4	35.0 (3)	962.8 (3)	NM	NM
18 March 1991	NM	NM	NM	NM	35.8	964.2	NM	NM	37.8	961.8	31.4 (3)	966.4 (3)	NM	NM
29 March 1991	NM	NM	NM	NM	32.4	967.6	NM	NM	36.9	962.7	28.2 (3)	969.6 (3)	24.7	974.4
3 April 1991	NM	NM	NM	NM	31.9	968.1	NM	NM	36.8	962.8	26.8 (3)	971.0 (3)	25.1	974.0
9 April 1991	NM	NM	NM	NM	31.6	968.4	NM	NM	36.9	962.7	26.5 (3)	971.3 (3)	25.9	973.2
16 April 1991	NM	NM	NM	NM	31.2	968.8	NM	NM	36.7	962.9	26.5 (3)	971.3 (3)	26.2	972.9
18 April 1991	NM	NM	NM	NM	31.1	968.9	NM	NM	36.8	962.8	26.5 (3)	971.3 (3)	26.2	972.9
30 April 1991	NM	NM	NM	NM	31.1	968.9	31.1 (3)	968.5 (3)	36.3	963.3	26.7 (3)	971.1 (3)	26.8	972.3
7 May 1991	NM	NM	NM	NM	31.2	968.8	31.3 (3)	968.3 (3)	36.2	963.4	27.0 (3)	970.8 (3)	27.4	971.7
16 January 1992	NM	NM	NM	NM	NM	NM	35.1 (3)	964.5 (3)	36.6 (3)	963.0 (3)	33.7 (3)	964.1 (3)	NM	NM
23 January 1992	NM	NM	NM	NM	35.5	964.5	NS	NS	NS	NS	NS	NS	32.5	966.6
Most recent total depth	NM	NM	NM	NM	44.4	955.6	45.0	954.6	38.8	960.8	42.4	955.4	44.9	954.2

General Notes

(a) Measurements in units of feet.

(b) Elevations relative to site-specific datum. Temporary Bench Mark No. 1, top of concrete at west corner of northernmost pump island. Assumed elevation = 1,000.00 feet.

(c) NM = not measured.

(d) NS = groundwater level not stabilized due to recent purging.

(e) For borings B10 and B11, water levels measured relative to ground surface. The remaining water levels measured relative to casing, except as footnoted.

Footnotes

(1) Measured relative to ground surface prior to surveying of PVC casing.

(2) An interface probe was used to discern whether free product was present - free product was not detected with the probe.

(3) A petroleum odor and/or coating was observed on the water level probe.

Table 5

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. Collect samples in liners for potential chemical testing. Collect additional liner samples if elevated organic vapor readings are observed.
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	Mandatory - wash with soap, rinse with tap water, rinse with distilled water. Pressure-wash or steam cleaning optional.
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. This sample will be available for grain size distribution analysis (ASTM D 422) if necessary.
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. Initially analyze approximately 3 samples per boring (selection based on results of field organic vapor screening) for TPH-Gasoline (extraction by EPA Method 5030 with analysis by GCFID), and BTEX (EPA Method 8020). If compounds are below detection limits or the contaminated zone is bracketed by the results, archive remaining samples for possible future analysis pending results of groundwater sampling and testing. If compounds are detected and the contaminated zone is not bracketed, 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 cross-contamination or un-reproducible results are suspect, analyze these samples. Otherwise discard these samples.

General Notes

(a) TPH-Gasoline = total petroleum hydrocarbons as gasoline.

(b) BTEX = benzene, toluene, ethylbenzene, and xylenes.

Table 6

Well Completion Specifications

Item	Requirement
Casing Type	Schedule 40 PVC, flush-threaded couplings.
Casing Diameter	Nominal 2-inch Inside Diameter.
Total Length	Drilled to ±10-feet below the groundwater table - this criteria is anticipated to produce a well ±45-feet deep.
Centralizers	None.
Bottom Cap	Threaded or Slip-0n (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 2 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 7

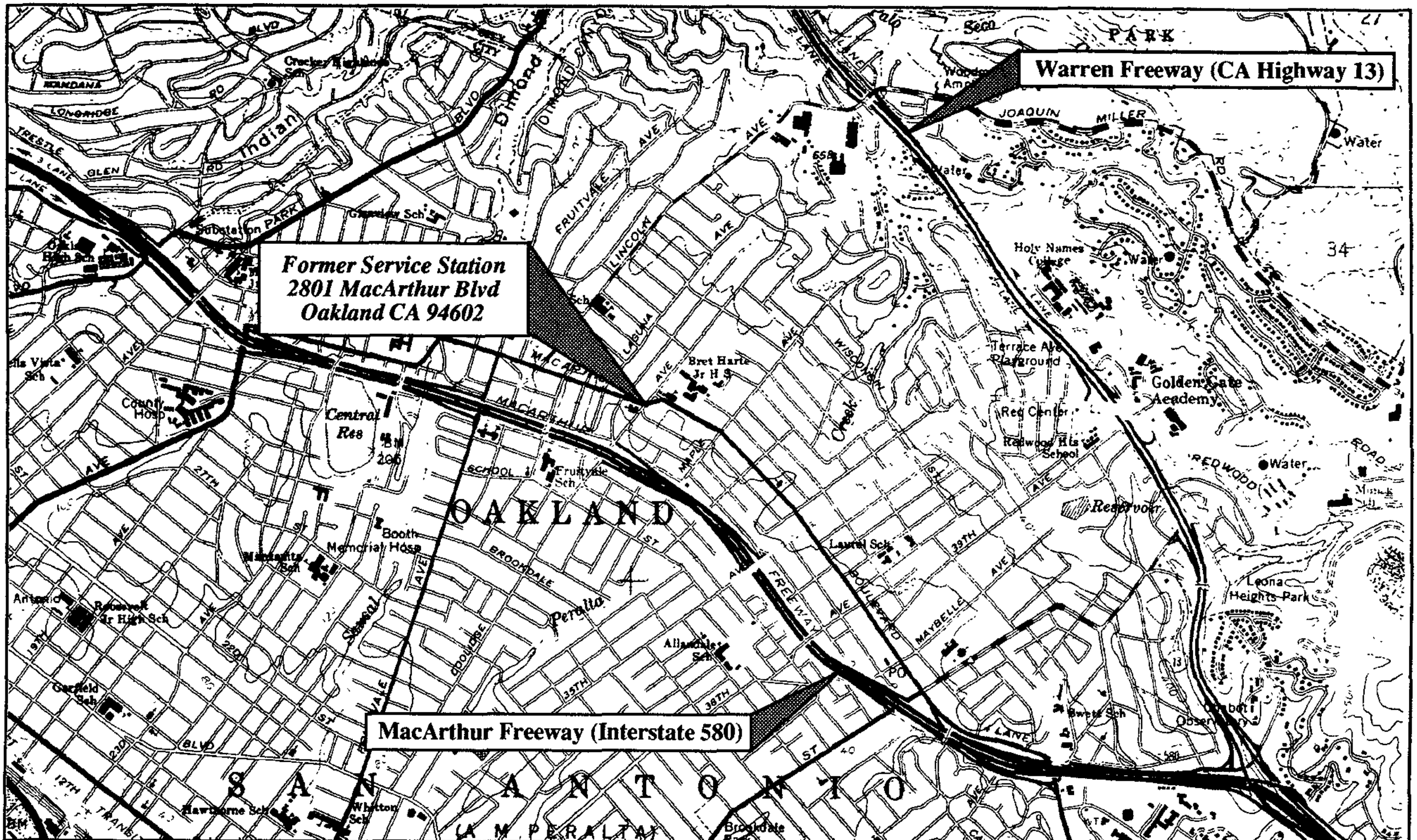
Groundwater Sampling and Testing Requirements

Item	Requirement
Sampling Frequency	Quarterly for 1 year (4 events, every 3 months).
Wells to be Sampled	New wells M3 and M4 plus existing well M2 and existing piezometer P2.
Purge Equipment	Bailer.
Purge Equipment Decontamination	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.
Purge Criteria	Wells that recharge in a timely manner should be purged of at least 3 static casing volumes and sampled after field parameters stabilize, provided that the wells are sampled before 10 static casing volumes. Wells that recharge slowly may be purged dry once and sampled once recharge is sufficient to submerge the bailer.
Sampler	Teflon bailer with bottom-emptying device.
Sampler Decontamination	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.
Analytical Parameters	Analyze samples for TPH-Gasoline (extraction by EPA Method 5030 with analysis by GCFID) and BTEX (EPA Method 8020).
Sample Containers	Three 40-milliliter glass vials for TPH-Gasoline and BTEX.
Sample Handling and Preservation	Verify no headspace, acidify containers 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 BTEX. Collect one cross-contamination blank and one duplicate during each subsequent sampling event if detectable concentrations of analytes are measured.

General Notes

(a) TPH-Gasoline = total petroleum hydrocarbons as gasoline.

(b) BTEX = benzene, toluene, ethylbenzene, and xylenes.



Basemap Reference: U.S. Geological Survey, 7.5 Minute Topographic Quadrangle, Oakland East CA, 1959 (photorevised 1980)

0 0.5 1.0
Approximate Scale in Miles

0 5,000
Approximate Scale in Feet

N

Figure 1

Location Map

2801 MacArthur Boulevard
Oakland CA

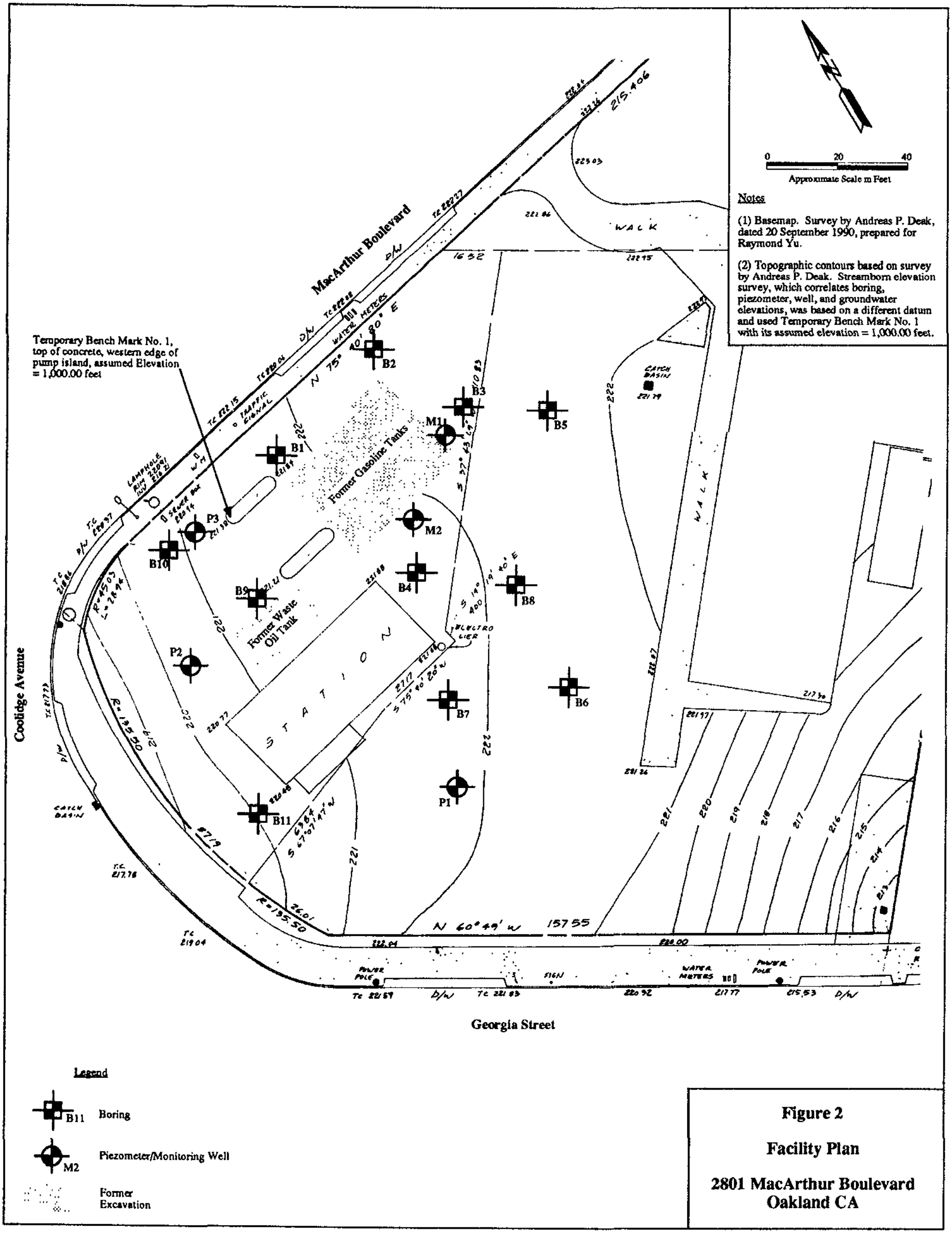


Figure 2

Facility Plan

2801 MacArthur Boulevard
Oakland CA

STREAMBORN

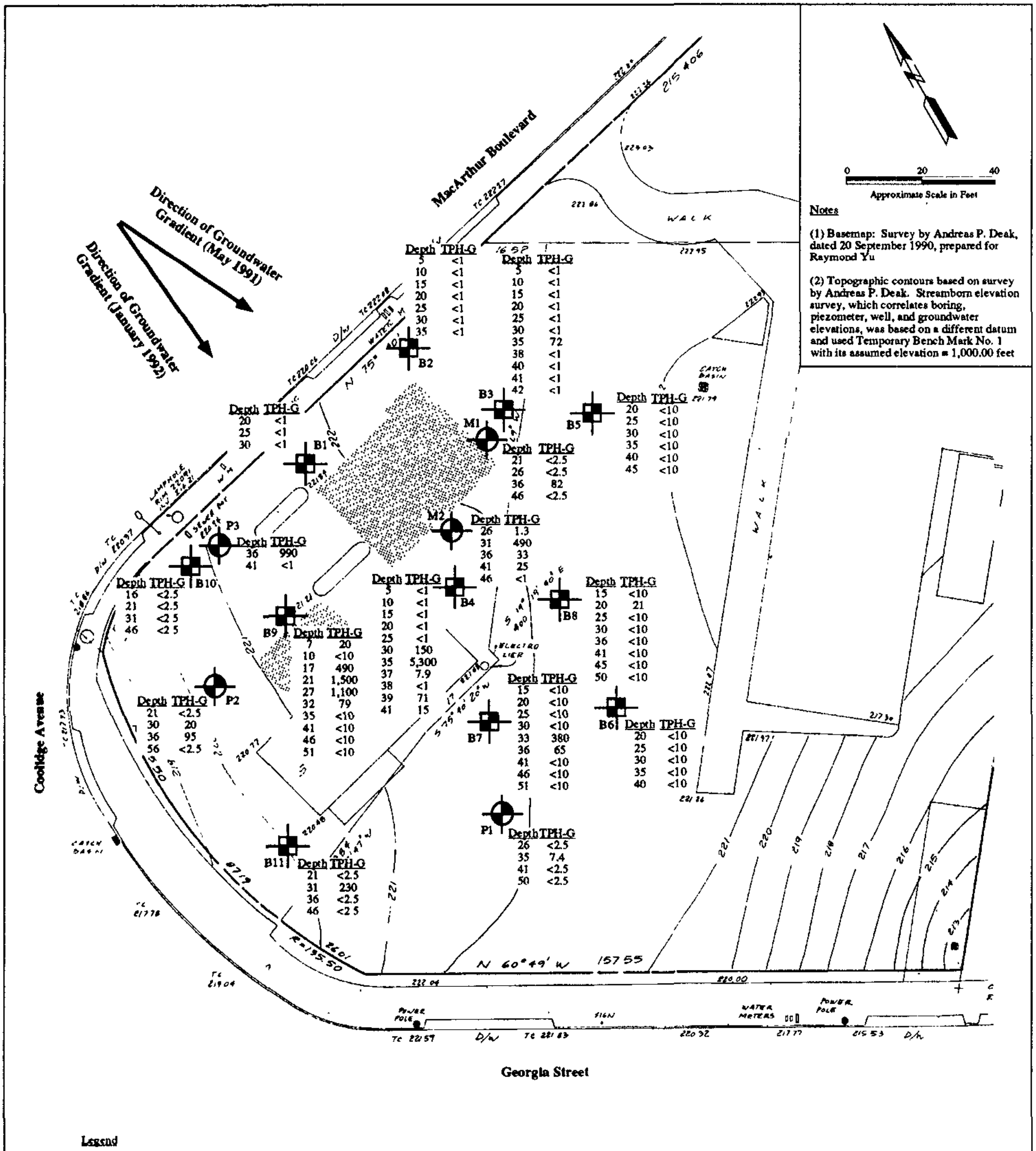
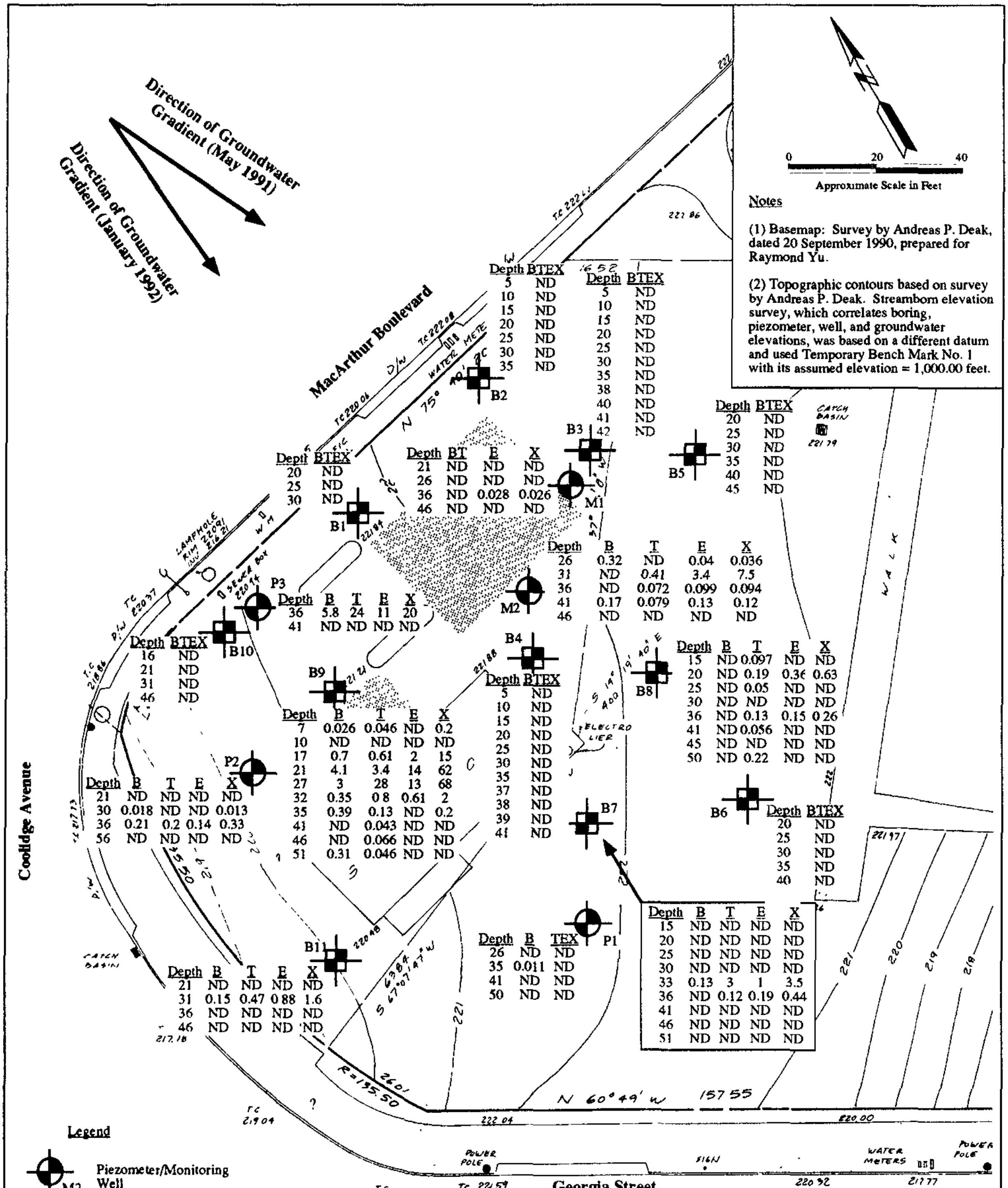


Figure 3

Summary of Soil Analyses for Total Petroleum Hydrocarbons as Gasoline

2801 MacArthur Boulevard
Oakland CA

STREAMBORN



Depth	BTEX
5	ND
10	ND
15	ND
20	ND
25	ND
30	ND
35	ND

Depth	BTEX
5	ND
10	ND
15	ND
20	ND
25	ND
30	ND
35	ND
38	ND
40	ND
41	ND
42	ND

Depth	BTEX
20	ND
25	ND
30	ND
35	ND
40	ND
45	ND

Depth	BTEX
20	ND
25	ND
30	ND

Depth	BT	E	X
21	ND	ND	ND
26	ND	ND	ND
36	ND	0.028	0.026
46	ND	ND	ND

Depth	B	T	E	X
26	0.32	ND	0.04	0.036
31	ND	0.41	3.4	7.5
36	ND	0.072	0.099	0.094
41	0.17	0.079	0.13	0.12
46	ND	ND	ND	ND

Depth	B	T	E	X
36	5.8	24	11	20
41	ND	ND	ND	ND

Depth	BTEX
16	ND
21	ND
31	ND
46	ND

Depth	B	T	E	X
15	ND	0.097	ND	ND
20	ND	0.19	0.36	0.63
25	ND	0.05	ND	ND
30	ND	ND	ND	ND
36	ND	0.13	0.15	0.26
41	ND	0.056	ND	ND
45	ND	ND	ND	ND
50	ND	0.22	ND	ND

Depth	BTEX
5	ND
10	ND
15	ND
20	ND
25	ND
30	ND
35	ND
37	ND
38	ND
39	ND
41	ND

Depth	B	T	E	X
7	0.026	0.046	ND	0.2
10	ND	ND	ND	ND
17	0.7	0.61	2	15
21	4.1	3.4	14	62
27	3	28	13	68
32	0.35	0.8	0.61	2
35	0.39	0.13	ND	0.2
41	ND	0.043	ND	ND
46	ND	0.066	ND	ND
51	0.31	0.046	ND	ND

Depth	B	T	E	X
21	ND	ND	ND	ND
30	0.018	ND	ND	0.013
36	0.21	0.2	0.14	0.33
56	ND	ND	ND	ND

Depth	BTEX
20	ND
25	ND
30	ND
35	ND
40	ND

Depth	B	T	E	X
15	ND	ND	ND	ND
20	ND	ND	ND	ND
25	ND	ND	ND	ND
30	ND	ND	ND	ND
33	0.13	3	1	3.5
36	ND	0.12	0.19	0.44
41	ND	ND	ND	ND
46	ND	ND	ND	ND
51	ND	ND	ND	ND

Depth	B	TEX
26	ND	ND
35	0.011	ND
41	ND	ND
50	ND	ND

Depth	B	T	E	X
21	ND	ND	ND	ND
31	0.15	0.47	0.88	1.6
36	ND	ND	ND	ND
46	ND	ND	ND	ND

0 20 40

Approximate Scale in Feet

Notes

(1) Basemap: Survey by Andreas P. Deak, dated 20 September 1990, prepared for Raymond Yu.

(2) Topographic contours based on survey by Andreas P. Deak. Streamborn elevation survey, which correlates boring, piezometer, well, and groundwater elevations, was based on a different datum and used Temporary Bench Mark No. 1 with its assumed elevation = 1,000.00 feet.

Legend

M2 Piezometer/Monitoring Well

B11 Boring

Former Excavation

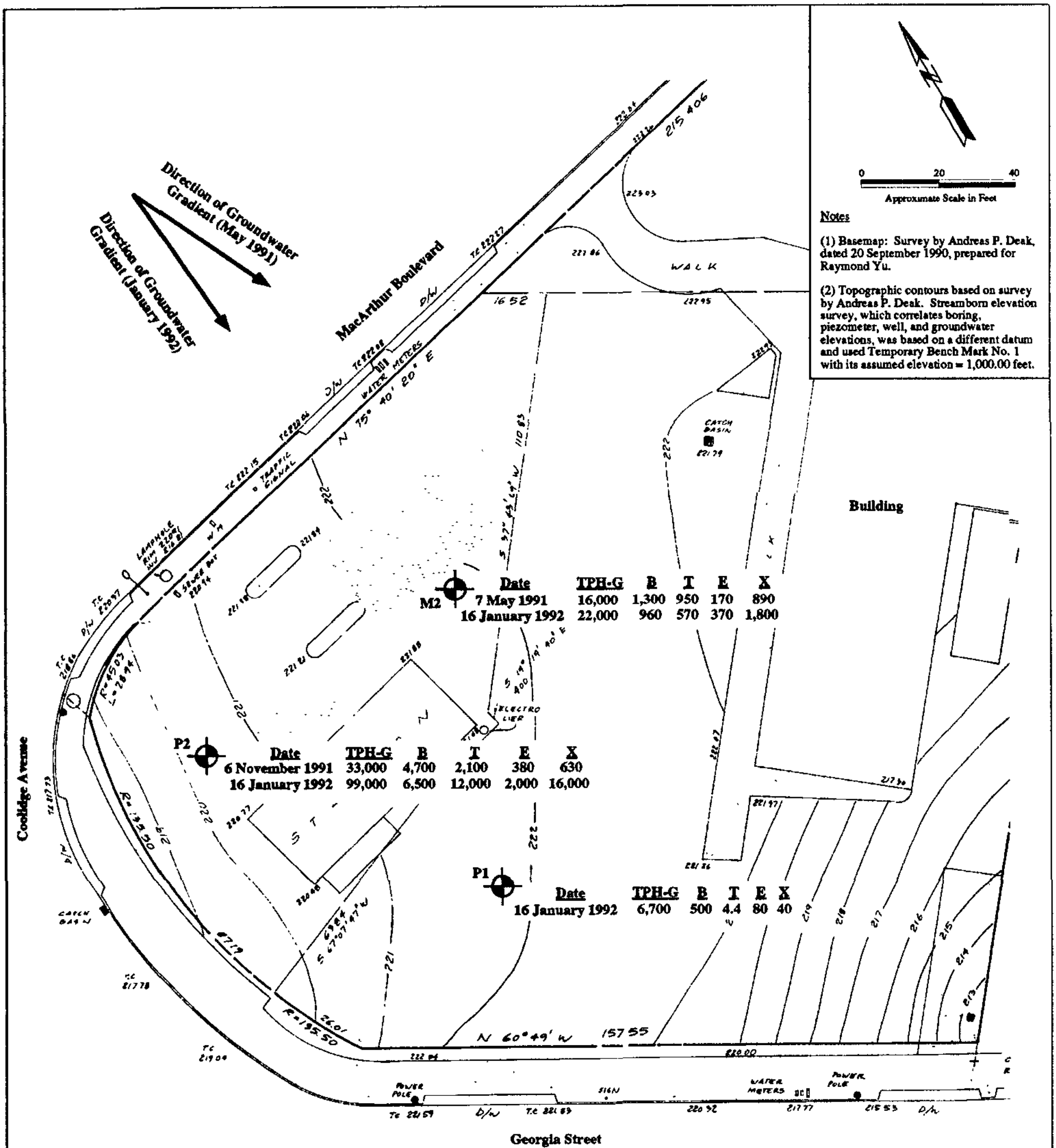
Analytical results from soil samples collected during drilling, measured in mg/kg.
Depths measured in units of feet.
B = benzene. T = toluene. E = ethylbenzene. X = xylenes.
Analytical results below detection limits shown in green

Figure 4

Summary of Soil Analyses for Benzene, Toluene, Ethylbenzene, and Xylenes

2801 MacArthur Boulevard
Oakland CA

STREAMBORN



Notes

(1) Basemap: Survey by Andreas P. Deak, dated 20 September 1990, prepared for Raymond Yu.

(2) Topographic contours based on survey by Andreas P. Deak. Streamborn elevation survey, which correlates boring, piezometer, well, and groundwater elevations, was based on a different datum and used Temporary Bench Mark No. 1 with its assumed elevation = 1,000.00 feet.

Legend

M2 — Piezometer/Monitoring Well

Former Excavation

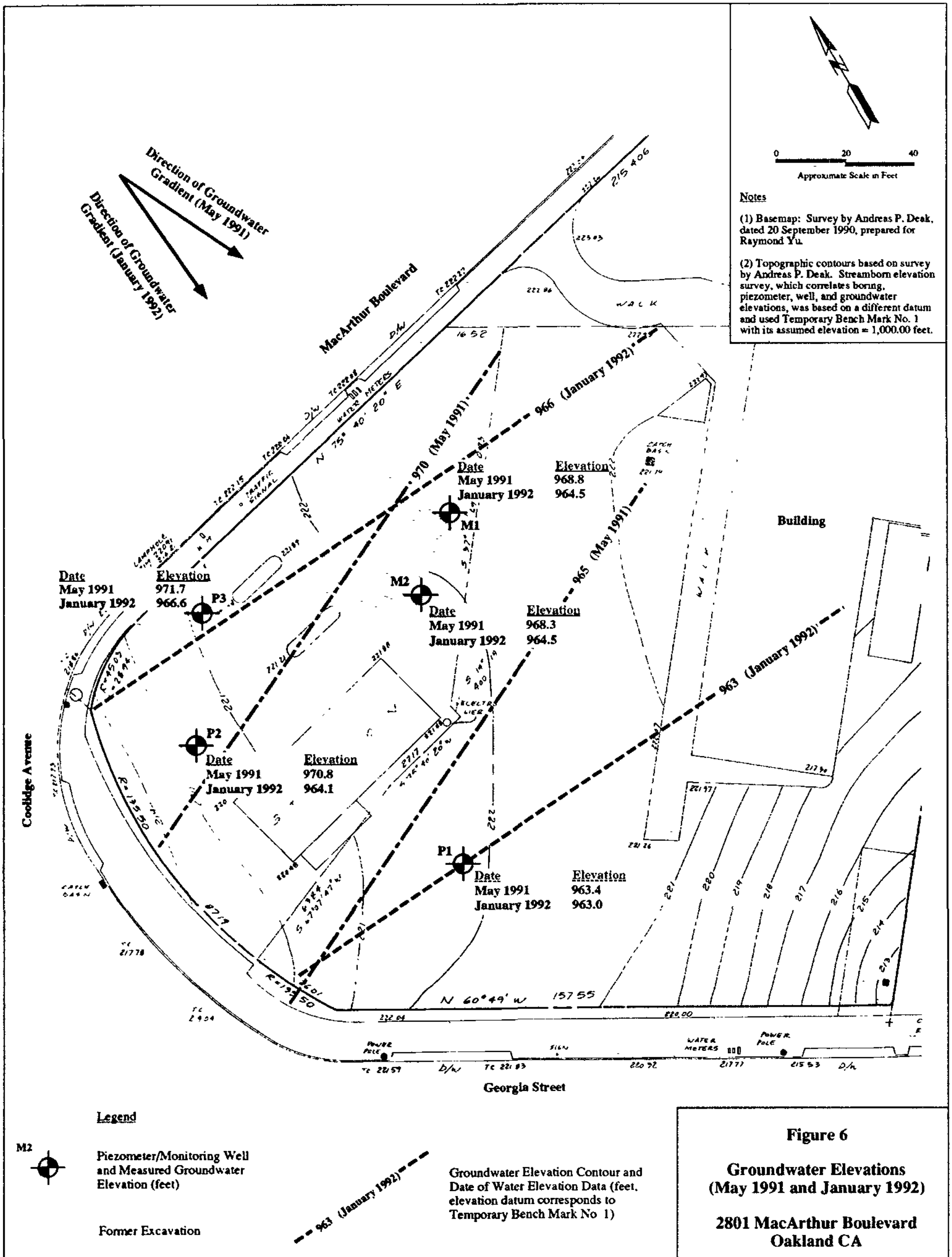
Analytical results from groundwater sampling, measured in µg/L.
TPH-G = Total Petroleum Hydrocarbons as Gasoline.
B = Benzene.
T = Toluene.
E = Ethylbenzene.
X = Xylenes.

Figure 5

Summary of Groundwater Analyses

2801 MacArthur Boulevard
Oakland CA

STREAMBORN



Notes

(1) Basemap: Survey by Andreas P. Deak, dated 20 September 1990, prepared for Raymond Yu.

(2) Topographic contours based on survey by Andreas P. Deak. Streamborn elevation survey, which correlates boring, piezometer, well, and groundwater elevations, was based on a different datum and used Temporary Bench Mark No. 1 with its assumed elevation = 1,000.00 feet.

Figure 6

Groundwater Elevations (May 1991 and January 1992)

2801 MacArthur Boulevard Oakland CA

STREAMBORN

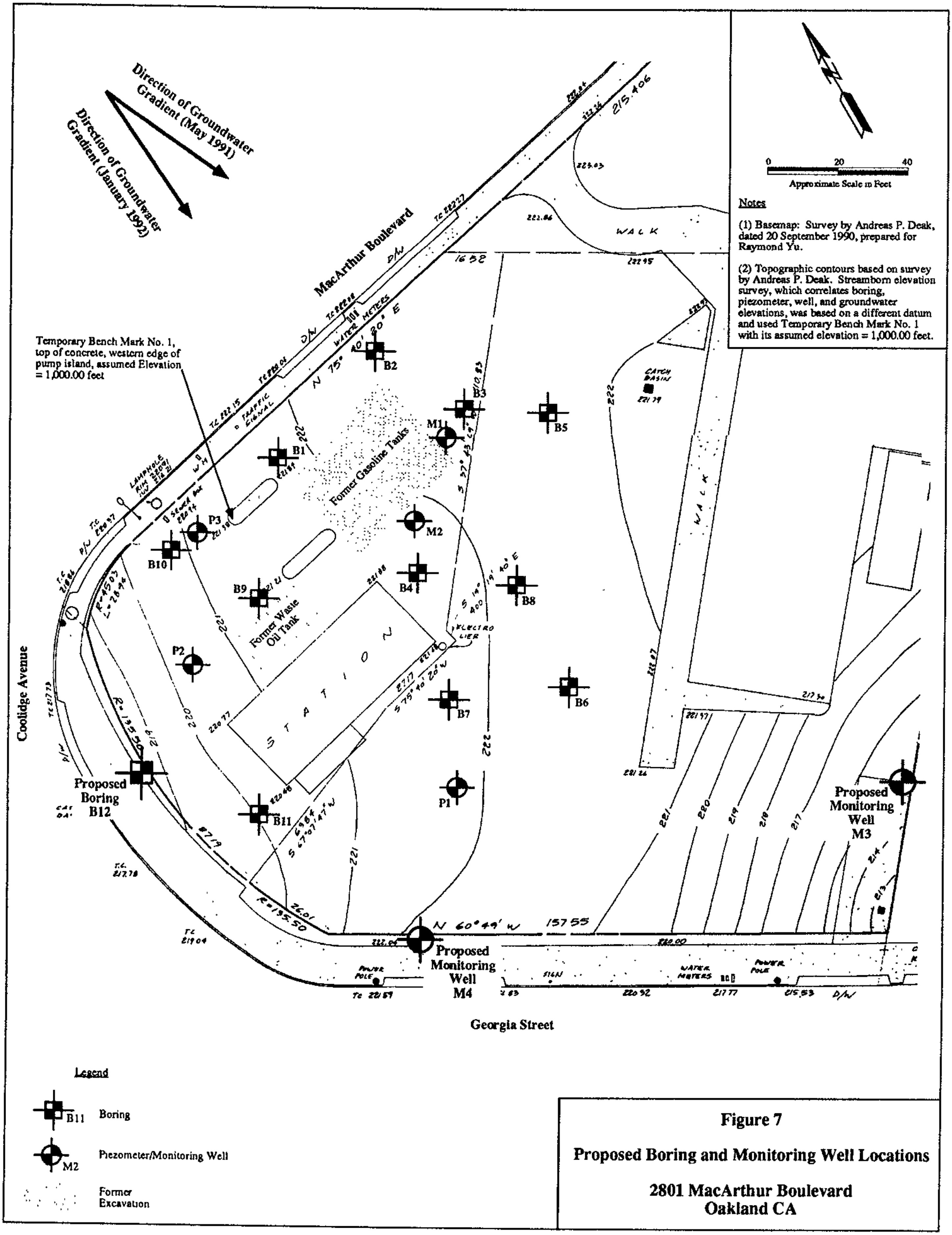
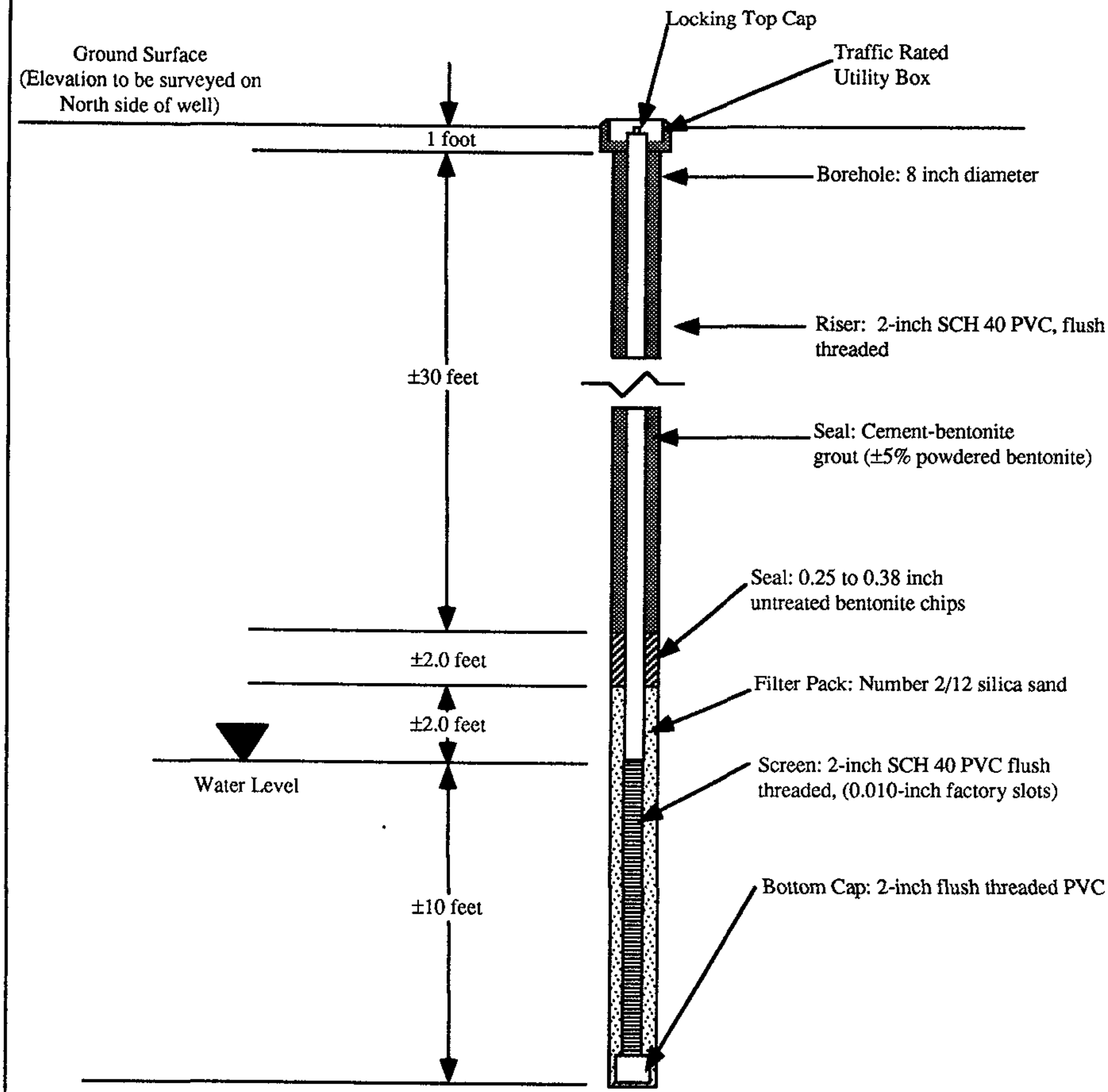


Figure 7

Proposed Boring and Monitoring Well Locations

2801 MacArthur Boulevard
Oakland CA

STREAMBORN



Note: This design should be modified to conform to site-specific conditions observed during drilling.

Figure 8

Monitoring Well Completion Schematic

2801 MacArthur Boulevard
Oakland CA

APPENDIX A

Standard Operating Procedures (SOP)

SOP 1A - Hollow-Stem Auger Drilling and Split-Spoon Soil Sampling

SOP 2A - Completion of Borings as Wells

SOP 3A - Well Development

SOP 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 3- to 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. 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 <u>Boring Log</u>

- 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, Liquinox, 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 (piezometers). 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

- Pressure washer or steam cleaner
- Grout mixing equipment
- Tap water
- 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)
- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- Filter pack material (typically clean sand of specified gradation)
- 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, with tap water rinse. If 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 casing (screen or blank depending on the specific well design) is attached and the process is repeated until the well extends from the ground 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.

5 Install the filter pack by pouring filter pack material into the annulus between the casing and borehole. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, 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 or slough 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. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, 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 overlying grout seal.

7 The grout seal should be tremied into the well to prevent inclusions of formation material or slough in the annular seal. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, grout seal may consist of (1) neat cement grout, using 1 sack (94 pounds dry weight) of Type I/II Portland cement to 5 gallons of water, or (2) cement-bentonite grout using the same basic formula but substituting approximately 5% powdered bentonite for part of the cement. 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. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, 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/swabing and overpumping/bailing, measurement and observation of well yield, turbidity, and field parameters, and containerizing the development wastewater. Development is typically conducted until (1) no further improvement in well response and turbidity is observed, or (2) 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.
- Glass beaker, ±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:

  Bailer: 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 Workplan, 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 descriptions 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

- 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 (for decontamination)
- Distilled water (for decontamination and quality control blank samples)
- Cooler with ice (do not use blue ice or dry 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.

- Glass beaker, ±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 occurred 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 recharge has submerged the entire screened interval, 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 Diesel	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
Soil and Groundwater Investigation
Former Service Station
2801 MacArthur Boulevard
Oakland CA 94602

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

Chemical Hazard Evaluation Chemical compounds detected during previous sampling at the facility, as well as hazard criteria, are summarized in Table B1.

Physical Hazard Evaluation Physical hazards which may be encountered include: heavy machinery, heavy lifting, slip-trip-fall, loud noise, and heat exposure.

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 area of 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 restricted by requesting people not directly involved in the work to stay out of the immediate work area, and/or by restricting access by other suitable means, such as traffic cones and blockades.

No smoking, chewing of tobacco or gum, eating, or drinking will be allowed in the work zone.

Personal Protective Equipment Field work will begin in modified Level-D personal protection (Table 3). If air monitoring results of the work zone exceed the action levels specified below, then personal protective equipment will be upgraded as necessary to modified Level-C (Table B3).

Monitoring Visual monitoring should be routinely conducted by the workers. Workers should evaluate themselves for signs of fatigue as the work progresses. Work breaks should be taken as reasonably required to maintain safety and efficiency.

The work area atmosphere will be monitored using a field organic vapor monitor (Thermo Environmental Instruments Model 580B, 10.0 eV photoionization detector, calibrated to 100 ppm v/v isobutylene). 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, personal protection should 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 1). If continual readings greater than 50 ppm above background are recorded in the breathing zone, work should stop. Work should be resumed after consultation with the project manager and possibly the 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 occurring on the worksite. A secondary purpose of these procedures is to allow documentation of emergencies.

Emergency information is summarized in Table B4. The location of the nearest hospital is shown on 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 officer's responsibility to document the emergency and report it to the project manager and client in a timely manner.

Documentation Documentation specific to the Site Safety Plan consists of the tail gate safety meeting form (attached). 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 health and safety 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 include disposable protective equipment such as gloves, tyvek-coveralls, and boot covers, as well as used paper towels. These items may be disposed of with normal municipal refuse.

Liquid wastes from washing may be disposed of in the sanitary sewer.

Table B1

Chemical Hazard Evaluation

Chemical	Measured in Soil (mg/kg)	Measured in Groundwater (mg/l)	Odor Threshold (ppm v/v)	Lower Explosive Limit (ppm v/v)	Permissible Exposure Limit (ppm v/v)	Time Weighted Average (ppm v/v)	Immediately Dangerous to Life and Health (ppm v/v)
Total Petroleum Hydrocarbons as Gasoline	<1 to 5,300	6.7 to 19	NA	14,000	300	300	NA
Benzene	<0.005 to 5.8	0.5 to 6.5	12	13,000	1	10	2,000
Toluene	<0.005 to 28	0.004 to 12	2.9	13,000	100	100	2,000
Ethylbenzene	<0.005 to 14	0.08 to 2	2.3	10,000	100	100	2,000
Xylenes	<0.005 to 68	0.04 to 16	1.1	10,000	100	100	10,000

General Notes

(a) Exposure criteria from: (1) American Conference of Governmental Industrial Hygienists, *1990-1991 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* (2) National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards*, 1985, (3) American Conference of Governmental Industrial Hygienists, *Guide to Occupational Exposure Values,* Undated (circa 1990), (4) Amoore, J. E. and Hautala, E., *Odor as an Aid to Chemical Safety: Odor Thresholds Compared with Threshold Limit Values and Volatilities for 214 Industrial Chemicals in Air and Water Dilution*, Journal of Applied Toxicology, Volume 3, Number 6, 1983, and (5) *Material Safety Data Sheet, Chevron Unleaded Gasoline*, Chevron Environmental Health Center, Richmond CA, 12 September 1991.

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

(c) NM = not measured

(d) < indicates parameter reported below detection limits

Table B2

Safety Personnel and Responsibilities

Personnel	Responsibilities
Project Manager (Doug Lovell)	Development and overall implementation of Site Safety Plan, provide properly trained onsite personnel to complete the work, coordination of safety issues with client.
Site Safety Officer (Mark Buscheck or Ken Chiang)	Onsite implementation 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, conduct tailgate site safety meeting, contact Underground Service Alert, clear underground utilities, maintain adequate supply of safety equipment onsite for Streamborn personnel.
Subcontractor's Site Safety Officer (to be determined)	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

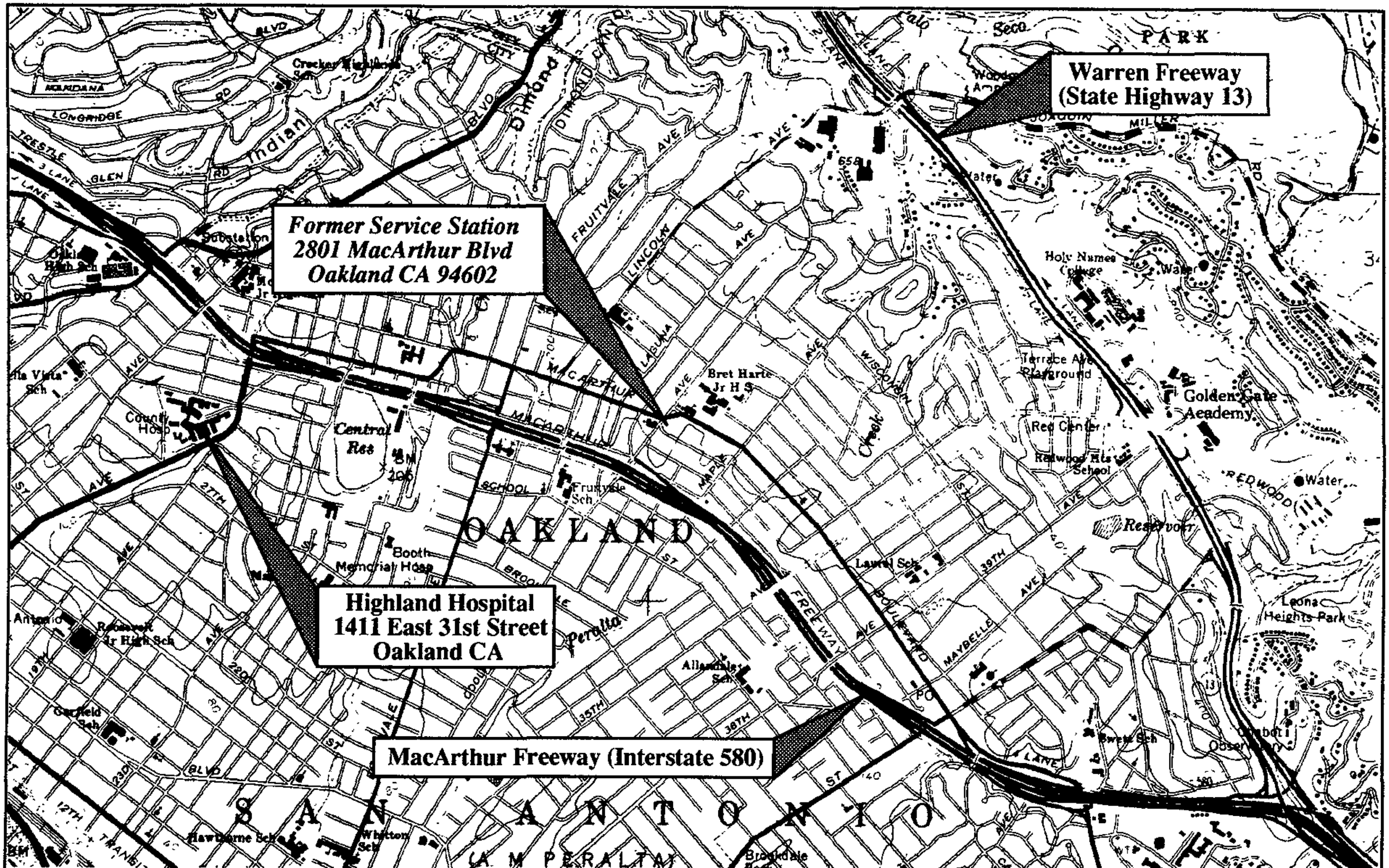
Personnel Protective and Monitoring Equipment

Item	Requirement
Modified Level-D Personal Protective Equipment	Hardhat, dedicated work clothing (cotton coveralls or tyveks), water repellent steel-toed boots, work gloves, latex gloves (as appropriate), nitrile gloves (as appropriate), first aid kit, fire extinguisher, warning tape, optional eye and hearing protection.
Modified Level-C Personal Protective Equipment	Add Half-face respirator with OV-HEPA cartridges and mandatory 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	Field organic vapor monitor capable of detecting organic vapor concentrations of 1 ppm (v/v). Field organic vapor monitor to be calibrated to known reference gas daily. Action levels (measurement in the breathing zone of work area): >5 ppm for 10 minutes: upgrade to modified Level C >50 ppm for 10 minutes: stop work, consult with project manager
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 (toward Berkeley) from the subject property on MacArthur Boulevard. • Turn left on 14th Street. • Turn right on 31st Street; the hospital is located on the left side of 31st Street. • Refer to Figure B1.
Ambulance	911	
Fire Department	911	
Police Department	911	
On-site Telephone	To be determined	
Streamborn Site Safety Officer	Mark Buscheck 510/528-4234 (work) 415/994-3127 (home) Ken Chiang 510/528-4234 (work) 510/724-9216 (home)	
Streamborn Project Manager	Doug Lovell 510/528-4234 (work) 510/528-2613 (home)	
CaliFrance	Nicholas Molnar 510/452-4711 (work)	
Subcontractors	To be determined	



Basemap Reference: U.S. Geological Survey, 7.5 Minute Topographic Quadrangle, Oakland East CA, 1959 (photorevised 1980)

Figure B1

Hospital Location Map

2801 MacArthur Blvd
Oakland CA