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510.528.4234
Fax 528.2613

ENVIRONMENTAL
PROTECTION

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Casimiro and Josephine Damele
3750 Victor Avenue
Oakland CA 94619

22 December 1999

Project No. P214

Revised Workplan
Investigation and Remediation of Gasoline-Contaminated Soil and Groundwater
4401 Market Street
Oakland CA

Dear Mr. and Mrs. Damele:

This revised workplan supercedes our 15 October 1999 workplan. It has been modified to include comments from Don Hwang, Alameda County Environmental Health Services (ACEHS) in his 10 December 1999 letter.

This revised workplan describes proposed investigation and remediation activities associated with gasoline releases from former underground storage tanks at 4401 Market Street, Oakland CA (Figure 1). Planned activities include (1) collection of soil and groundwater samples, (2) installation of monitoring wells, (3) removal of free product, if necessary, and (4) completion of a conduit study. This workplan has been prepared pursuant to Streamborn's 28 September 1999 proposal.

BACKGROUND

A chronology of activities associated with the former underground gasoline tanks is summarized in Table 1.

The subject property contains a one-story building constructed in 1943 and operated as a service station until the mid-1970's. Since then, a vehicle repair business has been operated at the property.

Four underground gasoline tanks (one 1,000-gallon tank and three 500-gallon tanks) were located on the southeast corner of the property near the intersection of Market Street and 44th Street (Figure 2). In June 1990, the four underground storage tanks were removed. All four tanks were rusted, pitted, and contained holes. In addition, a 3-inch split seam was observed in the top of the 1,000-gallon gasoline tank. Contaminated soil was discovered within the tank excavation (Table 2). Soil excavated during the tank removal was placed back into the excavation. Removal of the fuel dispensers, product piping, and pump island was not documented.

In September 1990, 2 trenches were excavated to a depth of approximately 5 feet in the vicinity of the former pump island. Contaminated soil was observed but no laboratory analyses were performed. Soil excavated during trenching was placed back into the trenches.

In October 1994, 7 borings were drilled at the property. Free product, presumably gasoline, was observed in boring SB2 at the southeast corner of the property (Figure 2). Gasoline constituents were detected at significant concentrations in soil samples from 3 of the borings (SB2, SB4, and

MW2) (Table 3). Three of the borings were completed as monitoring wells (MW1, MW2, and MW3). Monitoring well completion data are summarized in Table 4. Monitoring wells MW1, MW2, and MW3 have 6- to 8-foot long intercepted intervals that do not straddle the groundwater table. Groundwater levels are typically 3 to 7 feet above the intercepted interval and direct observations regarding the presence or absence of free product are not possible using the wells.

Between November 1994 and June 1997, 9 rounds of groundwater monitoring were performed. Analytical data from well sampling are summarized in Table 5. Gasoline constituents have been detected in samples from well MW2 during each monitoring event (Table 5).

In April and July 1999, 9 borings were drilled at the property and adjacent properties. Subsurface conditions encountered in the borings typically consisted of (Table 6):

- Lean Clay, Silt, and Fat Clay, beginning at the ground surface and extending to a depth of approximately 17 to 19 feet.
- Clayey Sand, beginning at a depth of 17 to 19 feet and extending to a depth of at least 24 feet (maximum depth sampled).

Soil and groundwater samples were collected from every boring except B14 (dry hole). Remarkable soil concentrations were encountered in boring B10 at a depth of 15 to 15.5 feet; otherwise, soil concentrations were typically very low or nondetect (Table 3). In borings B9, B11, and B15, groundwater sampling revealed elevated concentrations of gasoline constituents (Table 7). Approximately 1 inch of free product, presumably gasoline, was observed in boring B10.

Since 1994, groundwater within the 3 monitoring wells has typically been measured at depths between 12 and 15 feet (Table 8). The groundwater gradient direction has varied between south-southeast and west-southwest.

In his 3 September 1999 letter, Don Hwang of ACEHS requested the following:

- Delineate the downgradient extent of groundwater contamination.
- Monitor for free product and, if found, remediate free product.
- Complete a conduit study.

APPROACH

Our proposed approach includes the following:

- We will install 4 groundwater monitoring wells downgradient of the subject property. One monitoring well will be adjacent to well MW2 (Well MW2 is improperly screened to detect the presence of free product). Two monitoring wells will be located on 44th Street near boring B10, where free product was observed in April 1999. The fourth monitoring well will be located downgradient of the property at 903 44th Street.
- We will monitor for free product, and if found, remediate the free product.
- We will monitor groundwater in the existing and new monitoring wells. Groundwater samples will be analyzed for gasoline constituents.
- We will complete a conduit study of natural and anthropologic pathways of preferred contaminant migration.

SCOPE OF WORK

Installation of Monitoring Wells

Four monitoring wells (MW4, MW5, MW6, and MW7) will be installed at the locations shown on Figure 4. Wells MW4, MW5, and MW6 are located in areas of suspected free product. Well MW7 is designed to evaluate the downgradient extent of contamination.

Prior to drilling, we will obtain drilling and encroachment permits from ACEHS and the City of Oakland. We will also negotiate an access agreement between the Dameles and the property owners of 903 44th Street. We will retain an underground utility locator service to search for buried utilities at each proposed drilling location. We will also notify Underground Service Alert (USA) to mark buried utilities in the vicinity of the proposed drilling locations. As appropriate, we will have concrete or asphalt cored at the drilling locations.

Drilling, soil sampling, well installation, and well development will be performed in accordance with the attached standard operating procedures.

Borings for the new wells will be drilled using 8-inch outside diameter hollow-stem augers. The borings will be drilled to a depth of approximately 25-feet. During drilling, soil samples will be collected continuously for borings MW4, MW5, and MW6. For boring MW7, soil samples will be collected at 5-foot intervals or detectable changes in lithology, whichever is more frequent. Soil samples will be classified in the field according to ASTM Standard 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Samples will be screened in the field using an organic vapor meter.

Soil samples will be selected for chemical analysis from each boring. If field observations indicate the presence of soil contamination, three soil samples will be collected from above, within, and below the contaminated horizon. If contamination is not observed, two soil samples will be collected from approximate depths of ±7- and ±12-feet (estimated depth to groundwater). The soil samples will be analyzed for gasoline constituents. Soil sampling and testing requirements are described in Table 9.

The borings will be completed as 2-inch PVC wells (Table 10, Figure 5). After installation, the well elevations (top of casing and ground surface) will be surveyed relative to the datum for the existing wells. The 4 new wells will then be developed.

Free Product Monitoring

The presence of free product will be periodically monitored in wells MW4, MW5, and MW6. An interface probe will be used to monitor the presence of free product and, if present, measure the thickness of free product. Free product monitoring will be performed monthly for a period of 1 year in wells MW4, MW5, and MW6.

Remediation of Free Product

If free product is observed in the new monitoring wells, the free product will be remediated. Remediation may be performed using a passive system, consisting of either (1) a canister with a hydrophobic filter suspended in the well across the water table or (2) a sorbent sock suspended in the well across the water table. Remediation may also be performed using an active system such as a soil vapor extraction or insitu biostimulation. Selection of the remediation system will depend on the thickness and extent of free product.

Groundwater Monitoring

Groundwater samples will be collected quarterly for a period of 1 year from 2 existing (excluding well MW2) and 4 new monitoring wells. If free product is present, groundwater samples will not be collected. Groundwater sampling will be performed in accordance with the attached standard operating procedure. Prior to purging and sampling, water levels will be measured.

Groundwater samples will be analyzed for gasoline constituents. Groundwater sampling and testing requirements are summarized in Table 11.

Conduit Study

We will perform a conduit study to evaluate possible subsurface conduits that may facilitate the transport of free product from the subject property. As part of the conduit study, we will compile and review underground utility schematics from the Oakland Public Works Agency and PG&E. We will verify and map the locations of some of the utilities in the field including storm sewer and sanitary sewer.

We will also review the lithologic data from the borings to evaluate the presence of subsurface conduits or preferred channels of groundwater flow. We will summarize the lithologic data on cross sections or a fence diagram to illustrate subsurface conditions.

Investigation-Derived Waste

Soil sampling and groundwater monitoring will generate the following wastes: (1) soil cuttings and excess soil samples; (2) development and purge water; and (3) decontamination wastewater. These wastes will be containerized in steel 55-gallon DOT 17H drums. Inert soil may be disposed of at a Class III landfill. Non-inert wastes require specific interpretation with respect to current regulations and will be disposed of accordingly. Decontamination wastewater will be discharged to the sanitary sewer.

Reporting

The results of the well installation, initial soil and groundwater sampling, and conduit study will be summarized in a report. Subsequent quarterly monitoring events will be summarized in quarterly letter reports.

QUALITY ASSURANCE/QUALITY CONTROL

Specific quality control procedures for sample collection and field testing are discussed in the standard operating procedures (attached).

Quality Control Samples

The laboratory will include laboratory blank, laboratory replicate, and laboratory spike quality control samples during soil and groundwater analysis. Field quality control samples will not be collected or analyzed.

Field Meter Quality Control Procedures

Meters for measurement of field parameters will be calibrated daily. Calibration standards should generally approximate or span the anticipated range of measurements. Recalibration may be appropriate if unusual measurements are noticed.

The field organic vapor monitor (used for site safety and to screen soil samples) will be calibrated using a standard gas prior to the beginning of each field day. Recalibration may be appropriate if unusual measurements are noticed.

HEALTH AND SAFETY

The attached Site Safety Plan presents the procedures to be followed to protect the safety of workers during planned field work. Physical and chemical hazards, such as working around 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 field work does not necessarily require adherence to safety protocols for hazardous waste sites, 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.

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If you have any questions or comments, please call.

Sincerely,
STREAMBORN

K.B. Alex

Kenneth B. Alexander, RG, CH
Certified Hydrogeologist

REGISTERED GEOLOGIST
KENNETH B. ALEXANDER
No. HG512
CERTIFIED HYDROGEOLOGIST
exp. 7/01
STATE OF CALIFORNIA

Attachments

cc: Don Hwang/Alameda County Environmental Health Services, Alameda CA

Table 1

Environmental Chronology
4401 Market Street, Oakland CA

Date	Activities Performed By	Description
Unknown	Unknown	• Four underground gasoline tanks (one 1,000-gallon and three 500-gallon tanks) were installed. • W.A. Craig reported that the structure at the property was constructed in 1943 and used as a gasoline station until the 1970's.
22 June 1990	Environmental Bio-Systems	• The 4 underground gasoline tanks were removed. Removal of the fuel dispensers, product piping, and pump island was not documented. Soil excavated during the tank removal was placed back into the excavation. • Soil samples were collected below the tanks and from the excavated soil. Soil samples were analyzed for TPH-gasoline and BTEX.
6 September 1990	W.A. Craig	• Two trenches were excavated to a depth of approximately 5 feet in the vicinity of the former pump island. • Contaminated soil was observed but no laboratory analyses were performed. Soil excavated during trenching was placed back into the trenches.
27 and 28 October 1994	W.A. Craig	• Seven borings were drilled (SB1, SB2, SB3, SB4, MW1, MW2, and MW3); three of which were completed as monitoring wells (MW1, MW2, and MW3). • Free product, presumably gasoline, was observed in one of the borings (SB2) at the southwest corner of the property. • Soil samples were analyzed for TPH-gasoline and BTEX.
8 November 1994	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline and BTEX.
14 February 1995	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline and BTEX.
7 June 1995	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline and BTEX.
29 August 1995	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline and BTEX.
8 December 1995	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline and BTEX.
7 March 1996	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline, BTEX, and MtBE.
19 June 1996	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline, BTEX, and MtBE.
20 December 1996	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline, BTEX, and MtBE.
12 June 1997	W.A. Craig	• Groundwater monitoring was conducted for wells MW1, MW2, and MW3. • Samples were analyzed for TPH-gasoline, BTEX, and MtBE.
April and July 1999	Streamborn	• Nine borings were drilled in Market and 44th Streets and at 903 44th Street (B8 through B16). Free product, presumably gasoline, was observed in boring B10. • Soil samples and grab groundwater samples were collected from all 9 borings. Samples were analyzed for TPH-gasoline, BTEX, and MtBE.

General Notes

(a) TPH = Total petroleum hydrocarbons.

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

(c) MtBE = Methyl tertiary butyl ether.

Table 2

Soil Analytical Data during Tank Removal
4401 Market Street, Oakland CA

Sample Identification	Sample Depth (feet)	Sample Description	Sample Date	Sample Type	TPH-Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)
S1A-D	NA	Composite sample (4 sub-samples) of soil excavated during tank removal	22 June 1990	Composite	38	0.22	0.37	0.38	1.1
S2	±8.5	±2-feet below invert of middle 500-gallon gasoline tank	22 June 1990	Grab (liner)	360	0.99	12	9.5	53
S3	±7.5	±2-feet below invert of southern 500-gallon gasoline tank	22 June 1990	Grab (liner)	160	1.2	2.5	2.8	13
S4	±8	±2-feet below invert at non-fill end of 1,000-gallon gasoline tank	22 June 1990	Grab (liner)	210	3.3	9.4	7.6	32
S5	±8	±2-feet below invert at fill end of 1,000-gallon gasoline tank	22 June 1990	Grab (liner)	870	3.2	24	20	110
S6	±8.5	±2-feet below invert of northern 500-gallon gasoline tank	22 June 1990	Grab (liner)	730	5	24	26	140
S7A-D	NA	Composite sample (4 sub-samples) of soil excavated during tank removal	22 June 1990	Composite	130	0.9	1..3	1.8	13
S8	±15	±8.5-feet below inverts and midway between the two northern 500-gallon gasoline tanks	22 June 1990	Grab (liner)	260	3.7	14	7.1	33

General Notes

(a) Analytical data from Environmental Bio-Systems (1990).

(b) TPH-Gasoline = Total Petroleum Hydrocarbons as Gasoline.

(c) Samples were collected by Environmental Bio-Systems, Inc. (Hayward CA). Samples were analyzed by Anametrix, Inc. (San Jose CA).

Table 3

Soil Analytical Data from Borings
4401 Market Street, Oakland CA

Boring or Well No.	Sample Depth (feet)	Sample Date	Sample Identification	Sampled By	TPH-Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)	MtBE (mg/kg)
SB1	10 to 10.5	27 October 1994	3365 SB1-10	WAC	<1	<0.005	<0.005	<0.005	<0.005	NA
	15 to 15.5	27 October 1994	3365 SB1-15	WAC	72	<0.01	0.13	0.21	0.18	NA
	20 to 20.5	27 October 1994	3365 SB1-20	WAC	<1	<0.005	<0.005	<0.005	<0.005	NA
SB2	10 to 10.5	27 October 1994	3365 SB2-10.5	WAC	40	0.079	0.034	0.43	4.7	NA
	15 to 15.5	27 October 1994	3365 SB2-15	WAC	19	0.46	0.041	0.31	4.2	NA
	20 to 20.5	27 October 1994	3365 SB2-20.5	WAC	5.7	0.006	<0.005	0.010	0.079	NA
SB3	10 to 10.5	27 October 1994	3365 SB3-10	WAC	<1	<0.005	<0.005	<0.005	<0.005	NA
	15 to 15.5	27 October 1994	3365 SB3-15	WAC	<1	<0.005	<0.005	<0.005	<0.005	NA
Residential Preliminary Remediation Goal					Established	0.62	520	230	210 – 370	Established

General Notes

(a) Depths measured from the adjacent ground surface.

(b) TPH = total petroleum hydrocarbons. MtBE = Methyl tertiary Butyl Ether. NA = Not analyzed. WAC = W.A. Craig (Napa CA).

(c) Residential Preliminary Remediation Goals from *Preliminary Remediation Goals (PRGs),* US Environmental Protection Agency, Region 9, San Francisco CA. 1998.

(d) Concentrations exceeding the PRGs in **bold**.

Footnote

(1) Laboratory reported that hydrocarbon found in gasoline range is uncharacteristic of gasoline profile.

Table 4

Well Completion Data
4401 Market Street, Oakland CA

Well Number:	MW1	MW2	MW3
Date of Installation	27 October 1994	28 October 1994	28 October 1994
Installed By	W.A. Craig	W.A. Craig	W.A. Craig
Installation Method	Hollow-stem auger	Hollow-stem auger	Hollow-stem auger
Measuring Point Description	Top of PVC casing, north side	Top of PVC casing, north side	Top of PVC casing, north side
Measuring Point Elevation (feet)	71.12	70.62	71.79
Approximate Ground Surface Elevation (feet)	72.1	71.9	72.9
Approximate Seal Depth (feet)	19	19	19
Total Boring Depth (feet)	25.5	27.5	27.5
Total Casing Length (feet)	25.5	25	25
Casing Diameter (inches)	2	2	2
Boring Diameter (inches)	8	8	8
Screened Casing Interval (feet) – depth	20 to 25.5	20 to 25	20 to 25
elevation	52 to 46.5	52 to 47	53 to 48
Sand Pack Interval (feet) – depth	19 to 25.5	19 to 27.5	19 to 27.5
elevation	53 to 46.5	53 to 44.5	52 to 45.5
Blank Casing Interval (feet) – depth	1 to 20	1.3 to 20	1.2 to 20
elevation	71 to 52	70.7 to 52	71.8 to 53
Screen Specifications	SCH 40 PVC, slot size unknown	SCH 40 PVC, slot size unknown	SCH 40 PVC, slot size unknown

General Notes

(a) Elevations referenced to Mean Sea Level.
(b) Depths measured relative to ground surface.
(c) W.A. Craig = W.A. Craig (Napa CA).

Table 5

Groundwater Analytical Data from Monitoring Wells
4401 Market Street, Oakland CA

Well Number	Sample Date	Sampled By	TPH-Gasoline (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Xylenes (µg/L)	MtBE (µg/L)
MW1	8 November 1994	W.A. Craig	54	<0.5	<0.5	<0.5	1.2	NA
	14 February 1995	W.A. Craig	71	<0.5	<0.5	<0.5	0.97	NA
	7 June 1995	W.A. Craig	**540**	0.6	<0.5	1.7	1.3	NA
	29 August 1995	W.A. Craig	**440**	<0.5	<0.5	1.3	1.1	NA
	8 December 1995	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	NA
	7 March 1996	W.A. Craig	77	<0.5	<0.5	<0.5	<0.5	**44**
	19 June 1996	W.A. Craig	**500**	<0.5	<0.5	0.85	0.36	**84**
	20 December 1996	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	28
	12 June 1997	W.A. Craig	**190**	<0.5	<0.5	<0.5	<0.5	12
MW2	8 November 1994	W.A. Craig	**20,000**	**1,400**	**960**	**980**	**4,600**	NA
	14 February 1995	W.A. Craig	**8,600**	**380**	**210**	410	**2,000**	NA
	7 June 1995	W.A. Craig	**6,200**	**500**	78	270	1,200	NA
	29 August 1995	W.A. Craig	**4,100**	**330**	61	210	980	NA
	8 December 1995	W.A. Craig	**9,400**	**360**	**190**	440	**2,000**	NA
	7 March 1996	W.A. Craig	**12,000**	**790**	**170**	440	**2,000**	18
	19 June 1996	W.A. Craig	**9,000**	**520**	82	350	1,500	ND
	20 December 1996	W.A. Craig	**13,000**	**830**	**180**	410	**2,200**	<16
	12 June 1997	W.A. Craig	**5,100**	**320**	32	190	880	<36
MW3	8 November 1994	W.A. Craig	<50	0.71	0.84	1.2	5.8	NA
	14 February 1995	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	NA
	7 June 1995	W.A. Craig	<50	<0.5	<0.5	<0.5	1.6	NA
	29 August 1995	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	NA
	8 December 1995	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	NA
	7 March 1996	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	<5
	19 June 1996	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	<5
	20 December 1996	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	<5
	12 June 1997	W.A. Craig	<50	<0.5	<0.5	<0.5	<0.5	<5

Drinking Water Criteria	TPH-Gasoline	Benzene	Toluene	Ethyl-benzene	Xylenes	MtBE
Drinking Water Criteria	100 (T&O)	1 (MCL)	150 (MCL)	700 (MCL)	1,750 (MCL)	35 (AL)

General Notes

(a) ND = Not detected.

(b) TPH = Total petroleum hydrocarbons. MtBE = Methyl tertiary Butyl Ether. NA = Not analyzed.

(c) MCL = California Primary Maximum Contaminant Level. AL = Interim Action Level established by California Department of Health Services. T&O = Taste and Odor threshold. From: Jon B. Marshack (1998). *A Compilation of Water Quality Goals.* Central Valley Regional Water Quality Control Board, Sacramento CA. March 1998. We have assumed the taste and odor criteria for diesel are also applicable to gasoline.

(d) Concentrations exceeding the drinking water criteria in **bold**.

Table 6

Field Observations from Borings
4401 Market Street, Oakland CA

Boring Number	Date Performed	Total Depth (feet)	Depth to Water (feet)	Depth Interval (feet) and Lithology	Depth Interval (feet), Organic Vapor Meter Measurement (ppm v/v), and Observations of Chemical Odor and Chemical Staining in Soil	Observations of Chemical Odor and Sheen in Groundwater
B8	8 April 1999	±16	±13	±1 to ±5: Lean Clay (CL) ±5 to ±7: Silt (ML) ±7 to ±16+: Fat Clay (CH)	±1 to 16: OVM <5, no odor or staining	No odor, no sheen
B9	8 April 1999	±16	±14	±1 to ±5: Lean Clay (CL) ±5 to ±7: Silt (ML) ±7 to ±16+: Fat Clay (CH)	±1 to 14: OVM <5, no odor or staining ±14.5: OVM = 5, slight gasoline odor, no staining	Slight gasoline odor, no sheen
B10	8 April 1999	±16	±13	±1 to ±5: Lean Clay (CL) ±5 to ±7: Silt (ML) ±7 to ±16+: Fat Clay (CH)	±1 to 13: OVM <5, no odor or staining ±13: OVM = 580, strong gasoline odor, no staining ±15: OVM = 850, strong gasoline odor, no staining	±1 inch of product (presumably gasoline) floating on groundwater (as observed in a bailer sample).
B11	8 April 1999	±19	±18	±1 to ±5: Lean Clay (CL) ±5 to ±7: Silt (ML) ±7 to ±18: Fat Clay (CH) ±18 to ±19+: Lean Clay (CL)	±1 to 15: OVM <5, no odor or staining ±15: OVM = 520, strong gasoline odor, no staining ±18: OVM = 180, strong gasoline odor, no staining	Strong gasoline odor, no sheen
B12	8 April 1999	±16	±13	±1 to ±5: Lean Clay (CL) ±5 to ±7: Silt (ML) ±7 to ±16+: Fat Clay (CH)	±1 to 16: OVM <5, no odor or staining	No odor, no sheen
B13	9 July 1999	±20	±15	±1 to ±8: Lean Clay (CL) ±8 to ±19.5: Fat Clay (CH) ±19.5 to ±20+: Clayey Sand (SC)	±1 to 2±1: OVM <5, no odor or staining	No odor, no sheen
B14	9 July 1999	±24	dry	0 to ±8: Lean Clay (CL) ±8 to ±20.5: Fat Clay (CH) ±20.5 to ±24+: Clayey Sand (SC)	0 to 19: OVM <5, no odor or staining ±19.5: OVM = 230, moderate gasoline odor, no staining ±20.5: OVM = 80, moderate gasoline odor, no staining ±21.5: OVM = 30, moderate gasoline odor, no staining	Dry hole. No groundwater sample collected.
B15	9 July 1999	±20	±15	0 to ±8: Lean Clay (CL) ±8 to ±17: Fat Clay (CH) ±17 to ±20+: Clayey Sand (SC)	0 to 18: OVM <5, no odor or staining ±18: OVM = 140, strong gasoline odor, no staining ±19.5: OVM = 250, strong gasoline odor, no staining	Strong petroleum odor, no sheen
B16	9 July 1999	±24	±21	±1 to ±9.5: Lean Clay (CL) ±9.5 to ±13: Clayey Sand (SC) ±13 to ±19: Lean Clay (CL) ±19 to ±21: Clayey Sand (SC) ±21 to ±23: Clayey Gravel (GC) ±23 to ±24+: Clayey Sand (SC)	±1 to 24: OVM <5, no odor or staining	No odor, no sheen

General Notes

(a) All depths measured from the adjacent ground or pavement surface.

(b) Organic vapor meter screening performed by placing the suction inlet of the organic vapor meter next to freshly exposed soil. Organic vapor meter = Thermo Environmental Instruments, Model 580B, equipped with 10.2 eV photoionization detector, calibrated to 100 ppm v/v isobutylene.

(c) The depth to groundwater was measured in each boring approximately 10 minutes following the conclusion of soil sampling. Reliable (stabilized) measurements of the depth to groundwater were not obtained and the groundwater table may be shallower than our measurements indicate.

Table 7

Groundwater Analytical Data from Borings
4401 Market Street, Oakland CA

Boring Number	Depth to Water (feet)	Sample Date	Sampled By	Purged?	TPH-Gasoline (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Xylenes (µg/L)	MtBE (µg/L)
B8	±13	8 April 1999	Streamborn	No	<50	<0.5	<0.5	<0.5	<0.5	<5
B9	±14	8 April 1999	Streamborn	No	**850**	**9.5**	2.4	3.5	48	<5
B10	±13	8 April 1999	Streamborn	No	**Free product (presumably gasoline) observed floating on groundwater. No sample collected.**					
B11	±18	8 April 1999	Streamborn	No	**2,600**	**34**	4.6	92	440	<10
B12	±13	8 April 1999	Streamborn	No	<50	<0.5	<0.5	<0.5	<0.5	<5
B13	±15	9 July 1999	Streamborn	No	<50	<0.5	<0.5	<0.5	<0.5	<5
B15	±15	9 July 1999	Streamborn	No	**5,100**[(1)]	<5	<5	<5	<5	<50
B16	±21	9 July 1999	Streamborn	No	<50	<0.5	<0.5	<0.5	<0.5	6.5
Drinking Water Criteria					100 (T&O)	1 (MCL)	150 (MCL)	700 (MCL)	1,750 (MCL)	35 (AL)

General Notes

(a) Depths measured from the adjacent ground surface.

(b) TPH = Total Petroleum Hydrocarbons. MtBE = Methyl tertiary Butyl Ether.

(c) MCL = California Primary Maximum Contaminant Level. AL = interim Action Level established by California Department of Health Services. T&O = Taste and Odor threshold. From: Jon B. Marshack (1998). *A Compilation of Water Quality Goals*. Central Valley Regional Water Quality Control Board, Sacramento CA. March 1998. We have assumed the taste and odor criteria for diesel are also applicable to gasoline.

(d) Concentrations exceeding the drinking water criteria in **bold**.

Footnote

(1) Laboratory reported that hydrocarbon found in gasoline range does not match their gasoline standard.

Table 8

Groundwater Level Measurements
4401 Market Street, Oakland CA

Well Number:	MW1		MW2		MW3		Groundwater Gradient		
Measuring Point:	TOC N Side, Elevation = 71.12		TOC N Side, Elevation = 70.62		TOC N Side, Elevation = 71.79				
	Depth	Elevation	Depth	Elevation	Depth	Elevation	Direction	Bearing	Magnitude
Intercepted Interval:	19 to 25.5	53 to 46.5	19 to 27.5	53 to 44.5	19 to 27.5	52 to 45.5			
7 June 1995	14.62	56.50	14.38	56.24	14.64	57.15	S 2° E	South	0.015
29 August 1995	15.04	56.08	14.40	56.22	14.94	56.85	S 45° W	Southwest	0.011
8 December 1995	15.94	55.18	15.22	55.40	15.82	55.97	S 57° W	West-Southwest	0.011
7 March 1996	12.36	58.76	12.04	58.58	12.89	58.90	S 23° E	South-Southeast	0.006
19 June 1996	13.70	57.42	13.38	57.24	13.94	57.85	S 3° E	South	0.010
20 December 1996	12.35	58.77	12.22	58.44	12.86	58.93	S 29° E	South-Southeast	0.010
12 June 1997	14.64	56.48	14.08	56.54	14.50	57.29	S 33° W	South-Southwest	0.012
31 March 1999	13.03	58.09	12.58	58.04	13.34	58.45	S 13° W	South-Southwest	0.006
Total Depth (Last Measurement)	24.6		24.5		24.6				

General Notes

(a) Measurements cited in units of feet. Elevations referenced to Mean Sea Level.

(b) Measurements prior to 1999 collected by W.A. Craig (Napa CA). 31 March 1999 measurements collected by Streamborn (Berkeley CA).

(c) TOC = top of PVC casing. N = north. Measuring points are the tops of PVC casing, north side.

(d) Intercepted intervals correspond to the sand pack interval. Depths of intercepted intervals measured relative to the ground surface.

Table 9

Soil Sampling and Testing Requirements
4401 Market Street
Oakland CA

Item	Requirement
Number of Borings	Four.
Hollow-Stem Auger	±4-inch ID by ±8-inch OD hollow-stem augers.
Depth	±25-feet.
Sampling Interval and Sample Type	Collect soil samples continuously for borings MW4, MW5, and MW6. For boring MW7, collect soil samples at 5-foot intervals or detectable changes in lithology, whichever is more frequent.
Sampler	2.5-inch OD (2-inch ID) drive sampler fitted with three 2-inch diameter by 6-inch long metal liners.
Sampler Decontamination	Wash with Alconox or other low-phosphate soap, rinse with tap water, rinse with distilled water.
Field Observations and Measurements	Screen samples with field organic vapor monitor. Note staining or odor. Visually classify samples according to ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
Samples Retained for Potential Physical Testing	None
Samples Retained for Chemical Testing	If field observations indicate the presence of soil contamination, three soil samples will be collected from above, within, and below the contaminated horizon. If contamination is not observed, two soil samples will be collected from approximate depths of ±7- and ±12-feet (estimated depth to groundwater). Analyze soil samples for TPH as gasoline, MtBE, and BTEX. MtBE to be analyzed by EPA Method 8260.
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, store on ice in cooler, enter onto chain-of-custody, and maintain sample custody until sent to laboratory.
Quality Control Samples for Chemical Testing	None.

General Notes

(a) TPH = Total petroleum hydrocarbons.

(b) MtBE = Methyl-tert-Butyl-Ether.

(c) BTEX = Benzene, toluene, ethylbenzene, and xylenes.

Table 10

New Well Completion Specifications
4401 Market Street, Oakland CA

Item	Specification
Number of new wells	Four new monitoring wells.
Depth of wells	Approximately 20 feet.
Screened interval	From 10 feet to 2~~0~~5 feet below ground surface.
Casing type	Schedule 40 PVC, flush-threaded couplings.
Casing diameter	Nominal 2-inch inside diameter.
Bottom plug	Schedule 40 PVC, flush-threaded couplings.
Sediment trap	None.
Screen length	1~~0~~5 feet.
Screen slot size	0.01-inch, factory slotted.
Casing and screen decontamination	None.
Filter pack	#2/12 silica sand (or similar gradation).
Filter pack interval	From bottom cap to approximately 1 foot above top of screened interval.
Bentonite seal	Natural bentonite chips or pellets, ±1-foot layer above filter pack.
Grout	Cement-bentonite grout (94 pounds cement, 7 gallons water, 5 pounds bentonite).
Surface completion	Flush mounted traffic-rated box with locking top cap. (When setting box, elevate top of box approximately 1 inch above ground surface and taper surrounding concrete to ground surface).

1/10/00 phone call with Kay Alexander screen interval will be changed to 10'-25', screen length will be changed to 15' DA

Table 11

Groundwater Sampling and Treatment Requirements
4401 Market Street
Oakland CA

Item	Specification
Monitoring Wells to be Sampled	• Two existing wells MW1 and MW3, and four new wells MW4, MW5, MW6, and MW7.
Sampling Frequency during Treatment	• Quarterly for one year.
Purge Equipment	• Bailer.
Purge Equipment Decontamination	• Wash with Alconox or other low-phosphate soap, rinse with tap water, rinse with distilled water.
Purge Criteria	• Wells that recharge in a timely manner should be purged of at least 3 (standing water) casing volumes and sampled after field parameters stabilize. If field parameters have not stabilized by the time 10 (standing water) casing volumes have been purged, sampling should be conducted anyway. • Wells that recharge slowly may be purged dry once and sampled after recharge is sufficient to submerge the sampling device.
Field Measurements and Observations	• Water level in well prior to purging, turbidity (qualitative clarity and color), pH, oxidation-reduction potential, temperature, specific conductivity, dissolved oxygen, and purge volume.
Sampler	• Teflon bailer with bottom-emptying device.
Sampler Decontamination	• Wash with Alconox or other low-phosphate soap, rinse with tap water, rinse with distilled water.
Natural Sample Collection	• Sample from the midpoint of standing water column.
Sample Filtration	• None.
Sample Container	• Three 40-milliliter glass vials with hydrochloric acid as preservative.
Sample Handling and Storage During Transport to Laboratory	• Verify no headspace in 40-milliliter vials. Label sample containers, place in ziplock bag, store on ice in cooler, enter onto chain-of-custody, and maintain sample custody until sent to laboratory.
Sample Analysis	• Analyze groundwater samples for TPH-gasoline, MtBE, and BTEX. • MtBE to be analyzed by EPA Method 8260.
Quality Control Samples	• None.

General Notes

(a) TPH = Total petroleum hydrocarbons.

(b) MtBE = Methyl-tert-Butyl-Ether.

(c) BTEX = Benzene, toluene, ethylbenzene, and xylenes.

Basemap: U.S. Geological Survey, 7.5 Minute Quadrangle, Oakland West CA, 1959 (Photorevised 1980).

0 1/2 1

Approximate Scale in Miles

1000 0 1000 2000 3000 4000

Approximate Scale in Feet

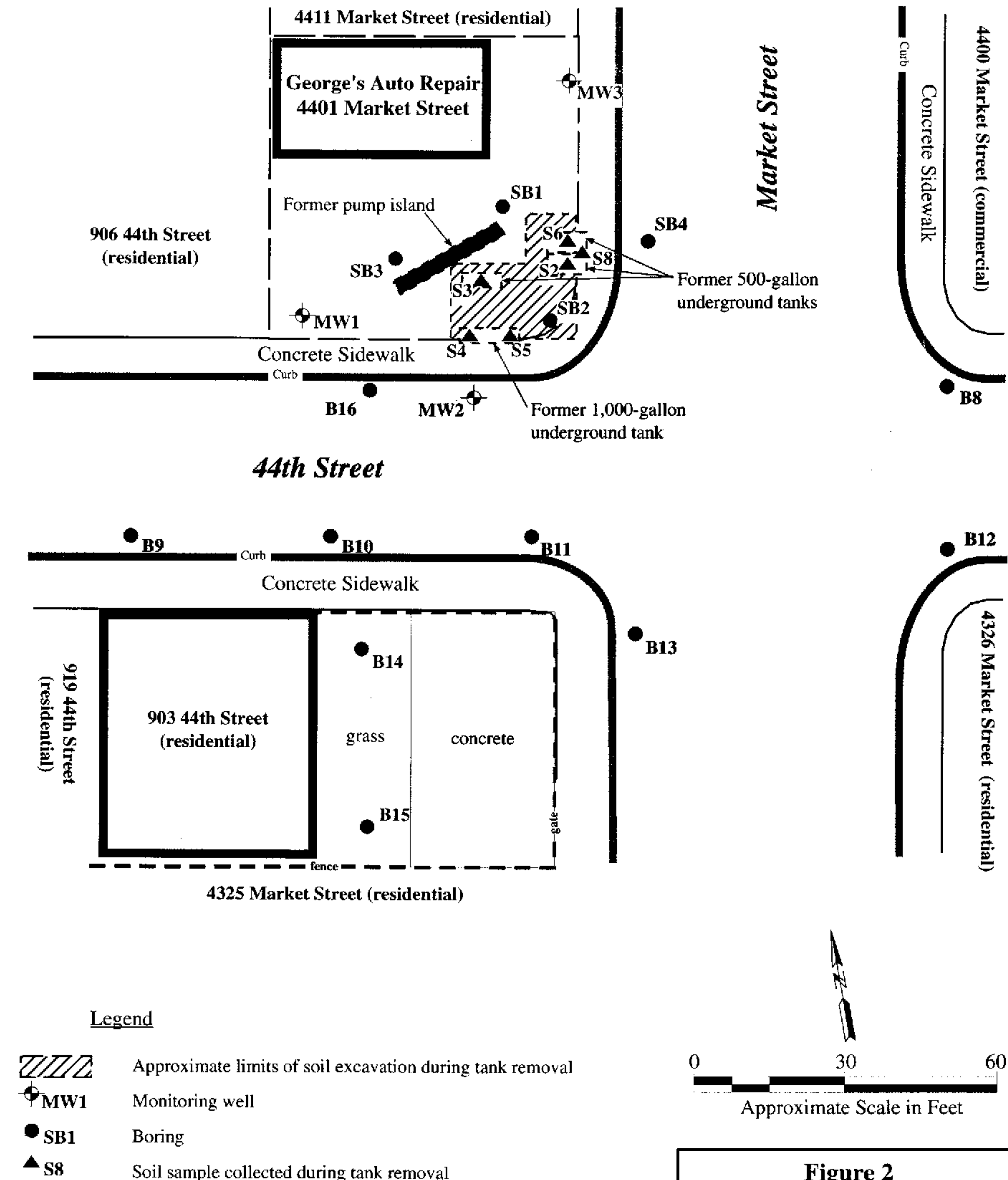
N

Figure 1

Location Map

4401 Market Street
Oakland CA

STREAMBORN



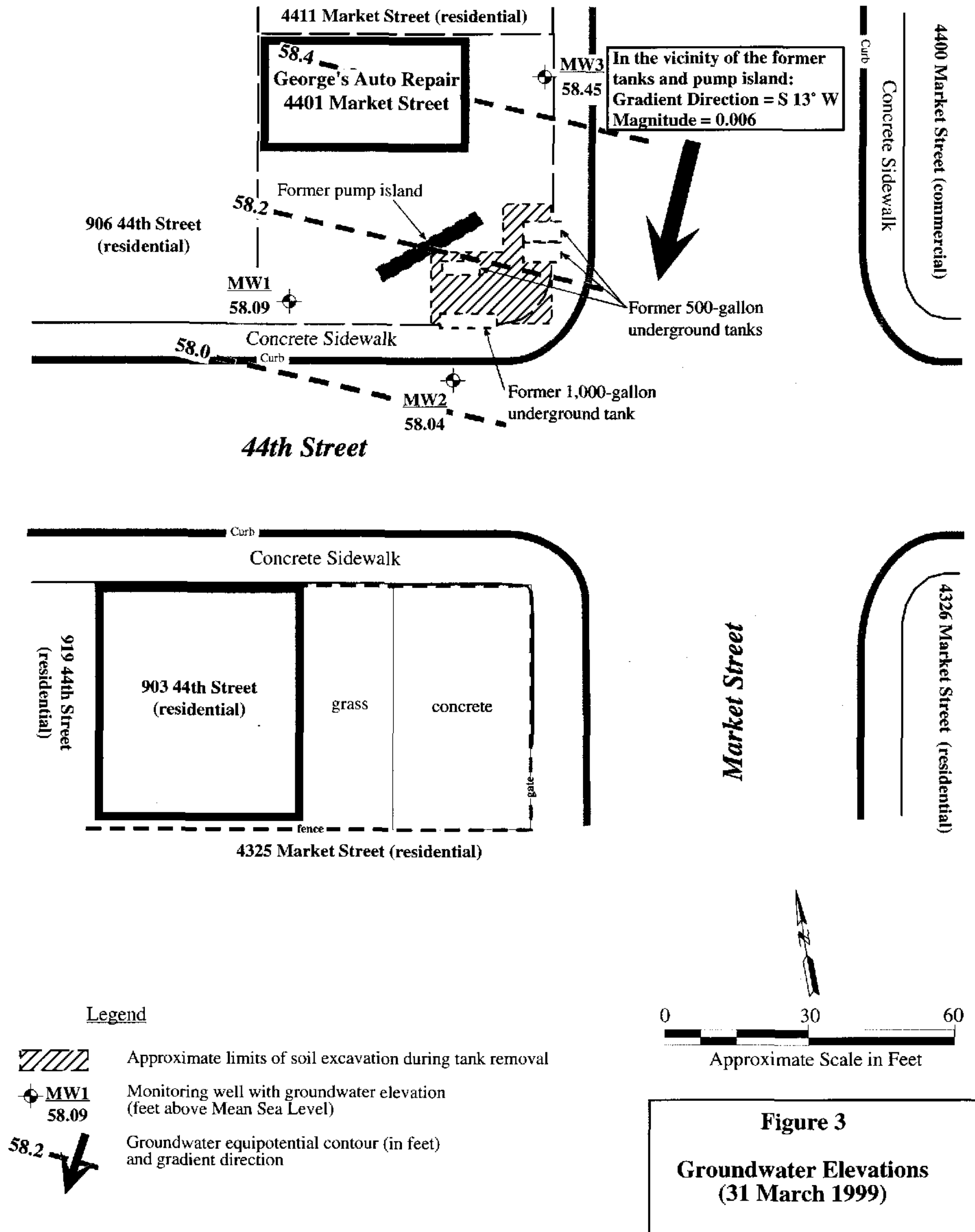
Locations of former underground tanks and limits of excavation from W.A. Craig (1994).

Figure 2

Soil and Groundwater Sample Locations

4401 Market Street Oakland CA

STREAMBORN



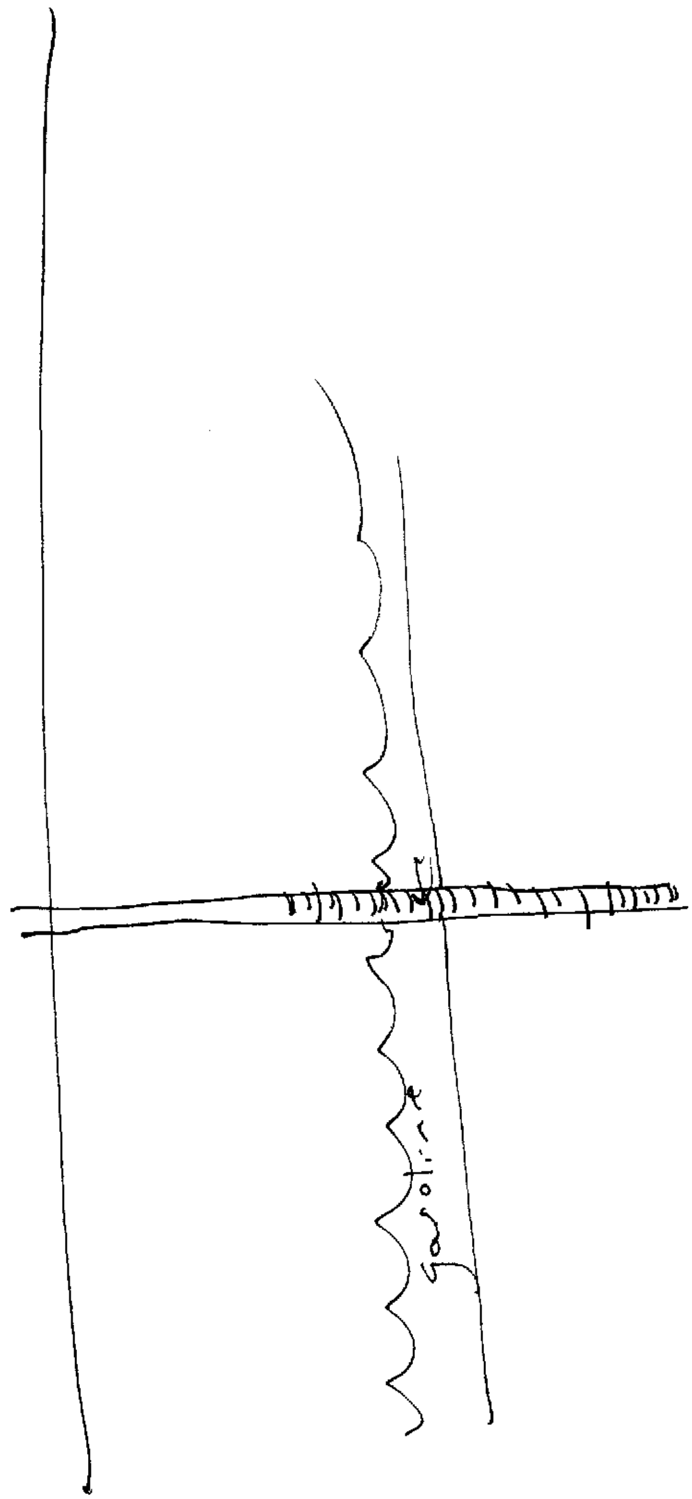
Locations of former underground tanks and limits of excavation from W.A. Craig (1994).

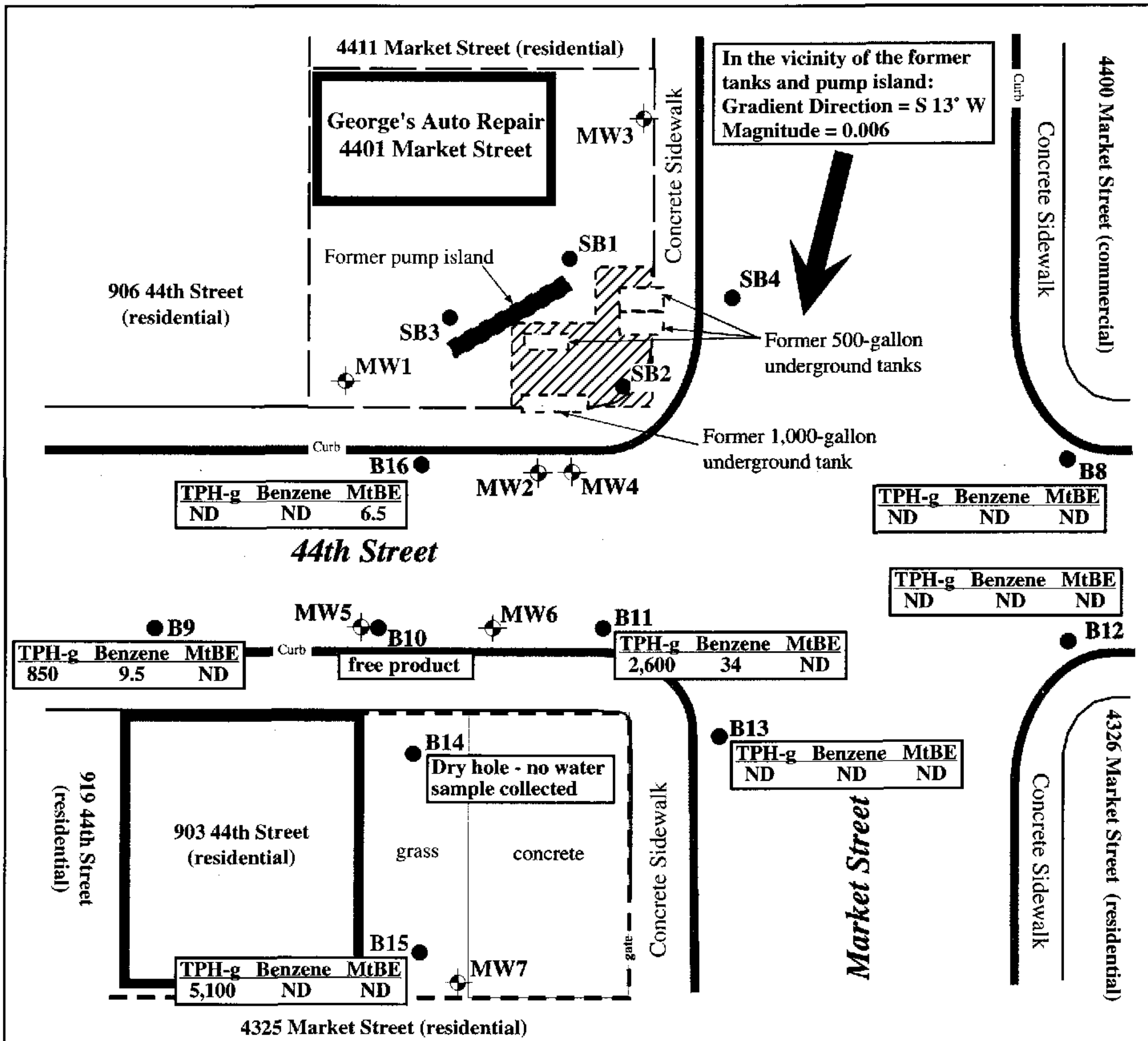
Figure 3

Groundwater Elevations (31 March 1999)

4401 Market Street Oakland CA

STREAMBORN


Gasoline



N

0 30 60

Approximate Scale in Feet

Legend

- Approximate limits of soil excavation during tank removal
- MW1 Monitoring well completed in October 1994
- SB1 Boring (Grab groundwater concentrations cited in units of ug/L. TPH-g = Total Petroleum Hydrocarbons as gasoline. ND = not detected.)
- MW4 Proposed new monitoring well

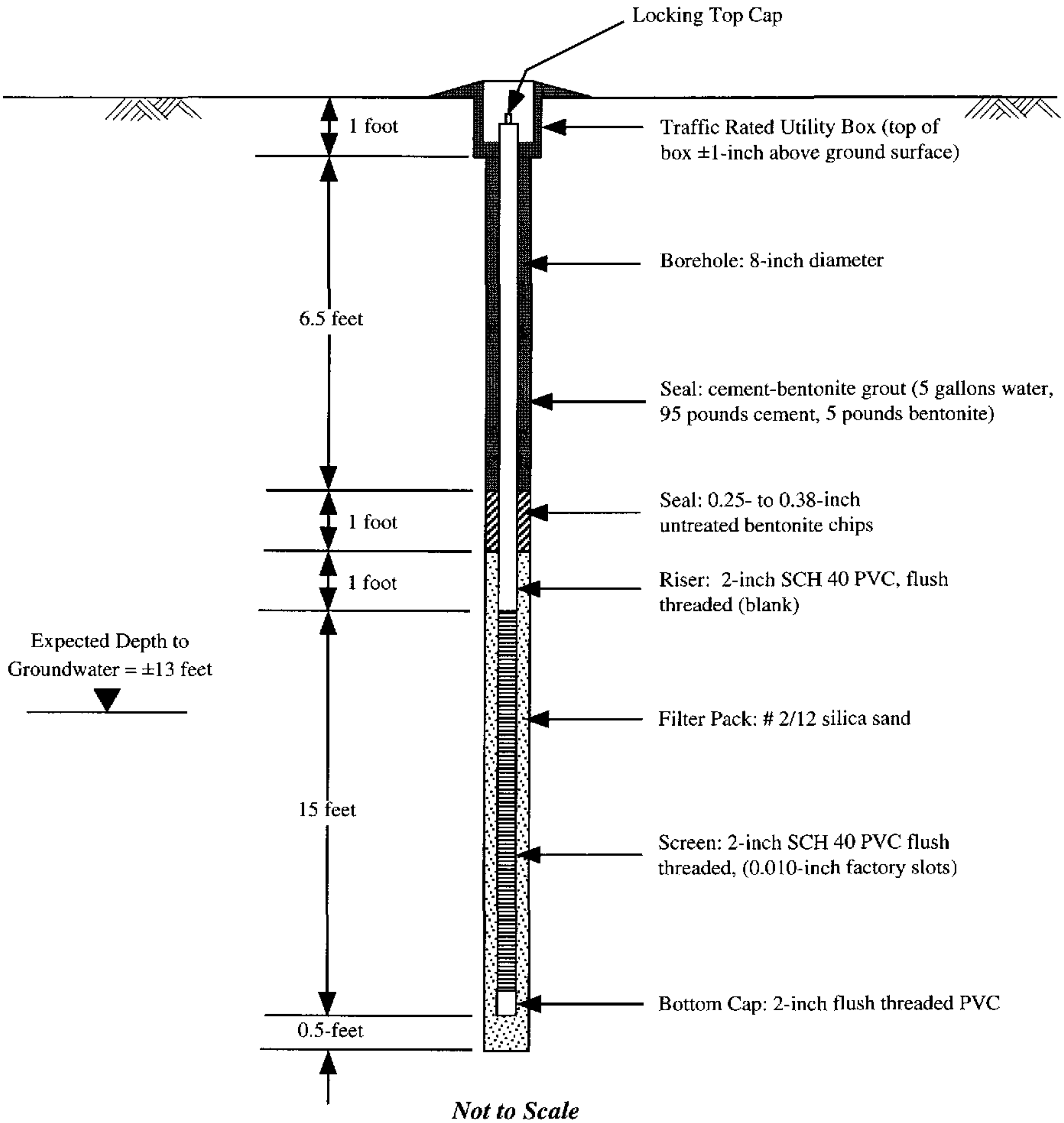
Locations of former underground tanks and limits of excavation from W.A. Craig (1994).

Figure 4

Groundwater Analytical Results and Proposed Monitoring Wells

4401 Market Street
Oakland CA

STREAMBORN



Not to Scale

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

Figure 5

Completion Schematic for New Wells

4401 Market Street
Oakland CA

STREAMBORN

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 Liquinox or Alconox
- Distilled water
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H

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

3.0 TYPICAL PROCEDURES

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

1. Decontaminate drill rig, drill rods, hollow-stem augers, split-spoon sampler and other drilling equipment immediately prior to mobilization to the site.
2. Investigate the location of the proposed boreholes for buried utilities and obstructions. At least 48 hours before drilling, contact known or suspected utility services individually or through collective services such as "USA" and "Underground Alert". As appropriate, retain private buried utility location services or geophysical investigation services to search for buried utilities and

obstructions. Also as appropriate, pothole suspect utility locations prior to drilling or relocate boreholes. During initial advancement of each borehole, drill cautiously and have the driller pay particular attention to the "feel" of the hollow-stem auger. The suspected presence of an obstruction, buried pipeline or cable, utility trench backfill, or similar may be cause for suspension of drilling, subject to further investigation.

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

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

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

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

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

8. Remove either bottom-most or second-from-bottom liner (or both) from split-spoon for purposes of chemical characterization and physical parameter testing. Observe soil at each end of liner(s) for purposes of completing sample description. Place teflon sheet at each end of liner, cover with plastic caps, and tape plastic caps with duct tape (do not use electrical tape) to further minimize potential loss of moisture or volatile compounds. Label liner(s) and place in ziploc bag on ice or dry ice inside cooler.

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

10. Visually classify soil sample in approximate accordance with ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Descriptions should include moisture content, color, textural information, group symbol, group name, and odor. Optional descriptions, especially if classification is performed with protective gloves, include particle angularity and shape, clast composition, plasticity, dilatancy, dry strength,

toughness, and reaction with HCl. Add notes on geologic structure of sample, as appropriate. Record depth interval, visual classification, and other notes to the boring log.

11. Repeat steps 3 through 10 until total depth of borehole is reached.
12. Complete borehole according to the requirements specified elsewhere.
13. Decontaminate hollow-stem augers, drill rod, and end plug between boreholes and after finishing last borehole prior to drill rig leaving site.
14. Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.
15. Containerize soil cuttings, excess soil sample, and decontamination wastewaters in steel drums. Affix hazardous waste labels to the drums.
16. Complete pertinent portion of the chain-of-custody form and daily activity report.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

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

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

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

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

5.0 DOCUMENTATION

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

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

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

5.1 Sample Label

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

5.2 Boring Log

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

- Other notations and recordings described previously in 2. EQUIPMENT AND MATERIALS and 3. TYPICAL PROCEDURES

6.0 DECONTAMINATION

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

Prior to each sample, the split-spoon sampler, liners, sample catcher, spatulas and knives, and other equipment or materials that may directly contact the sample should be decontaminated. Decontamination for these items should consist of a soap wash (Alconox, 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 accepted practices (Aller et al. 1989, USEPA 1989, and DWR 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 (generally not 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.

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 may occur 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 purpose for the well, and should include consideration of the 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.

3. Prior to installation in the borehole, well casing and screen should be decontaminated and inspected.

   Decontamination may consist of steam cleaning/pressure washing, hand washing, or equivalent. A tap water rinse should be employed after washing. If oil or grease is observed on the casing or screen, a soap wash and tap water rinse should be employed. 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 that (1) exceeds 30-feet depth or (2) is below the groundwater table, 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 filter pack material to settle through standing water prior to tagging or the tape may be lost by burial. Tagging may be time consuming, but 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 theoretical 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 theoretical 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.

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.

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 indicating the generator's name, accumulation date, contents, and well number.

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.

DWR, 1990. *California Well Standards, Bulletin 74-90 (Supplement to Bulletin 74-81), Final Draft*. California Department of Water Resources, Sacramento CA. January 1990.

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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/swabbing 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.

<u>Air-Lift Pump</u>: 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 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 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/swabbing 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/over-pumping 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/swabbing. 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/swabbing 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	Three 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	14 days after collection
Purgeable Aromatics by GC	EPA 8020	Three 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 or 8260	Three 40-ml glass vials	HCl to pH<2, Cool to 4 degrees Celsius	14 days after collection
Fuel Oxygenates (MTBE, TAME, ETBE, DIPE)	EPA SW846 8260 Modified	Three 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 Gasoline/BTEX	Extract by EPA 5030, analyze by EPA 8015	Three 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	Extract 7 days after collection Analyze 7 days after extraction
Total Petroleum Hydrocarbons Diesel, Kerosene, or Motor Oil	Extract by EPA 3510, analyze by EPA 8015	One 1-liter amber glass	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

Site Safety Plan
Investigation and Remediation of Gasoline-Contaminated Soil and Groundwater
4401 Market Street
Oakland CA

Anticipated Field Work The anticipated field work includes installation of monitoring wells, soil and grab groundwater sampling, and removal of free product (gasoline).

Chemical Hazard Evaluation Gasoline constituents, which have been detected in soil and groundwater during previous investigations at the property, are summarized in Table 1.

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 an appropriate client representative. Safety personnel and their responsibilities are presented in Table 2.

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 with a work fence, traffic cones, or barricades.

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 to modified Level-C (Table 3).

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

The breathing zone in the work area 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). 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 using the exposure criteria in 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 4. The location of the nearest hospital is shown on Figure 1.

If required, first aid will be provided for injured workers.

The site safety officer will 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.

Decontamination Decontamination refers to removal of potential chemical contamination from worker's clothing and from 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 will be washed 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 1

Chemical Hazard Evaluation
4401 Market Street
Oakland CA

Chemical	Maximum Measured in Soil (mg/kg)	Maximum Measured in Groundwater (μg/L)	Odor Threshold (ppm v/v)	Lower Explosive Limit (ppm v/v)	Time Weighted Average or Permissible Exposure Limit (whichever is lower) (ppm v/v)	Immediately Dangerous to Life and Health (ppm v/v)
Total Petroleum Hydrocarbons as Gasoline	1,300	free product	NA	14,000	300	NA
MtBE	not detected	84	NA	NA	NA	NA
Benzene	12	1,400	34 – 119	13,000	1	500 – 1,000
Toluene	24	960	0.16 – 37	12,000	50	2,000
Ethylbenzene	26	980	0.092 – 0.6	10,000	100	800
Xylenes	140	4,600	20	10,000	100	900

General Notes

(a) Exposure criteria from: (1) American Conference of Governmental Industrial Hygienists, *1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* (2) 3M Occupational Health and Environmental Saftey Division, *1996 Respirator Selection Guide*, 1996, (3) American Conference of Governmental Industrial Hygienists, *Guide to Occupational Exposure Values,* Undated (circa 1990), (4) National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards*, June 1990, and (5) *Material Safety Data Sheet, Chevron Unleaded Gasoline*, Chevron Environmental Health Center, Richmond CA, 12 September 1991.

(b) NA = applicable value was not found in the cited references.

Table 2

Safety Personnel and Responsibilities
4401 Market Street
Oakland CA

Personnel	Responsibilities
Project Manager (Kenneth B. Alexander)	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 (Kenneth B. Alexander)	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, 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 3

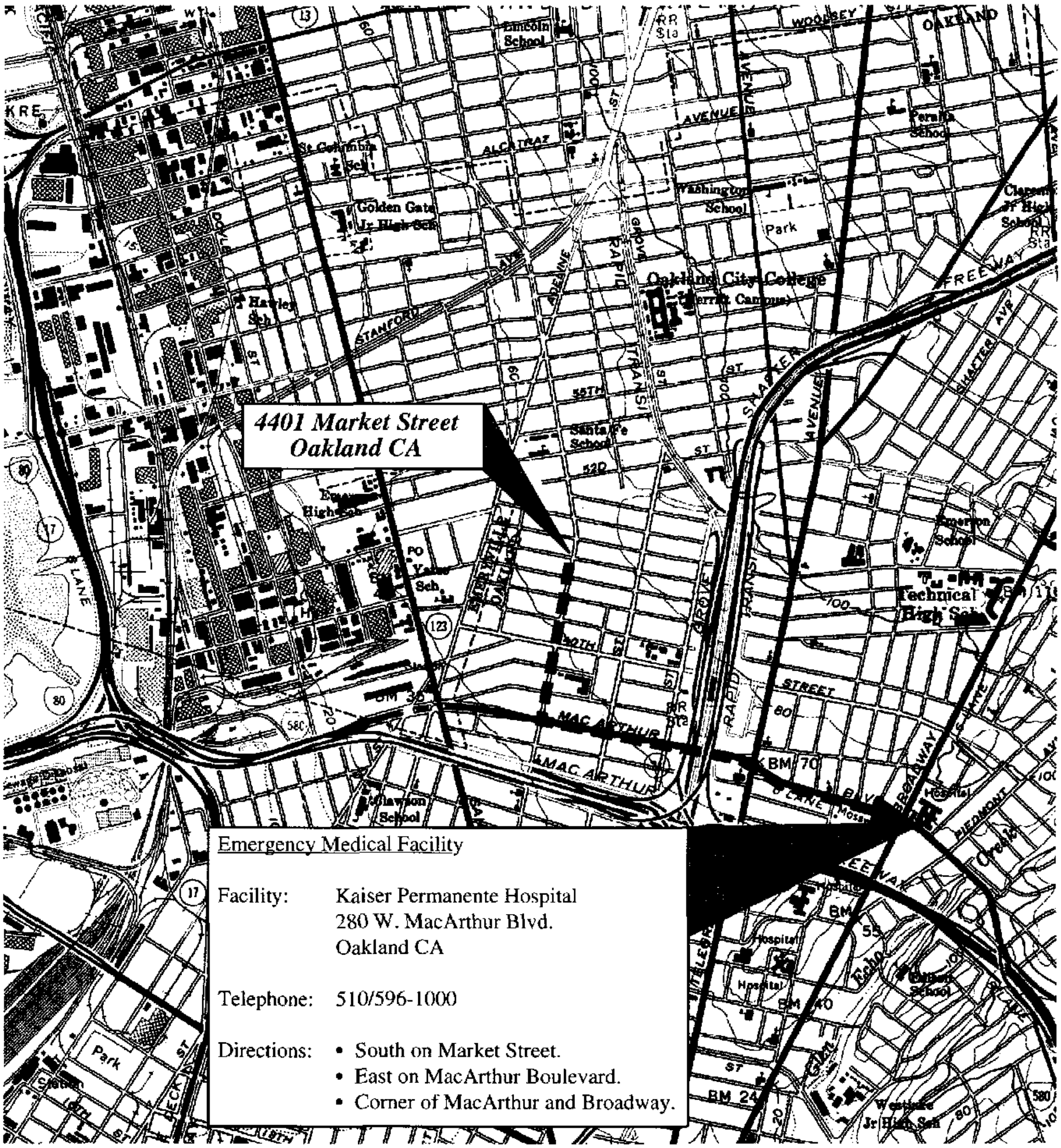
Personnel Protective and Monitoring Equipment
4401 Market Street
Oakland CA

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 yourself and co-workers for signs of fatigue and visual signs of distress (that may be caused by physical labor and possible chemical exposure).

Table 4

Emergency Information
4401 Market Street
Oakland CA

Emergency Service or Contact	Telephone	Address and Directions
Hospital	510/596-1000	• Kaiser Permanente Hospital 280 W. MacArthur Boulevard Oakland CA • From property, go south on Market Street. • Turn left on MacArthur Boulevard. • Hospital is on the left after crossing Broadway. • See Figure 1 for the route.
Ambulance	911	
Fire Department	911	
Police Department	911	
Onsite Telephone	none	
Site Safety Officer	Kenneth B. Alexander 510/528-4234 (work) 510/663-2115 (home)	
Project Manager	Kenneth B. Alexander 510/528-4234 (work) 510/663-2115 (home)	
Property Owner (or Representative)	Casimiro and Josie Damele 510/531-0778	
Subcontractors	To be determined	



Emergency Medical Facility

Facility: Kaiser Permanente Hospital
280 W. MacArthur Blvd.
Oakland CA

Telephone: 510/596-1000

Directions:
- South on Market Street.
- East on MacArthur Boulevard.
- Corner of MacArthur and Broadway.

0 0.5 1.0
Approximate Scale in Miles
0 5,000
Approximate Scale in Feet

N

Basemap: U.S. Geological Survey, 7.5 Minute Topographic Quadrangle, Oakland West CA, 1959 (Photorevised 1980).

Figure 1

Hospital Location Map

4401 Market Street
Oakland CA

STREAMBORN