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AUGUST 14, 1996

ALAMEDA COUNTY ENVIRONMENTAL HEALTH DIV.
1131 HARBOR BAY PARKWAY, ROOM 250
ALAMEDA CA 94502-6577
ATTN: JENNIFER EBERLE

RE : CORRECTIVE ACTION PLAN
208 JACKSON STREET, OAKLAND, CALIFORNIA
ACC PROJECT NO. 95-6238-1.0

Dear Madam:

Enclosed please find one copy of the Corrective Action Plan (CAP) prepared by ACC Environmental Consultants, Inc. (ACC). The purpose of the CAP is to identify and evaluate the appropriate, cost-effective corrective or remedial actions based on the results of site investigations completed at the above referenced site.

Sincerely,

Janice Chow

(JANICE CHOW)
Secretary

A·C·C
ENVIRONMENTAL
CONSULTANTS

# CORRECTIVE ACTION PLAN

**Wo Lee Food**
**208 Jackson Street**
**Oakland, California**

*ACC Project No. 95-6238-1.0*

Prepared for:

Mr. Tzu Ming Chen
c/o Ms. Janice Chow
Wo Lee Foods Company
208 Jackson Street
Oakland, California

July 9, 1996

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**CORRECTIVE ACTION PLAN**
**208 Jackson Street**
**Oakland, California**

## 1.0 INTRODUCTION

At the request of Wo Lee Food Company, ACC Environmental Consultants, Inc., (ACC) has prepared this Corrective Action Plan (CAP) to identify and evaluate the appropriate corrective action based on the results of the subsurface site investigations at 208 Jackson Street, Oakland, California (Figure 1). Previous environmental investigations identified concentrations of fuel hydrocarbons (FHCs) in the subsurface beneath the site in the vicinity of four former underground storage tanks (USTs).

### 1.1 Background

Four USTs were removed from the site in March 1990 (Figure 2). Tanks #1 and #3 are reported to have contained diesel fuel and tanks #2 and #4 contained gasoline fuel. Analytical results indicated that concentrations of total petroleum hydrocarbons as diesel (TPHd) and benzene, toluene, ethylbenzene, and total xylenes (BTEX) were reported in the soil from the excavation of tank #1. Soils left in place in the other tank excavations contained relatively low concentrations of total petroleum hydrocarbons as gasoline (TPHg), TPHd, and BTEX. Overburden soils from the tank locations and approximately 125 cubic yards of soil were excavated and stockpiled on site.

### 1.2 Initial Site Investigation

Three exploratory soil borings were drilled at the site by Subsurface Consultants, Inc., (SCI) in May 1990 and converted into groundwater monitoring wells (Figure 2). SCI collected water samples from monitoring wells MW-2 and MW-3 and the tank #2 excavation in January 1994 and submitted the samples for analyses. Analytical results of groundwater samples from wells MW-2 and MW-3 did not indicated concentrations of TPHg, TPHd or BTEX, but excavation water from tank #2 indicated 3,700 micrograms per liter ($\mu$g/L), equivalent to parts per billion (ppb) TPHd and 1.1 ppb xylenes.

SCI conducted further subsurface assessment in May 1994. Two additional groundwater monitoring wells (MW-4 and MW-5) were installed downgradient of the former USTs, adjacent to Second Street in the southern corner of the property. SCI sampled the onsite monitoring wells but was unable to locate well MW-1. Well MW-1 is believed to have been destroyed during previous site excavation of tanks #1 and #3. Analytical results of groundwater samples collected from wells MW-2, MW-4, and MW-5 indicated that groundwater has been impacted by FHCs from the former underground storage of gasoline and diesel fuels. FHCs may have migrated off site but this is considered minimal due to nondetectable analytical results in off site borings.

Due to the constituents in the groundwater detected on site, Alameda County Health Care Services Agency, Environmental Health Services (ACHCSA) requested additional offsite and onsite subsurface investigation.

## 1.3 Groundwater Monitoring and Sampling

Previous groundwater monitoring included measuring depth to water, subjectively evaluating groundwater, and purging and sampling the wells for laboratory analysis. Groundwater beneath the site was encountered between a depth of 4.2 to 5.4 feet below ground surface (bgs). The direction of groundwater flow was reported to be southerly with a gradient of approximately 0.011 foot/foot. Historic groundwater monitoring data from onsite wells is summarized in Table 1, as reported in SCI's *Groundwater Contamination Assessment Report* dated July 12, 1994.

**TABLE 1 - GROUNDWATER SAMPLE ANALYTICAL RESULTS**

| Well No. | Date Sampled | TPHg (µg/L) | Benzene (µg/L) | Toluene (µg/L) | Ethyl-benzene (µg/L) | Xylenes (µg/L) | TPHd (µg/L) |
|---|---|---|---|---|---|---|---|
| MW-1 (destroyed) | 5/21/90 | 25,000 | 400 | 440 | 330 | 650 | 5,500 |
| MW-2 | 5/21/90<br>1/6/94 | <50<br><50 | <1.0<br><0.5 | <1.0<br><0.5 | <1.0<br><0.5 | <1.0<br><0.5 | <50<br><50 |
| MW-3 | 5/21/90<br>1/6/94<br>6/3/94 | <50<br><50<br><50 | <1.0<br><0.5<br><0.5 | <1.0<br><0.5<br><0.5 | <1.0<br><0.5<br><0.5 | <1.0<br><0.5<br><0.5 | <50<br><50<br>230* |
| MW-4 | 6/3/94 | 210,000 | 7,600 | 28,000 | 3,700 | 24,000 | 9,800 |
| MW-5 | 6/3/94 | 7,800 | 3.8 | 6.2 | 10 | 16 | 4,600 |

Notes: < = Less than detection limit indicated
*Reported to be an anomalous result from one chromatogram peak

## 1.4 Additional Site Investigation

In March 1995, ACC performed an additional subsurface investigation which included drilling five exploratory soil borings (B-1 through B-5) off site along Second and Madison Streets and 11 onsite borings (B-6 through B-16). The borings were drilled in locations specified in SCI's Work Plan dated August 22, 1994, approved by ACHCSA. The boring locations were anticipated to provide the most information on the lateral extent of the dissolved FHC plume. The five offsite soil borings were drilled to a depth of approximately 10 feet bgs using a pneumatic sampler. Drilling was terminated once saturated soil conditions were encountered, approximately 4 to 5 feet into the saturated zone. Soil samples were collected near the capillary zone in each boring and were submitted for analysis of TPHg, TPHd, and BTEX. In addition, grab groundwater samples were collected from each boring and analyzed for TPHg, TPHd, and BTEX. Boring locations are illustrated on Figure 3.

Based on field observations made during the drilling of soil borings B6 through B10 (i.e., hydrocarbon odors noted in soil and groundwater samples), grab groundwater samples collected from the borings were analyzed for TPHg and BTEX and samples collected from borings B6 through B8 were analyzed for TPHd. Due to the location of the former tanks, the elevated concentrations of FHCs in monitoring wells MW-4 and MW-5, and field indications of FHC impacted groundwater, ACC collected additional grab groundwater samples from the onsite borings to further characterize groundwater conditions.

### 1.4.1 *Analytical Results - Soil*

The soil samples collected were submitted to Sequoia Analytical in Concord, California, for analysis of TPHg and BTEX by EPA Method 8015/8020, and TPHd by EPA Method 3550/8015. Results of the soil analytical results are summarized in Table 2. Boring locations are shown on Figure 3.

**TABLE 2 - SOIL SAMPLE ANALYTICAL RESULTS**

| Sample # - depth | Date Collected | TPHg (mg/kg) | Benzene (mg/kg) | Toluene (mg/kg) | Ethyl-benzene (mg/kg) | Xylenes (mg/kg) | TPHd (mg/kg) |
|---|---|---|---|---|---|---|---|
| B1-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | <0.005 | 1.3 |
| B2-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | <0.005 | 5.4 |
| B3-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | 0.013 | <1 |
| B4-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | 0.014 | <1 |
| B5-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | 0.019 | <1 |
| B6-4.0 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | 0.013 | <1 |
| B7-4.0 | 3/21/95 | 1.7 | 0.040 | 0.011 | 0.0074 | 0.029 | <1 |
| B8-4.0 | 3/21/95 | 2.9 | 0.026 | 0.012 | 0.030 | 0.091 | 94 |
| B9-3.5 | 3/21/95 | <1 | <0.005 | <0.005 | <0.005 | <0.005 | <1 |
| B10-3.5 | 3/21/95 | 2,300 | 5.3 | 26 | 40 | 200 | 71 |
| B11-3.5 | 3/22/95 | <1 | <0.005 | <0.005 | <0.005 | <0.005 | 1.4 |
| B12-3.5 | 3/22/95 | 22 | 0.023 | 0.43 | 0.21 | 3.6 | 1,100 |
| B13-3.5 | 3/22/95 | 2,700 | 1.9 | 3.9 | 34 | 210 | 66 |
| B14-3.5 | 3/22/95 | 4.2 | <0.005 | 0.044 | 0.024 | 0.25 | <1 |
| B15-3.5 | 3/22/95 | 710 | 1.5 | 0.40 | 1.3 | 7.6 | 5.6 |

| Sample # - depth | Date Collected | TPHg (mg/kg) | Benzene (mg/kg) | Toluene (mg/kg) | Ethyl-benzene (mg/kg) | Xylenes (mg/kg) | TPHd (mg/kg) |
|---|---|---|---|---|---|---|---|
| B16-3.5 | 3/22/95 | 270 | 2.2 | 25 | 9.6 | 59 | 1,200 |

Notes: mg/kg = milligram per kilogram, approximately equal to parts per million (ppm)
< = Less than detection limit indicated

### 1.4.2 *Analytical Results - Groundwater*

One water sample was collected from each offsite boring and onsite borings drilled in the vicinity of the former tank excavations. Samples selected for analysis were chosen based on observations made in the field and were submitted to an analytical laboratory for analysis of TPHg, TPHd, and BTEX. The groundwater samples were collected from the open borings with the use of a pre-cleaned stainless steel bailer. Results of the grab groundwater sample analyses are summarized in Table 3.

**TABLE 3 - GRAB GROUNDWATER ANALYTICAL RESULTS**

| Sample No. | Boring Number | TPHg (μg/L) | Benzene (μg/L) | Toluene (μg/L) | Ethyl-benzene (μg/L) | Xylenes (μg/L) | TPHd (μg/L) |
|---|---|---|---|---|---|---|---|
| W1 | B1 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <50 |
| W2 | B2 | 53 | 0.56 | <0.5 | <0.5 | 1.4 | 170 |
| W3 | B3 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | 140 |
| W4 | B4 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <50 |
| W5 | B5 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | 170 |
| W6 | B6 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | 160 |
| W7 | B7 | <50 | 1.0 | 0.52 | <0.5 | 1.2 | <50 |
| W8 | B8 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | 320 |
| W9 | B9 | 78 | 2.1 | <0.5 | <0.5 | 5.3 | -- |
| W10 | B10 | 140,000 | 2,100 | 7,700 | 4,600 | 27,000 | -- |
| W11 | B11 | 46,000 | 55 | 36 | 570 | 3,500 | 33,000 |
| W12 | B12 | 330,000 | 1,200 | 27,000 | 9,700 | 61,000 | 100,000 |
| W13 | B13 | 150,000 | 1,100 | 5,500 | 6,200 | 37,000 | 38,000 |

| Sample No. | Boring Number | TPHg (µg/L) | Benzene (µg/L) | Toluene (µg/L) | Ethyl-benzene (µg/L) | Xylenes (µg/L) | TPHd (µg/L) |
|---|---|---|---|---|---|---|---|
| W14 | B14 | 200,000 | 2,700 | 61,000 | 5,900 | 37,000 | 84,000 |
| W15 | B15 | 72,000 | 2,300 | 3,600 | 5,200 | 27,000 | 5,500 |
| W16 | B16 | 200,000 | 22,000 | 69,000 | 6,300 | 39,000 | 6,200 |

Notes: < = Less than detection limit indicated

### 1.5 Regional Geology and Hydrogeology

The site is located within the Bay Plain. The Bay Plain is a geomorphic terrain, which is the gently bayward sloping alluvial plain of Alameda County adjacent to the eastern shore of San Francisco Bay. The Bay Plain is situated on the eastern side of the San Francisco Bay depression. This depression is an irregular warpage of the earth's crust resulting principally from downward movement along northwest-trending faults at its edge (California Department of Water Resources, 1988). The regional topography slopes toward the west-southwest, which is the interpreted direction of regional groundwater movement. The nearest marine water is approximately 730 feet southwest of the site.

### 1.6 Well Inventory

According to records of the County of Alameda Public Works Agency (CAPWA), 10 operating wells are located within a 0.2-mile radius of the subject property. Of the wells, two are listed as cathodic protection wells and seven wells are listed as monitoring wells. One site has only geotechnical borings. Two monitoring wells at the subject site were not included in the well inventory supplied by the CAPWA.

The inventory did not identify any wells as being used for domestic purposes. It is unknown how many of the identified wells are still in use today. Total depths of monitoring wells in the search area range from 10 to 32 feet bgs. Cathodic protection wells in the search area were reported to have a total depth of 120 feet bgs. A copy of the well inventory is included as Appendix 1.

## 2.0 SUBSURFACE CHARACTERISTICS

### 2.1 Site Geology and Hydrogeology

Shallow soils present at the site consist entirely of sand with varying amounts of silt. Surface sands contain approximately 5 to 10 percent silts and clays, which decreased with depth. According to the Unified Soil Classification System, soils from surface to a depth of approximately 4 feet bgs were a silty sand (SM), and soils below 4 feet bgs to approximately 10 feet bgs were a sand (SP). Sands were present across the subject site to the depth of investigation, approximately 10 feet bgs.

Discharge from groundwater aquifers consists of natural and artificial discharge. Natural discharge includes evapotranspiration, groundwater discharge to streams, and underflow to San Francisco Bay. Artificial discharge comprises pumping from groundwater extraction wells. East Bay Municipal Utility District supplies domestic water to the site from surface water sources outside the Alameda County area, which include the Hetch-Hetchy Reservoir system.

Groundwater beneath the site occurs at a depth of approximately 4 to 5 feet bgs in Merritt Sand. The elevation of groundwater is approximately 1.2 to 1.6 feet above mean sea level. Based on recent investigation, groundwater flow direction is south at an approximate gradient of 0.003 foot/foot.

## 2.2 Potential Sources of Hydrocarbons

The four former onsite USTs, two gasoline and two diesel fuel USTs, removed in March 1990 were the source of FHCs detected in soil and groundwater at the site. Offsite sources of FHCs have not been identified at the site.

## 2.3 Hydrocarbons in the Soil

The subsurface soil investigation conducted by ACC in March 1995 indicated concentrations of TPHd in soil from offsite borings B1 and B2, ranging from 1.3 to 5.4 ppm. ACC believes these results to be anomalous and possibly the result of surface impacts. No TPHg or BTEX constituents were detected in any of the soil samples collected from offsite borings B1 through B5.

Analytical results of soil samples collected from onsite soil borings indicated that detectable levels of constituents exist in the capillary zone. Soil impacted by FHCs in the immediate vicinity of the former USTs has largely been removed with overexcavation. Soil downgradient of the former USTs appears to be impacted in the capillary zone due to subsurface migration of FHCs through fluctuating, shallow groundwater.

## 2.4 Hydrocarbons in the Groundwater

Grab groundwater samples collected in the offsite borings revealed varying concentrations of TPHd ranging from 140 to 170 ppb. The concentration of TPHg noted in grab groundwater sample W2 (from boring B2) of 53 ppb appears to be anomalous and possibly the result of surface impacts.

Groundwater at the site on March 21, 1995, was estimated to be at a depth of approximately 4 to 5 feet bgs. ACC's previous experience indicates that poor quality water bearing zones, similar to conditions encountered at the site, typically exhibit retarded FHC migration in groundwater. A relatively flat gradient and pavement capping of the site and nearby areas reduce water infiltration, which further retards migration of FHCs in the groundwater.

Analysis of grab groundwater samples collected in the borings indicate that water beneath the site has been impacted by FHCs. Although concentrations of TPHg in grab groundwater samples do not represent overall groundwater conditions, grab groundwater samples are indicative of water conditions at the top of the saturated zone. TPHg concentrations of 200,000 to 330,000 ppb in groundwater collected from borings B12, B14, and B16, may indicate the existence of free-phase product (Guard et al 1983).

To illustrate the distribution of constituents in groundwater, ACC used Surfer® (Golden Software, Inc.) to generate contours based on reported concentrations from groundwater samples collected in the borings during the March 1995 investigation (Table 3). Iso-concentration contours are an approximation based on limited data points and may not reflect actual subsurface conditions. It has been included in this discussion because data quality is believed to be high and general soil conditions in the saturated zone appear to be uniform.

### 2.4.1 *Distribution of TPHg*

Iso-concentration contours for the approximate distribution of TPHg in groundwater are illustrated on Figure 4. The contour interval is 50,000 ppb.

Figure 4 demonstrates that concentrations of TPHg appear to be centered in the vicinity of boring B12 and contours indicate a plume of decreasing concentrations migrating southeast, toward Madison Street and approximately parallel to Second Street. The majority of impacted groundwater exists on the site property. The water samples from borings B1 and B4 did not indicate detectable concentrations of TPHg.

### 2.4.2 *Distribution of TPHd*

Iso-concentration contours for the approximate distribution of TPHd in groundwater are illustrated on Figure 5. The contour interval is 20,000 ppb.

Figure 5 demonstrates that concentrations of TPHd appear to be centered in the vicinity of borings B12 and B14 and contours indicate a radial plume of decreasing concentrations migrating in all directions, with a slight inclination to the south. The majority of impacted groundwater exists on the site property. The water samples collected from borings B1 and B4 did not indicate detectable concentrations of TPHd.

### 2.4.3 *Distribution of Benzene*

Iso-concentration contours for the approximate distribution of benzene in groundwater are illustrated on Figure 6. The contour interval is 4,000 ppb.

Figure 6 demonstrates that concentrations of benzene appear to be centered in the vicinity of boring B16, and contours indicate a plume of decreasing concentrations migrating southeast, toward

Madison Street and approximately parallel to Second Street. The majority of impacted groundwater appears to exist at the site boundary. The water samples collected from borings B1 and B4 did not indicate detectable concentrations of benzene.

## 2.5 Physicochemical Properties

Gasoline is a volatile, flammable, hydrocarbon-based liquid formed by the distillation of crude oil. It is composed of hydrocarbons and additives designed to improve fuel performance. These hydrocarbons fall primarily in the C4 to C12 range (4 to 12 carbon atoms per molecule). The boiling range is 25° to 215°C (77° to 419°F) and the flash point is -40°C (-40°F). Analysis of gasoline usually includes analysis of BTEX. The BTEX components (aromatic hydrocarbons) may comprise 10 to 40 percent of gasoline (ASTM Guide E1739-95) but typically are approximately 19 percent of its total composition (Guard, Ng, & Laughlin, 1983). Gasoline is a clear liquid with a characteristic petroleum odor.

Diesel is a semi-volatile, flammable liquid comprised of petroleum-derived hydrocarbons. The hydrocarbons fall primarily in the C10 to C20 range. The boiling range is 160° to 400°C (320° to 752°F) and the flash point is greater than 35°C (greater than 95°F). Because of their higher molecular weights, diesel range constituents are less volatile, less water soluble, and less mobile than hydrocarbons in the gasoline range (ASTM Guide E1739-95). Analysis of diesel components usually includes analysis for BTEX components. BTEX components usually are approximately 0.1 percent of the total composition.

### 2.5.1 *Toxicity*

Benzene is highly toxic, and exposure to acute levels can irritate mucous membranes, cause restlessness, convulsions, excitement, depression, and even death from respiratory failure. Chronic levels of benzene can cause bone marrow depression or leukemia. The California Department of Health Services action level for benzene in groundwater is 0.7 ppb and the Maximum Contaminant Level (MCL) for drinking water is 1 ppb. Toluene, ethylbenzene, and xylene are less toxic than benzene with MCLs at 100, 680, and 1,750 ppb, respectively. BTEX compounds pose the most potential threat to human health, and they have the potential to volatilize or move through soil and impact groundwater.

### 2.5.2 *Persistence*

The solubility of benzene in water at 23.1°C is 0.188 percent. The boiling point of benzene is 80°C. Toluene, ethylbenzene, and xylene are slightly more soluble in water than benzene. These constituents volatilize quickly in air. Research has indicated that FHCs are subject to degradation by the action of bacteria.

2.5.3 *Potential for Migration*

The lighter fractions of gasoline and diesel (BTEX constituents and shorter carbon chain molecules) are more mobile than heavier fractions. BTEX can therefore migrate or dissipate away from the main FHC plume. This appears to be occurring at the subject site. However, migration has been minimal during the last 4 years. Mobility has been reduced due to the fine-grained silts and clays present in the sandy soils observed at the site, inferred low hydraulic conductivity, lack of surface water infiltration due to pavement capping at the site and on nearby surfaces, and relatively flat groundwater gradient.

2.5.4 *Exposure Assessment*

Exposure routes for site employees and the public could be via dermal contact and inhalation of volatilized FHC constituents and windblown dust. Because the asphalt cap covers the site, the potential risk of human exposure to subsurface FHCs is extremely low.

## 3.0 EVALUATION OF CORRECTIVE ACTION ALTERNATIVES

This section presents discussions on selection criteria and cleanup levels, available alternatives to treat FHCs in soil and groundwater, and an initial screening to identify treatment alternatives that can be applied successfully to the site. Interim remedial measures and source control actions are not addressed. This rational assumes that a threat to public health and safety appears not to be imminent and we are aware of no continuous release of FHCs at the site.

### 3.1 Protocol For Selection Of Corrective Action

California Code of Regulations Title 23, Chapter 16, Articles 5, 7, and 11 require that a soil and groundwater investigation phase be implemented to assess the nature of the release and to determine a method of cleanup. The regulations also specify that the CAP shall consist of those activities determined to be cost effective. "Cost-effective" actions are defined in the regulations as "actions that achieve similar or greater water quality benefits at an equal or lessor cost than other corrective actions."

Corrective action alternatives should address an assessment of impacts including:

1) the physical and chemical characteristics of the hazardous substances or its constituents, including toxicity, persistence, and potential for migration;

2) hydrogeologic characteristics of the site and surrounding area;

3) proximity and quality of surface water or groundwater, and the current or beneficial uses of the waters; and

4) the potential effects of residual impacts to nearby surface water and groundwater.

The primary remedial objective is to minimize the impact of FHCs to groundwater that is considered to be of potential beneficial use. Criteria used to evaluate treatment alternatives are effectiveness, treatment time, future liability, and cost. Proposed cleanup levels for soil and groundwater should be consistent with the primary objective and selection criteria.

## 3.2 Remedial Alternatives for Soil

Alternatives considered in regard to treatment of FHCs in soil are no action and active treatment. Active treatment technologies include non-in situ, in situ and removal with aboveground treatment. The primary advantages of the in situ technologies are minimal cost for excavation and soil is treated in place with minimal disruption to the surface. The primary disadvantages of in situ technologies are lower effectiveness in impermeable soil and residual concentrations of FHCs commonly persist in the subsurface after treatment.

### 3.2.1 *No Action Alternative*

The no action response results in continued migration of FHCs from soil to the groundwater and continued expansion of the dissolved FHC plume. A prerequisite of this alternative is delineation of the FHCs in groundwater and identification of points of potential human impact. Continued migration of the plume is monitored closely to verify that no FHCs impact human health.

Disadvantages of the no action response are that FHCs in the subsurface are not treated or removed, implementation of the monitoring and health risk investigations require delineation of the plume, the property owner is not released from potential future liability, and no action may lengthen the site closure process.

### 3.2.2 *Action or Treatment Alternatives for Soil*

Non-in situ technologies require soil removal by excavation, and disposal at an appropriate landfill or treatment of the impacted soil by aeration, landfarming, fixation/solidification, or incineration. The effectiveness of excavation may be limited by the location of existing aboveground and underground facilities.

To facilitate this alternative, soil around the former tank excavation and in the vicinity of monitoring well MW-2, MW-4, and MW-5 would be removed to the soil/groundwater interface. Process descriptions of treatment technologies for excavated soil are described below.

1) Soil aeration is the process by which soil is spread out on polyethylene sheeting on the ground surface in 1 to 2 foot lifts and FHCs are volatilized by incident solar radiation. The soil is periodically turned or tilled to increase exposure of volatile hydrocarbons to the atmosphere. When FHC levels drop to acceptable concentrations, soils are then used on site or transported

off site for appropriate disposal. Two requirements for this technology are compliance with Bay Area Air Quality Management District (BAAQMD) atmospheric discharge rates and sufficient area for treatment.

Primary advantages of this technology are relatively low capital and operation and maintenance (O&M) costs, simplified technology, and onsite treatment. Primary disadvantages are: 1) treatment time depends on weather conditions; 2) impermeable soil increases treatment time; 3) the volume of soil aerating is dependent upon concentration levels and must be in compliance with BAAQMD requirements; and 4) after treatment, soil must be transported and disposed of at an accepting facility.

2) Landfarming of FHC impacted soil is accomplished by spreading the soil in 1 to 2 foot lifts. Nutrients and/or microorganisms are periodically incorporated into the soil and the soil is turned or tilled periodically. The nutrients and tilling enhance biologic activity which decomposes the hydrocarbon chain links.

   Primary advantages of landfarming are low capital costs, onsite treatment, and the technology is technically well understood. Primary disadvantages are: 1) lengthy treatment time; 2) labor intensive O&M; 3) volatile compound emissions must be in compliance with BAAQMD discharge requirements; 4) treated soil must be reused onsite or transported and disposed of at an appropriate facility; and 5) the upper few feet of the aquifer should be excavated.

3) Fixation/solidification is the process by which materials (cement, lime, fly, ash, organic polymers, or other chemicals) are added to the impacted soils to produce a solid or convert the constituents of concern to a more chemically stable form.

   Primary advantages of this process are: 1) complete containment of constituents of concern; 2) lower future liability; 3) effectiveness on all types of soil; and 4) short treatment time. Primary disadvantages are relatively high process costs and associated transportation and disposal costs. In addition, some regulatory agencies will not accept this type of technology without approving a long-term management plan and possible deed and/or land use restrictions.

4) Incineration is the process by which soil is removed and processed through a high temperature combustion chamber (e.g., rotary kiln, hearth, and fluidized bed) where the organic compounds are incinerated and converted primarily to ash, carbon dioxide, and water. Thermal treatment is most cost effective on soil containing high levels of organic material (greater than 1,000 ppm). There are no permanent operating thermal treatment facilities in California; however, temporary (either stationary or mobile) treatment systems are available for either onsite or offsite remediation. Cement kilns are temporarily permitted for soil incineration. In the San Francisco Bay area, two thermal treatment facilities operate under temporary 90-day variances, can process only a designated volume of soil, and may not be available to treat soil promptly.

Primary advantages of incineration are: 1) effectiveness on all types of soil; 2) relatively short treatment time; 3) relatively low future liability; and 4) treated soil may be used to backfill the excavation (upon approval by ACHCSA). The primary disadvantage is relatively high cost.

5) Disposal with no pretreatment is possible for soil excavated at the site. Soil containing hydrocarbon concentrations greater than 100 ppm and less than 1000 ppm may be excavated and transported to a Class III landfill. The primary advantage of the direct disposal of excavated soil is the short time soils remain onsite. The primary disadvantage is moderate to high cost and the limitation of only removing accessible soils.

In situ technologies include bioremediation and bioventing. Process descriptions of treatment technologies are described below.

1) Biological treatment uses the action of microorganisms to metabolize the FHC compounds present. Under aerobic conditions, FHC constituents may be completely converted to carbon dioxide, water, and additional bacterial matter. The majority of the compounds found in FHCs are degradable by bacteria; however, biotreatment methods usually require improvements in the subsurface growth environment surrounding the indigenous microorganisms.

   Primary advantages of bioremediation are: 1) surface conditions are left relatively undisturbed; and 2) low cost for system design and microorganisms that will work for varying site specific conditions. Primary disadvantages are: 1) extended treatment time due to natural degradation and microbial growth; 2) potential for costly O&M in that oxygen and nutrients will be monitored for changes in subsurface environment; and 3) difficult treatment method in fine-grained soils.

2) Bioventing, involves aeration of FHC impacted soils to sustain respiration and thus biodegradation. Feasibility of the bioventing process is based on a sufficient baseline of natural hydrocarbon-degrading microorganisms and availability of nutrients. Bioventing utilizes low air flow rates to provide oxygen to naturally occurring microorganisms that degrade the FHCs by using them as a carbon source for cell production and carbon dioxide production during respiration. Enough oxygen is necessary to sustain microbial activity, which minimizes the volatilization of FHCs. Air injection can often be utilized for venting soils in lieu of air extraction, thereby eliminating off-gas treatment.

   Primary advantages of bioventing are low capital costs and onsite treatment. Primary disadvantages are: 1) extended treatment time due to natural degradation and microbial growth; 2) the potential for emitting volatile compounds that must be in compliance with BAAQMD discharge requirements; and 3) difficulty in injecting air into clayey soil.

The most common in situ removal with aboveground treatment is vapor extraction. In moderately to highly permeable soils, vapor extraction is an effective method for removal of liquid, residual, and vapor phase volatile FHCs from subsurface soils and liquid phase volatile FHCs floating on the groundwater. Application of this technology has demonstrated that in soil with low permeability, high concentrations of FHC constituents, and high water saturation limits the effectiveness of the vacuum extraction process. Higher volume vacuum techniques can sometimes be used to enhance FHC extraction rates.

1) The vapor extraction process involves the induction of air flow through soils by applying a vacuum within the soil matrix. Induction of air flow is typically accomplished with a vapor extraction system piped to vertical extraction wells. As air flows through the soil void space, FHCs are volatilized and the vapors are purged from the soils into a vapor treatment unit. Based on the FHC mass to be remediated, vapor treatment is accomplished by dispersion, adsorption onto activated carbon, catalytic oxidation, or thermal incineration.

   A) Adsorption onto activated carbon involves passing vapor-phase FHCs over activated carbon for adsorption and discharge of the clean air. Spent carbon can be regenerated or disposed offsite. Typically, activated carbon is economic for FHC removal of less than 25 pounds per day.

   B) Catalytic oxidation involves heating the soil vapors at 500°F to 700°F, then passing the FHC vapors over a catalyst bed for oxidation. Catalytic oxidation is generally economic for FHC removal of between 25 and 50 pounds per day, but less than 50 milligrams per liter (ppm) for most of the operation.

   C) Thermal incineration involves heating the vapors at 1,500°F to 1,800°F for 1 to 2 seconds (residence time) to oxidize the FHC vapors. This process is economic for high FHC concentrations and removal rates of greater than 50 ppm for any extended period.

   Primary advantages of vapor extraction are: 1) well known technology; 2) effective in combination with other technologies (i.e., groundwater extraction, air sparging, and bioremediation); 3) onsite treatment; 4) relatively short treatment time in high permeable soil; and 5) relatively low future liability. Primary disadvantages are: 1) relatively high capital and O&M costs; 2) soil with low permeability increases treatment time; 3) released air emissions must be in compliance with BAAQMD requirements; and 4) the relatively high cost of catalytic oxidation and thermal incineration for lower volumes of soil.

### 3.2.3 *Screening Acceptable Treatment Alternatives for Soil*

For non-in situ technologies, excavation is generally the most cost effective method to achieve desirable soil cleanup levels. Because the impacted soil at the subject site is relatively shallow (maximum depth of 6 to 8 feet), excavation will effectively remove impacted soils. The cost of excavating the soil is approximately $25 to $65 per cubic yard depending on the amount of soil to be removed and the type of equipment necessary to perform the work. Onsite treatment of the soil may cost $25 to $65 per cubic yard depending on the FHC levels and the space available for treatment and/or aeration. Soil disposal can range from $35 upward depending on levels of constituents, acceptance criteria at the disposal facility, and the method of disposal. Excavation would remove the impacted source in the soil only. Other methods would have to be included with soil excavation to remediate the groundwater, including pumping groundwater from the excavation. The combination of soil removal and groundwater removal during excavation would likely remove the main source of impact and prevent further migration.

The no action alternative is not considered feasible because of the elevated concentrations of dissolved-phase FHCs, existence of free-phase product, and remaining liability of untreated soil. No action may jeopardize or delay site closure and would require a risk assessment to evaluate risks to human health and safety, and the environment. For treatment of the excavated soil, fixation/solidification is not appropriate, because this method is only economically justified for a considerably larger volume of soil. Landfarming will not significantly reduce the treatment time compared to aeration. The additional O&M cost associated with landfarming is judged to be unwarranted. Treatment technologies that can be successfully applied to the site are aeration, bioremediation, thermal treatment, and direct disposal.

For in situ technologies, bioventing is considered potentially feasible in combination with water treatment; however, this technique applied to a small site may cost $60 to $75 per cubic yard of impacted soil and it is not likely to achieve the cleanup levels that soil vapor extraction would achieve.

Vapor extraction is potentially feasible to achieve desired soil cleanup levels. However, the impacted soil is relatively shallow in depth and inadvertently pulling surface air into vapor extraction wells or "short circuiting" is a concern. As with bioventing and air sparging, vapor extraction has physical and hydrogeological limitations.

Excavating impacted soil is considered the most feasible remedial option to achieve appropriate soil cleanup levels. Due to shallow depth and limited volume, excavation would be the most cost-effective treatment method for impacted soil.

## 3.3 Groundwater Remedial Alternatives

Remedial alternatives for groundwater include no action and active treatment. Active treatment alternatives reduce FHC concentrations or minimize the continued migration of the dissolved FHC plume. Preliminary aquifer test and permeability tests of soil are necessary to properly characterize subsurface conditions for potential recovery and treatment alternatives.

### 3.3.1 *No Action Alternative*

The no action response for groundwater is similar to the no action response discussed for soil. Under this alternative, groundwater monitoring would probably continue for an indefinite period of time. Implementation of the no action response for groundwater requires delineation of the dissolved FHC plume and evaluation of the risks to human health. Advantages and disadvantages of the no action response for groundwater are similar to those previously discussed in Section 3.2.1.

### 3.3.2 *Recovery/Containment Alternatives*

Groundwater recovery or containment can be implemented by removal of groundwater encountered during excavation, from extraction wells, by horizontal subsurface drains, during dewatering of pits, or from low permeability barriers. A discussion of the methods is presented below.

1) Groundwater pumping from the open excavation involves the active manipulation and management of groundwater to contain, divert, or remove impacted groundwater. Pumping is most effective in high permeability sediments. The effectiveness of extraction in relatively low permeability sediments may not be increased by enlarging the well diameter. Hydraulic control may be achieved as a result of groundwater extraction.

2) Horizontal subsurface drains include any type of buried conduit (e.g., perforated pipe) used to convey and collect aquifer discharges by gravity. Subsurface drains function like an infinite line of extraction wells by introducing a continuous zone of influence within which groundwater flows toward the drain. A system of drains are installed to direct water flow toward an extraction point or points. Drains are generally applicable to shallow depths to groundwater. The most widespread use of drains is to intercept a dissolved-phase plume hydraulically downgradient from a source.

3) Dewatering of open pits involves excavation to below the groundwater surface and removing fluids seeping into the pit. This method may be effective in areas of low permeability sediments by significantly increasing the surface area available for withdrawal. Dewatering would only be considered for the subject site if excavation took place. Under this option, dewatering is assumed to take place for approximately 2 weeks, or until concentrations of dissolved FHCs are below levels deemed acceptable by the ACHCSA and/or risk-based cleanup criteria.

4) Low permeability barriers include a variety of methods whereby low permeability cutoff walls or diversions are installed below grade to contain impacted groundwater or divert the flow of unaffected groundwater. The common subsurface barriers are slurry walls, grouted barriers, and sheet piling. Impacted groundwater can be either left untreated, if fully contained, or may be recovered and treated.

### 3.3.3 *Treatment Alternatives*

Groundwater impacted by FHCs can be treated on site or off site. Onsite alternatives include the use of interim treatment units or the construction of stationary longer-term treatment systems. Interim treatment units are usually used for temporary groundwater containment or free-phase FHC recovery. Stationary systems, with some components installed underground, are used for longer-term cleanup of groundwater. The groundwater can be fully treated on site and either reinjected to the subsurface, discharged to surface water, or discharged to a municipal wastewater treatment plant. Groundwater may also be collected and hauled to an offsite treatment facility. Offsite treatment is not cost effective for larger volumes of water because of high transportation and disposal costs.

In situ groundwater treatment and in situ removal with aboveground treatment technologies are described below.

1) In situ technologies include biodegradation and chemical degradation.

   A) Biodegradation is the process by which naturally occurring soil microorganisms are stimulated to degrade dissolved-phase FHCs. Water is mixed in an aboveground tank with nutrients, oxygen, and pH neutralizers to support microbial growth. The enriched water is injected into the subsurface through injection wells or filtrating ponds. Stimulation of microbial growth and activity for FHC destruction is accomplished primarily through the addition of oxygen and nutrients. Treatability studies must be performed to refine operating parameters prior to applying this technology to the site.

   B) Chemical degradation is an oxidation technique that is used to detoxify FHCs in the groundwater. Hydrogen peroxide or hypochlorite is usually incorporated into the saturated zone through injection wells and oxidizes FHCs in the groundwater. As with in situ biodegradation, chemical degradation has physical and hydrogeological limitations.

2) In situ source removal technologies involve groundwater recovery, aboveground treatment of water with dissolved-phase FHCs, and fluid disposal. Selection of a treatment system depends on the constituents to be removed and may consist of a combination of several technologies to effect a solution.

Alternatives for removal of dissolved-phase FHCs in groundwater include air stripping, carbon adsorption, and biodegradation. These alternatives are discussed below.

   A) Air stripping would not be as useful for the removal of diesel constituents because they are less volatile. The technology works by transferring the dissolved-phase FHCs in the groundwater from the liquid phase into a flowing gas or vapor stream. FHC impacted water is pumped to the top of the air stripper tower and distributed uniformly across packing material. Water flows downward in a film layer along the packing material surfaces. Air blown into the base of the tower flows upward, contacting the water. Volatile organics are transferred from the water to the air and carried to the top of the column. A properly designed and operated packed-tower air stripper can achieve greater than 95 percent removal of the volatile organics from water. Residuals from an air stripping process include the treated water and the impacted off-gas, which may be either discharged to the atmosphere in low volumes, or directed through carbon filtration units.

   B) Carbon adsorption is used to remove the dissolved-phase FHCs by adsorption to activated carbon. At least two carbon filtration units are placed in series. The efficiency of removal is approximately 98 percent. Activated carbon is used as a primary or secondary treatment technology.

C) Biodegradation uses enhanced biologic activity to degrade dissolved-phase FHCs in groundwater. Impacted groundwater is pumped into a bioreactor and flows around a medium (typically plastic packing material) on which bacteria grow. A typical bioreactor with proper maintenance can achieve a FHC destruction efficiency of greater than 85 percent. Any remaining FHCs may be removed using carbon filtration.

### 3.3.4 *Screening Acceptable Alternatives*

#### 3.3.4.1 Recovery/Containment

Site-specific hydrogeologic data is necessary to evaluate whether groundwater pumping from existing wells would yield sufficient water to control plume migration. Aquifer parameter data from beneath the subject site would be necessary to utilize groundwater pump and treat as a viable treatment alternative in a cost-effective manner. Soil residual would need to be remediated using an appropriate method described in Section 3.2. Similar data from the subject site may be sufficient to utilize groundwater pump and treat as a viable treatment alternative in a cost-effective manner. Soil residual would need to be remediated using an appropriate method described in Section 3.2.

Dewatering of open pits during excavation would effectively remove FHC impacted groundwater in the vicinity of the excavation.

Construction of low permeability barriers to contain plume migration is not considered appropriate for this site. The cost of constructing a containment structure around the FHC impacted groundwater would be high relative to installing drains or extraction wells. A recovery system would additionally have to be installed if groundwater treatment was selected. If groundwater is not treated, owner liability would remain until concentrations were reduced through natural dispersion, dilution, and degradation.

Extracting groundwater via 4-inch-diameter to 6-inch-diameter wells and pumping the water through an air stripper and/or activated carbon canisters in series is not a viable treatment alternative for the subject site due to the low volatility of diesel components, low permeability soils, and the limited success potential of pump and treat technology. FHC residuals will probably persist and specific soil treatment may be necessary to obtain a no further action site status.

#### 3.3.4.2 Treatment

In situ technologies have a limited application for this site to treat the impacted groundwater, because the water bearing formation exhibits low permeability. Treatment of the entire impacted area would likely require installation of numerous closely spaced removal and injection wells. Numerous injection points, a potentially extended treatment time, and the uncertainty of effective treatment do not make in situ methods technically or cost effective for the site. Non-in situ treatment of groundwater appears to be a more effective alternative.

## 4.0 DISCUSSION

Senate Bill 1764 (SB 1764) was signed into law on January 1, 1995, which created an advisory committee to make recommendations for improving the Underground Storage Tank Program to the California State Water Resources Control Board (SWRCB). Recommendations reported by this committee have an impact on this CAP and its implementation. ACC requests that these recommendations be evaluated for their applicability before remedial activity begins. Recommendations that are applicable to the subject site are:

1) Risk Classification (#3) - *"To aid in decision making and resource allocation, it would be useful to classify leaking underground fuel tank (LUFT) sites based on the risks they pose. Risk reduction should be achieved using the most cost-effective means, not necessarily through the application of best available technology."*

   The initial perceived risk associated with FHCs in the subsurface at the subject site is minimal due to the lack of potential receptors, little or no migration in the subsurface, and the lack of beneficial uses of shallow groundwater in the vicinity.

2) Consideration of Economic Factors (#9) - *"The appropriate level of water-quality protection and the degree of required LUFT site restoration should be governed by a balanced consideration of economic factors, along with the need to protect human health, safety, the environment, and existing and probable future uses of the waters of the State."*

   Due to the minimal perceived risk, we believe remedial activity should utilize the most cost-effective means possible, including removing impacted soil and groundwater through excavation.

3) Adequate Source Removal (#12) - *"The determination of what constitutes adequate source removal should be determined site-specifically, base on a risk-based corrective-action approach, to achieve adequate protection for human health, safety, the environment and beneficial water uses."*

   Defining "source" has always been difficult. Free-phase product, above the level of residual saturation, is generally considered a "source." However, if equilibrium conditions are reached with little or no groundwater infiltration, concentrations of dissolved-phase constituents should remain constant and naturally degrade over time. Is the impacted soil and free-phase floating product at the site acting as a "source"? Based on analytical results of grab groundwater samples collected downgradient off site and the apparent lack of an increasing plume of impacted groundwater, the answer would be a qualified "no."

4) Site Closure Criteria (#2) - *"The State should issue clear written guidance on acceptable criteria for closure of LUFT sites."*

Final guidance for site closure has not been issued by the state. Site specific criteria for closure should be based on site investigation, characterization, and the assessment of risks based on remaining residual FHC concentrations. Site closure criteria need to be based on regional water quality goals and realistic current and future beneficial uses (or the lack of) of shallow groundwater in the vicinity of the subject site.

5) Insignificant Risk Sites (#4) - *"Make it a matter of 'public record' that a LUFT site contains residual petroleum hydrocarbons in the subsurface, but that insignificant-risk sites pose no foreseeable risk to human health, safety, the environment and beneficial water uses."* does this mean "low risk" sites should not have deed not's, even if residuals in place?

   Since the USTs were removed in March 1990, residual petroleum hydrocarbons have existed in the subsurface and posed minimal risk to human health, safety, and the environment.

6) Beneficial Use Designations and Water Quality Objectives (#8) - *"The State should examine the possibility of categorizing or classifying groundwater systems for beneficial use suitability on a sub-regional scale."*

   Water quality in the first-encountered aquifer at the site is suspected to be poor due to shallow depth, impacts from surface infiltration, and increased total dissolved solid concentration. Potential future water use from the first-encountered aquifer is highly unlikely.

7) Soil Cleanup Standards (#16) - *"Soil cleanup 'standards' need to remain flexible, considering the widely varying site conditions, and should generally be developed site specifically, as outlined in the adopted risk-based corrective-action guidance."*

   The majority of FHC impacted soil is due to migration of FHCs in groundwater and contact between soil and fluctuating groundwater levels. Some impacted soil is beneath a storage building and cannot be removed easily.

8) Intrinsic Bioremediation (#6) - *"If the effectiveness of intrinsic bioremediation can be established at a given site, this process should be considered a viable treatment alternative."*

   Based on shallow groundwater depth and expected high dissolved oxygen concentration, bioremediation is expected to readily occur where FHC concentration is sufficiently dilute. Intrinsic bioremediation is expected to treat FHC residues not removed by the proposed corrective action.

9) Use of Risk Assessment (#1) - *"The committee recommends that a framework for formulating corrective actions be developed that uses the concepts and tools of risk assessment..."*

   A risk assessment may show that the risks associated with leaving FHCs in the subsurface are minimal to human health, safety, and the environment. Evaluating possible impacts on potential receptors may show the FHC concentrations at the subject site pose an acceptable risk.

## 5.0 CONCLUSIONS

This work is ineligible for reimbursement by the California SWRCB Underground Storage Tank Cleanup Fund. ACC believes any remedial action should be the most cost-effective approach and thoroughly evaluated for its potential for success.

The majority of FHC impacted soil exists from a depth of approximately 4 to 6 feet bgs in the soil/water interface. The distribution of FHCs in soil is primarily a result of source migration in groundwater. The distribution of FHCs in groundwater indicates that dissolved-phase FHCs are essentially stable but may be slowly migrating south to southeast at the rate of 0 to 3 feet per year.

low ?

Due to shallow groundwater depth and reduced soil permeability, we believe remedial options which require liquid-phase or vapor-phase transport would have limited success and be needlessly expensive. These remedial options include pump and treat, air sparging, biosparging, dual-phase extraction, soil venting, bioventing, and soil vapor extraction.

At this time, two remedial alternatives appear to be feasible at the subject site. The first remedial alternative is selective excavation and water removal from the excavation. An attempt to remediate the layer of FHC impacted soil beneath the site and control migration of the dissolved-phase FHC plume would be technically feasible and cost effective using a combination soil excavation and groundwater extraction from the excavation. This remedial plan would effectively remove free-phase FHCs (source) and impacted soil in the capillary zone, and control further migration. Proposed excavation limits are illustrated on Figure 7. Water removed from the excavation could be stored temporarily in a 10,000-gallon holding tank, treated using activated carbon, and disposed in the sanitary sewer system under permit from the East Bay Municipal Utility District. Excavation water could be alternatively pumped via vacuum truck and transported to an oil/water recycling facility.

The second remedial alternative is the no action alternative with a risk assessment performed to verify that risks to human health, safety, and the environment are acceptable during the time period that intrinsic bioremediation removes residual FHCs in the subsurface. Any risk assessment performed at the site should follow the American Society of Testing and Materials (ASTM) standard for Risk-Based Corrective Action, ASTM E-1739-95, and include specific recommendations of ACHCSA and the Bay Area Regional Water Quality Control Board.

The remedial method of selective excavation and removing impacted water from the excavation will likely be more cost effective and obtain the goal for site closure faster than other methods. Removal of easily obtained, impacted soil and groundwater would reduce potential migration and aid in natural degradation processes.

## 6.0 RECOMMENDATIONS

ACC recommends that soil along the eastern edge of the steel storage shed be excavated as a means of source removal. Surface soils from a depth of approximately 0 to 4 feet bgs should be removed, stockpiled on site, and reused as clean fill material, and soils from 4 to 8 feet bgs should be removed, stockpiled separately, and sampled. Excavated soils could be aerated on site for possible use as backfill or profiled for disposal off site, if appropriate. Soil screening test kits that give instant, approximate FHC concentration values would be useful for this purpose, followed by a minimum of verification soil sampling.

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Groundwater from the excavation should be removed, stored temporarily, and sampled for analysis of the constituents of concern. Based on the volume of soil excavated and assuming a 30% porosity, groundwater volume within the excavation should be approximately 10,000 gallons. ACC anticipates a minimum of four pore volumes, or 40,000 gallons of water should be removed to evaluate the effectiveness of water removal as a means of source removal. If FHC concentrations remain elevated, additional groundwater should be removed as a means of source removal.

ACC further recommends that any excavation be properly backfilled, compacted with clean fill, and capped with pavement to remove the opening as a source of recharge to the shallow groundwater. Stockpiled soil, presently at the site from the original UST removal, should be sampled and, if appropriate, be used as backfill material.

After remedial activity is performed and the results of soil and groundwater removal evaluated, a risk assessment should be performed. The risks associated with FHC residuals in soil and groundwater not removed during remedial activity should be assessed. This information is critical to future management of the site and obtaining ultimate site closure.

## 7.0 REFERENCES

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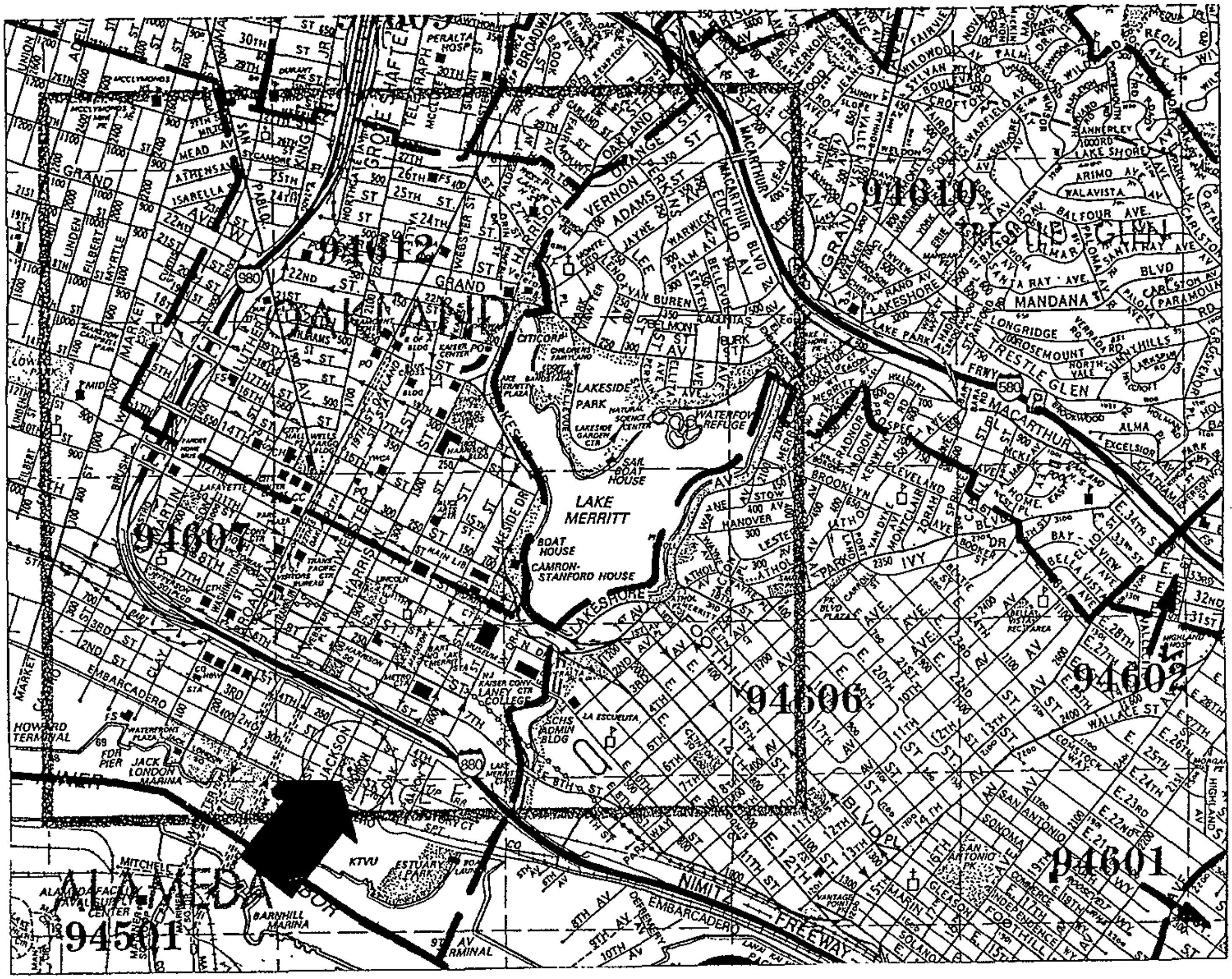
## 8.0 LIMITATIONS

The service performed by ACC has been conducted in a manner consistent with the levels of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions in the area. No other warranty, expressed or implied, is made.

The conclusions presented in this report are professional opinions based on the indicated data described in this report and applicable regulations and guidelines currently in place. They are intended only for the purpose, site, and project indicated. Opinions and recommendations presented herein apply to site conditions existing at the time of our study.

ACC has included analytical results from a state-certified laboratory, which performs analyses according to procedures suggested by the U.S. Environmental Protection Agency and the State of California. ACC is not responsible for laboratory errors in procedure or result reporting.

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Source: Thomas Brothers Guide

| Figure 1 |
|---|
| Site Plan<br>208 Jackson Street<br>Oakland, California |

| May 5, 1995 | Drawn by: DRD | Project No.: 95-6238-1.0 |
|---|---|---|


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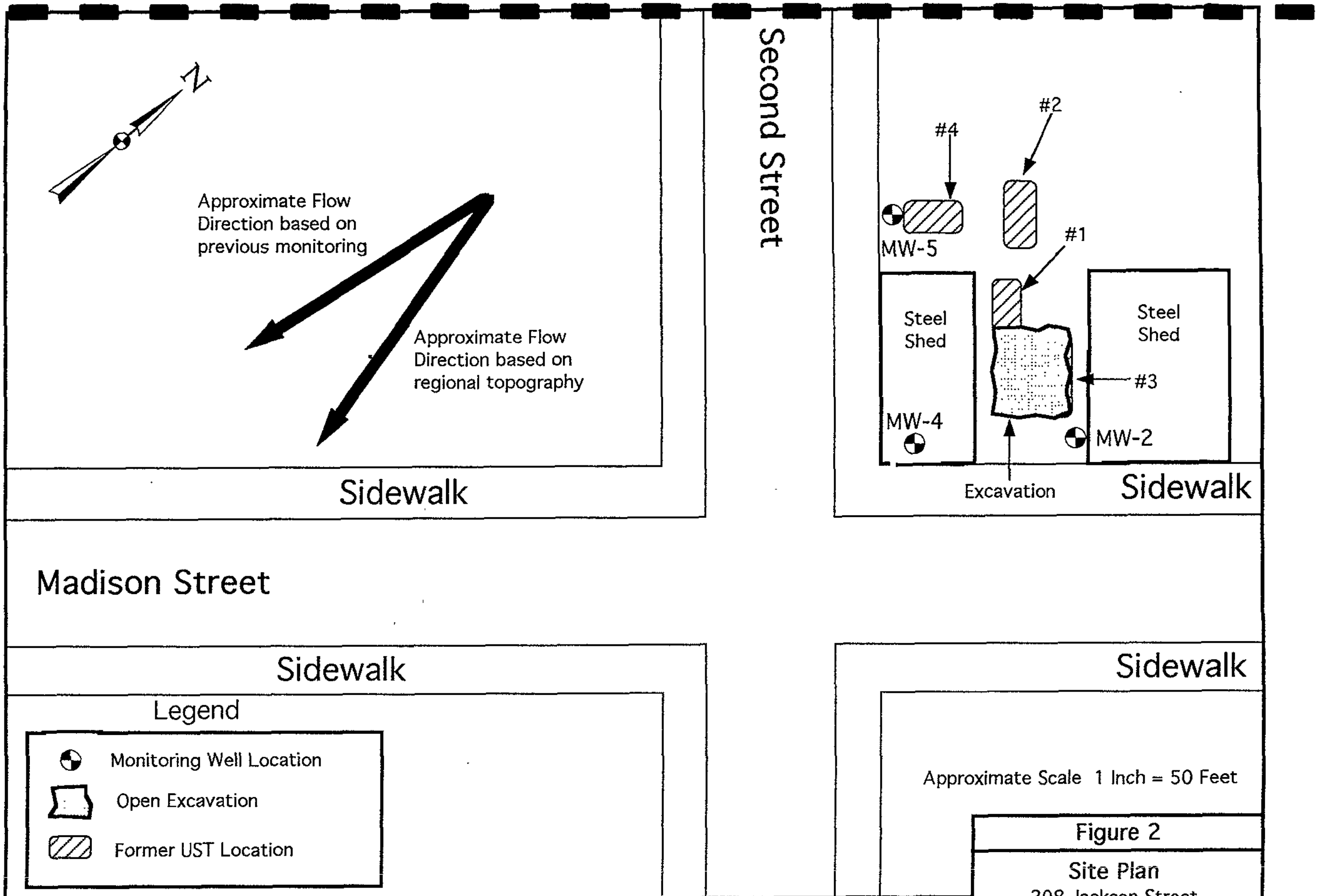


Figure 2

Site Plan
208 Jackson Street
Oakland, California

| May 2, 1995 | Drawn by: DRD | Project No.: 95-6249-1.0 |
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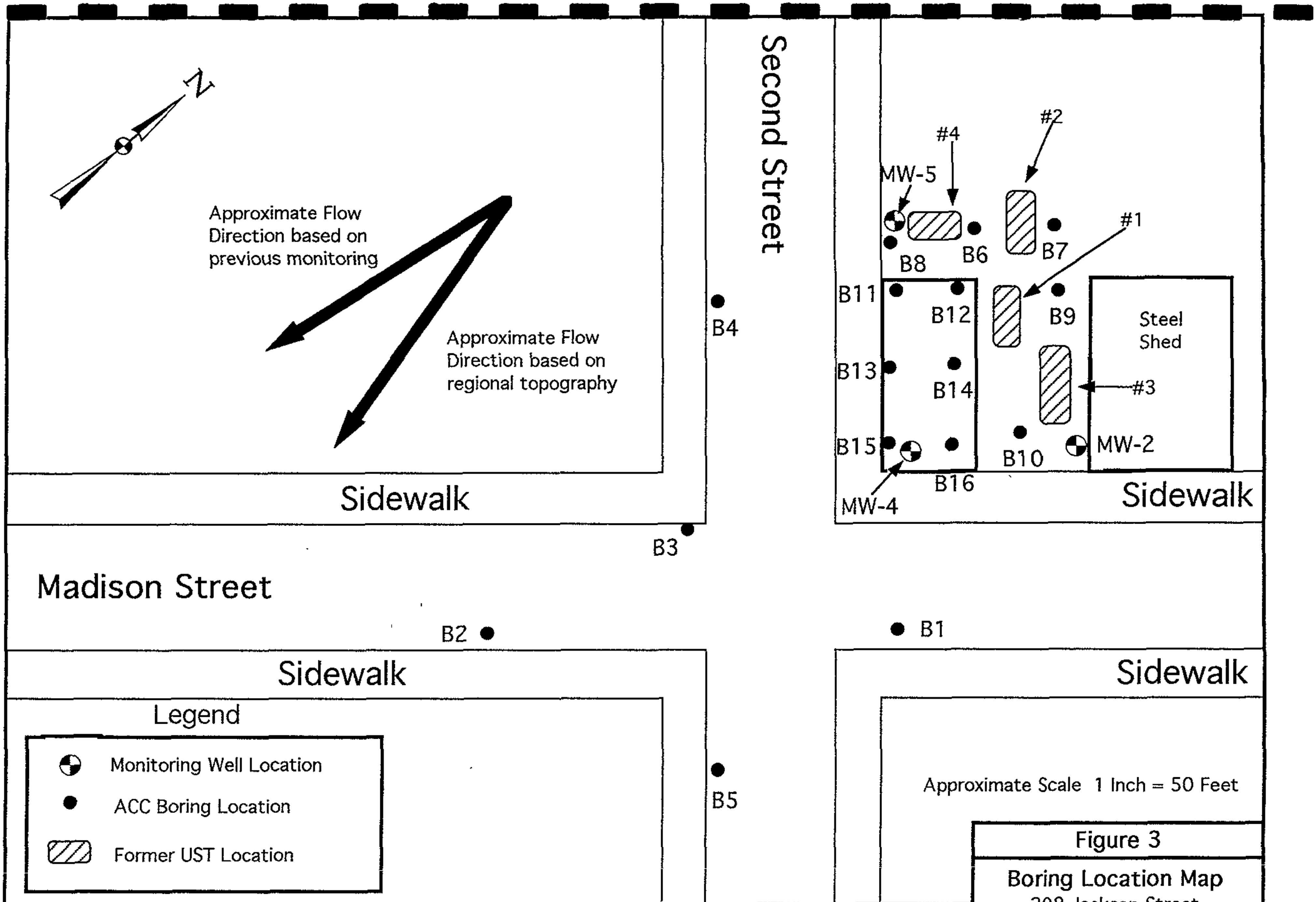


Figure 3

Boring Location Map
208 Jackson Street
Oakland, California

| May 2, 1995 | Drawn by: DRD | Project No.: 95-6249-1.0 |
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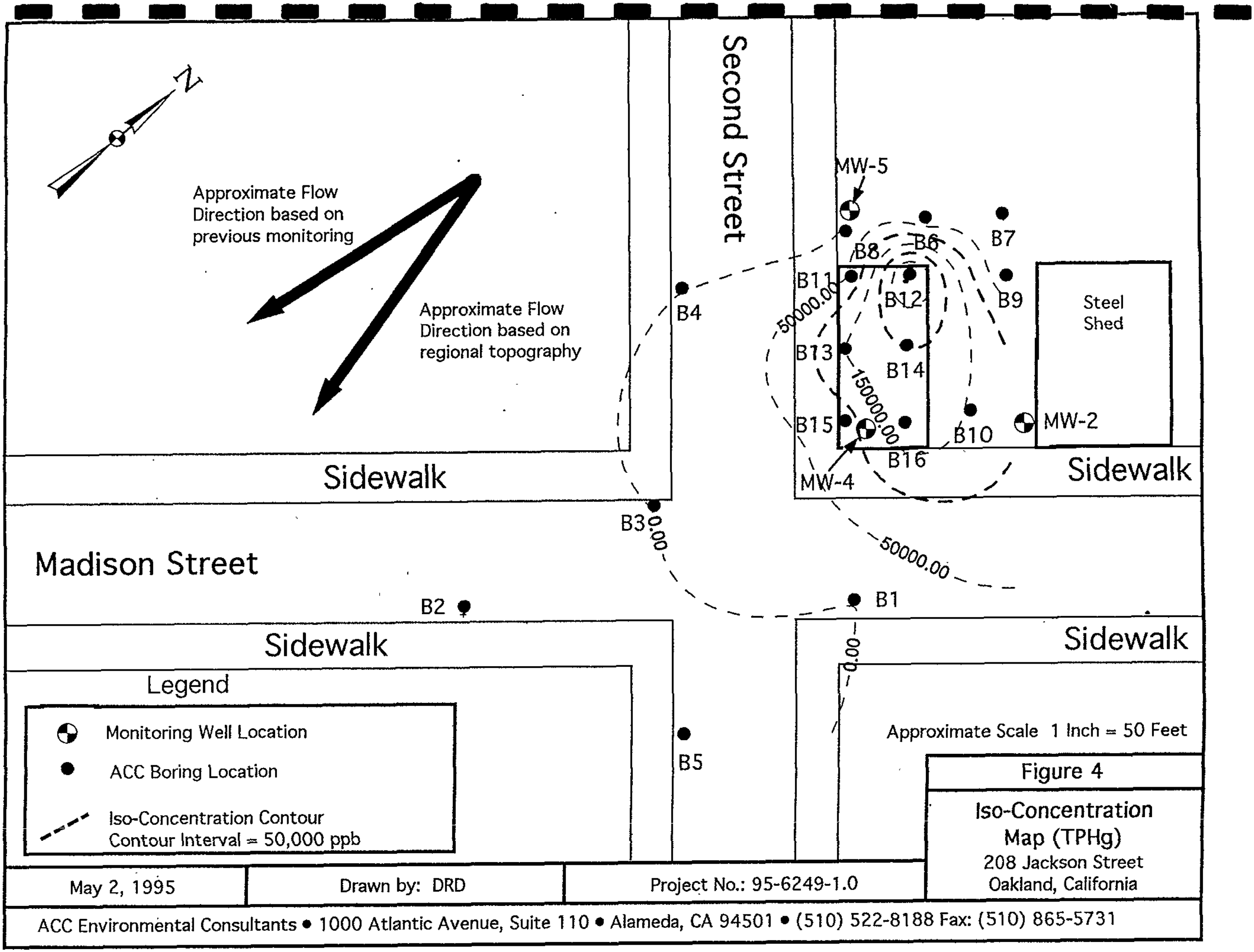
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Approximate Flow Direction based on previous monitoring
Approximate Flow Direction based on regional topography
Second Street
Madison Street
Sidewalk
Sidewalk
Sidewalk
Sidewalk
MW-5
MW-4
MW-2
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
Steel Shed
50000.00
150000.00
50000.00
0.00
0.00
Legend
Monitoring Well Location
ACC Boring Location
Iso-Concentration Contour
Contour Interval = 50,000 ppb
Approximate Scale 1 Inch = 50 Feet
Figure 4
Iso-Concentration Map (TPHg)
208 Jackson Street
Oakland, California
May 2, 1995
Drawn by: DRD
Project No.: 95-6249-1.0
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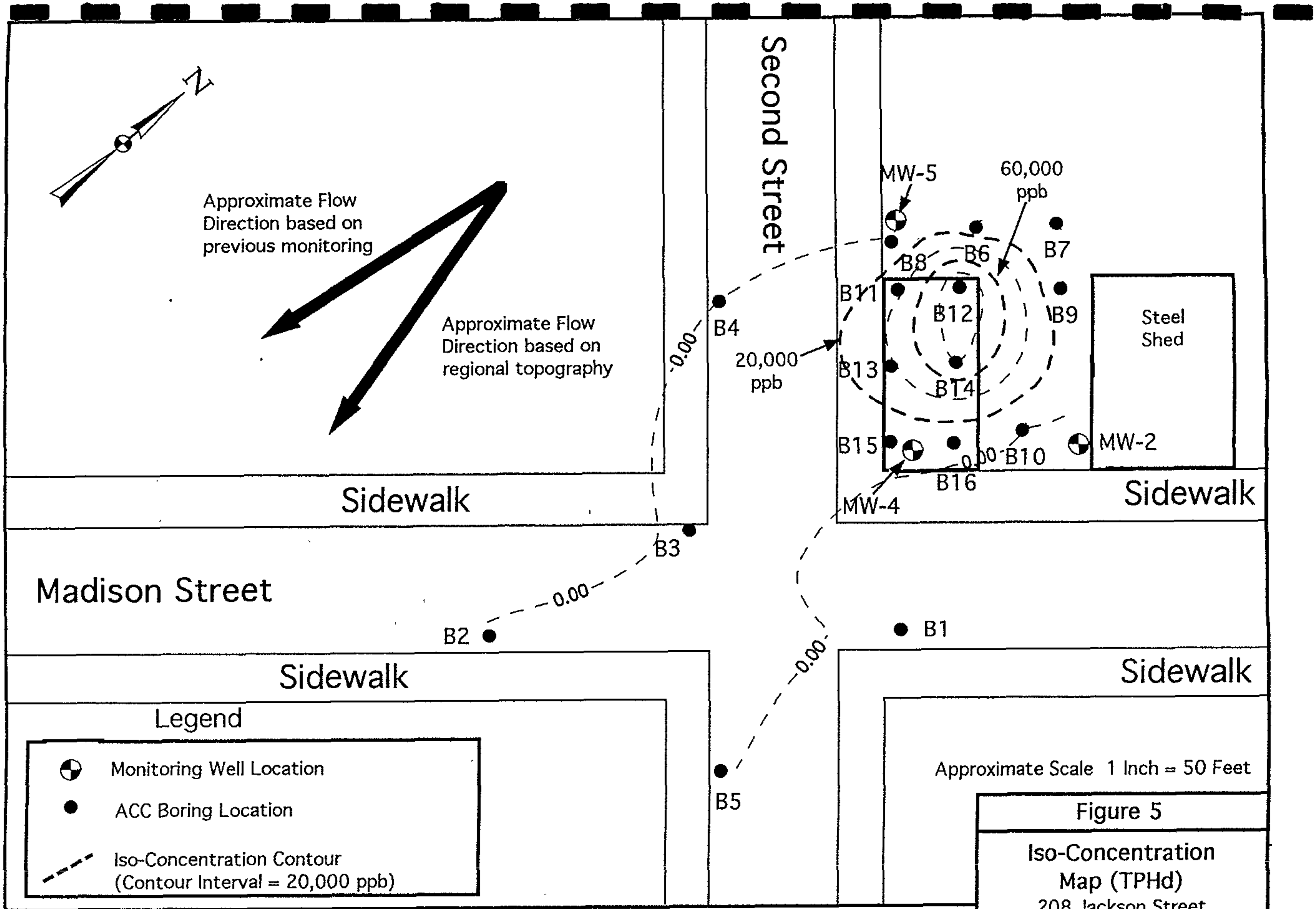


Figure 5

Iso-Concentration Map (TPHd)
208 Jackson Street
Oakland, California

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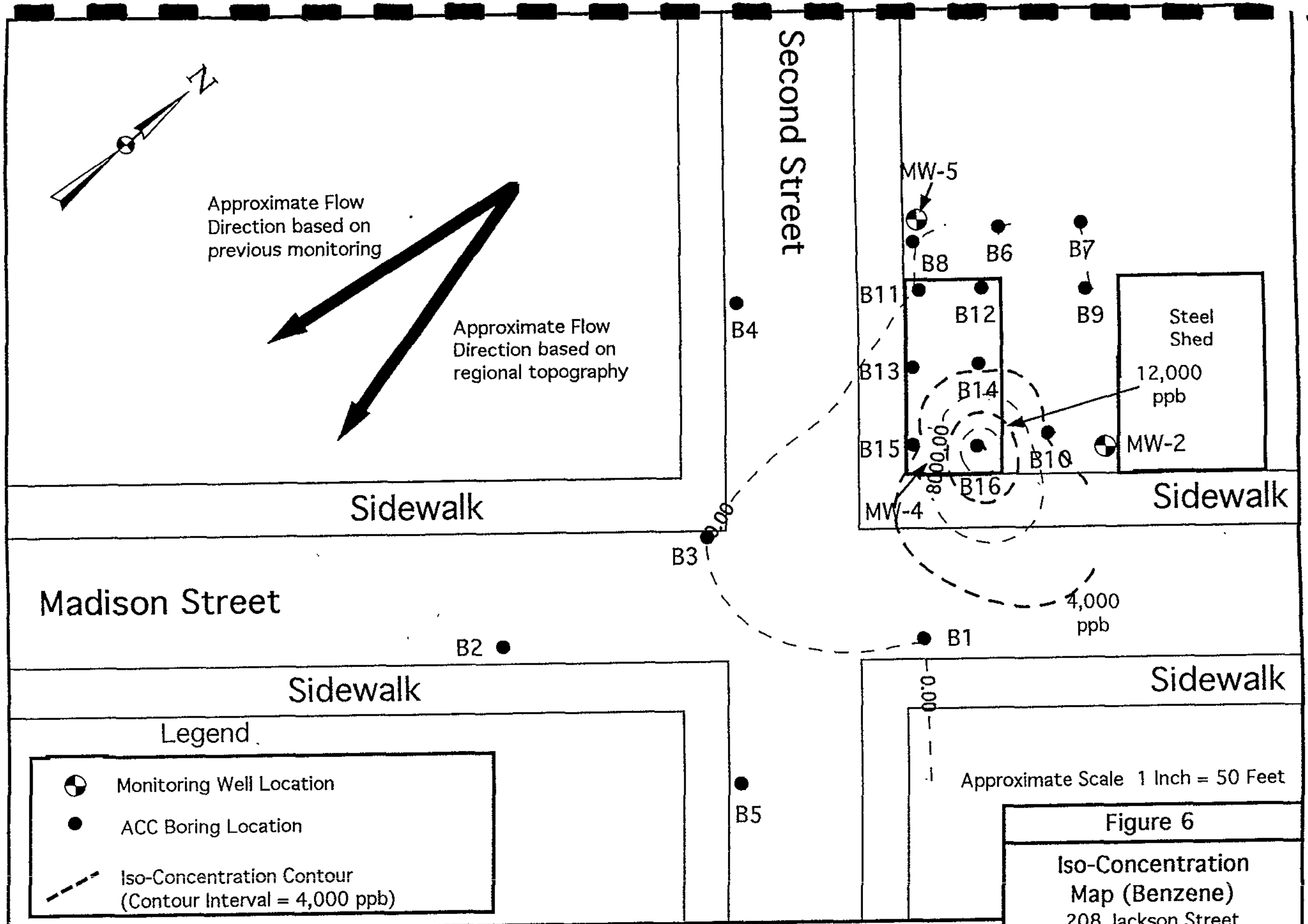


**Figure 6**

**Iso-Concentration Map (Benzene)**
208 Jackson Street
Oakland, California

| May 2, 1995 | Drawn by: DRD | Project No.: 95-6249-1.0 |
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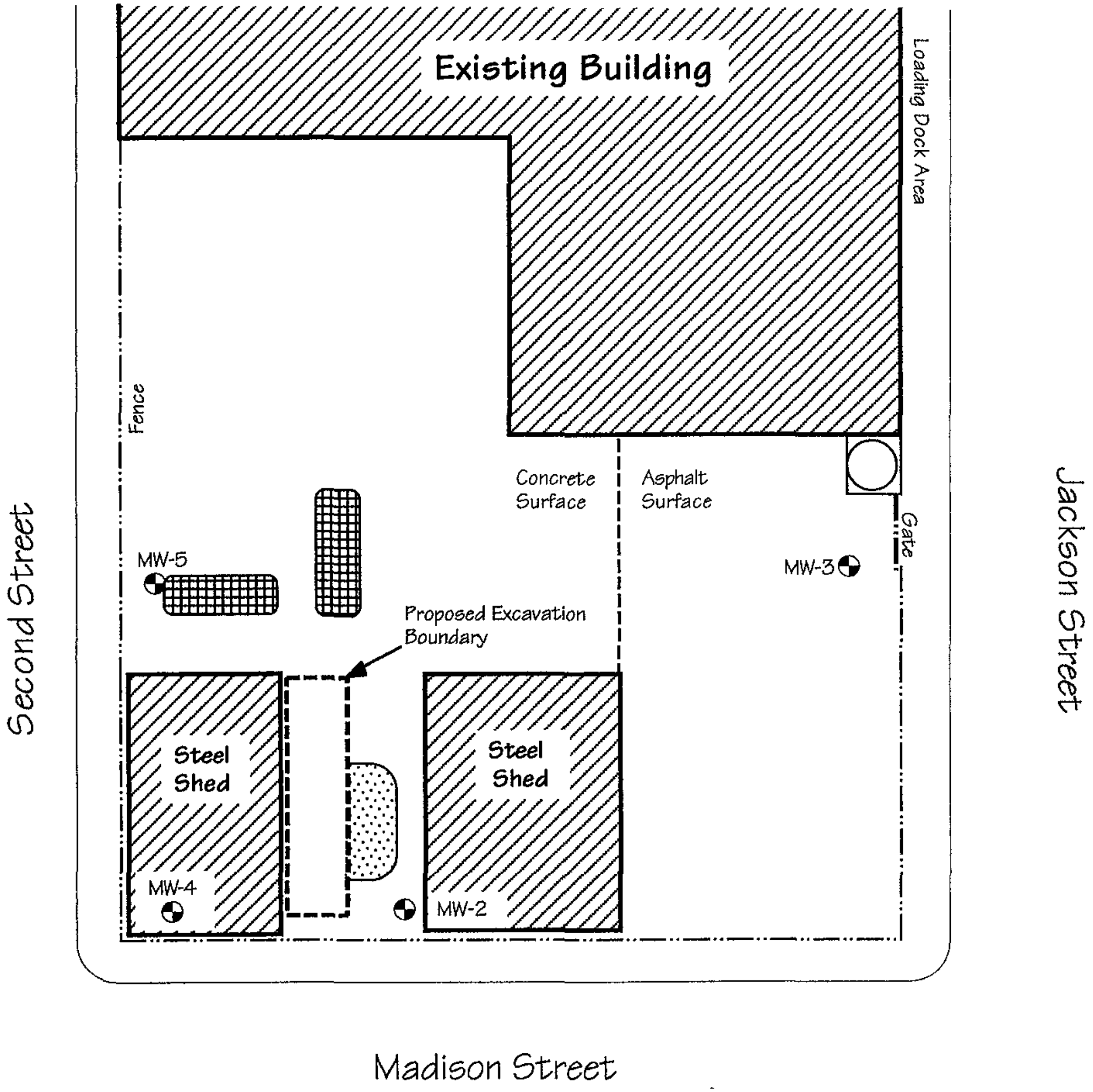


## Legend

- Open Excavation
- Proposed Excavation Limit
- Former UST Location
MW-2 - Existing Groundwater Monitoring Well

| | |
|---|---|
| Title: **Proposed Excavation Map** 208 Jackson Street Oakland, California | |
| Figure No: 7 | Scale: 1" = 40' |
| Drawn By: JVC/DRD | Date: 6/20/96 |
| Project No: 6249-1.0 | |


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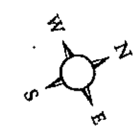


# WELL INVENTORY

# WELL INVENTORY FILE

Definitions and abbreviations for items listed in the well inventory file are as follows:

**[WELLNO]** Well number - Wells are numbered according to their location in the rectangular system of the Public Land Survey. The part of the number preceding the slash indicates the township; the part following the slash indicates the range and section number; the letter following the section number indicates the 40-acre subdivision; and the final digit is a serial number for wells in each 40-acre subdivision.

**[DAT]** Date - The month and year when drilling or boring was completed.

**[ELEV]** Surface elevation - The surface elevation of the well, if known, in feet above mean sea level. A zero designates an unknown elevation.

**[TD]** Total depth - The depth of the well. This usually designates the completed well depth. If the well has a well log available on file, then the total drilled depth of the well is given. The inventory does not show total depth data for geotechnical borings. This is because only one state well number is assigned to one boring at a site, and there are usually several borings of different depth.

**[DTW]** Depth to water - This category usually indicates the standing groundwater level in the well on the date of completion. The "depth to first water encountered" is recorded in the inventory when it is the only water level data reported on the well driller's report.

**[USE]** Use - The well use (or in the case of cathodic protection wells and geotechnical borings, the reason for the excavation) as indicated in the well driller's report or data sheets. A plus sign (+) after the well use indicates a well in the current ACFC & WCD monitoring network.

**[ABN]** Abandoned well - A well whose use has been permanently discontinued or which is in such a state of disrepair that no water can be produced. In the inventory, this may include wells which are covered or capped but not properly destroyed.

**[CAT]** Cathodic protection well - Any artificial excavation constructed by any method for the purpose of installing equipment or facilities for the protection from corrosion by electrochemical methods of metallic equipment (usually piping) in contact with the ground; commonly referred to as cathodic protection.

**[DES]** Destroyed well - A well that has been properly filled so that it cannot produce water nor act as a vertical conduit for the movement of groundwater.

**[DOM]** Domestic well - A water well which is used to supply water for the domestic needs of an individual residence or systems of four or less service connections or "hookups".

[EXT] Extraction well - generally used in site remediation to extract contaminated water for treatment.

[GEO] Geotechnical boring - A temporary boring made to determine certain engineering properties of soils. An asterisk (*) indicates that the state well number assigned to the boring represents more than one boring at a particular site.

[INA] Inactive well - A well not routinely operating but capable of being made operable with a minimum of effort. Also called a "standby well".

[IND] Industrial well - A well used to supply water for industrial use

[INJ] Injection well - reintroduces water into the aquifer for recharge

[IRR] Irrigation well - A water well used to supply water only for irrigation or other agricultural purposes. In the inventory, this category includes large capacity wells as well as small capacity wells for lawn irrigation.

[MON] Monitoring or observation well - Wells constructed for the purpose of observing or monitoring groundwater conditions. (see piezometer).

[MUN] Municipal well - A water well used to supply water for domestic purposes in systems subject to Chapter 7, Part 1,
Division 5 of the California Health and Safety Code. Included are wells supplying public water systems classified by the Department of Health Services. (Also referred to as community water supply wells).

[PIE] Piezometer - A piezometer is a well specifically designated to measure the hydraulic head within a zone small enough to be considered a point as contrasted with a well that reflects the average head of the aquifer for the screened interval.

[REC] Recovery well - same as extraction well

[STO] Stock - A water well used primarily for livestock.

[TES] Test well and test hole - A test well is constructed for the purpose of obtaining the information needed to design a well prior to its construction. Such wells are not to be confused with "test holes" which are temporary in nature (i.e., uncased excavations whose purpose is the immediate determination of existing geologic and hydrologic conditions). Test wells are cased and can be converted to observation or monitoring wells, and under certain circumstances, to production wells. In the inventory, "TES" includes both test wells and test holes.

[?] Unidentified use - This indicates water wells whose use could not be ascertained from the available well data.

**[LOG]** Log - This category indicates whether a geologic record, or log, for the well or boring is available in the Agency's files. Abbreviations are as follows:

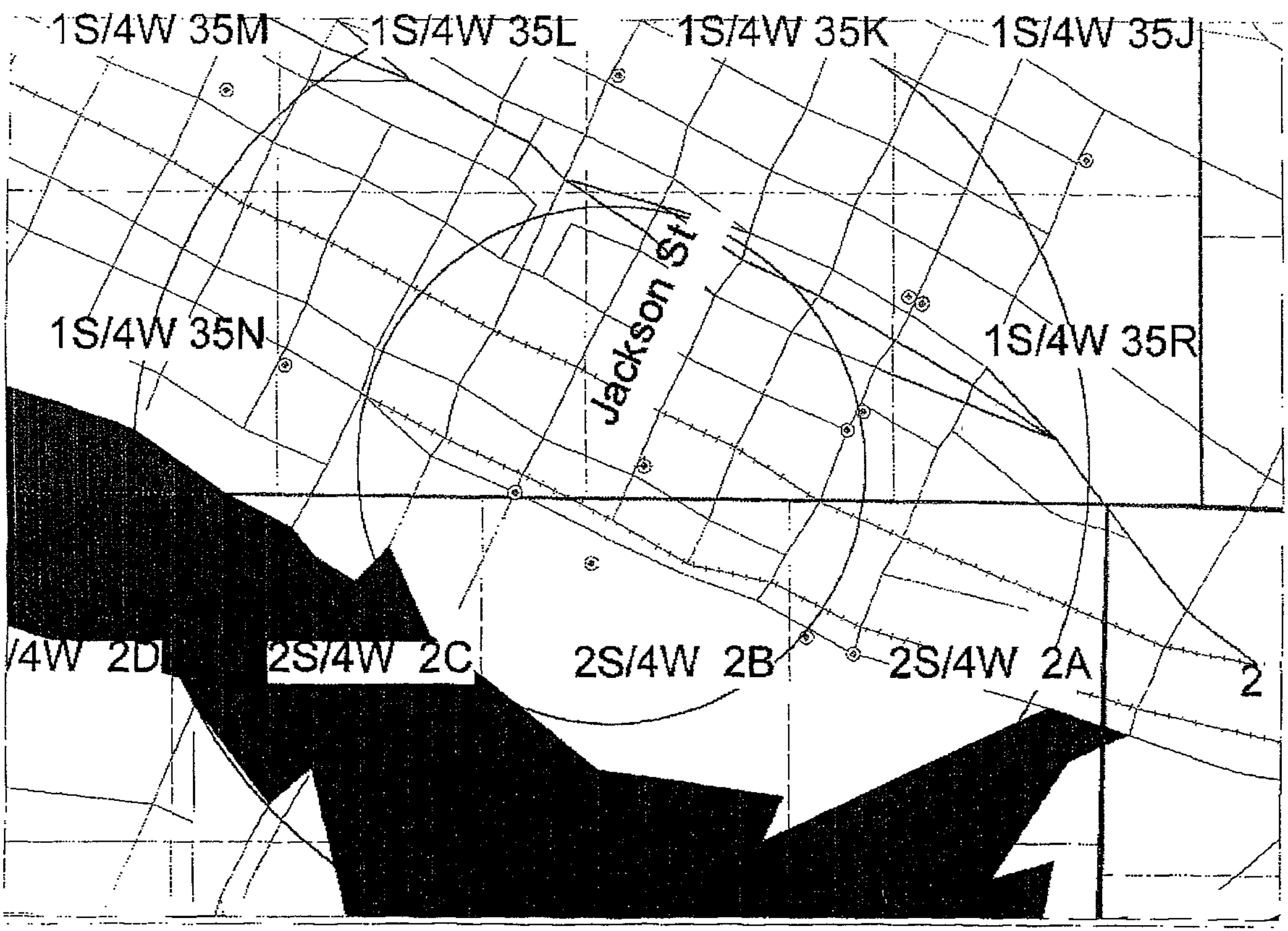
D - well driller's log
G - geotechnical boring log
E - electric (resistivity) log or other subsurface geophysical logs.

**[WQ]** Water quality data available - This category indicates which wells have water quality data available in ACFC & WCD files. The numbers 1 through 9 signify the number of sets of water quality measurements available for that well. A plus sign (+) indicates that 10 or more sets of data are available. A "0" indicates that no data is available.

**[WL]** Water level data available - This category indicates which wells have water level data other than the data reported on the well driller's logs. The numbers 1 through 9 signify the number of water level measurements available. A plus sign (+) indicates that 10 or more measurements are available for that well.
A "0" indicates that no data is available.

**[YLD]** Yield - The maximum pumping rate in gallons per minute that can be supplied by a well without lowering the water level in the well below the pump intake. This data is taken from pump test data recorded in the driller's records. Some of the yield data reflects current production rates and does not reflect maximum yield values determined in a capacity test.

**[DIA]** Diameter - The diameter in inches of the main casing in a well. May also indicate the diameter of a hand-dug well. Diameter data is not recorded for geotechnical borings.




**.2 MILE RADIUS**
**03/06/1996**

.2 MILE RADIUS (Page 1)

| WELL # | CITY | ADDRESS | OWNER | PHONE | USE | DR.DATE | DIAM | TOT.DEPTH | DTW | ST.ELEV | WA.ELEV | YIELD | LOG | WQ | WL | DATAORGN | MARGIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1S/4W 35K 1 | OAK | 6 & HARRISON ST | PACIFIC GAS AND ELECTRIC | 0 | CAT | 6/73 | 0 | 120 | 0 | 0 | 0 | 0 | D | 0 | 0 | L | Yes |
| 1S/4W 35Q 1 | OAK | 208 Jackson Street | East Bay Parking | 0 | MON | 05/90 | 2 | 10 | 6 | 0 | 0 | 0 | G | 0 | 0 | D | |
| 1S/4W 35Q 2 | OAK | 208 Jackson Street | East Bay Parking | 0 | MON | 05/90 | 2 | 10 | 6 | 0 | 0 | 0 | G | 0 | 0 | D | |
| 1S/4W 35Q 3 | OAK | 208 Jackson Street | East Bay Parking | 0 | MON | 05/90 | 2 | 10 | 6 | 0 | 0 | 0 | G | 0 | 0 | D | |
| 1S/4W 35Q 9 | OAK | 300 Oak Street | Nancy Cotteral | 0 | MON | 12/91 | 4 | 20 | 5 | 0 | 0 | 0 | D | 0 | 0 | D | |
| 1S/4W 35Q10 | OAK | 300 Oak Street | Nancy Cotteral | 0 | MON | 12/91 | 4 | 20 | 6 | 0 | 0 | 0 | D | 0 | 0 | D | |
| 1S/4W 35R 1 | OAK | 609 6TH ST | KEN BETTS | 0 | MON | 02/88 | 4 | 12 | 18 | 0 | 0 | 0 | D | 0 | 0 | L | Yes |
| 2S/4W 2B 2 | OAK | EMBARCADERO & MADISION | KTVU TV | 0 | GEO* | 6/78 | 0 | 0 | 0 | 0 | 0 | 0 | G | 0 | 0 | L | |
| 2S/4W 2B 3 | OAK | ALICE & EMBARCADERO | PG&E | 0 | CAT | 2/75 | 0 | 120 | 0 | 0 | 0 | 0 | D | 0 | 0 | L | |
| 2S/4W 2B 4 | OAK | Embarcadero && Jackson St | Port of Oakland MW-E&J | 0 | MON | 9/92 | 2 | 32 | 6 | 0 | 0 | 0 | G | 0 | 0 | D | |