aqua science engineers inc.

SOP 1585

June 5, 1997

REMEDIAL ACTION PLAN
FOR
REMEDIATION OF HYDROCARBON IMPACTED GROUNDWATER
at
Lim Family Property
250 8th Street
Oakland, California

Submitted by:
AQUA SCIENCE ENGINEERS, INC.
2411 Old Crow Canyon Road, #4
San Ramon, CA 94583
(510) 820-9391

REGISTERED PROFESSIONAL ENGINEER
DAVID M. SCHULTZ
No. 38738
Exp. 4-1-99
CIVIL
STATE OF CALIFORNIA

97 JUN -9 PM 3:49

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

This submittal outlines Aqua Science Engineer's, Inc. (ASE) remedial action plan for groundwater remediation at 250 - 8th Street in Oakland, California (Figure 1). The proposed remediation activities were initiated by the Lim Family in accordance with a letter received from the Alameda County Health Care Services Agency (ACHCSA), dated November 5, 1996 (Appendix A). Based on the site history presented below and limitations on other remedial options, ASE is proposing the injection of hydrogen peroxide into groundwater as the preferred remedial option at the site.

II. SITE HISTORY

A gasoline service station previously occupied the site. In May 1992, ASE removed ten underground fuel storage tanks from the site. The tanks consisted of one (1) 10,000-gallon gasoline tank, one (1) 5,000-gallon diesel tank, three (3) 2,000-gallon gasoline tanks, one (1) 2,000-gallon diesel tank, three (3) 500-gallon gasoline tanks and one (1) 250-gallon waste oil tank. Up to 10,000 parts per million (ppm) total petroleum hydrocarbons as gasoline (TPH-G) and 5,900 ppm total petroleum hydrocarbons as diesel (TPH-D) were detected in soil samples collected during the tank removal.

Between December 1992 and March 1993, All Environmental of San Ramon, California overexcavated 1,762 cubic yards of soil from the site and off-hauled the soil to the BFI Landfill in Livermore, California. Analytical results show that all on-site soil with hydrocarbon concentrations greater than 10 ppm was removed from the site with the exception of soil along the 8th Street shoring. Up to 1,800 ppm TPH-G and 120 ppm TPH-D were detected in soil samples collected along the shoring indicating that contamination likely extends below 8th Street. This contamination left in place may still be a source for groundwater contamination.

In January 1995, ASE installed monitoring wells MW-1 and MW-2 at the site (Figure 2). High hydrocarbon concentrations were detected in monitoring well MW-2, downgradient of the site. Moderate hydrocarbon concentrations were detected in on-site monitoring well MW-1.

In July 1996, ASE sampled groundwater from each monitoring well and drilled borings BH-C and BH-D to further define the width of the hydrocarbon plume downgradient of the site. Relatively high hydrocarbon concentrations continued to be detected in groundwater samples collected from monitoring well MW-2 downgradient of the site. Slightly lower but still very high hydrocarbon concentrations were detected in groundwater samples collected from boring BH-D, west of monitoring well MW-2. Very low hydrocarbon concentrations, below California Department of Toxic Substances Control (DTSC) maximum contaminant levels (MCLs) and recommended action levels (RALs) for drinking water, were detected in groundwater samples collected from monitoring well MW-1, located on the site, and boring BH-D, east of monitoring well MW-2. Based on these findings, the plume appears to be moving to the south of Excavation I on the site and not toward the Lum property south-southeast of the site.

Between April 1995 and January 1996, the site was on a quarterly groundwater monitoring schedule. The site is currently on a semi-annual groundwater monitoring schedule with volatile organic compound (VOC) analyses only being performed annually. Analytical results for all previous sampling periods are included in Table One and Table Two of this report.

III. REMEDIAL OPTIONS

The following remedial options were considered for this site:

3.1 Overexcavation

Overexcavation of contaminated soil and off-haul to a disposal facility was previously performed at the site. Between December 1992 and March 1993, All Environmental of San Ramon, California overexcavated 1,762 cubic yards of soil from the site and off-hauled the soil to the BFI Landfill in Livermore, California. However, contaminated soil still remains beneath 8th Street and there has been significant impact to the groundwater which was not remediated during the overexcavation process. Any further overexcavation would have to involve off-site soil beneath 8th Street and the buildings across the street from the site which is not a feasible option.

3.2 Groundwater "Pump and Treat"

Groundwater "pump and treat" was considered as a groundwater remediation option. Although "pump and treat" is considered an effective method of containing a hydrocarbon plume, "pump and treat" has very limited success in remediating groundwater contamination in the many years it has been used. In addition, the groundwater contamination now extends beneath the buildings opposite the site and it is unlikely that "pump and treat" could pull the contamination back from beneath the buildings. It is also a very costly method which takes many years for any significant remediation to be realized. For these reasons, it was ruled out as a remedial option at this site.

3.3 In-Situ Bioremediation

In-situ bioremediation was considered as a remedial option at the site. There are several options to achieve this form of remediation which involves increasing the amount of dissolved oxygen in the groundwater to enhance naturally occurring aerobic bacterial degradation of petroleum hydrocarbons in-situ. It has been known for some time that naturally occurring bacteria readily degrade (digest) petroleum hydrocarbons into harmless byproducts. Although anaerobic bacteria will degrade petroleum hydrocarbons, the rate is much slower then with aerobic bacteria. Depleted levels of oxygen appear to be the primary limiting factor for aerobic bacterial activity. Four methods to increase dissolved oxygen in groundwater to enhance aerobic bacterial degradation are air sparging, injection of hydrogen peroxide, periodic application of Oxygen Releasing Compound (ORC) and one-time application of ORC.

3.3a Air Sparging

In-situ air sparging is a proven method of increasing the amount of dissolved oxygen in groundwater. It also forces hydrocarbons from the groundwater into the vadose (unsaturated) zone where they are often removed with vapor extraction. Although ASE likes this technology, there are several factors which would limit its usage at this site. These factors include the fact that the groundwater contamination lies off-site under a city street and buildings opposite the site. It would be nearly impossible to install air sparge wells which would be effective cleaning contamination off-site under buildings, although theoretically horizontal wells could be installed but this would be at an enormous cost. If horizontal air sparging wells were installed, horizontal extraction wells would also be needed to removed hydrocarbon laden vapor driven from groundwater.

3.3b Injection of Hydrogen Peroxide

Injection of diluted hydrogen peroxide into well points installed at the site is a relatively low cost method of increasing dissolved oxygen in groundwater. ASE recommends this type of remediation at the site for the following reason. Hydrogen peroxide would be able to flow with the groundwater through the permeable soil beneath the site to areas beneath the street and buildings across the street from the site.

3.3c Periodic application of ORC

Periodic application of ORC to existing monitoring wells is a common, but usually ineffective, means of increasing oxygen in groundwater. Regenesis, the manufacturer of ORC, has stated that ORC is generally only effective for a radius of 10-20 feet around each well, which would provide little effective remediation at this site without installing several additional monitoring wells at the site at great expense.

3.3d One-time application of ORC

A one-time application of ORC in boreholes installed in a tight pattern in areas of contamination is considered an effective means of treating contaminated soil and groundwater. ORC application in a slurry wall meant to treat groundwater as it leaves the site is also a common method of remediation. This type of remediation, although having an advantage of not having equipment that must be stored at the site, has a similar cost to the injection of hydrogen peroxide method but would have the following disadvantages: (1) If the initial application of ORC is not successful, there is great expense to drill additional borings and add additional ORC whereas the hydrogen peroxide is continuously being added to the groundwater for as long as remediation is needed. (2) Hydrogen peroxide will travel in the water to assist in remediation of contaminated groundwater beneath the building across the street rather than relying on dilution to lower hydrocarbon contamination concentrations that have already left the site.

A list of each method (other than overexcavation) with anticipated costs, advantages and disadvantages is included as Table Three.

IV. PROPOSED REMEDIAL ACTION PLAN

ASE proposes to enhance the natural biodegradation of gasoline, benzene, toluene, ethylbenzene, and total xylenes (BTEX), methyl tertiary butyl ether (MTBE), and halogenated volatile organic compounds (VOCs) in shallow groundwater on the subject site to increase the rate of groundwater bioremediation. ASE proposes to enhance the natural biodegradation by introducing low concentrations of hydrogen peroxide (HP) into the contaminated groundwater to increase dissolved oxygen (DO) concentrations in the groundwater, which will enhance natural aerobic hydrocarbon degrader microbes in the groundwater.

This remedial option has been performed with success by others at sites within Oakland with geology and hydrogeology similar to that of the subject site. However, the diameter of the plume and degree of petroleum hydrocarbon contamination at these other sites is not nearly as severe as it is at the subject site. Therefore, ASE's proposed remedial plan has been designed as a "pilot study". Modifications to the proposed system such as: number of injection wells, HP solution make-up, and HP injection rates will most likely be required.

ASE's ultimate goal is to raise the DO concentration in groundwater within and downgradient of the injection wells, thus enhancing the biodegredation of petroleum hydrocarbons in groundwater to a point when remedial activities are no longer necessary.

4.1 Remedial Action Plan Description

ASE proposes injecting dilute HP solution into five (5) proposed injection wells in the parking area on 8th Street in front of the Lim Property (see Figure 3). The injection wells will enable DO concentrations to be maintained in the groundwater in each well at between 5 and 20 parts per million (ppm). The HP in the groundwater will slowly convert to DO and water, which will increase the DO concentration in the groundwater from nearly zero ppm (i.e., nearly anoxic) to concentrations between 5 and 20 ppm. The increased DO concentration in groundwater will enhance aerobic microbial activity including native hydrocarbon degraders to biodegrade the groundwater contaminants at a higher rate than the native anaerobic microbes.

4.2 Prepare Site Safety Plan

Based on the site history and the analytical results of the soil and groundwater samples collected during the previous site investigations, a site-specific safety plan will be prepared. The safety plan will identify potential site hazards and specifies procedures to protect site workers and the public. A nearby hospital will be designated in the site safety plan as the emergency medical facility of first choice.

4.3 Permits

Drilling permits will be obtained from the Alameda County Flood Control and Water Conservation District (Zone 7). A notification card will also be sent to the California Department of Water Resources (DWR). Underground Service Alert (USA) will also be contacted at least 48 hours prior to drilling to have all known utilities marked in the immediate site vicinity. City of Oakland encroachment and excavation permits will be obtained for permission to drill and excavate in the City right-of-way. A City of Oakland building permit will be obtained for permission to install the security fence and trench through the sidewalk on 8th Street.

4.4 Install and Develop Injection Wells

Five (5) soil borings will be drilled at the site in the locations shown on Figure 3. The borings will be drilled with a drill rig equipped with 8-inch diameter hollow-stem augers. The drilling will be directed by a qualified geologist. Undisturbed soil samples will be collected at least every 5-feet, at lithographic changes, and from just above the water table for subsurface hydrogeologic description. The samples will be described by the geologist according to the Unified Soil Classification System. The samples will be collected in brass or stainless steel tubes using a split-barrel drive sampler advanced ahead of the auger tip by successive blows from a 140-lb. hammer dropped 30-inches. Soil will be removed from the tubes for hydrogeologic description and will be screened for volatile compounds with an OVM. The soil will be screened by emptying soil from one of the tubes into a plastic bag. The bag will be sealed and placed in the sun for approximately 10 minutes. After the hydrocarbons have been allowed to volatilize, the OVM will measure the vapor through a small hole, punched in the bag. These OVM readings will be noted on the boring logs. Soil cuttings will be stored on-site in 55-gallon DOT 17H drums for temporary storage until off-site disposal can be arranged.

All sampling equipment will be cleaned in buckets with brushes and a TSP or Alconox solution, then rinsed twice with tap water. The drill rig and augers will be steam cleaned between borings and prior to departure. Rinsates will be contained on-site in 55-gallon DOT 17H drums for future disposal by the client.

The soil borings will be completed as 2-inch diameter hydrogen-peroxide injection wells. The wells will be constructed with 2-inch diameter, flush-threaded, schedule 40, 0.020-inch slotted PVC well screen and blank casing. The wells will be screened between 5-feet bgs and 20-feet bgs. The well casings will be lowered through the augers and #3 Monterey sand will be placed in the annular space between the well casings and the boreholes to about 2-feet above the screened intervals. Approximately 2-feet of bentonite pellets will be placed on top of the sand pack and hydrated with deionized water. This bentonite layer will prevent the cement sanitary seal from infiltrating into the sand pack. Cement will be used to fill the annular space between the bentonite layer and the surface to prevent surface water from infiltrating into the wells. The well heads will be protected by a locking well plug and an at-grade, traffic-rated well box (See Figure 4 - Typical Injection Well).

The injection wells will be developed after waiting at least 72 hours after well construction. The wells will be developed using at least two episodes of surge block agitation and bailer evacuation. At least ten well casing volumes of water will be removed during the development, and development will continue until the water appears to be reasonably clear.

4.5 Hydrogen Peroxide Injection System

A HP solution with a concentration of approximately 1,000 ppm will be prepared in a 200 gallon black high density polyethylene (HDPE) tank for injection into the five (5) proposed injection wells. Variable speed peristaltic pumps will be used to meter the HP solution into the five (5) proposed injection wells. The HP solution will be pumped to each injection well through buried HDPE tubing (Figure 5). The concentration of DO in the groundwater in each well will be maintained at between 5 and 20 ppm by periodic monitoring of DO concentration in each well using a DO meter and by making necessary adjustments to the HP metering pump flows.

1000ppm
$H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2 \uparrow$
34 (32)

$2(.3) = 602(x)$
$x = .001$ or .1%
or 1000 ppm

4.6 Hydrogen Peroxide Solution Preparation

The 1,000 ppm HP solution will be prepared by diluting 2.0 liters of 30 w/w percent HP with 600 liters of water to make 602 liters of solution. The HP solution will be stored in a 200 gallon capacity black HDPE tank equipped with a black HDPE lid, which will prevent HP degradation by sunlight and algae. The HP solution will be prepared as needed.

density 1.11

4.7 Hydrogen Peroxide Solution Pump System

The HP solution pump system will consist of five (5) peristaltic pump heads driven by two variable speed pump motors, which have speeds ranging from one to 100 revolutions per minute (RPM). Three of the pumps heads will be driven by one motor. Two of the pump heads will be driven by the other motor. Each pump head will be equipped with one-quarter inch inside diameter (ID) by one-half inch outside diameter (OD) peristaltic pump tubing, which will pump approximately 0.5 milliliters per revolution. The two pump motors will be powered by 115-volt alternating-current (AC) single-phase electrical power.

4.8 Hydrogen Peroxide Solution Distribution System

The HP solution will be distributed from the HP solution pump system, through buried HDPE tubing, and into the five (5) proposed injection wells. The five (5) peristaltic pump tubes will be connected to five one-half inch ID by three-quarter inch OD HDPE tubes, which will extend from the five pump heads to the five injection wells. The HDPE tubes will be buried at approximately 18 inches below ground surface (bgs) in trenches that will be dug from the pump heads to the wells. HDPE tubes will be covered with sand and concrete paving to protect the tubes from damage. The HDPE tubes will extend down into each well to approximately the mid-point of the groundwater column height in each well. Enough tubing will be designed into the injection system to anticipate for groundwater level fluctuations within each injection well.

4.9 Initial Start-Up, Operation, and Monitoring of System

The HP solution injection rate to each well will initially be set between approximately 5 to 10 milliliters per minute (ml/min). The HP solution will be injected at the initial rate for about a week to let the HP solution come to equilibrium in each well. Prior to HP injection, the concentration of DO in groundwater for each of the five injection wells and two monitoring wells will be monitored to establish a baseline DO concentration for each well. After the first week of HP injection, the DO concentration in groundwater will be monitored in each injection and monitoring well to determine if the DO has increased to between 5 and 20 ppm. HP injection rates to the injection wells will be adjusted as necessary according to results of the groundwater DO monitoring. Groundwater DO monitoring and necessary HP pump flow adjustment will continue on a weekly basis until it is established that less frequent DO monitoring is required to keep DO concentrations in groundwater between 5 and 20 ppm. Weekly monitoring of the DO in groundwater and HP injection adjustments may need to be continued periodically to the end of the bioremediation project to keep concentrations of DO in groundwater between 5 and 20 ppm because of continuous variations in aerobic microbe populations, nutrient concentrations, contaminant concentrations, groundwater flows, groundwater temperature, groundwater pH, electrolytes concentrations, groundwater salinity, and atmospheric pressure.

5.0 Occasional Large Volume HP Injection

On an occasional basis and only as necessary, 30% HP will be added directly into each injection well if the DO has not risen at a fast enough rate using the all-time distribution system detailed above. In this event, 1 gallon of 30% HP solution will be added to each well every 60 minutes until the DO concentration is optimum.

5.1 Continuing Groundwater Monitoring and Sampling

Monitoring of the petroleum hydrocarbons in groundwater (TPH-G, BTEX and MTBE) should be performed monthly for the first three months of operation; every other month for the second three months; and every third month thereafter until concentrations of TPH-G, BTEX and MTBE have dropped to a level suitable for shut-down of the system.

5.2 Discontinuation of Enhanced Bioremediation of Contaminated Groundwater

Groundwater remediation will be discontinued when deemed appropriate by the local regulatory. Groundwater monitoring will continue as scheduled for a period of at least one year after the remediation system is turned-off.

5.3 System Security

The HP solution storage tank and injection pump system will be placed within a secured chain link fenced area of the subject site (Figure 3).

5.4 Report Preparation

Within the groundwater monitoring report following the installation and start-up of the system, a section that describes the installation, start-up, baseline figures, and operating parameters will be included. A log will be kept detailing measured parameters such as DO in groundwater, injection rates, and operating times during each visit.

V. SCHEDULE

It appears at this time that this project will have to be placed out to bid in order to be eligible for reimbursement from the California State Underground Storage Tank Cleanup Fund. The successful bidder will set the schedule once the contract is awarded.

Should you have any questions or comments, please feel free to call us at (510) 820-9391.

Respectfully submitted,

AQUA SCIENCE ENGINEERS, INC.

David Allen, R.E.A.
Senior Project Manager

Robert E. Kitay, R.G., R.E.A.
Senior Geologist

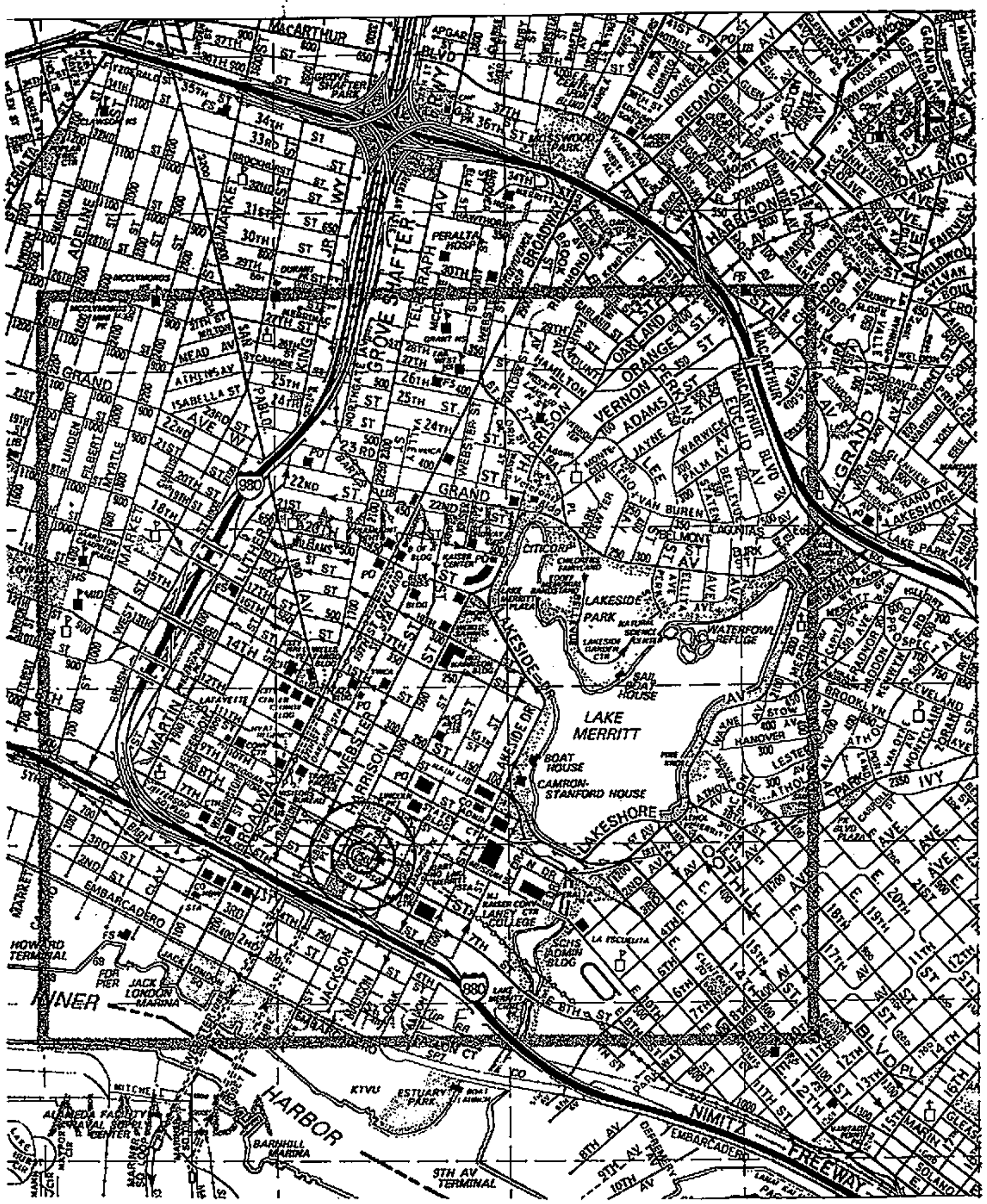
cc: Mr. Russell Lim, Property Owner
3100 La Playa Court, Lafayette, CA 94549

Ms. Jennifer Eberle, Alameda County Health Care Services Agency, 1131 Harbor Bay Parkway, Suite 250, Alameda, CA 94502-6577

Mr. Kevin Graves, RWQCB, San Francisco Bay Region, 2101 Webster Street, Suite 500, Oakland, CA 94612

Mr. Steve Marquez, California State Underground Storage Tank Cleanup Fund, P.O. Box 944212, Sacramento, CA 94244-2120

N

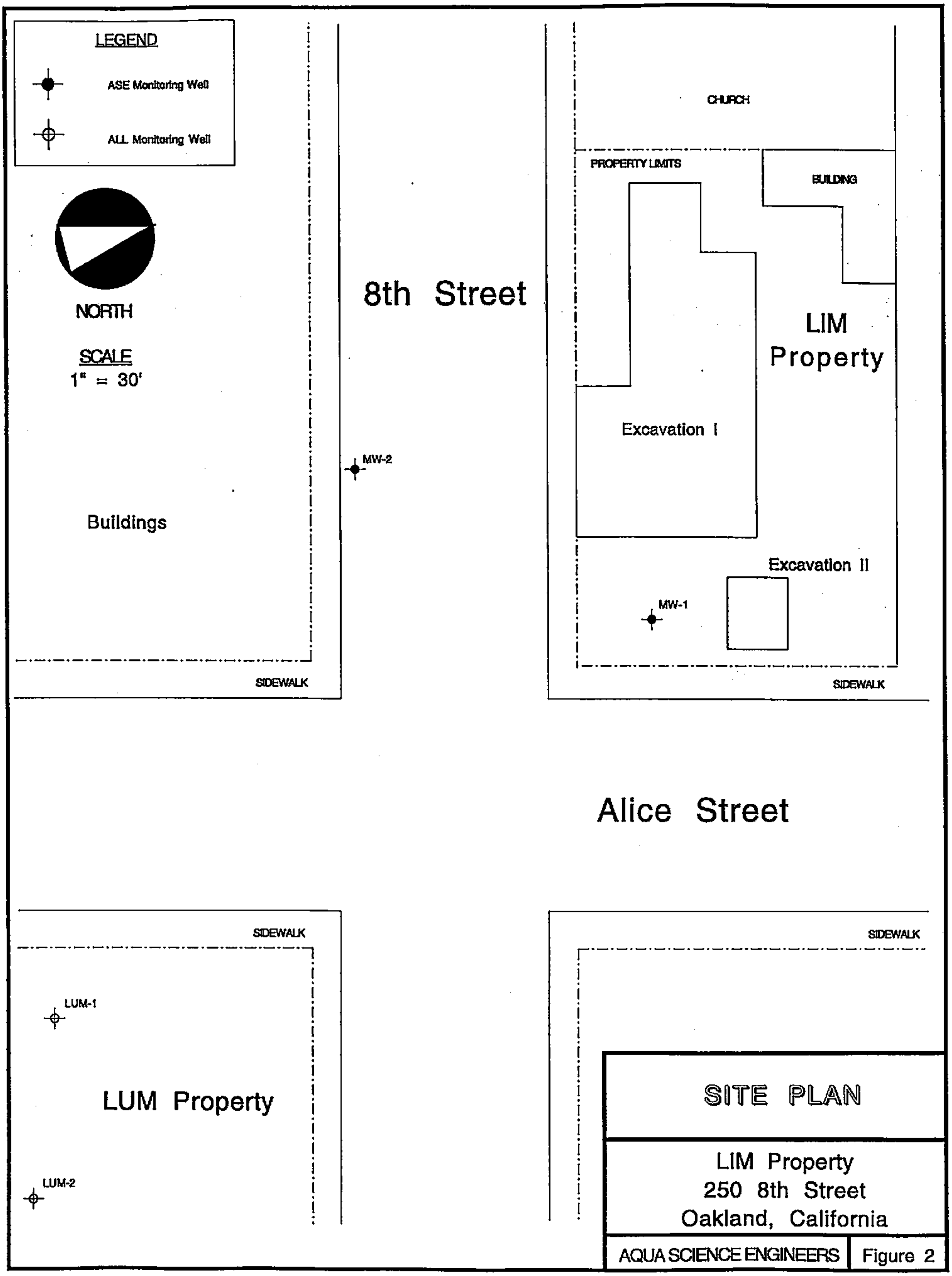


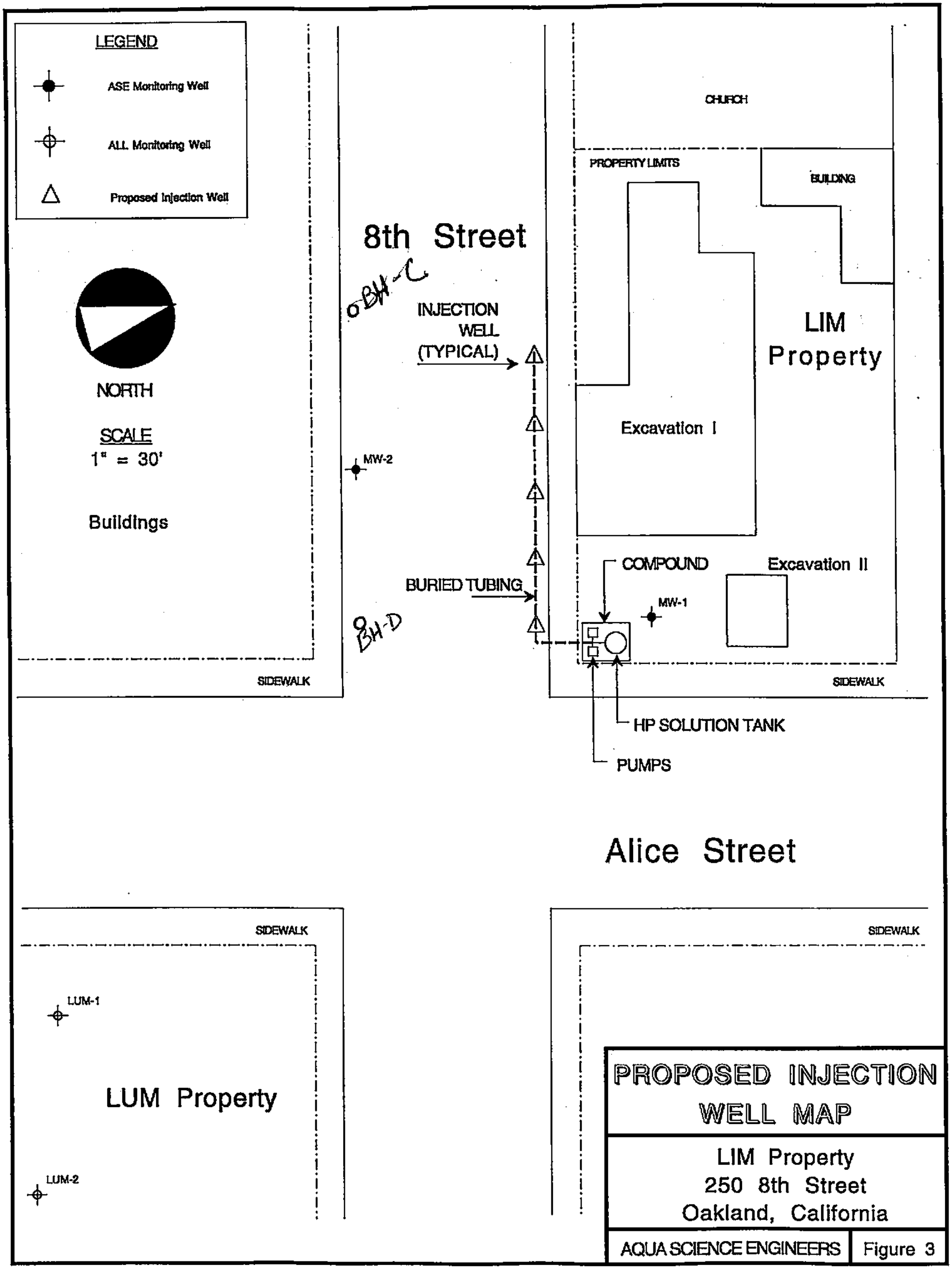
SITE LOCATION MAP

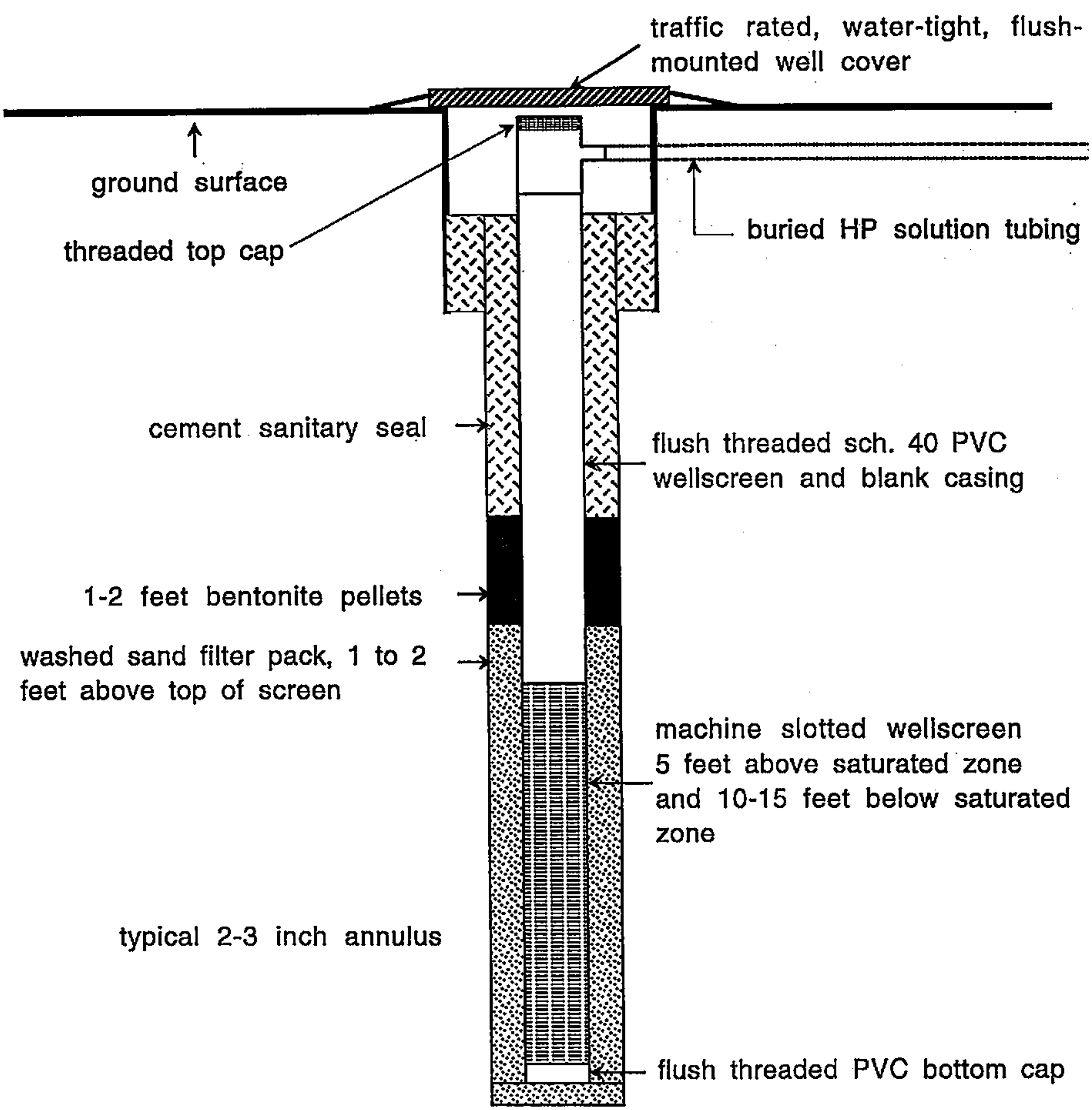
Lim Property
250 8th Street
Oakland, California

BASE: The Thomas Guide, Alameda and Contra Costa Counties Street Guide & Directory, 1990

Aqua Science Engineers | Figure 1


LEGEND
ASE Monitoring Well
ALL Monitoring Well
NORTH
SCALE
1" = 30'
Buildings
8th Street
MW-2
CHURCH
PROPERTY LIMITS
BUILDING
LIM
Property
Excavation I
Excavation II
MW-1
SIDEWALK
SIDEWALK
Alice Street
SIDEWALK
SIDEWALK
LUM-1
LUM Property
LUM-2
SITE PLAN
LIM Property
250 8th Street
Oakland, California
AQUA SCIENCE ENGINEERS
Figure 2


LEGEND
ASE Monitoring Well
ALL Monitoring Well
Proposed Injection Well
NORTH
SCALE
1" = 30'
Buildings
8th Street
BH-C
INJECTION WELL (TYPICAL)
MW-2
BURIED TUBING
BH-D
CHURCH
PROPERTY LIMITS
BUILDING
LIM Property
Excavation I
COMPOUND
Excavation II
MW-1
SIDEWALK
SIDEWALK
HP SOLUTION TANK
PUMPS
Alice Street
SIDEWALK
SIDEWALK
LUM-1
LUM Property
LUM-2
PROPOSED INJECTION WELL MAP
LIM Property
250 8th Street
Oakland, California
AQUA SCIENCE ENGINEERS
Figure 3



TYPICAL
INJECTION WELL CONSTRUCTION
IN CROSS SECTION

Aqua Science Engineers	Figure 4

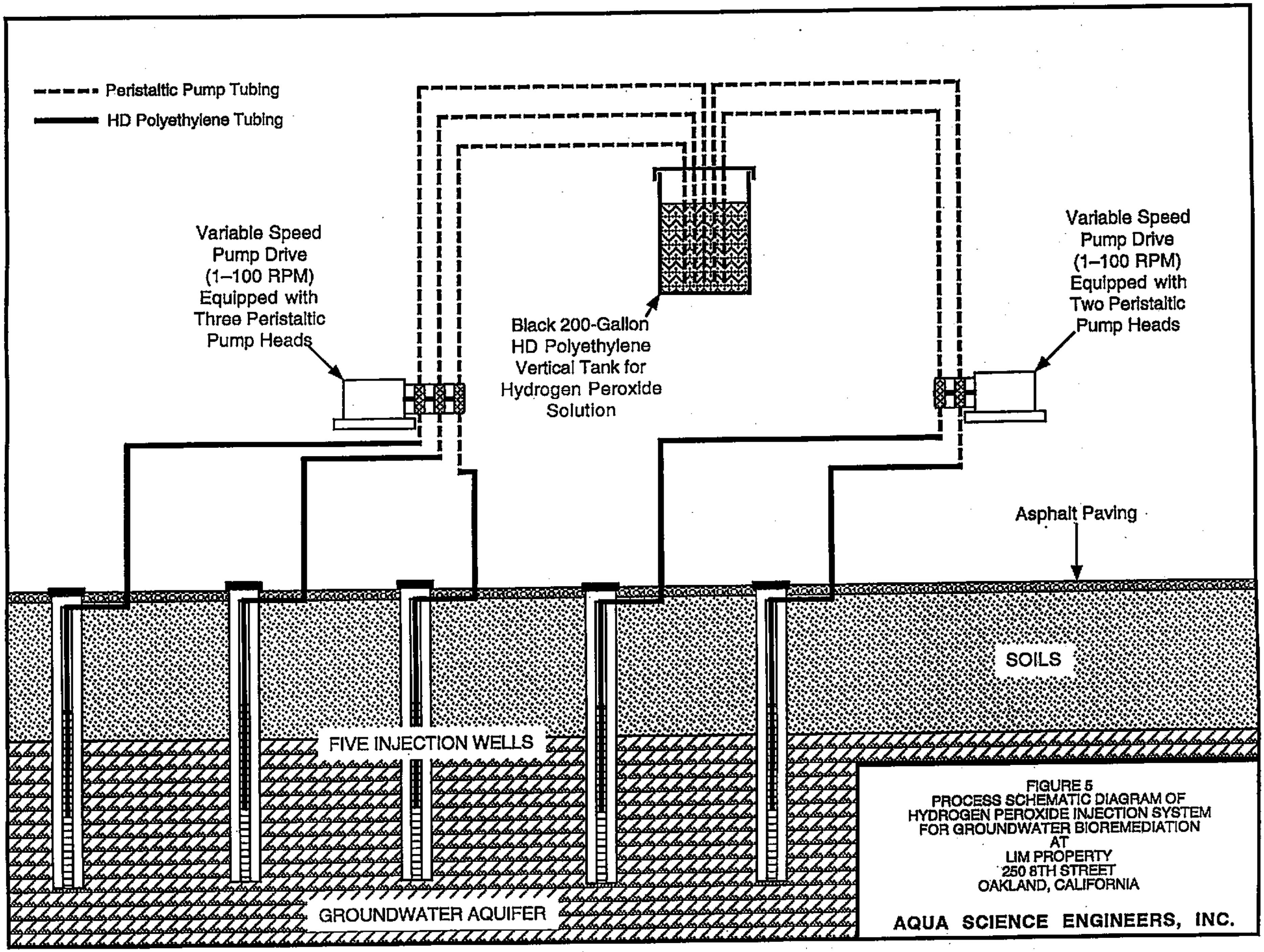


FIGURE 5
PROCESS SCHEMATIC DIAGRAM OF HYDROGEN PEROXIDE INJECTION SYSTEM FOR GROUNDWATER BIOREMEDIATION
AT
LIM PROPERTY
250 8TH STREET
OAKLAND, CALIFORNIA

AQUA SCIENCE ENGINEERS, INC.

TABLE ONE
Summary of Chemical Analysis of **GROUNDWATER** Samples
TPH-G, TPH-D, BTEX and MTBE
All results are in **parts per billion**

Well/ Date Sampled	TPH Gasoline	TPH Diesel	Benzene	Toluene	Ethyl Benzene	Total Xylenes	MTBE
------	------	------	------	------	------	------	------
MW-1							
01-30-95	740	200	3	5	1	4	--
04-12-95	400	500	<0.5	<0.5	3	<2	--
07-14-95	520	400	1	<0.5	2	3	--
10-17-95	400	200	0.5	1	3	<2	--
01-12-96	120	890	<0.5	<0.5	<0.5	<1.0	<2
07-08-96	320	300	0.52	2.7	1.2	2.3	<5
01-06-97	110	75	<0.5	0.68	<0.5	<0.5	<5
MW-2							
01-30-95	88,000	800	19,000	18,000	2,400	10,000	--
04-12-95	110,000	990	21,000	28,000	2,800	14,000	--
07-14-95	120,000	5,000	20,000	25,000	3,200	15,000	--
10-17-95	190,000	4,000	15,000	26,000	4,900	23,000	--
01-12-96	32,000	2,600	10,000	8,000	1,100	4,800	<2
07-08-96	110,000	2,500	20,000	18,000	2,500	12,000	<500
01-06-97	230,000	37,000	11,000	19,000	4,300	20,000	<1,200
EPA METHOD	5030/ 8015M	3550/ 8015M	8020	8020	8020	8020	8020

TABLE TWO

Summary of Chemical Analysis of **GROUNDWATER** Samples
Lead, Oil & Grease and Volatile Organic Compounds
All results are in **parts per billion**

Compound	MW-1	MW-2
1-30-95		
Dissolved Lead	< 0.04	< 0.04
Total Oil and Grease	< 500	19,000
Hydrocarbon Oil and Grease	< 500	17,000
Chloroform	0.5	< 30
Tetrachloroethene (PCE)	8	< 30
Other VOCs	< 0.5-2	< 30-100
4-12-95		
Dissolved Lead	< 0.04	< 0.04
Hydrocarbon Oil and Grease	< 500	22,000
Tetrachloroethene (PCE)	6	0.9
1,2-Dichloroethane	< 0.5	43
Other VOCs	< 0.5-2	< 30-100
7-14-95		
Total Oil and Grease	< 500	25,000
Hydrocarbon Oil and Grease	< 500	23,000
1,2-Dichloroethane	< 0.5	35
Tetrachloroethene (PCE)	4	<5
Other VOCs	< 0.5-2	< 5-20
10-17-95		
Total Oil and Grease	< 1,000	15,000
Hydrocarbon Oil and Grease	< 1,000	13,000
Tetrachloroethene (PCE)	5	< 0.5
Trichloroethene (TCE)	< 0.5	5
01-12-96		
Hydrocarbon Oil and Grease	< 5,000	< 5,000
07-08-96		
Hydrocarbon Oil and Grease	---	< 1,000
Chloroform	0.8	< 0.5
Tetrachloroethane (PCE)	6.4	< 0.5
Other VOC's	< 0.5-3	< 0.5-3
01-06-97		
Hydrocarbon Oil and Grease	---	4,100

Table 3: Summary of Groundwater Remediation Alternatives for Lim Property, 250 8th Street, Oakland, CA

METHOD	DURATION	COST	ADVANTAGES	DISADVANTAGES
Pump and treat using air-stripping and thermal oxidation. Treated water discharge by NPDES	Unknown, possibly 2 to 5 years.	$100,000 to $200,000 first year.	• Prevents further migration of contamination (plume capture)	• High cost and high maintenance • Primarilly useful for plume capture and not aquifer restoration • No longer considered an efficent or cost effective remediation alternative • Noise • Water discharge point needed for NPDES • Monthly electrical and gas costs • Large area needed for equipment • Long remediation time-frame
Air-sparging for enhanced insitu biodegradation.	Unknown, possibly 2 to 5 years	$40,000 to $60,000 first year	• Considered a proven method for aquifer restoration • Relatively low maintenance once established • No treatment or discharge of water needed • Relatively small area needed for equipment	• Does not prevent migration of contamination. May enhance migration • AQMD may require vapor extraction and treatment of air • Noise • High monthly electrical cost • Air sparging wells needed • Possibly long remediation time-frame
Injection of hydrogen peroxide for enhanced insitu biodegradation.	Unknown, possibly 2 to 5 years	$25,000 to $30,000 first year	• Relatively low cost • Relatively low maintenance once established • No treatment or discharge of water needed • Relatively small area needed for equipment • Low monthly utilities cost • Does not enhance migration of contamination • Low noise	• Does not prevent migration of contamination • Possibly long remediation time-frame • Experimental technology • Additional wells needed
Periodic appliction of Oxygen Releasing Compound (ORC) to groundwater	Unknown, possibly 2 to 5 years	$20,000 to $30,000 first year	• Relatively low cost • Low maintenance once established • No treatment or discharge of water needed • No permanant equipment needed • Low monthly utilities cost • Does not enhance migration of contamination • No on-going noise	• Does not prevent migration of contamination • Possibly long remediation time-frame • Experimental technology • Additional wells needed • Sole-source supplier of ORC
One-time application of Oxygen Releasing Compound (ORC) to groundwater	Unknown, possibly 3-4 months	$20,000 to $30,000	• Low cost • No maintenance • No treatment or discharge of water needed • No monthly utilities cost • Does not enhance migration of contamination • No on-going noise	• Does not prevent migration of contamination • Unknown remediation time-frame • Experimental technology • Multiple borings needed • Sole-source supplier of ORC • May need to re-apply if first application is not adequate

APPENDIX A

Alameda County Health Care Services Agency
Letter Dated November 5, 1996

ALAMEDA COUNTY
HEALTH CARE SERVICES
AGENCY
DAVID J. KEARS, Agency Director

ENVIRONMENTAL HEALTH SERVICES
ENVIRONMENTAL PROTECTION
1131 Harbor Bay Parkway, #250
Alameda, CA 94502-6577
(510) 567-6700 FAX (510) 337-9335

November 5, 1996
STID 1585

Alice, Edward, and May Lim
c/o Russell Lim
601 Brush St.
Oakland CA 94607

RE: former Exxon station, 250-8th St., Oakland CA 94607

Dear Lim Family,

I am in receipt of the "Report of Soil and Groundwater Assessment and Semi-Annual Groundwater Sampling," prepared by Aqua Science Engineers, dated 8/1/96.

This report documents the Geoprobe investigation conducted in July 1996. Two borings were emplaced, and soil and grab groundwater samples collected. Results indicated minor to ND soil contamination, while groundwater had elevated concentrations in MW2 and BH-C (the boring to the west of MW2). Maximum concentrations included 20,000 ppb benzene, 110,000 ppb TPH-gasoline (MW2), and 3,200 ppb TPH-diesel (BH-C). In addition, there was a hydrocarbon sheen in MW2.

The gasoline contamination in MW2 has been fairly consistent since monitoring began in 1/95. Benzene concentrations have ranged from 10,000 ppb to 21,000 ppb, while TPH-gasoline concentrations have shown more fluctuation in their range (from 32,000 ppb to 190,000 ppb). **Therefore, you are requested to review options for groundwater remediation in the vicinity of MW2. At a minimum, a hydrocarbon absorbent sock should be placed in MW2 to absorb the hydrocarbon sheen.**

Please respond in writing within 45 days, or by December 20, 1996. If you have any questions, please contact me at 510-567-6761.

Sincerely,

Jennifer Eberle
Hazardous Materials Specialist

cc: Mr. Kitay, Aqua Science Eng., 2411 Old Crow Canyon Rd #4, San Ramon CA 94583
Cheryl Gordon, SWRCB, UST Cleanup Fund
J. Eberle/file

je.1585-E