LFR ENVIRONMENTAL MANAGEMENT & CONSULTING ENGINEERING

September 23, 2008 | 003-09155-00

Mr. Paresh Khatri
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Subject: Work Plan to Conduct an Air Injection and Soil-Vapor Extraction Pilot Test at the Former Pacific Electric Motors Site, 1009 66th Avenue, Oakland, California (Fuel Leak Case No. RO0000411)

Dear Mr. Khatri:

This letter presents a proposed Work Plan for conducting an air injection and soil-vapor extraction (SVE) pilot test at the Former Pacific Electric Motors Site located at 1009 66th Avenue, Oakland, California ("the Site"; Fuel Leak Case No. RO0000411). The objective of the pilot testing activities described in this Work Plan is to collect field data to assess whether air/ozone injection in conjunction with SVE is a potentially viable remediation technology to address petroleum-affected groundwater beneath a portion of this Site.

Background

The approximately 2.5-acre Site is the location for a proposed Aspire Charter High School on the western side of 66th Avenue between East 14th Street to the north and San Leandro Street to the south (Figure 1). The area around the Site is developed with a mixture of commercial, industrial, government, and multi-family residential buildings. The Site was previously used for manufacturing and warehousing. Past operations at the Site included manufacturing of specialty magnets, power supplies, and components used in high-energy physics, and repairing and rebuilding of motors, generators, transformers, and specialty magnets. Additional historical land use information for the Site was presented in the report prepared by LFR Inc. (LFR) entitled "Additional Supplemental Site Investigation," dated January 23, 2006.

Eight groundwater monitoring wells are located on the Site. Five of the wells were installed during previous investigations for a former gasoline underground storage tank. In addition, LFR installed three multi-depth, nested groundwater wells (NW-1, NW-2, and NW-3) during the additional supplementary site investigation (Figure 2).

This pilot test is being conducted as a first step to evaluate whether air/ozone injection in conjunction with SVE represents a potentially viable technology to address groundwater affected by total petroleum hydrocarbons (TPH) as gasoline (TPHg), benzene, toluene, ethylbenzene, and total xylenes (BTEX), and methyl tertiary-butyl ether (MTBE) in the "SWW Area" of the Site

512.895.0002 m
512.366.8003 f
15808 Ranch Road 620 N, Suite 205
Austin, Texas 78717
Offices Nationwide
www.lfr.com

(Figure 2). For the purposes of this Work Plan, the above-listed constituents of concern (COCs) will be referred to as "Targeted SWW Area COCs."

As presented in previous reports, other COCs at this Site include: polychlorinated biphenyls (PCBs), lead, arsenic, and polycyclic aromatic hydrocarbons (PAHs). The remedial approach that is the topic of this Work Plan does not attempt to address all of these other COCs within the SWW Area, or COCs in other areas of the Site. Those COCs will be addressed in a future corrective action plan (CAP) for the Site. The CAP will incorporate the results of the pilot testing presented in this Work Plan, and will include a proposed remedial approach to address all site COCs.

Objectives, Approach, and Rationale for Proposed Pilot Testing

The overall objective of the pilot testing activities described in this Work Plan is to collect field data to assess whether air/ozone injection in conjunction with SVE is a potentially viable remediation approach to address the targeted SWW Area COCs.

SVE is the U.S. Environmental Protection Agency (EPA) Presumptive Remedy for the remediation of volatile organic compound- (VOC-) affected soil, and is generally considered the most practical means of limiting potential VOC vapor intrusion into the buildings and removing VOCs from beneath a building. One of the objectives of this pilot test, therefore, is to evaluate the potential effectiveness of SVE and air/ozone injection working in tandem to remediate both soil and groundwater at the Site.

Air and ozone injection are known to be an effective and proved technologies to remediate VOC-affected groundwater such as is located in the Targeted SWW Area. The key limiting factor for the viability of these technologies is the permeability of the formation. If the soil has a low permeability, then the vapor cannot be extracted from the subsurface and SVE would not be effective in recovering the vapors containing VOCs. Similarly, if the soil has a low permeability, then the air that is injected into the subsurface will not effectively come in contact with the VOC-affected groundwater and will not be effective in remediating the groundwater. Thus, one of the overall objectives of this pilot test is to collect field data to evaluate the formation permeability, and the ability of the formation to accept and distribute injected gas.

The following specific objectives were developed from the overall objectives described above:

- Collect unsaturated-zone air flow and pressure response data to assess SVE well spacing requirements.
- Assess if air can be injected into shallow saturated sediments at reasonable flow rates (i.e., flow rates between 2 cubic feet per minute [ft^3/min] and 10 ft^3/min) at a pressure below the soil overburden pressure.
- Assess the distribution of injected gas into the formation through the collection of groundwater elevation, dissolved oxygen (DO), and helium tracer gas.

- Collect data to develop injection well spacing requirements for the design of a full-scale ozone system to address Targeted SWW Area COCs, if deemed viable.
- Collect soil-vapor concentration data to estimate the VOC mass removal rates. The data will be used to assess the Targeted SWW Area COC mass loading rates for sizing the emission control systems and estimating total system operating time frames.

Scope of Work Overview

The SVE pilot test will be performed first to assess its effectiveness and measure baseline concentrations of VOCs in the vadose zone before beginning the air injection test. Upon completion of the initial SVE test, a 2- to 4-hour air injection test will be performed. The air injection pilot test will be performed to assess if air can effectively be injected into the subsurface. Upon cessation of the air injection test, the pilot SVE system will be re-started to assess changes in VOC concentrations within the vadose zone as a result of the injection of air.

The specific tasks that comprise this scope of work include the following and are described in more detail in the following sections.

Task 1: Install, Develop, and Sample Wells

Task 2: Conduct SVE Pilot Step Test

Task 3: Conduct Air Injection Test

Task 4: Re-Start and Monitor SVE System

Task 5: Data Analysis and Reporting

Task 1: Install, Develop, and Sample Wells

To achieve these goals, LFR proposes to install two sets of clustered air injection and SVE wells (total of six wells) as illustrated on Figure 3. One primary air injection and SVE well cluster (AS-1I, AS-1D, and SVE-1) and another cluster of co-located SVE and air injection monitoring wells (SVMW-2, ASMW-2I, and ASMW-2D) will be installed approximately 15 feet from the primary co-located air injection and SVE wells (Figure 3). This spacing is designed to investigate the radius of influence of each technology.

Well nomenclature for this pilot test is provided below.

Well ID Designation	Description/Purpose
AS	Air Injection Well
SVE	Soil-Vapor Extraction Well
ASMW	Air Injection Monitoring Well
SVMW	Soil-Vapor Monitoring Well
S	Well Screened in Shallow Zone (less than 8 feet bgs)
I	Well Screened in Intermediate Zone (approximately 10 to 16 feet bgs)
D	Well Screened in Deep Zone (approximately 20 to 32 feet bgs)

Methodology for Well Installation

Site Setup

Prior to the well drilling and installation work, LFR will obtain the appropriate drilling permits from the Alameda County Public Works Agency - Water Resources. LFR will contact Underground Service Alert to notify them of the surface drilling work, and will subcontract a private underground utility clearance contractor to clear the proposed well locations and nearby areas. Downhole drilling equipment will be appropriately cleaned with high-pressure hot water (steam cleaned) before use at each new drilling location. Waste soil generated during drilling will be placed on plastic tarps on the ground surface near each well location and will be disposed of as necessary during future land development activities. Wastewater generated during drilling and/or well development and sampling will be temporarily placed in 55-gallon steel drums, properly labeled as nonhazardous wastewater, and properly characterized for disposal.

The site-specific Health and Safety Plan prepared by LFR for previous subsurface investigations at the Site will be updated to address health and safety concerns specific to the planned field activities. Daily health and safety tailgate meetings will be conducted by the LFR field geologist prior to beginning any fieldwork, and fieldwork will be monitored to ensure that appropriate health and safety procedures are followed during the field investigations.

Advancement of Borings

The ASM, SVE, and SVM wells will be installed using the hollow-stem auger drilling method. The drilling is proposed to be completed by a California-licensed, hollow-stem auger drilling subcontractor under the direction of an LFR field geologist. Continuous soil cores will be collected during drilling. The soil cores will be visually logged and screened in the field using a photoionization detector (PID) to evaluate the presence of hydrocarbons or other VOCs. The LFR field geologist will classify the soils encountered using American Society for Testing and Materials D 2488-00, based on the Unified Soil Classification System. Lithologic soil descriptions and field screening results will be recorded on field boring logs that will be reviewed, edited, and signed by a California Professional Geologist. Soil samples for laboratory analyses may be collected from the continuous soil cores from intervals where visual and PID screening results indicate the potential presence of petroleum hydrocarbons.

Construction of Wells

The AS monitoring wells will be constructed using 2-inch-diameter, solid polyvinyl chloride (PVC) casing and slotted well screen. The well screen will be surrounded by sand pack to approximately 1 to 2 feet above the screen. The filter pack for AS, SVE, and SVM wells will extend to the top of the well screens, but not above them. Approximately 2 feet of hydrated bentonite will be placed on top of the sand pack. The annular space between the bentonite and the surface will be sealed using a bentonite and cement grout in order to limit short-circuiting of the air injection/ SVE system from the surface. The surface completions will consist of an at-grade, traffic-rated well box installed in concrete. The top of the PVC casing will be equipped with a locking well cap.

The SVE and SVM wells will be installed to a maximum depth of 5 feet below ground surface (bgs) with a 2-foot screen extending to approximately 3 feet bgs. The intermediate air injection well (AS-1I) will be installed to a maximum depth of approximately 16 feet bgs with a 2-foot-long well screen. The intermediate air injection monitoring well (ASMW-2I) will be installed to a maximum depth of approximately 16 feet bgs with a 6-foot-long well screen. The deep air injection well (AS-1D) will be installed to a maximum depth of approximately 32 feet bgs with a 2-foot-long well screen. The deep air injection monitoring well (ASMW-2D) will be installed to a maximum depth of approximately 32 feet bgs with a 10-foot screen. Final well depths will be assessed in the field at the time of installation with the objective of installing the air injection points within the two more permeable or sandy sediments units located between 14 to 16 feet bgs and 22 to 32 feet bgs.

Well Development

The cement grout around the new wells will be allowed to cure for a minimum of 24 hours, after which the new air injection wells will be developed by bailing, swabbing, or pumping. The development will remove any sediment left in the well during construction and will enhance the hydraulic communication between the well and surrounding sediments. Observations concerning the quantity and clarity of water withdrawn will be recorded during this process. Indicator parameters (pH, temperature, and specific conductance) will be recorded during well development. Approximately three to 10 well casing volumes will be removed from each well during the development process. This process will continue until the indicator parameters stabilize.

Collection and Analysis of Baseline (Pre-Air Injection Test) Groundwater Samples

One set of groundwater samples will be collected from the air injection wells and the closest two groundwater monitoring wells after well development. The purpose of these samples is to assess the quality of the groundwater prior to initiating the pilot test.

The containers will be labeled with the well identification number, the time and date of collection, the analysis requested, and the initials of the sampler. The samples will be stored in an ice-chilled cooler and maintained under strict chain-of-custody protocols until they are submitted to the analytical laboratory.

The groundwater samples will be submitted to a state-certified laboratory and will be analyzed for TPHg, TPH as diesel (TPHd), and TPH as motor oil (TPHmo) using EPA) test Method 8015, modified. The samples will also be analyzed for VOCs (including BTEX and fuel oxygenates) using EPA test Method 8260B.

Task 2: Conduct SVE Pilot Step Test

LFR will perform an SVE pilot step test at well SVE-1 to provide data to assess the most efficient vacuum and flow rate combination for this Site. This step test will include applying a series of different vacuum rates to the extraction well, and measuring resulting flow rates and vacuum responses. The initial vacuum will be applied to the extraction well, and the extraction well (and surrounding wells) are monitored for SVE flow rate, SV monitoring well vacuum, and extracted vapor PID readings as the flow rate comes to a state of equilibrium. The vacuum is then increased and the process is repeated. The data are then plotted on a graph to illustrate the flow rate versus vacuum. This curve is useful in assessing the full-scale system equipment requirements and performance.

A pre-packaged, skid-mounted SVE system will be used to apply a vacuum to the well as described below. Extracted vapor will be treated by passing the SVE system exhaust through two vapor-phase carbon canisters connected in series. Each step of the pilot test will continue until vacuum rates have stabilized in the SV monitoring wells as evidenced by less than a 10 percent change in vacuum between readings for two consecutive measurements taken 15 minutes apart.

The subsurface response to the applied vacuum will be monitored by measuring the vacuum at proposed SVE monitoring point SV-2 (Figure 3). Vacuum measurements will be collected at approximately 30-second intervals or as frequently as practical during the initial stage of the test, and then at a decreasing frequency as the test continues and pressure differentials begin to stabilize. Field monitoring of organic vapors using Tedlar™ bags and a handheld PID also will be conducted from the extraction well at a similar frequency to the vacuum readings.

Vapor samples for laboratory analyses will be collected and submitted to the laboratory for TO-15 analysis using procedures described below. The vapor samples will be collected at the beginning of the test, after approximately 15 minutes, and near the end of the test. Additional samples may be collected after the air injection test to assess any impacts on COC concentrations within the vadose zone due to the air injection test. After the air injection test, the SVE system will be re-started and a vapor sample will be collected immediately upon reactivation of the SVE test well.

One potential effect of air injection and SVE is the upwelling of the shallow groundwater in response to the applied vacuum and induced pressure. To evaluate the potential effect on the groundwater elevations at the Site, water-level measurements will be collected using a water-level meter from groundwater monitoring wells NW-2I, MW-4, and ASMW-2I. Water-level measurements will be recorded on field sheets and collected before a vacuum or pressure is applied, as frequently as is practical for the first 15 minutes, and then at 15-minute intervals for the remainder of the tests.

SVE Test Equipment

A variety of extraction and instrumentation equipment will be used to perform the SVE pilot test. The extraction blower, piping, and emissions control equipment will be configured to provide maximum flexibility so that a range of air flow rates and vacuums can be achieved.

Instrumentation and Monitoring

The following parameters will be measured during the SVE test:

- air pressure (vacuum)
- air flow rate
- extracted air temperature
- halogenated VOC concentrations

A summary description of the types of frequencies of measurements is provided below.

Summary of SVE Monitoring Parameters and Frequency

Parameter	Water Level	Vacuum	Flow Rate and Temperature	Organic Vapor Concentration	
Instrumentation	**Water-Level Meter**	**Magnehelic Gauge**	**Pitot Tube or Anemometer and Thermometer**	**PID**	**Laboratory Sample (TO-15)**
SVE Well	NA	Initially: 30-second interval[3] Duration: 5-minute interval	Every 5 minutes or as frequently as practical	Every 5 minutes[3]	At start of test, after 15 minutes of extraction, and at test completion
SVE Monitoring Points [1]	NA	Initially: 30-second interval[3] Duration: 5-minute interval	NA	Before start of test	Before start of test

Parameter	Water Level	Vacuum	Flow Rate and Temperature	Organic Vapor Concentration	
Instrumentation	**Water-Level Meter**	**Magnehelic Gauge**	**Pitot Tube or Anemometer and Thermometer**	**PID**	**Laboratory Sample (TO-15)**
Groundwater Monitoring Wells (2)	5- to 15-minute intervals or as frequently as practical	NA	NA	NA	NA
Carbon Effluent	NA	NA	NA	Every 30 minutes(3)	NA

Notes:

NA = test not applicable

PID and laboratory samples will be collected in and analyzed in 1-liter Tedlar™ bags.

(1) SVMW-2, SVMW-3

(2) ASMW-2I, ASMW-2D, ASMW-3I, ASMW-3D, NW-2S, NW-2I, NW-2D, and MW-4

(3) or as frequently as practical in the field

Vacuum Pressure Monitoring

The SVE monitoring point (SVMW-2) will be equipped with a vacuum gauge to measure pressure changes in unsaturated-zone soils. The extraction well vacuum will be monitored with a pressure gauge connected to a sample port installed at the wellhead.

Vapor Flow Monitoring

The vapor flow rate of the extraction system will be monitored with a Pitot tube and differential pressure gauge or with an anemometer installed in the conveyance piping where it exits the extraction well. The temperature of the extracted air will also be measured using a thermometer.

Field Monitoring Samples

Screening-level vapor samples will be collected from the extraction well before, during, and after the SVE test. Samples will be collected directly from the sample port mounted to ASMW-1 or in 1-liter Tedlar™ bags for total Targeted SWW Area COC monitoring using a PID. Samples may be collected using a vacuum pump connected to a Tedlar™ bag. The Tedlar™ bag will be connected to the SVE well sampling port using inert Teflon™ or silicon tubing. To overcome the vacuum in the extraction well, a small vacuum pump will be connected to the well. When the vacuum of the pump exceeds the vacuum in the well, soil vapor will flow from the well into the Tedlar™ bag.

Once filled, the Tedlar™ bag will be connected to a calibrated PID and a total Targeted SWW Area COC concentration reading will be taken.

Soil-Vapor Laboratory Sample Collection and Analysis

Soil-vapor samples will be collected for laboratory analysis from the extraction well and from the SVE monitoring point (SVMW-2) before the start of the test. In addition, one sample for laboratory analysis will be collected from the extraction well at the beginning of the test, during the test, and near the end of the extraction period. An additional sample will be collected from the extraction well at the end of the air injection test and at the beginning of the SVE system re-start. Samples for laboratory analysis will be collected in clean, 1-liter Summa™ canisters provided by the state-certified laboratory. The Summa™ canister will be connected to the well or conveyance line. Pre- and post-sampling vacuum will be recorded, and the canister will be shipped to the laboratory under standard chain-of-custody protocols. Samples will be analyzed for Targeted SWW Area COCs by a California-certified analytical laboratory using EPA Method TO-15.

Task 3: Conduct Air Injection Test

After the initial SVE step test has been completed, LFR will initiate injection of air into the newly installed injection wells, and measure responses in the formation, as described below.

Air Injection Test Equipment and Operation

Air injection system piping will be configured to provide maximum flexibility so that a range of tests can be performed. Key test equipment to be used during the air injection portion of this test is described below.

Because of the temporary nature of the pilot test program, a rental air injection system will be used that will include a blower capable of providing a range of injection pressures and flow rates, up to 20 ft^3/min at 10 pounds per square inch gauge. Air injection wells AS-1I and AS-1D will be connected to the blower using PVC piping and heavy-wall flexible tubing. All conveyance piping will be sized adequately to minimize flow restrictions and pressure losses, and sampling ports will be installed downstream from the injection unit. The air injection system will also include a dilution air inlet for increased operational flexibility.

Air Injection Pressure, Rates, and Duration

Air injection wells AS-1I and AS-1D will be tested at a flow rate of approximately 15 ft^3/min or at the highest flow rate obtainable. Air injection will be conducted for approximately 1 to 2 hours in each injection well. In general, the operating pressure for an air injection well is determined by the total depth of the air injection well relative to the water level in the well, and the permeability of the water-bearing sediments.

Injection pressures will be regulated using a vent valve. This valve will be fully open at the beginning of the test and will be slowly closed while monitoring pressure and flow rate increase to the desired flow rate. During this process, care will be taken not to exceed the upper pressure limit for the system. The air injection pressure and flow rate will be recorded approximately every minute until the pressure and flow stabilize, and less frequently thereafter.

The air steam will be amended with helium at a concentration of approximately 10 percent helium. Helium is the most common tracer gas used, because it is relatively inexpensive and readily available, and analytical instrumentation is available for field use. Typical field instrumentation is a Marks Product helium detector. The detector can detect helium concentrations from 0.1 to 100 percent. Detectors are typically factory calibrated; however, calibration checks will be conducted using helium standards to verify the instrument is operating properly. Helium concentrations will be measured in nearby SVE wells. Soil-vapor samples will be collected in Tedlar™ bags. The helium detector will be attached directly to the Tedlar™ bags for measurement.

Task 4: Re-Start and Monitor SVE System

The SVE system will be reactivated after the first two to four hours of the injection test to allow for evaluation of Targeted SWW Area COC concentrations that may be volatilized into the vadose zone during air injection. Samples for laboratory analysis will be collected in clean, 1-liter Summa™ canisters provided by the state-certified laboratory that will be connected to the well or conveyance line. Pre- and post-sampling vacuum will be recorded, and the canisters will be shipped to the laboratory under standard chain-of-custody protocols. Samples will be analyzed for Targeted SWW Area COCs by a California-certified analytical laboratory using EPA Method TO-15.

Task 5: Data Analysis and Reporting

The air injection/SVE pilot test data obtained from the investigation will be tabulated, reviewed, and interpreted to assess the viability of air injection and SVE in the SWW Area of the Site.

LFR will prepare and submit to Alameda County Environmental Health (ACEH) a report summarizing the air injection/SVE pilot test data obtained from the investigation. The report will include lithologic logs, well completion details, copies of the drilling permit, well development field forms, chain-of-custody forms, and certified laboratory analytical reports. The report will also present an interpretation and discussion of data obtained during the tests to assess the viability of air injection and SVE in the SWW Area of the Site. Data collected during the air injection pilot test will be evaluated and used to develop the necessary design parameters for an air and ozone injection system. If applicable, the following analyses will be performed:

- tabulations of air flow and injection pressures to assist in sizing and specifying injection equipment and piping

- tabulations and plan view estimates of the area of influence (e.g., VOC and helium concentration in soil gas, and VOC and DO concentration and pressure/elevation in groundwater)
- tabulations and plots of VOC mass removal rates to estimate the likely duration of operation and estimated rates of VOC loading for the SVE and treatment system
- tabulations and plots of placement and helium recovery

Schedule

After receiving approval from ACEH for this Work Plan, LFR will oversee the installation, development, and sampling of the proposed wells as described above. Subsequently, LFR will initiate the pilot test and provide a summary of the tests within 60 days after the approval of this Work Plan.

In accordance with ACEH, all reports will be uploaded to the ACEH file transfer protocol site and to the Regional Water Quality Control Board GeoTracker database.

Closure

Please contact either of the undersigned at (510) 652-4500 if you have questions regarding the scope of work presented in this Work Plan.

Sincerely,

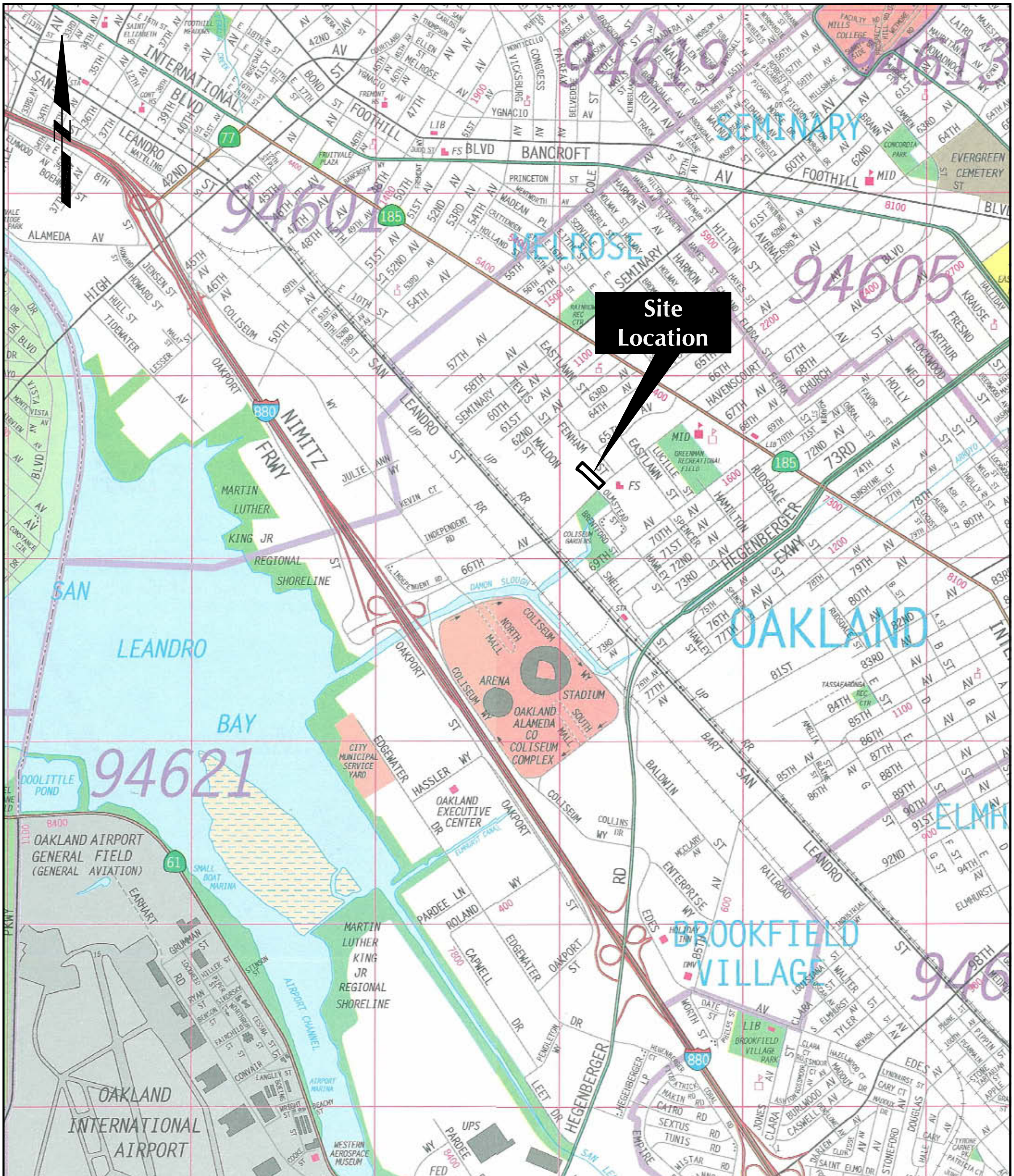
REGISTERED PROFESSIONAL ENGINEER
LUCAS GOLDSTEIN
C 72455
EXP 6/30/2010
CIVIL
STATE OF CALIFORNIA

Lucas Goldstein, P.G., P.E.
Senior Associate Engineer
California Professional Civil Engineer (72455)

Ron Goloubow
Senior Associate Geologist

cc: Mr. Charles Robitaille - Aspire Public Schools

Attachments: Figures 1 through 3



0 1,000' 2,000' 4,000'

Scale in Feet

Source: Thomas Guide 2001

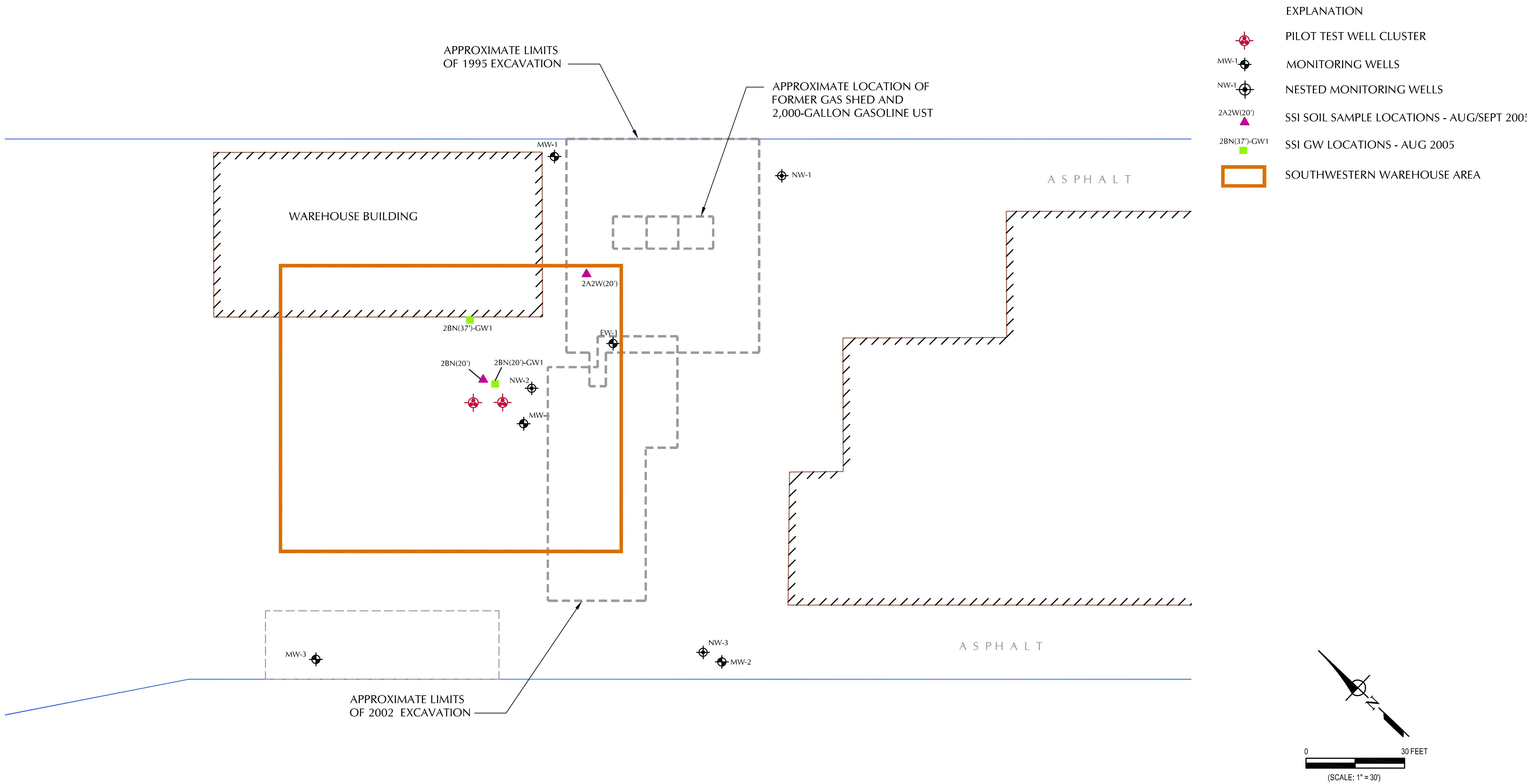
Site Location Map

1009 66th Ave, Oakland, California

LFR

Figure 1

I:\Design\003\09155\00\000\dwg\Site Vicinity-2.dwg Sep 18,2008-2:48pm



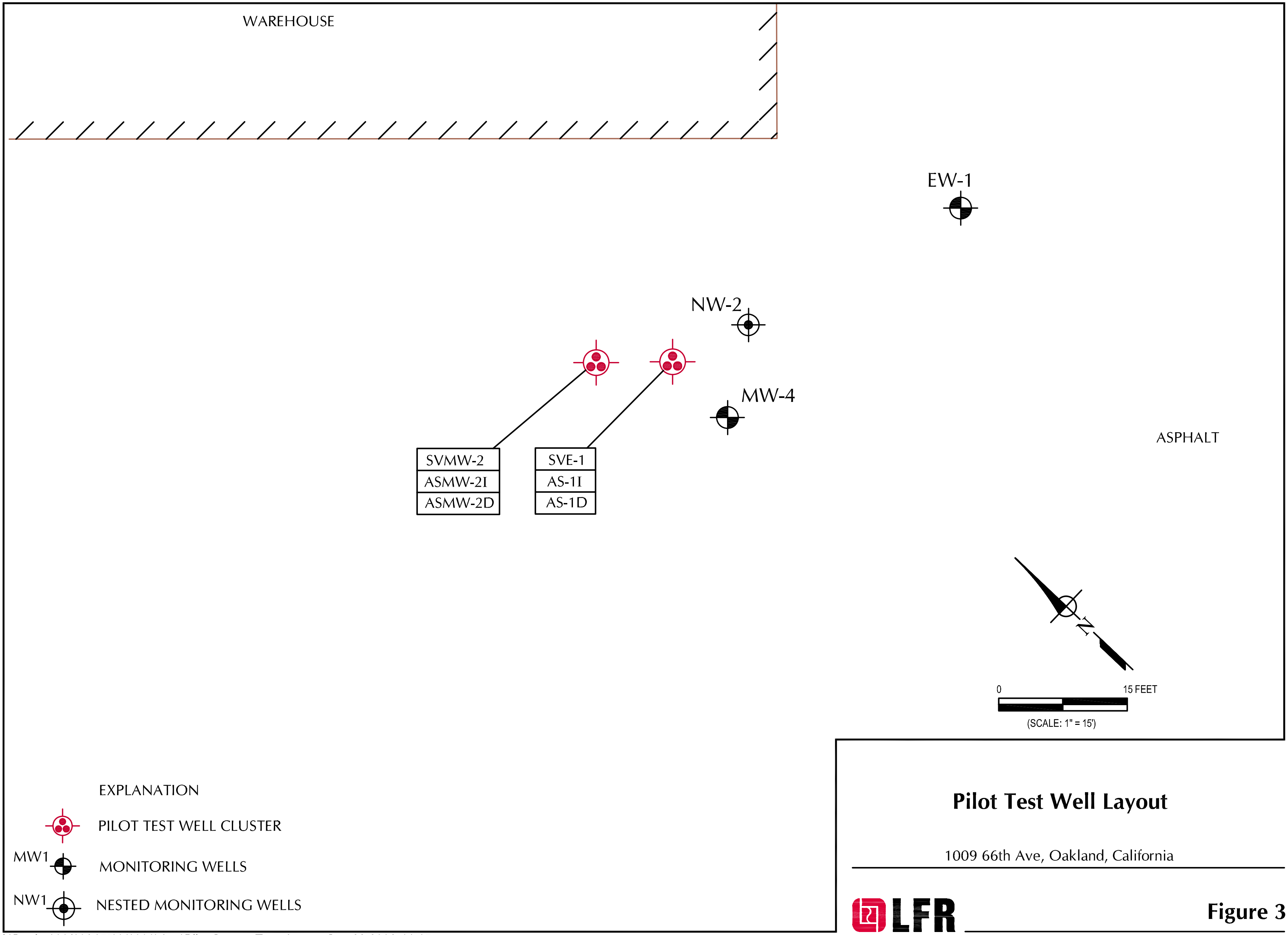
Site Layout with Approximate Extent of the Southwestern Warehouse Area

1009 66th Ave, Oakland, California

LFR

Figure 2

I:\Design\003\09155\00\000\dwg\Pilot Sparge Test.dwg Sep 23,2008-11:14am



Pilot Test Well Layout

1009 66th Ave, Oakland, California

LFR

Figure 3

I:\Design\003\09155\00\000\dwg\Pilot Sparge Test.dwg Sep 23,2008-11:15am