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Environmental Health

IES

REMEDIATION WORKPLAN
1409-1417 12TH STREET
OAKLAND CALIFORNIA
ACEH File No. RO2933

On behalf of Mrs. Shirley E. Thompson, Impact Environmental Services (IES) is presenting this Remediation Work Plan for 1409-1417 12th Street in Oakland, California (Figure 1). This work plan presents the proposed scope of work to remediate residual petroleum hydrocarbons and associated aromatic compounds in possible smear-zone soils and groundwater at the subject property. The work plan is being prepared in response to a request from the Alameda County Environmental Health (ACEH) for a remediation work plan[1] for the unauthorized release of fuel at the subject property.

This workplan describes our approach for corrective action to remove separate phase petroleum hydrocarbon (SPH) contamination from the site and to prevent off-site migration of dissolved phase petroleum hydrocarbon groundwater contamination. IES anticipates instituting groundwater extraction and treatment in conjunction with vacuum-enhanced multi-phase extraction to remove petroleum hydrocarbon contamination from the site. Groundwater extraction will be used to remove groundwater with dissolved hydrocarbons and to lower the level of groundwater and expose smear-zone soils. Vacuum-enhanced extraction will be applied to the capillary fringe and smear-zone soils to remove SPH, interstitial groundwater, and hydrocarbon vapors.

This work plan presents site background information and the proposed scope of work for interim remedial action and soil and groundwater corrective action.

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[1] Alameda County Environmental Health, "Fuel Leak Case No. RO2933, 1409-1417 12th Street, Oakland, California CA 94607-2003_Request for Work Plan", September 10, 2007.

SITE CONTACT INFORMATION

The site address and contact information is as follows:

Site Address:	Contact Information:
1409-1417 12th Street	Mrs. Shirley Thompson
Oakland, CA	Edward C. and Shirley E. Thompson Trust
APN 004-063-06	1155 Hopkins Street, Berkeley, CA 94702-1359

SITE BACKGROUND

The Subject Property is located in a predominately residential area in the western section of the city of Oakland, Alameda County, California (Figure 1). The subject Property comprises the Alameda County assessor parcel 004-063-06 and is bordered to the north by 12th Street and residential development, to the south by a vacant lot, on the east by Mandela Parkway, and to the west by a residential development (Figure 2). The property is located approximately 1-mile southeast of San Francisco Bay and 1-mile north of Oakland Inner Harbor. The elevation of the site is approximately 17 feet above mean sea level (USGS West Oakland 7.5 Minute Quadrangle). Portions of the site are paved with asphalt and the remainder is covered by grass and soil. Several mounds of soil up to 2 feet high are present in the southeast portion of the subject property.

Historical records indicate that the property was occupied by a service station from circa 1957 to the circa 1969. The subject property was either vacant or occupied by residential dwellings from at least 1902 to circa 1956. Sanborn maps from 1957, 1958, 1961 and 1967 appear to show three underground fuel storage tanks (USTs) located in the southeast corner of the service station. The 1961 Sanborn map appears to show a fourth UST or AST along the west property boundary. According to a previous report, a magnetometer survey performed at the subject property (circa 1999) revealed no magnetic anomalies indicative of buried underground storage tanks. However, communications with the Oakland Fire Department Hazardous Materials Division, confirmed that no records exist of UST removal from the Subject Property[2].

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2 Verbal Communication, *LeRoy Griffin, Oakland Fire Department Hazardous Materials Division,* May 25, 2006.

Geologic Setting

The Subject Property is located in the East Bay Plain of the San Francisco Bay Area. This region is dominated by northwest trending topography enclosed in the Coast Range Province of California. The site is located in the "Merritt Sand Outcrop" groundwater subarea, which has a maximum thickness of 65 feet, and the local gradient is directed toward the west to southwest[3]. Based on information provided by a previous investigation, soil beneath the property consists primarily of silty-sand to at least 20 feet bgs. Groundwater is first encountered between 10.5 and 13.5 below ground surface (bgs) and stabilizes at approximately 11 feet bgs. Groundwater in the vicinity of the subject property is assumed to flow to the west of southwest, towards San Francisco Bay.

Previous Phased Environmental Investigations

In August 1999, East Bay Asian Local Development Corporation (EBALDC) contracted Blymer Engineers of Alameda, California to conduct a subsurface investigation at the subject property[4]. EBALDC was considering purchasing the subject property from Mrs. Thompson for infill development of residential housing units.

The investigation consisted of the installation of five on-site exploratory borings (B1 through B5) and the collection of soil and grab groundwater samples. All soil and grab groundwater samples were analyzed for total petroleum hydrocarbons (TPH) as gasoline (TPHg) by modified EPA Method 8015, and benzene, toluene, ethylbenzene and total xylenes (BTEX) and methyl *tert*-butyl ether (MTBE) by EPA Method 8020. In addition, all of the soil samples and three groundwater samples (GW-3, GW-4, and GW-5) were analyzed for total lead using EPA Methods 6010 and 239.2. Grab groundwater sample GW-5 was also analyzed for Volatile Organic Compounds (VOCs) by EPA Method 8260.

TPHg at concentrations up to 1,500 milligrams per kilogram (mg/kg) and BTEX compounds at concentrations up to 120 mg/kg were detected in soil samples collected from the apparent

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3 Hickenbottom and Muir, *Geohydrology and Groundwater Quality Overview of the East Bay Plain Area, Alameda County, California, 205 (J) Report*, 1988.

4 Blymer Engineers, Inc., *Subsurface Investigation Vacant Parcel 1409-1417 12th Street, Oakland, California,* August 25, 1999.

capillary fringe in borings B-3 and B-5. The highest concentrations were detected just above first-encountered groundwater at a depth of 10.5 to 11.5 feet bgs. Lead was detected in all soil samples (with the exception of sample B1-5) at concentrations indicative of background levels. TPHg at concentrations up to 110,000 micrograms per liter (µg/L), benzene up to 5,800 µg/L, toluene up to 16,000 µg/L, ethylbenzene up to 31,000 µg/L, and total xylenes up to 18,000 µg/L were detected in groundwater samples GW-2 and GW-3. The laboratory noted the presence of a "lighter than water immiscible sheen" in groundwater samples GW-3 and GW-5. Lead was not detected in any of the groundwater samples above the method reporting limit of 0.005 milligrams per liter (mg/L). The following VOCs were detected in groundwater sample GW-5: benzene (5,400 µg/L), 1,2-dichloroethane (1,2-DCA, 500 µg/L), ethylbenzene (3,800 µg/L), n-propyl benzene (550 µg/L), toluene (18,000 µg/L), 1,2,4-trimethylbenzene (4,900 µg/L), 1,3,5-trimethylbenzene (1,100 µg/L), and total xylenes (23,000 µg/L). The detected concentrations of TPHg and BTEX in groundwater samples from borings B2, B3, and B5 exceed respective San Francisco Bay Regional Water Quality Control Board (RWQCB) environmental screening levels (ESLs)[5] for commercial and residential land use scenarios. The concentration of 1, 2-DCA detected in groundwater sample GW-5 also exceeds the ESL for that compound.

In July, 2006, Impact conducted a Phase I Environmental Site Assessment (Phase I) for the Subject Property[6]. The scope of the Phase I included a reconnaissance of the site and vicinity to assess current land use, review of historical records to establish past land use and to help evaluate the likelihood that past land use resulted in subsurface contamination. Geologic maps and environmental reports were also reviewed to evaluate general geologic and hydrogeologic conditions in the area including the presence of groundwater and regional hydrogeologic features dictating groundwater flow direction. Government agency files were reviewed for information regarding subsurface contamination and use, storage and disposal of hazardous materials at the site and vicinity.

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5 *Screening For Environmental Concerns at Sites with Contaminated Soil and Groundwater*, San Francisco Bay Regional Water Quality Control Board, February 2005.

6 Impact Environmental Services, *Phase I Environmental Site Assessment 1409-1417 12th Street Oakland California*, August 25, 2006 (revised December 13, 2006).

The subject property was not on any government lists. However, the Phase I concluded that the subject property was occupied by a gasoline service station from circa 1957 to circa 1969. Based on review of the Blymer report, previous activities at the site appear to have resulted in hydrocarbon contamination of soils and groundwater at the property.

In May 2007, Impact conducted site characterization study to further evaluate the presence of petroleum hydrocarbons and VOCs in soil, soil-vapor, and groundwater at the subject property. Thirty-six discrete soil samples and nine grab groundwater samples from nine exploratory borings (B-6, B-7, and B-9 through B-15) at the Subject Property. In addition, nine soil-vapor samples were collected from property[7]. Soil and grab groundwater samples were analyzed for TPH as diesel (TPHd) and motor oil (TPHmo) by EPA Method 8015, and TPHg, benzene, toluene, ethylbenzene and total xylenes (BTEX), methyl *tert*-butyl ether (MTBE), and other fuel oxygenates by EPA Method 8260. Soil-vapor samples were analyzed for TPHg (by modified EPA Method TO-3) and VOCs (by EPA Method TO-15).

TPHg was detected in three of the thirty-six soil samples at concentrations ranging from 32 mg/kg and 20,000 mg/kg. Soil samples with TPHg detections were collected from boring B-9 at depths of 10, 12, and 20 feet bgs. Two of these samples (B-9:10' [4,600 mg/kg] and B-9:12' [20,000 mg/kg]) contained concentrations of TPHg that exceed the ESL of 100 mg/kg. TPHd was not detected at or above method detection limits (MDLs) in soil samples. TPHmo was only detected in one soil sample (B-10:5'), at a concentration significantly below the residential ESL of 500 mg/kg. BTEX were only detected in soil samples retrieved from exploratory boring B-9. Benzene was detected at 830 µg/kg in soil sample B-9:20'. The concentration of benzene in this sample is above the residential ESL of 44 µg/kg. Toluene was detected at 210,000 µg/kg and 320 µg/kg in samples B-9:12' and B-9:20', respectively. The concentration of toluene in sample B-9:12' exceeds to residential ESL of 2,900 µg/kg. Ethyl benzene was detected at concentrations of 220,000 µg/kg and 440 µg/kg in samples B-9:12' and B-9:20', respectively. The concentration of ethyl benzene in sample B-9:12' exceeds to residential ESL of 220,000 µg/kg. Total xylenes were detected in soil samples B-9:10' (88,000 µg/kg), B-9:12' (1,300,000 µg/kg), and B-9:20' (1,600 µg/kg). The concentrations of total xylenes in samples B-9:10' and

[7] Impact Environmental Services, Site Characterization Report *1409-1417 12th Street Oakland California*, June 5, 2007.

B-9:12' are above the residential ESL of 2,300 µg/kg. Fuel oxygenates were not detected at or above MDLs in soil samples collected from the site.

The grab groundwater sample collected from boring B-9 contained 52,000 µg/L TPHg, significantly above the TPHg ESL of 100 µg/L. The grab groundwater sample collected from boring B-7 contained TPHd at 59 µg/L. The grab groundwater sample collected from boring B-6 contained TPHmo at 150 µg/L, which exceeds the ESL of 100 µg/L. BTEX were not detected at or above MDLs in grab groundwater samples collected from the site, with the exception of the following samples. The groundwater sample collected from boring B-9 contained 8,700µg/L of benzene, 2,200 µg/L toluene, 2,000 µg/L mg/kg ethylbenzene, and 7,200 µg/L total xylenes. Fuel oxygenates (including MTBE) were not detected at or above MDLs in grab groundwater samples collected from the site during this investigation, with the following exception. 1, 2-Dichloroethane was detected at 570 µg/L in the grab groundwater sample collected from boring B-9. The concentrations of 1, 2-dichloroethane in this sample exceeds the residential ESL of 0.5 µg/L.

Nine soil-vapor samples (SV-1 through SV-9) were collected from the subject property. The soil-vapor sample collected from SV-6 (near boring B-9) contained concentrations of TPHg, benzene, and vinyl chloride that exceed residential ESLs for shallow soil gas. TPHg was detected in sample SV-6 at a concentration of 52,000 ug/m^3, which is twice the ESL of 26,000 ug/m^3. The soil-vapor sample from SV-6 also contained benzene and vinyl chloride at concentrations of 1,200 ug/m^3 and 260 ug/m^3, which is significantly above their respective ESLs of 32 ug/m^3 and 85 ug/m^3. The remaining soil-vapor samples collected as part of this investigation did not contain constituents of concern above ESLs.

The investigation concluded that soil, soil-vapor, and grab groundwater samples collected from boring B-9 contained gasoline-range hydrocarbons, BTEX, and 1, 2-dichloroethane at concentrations that present a potential risk to human health in a residential land-use scenario. The groundwater sample collected from boring B-6 contained motor-oil range hydrocarbons above residential ESLs.

Petroleum contamination in groundwater appears to be isolated in hot-spots in the northern portion of the property. These hot-spots are located in the vicinity of borings B-2, B-3, B-5 (advanced during the Blymer investigation), and B-9. Free-product (gasoline) was identified in soils just above first encountered groundwater in boring B-9. Grab groundwater samples collected from exploratory borings B-2, B-3, and B-5, and B-9 contained TPHg at concentrations indicative of free-phase product (i.e., greater than 5 milligrams per liter [mg/L], which is the assumed solubility limit of TPH in water) [8,9]. The concentration of TPHg and BTEX in soil at borings B-2, B-3, and B-4, and B-9 appears to be a result of adsorption of residual free-phase petroleum or dissolved hydrocarbons to soil in contact with a fluctuating water table.

SCOPE OF WORK –REMEDATION WORK PLAN

This remediation work plan describes our approach for corrective action to remove SPH contamination from the site and to prevent off-site migration of dissolved phase petroleum hydrocarbons contamination in groundwater. IES proposes the use of groundwater extraction and vacuumed enhanced multi-phase extraction as the corrective action mechanism to mitigate contamination at the subject property. Groundwater extraction will be used to remove dissolved phase petroleum hydrocarbons and to lower groundwater levels to expose smear-zone soils and subject them to vacuum-enhanced extraction to remove petroleum vapors, SPH, and residual interstitial dissolved hydrocarbons. IES also proposes immediate interim remedial action by means of mobile enhanced multi-phase extraction (MEME) [10] using a vacuum truck equipped with a 5,000-gallon tank and vacuum pump to extract both soil vapor and SPH/groundwater from one or a series of onsite wells. MEME will provide immediate source removal by targeting SPH and allow IES to evaluate existing contamination responds to vacuum extraction.

Field activities related to interim remediation and corrective action will be performed in a phased approach. The first phase of work includes installing three (3) exploratory borings, eight (8) groundwater monitoring wells, up to sixteen (16) multi-phase extraction wells, and up to four (4)

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[8] Total Petroleum Hydrocarbon Criteria Working Group Series Volume 3, Selection of Representative TPH Fractions Based on Fate and Transport Considerations, July 1997

[9] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Fuel Oils*, 1995.

[10] Smith, Grant and Howard, Leslie_Burns and McDonnell Consultants, *Low-Cost, High-Impact Free-Product Recovery, Using MEME at Fuel System Leak Sites*.

groundwater extraction wells. Phase 1 also includes instituting a quarterly groundwater monitoring program for the site. Phase 2 includes performing immediate source (i.e. SPH) removal and interim remediation using mobile enhanced multi-phase extraction (MEME). Phase 3 includes performing a free-product recovery (bail-down) test, bioslurping pilot test, and groundwater pumping test to demonstrate the feasibility of these combined technologies as viable corrective action for petroleum contamination at the site. The final phase of work includes completing the final design, installation, and start-up of the groundwater extraction and vacuum-enhanced multi-phase extraction and treatment systems.

The following tasks are required to achieve the remedial and corrective action objectives of minimizing risk to human health and the environment.

Phase I tasks include the following tasks:

Task 1 - Pre-field and Activities

Task 2 - Installation of Exploratory Borings

Task 3 – Installation of Groundwater Monitoring and Extraction Wells

Task 4 – Installation of Multi-Phase Extraction Wells

Task 5 – Quarterly Groundwater Monitoring

Phase II task include the following tasks:

Task 6 –Mobile Vacuum Enhanced Multi-phase Extraction Operation (Interim Remediation)

Phase III tasks include the following tasks:

Task 7 – SPH Recovery Bail-Down Test

Task 8 – Multi-Phase Extraction Pilot Test

Task 9 – Groundwater Pumping Test

Phase IV tasks include the following tasks:

Task 10 – Remediation System Installation

Task 11 – Remediation System Start-up

These tasks are described in detail in the following section.

Task 1 – Pre-field and Pre-excavation Activities

Pre-field activities include preparing this remediation work plan, scheduling subcontractors, and preparing a site health and safety plan, and obtaining boring and well installation permits. Exploratory boring locations will be marked and cleared by a private underground utility locating contractor. IES will obtain the necessary well installation and exploratory boring permits from Alameda County Department of Public Works (ACPW). Underground Service Alert (USA) will be notified a minimum of 48-hours before the start of fieldwork. ACEH will be notified at least 5 days in advance of all phases of work.

Task 2 – Install Exploratory Borings

Moderate to significant concentrations of petroleum hydrocarbons were detected in smear-zone soils and in grab groundwater samples collected from borings B-2, B-3, and B-5 during the 1999 Blymer investigation. However, petroleum hydrocarbons and related compounds were not detected in soil, soil-vapor, or grab groundwater samples collected from borings (B-10, B-13, and B-14) in proximity (approximately 15 feet) to borings B-2 and B-3. The absence of detectable concentrations of petroleum hydrocarbons in soil and groundwater samples collected from nearby borings has produced some uncertainty about the distribution of petroleum hydrocarbons in these areas and caused a lack of confidence (by ACEH and IES) in soil and groundwater results from boring B-2 and B-3. As a result, IES proposes installing two "confirmation" exploratory borings (B-18 and B-19) near former borings B-2 and B-3 to substantiate historical soil (smear-zone) and groundwater results at these locations. If contamination is confirmed at the former boring B-3, IES also proposes installing a third exploratory boring (B-8) in the northeast corner of the property to define the extent of petroleum hydrocarbons in this area. Proposed exploratory boring locations are presented in Figure 4.

<u>Subsurface Data Collection</u>

Exploratory borings will be advanced using the Enviro-Core direct push sampling methods. The Enviro-Core system consists of 2.5-inch-diameter steel drive casing and a 1.8-inch-diameter inner sample barrel that are simultaneously pushed, driven, or vibrated into the ground.

Continuous soil cores will be collected in butyrate tubes inside the inner sample barrel. After being advanced three feet, the inner sample barrel is retrieved while the drive casing is left in place to prevent borehole collapse. After retrieving the inner core barrel, the samples are removed and stored for chemical analyses or lithologic identification. Sample rods will then be placed at the bottom of the borehole for additional three-foot sample collection runs until the desired borehole depth is achieved. Each boring will be advanced to first anticipated groundwater.

Soil samples for lithologic identification will be collected continuously to the depth of exploration. Soil cores will be logged in accordance with the Unified Soil Classification System (USCS) under the direction of a California Registered Geologist. Periodic soil samples will be screened in the field using an organic vapor meter (OVM) to provide a qualitative estimate of volatile hydrocarbons in the soil.

Soil samples will be collected from intervals where staining, odor or elevated OVM readings occur within the capillary fringe, where groundwater is first encountered, and at distinct changes in lithology. If no changes in lithology or elevated OVM readings occur then soil samples will be collected at five-foot intervals until groundwater is encountered, at the capillary fringe and at the total depth of soil boring or at least 20 feet bgs.

Borings will be advanced at least three feet into the first groundwater-bearing zone and grab groundwater samples will be collected. Grab groundwater samples will be collected through the hollow portion of the drill rods using new, disposable Teflon® bailers.

All soil and grab groundwater samples will be properly containerized, labeled, and preserved in ice upon collection. Chain of custody documentation will accompany the samples to the laboratory for analysis. All soil will be contained for proper disposal. All down-hole equipment will be steam cleaned before use and between borings. Soil cuttings and decontamination rinsate will be collected in 55-gallon drums for proper disposal. These materials will be properly disposed of consistent with analytical results. Following completion of work at each location, each boring will be grouted to the ground surface with bentonite-cement slurry via tremie pipe.

Soil and Groundwater Sample Analysis

Soil and grab groundwater samples will be analyzed at Torrent Laboratory Inc. (Torrent) of Milpitas, California. Torrent is a state-certified laboratory. Soil and grab groundwater will analyze soil and groundwater samples for TPHd, TPHmo by EPA Method 8015, and TPHg, BTEX, fuel oxygenates EDB and EDC using EPA Method 8260.

Task 3 – Groundwater Monitoring Well and Extraction Well Installation

IES proposes installing a maximum seven (7) groundwater monitoring/observation wells and up to four (4) groundwater extraction wells at the locations identified in Figure 5. Groundwater monitoring wells will be used to evaluate temporal changes in groundwater water quality and monitor hydrocarbon plume migration. Groundwater extraction wells will be used to remove groundwater with dissolved hydrocarbons and lower groundwater levels to expose soils in the smear-zone that will be subjected to vacuum extraction. It should be noted that proposed groundwater extraction wells GX-3 and GX-4 and groundwater monitoring well MW-7 will only be installed if samples collected from confirmation borings verify that significant concentrations of petroleum hydrocarbons are present in groundwater or soils near former borings B-2 and B-3 as described in Task 2.

Woodward Drilling Company Inc., a licensed drilling company from Rio Vista, will install the wells under the supervision of an IES geologist. For groundwater monitoring\observation wells, the pilot soil boring for the well will be advanced to the base of the shallow water-bearing zone using 8-inch-diameter hollow-stem augers (HSA). For wells installed within the petroleum impacted-zone or along the presumed margins of this area, soil samples will be collected at the intervals and analyzed for constituents of concern described in Task 2. IES field staff, under the supervision of a California State Registered Geologist, will log the soil samples according to the USCS and field screen soils using the OVA. Groundwater monitoring wells will be constructed within the 8-inch HSA using Schedule 40, 2-inch-diameter, flush-threaded, PVC casing. Well screens will consist of Schedule 40, 2-inch-diameter, flush-threaded, 0.010-inch, machine-slotted, PVC well screen. The screen will extend approximately 2-feet above the static groundwater elevation to allow floating product thickness, if present, to be monitored. The entire saturated interval of the targeted water-bearing zone will be screened.

Groundwater extraction wells will be constructed within 10-inch diameter HSA using Schedule 40, 4-inch-diameter, flush-threaded, PVC casing. Well screens will consist of Schedule 40, 4-inch-diameter, flush-threaded, 0.020-inch, machine-slotted, PVC well screen. The screen will extend approximately 2-feet above the water-bearing zone to allow floating product, if present, to be monitored. The entire saturated interval of the targeted water-bearing zone will be screened. A five-foot sump constructed of blank Schedule 40, 4-inch-diameter, PVC casing will be added to the well to accommodate any future down-hole pumping equipment. An appropriately sized sand pack will be placed in the annular space around the casing from the bottom of the boring to 1 to 2 feet above the top of the well screen and/or above static groundwater. The size of the well-screen slots and the sand-pack material will be determined based on inspection of the water-bearing zone material collected during our initial day of investigation. We anticipate that the well screen will have 0.020-inch slots and the surrounding sand pack will be comprised of #3. The well will be gently surged or bailed prior to setting the annular seal to settle the filter pack. A 1- to 2-foot seal of bentonite pellets will be placed above each sand pack. Above the bentonite seal, a sanitary seal of cement grout will be placed to within approximately one-foot of the ground surface.

One deep groundwater monitoring well be installed in the second water-bearing zone to evaluate the vertical extent of the hydrocarbon plume near the apparent source area. The well will be double cased to minimize the potential for cross contamination between the shallow and the deeper water bearing unit. A pilot boring will be drilled using 8-inch diameter HSAs to approximately 5 feet in the confining unit at the base of the shallow water bearing unit. The pilot boring will be reamed with 15-inch diameter HSAs to allow installation of a 10-inch diameter steel conductor casing. The conductor casing will be set approximately 3 feet into the confining unit at the base of the shallow water-bearing unit. The conductor casing will be set through the HSA and driven at least 1-foot additional into the confining layer. Should the conductor casing be set into an open hole, then centralizers will be used to ensure true vertical installation of wells.

Standing water will be pumped from the conductor casing and annular space prior to sealing the conductor casing with neat cement grout. The grout will be emplaced in the annular space with a tremie pipe in a continuous operation keeping the bottom end of the tremie pipe submerged. The neat cement grout seal will be allowed to cure for 48 hours.

Prior to further drilling, standing water will be pumped from the conductor casing. If necessary, bentonite will be placed inside the conductor casing to further absorb residual water and to improve conductor seal. After the conductor casing has been adequately installed, a hollow stem auger will placed inside the conductor and advanced through the confining layer and into the deeper water bearing unit. The deep monitoring well will be constructed with 2-inch diameter PVC casing with an appropriately screened slotted size the entire length of the second-water bearing unit.

A watertight vault will be installed at the surface to complete installation of all wells. The wellhead will be capped with a watertight, locking well cap. Well construction details will be recorded on a well completion diagram.

At least 48 hours after installation, the wells will be developed using surge and bail techniques. The wells will be developed until the water is relatively free of sediment, and the temperature, pH, and specific conductance of the water has stabilized. Measurements will be recorded on a well development log. A licensed surveyor will survey the top-of-casing elevation of the monitoring wells to the nearest 0.01-foot relative to NAVD88.

Soil Sample Analysis

Soil samples will be analyzed for TPHd, TPHmo by EPA Method 8015, and TPHg, BTEX, fuel oxygenates EDB and EDC using EPA Method 8260.

Task 4 – Installation of Dual-Phase Extraction Wells

IES proposes installing up to fifteen (15) multi-phased extraction (MPE) wells at the locations shown of Figure 6. A schematic of a typical MPE well is presented in Figure 7. MPE wells will be located in highly contaminated soils within the free-product plume and be positioned to allow detailed monitoring of in-situ changes in soil-vapor composition caused by the MPE system. MPE wells will be used to facilitate removal of vapor, adsorbed, dissolved, and free-phase volatile organic vapors from the unsaturated and upper saturated zones. It should be noted that the array of MPE wells near former borings B-2 and B-3 will only be installed if samples collected from confirmation borings verify that significant concentrations of petroleum hydrocarbons are present in groundwater or soils near these two locations. The actual number of MPE wells may also change depending on radius of influence determined during MPE pilot testing operations.

Woodward will install the wells under the supervision of an IES geologist. MPE wells will be advanced to approximately 5-feet above and beneath the water-table with the screened portion of the wells extending from the well bottom at an estimated 18-feet bgs to approximately 8-feet bgs. The screen design will allow floating product thickness, if present, to be monitored. Soil samples will be collected from 5-feet bgs and deeper unsaturated soil with the highest OVA reading (which is expected to be in the capillary fringe or unsaturated portion of the smear-zone at 10 to 13-feet bgs). One additional soil sample will be collected from the bottom of the well bore. IES field staff, under the supervision of a California State Registered Geologist, will log the soil samples according to the USCS and field screen soils using the OVA. MPE wells will be constructed within the 8-inch HSA using Schedule 40, 2-inch-diameter, flush-threaded, PVC casing. Well screens will consist of Schedule 40, 2-inch-diameter, flush-threaded, 0.010-inch, machine-slotted, PVC well screen.

Soil Sample Analysis

Soil samples will be analyzed for TPHd, TPHmo by EPA Method 8015, TPHg, BTEX, fuel oxygenates EDB and EDC using EPA Method 8260, bulk density, moisture content, particle size distribution, and porosity.

Well Installation and Groundwater Sampling Report

IES will prepare a Well Installation Report describing monitoring, extraction, and MPE installation well activities and presenting the results of the initial groundwater sampling event. Boring logs, well development forms, groundwater sampling forms, and survey data will also be included in this report.

Task 5 – Quarterly Groundwater Monitoring Program

IES recommends instituting quarterly groundwater monitoring to evaluate temporal groundwater quality and petroleum hydrocarbon plume migration at the site. Prior to sampling, all wells will be measured for product thickness and the depth-to-water (DTW) will be gauged to the nearest 0.01-foot using an electronic measuring device. Field measurements of temperature, pH, dissolved oxygen, turbidity, and electrical conductivity will be taken during the pre-sample purging. Field measured values and DTW and product thickness will be recorded on water sample field data sheets. All samples were properly stored (on ice and in coolers) and submitted under chain-of-custody control to Torrent for analysis for TPHd, TPHmo by EPA, Method 8015, and TPHg, BTEX, fuel oxygenates EDB and EDC using EPA Method 8260. Purge water generated during sampling will be stored on-site pending disposal. IES will prepare quarterly reports presenting the results of groundwater monitoring efforts.

Task 6 –Mobile Enhanced Multi-Phase Vacuum Extraction (MEME)–Interim Remediation

IES proposes conducting weekly interim remediation and source (i.e. SPH) removal using mobile vacuum enhanced multi-phase extraction (MEME). The goal of the MEME system is to remove vapor, adsorbed, dissolved and free-phase petroleum hydrocarbons and VOCs from the unsaturated and upper saturated zones by means of a 5,000-gallon truck equipped with a high-capacity vacuum pump. Multi-phase vacuum-enhanced extraction has been successful at removing petroleum hydrocarbons from sites with similar soil conditions. The MEME program involves setting up on an MPE well or series of MPE wells for an 8-hour period, creating a vacuum (approximately 10 to 29 inches of mercury) on the subsurface over the entire time period. A stinger (i.e., suction tube) is inserted into a single MPE well or a series of MPE wells and is positioned in the screened interval approximately 6-inched to 1-foot below the water table and the vacuum is applied to the wells. The depth of the stinger pipe can be easily adjusted, enabling controlled SPH extraction from the top of the water table downward. Vapor and liquid will be suctioned via the suction tube to a vacuum truck. Vapors from the extraction process will be directed to granular activated carbon for on-site treatment. The vacuum truck will transport the liquid to a licensed treatment facility for treatment/recycling.

During MEME operations, manometers will be used to measure the influence of the vacuum on other wells. To assess hydrocarbon vapor concentrations trends during MEME operations, grab vapor samples will be collected from the vapor-stream (prior to treatment) at the startup of MEME operations, after the initial five treatments, and every ten treatments thereafter. The samples will be collected in Tedlar bags using a vacuum pump and analyzed for TPHg, BTEX, and MTBE using Modified EPA Method TO-3 and TO-15.

Prior to and following completion of MEME operations, well vapor samples will also be analyzed for oxygen, and carbon dioxide using a Horibu gas analyzer to determine concentration radius of influence observations from vacuum data.

Task 7 – Floating Product Bail-Down Test

Bail-down tests will be performed on the groundwater extraction wells to measure the estimated rate of free-product recovery and to determine the most effective (active or passive free-product recovery) method of free-product recovery. Bail-down test data combined with exploratory boring data and monitoring well information to estimate the volume of free-product in the subsurface at the site.

Standing floating product will be removed from the well prior to initiating the recovery portion of the test. Floating product thickness in the well will be monitored periodically using the oil/water interface probe to determine the rate of floating product recovery. A clean Teflon bottom-filling bailer will be lowered into each target well to collect floating product. The collected floating product will then be poured into a graduated cylinder to determine its volume. Efforts will be made to minimize the volume of water removed from the well during bailing. Bailing will continue until all floating product has been removed from the well and the filter pack surrounding the well.

Measurements will be taken every hour for two hours then every 2 to 4 hours for a maximum of 24-hours. Measurements will be more frequent if floating product recovery is more rapid and less frequent if recovery is slow. In order for the bail down test to be applicable, the free product recharge rate should be slow relative to the rate of groundwater recharge. Data will be recorded on a bail-down test record sheet and submitted in a free-product recovery workplan.

IES will prepare a Free-Product Recovery Workplan presenting the results of the Bail-down Test and presenting recommendations for free-product recovery at the site.

Task 8 – Multi-Phase Extraction Pilot Testing

Based on physical characteristics of soils beneath the site and presence of residual petroleum hydrocarbons results of the soil samples collected from the apparent smear-one, IES will conduct a multi-phase extraction (MPE) test to determine vadose zone characteristics of vacuum vs. flow rate relationships (i.e. permeability, radius of influence and vapor concentrations). Testing will involve installation of MPE-treatment extraction wells. The extraction test will be used to collect design information for sizing the MPE system. Dual phase extraction (MPE) is the process of applying high vacuum (up to 29 inches of mercury) through an airtight well seal to simultaneously extract soil vapor and groundwater from the subsurface. MPE equipment typically consists of dedicated extraction "stingers" installed in each target well, a vacuum source, a knockout drum to separate the extracted vapor and groundwater mix into separate streams, and treatment systems for the vapor and groundwater streams.

Our MPE pilot testing approach consists of applying vacuum to a target test wells while monitoring vacuum influence, oxygen, carbon dioxide and water levels in nearby wells. In addition, the test will be used to monitor the applied vacuum, induced vapor and water flow rates, hydrocarbon concentrations in extracted vapor and water, and the vacuum influence induced in nearby wells. The duration of the test will be for one week. During the test IES will measure the water level in nearby wells before and after each test. Measurement of SPH volume recovered in treatment system.

To assess aqueous-phase concentration trends and mass removal, water samples at the end of each test will collected from the extraction system and analyzed for TPHg, TPHd, TPHmo, BTEX, MTBE, 1,2-DCA, fuel oxygenates, EDB and EDC. To assess vapor-phase concentration trends and mass removal, vapor concentrations in extracted vapor will be monitored periodically using field instruments and select influent vapor samples will be analyzed for TPHg and BTEX. The following guideline will be used for influent vapor sample analysis: 1) an influent vapor sample from the end of each test will be analyzed, and 2) for tests longer than 24 hours, an influent vapor sample will be analyzed after the first 24 hours of testing. In addition, select influent vapor samples may be analyzed for oxygen, carbon dioxide, and methane using EPA Method 3C.

To further evaluate the influence of MPE, oxygen and carbon dioxide concentrations in observation wells will be measured in the field or by laboratory analysis of vapor samples. Vapor samples will be collected from observation wells before and after testing. Changing concentrations of oxygen and carbon dioxide help evaluate the extent of subsurface gas flow, and therefore the extent of influence in a given test area.

Extracted vapors will be treated during the pilot test using a thermal oxidizer, catalytic oxidizer, internal combustion engine, or activated carbon adsorption. A flame ionization detector will be used to monitor the effectiveness of vapor abatement. The Bay Area Air Quality Management District will be notified of the MPE pilot test activities. Water produced during the pilot test will be temporarily stored onsite. The extracted water will either be treated onsite and discharged to the sanitary sewer or transported offsite for recycling.

IES will prepare a report documenting MPE pilot test procedures and results.

Task 9 - Pumping Test in Extraction Well GX-1

IES will perform a groundwater pumping test in one of the extraction wells to determine aquifer characteristics such as well yield, permeability, transmissivity and radius of influence. These data will be used for designing the groundwater extraction and treatment system. The groundwater extraction system will be used to lower the groundwater level to expose the entire smear zone and allow this area to be treated by MPE to remove free-product and petroleum-impacted soil-vapor.

The pumping test will involve a step-discharge test, constant-discharge pumping test, recovery test, and data analysis. The pumping test will be used to determine the capacity of the well and the hydraulic characteristics of the shallow water bearing unit.

A step-discharge test will be performed by pumping the extraction well at increasing rates while monitoring water level changes in the well (drawdown). Approximately two to four steps, each between 60 to 90 minutes long, will be performed during the step-discharge test. The test will be stopped short if dewatering of the well is likely to occur. This data will be analyzed to evaluate pumping rate for the constant-discharge pumping test.

Following recovery of the step-discharge test, a constant-discharge pumping test will be performed in the extraction well. This pumping test will be performed for approximately 24 hours by pumping the well at a constant rate and monitoring drawdown in the extraction well and surrounding monitoring wells. Analysis of the constant-discharge pumping test data will provide estimates of aquifer permeability and transmissivity.

Following the constant-discharge pumping test, a post-pumping recovery test and baseline water level measurements will be performed. This recovery test is performed by monitoring water level as it returns to static level. The recovery data will also used to determine aquifer permeability and transmissivity. Baseline water level measurements will be used to evaluate temporal water level changes.

During the pumping test water level change will be monitored using pressure transducers and data loggers and the discharged water will be contained temporarily in a Baker Tank prior to discharge to the sanitary sewer or may be discharged directly to the sewer under permit.

The pumping test results will be analyzed using AQTESOLV, a computer program created for the purpose of analyzing pumping test data and presented in a report.

Task 10 – Remediation System Installation

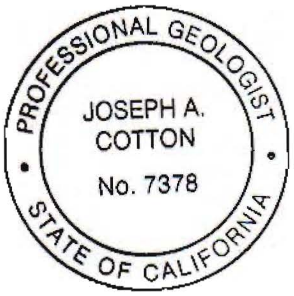
Once all pilot-testing data has been evaluated, the remediation system design will be installed. A general schematic of the anticipated MPE and groundwater extraction and treatment systems are shown on Figure 8 and 9.

Task 11 – Remediation System Start-Up

Start-up tests will be performed on the groundwater extraction and MPE system to ensure that the equipment operates properly and safely. Once start-up test have been completed, the system will be put into full-scale operation and be monitored, operated, maintained as needed. Treated groundwater will be discharged under a NPDES permit. Treated vapors will be discharged under a BAAQMD permit. NPDES and BAAQMD sampling requirements will be adhered to by IES during system operations.

If you have any questions or require additional information, please feel free to contact us.

Sincerely,
Impact Environmental Services



Joseph A. Cotton, P.G.7378
Principal Environmental Geologist

Attachments:
Figure 1 – Site Location Map
Figure 2 – Site Plan
Figure 3 – Historical Grab Groundwater Sample Results
Figure 4 – Proposed Exploratory Boring Locations
Figure 5 – Proposed Groundwater Monitoring Well Locations
Figure 6 – Proposed Multi-Phased Extraction Wells
Figure 7 – Schematic of Multi-Phase Extraction Well.
Figure 8 – Illustration of Multi-Phase Extraction and Treatment System

cc: Ms. Shirley E. Thompson, 1155 Hopkins Way. Berkeley, CA

PROFESSIONAL CERTIFICATION

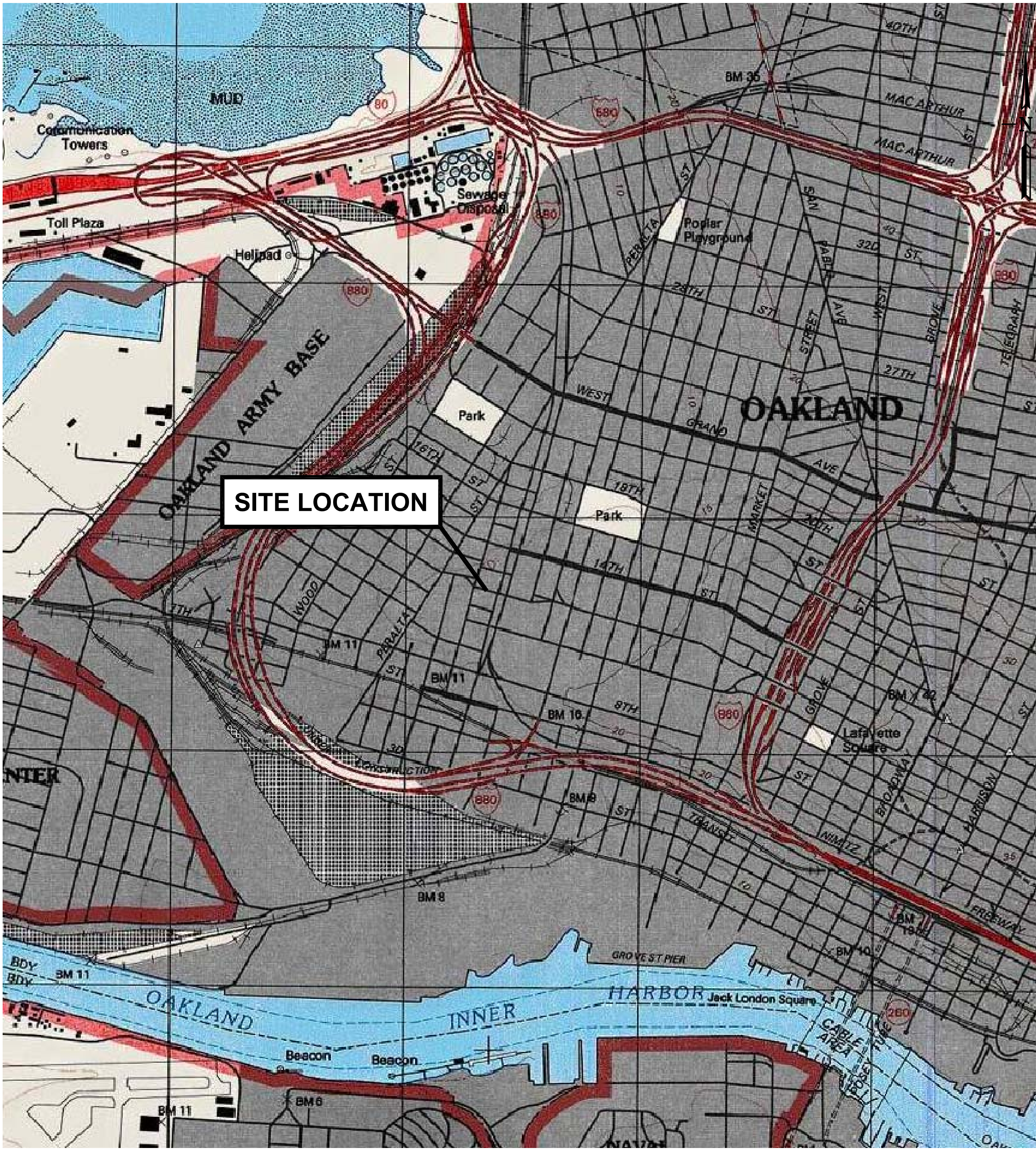
Remediation Work Plan
1409-1417 12th Street
Oakland, California

I declare, under penalty of perjury, that the information in this workplan is true and correct to the best of my knowledge.

The report has been prepared by:

PROFESSIONAL GEOLOGIST
JOSEPH A. COTTON
No. 7378
STATE OF CALIFORNIA

Joseph A. Cotton, P.G. 7378
Principal Geologist
Impact Environmental Services



Scale 1:24,000

1 1/2 0 1 Mile

1000 0 1000 2000 3000 4000 5000 6000 7000 Feet

1 .5 0 1 Kilometer

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Figure 1

1409 to 1417 12TH STREET
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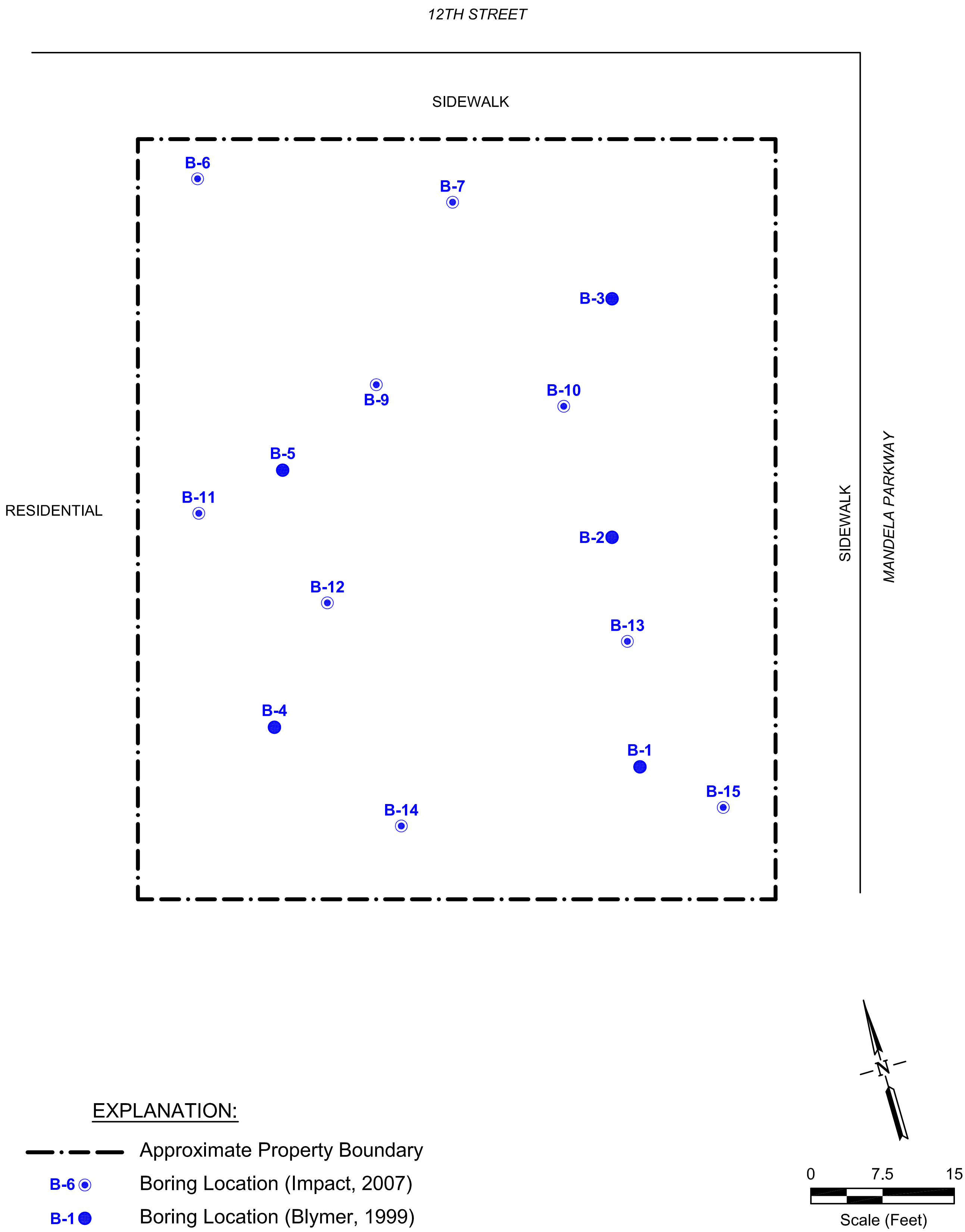
SITE LOCATION MAP



EXPLANATION:

Approximate Property Boundary
B-6 Boring Location (Impact, 2007)
B-1 Boring Location (Blymer, 1999)

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Figure 2
1409 to 1417 12TH STREET
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SITE PLAN

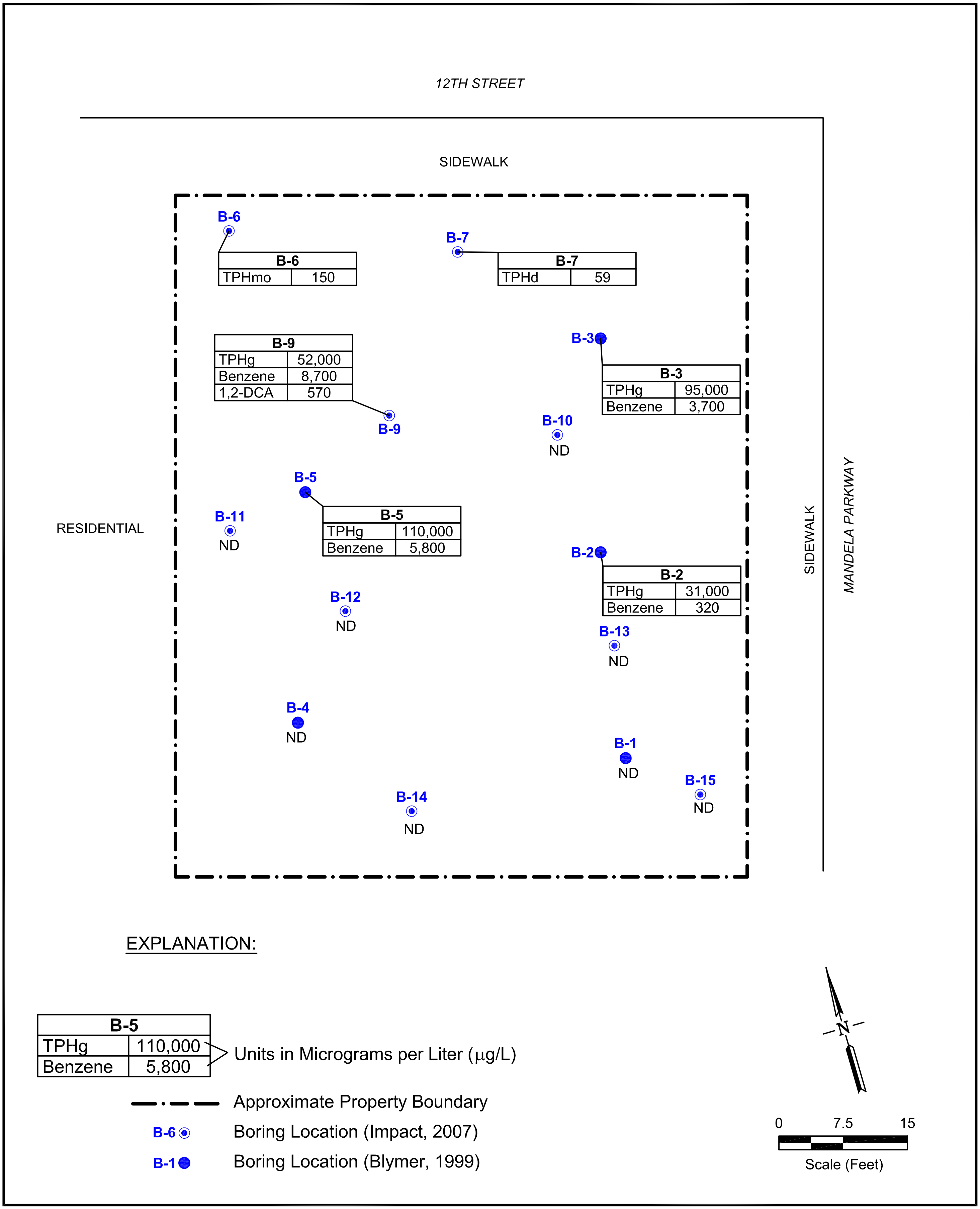

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Figure 3
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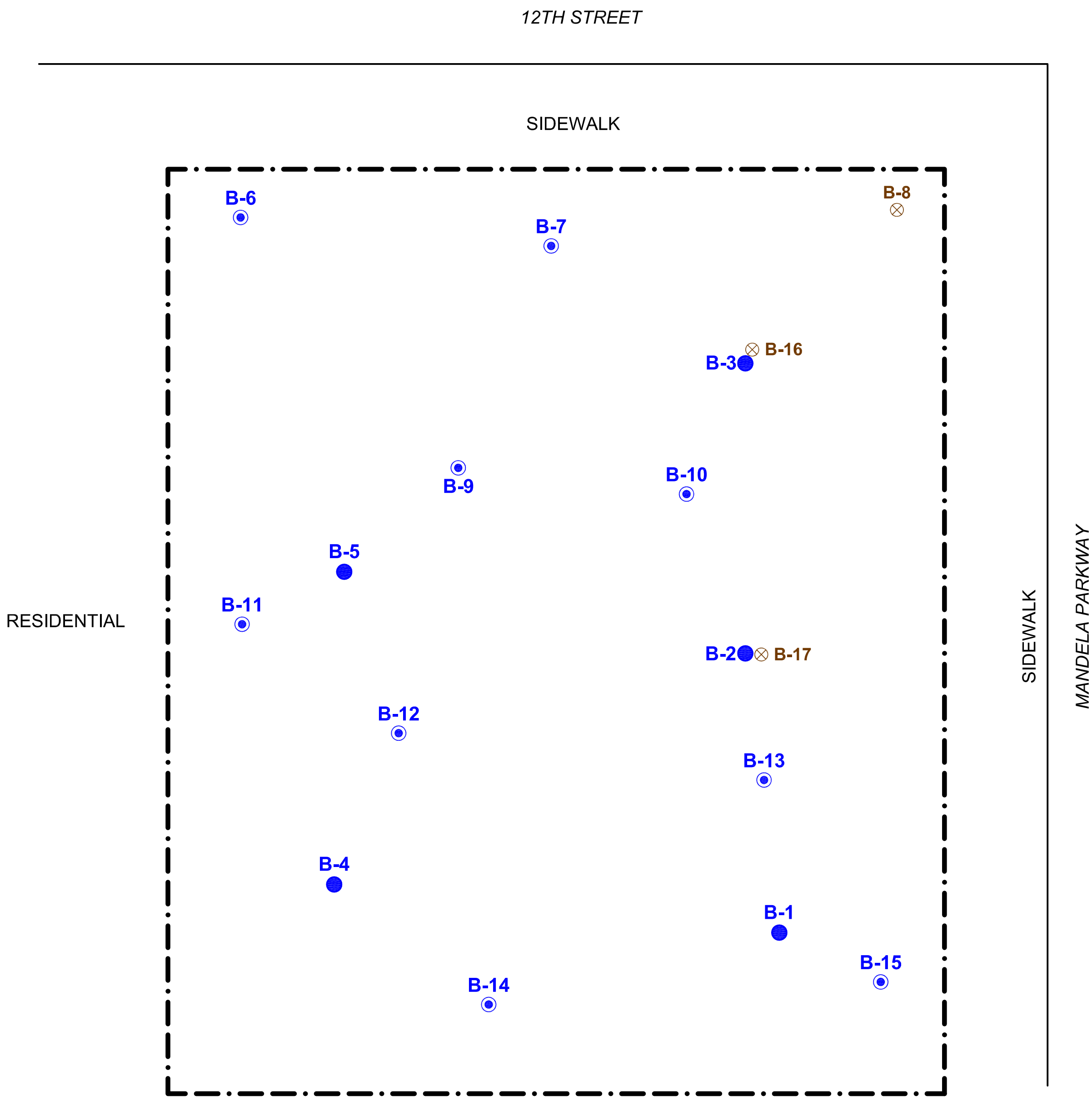
HISTORICAL GRAB GROUNDWATER SAMPLE RESULTS
REMEDIATION DRIVER COMPOUNDS



EXPLANATION:

Approximate Property Boundary

B-6 Boring Location (Impact, 2007)

B-1 Boring Location (Blymer, 1999)

B-8 Proposed Exploratory Boring Location

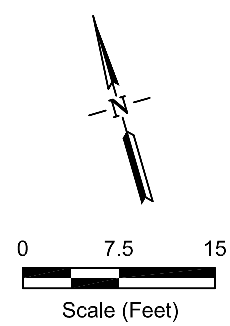


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Figure 4

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PROPOSED EXPLORATORY BORING LOCATIONS

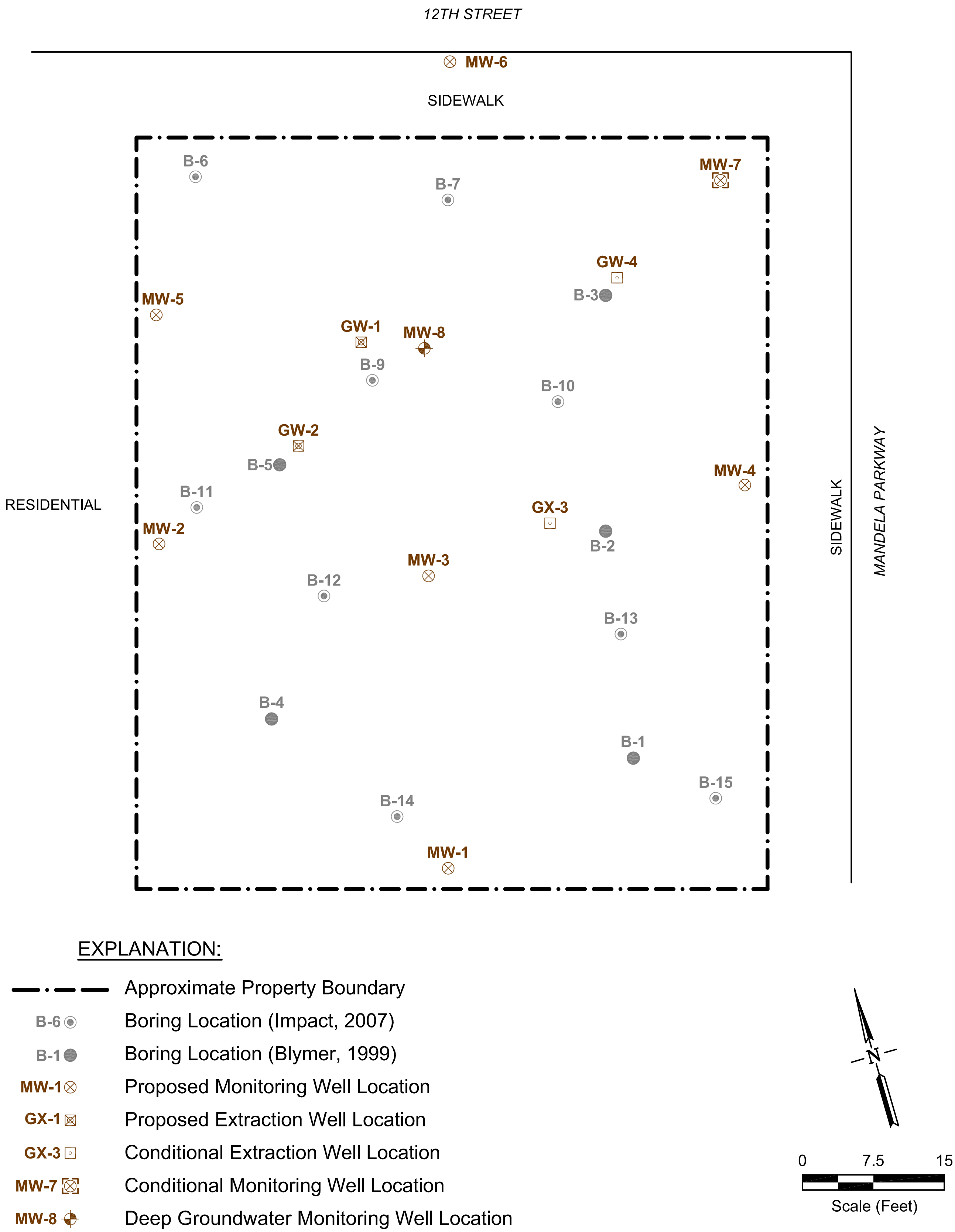

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Figure 5
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PROPOSED GROUNDWATER WELL LOCATIONS

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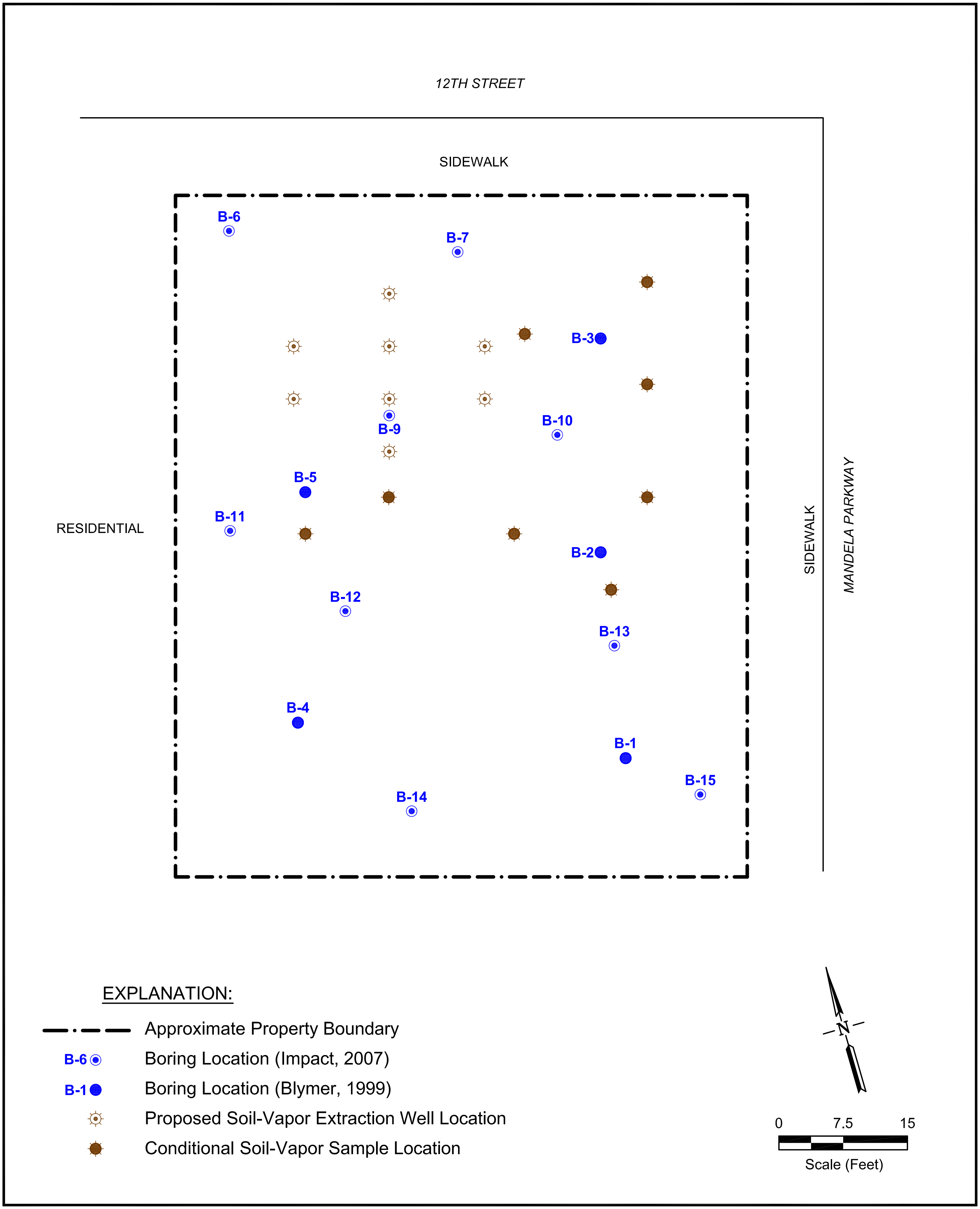

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Figure 6
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PROPOSED SOIL-VAPOR EXTRACTON WELLS

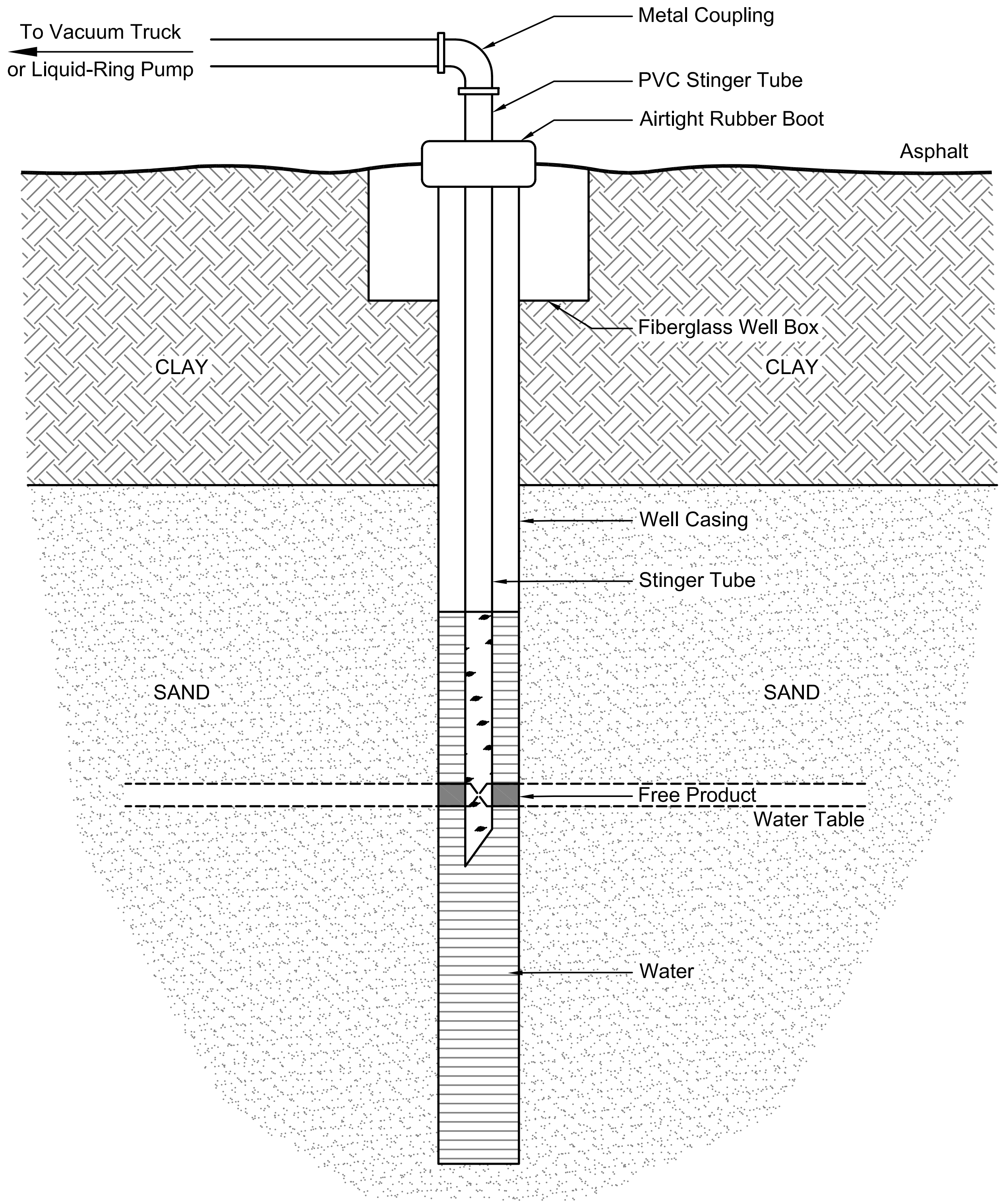

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Figure 7

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MULTI-PHASE EXTRACTION WELL

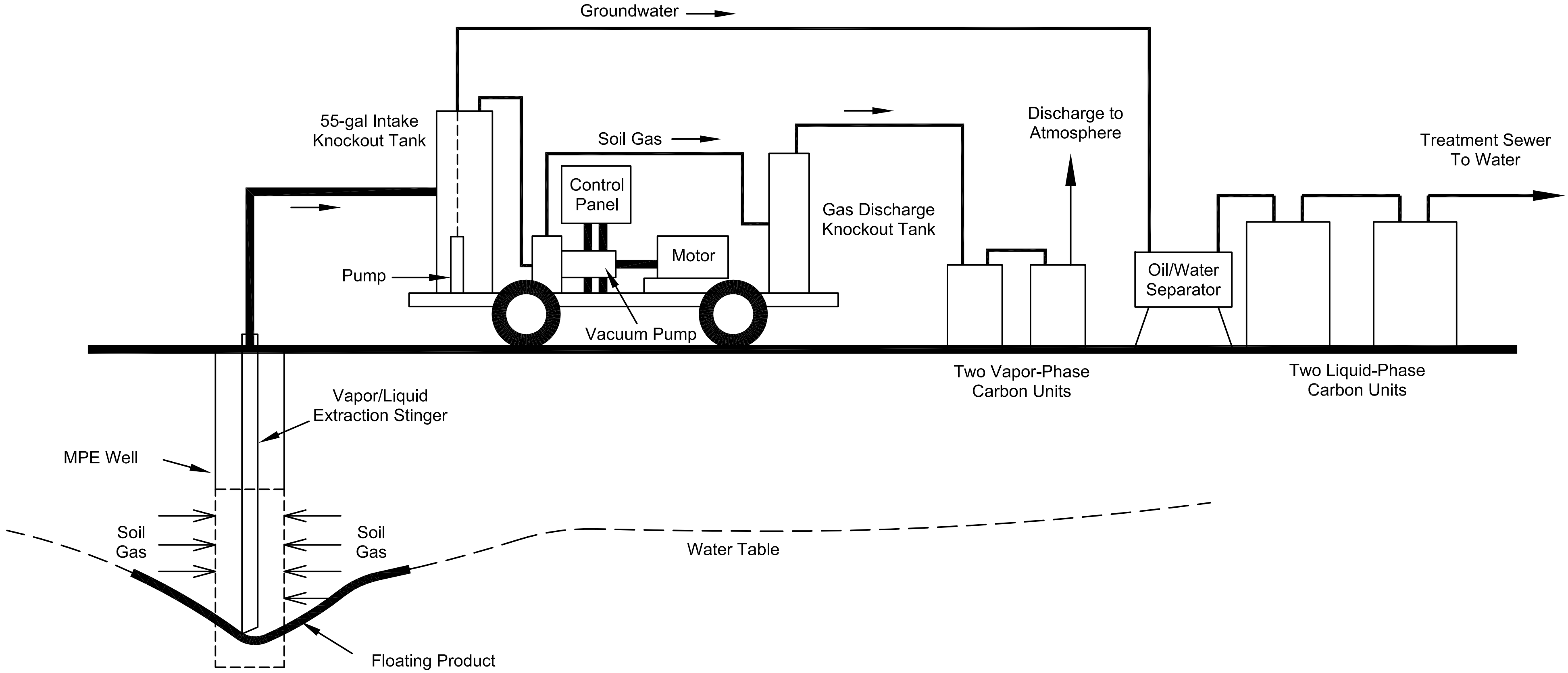

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Figure 8

1409 to 1417 12TH STREET
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ILLUSTRATION OF SYSTEM - MULTI-PHASE EXTRACTION AND TREATMENT

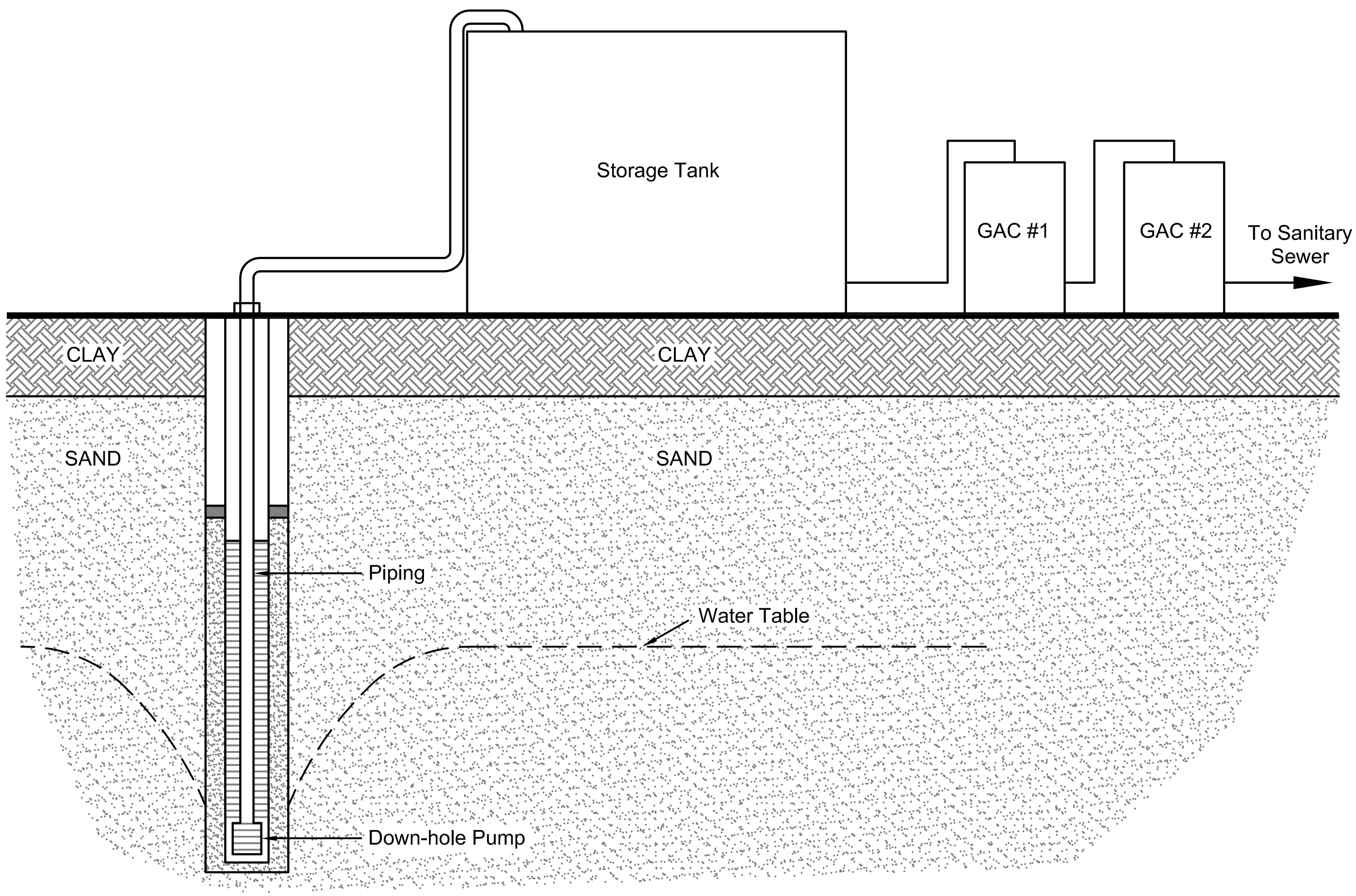

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Figure 9

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GROUNDWATER EXTRACTION AND TREATMENT SYSTEM