ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

East River Petroleum, LLC

Remedial Action Plan

Mobil Branded Service Station
Former Mobil #12833 (17-GBR)
96-27 Queens Boulevard
Rego Park, New York
NYSDEC Case No. 09-02519
PBS No. 2-157139

February 2012

ARCADIS

Matthew Swensson
Senior Environmental Engineer

Andrew Korik
Senior Scientist

Cullen Flanders, P.E.
Principal Environmental Engineer

STATE OF NEW YORK
CULLEN MATTHEW FLANDERS
2/10/12
083577
LICENSED PROFESSIONAL ENGINEER

Remedial Action Plan

Mobil Branded Service Station
Former Mobil #12833 (17-GBR)
96-27 Queens Boulevard
Rego Park, New York
NYSDEC Case No. 09-02519
PBS No. 2-157139

Prepared for:
East River Petroleum, LLC

Prepared by:
ARCADIS of New York, Inc.
6723 Towpath Road
P O Box 66
Syracuse
New York 13214-0066
Tel 315 446 9120
Fax 315 446 8053

Our Ref.:
B0085850.2833

Date:
February 2012

Tables

Figures

Appendices

1. Introduction

On behalf of East River Petroleum (East River), ARCADIS of New York, Inc. (ARCADIS) has prepared this Remedial Action Plan (RAP) to install and operate a combined Soil Vapor Extraction (SVE)/Air Sparge (AS) remediation system at the Former Mobile Service Station # 12833, located at 96-27 Queens Boulevard in Rego Park, New York (the Site). The system is designed to remediate dissolved-phase hydrocarbon impacts along with residual amounts of Site-related liquid phase hydrocarbon product (LPH). The RAP provides details on the proposed remedial system design, installation, operation and performance monitoring. This document has been developed to obtain New York State Department of Environmental Conservation (NYSDEC) approval to proceed with the implementation of the proposed remedy and investigation activity.

2. Background Information

2.1 Site Description

The Site (ExxonMobil Station No. 12833) is located at 96-27 Queens Boulevard in the neighborhood of Rego Park in the borough of Queens in Queens County, New York. The Site occupies a parcel approximately 0.28-acres in area that is situated on the northeast corner of the intersection of Queens Boulevard and 63rd Road. A Site Location Map is provided in this report as Figure 1. According to the United States Geological Survey's (USGS) topographic quadrangle map for Jamaica, New York the approximate geographical coordinates for the Site are 40 degrees, 43 minutes, 48.7 seconds North (Latitude) by 73 degrees 51 minutes, 41.8 seconds West (Longitude). The average ground surface elevation at the Site is approximately 36 feet above mean sea level (amsl).

The Site is currently an operational gasoline service station, convenience store and automotive repair shop. Pertinent features surrounding the Site include: a one-story building containing a convenience store; three dispenser islands with double-sided multi-product dispensers; one 10,000-gallon gasoline underground storage tank (UST) and one 12,000-gallon gasoline UST located in the western portion of the property; two tank field observation wells north and west of the tank field; and one 250-gallon waste oil AST located outside the northeastern corner of the building. The building consists of a gasoline sales kiosk and two operational hydraulic automobile lifts east of the station building. Eight groundwater monitoring wells are located on the Site's property (MW-1 through MW-8) and three (MW-9, MW-10 and MW-11) are located off site on the opposite side of 63rd Road from the Site. A New York City Metropolitan Transit Authority (NYC MTA) subway runs beneath Queens Boulevard immediately south of the Site. The Site features are illustrated on the Site Plan provided in this report as Figure 2.

2.2 Site History

2.2.1 Assessment Activities

The following NYSDEC spill numbers were issued for the Site historically, but have since been closed.

- Spill number 90-08859 was issued on November 13, 1990, after impacted soil was discovered during removal of two 4,000-gallon USTs. The spill number was closed on November 15, 2005.

- Spill Number 92-02690 was opened due to a tank test failure of a gasoline UST. The spill number was closed on June 22, 1992.

- Spill number 02-04910 was opened on August 9, 2002 in response to a tank test failure of a waste oil UST. The waste oil UST was removed from the Site in December of 2002, and the spill number was closed on October 15, 2003.

- Spill Number 09-09175 was assigned to the Site on November 16, 2009, based on results reported during subsurface investigation activities completed as part of a Phase II Environmental Site Assessment (ESA). This spill number was closed on November 20, 2009.

Nine 550-gallon USTs were removed in 1973, according to a Tank Closure Plan figure provided to ExxonMobil in December 2003 (Roux, 2008). The removed USTs were originally installed from 1958 through 1960 and sealed with concrete in 1987. Two 4,000-gallon gasoline USTs were removed from the Site in 1990 and the impacted soil around the USTs was stockpiled and transported off-site for proper disposal in March of 1991.

A Soil Vapor Extraction (SVE) system was operated at the Site between August 1994 and September 1995, and reportedly removed approximately 12,508 pounds of VOCs from the subsurface during this time (Roux, 2008).

Available records indicate that the following assessment activities have been performed at the Site.

- Roux Associated, Inc. (Roux) performed a Phase I ESA in December 2008. Based on the results of the Phase I ESA, NYSDEC assigned Spill Number 09-02519 to the Site on June 2, 2009, which is currently active.

- Roux performed a Phase II ESA at the Site between October 2009 and January 2010, during which monitoring wells MW-1 through MW-6 were installed on site.

- In February 2010, Kleinfelder installed monitoring wells MW-7 and MW-8 on site.

- A Phase I ESA Update was submitted to NYSDEC by Roux in October 2010.

- ARCADIS installed off-site wells MW-9 and MW-10 during June and July of 2011. MW-11 was installed off-site by ARCADIS in January 2011. MW-9, MW-10 and MW-11 are located down-gradient of the site in the sidewalk on the west side of 63rd Road.

Liquid phase hydrocarbon (LPH) was detected in MW-8 at a thickness of 0.12 feet on April 22, 2010 during the first groundwater gauging event after installation. LPH recovery by hand bailing was attempted, but no product was recovered. A hydrocarbon sorbent sock was subsequently installed in MW-8 as a passive recovery measure. LPH has not been detected at this well since.

2.3 Geology and Hydrogeology

2.3.1 Regional Geology and Hydrogeology

According to the Surficial Geologic Map of New York, Lower Hudson Sheet (Cadwell

1989), the Site and surrounding vicinity are underlain by Pleistocene-age glacial till, predominantly consisting of fine to coarse grained sand with interstitial lenses of gravel and silt, which are remnants of glacial deposition.

2.3.2 Site-Specific Geology and Hydrogeology

Subsurface lithology descriptions provided in the available soil boring logs indicate that the Site is underlain by an interbedded sequence of finer-grained silty and clayey soil, and coarser-grained sandy soils, which extends from just below ground surface to a depth of between five to fourteen feet below ground surface (bgs). This upper interbedded sequence is underlain by sand, which extends to a depth of at least 34 feet bgs, the maximum soil boring depth advanced at the Site. The lower sand unit appears to coarsen downward from fine to fine to coarse sand at most locations on site. Bedrock was not encountered during any of the previous investigations.

The available groundwater monitoring data for the site (Table 1) indicate that groundwater depths can vary from 16.80 feet bgs to 19.98 feet bgs across the Site. The long-term average groundwater depth at the Site is approximately 18.6 feet bgs. The October 2011 groundwater contour plot illustrated in Figure 3 shows that groundwater flows generally toward the southwest across the northeastern portion of the Site. The groundwater flow direction then shifts gradually toward the west and northwest down-gradient across the southwestern portion of the Site and off site. The groundwater contour plots submitted in previous quarterly monitoring reports generally show a similar flow pattern. The average horizontal hydraulic gradient across the site was inferred to be 0.02 foot/foot (ARCADIS, 2011). No site-specific hydraulic conductivity estimates are available.

2.4 Nature and Extent of Hydrocarbon Impacts

2.4.1 Sources

It is assumed that the former USTs and associated product delivery piping are the source of the hydrocarbons impacts that are currently observed in the soil and groundwater at the Site.

2.4.2 Groundwater

Groundwater analytical data from gauging and quarterly groundwater monitoring and sampling events completed at the site since April 2010 are summarized in Table 1, and are screened against the NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1, Ambient Water Quality Standards and Guidance Values (NYSDEC 1998). The groundwater analytical results from the most recent monitoring event completed at the Site in October 2011 are illustrated on Figure 4. These data show that dissolved-phase benzene, toluene, ethylbenzene and xylenes (BTEX) and methyl tertiary butyl ether (MTBE) are detected above their respective TOGS standards in groundwater both on and off site.

The dissolved-phase plume extends beneath the entire western portion of the Site along 63rd Road, and appears to be centered beneath in the vicinity of monitoring wells MW-7 and MW-8, down-gradient from the former USTs. The BTEX and MTBE detections observed at MW-9 and MW-10 indicate that the plume extends across 63rd Road to the northwest of the Site.

2.4.3 Soil

Data for soil samples collected during investigations completed at the site between 2009 and 2011 are presented in Table 2. These data are screened against the Soil Cleanup Levels for Gasoline Contaminated Sites listed in Table 2 of NYSDEC Policy CP-51/Soil Cleanup Guidance (NYSDEC 2010). The soil data are classified based on sample collection depths as being representative of unsaturated zone soil, smear zone soil (interval of soil between the average and high water table elevations where hydrocarbon impacts are transferred to the soil from groundwater during high water table conditions), and saturated zone soil. The following constituents have been detected above NYSDEC Soil Cleanup Levels in soil samples collected from either unsaturated zone or underlying smear zone soils at the Site.

- Total Xylenes
- M & p-Xylenes
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene

As illustrated on Figure 5, unsaturated and smear soil impacts are concentrated at MW-6, located northwest of the service station building. Although boring logs and/or other characterization data collected during the installation of wells MW-7 and MW-8 are not available for review, it is suspected that the unsaturated zone soil impacts observed at MW-6 extend further to the south beneath this area of the Site as well.

2.5 Liquid Phase Hydrocarbon

LPH was observed once in MW-8 at a thickness of 0.12 ft in April 2010 (Table 1), the first time this well was sampled after installation. LPH has not been detected at this well in any of the quarterly monitoring event completed since April 2010, and has not been detected in any of the other Site monitoring wells.

3. Remedial Action Plan

ARCADIS proposes installing a combined air sparge and soil vapor extraction system to reduce hydrocarbon mass in soil and groundwater on site. Details on the system layout, design and operation are provided in the following sections.

3.1 Remediation System Conceptual Design

3.1.1 Summary of Technology and Governing Principles

3.1.1.1 Soil Vapor Extraction

SVE is a commonly used remediation technique for the treatment of adsorbed-phase petroleum hydrocarbons in the vadose zone. SVE systems apply vacuum to extraction wells to allow for the recovery of soil vapor from unsaturated soils. As air moves through soil in the vadose zone, VOCs, including adsorbed-phase hydrocarbons, are transferred into the vapor stream for recovery and treatment. SVE systems can also promote aerobic bioremediation due to the introduction of oxygen into subsurface soils by promoting air flow from the ambient atmosphere to the subsurface.

Overall, SVE systems have been proven effective in unsaturated soils of moderate to high air permeability for compounds which have high vapor pressures (>1 millimeter of mercury) and/or that are aerobically biodegradable. As groundwater levels fluctuate, SVE can remediate the petroleum hydrocarbons that are exposed in the capillary fringe as well. However, using SVE without groundwater pumping or air sparging often may not remediate adsorbed- and dissolved-phase hydrocarbons below the groundwater table.

The portion of the unsaturated zone soil that will be targeted by the SVE system consists primarily of permeable sandy soil. The contaminant mass at the Site consists mainly of BTEX and MTBE, which have relatively high vapor pressures. Therefore, the Site conditions are favorable for the application of SVE technology to extract hydrocarbons from the subsurface.

3.1.1.2 Air Sparge

Air sparge systems introduce ambient air into the saturated zone typically via use of a compressor. The physical action of the sparged air rising through the subsurface (groundwater and soil) promotes the volatilization of dissolved- and adsorbed-phase petroleum hydrocarbons into the air. Once separated from the groundwater and/or soil, soil gas is extracted from the subsurface by a SVE system. Typically, air sparge systems are used in conjunction with SVE systems so that the sparged vapors can be recovered for treatment. Air sparging is most effective at removing volatile dissolved-phase compounds within a permeable aquifer matrix. Air sparging is therefore considered an appropriate remedial technology for the Site, since the conditions satisfy these two criteria.

3.1.2 Soil Vapor Extraction System Layout and Design

The proposed SVE system consists of six SVE wells (SVE-101, SVE-102, SVE-103, SVE-104, SVE-105, and SVE-106). The SVE well network is illustrated on Figure 6. This system layout was developed to provide coverage across the air sparge treatment zone and to target hydrocarbon impacts present in unsaturated and smear zone soils. A 20-foot pneumatic radius of influence (ROI) represents a conservative estimate that was determined from an evaluation of the SVE systems operated previously at similar Sites.

The extraction wells SVE-101, SVE-102, SVE-104, SVE-105 and SVE-106 will be constructed of 2-inch inside diameter (ID), Schedule 40 Polyvinyl Chloride (PVC) casing with 10-foot, continuous-wire-wrapped 0.01-inch-slotted screens, screened from approximately 10 to 20 feet bgs. SVE-103, which will be used for pilot testing, will be constructed as 4-inch inside diameter (ID), Schedule 40 Polyvinyl Chloride (PVC) well with a 20-foot-long, continuous-wrapped, 0.01-inch-slotted PVC screen, installed from approximately 10 to 30 feet bgs. The construction and screen length for SVE-103 were selected so that it can be used to perform a dual-phase extraction (DPE) pilot test in the event that AS/SVE pilot testing is unsuccessful due to lower than anticipated formation permeability. An appropriately sized silica sand filterpack will be installed in the annular space surrounding the well screen to a depth of approximately 1-foot above the top of the screen. A 1-foot thick layer of very fine silica sand will be installed above the sand filterpack. The remaining annular space surrounding the well casing will be filled with a cement grout seal. Extraction wells will be completed at the surface within a flush-mounted traffic vault. Figure 7 provides details illustrating the construction of a wellhead completion.

One observation well will be installed adjacent to wells SVE-103 and AS-103 for use during pilot testing, as discussed below. OW-1 will be installed approximately 10 feet from extraction well SVE-103 and screened from approximately 10 to 30 feet bgs.

The observation well will be installed as 2-inch diameter, Schedule 40 PVC well with 2-foot, 0.01-inch-slotted screen, and the same completion as the extraction wells.

Two geotechnical soil samples will be collected from the subsurface in the vicinity of pilot test wells SVE-103 and AS-103. These samples will either be collected from the borings advanced to install SVE-103, AS-103 or OW-1 or from separate borings advanced in the vicinity of these wells. One of the samples will be collected at a depth within the screened interval of the extraction wells, and the other at a depth within the screened interval of the air sparge wells. The samples will be submitted to a geotechnical laboratory for grain size distribution analysis, which will include both sieve analysis for the coarse-grained fraction and hydrometer analysis for the fine-grained fraction. These data enable a better understanding of the composition of the formation, specifically the amount of fine-grained material that is present, and confirm the screen design of the air sparge and extraction wells.

Based on the available Site characterization data, ARCADIS has assumed for design purposes that each of the SVE wells will operate at a flow rate of approximately 50 standard cubic feet per minute (scfm) and an applied vacuum of approximately 30 inches of water column (iwc). Vacuum will be applied to the extraction wells by a regenerative blower capable of generating an assumed total air flow rate of at least 360 scfm at 60 iwc wellhead vacuum. A process and instrumentation diagram (P&ID) for a typical SVE system that will be installed at the Site is illustrated in Figure 8.

The layout and design of the proposed SVE well network and construction of the individual SVE wells are subject to change based on in-field observations recorded during the installation of the extraction wells and other components of the remediation system, and based on pilot testing results.

It is assumed that a catalytic oxidizer (CatOX) will be used to treat the influent vapors recovered by the SVE system initially. The CatOX unit will be replaced by two vapor-phase granular activated carbon (VGAC) units placed in series after vapor-phase mass recovery levels have decreased, or the off-gas may be directed to the atmosphere, depending on the vapor concentrations.

3.1.3 Air Sparge System Layout and Design

The proposed air sparge system consists of six wells (AS-101, AS-102, AS-103, AS-104, AS-105, and AS-106), which will be installed on site at the locations shown on Figure 6. The AS wells will be installed to terminal depths of approximately 36 feet bgs, such that the top of the well screen is approximately 15 feet below the average water table depth within the treatment area. The 15-foot air sparge ROI used to develop the AS well layout is based on assumed 45° cone of sparge influence extending outward from the top of the sparge well screen to water table surface.

The AS wells will be constructed of 1-inch inside diameter (ID), Schedule 40 PVC casing with 2-foot-long, 0.01-inch-slotted screens installed from approximately 34 to 36 feet (bgs). An appropriately sized silica sand filterpack will be installed in the annular space surrounding the wells screen to a depth of approximately 1-foot above the top of the screen. A 1-foot thick layer of very fine silica sand will be installed above the sand filterpack. The remaining annular space surrounding the well casing will be filled with a cement grout seal. AS wells will be completed at the surface within a flush-mounted traffic vault. Figure 7 provides details illustrating the construction of a typical AS well and wellhead completion.

The layout and design of the proposed AS well network is subject to change based on data collected during pilot testing, as well as in-field observations recorded during the installation of the air sparge wells and other components of the remediation system.

Based on the available Site data, ARCADIS has assumed for design purposes that each AS well will operate at flow rate of approximately 15 scfm and a pressure of between 8 and 19 psi. Air flow will be applied to the subsurface by a blower capable of generating an assumed total air flow rate of approximately 120 scfm to generate the desired wellhead pressure. This design wellhead pressure range was selected to be above the formation breakout pressure and below the Site formation fracture pressure, which are estimated to be approximately 7.3 psi and 20.4 psi, respectively. Formation breakout and fracture pressure estimates were calculated using available Site data as summarized in Appendix A. A process and instrumentation diagram for a typical AS system that will be installed at the Site is illustrated in Figure 9. The assumed air flow rate and pressure settings used in this design may be adjusted based on actual responses observed during system startup operations.

The AS system will be interlocked with SVE system, so that it will shut down if the SVE system shuts down to prevent air sparging from continuing without vapor recovery.

3.1.4 System Layout and Design

Blowers, off-gas treatment units and other system equipment will be housed in a system enclosure building/trailer that will be located on the Mobil Service Station No. 12833 (#17-GBR) at the approximately location illustrated on Figure 10. A diagram of a typical SVE/AS system enclosure that will be used at this Site is provided in Figure 11.

Piping between the AS and SVE wellheads and the system enclosure will installed below-grade in trenches. The proposed system trenching layout is illustrated on Figure 10. Diagrams of a typical AS/SVE piping trench that will be installed at the Site are provided in Figure 12. Individual air and vacuum lines will be extended from the system enclosure to each of the AS and SVE wells allowing for simple modifications/optimization of the system. Prior to system installation, ARCADIS will attempt to locate any trenching that was installed for the former SVE system that was reportedly operated at the Site during 1994 and 1995. The trenching plan layout illustrated in Figure 10 may be modified to reuse existing trenching from the former system if it can be located.

The system will be equipped with a telemetry system that will alert O&M personnel of any alarm conditions or other anomalies in system operation that require attention.

3.2 System Installation and Operation

3.2.1 Pilot Testing

An AS/SVE pilot test will be completed at the Site prior to full-scale system installation to verify that AS/SVE can be used effectively to remediate the Site and confirm the design parameters for the full-scale AS/SVE system. Pilot testing will be performed as a one-day event on wells SVE-103 and AS-103. During the test, monitoring data will be collected from the pilot test wells; monitoring wells MW-8 and MW-7, which are installed approximately 5 and 15 feet from the proposed location of SVE-103. Data may also be collected from other existing monitoring wells located in the vicinity of the test area.

Prior to initiating the pilot test, groundwater levels, well head pressures, and FID or PID measurements will be collected from the pilot test wells and surrounding monitoring points/wells. These measurements will provide a set of static/baseline conditions, against which to compare data collected during the pilot test.

Pilot testing will begin with a step test, during which the system will be operated at steps of increasing vacuum strength in order to determine the optimal vacuum strength and air flow rate settings to be used in the full-scale system. Vacuum will be maintained at each step for a period of 15 – 30 minutes until the vacuum responses in the observation wells have stabilized. The following measurements will be recorded periodically during step testing:

- Wellhead vacuums at extraction and observation wells
- Water levels at extraction and observation wells
- System vacuum
- System air flow rate
- System influent FID or PID reading
- System influent and effluent air temperatures

Step testing will continue until the maximum wellhead vacuum is reached that does not produce an undesirable amount of water table mounding at the extraction well, which can prevent vacuum from reaching the smear zone where the majority of the hydrocarbon mass is typically concentrated. The step test results will then be reviewed to determine the optimal vacuum strength at which to operate the system during the next phase of testing.

After the optimal vacuum strength has been identified, the system will be dialed to this setting and operated for a period of several hours until vapor phase mass recovery, as indicated by PID/FID measurements, is observed to be trending toward asymptotic. The same measurements will be recorded periodically during this phase of the test as were recorded during the step test.

Once influent PID/FID readings are trending toward stable, the air sparge pilot test well will be activated. The flow of air injected into the formation will be increased steadily until the pressure reaches approximately 19.5 psi, which is below the estimated formation fracture pressure of 20.4 psi. Field personnel will monitor the water level in the air sparge and SVE pilot test wells for groundwater mounding while increasing the air flow rate, and will reduce the air flow rate if an undesirable amount of groundwater mounding is observed. Upon reaching the maximum air injection flow rate sustainable for the formation, field personnel will operate the pilot system at this setting for a period of several hours. During this time, field personnel will monitor the steady-state pressure field that develops around the sparge well along with other system performance metrics by recording the same set of measurements listed in the previous step along with the following measurements specific to the AS system:

- Flow rate and pressure at the sparge well

- Percent oxygen in well head space and dissolved oxygen in groundwater at the observation wells

- Groundwater elevations at the observation wells

System influent PID/FID readings will be monitored during the test to confirm that air sparging is increasing the vapor-phase mass recovery. The test will be terminated if the data indicate that air sparging produces little or no increase in vapor phase mass recovered by the SVE system.

One sample will be collected for laboratory analysis from the influent vapor stream at the end of the air sparge portion of the pilot test once system influent PID/FID readings have somewhat stabilized. The sample will be collected in a Tedlar Bag and analyzed for VOCs by USEPA Method TO-14. The analytical results will be used to estimate vapor-phase mass recovery rates, and confirm the vapor phase treatment requirements assumed for the full-scale system at the Site.

If, during the course of AS/SVE pilot, the results indicate that the upper silty sand unit beneath the Site is not sufficiently permeable for effective AS/SVE application, ARCADIS will switch to a DPE pilot test where adsorbed-phase and dissolved-phase hydrocarbon impacts in the saturated zone are remediated through a combination of groundwater recovery and SVE application. Depending on the permeability of the formation, Groundwater and soil vapor may be recovered together using vacuum applied through a drop tube inserted in the extraction well, or separately applying the vacuum directly to the well casing and using a submersible pneumatic pump to recover groundwater.

ARCADIS will evaluate the data collected during the pilot test and make any necessary modifications to the proposed full-scale system design. The pilot test results and any recommended changes to the design will be communicated to NYSDEC in a pilot test summary report.

3.2.2 System Startup

After the AS/SVE wells and associated trenching/piping are installed, the various components of the AS/SVE system will be transported to the site, assembled and connected to the piping in preparation for system startup.

During the system startup phase, ARCADIS personnel will complete a limited startup testing on one or more of the extraction and sparge wells located within the area of highest hydrocarbon impacts to confirm that the design parameters are correct, and make any necessary adjustments to these design settings. The full-scale system will then be brought online and operated at the final operational settings identified during the startup test.

Field personal will be on site for the duration of the initial startup period to monitor system operating parameters (i.e., vacuum strength, air flow, pressure, VOC content of influent and effluent vapors). Startup measurements will be used to optimize the system and make any adjustments necessary such that the system operates as designed.

Field personnel will collect one pair of system influent and effluent air samples for laboratory analysis after the full-scale system is brought online and system readings have stabilized. The influent sample will be collected from a sample port located on the pressurized side of the system between the blower and the CATOX unit. The effluent samples will be collected from a sample port located in the CATOX effluent line. The samples will be collected using a Tedlar® Bag, and sent to a New York State Department of Health-certified laboratory for VOC analysis by USEPA Method TO-14. Air analytical data will be used to calibrate total VOC concentrations measured in the field with the PID/FID readings and improve the accuracy of system mass removal calculations.

After startup operations are completed and the system is running at the desired operational settings, field personnel will demobilize from the Site and the standard system operation phase will begin.

3.2.3 Standard Operation

After identifying the optimal system settings during the startup phase, ARCADIS will begin operating the full scale system with six SVE wells and six AS wells. Once the full-scale system is operating, personnel will visit the Site on a monthly basis to perform routine operations and maintenance (O&M) activities. O&M personnel will perform any routine maintenance and adjustments needed and, collect the following system performance monitoring data during these monthly visits:

- Flow rate, temperature, pressure and VOC concentrations (by PID/FID) at the extraction wellheads

- Flow rate and pressure readings at the air sparge wellheads
- Pressure readings and water levels at the SVE observation wells
- Pressure readings and water levels at the AS observation wells
- Pressure, temperature, and air flow readings at AS/SVE system enclosure
- VOC concentrations (by PID/FID) of the SVE system influent and effluent vapor streams
- System operating time

System components will be maintained in accordance with the manufacturer's guidance and equipment manuals.

An influent and effluent air sample will be collected via Tedlar® bag during each month of system operation and submitted to a New York State Department of Health-certified laboratory for analysis of BTEX, MTBE, and TPH via USEPA Method TO-14.

The data collected during the monthly O&M visits will be used to estimate the hydrocarbon mass recovery rate and evaluate the system performance. When the data suggest that mass recovery is becoming asymptotic, ARCADIS will take steps to optimize system performance and increase mass recovery. Potential system optimization measures may include.

- Deactivating extraction wells with low vapor-phase VOC concentrations, or AS wells located in areas of minimally impacted groundwater, so the system can focus on the wells located in hot-spot areas that are responsible for most of the mass removal.
- Changing the air flow rates and/or vacuum/pressure applied to SVE and AS wells.
- Transitioning to a pulsed method of operation, where the system is repeatedly turned on and then off for specific periods of time to allow hydrocarbon concentrations in soil and groundwater to rebound.

3.3 System Shutdown and Demobilization

ARCADIS will continue to run the system until the mass removal rate becomes asymptotic, and is no longer affected by optimization measures. Confirmatory groundwater and soil sampling will be performed to confirm attainment of regulatory standards. The system will be removed from the site once the standards have been attained.

4. Permitting

Before beginning site activities, all necessary permits will be obtained from federal, state and local agencies having jurisdiction over aspects of the work. It will be determined during final design if an air permit is required from the NYSDEC to operate the system. If discharge is below DAR-1 values, an air permit will not be obtained and a certificate to operate will be sought. Documentation demonstrating compliance will be provided to the NYSDEC and other permitting entities as necessary. If an air permit is required, a permit to install and operate will also be obtained. All required sidewalk construction/closure permits will be obtained to cover the well installation and trenching that will be performed on the sidewalk along 63rd Road. Due to the proximity of the subway that runs beneath Queens Blvd. adjacent to the Site, an MTA Permit will be obtained prior to performing any intrusive work at the Site. Building and electrical permits will be obtained as appropriate prior to the system and trenching installation.

5. Schedule

An approximate RAP implementation schedule is provided as Table 3. The schedule was developed based on an assumed review and approval timeframe for NYSDEC and the various state and local permitting agencies. ARCADIS will be prepared to begin the proposed additional investigation activities within 60 days after receiving final approval of the RAP from NYSDEC.

6. References

ARCADIS, 2011. *Site Status Update Report*, December 15, 2011

Cadwell, Donald H., et al., 1989*, Surficial Geologic Map of New York*, Lower Hudson Sheet: New York State Geologic Survey

Fetter, C.W. 1994. *Applied Hydrogeology*, ed. 3, Prentice Hall, New Jersey, pg. 98.

New York State Department of Environmental Conservation (NYSDEC) 1998. NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1, *Ambient Water Quality Standards and Guidance Values*, June 1998 and Addendum April 2000.

New York State Department of Environmental Conservation (NYSDEC) 2010. *DEC Policy CP-51 / Soil Cleanup Guidance*, October 21, 2010.

Roux Associates, Inc. *Phase I Site Assessment Report*, ExxonMobil Station #12833, December 29, 2008.

Roux Associates, Inc. *Phase II Site Assessment Report*, ExxonMobil Station #12833, March 5, 2010.

USGS Topographic Quadrangle Map, 7.5-Minute Series, Jamaica, 1994.

Tables

Table 1
Groundwater Monitoring Data

Mobil Branded Service Station
Former Mobil #12833 (17-GBR) - 96-27 Queens Blvd., Rego Park, New York

		Gauging Data					Analytical Data								
Sample ID	Date	Top of Casing Elevation	Depth to Water (feet)	Depth to Hydrocarbon (feet)	Hydrocarbon Thickness (feet)	Corrected GW Elevation (feet)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	MTBE (µg/L)	Ethyl Alcohol (µg/L)	Dissolved Oxygen (mg/L)	Comments
NYSDEC Standards		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**1**	**5**	**5**	**5**	**~**	**~**	**~**	**~**	
NYSDEC Guidance Values		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**~**	**~**	**~**	**~**	**~**	**10**	**~**	**~**	
MW-1	4/22/2010	32.08	18.2	ND	ND	13.88	0.51 J	0.76 J	0.57 J	2.8	4.6	**1,480**	ND<100	3.62	
	7/16/2010	32.08	18.26	ND	ND	13.82	ND<1.0	ND<1.0	ND<1.0	0.66 J	0.66	**751**	ND<100	3.31	
	10/22/2010	32.08	18.31	ND	ND	13.77	0.51 J	ND<1.0	ND<1.0	ND<1.0	0.51	**123**	ND<100	0.85	
	1/19/2011	32.08	18.47	ND	ND	13.61	NS	NS	NS	NS	NS	NS	NS	0.99	Not submitted to laboratory.
	2/25/2011	32.08	18.28	ND	ND	13.8	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	**210**	ND<200	NM	
	4/12/2011	32.08	18.32	ND	ND	13.76	ND<0.5	0.5 J	ND<0.5	1	1.5	**280**	ND<200	NM	
	7/29/2011	32.08	18.34	ND	ND	13.74	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	**78**	ND<200	NM	
	10/25/2011	32.08	17.12	ND	ND	14.96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	**110**	NM	NM	
MW-2	4/22/2010	32.58	18.65	ND	ND	13.93	**33.1**	**8.0 J**	**1,540**	**8,580**	10,161	**150**	ND<2500	3.10	
	7/16/2010	32.58	18.72	ND	ND	13.86	**44.7**	ND<20	**1,210**	**7,250**	8,505	**165**	ND<100	2.81	
	10/22/2010	32.58	18.77	ND	ND	13.81	**26.9**	ND<25	**976**	**5,680**	6,683	**117**	ND<100	2.60	
	1/19/2011	32.58	18.94	ND	ND	13.64	**7**	1.0 J	**390**	**2,200**	2,598	**27**	ND<200	0.31	
	4/12/2011	32.58	18.72	ND	ND	13.86	**20**	ND<3	**610**	**4,300**	4,930	**97**	ND<200	NM	
	7/29/2011	32.58	18.8	ND	ND	13.78	**18**	2.0 J	**770**	**3,800**	4,590	**60**	ND<200	NM	
	10/25/2011	32.58	17.53	ND	ND	15.05	**17**	ND<3	**770**	**4,100**	4,887	**37**	NM	NM	
MW-3	4/22/2010	33.12	18.99	ND	ND	14.13	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	2.87	
	7/16/2010	33.12	19.07	ND	ND	14.05	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	2.55	
	10/22/2010	33.12	19.15	ND	ND	13.97	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	0.92	
	1/19/2011	33.12	19.33	ND	ND	13.79	ND<0.5	ND<0.5	ND<0.5	0.9 J	0.9	ND<0.5	ND<200	NM	
	4/12/2011	33.12	19.08	ND	ND	14.04	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	ND<200	NM	
	7/29/2011	33.12	19.14	ND	ND	13.98	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	ND<200	NM	
	10/25/2011	33.12	17.87	ND	ND	15.25	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	NM	NM	
MW-4	4/22/2010	32.47	18.36	ND	ND	14.11	ND<1.0	ND<1.0	ND<1.0	0.45 J	0.45	ND<1.0	ND<100	3.29	
	7/16/2010	32.47	18.48	ND	ND	13.99	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	2.58	
	10/22/2010	32.47	18.55	ND	ND	13.92	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	2.57	
	1/19/2011	32.47	18.7	ND	ND	13.77	ND<0.5	ND<0.5	ND<0.5	0.5 J	0.5	ND<0.5	ND<200	NM	
	4/12/2011	32.47	NA	NA	NA	NA	NS	NS	NS	NS	NS	NS	NS	NS	Could not access due to a parked car over well.
	7/29/2011	32.47	18.15	ND	ND	14.32	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	ND<200	NM	
	10/25/2011	32.47	16.90	ND	ND	15.57	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	NM	NM	
MW-5	4/22/2010	33.80	19.65	ND	ND	14.15	ND<1.0	0.32 J	ND<1.0	ND<1.0	0.32	ND<1.0	ND<100	4.42	
	7/16/2010	33.80	19.71	ND	ND	14.09	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	3.42	
	10/22/2010	33.80	19.78	ND	ND	14.02	ND<1.0	ND<1.0	ND<1.0	ND<1.0	BRL	ND<1.0	ND<100	2.72	
	1/19/2011	33.80	19.98	ND	ND	13.82	ND<0.5	**7**	2	**12**	21	ND<0.5	ND<200	3.15	
	4/12/2011	33.80	19.69	ND	ND	14.11	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	ND<200	NM	
	7/29/2011	33.80	19.79	ND	ND	14.01	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	ND<200	NM	
	10/25/2011	33.80	18.51	ND	ND	15.29	ND<0.5	ND<0.5	ND<0.5	ND<0.5	BRL	ND<0.5	NM	NM	
MW-6	4/22/2010	33.26	19.25	ND	ND	14.01	**1.6**	0.49 J	**17**	**108**	127	2.1	ND<100	4.02	
	7/16/2010	33.26	19.26	ND	ND	14	1	ND<1.0	**10.8**	**68.5**	80.3	1	ND<100	3.11	
	10/22/2010	33.26	19.35	ND	ND	13.91	0.98 J	0.34 J	**11.3**	**65.5**	78.1	2.1	ND<100	2.97	
	1/19/2011	33.26	19.56	ND	ND	13.7	1	ND<0.5	**23**	**150**	174	0.8 J	ND<200	NM	
	4/12/2011	33.26	19.3	ND	ND	13.96	**4**	ND<0.5	**48**	**260**	312	ND<0.5	ND<200	NM	
	7/29/2011	33.26	19.41	ND	ND	13.85	**4**	0.8 J	**73**	**440**	518	3	ND<200	NM	
	10/25/2011	33.26	18.12	ND	ND	15.14	**4**	ND<0.5	**63**	**410**	477	8	NM	NM	

See Notes on Page 2.

Table 1
Groundwater Monitoring Data

Mobil Branded Service Station
Former Mobil #12833 (17-GBR) - 96-27 Queens Blvd., Rego Park, New York

		Gauging Data					Analytical Data								
Sample ID	**Date**	**Top of Casing Elevation**	**Depth to Water (feet)**	**Depth to Hydrocarbon (feet)**	**Hydrocarbon Thickness (feet)**	**Corrected GW Elevation (feet)**	**Benzene (µg/L)**	**Toluene (µg/L)**	**Ethyl-benzene (µg/L)**	**Total Xylenes (µg/L)**	**Total BTEX (µg/L)**	**MTBE (µg/L)**	**Ethyl Alcohol (µg/L)**	**Dissolved Oxygen (mg/L)**	**Comments**
NYSDEC Standards		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**1**	**5**	**5**	**5**	**~**	**~**	**~**	**~**	
NYSDEC Guidance Values		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**~**	**~**	**~**	**~**	**~**	**10**	**~**	**~**	
MW-7	4/22/2010	31.84	17.9	ND	ND	13.94	**1,120**	**16,800**	**4,830**	**23,800**	46,550	**19.9 J**	ND<5000	2.72	
	7/16/2010	31.84	18	ND	ND	13.84	**1,980**	**21,000**	**5,150**	**31,800**	59,930	ND<200	ND<100	2.83	
	10/22/2010	31.84	18.06	ND	ND	13.78	**1,530**	**27,600**	**5,520**	**29,200**	63,850	ND<100	ND<100	1.16	
	1/19/2011	31.84	18.23	ND	ND	13.61	**1,100**	**15,000**	**3,900**	**24,000**	44,000	ND<10	ND<200	0.37	
	4/12/2011	31.84	18.51	ND	ND	13.33	**120**	**25,000**	**6,700**	**30,000**	61,820	ND<10	ND<200	NM	
	7/29/2011	31.84	18.05	ND	ND	13.79	**1,200**	**30,000**	**5,600**	**31,000**	67,800	ND<10	ND<200	NM	
	10/25/2011	31.84	16.80	ND	ND	15.04	**280**	**4,000**	**3,000**	**18,000**	25,280	**14**	NM	NM	
MW-8	4/22/2010	32.36	18.52	18.4	0.12	13.93	NS	NS	NS	NS	NS	NS	NS	NS	LPH Present, not sampled
	7/16/2010	32.36	18.5	ND	ND	13.86	**226 J**	**34,600**	**7,370**	**32,800**	74,996	ND<250	ND<100	2.73	
	10/22/2010	32.36	18.56	ND	ND	13.8	**156**	**23,900**	**7,670**	**29,100**	60,826	ND<100	ND<100	2.82	
	1/19/2011	32.36	18.75	ND	ND	13.61	**120**	**20,000**	**6,100**	**33,000**	59,220	ND<13	ND<200	NM	
	4/12/2011	32.36	18.03	ND	ND	14.33	**1,200**	**20,000**	**3,500**	**32,000**	56,700	ND<10	ND<200	NM	
	7/29/2011	32.36	18.56	ND	ND	13.80	**89**	**25,000**	**7,000**	**30,000**	62,089	ND<10	ND<200	NM	
	10/25/2011	32.36	17.31	ND	ND	15.05	**120**	**26,000**	**7,300**	**31,000**	64,420	ND<25	NM	NM	
MW-9	7/29/2011	31.92	18.50	ND	ND	13.42	0.6 J	1 J	ND<0.8	3 J	5	ND<0.5	ND<200	NM	
	10/25/2011	31.92	17.45	ND	ND	14.47	0.7 J	2	5	**8**	15.7	ND<0.5	NM	NM	
MW-10	7/29/2011	31.83	18.68	ND	ND	13.15	**680**	**71**	**9.0**	**174 J**	934	10	ND<200	NM	
	10/25/2011	31.83	17.82	ND	ND	14.01	**360**	**37**	3	**51**	451	**12**	NM	NM	

Notes:
~ = no standard or guidance value exists.
ND<1.0 = Not detected at or above the laboratory reporting limit shown.
µg/L = micrograms per liter.
Bold Items = Reported concentration detected above the applicable standard(s) or guidance value(s).
BRL = Below laboratory reporting limits.
BTEX = Benzene, toluene, ethylbenzene, and total xylenes.
Corrected GW elevation = calculated with following formula: (top of casing - depth to water) + (hydrocarbon thickness * (hydrocarbon specific gravity)).
Depth to Water = measured in feet below land surface from top of casing.
GW = Groundwater.
Hydrocarbon = liquid-phase hydrocarbon (LPH).
J = Indicates an estimated value.
mg/L = milligram per liter.
MTBE = methyl tertiary-butyl ether.
N/A = Not applicable.
NA = Not analyzed.
ND = Not detected.
NM = Not monitored.
NS = Not sampled.
NSVD = Not surveyed to vertical datum.
NYSDEC Standards and Guidance Values = New York State Department of Environmental Conservation Technical and Operational Guidance Series (TOGS) 1.1.1, Ambient Water Quality Standards and Guidance Values, June 1998 and Addendum April 2000.
Survey data = Monitoring wells surveyed to the Borough of Queens Highway Datum on May 25, 2010.
Total Xylenes for MW-9 and MW-10 calculated by adding results for individual congers (m+p and o) for July29, 2011 sampling event.

Table 2
Soil Analytical Data

Branded Mobil Service Station
Former Mobil #12833 (17-GBR) - 96-27 Queens Blvd.
Rego Park, New York

Sample Designation: Sample Date: Sample Depth (ft bgs): Soil Zone:	NYSDEC CP-51 Soil Cleanup Criteria (µg/kg)	B-1 11/12/2009 20-22 Saturated	MW-1 12/17/2009 18-19 Saturated	MW-2 11/3/2009 7.5-8 Unsaturated	MW-2 11/17/2009 18-20 Saturated	MW-3 11/17/2009 14-16 Unsaturated	MW-4 11/13/2009 18-20 Saturated	MW-5 11/13/2009 18-20 Smear	MW-6/B-2 11/16/2009 12-14 Unsaturated	MW-9 Interface 7/1/2011 18.5-19 Saturated	MW-9 7/1/2011 22-24 Saturated	MW-9 7/1/2011 24-26 Saturated	MW-10 Interface 6/30/2011 17.5-18 Smear	MW-10 6/30/2011 24-25 Saturated	MW-10 6/30/2011 25-26 Saturated
VOC															
Benzene	60	1.92U	46.3	11.1	14.5	2.13U	1.95U	1.86U	3.19	ND<37	ND<24	ND<22	ND<29	ND<42	ND<26
Toluene	700	1.92U	30	16.9	40.6	2.13U	1.95U	1.86U	2.07U	200 J	63 J	56 J	140 J	190 J	ND<52
Ethylbenzene	1,000	1.92U	15.5	14.8	**18800**	2.13U	1.95U	1.86U	682	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
Total Xylenes	260	4.81U	37.2	61.5	**163000**	5.33U	4.87U	4.65U	**4980**	170 J	56 J	47 J	130 J	180 J	ND<52
1,3,5-Trimethylbenzene	8,400	1.92U	102U	371	**67300**	2.13U	1.95U	1.86U	**3760**	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
Isopropylbenzene	2,300	1.92U	36.7	15.5	**3780**	2.13U	1.95U	1.86U	115	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
m&p- Xylene	260	2.88U	30.5	46.5	**134000**	3.2U	2.92U	2.79U	**4880**	170 J	56 J	47 J	130 J	180 J	ND<52
Naphthalene	12,000	4.81U	255U	152	**23600**	5.33U	4.87U	4.65U	1350	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
n-Butylbenzene	12,000	1.92U	119	186	**20700**	2.13U	1.95U	1.86U	1190	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
n-Propylbenzene	3,900	1.92U	200	48.3	**11300**	2.13U	1.95U	1.86U	567	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
o-Xylene	260	1.92U	6.71	15	**29200**	2.13U	1.95U	1.86U	69.5	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
p-Isopropyltoluene	10,000	1.92U	102U	38.4	2450	2.13U	1.95U	1.86U	101	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
sec-Butylbenzene	11,000	1.92U	102U	23.1	2720	2.13U	1.95U	1.86U	75.7	ND<75	ND<47	ND<44	ND<58	ND<84	ND<52
SVOC															
Acenaphthene	20,000	342U	91.2	77.5U	76.1U	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Benzo[a]anthracene	1,000	342U	71.9U	108	76.1U	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Benzo[b]fluoranthene	1,000	342U	71.9U	82.9	76.1U	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Chrysene	1,000	342U	71.9U	95.6	76.1U	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Fluoranthene	100,000	342U	71.9U	208	76.8	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Fluorene	30,000	342U	71.9U	77.5U	110	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Naphthalene	12,000	342U	71.9U	117	7170	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Phenanthrene	100,000	342U	71.9U	99.1	181	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Pyrene	100,000	342U	71.9U	178	78	75.4U	360U	343U	363U	NS	NS	NS	NS	NS	NS
Metals															
Arsenic	NSTD	1.02U	NA	NA	NA	NA	1.07U	1.03U	1.48	NS	NS	NS	NS	NS	NS
Barium	NSTD	32.9	NA	NA	NA	NA	29.7	40.4	38.3	NS	NS	NS	NS	NS	NS
Chromium	NSTD	10.5	NA	NA	NA	NA	10.6	23	17.8	NS	NS	NS	NS	NS	NS
Lead	NSTD	3.35	9.54	41.8	7.9	3.38	3.3	4.27	43.5	NS	NS	NS	NS	NS	NS

Notes:
NYSDEC = New York State Department of Environmental Conservation.
µg/kg = Micrograms per kilogram.
Bold data indicates that parameter was detected above the CP-51 Soil Cleanup Criteria.
-- = No standard available (value presented is the detection limit).
U = Compound was analyzed for but not detected at or above the provided detection limit.
B = Compound was detected in the associated Method Blank.
Only detections including J values are reported, except for BTEX and MTBE.
ft bgs = Feet below ground surface.
BTEX = Benzene, Toluene, Ethylbenzene, Xylenes (total).
MTBE = Methyl-tertiary Butyl Ether.
VOC = Volatile Organic Compounds.
SVOC = Semi Volatile Organic Compounds.
NA = Not analyzed.
NS = Not Sampled.
ND = Not Detected (numerical value is method detection limit).
NSTD = No Standard.

Table 3
Tentative RAP Implementation Schedule

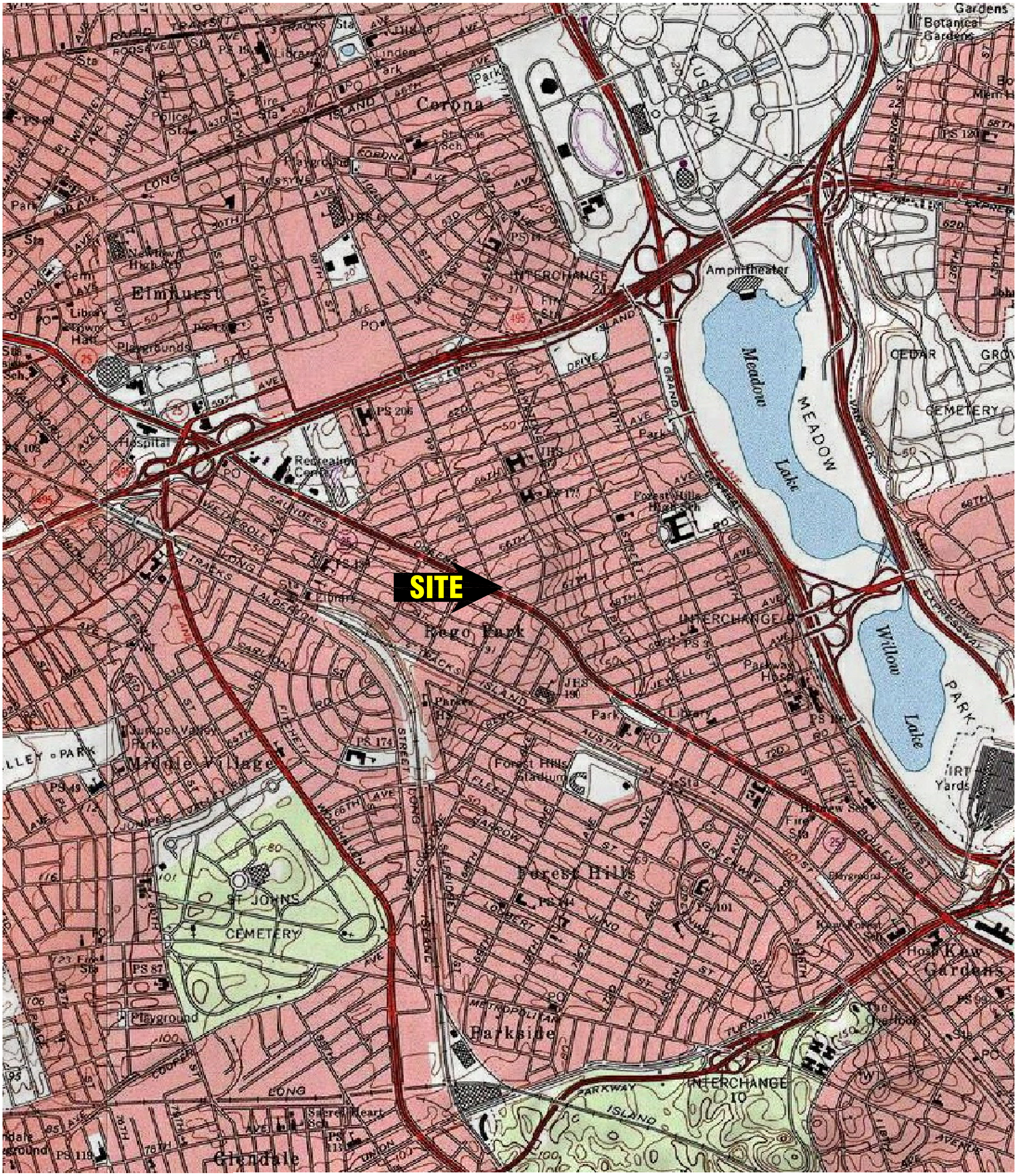
Mobil Branded Service Station
Former Mobil #12833 - 96-27 Queens Blvd., Rego Park, NY

Task	Time (weeks)																																																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Receive NYSDEC Approval of RAP																																																		
Secure Sidewalk Closure & MTA Permits, Install Pilot Test Wells and Perform SVE/AS Pilot Test.	■	■	■	■	■	■	■	■	■	■	■	■																																						
Submit pilot test summary report and proposed modifications to full-scale system design to NYSDEC													■	■	■	■	■																																	
Receive NYSDEC Approval of Modified System Design (assumes a 2 month NYSDEC review period)																		■	■	■	■	■	■	■	■																									
Permitting (MTA, construction, air, sidewalk closure, etc.)																										■	■	■	■	■	■	■	■	■	■	■	■													
Prepare Contractor Bid Specifications for Trenching & System Installation																										■	■	■																						
Bidding & Contractor Selection																													■	■	■																			
Install SVE & AS Wells for Full-Scale System																																						■	■	■	■	■	■							
Premobilization Activities (surveying, utility location, power drop, etc.)																																						■	■	■	■									
Install System Trenching and Below Grade Piping																																												■	■	■	■			
AS/SVE System Mobilization and Installation																																																■	■	
AS/SVE System Startup																																																		■

Task	Time (months)																							
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Periodic System O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Note:
Proposed schedule is subject to change based on actual NYSDEC and permitting agency review timeframes, contractor availability, weather and similar external factors.

Figures



REFERENCE: TOPO!, USGS 7.5 MINUTE
QUAD: JAMAICA, NEW YORK
DATED: 2010

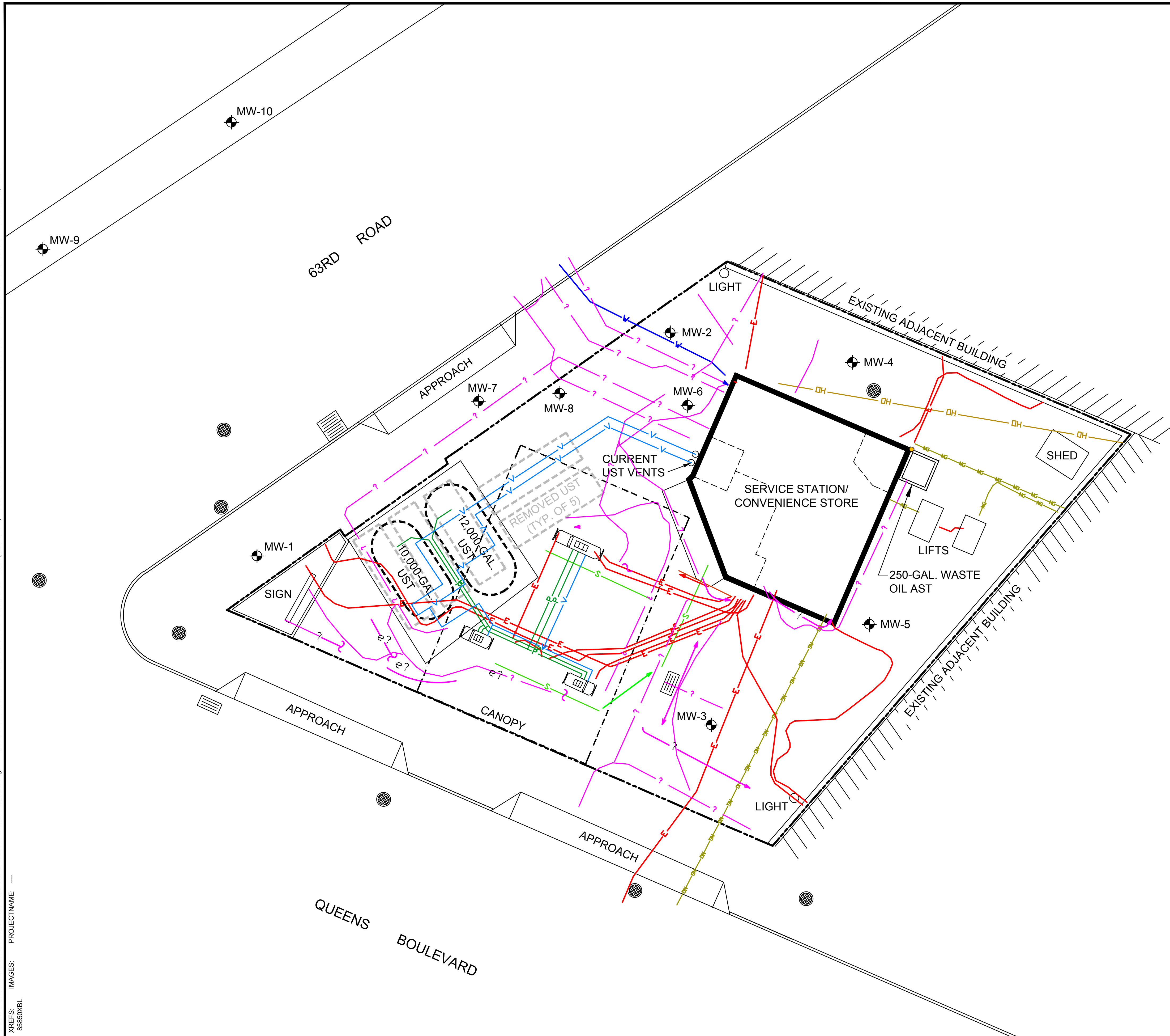
0 2000' 4000'
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

SITE LOCATION MAP

ARCADIS

FIGURE
1



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- UST — UNDERGROUND STORAGE TANK
- AST — ABOVE GROUND STORAGE TANK
- MONITORING WELL
- MANHOLE
- CATCH BASIN
- E — ELECTRIC LINE
- W — WATER LINE
- NG — NATURAL GAS LINE
- S — STORM SEWER
- ? — SUSPECTED UTILITY
- C — CATHODIC PROTECTION
- OH — OVERHEAD LINE
- P — PRODUCT LINE
- V — VENT LINE

NOTES:

1. BASE MAP PREPARED FROM A DRAWING BY KLEINFELDER, TITLED "PROPOSED MONITORING WELL LOCATIONS", DATED: 8/03/10, AT A SCALE OF 1"=20'.
2. MONITORING WELL LOCATIONS ARE APPROXIMATE AND BASED ON FIELD MEASUREMENTS.
3. UTILITY LOCATIONS ARE APPROXIMATE.
4. PRODUCT AND VENT LINE LOCATIONS BASED ON A SCAN OF A DRAWING BY WTG ENGINEERS AND ARE APPROXIMATE.

0 20' 40'

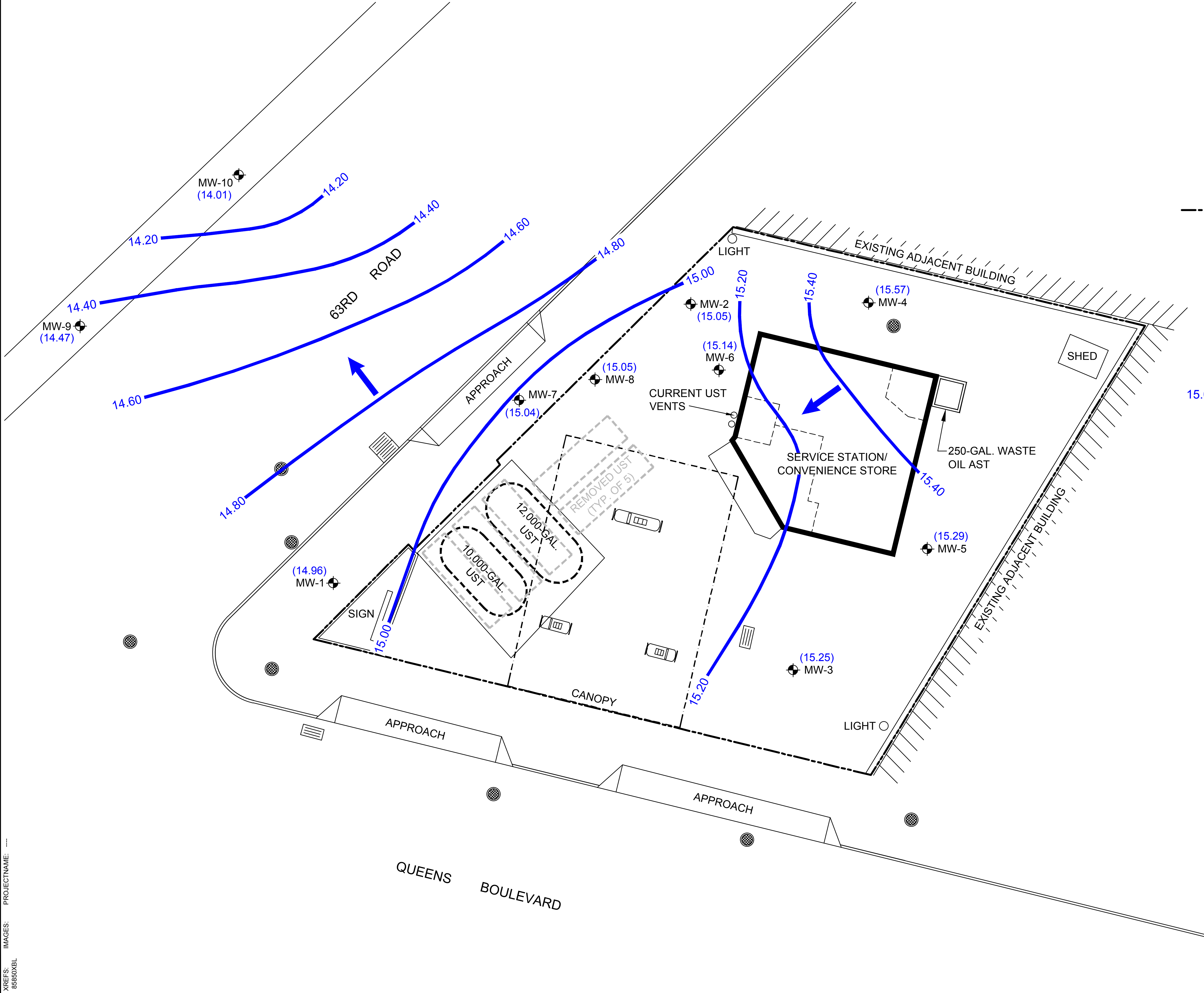
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

SITE PLAN

ARCADIS

FIGURE
2



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- UST — UNDERGROUND STORAGE TANK
- AST — ABOVE GROUND STORAGE TANK
- MONITORING WELL
- MANHOLE
- CATCH BASIN
- (15.05) — GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL [AMSL])
- 15.00 — GROUNDWATER CONTOUR LINE (FEET ASML) (DASHED WHERE INFERRED)
- GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP PREPARED FROM A DRAWING BY KLEINFELDER, TITLED "PROPOSED MONITORING WELL LOCATIONS", DATED: 8/03/10, AT A SCALE OF 1"=20'.
2. MONITORING WELL LOCATIONS ARE APPROXIMATE AND BASED ON FIELD MEASUREMENTS.

0 20' 40'

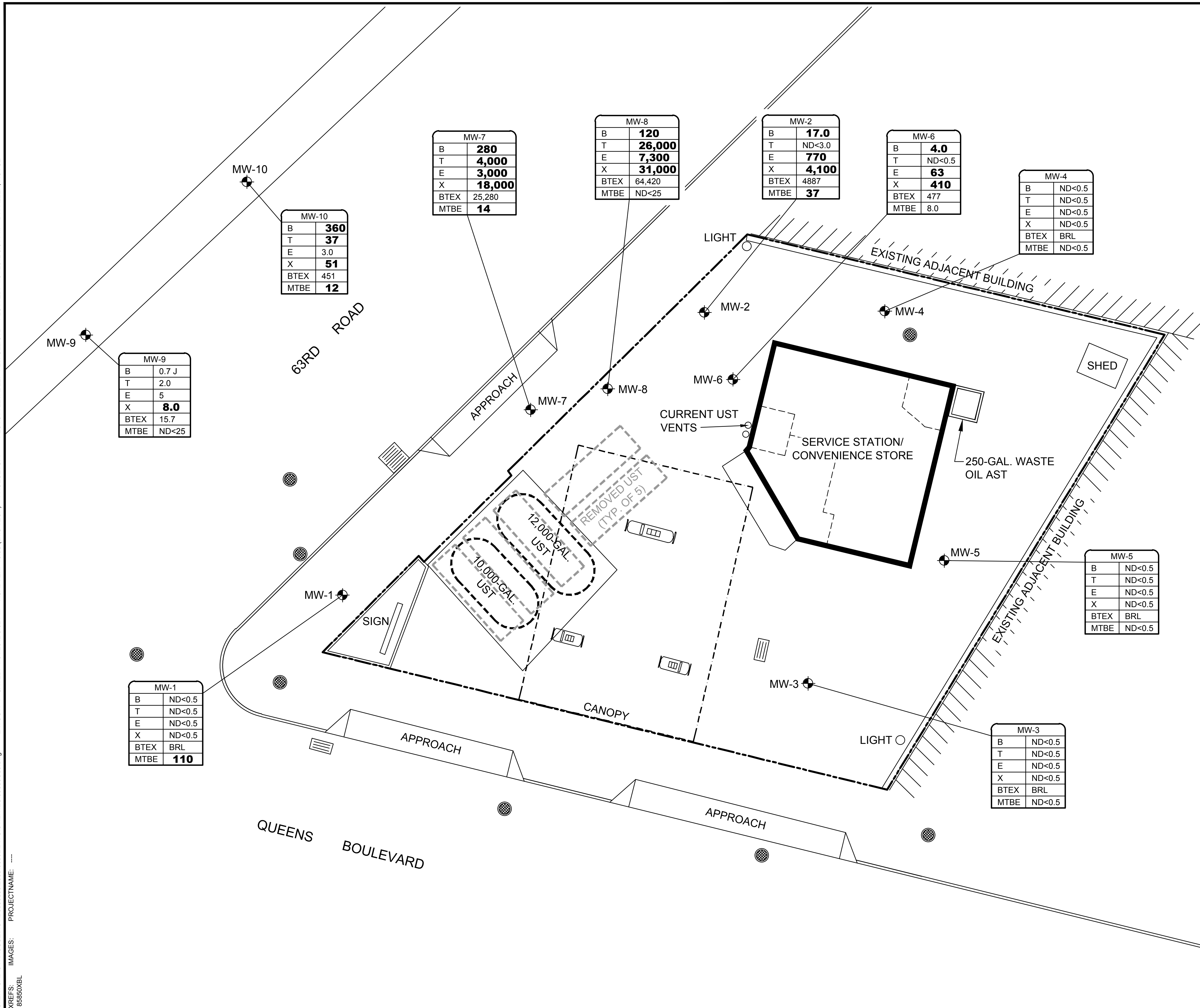
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

GROUNDWATER CONTOUR MAP
OCTOBER 25, 2011

ARCADIS

FIGURE 3



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- (UST) UNDERGROUND STORAGE TANK
- AST ABOVEGROUND STORAGE TANK
- MONITORING WELL
- MANHOLE
- CATCH BASIN

WELL IDENTIFICATION	
CONSTITUENT	GROUNDWATER STANDARDS AND GUIDANCE VALUES
B = BENZENE	1
T = TOLUENE	5
E = ETHYLBENZENE	5
X = TOTAL XYLENES	5
BTEX = TOTAL BTEX	--
MTBE = METHYL TERTIARY BUTYL ETHER	10

ND< CONSTITUENT NOT DETECTED AT OR BELOW THE INDICATED REPORTING LIMIT

J ESTIMATED VALUE

BRL BELOW LABORATORY REPORTING LIMIT

NOTES:

1. BASE MAP PREPARED FROM A DRAWING BY KLEINFELDER, TITLED "PROPOSED MONITORING WELL LOCATIONS", DATED: 8/03/10, AT A SCALE OF 1"=20'.
2. MONITORING WELL LOCATIONS ARE APPROXIMATE AND BASED ON FIELD MEASUREMENTS.
2. ALL UNITS REPORTED IN MICROGRAMS PER LITER (µg/L).
3. BOLDED VALUES INDICATES RESULT ABOVE NYSDEC STANDARDS AND GUIDANCE VALUES.

0 20' 40'

GRAPHIC SCALE

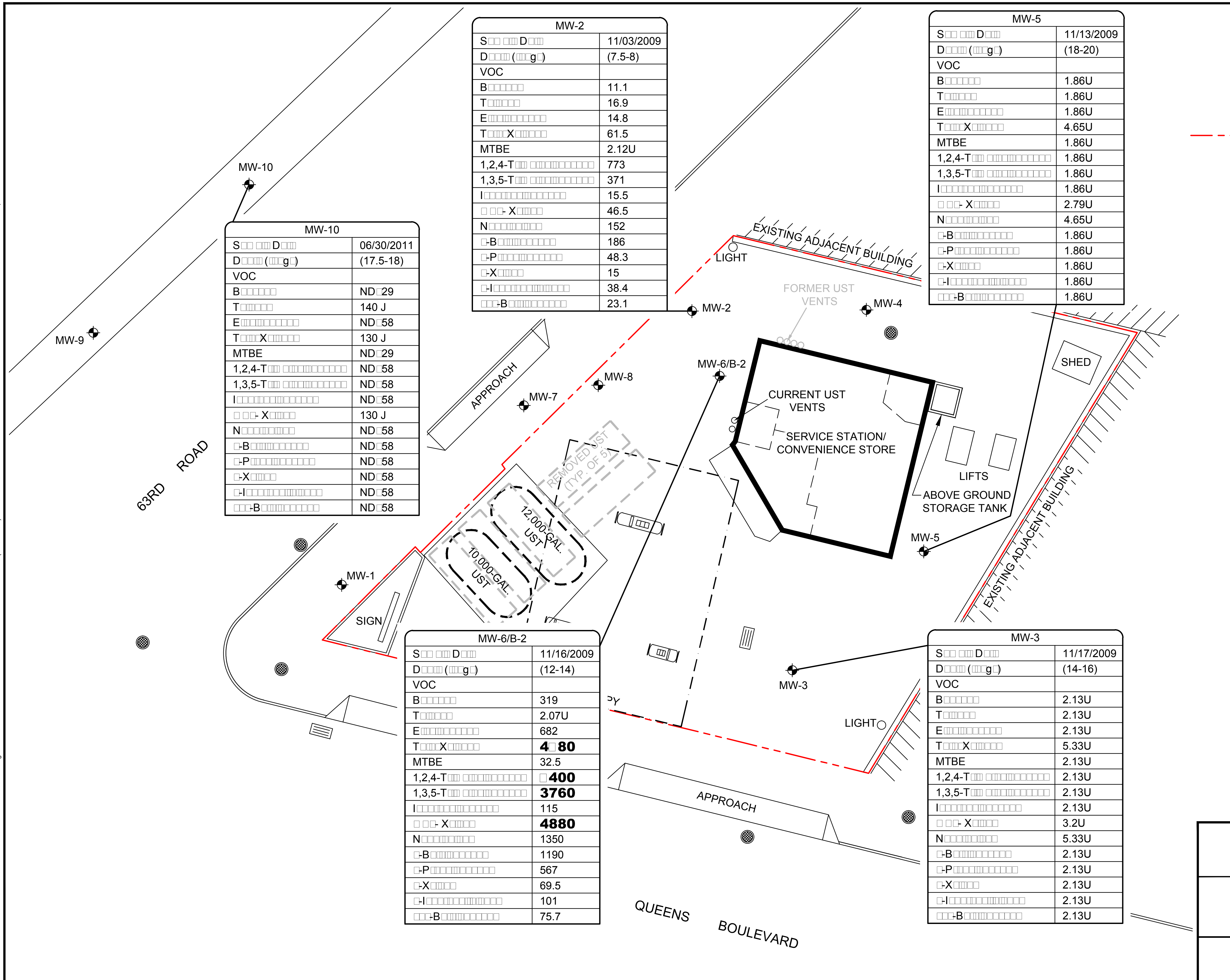
MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

GROUNDWATER ANALYTICAL MAP
OCTOBER 25, 2011

ARCADIS

FIGURE 4

CITY: (MANCHESTER, CT) SYRACUSE, NY DIV/GROUP: ENV/CADD DB: (B. SMALL) L. FORAKER, P. LISTER PM: E.CHOQUETTE TM: D.ROY TR: N. BERNARDO LYR: ON=*, OFF=REF, (FRZ)
G:\ENVCAD\SYRACUSE\ACT\B0085850\2833\0002\DWG\B5850C02.dwg LAYOUT: 5 SAVED: 12/12/2011 3:33 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/12/2011 3:34 PM BY: ALLEN, ROYCE



MW-10	
S□□ □□□ D□□□	06/30/2011
D□□□□ (□□□g□)	(17.5-18)
VOC	
B□□□□□□	ND□29
T□□□□□□	140 J
E□□□□□□□□□□□	ND□58
T□□□□X□□□□□□	130 J
MTBE	ND□29
1,2,4-T□□ □□□□□□□□□□□□	ND□58
1,3,5-T□□ □□□□□□□□□□□□	ND□58
I□□□□□□□□□□□□□□□□	ND□58
□ □□- X□□□□□	130 J
N□□□□□□□□□□	ND□58
□-B□□□□□□□□□□□	ND□58
□-P□□□□□□□□□□□□	ND□58
□-X□□□□□	ND□58
□-I□□□□□□□□□□□□□□□	ND□58
□□□-B□□□□□□□□□□□	ND□58

MW-2	
S□□ □□□ D□□□	11/03/2009
D□□□□ (□□□g□)	(7.5-8)
VOC	
B□□□□□□	11.1
T□□□□□□	16.9
E□□□□□□□□□□□	14.8
T□□□□X□□□□□□	61.5
MTBE	2.12U
1,2,4-T□□ □□□□□□□□□□□□	773
1,3,5-T□□ □□□□□□□□□□□□	371
I□□□□□□□□□□□□□□□□	15.5
□ □□- X□□□□□	46.5
N□□□□□□□□□□	152
□-B□□□□□□□□□□□	186
□-P□□□□□□□□□□□□	48.3
□-X□□□□□	15
□-I□□□□□□□□□□□□□□□	38.4
□□□-B□□□□□□□□□□□	23.1

MW-5	
S□□ □□□ D□□□	11/13/2009
D□□□□ (□□□g□)	(18-20)
VOC	
B□□□□□□	1.86U
T□□□□□□	1.86U
E□□□□□□□□□□□	1.86U
T□□□□X□□□□□□	4.65U
MTBE	1.86U
1,2,4-T□□ □□□□□□□□□□□□	1.86U
1,3,5-T□□ □□□□□□□□□□□□	1.86U
I□□□□□□□□□□□□□□□□	1.86U
□ □□- X□□□□□	2.79U
N□□□□□□□□□□	4.65U
□-B□□□□□□□□□□□	1.86U
□-P□□□□□□□□□□□□	1.86U
□-X□□□□□	1.86U
□-I□□□□□□□□□□□□□□□	1.86U
□□□-B□□□□□□□□□□□	1.86U

MW-6/B-2	
S□□ □□□ D□□□	11/16/2009
D□□□□ (□□□g□)	(12-14)
VOC	
B□□□□□□	319
T□□□□□□	2.07U
E□□□□□□□□□□□	682
T□□□□X□□□□□□	**4□80**
MTBE	32.5
1,2,4-T□□ □□□□□□□□□□□□	**□400**
1,3,5-T□□ □□□□□□□□□□□□	**3760**
I□□□□□□□□□□□□□□□□	115
□ □□- X□□□□□	**4880**
N□□□□□□□□□□	1350
□-B□□□□□□□□□□□	1190
□-P□□□□□□□□□□□□	567
□-X□□□□□	69.5
□-I□□□□□□□□□□□□□□□	101
□□□-B□□□□□□□□□□□	75.7

MW-3	
S□□ □□□ D□□□	11/17/2009
D□□□□ (□□□g□)	(14-16)
VOC	
B□□□□□□	2.13U
T□□□□□□	2.13U
E□□□□□□□□□□□	2.13U
T□□□□X□□□□□□	5.33U
MTBE	2.13U
1,2,4-T□□ □□□□□□□□□□□□	2.13U
1,3,5-T□□ □□□□□□□□□□□□	2.13U
I□□□□□□□□□□□□□□□□	2.13U
□ □□- X□□□□□	3.2U
N□□□□□□□□□□	5.33U
□-B□□□□□□□□□□□	2.13U
□-P□□□□□□□□□□□□	2.13U
□-X□□□□□	2.13U
□-I□□□□□□□□□□□□□□□	2.13U
□□□-B□□□□□□□□□□□	2.13U

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- UST UNDERGROUND STORAGE TANK
- MONITORING WELL
- MANHOLE
- CATCH BASIN
- U COMPOUND WAS ANALYZED FOR BUT NOT DETECTED AT OR ABOVE THE DETECTION LIMIT

NYSDEC CP-51 SOIL CLEANUP CRITERIA	
C□□□□□□□□□□□	□g/□g
VOC	
B□□□□□□	60
T□□□□□□	700
E□□□□□□□□□□□	1000
T□□□□X□□□□□□	260
1,2,4-T□□ □□□□□□□□□□□□	3600
1,3,5-T□□ □□□□□□□□□□□□	8400
I□□□□□□□□□□□□□□□□	2300
□ □□- X□□□□□	260
N□□□□□□□□□□	12000
□-B□□□□□□□□□□□	12000
□-P□□□□□□□□□□□□	3900
□-X□□□□□	260

NOTES:

1. BASEMAP ADAPTED FROM A DRAWING BY KLEINFELDER TITLED □PROPOSED MONITORING WELL LOCATIONS□, DATED 8/03/10, AT A SCALE OF 1□=20□.
2. ALL UNITS REPORTED IN MICROGRAMS PER KILOGRAM (µg/□g).
3. BOLDED VALUES INDICATES RESULT ABOVE NYSDEC CP-51 SOIL CLEANUP CRITERIA.
4. FT BGS - FEET BELOW GROUND SURFACE

0 20' 40'
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

SOIL ANALYTICAL DATA FOR UNSATURATED AND SMEAR ZONE SAMPLES-2009-2011

ARCADIS

FIGURE
5

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- UST UNDERGROUND STORAGE TANK
- AST ABOVE GROUND STORAGE TANK
- MONITORING WELL
- PROPOSED AIR SPARGE WELL
- PROPOSED SOIL VAPOR EXTRACTION WELL LOCATION
- MANHOLE
- CATCH BASIN
- E ELECTRIC LINE
- V WATER LINE
- NG NATURAL GAS LINE
- S STORM SEWER
- ? SUSPECTED UTILITY
- C CATHODIC PROTECTION
- OH OVERHEAD LINE
- P PRODUCT LINE
- V VENT LINE
- ASSUMED PNEUMATIC RADIUS OF INFLUENCE – 20 FEET
- ASSUMED AIR SPARGE RADIUS OF INFLUENCE – 15 FEET

NOTES:

1. BASE MAP PREPARED FROM A DRAWING BY KLEINFELDER, TITLED "PROPOSED MONITORING WELL LOCATIONS", DATED: 8/03/10, AT A SCALE OF 1"=20'.
2. MONITORING WELL LOCATIONS ARE APPROXIMATE AND BASED ON FIELD MEASUREMENTS.
3. UTILITY LOCATIONS ARE APPROXIMATE.
4. PRODUCT AND VENT LINE LOCATIONS BASED ON A SCAN OF A DRAWING BY WTG ENGINEERS AND ARE APPROXIMATE.

0 20' 40'

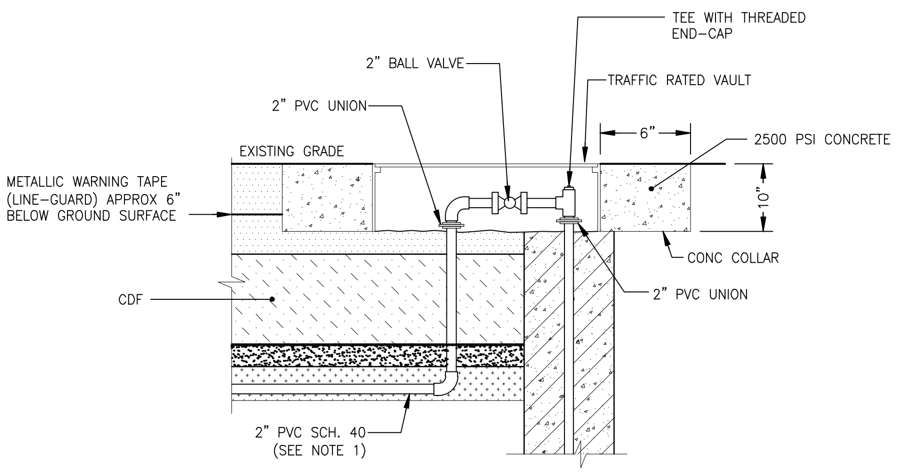
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

PROPOSED SOIL VAPOR EXTRACTION AND AIR SPARGE WELL LOCATIONS

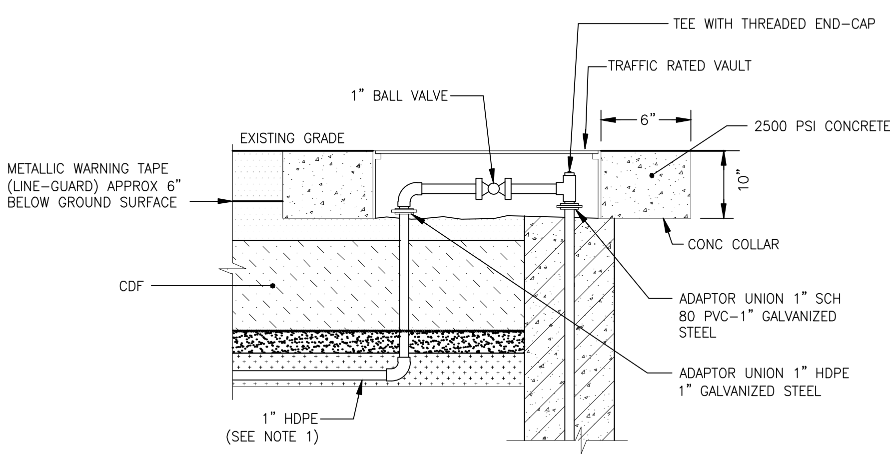
ARCADIS

FIGURE 6



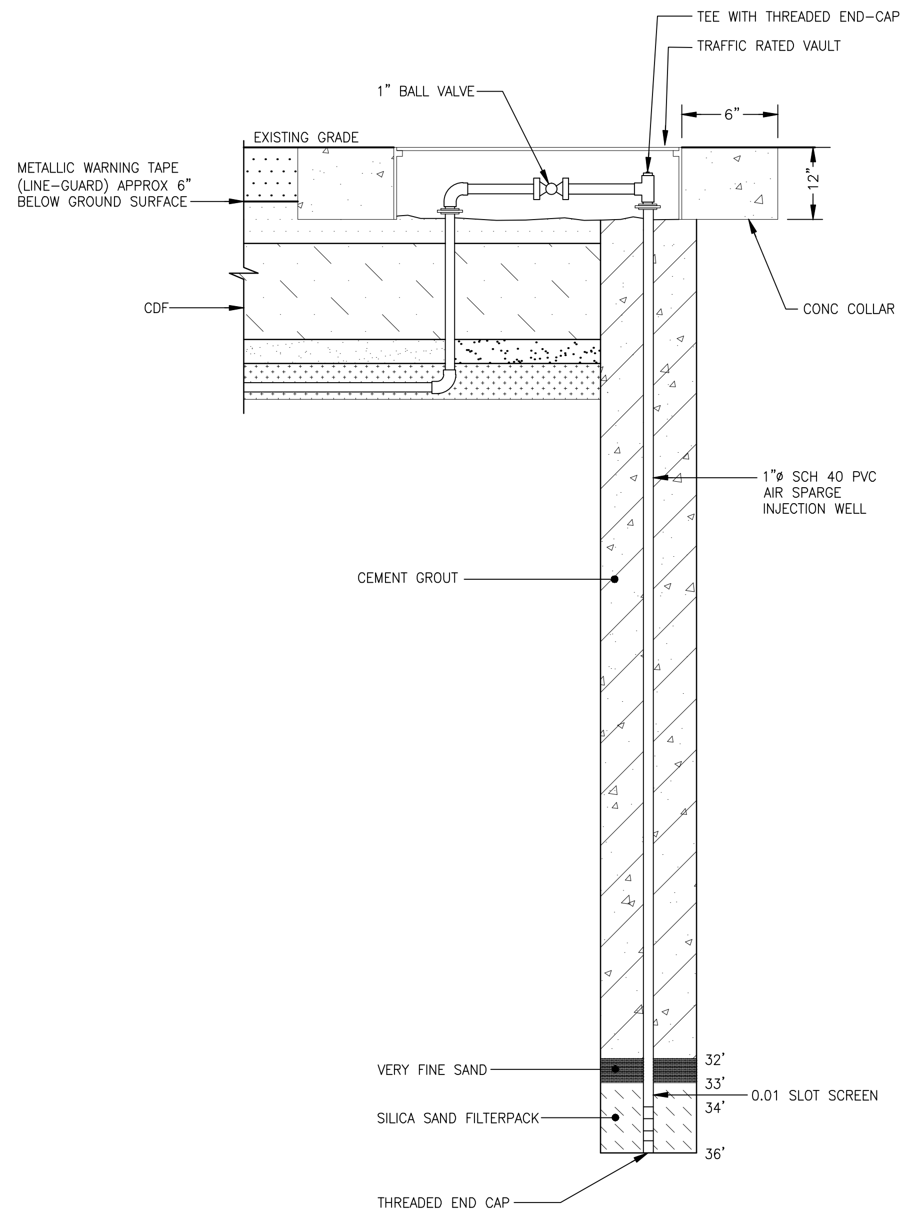
1/7 SOIL VAPOR EXTRACTION WELLHEAD DETAIL

NOT TO SCALE



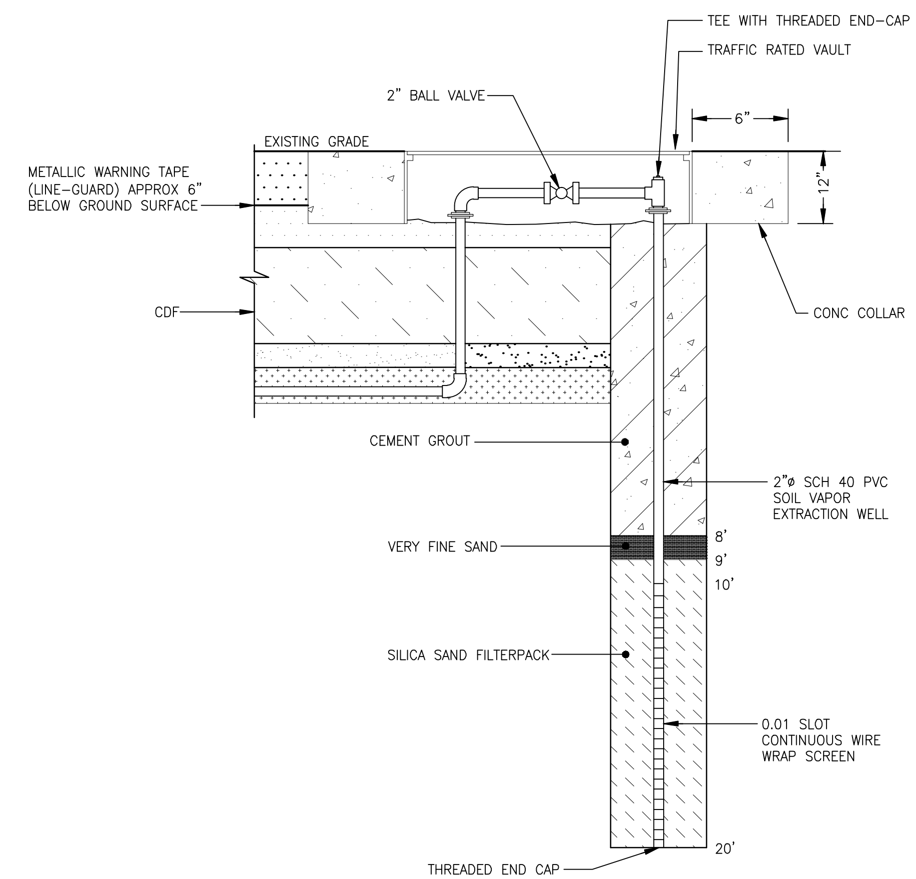
2/7 AIR SPARGE WELLHEAD DETAIL

NOT TO SCALE



3/7 AS SECTION

NOT TO SCALE



4/7 SVE SECTION (SEE NOTE 2)

NOT TO SCALE

NOTES:

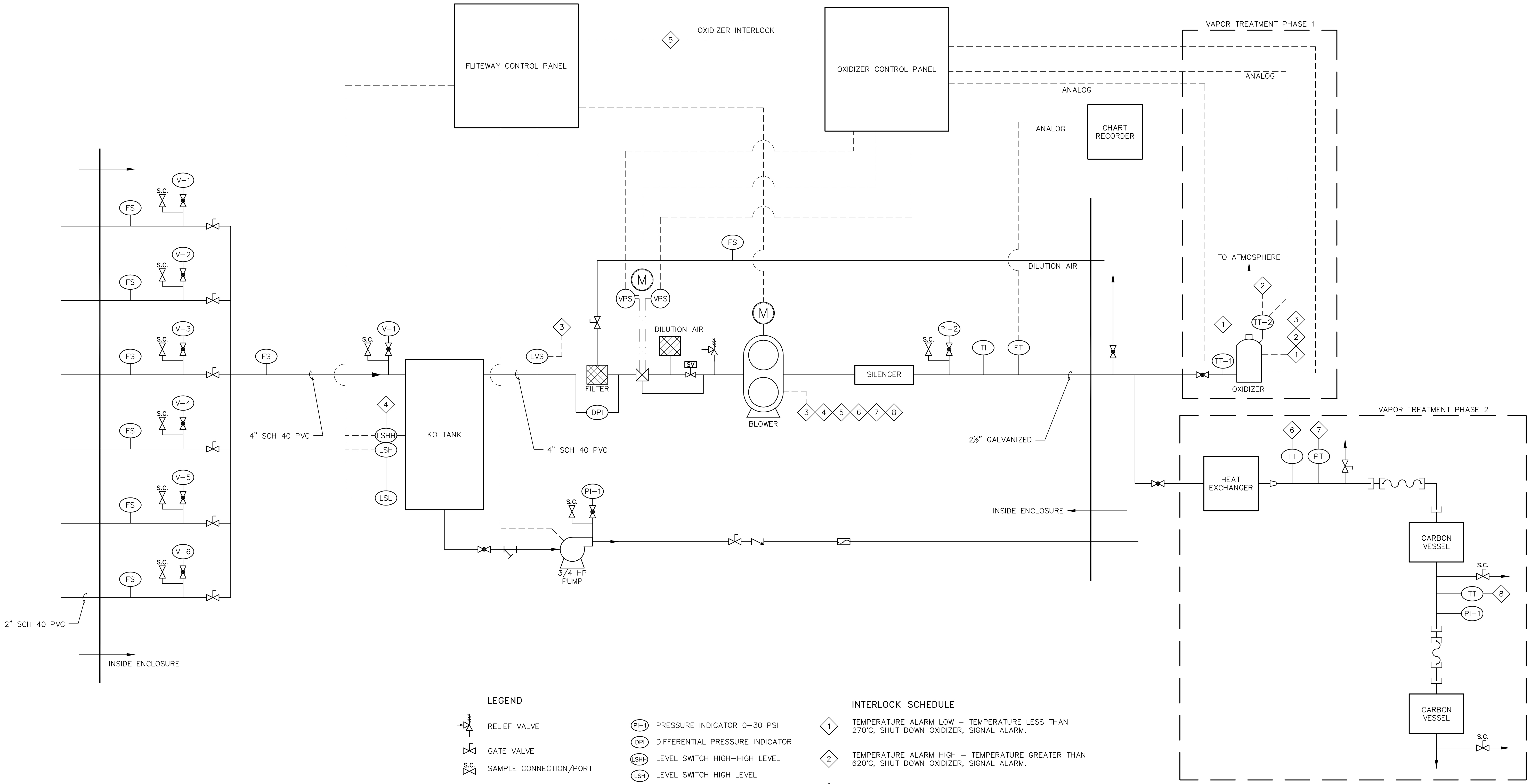
1. SUBSURFACE PIPING WILL BE SLOPED TOWARD INDIVIDUAL AIR SPARGE AND EXTRACTION WELLS AND AWAY FROM MANIFOLD.
2. SVE SECTION DETAIL SHOWN IS FOR EXTRACTION WELLS THAT WILL BE INSTALLED IN PROPOSED FULL-SCALE SYSTEM. EXTRACTION WELL SVE-103, WHICH WILL BE USED FOR PILOT TESTING, WILL BE CONSTRUCTED OF 4" DIAMETER, SCHEDULE 40 PVC WITH A 20-FOOT, 0.01-SLOTTED CONTINUOUS WIRE WRAP SCREEN.

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

TYPICAL WELL, VAULT AND WELLHEAD DETAILS FOR AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM

ARCADIS

FIGURE 7



LEGEND

- RELIEF VALVE
- GATE VALVE
- SAMPLE CONNECTION/PORT
- CHECK VALVE
- BALL VALVE
- WYE STRAINER
- TOTALIZING FLOW METER
- FS — PITOT TUBE FLOW SENSOR
- LVS — LOW VAC SWITCH
- VPS — VAPOR CONTROL SWITCH
- SV — SOLENOID VALVE
- PI–1 — PRESSURE INDICATOR 0–30 PSI
- DPI — DIFFERENTIAL PRESSURE INDICATOR
- LSHH — LEVEL SWITCH HIGH–HIGH LEVEL
- LSH — LEVEL SWITCH HIGH LEVEL
- LSL — LEVEL SWITCH LOW LEVEL
- TI — TEMPERATURE INDICATOR 0–250
- PI–2 — PRESSURE INDICATOR 0–30" WC
- V–1 — VACUUM INDICATOR 0–30" HG
- TT — TEMPERATURE TRANSMITTER
- FT — FLOW TRANSMITTER
- THREE WAY VALVE

INTERLOCK SCHEDULE

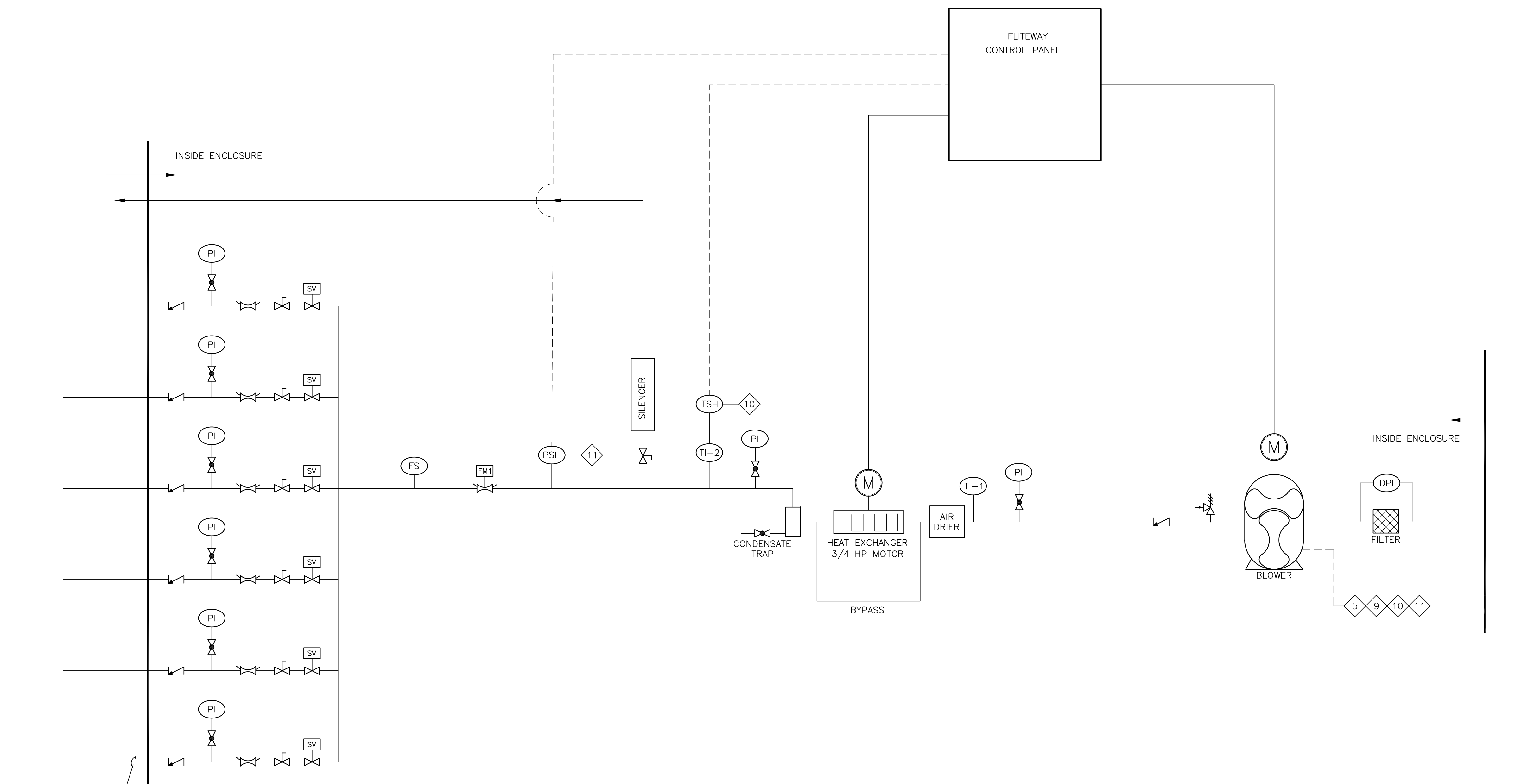
1. TEMPERATURE ALARM LOW – TEMPERATURE LESS THAN 270°C, SHUT DOWN OXIDIZER, SIGNAL ALARM.
2. TEMPERATURE ALARM HIGH – TEMPERATURE GREATER THAN 620°C, SHUT DOWN OXIDIZER, SIGNAL ALARM.
3. LOW VACUUM ALARM – VACUUM LESS THAN 1 IN. H2O, SHUT DOWN BLOWER AND OXIDIZER, SIGNAL ALARM.
4. HIGH LEVEL ALARM – SHUT DOWN BLOWER AND OXIDIZER, SIGNAL ALARM.
5. OXIDIZER FAILURE – SHUT DOWN BLOWER, SIGNAL ALARM.
6. TEMPERATURE ALARM HIGH – TEMPERATURE IN CARBON VESSEL INFLUENT LINE EXCEEDS MAXIMUM PERMITTED, SHUT DOWN BLOWER, SIGNAL ALARM.
7. PRESSURE ALARM HIGH – PRESSURE IN CARBON VESSEL INFLUENT LINE EXCEEDS MAXIMUM PERMITTED, SHUT DOWN BLOWER, SIGNAL ALARM.
8. TEMPERATURE ALARM HIGH – TEMPERATURE IN MID–FLUENT LINE BETWEEN CARBON VESSELS EXCEEDS MAXIMUM PERMITTED, SHUT DOWN BLOWER, SIGNAL ALARM

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

TYPICAL SOIL VAPOR EXTRACTION SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

ARCADIS

FIGURE
8



LEGEND:

- PI — PRESSURE INDICATOR 0–30 PSI
- PSL — PRESSURE SWITCH LOW 0–30 PSI
- TI–1 — TEMPERATURE INDICATOR 50–400
- DPI — DIFFERENTIAL PRESSURE INDICATOR
- TSH — TEMPERATURE SWITCH HIGH 0–250
- FS — PITOT TUBE FLOW SENSOR
- TI–2 — TEMPERATURE INDICATOR 0–250
- RELIEF VALVE
- BALL VALVE
- GATE VALVE
- CHECK VALVE
- DWYER VFC–121 FLOWMETERS
- FM1 — CHEMLINE FLOW METER 10–100 CFM
- SV — SOLENOID VALVE

INTERLOCK SCHEDULE:

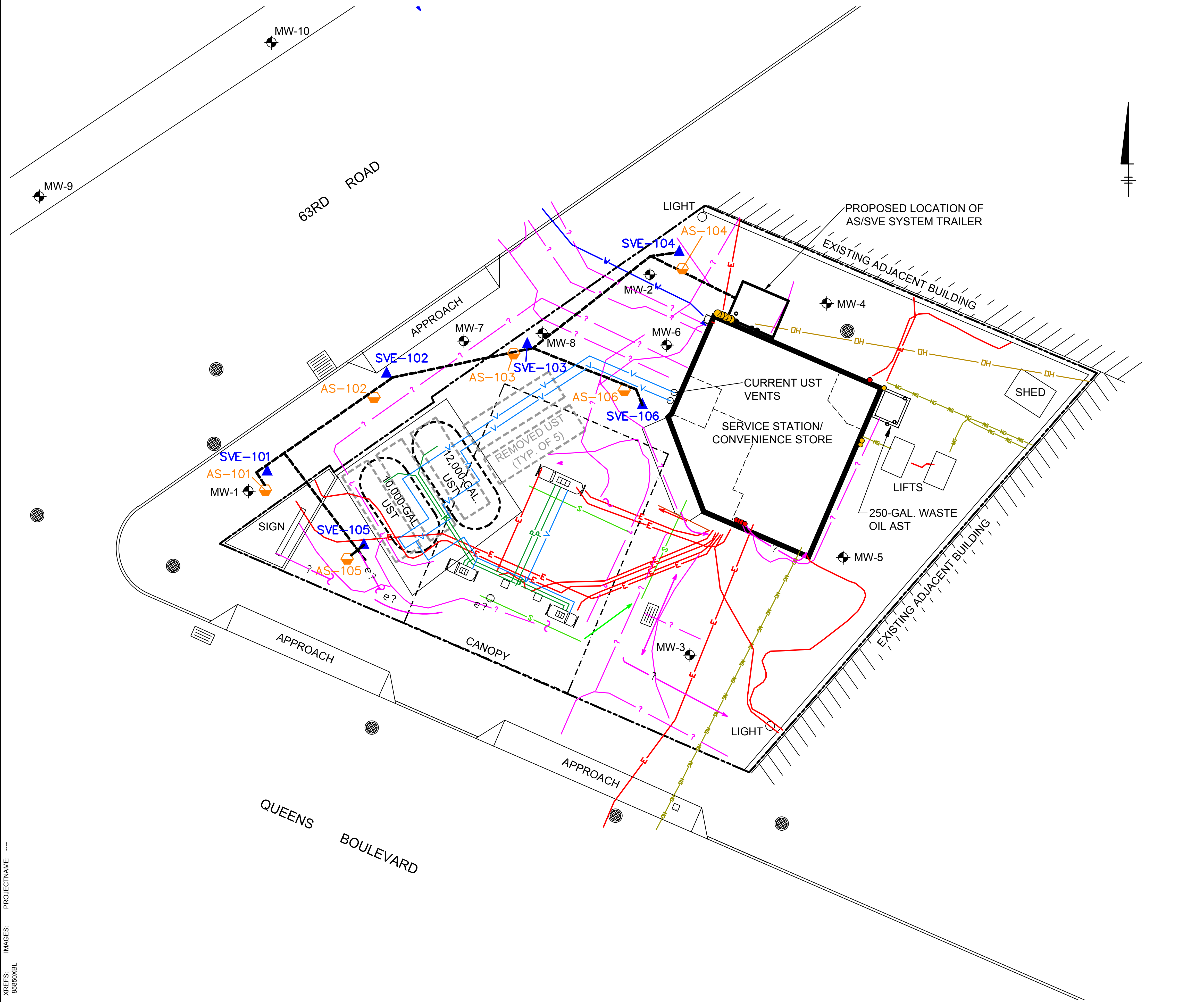
- 5 — OXIDIZER FAILURE – SHUT DOWN BLOWER.
- 9 — SVE SYSTEM FAILURE – SHUT DOWN BLOWER.
- 10 — TEMPERATURE ALARM HIGH – TEMPERATURE IN AIR LINE EXCEEDS MAXIMUM PERMITTED, SHUT DOWN BLOWER, SIGNAL ALARM.
- 11 — PRESSURE ALARM LOW – PRESSURE IN AIR LINE FALLS BELOW MINIMUM PERMITTED (POTENTIAL AIR LEAK), SHUT DOWN BLOWER, SIGNAL ALARM.

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

TYPICAL AIR SPARGE SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

ARCADIS

FIGURE
9



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- DISPENSER ISLAND
- UST — UNDERGROUND STORAGE TANK
- AST — ABOVEGROUND STORAGE TANK
- MONITORING WELL
- PROPOSED AIR SPARGE WELL
- PROPOSED SOIL VAPOR EXTRACTION WELL LOCATION
- MANHOLE
- CATCH BASIN
- E — ELECTRIC LINE
- W — WATER LINE
- NG — NATURAL GAS LINE
- S — STORM SEWER
- ? — SUSPECTED UTILITY
- C — CATHODIC PROTECTION
- OH — OVERHEAD LINE
- P — PRODUCT LINE
- V — VENT LINE
- PROPOSED REMEDIATION SYSTEM TRENCHING

NOTES:

1. BASE MAP PREPARED FROM A DRAWING BY KLEINFELDER, TITLED "PROPOSED MONITORING WELL LOCATIONS", DATED: 8/03/10, AT A SCALE OF 1"=20'.
2. MONITORING WELL LOCATIONS ARE APPROXIMATE AND BASED ON FIELD MEASUREMENTS.
3. UTILITY LOCATIONS ARE APPROXIMATE.
4. PRODUCT AND VENT LINE LOCATIONS BASED ON A SCAN OF A DRAWING BY WTG ENGINEERS AND ARE APPROXIMATE.

0 20' 40'

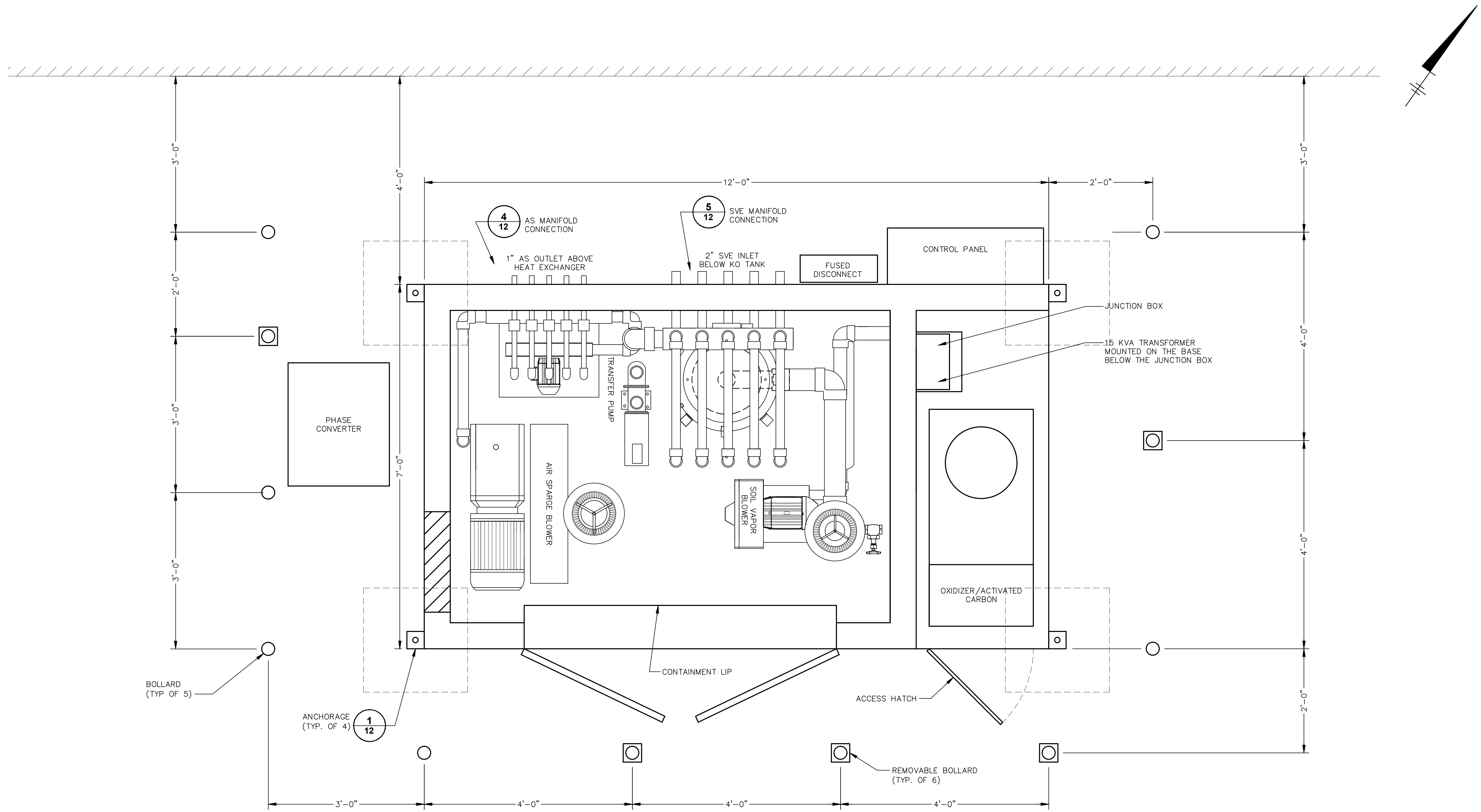
GRAPHIC SCALE

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

PROPOSED SVE/AS TRENCHING PLAN

ARCADIS

FIGURE 10



PLAN

SCALE: 1"=1'-0"

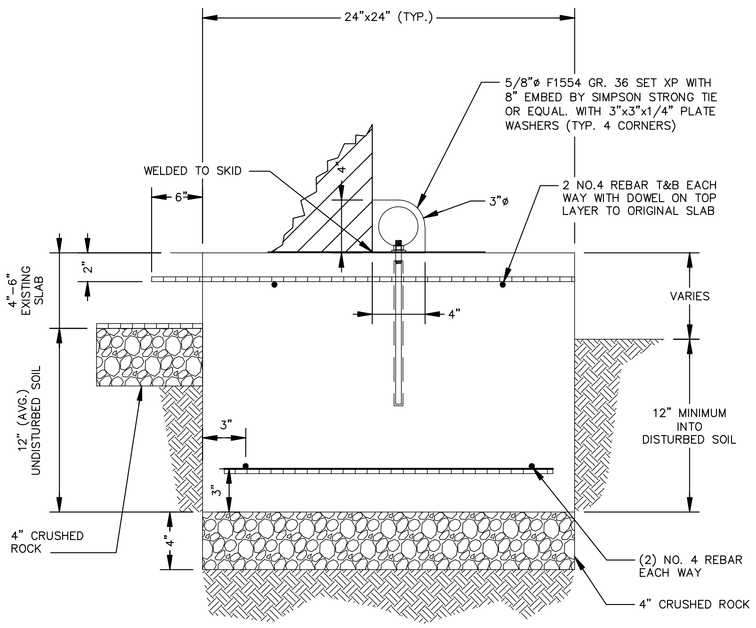
CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: S. KOWALCZYK, P. LISTER LD: G. STEINBERGER PIC: S. GLENN PM: D. EVANS TM: T. POTTER TR: N. BERNARDO LYR:ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\B0085850\2833\00002\DWG\85850G11.dwg LAYOUT: 11 SAVED: 12/9/2011 2:17 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTCONT1.CTB PLOTTED: 12/9/2011 2:19 PM BY: ALLEN, ROYCE
XREFS: GP09BPX00 IMAGES: PROJECTNAME: ----

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

TYPICAL AIR SPARGE/SOIL VAPOR EXTRACTION TREATMENT SYSTEM ENCLOSURE

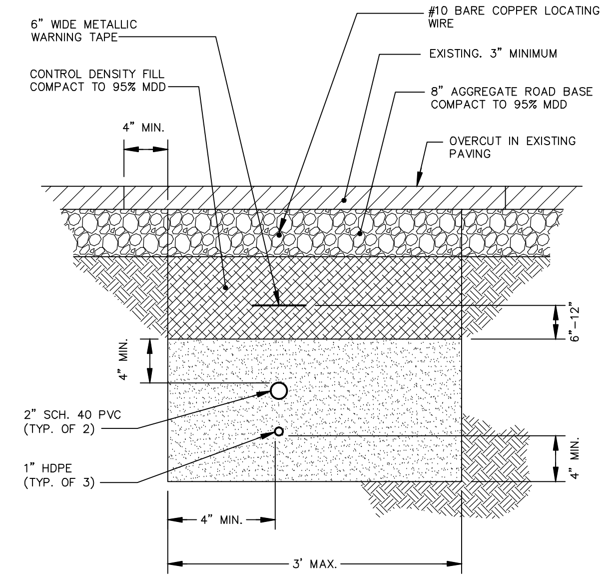
ARCADIS

FIGURE
11



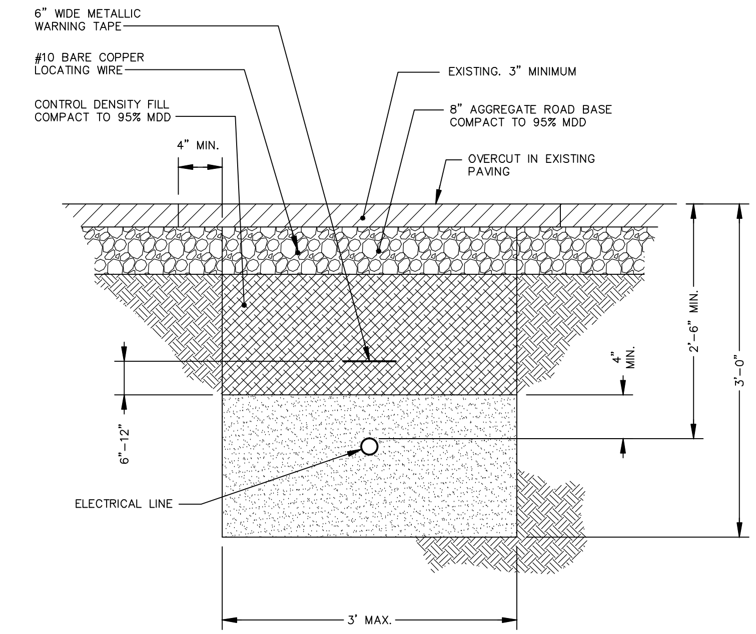
1/12 **EQUIPMENT ANCHORAGE DETAILS**

NOT TO SCALE



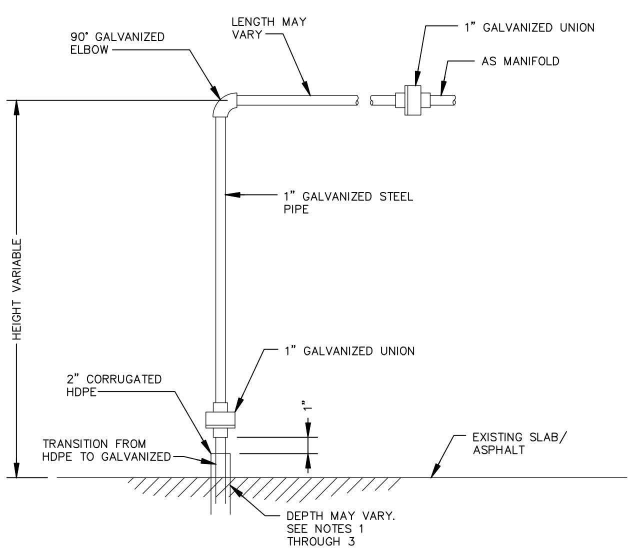
2/12 **MULTIPLE AS/SVE PIPING TRENCH DETAILS**

NOT TO SCALE



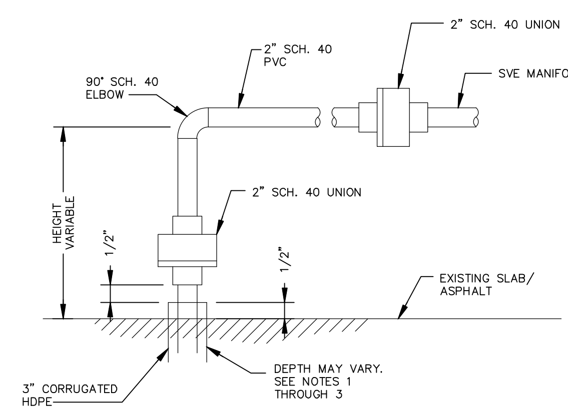
3/12 **ELECTRICAL LINE TRENCH DETAILS**

NOT TO SCALE



4/12 **AS MANIFOLD CONNECTION DETAIL**

NOT TO SCALE



5/12 **SVE MANIFOLD CONNECTION DETAIL**

NOT TO SCALE

NOTES:

1. PROVIDE CORRUGATED HDPE PIPE SLEEVES AT ALL SLAB/ASPHALT PENETRATIONS.
2. SLEEVES FOR SVE TO EXTEND 1" ABOVE AND 3" BELOW SLAB/ASPHALT. SLEEVES FOR AS TO EXTEND 1/2" ABOVE AND 3" BELOW SLAB/ASPHALT.
3. SLEEVE TO BE 1" LARGER THAN RISER DIAMETER.
4. ANCHOR TO BE CENTERED ON FOOTER.
5. SAW CUT SLAB 24" X 24".
6. ELECTRICAL LINE WILL BE INSTALLED ACCORDING TO SPECIFICATIONS OF ELECTRICAL UTILITY SERVICING THE SITE.
7. THE REMEDIATION SYSTEM CORNER WILL BE PLACED SO THE ANCHOR IS IN THE CENTER OF THE FOOTING.

MOBIL SERVICE STATION 12833 #17-GBR
96-27 QUEENS BOULEVARD
REGO PARK, NEW YORK

TYPICAL TRENCHING, ANCHOR, AND MANIFOLD CONNECTION DETAILS FOR AIR SPARGE / SOIL VAPOR EXTRACTION SYSTEM

ARCADIS

FIGURE
12

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: S. KOWALCZYK, P. LISTER LD: G. STEINBERGER PIC: S. GLENN PM: D. EVANS TM: T. POTTER TR: N. BERNARDO LYR:ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\B0085850\2833\00002\DWG\85850G12.dwg LAYOUT: 12 SAVED: 12/9/2011 2:24 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTCONT1.CTB PLOTTED: 12/9/2011 2:26 PM BY: ALLEN, ROYCE
XREFS: GP09BPX00 IMAGES: PROJECTNAME: ----

ARCADIS

Appendix A

Fracture and Breakout Pressure Calculations

Appendix A
Air Sparge System Design Calculations

Mobil Branded Service Station
Former Mobil #12833 (17-GBR) - 96-27 Queens Blvd., Rego Park, New York

Estimated Formation Fracture Pressure

Equations

$P_F = P_{soil} + P_{water} = (d_s)(SG_s)(1-\theta)(\delta_w) + (d_s-d_{wt})(SG_w)(\theta)(\delta_w)$

where: P_{soil} = pressure component due to soil column
P_{water} = pressure component due to water column
d_s = depth from ground surface to top of well screen
SG_s = specific gravity of soil = 1.73 (assumed for sand and gravel mixture)
θ = soil porosity = 0.3 (assumed for sand and gravel mixture)
δ_w = specific weight of water = 64.2 lbf/ft^3
dwt = depth of static water table
SG_w = specific gravity of water = 1 (assumed)

Reference

USACE 2008. Engineering Design, In-Situ Air Sparging, EM 1110-1-4005, January 31, 2008.

Calculations

Air Sparge Well	Screen Int (ft bgs)	d_s (ft)	d_{wt} (ft)	SG_s	SG_w	θ	δ_w (lbf/ft^3)	P_{soil} (psi)	P_{water} (psi)	P_F (psi)
AS-101 thru AS-106	34-36	34	18.44	1.73	1	0.3	64.2	18.4	2.1	20.4

Average GW depth within air sparge treatment area for monitoring period of record (ft bgs)

	MW-1	MW-2	MW-6	MW-7	MW-8	Average
Ave per well	18.16	18.59	19.18	17.94	18.32	18.44

Appendix A
Air Sparge System Design Calculations

Mobil Branded Service Station
Former Mobil #12833 (17-GBR) - 96-27 Queens Blvd., Rego Park, New York

Formation Break out Pressure Calculation

Equations

$P_h = (D_w) * g * (ds - dwt)$

where: P_h = hydrostatic pressure

d_s = depth from ground surface to top of well screen

D_w = Density of water= 1.94 slugs/ft^3

dwt = depth of static water table

g= gravity = 32.2 ft/s^2

Reference

USACE 2008. Engineering Design, In-Situ Air Sparging, EM 1110-1-4005, January 31, 2008.

Calculations

Air Sparge Well	Screen Int (ft bgs)	Dw (slugs/ft^3)	g (ft/s^2)	ds (ft)	dwt (ft)	P_h (psi)	Increases due to minor components(1) (psi)	P_h Final (psi)
AS-101 thru AS-106	34-36	1.94	32.2	34	18.44	6.8	0.5	7.3

Notes

(1) Minor components of breakout pressure include: piping friction losses, filterpack entry pressure, formation entry pressure.