REMEDIAL ACTION WORK PLAN
For the
75-20 ASTORIA BOULEVARD SITE
JACKSON HEIGHTS, QUEENS, NEW YORK

VCA NO.: W2-0854-9906

CONSULTANT PROJECT NO.: 821687

January 30, 2008

Prepared for:

Bulova Corporation

Prepared by:

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LIST OF ACRONYMS

BGS	Below Grade Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CA	Chloroethane
CO_2	Carbon Dioxide
CQAP	Construction Quality Assurance Plan
DCA	1,1-Dichloroethane
DCE	Dichloroethene
DNAPL	Dense Non-Aqueous Phase Liquids
ELAP	Environmental Laboratory Acceptance Program
EOS	Emulsified Oil Substrate
EPA	Environmental Protection Agency
EW	Extraction Well
FER	Final Engineer Report
GTI	Groundwater Technology, Inc.
HVAC	Heating, Ventilation, Air Conditioning
ITRC	Interstate Technology Regulatory Council
IW	Injection Well
MAC	MAC Consultants, Inc.
MNA	Monitored Natural Attenuation
mV	Milli Volt
MW	Monitoring Well
NaOH	Sodium Hydroxide
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene
ppm	Parts Per Million
PSIW`	Pilot Study Injection Well
PSMW	Pilot Study Monitoring Well
PID	Photo-Ionization Detector
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objectives
RAS	Remedial Action Selection
RAWP	Remedial Action Work Plan
RIR	Remedial Investigation Report
RSCO	Recommended Soil Cleanup Objectives

SCG	Standards, Criteria & Guidance
SMP	Site Management Plan
SoMP	Soil/Materials Management Plan
SVOC	Semi-Volatile Organic Compound
TAGM	Technical and Administrative Guidance Manual
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
µg/L	Micrograms Per Liter
UV	Ultraviolet
VCA	Voluntary Cleanup Agreement
VOC	Volatile Organic Compounds

CERTIFICATIONS

I, August Arrigo, am currently a registered professional engineer licensed by the State of New York. I have primary direct responsibility for implementation of the remedial program for the 75-20 Astoria Boulevard Site (NYSDEC VCA Index No. W2-0854-9906, Site No. 002453).

I certify that the Site description presented in this RAWP is identical to the Site descriptions presented in the Voluntary Cleanup Agreement for 75-20 Astoria Boulevard Site and related amendments.

I certify that this plan includes proposed use restrictions, Institutional Controls, Engineering Controls, and plans for all monitoring requirements applicable to the Site. This RAWP requires that if residual impacts remain, a Site Management Plan must be submitted by the Volunteers for the continual and proper operation, maintenance, and monitoring of all Engineering Controls employed at the Site, including the proper maintenance of all remaining monitoring wells, for approval by the Department.

I certify that this RAWP has a plan for transport and disposal of all soil, fill, fluids and other material removed from the property under this Plan, and that all transport and disposal will be performed in accordance with all local, State and Federal laws and requirements. All exported material will be taken to facilities licensed to accept this material in full compliance with all Federal, State and local laws.

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

AUGUST ANTHONY ARRIGO

4/16/08

NYS Professional Engineer#

4/16/08

Date

Signature

It is a violation of Article 130 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 130, New York State Education Law.

EXECUTIVE SUMMARY

Site Description/Physical Setting/Site History

Remedial activities are being completed pursuant to VCA #W2-0854-9906 between the New York State Department of Environmental Conservation (NYSDEC), Bulova Corporation (Bulova) and LaGuardia Corporate Center Associates, LLC (LaGuardia).

The Site is located at 75-20 Astoria Boulevard, Jackson Heights, New York. Jackson Heights is located near the north shore of Queens County. The Site is listed as block number 1027 and lot 50, and is bordered to the south by 25th Avenue, to the east by 77th Street, to the north by Astoria Boulevard and Grand Central Parkway, and to the west by the Brooklyn-Queens Expressway and a retail center.

In 1951, Bulova purchased the undeveloped property from Mow Bray Realtor. In 1952, Bulova developed the Site with a two-story building and a parking lot. Between 1952 and 1986, Bulova occupied the Site as its corporate headquarters, for research and development activities, and for the manufacturing of watch movements. In 1985, the Site was sold to LaGuardia, which later developed the existing building into a multi-tenant office complex. During Bulova's ownership, various chemical products were stored in several underground storage tanks. These tanks have since been removed.

Summary of the Remedial Investigation

Between March 2004 and December 2006, a Remedial Investigation (RI) was completed. As part of this RI, a total of 42 soil, 66 groundwater and 25 soil gas samples were collected and analyzed. In addition, precautionary soil vapor intrusion (SVI) testing was completed at the Site building and at nine (9) nearby residences. Results of the RI identified the following:

- The general stratigraphy at the Site can be described as fill material (sand, gravel and construction debris) overlying a low permeable silt layer. Underlying the low permeable silt layer is a fine sandy zone.
- The primary VOC contaminants included 1,1-dichloroethane (DCA) and 1,1,1-trichloroethane (TCA). Sporadic detections of other VOCs, including 1,1-dichloroethene (DCE), trichloroethene (TCE) and tetrachloroethene (PCE) above groundwater standards were also detected;
- The highest soil and groundwater concentrations were detected beneath a parking lot area, and were located within the low-permeable silt layer. Figures depicting the horizontal and vertical extent of soil impacts is presented below; and
- Soil and groundwater data indicate that TCA and DCA are being degraded naturally via biotic and/or abiotic mechanisms, but at insufficient rates.

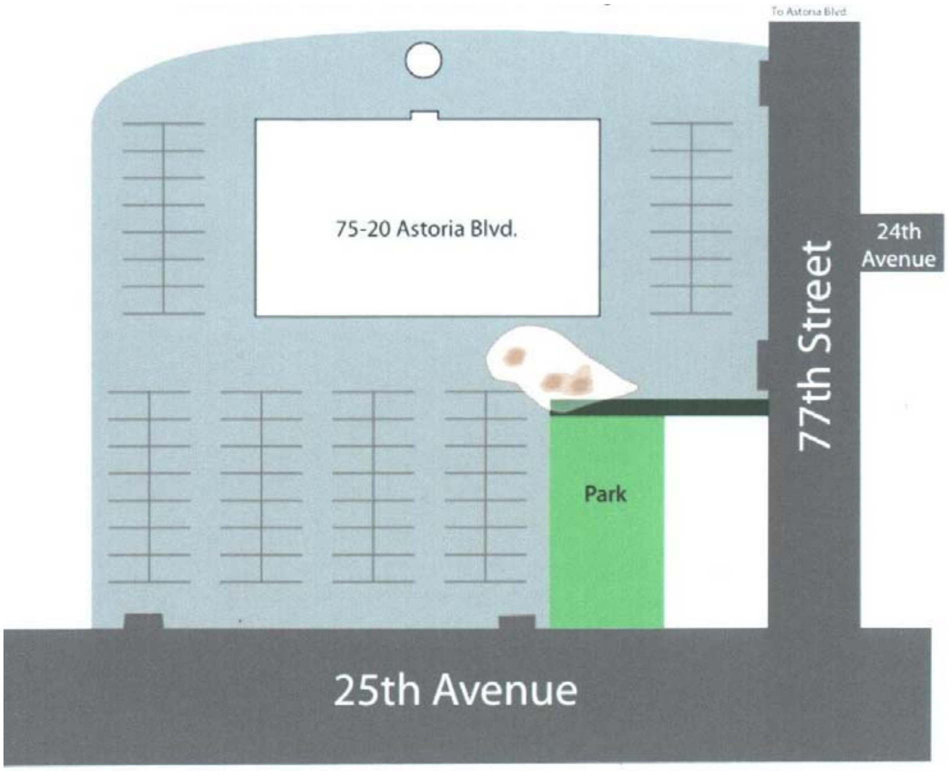

Figure 1 – Areal Placement of Soil Impacts

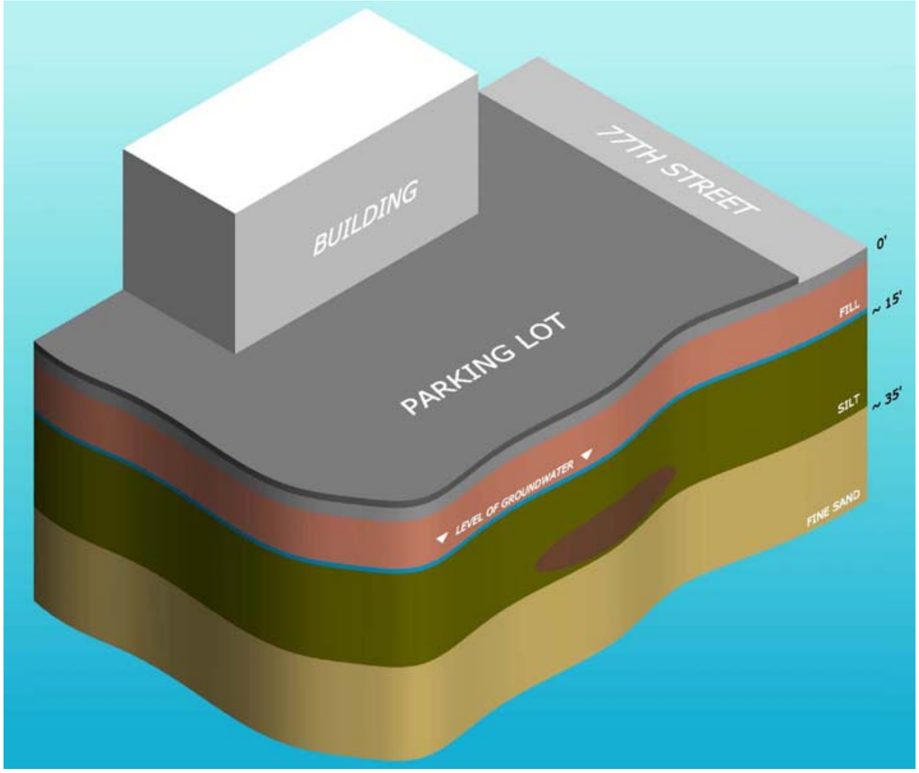

Figure 2 – Vertical Placement of Soil Impacts

In 2005, an anaerobic biostimulation treatability study was performed to screen this technology for implementation at the Site. The study was completed by adding lactate and nutrients to serum bottles containing Site soil and groundwater. Results of the biostimulation treatability study determined that TCA and DCA biodegradation rates in the source area (silt) soils were enhanced by the addition of lactate and nutrients.

Between October 2005 and October 2006, a biostimulation pilot study was completed. The purpose of the pilot study was to determine whether full-scale biostimlation treatment is feasible and practical. To complete the biostimulation pilot study, lactate and nutrients were added to the subsurface. This was initially implemented by pumping groundwater into a holding tank, amending the holding tank with the lactate/nutrients and injecting the groundwater/lactate mixture into the subsurface. Post injection monitoring identified a lactate consumption rate greater than expected; therefore, a continuous injection system was installed. This continuous injection system operated by constantly pumping groundwater from an extraction well, amending the extracted water with lactate/nutrients and reinjecting it into an injection well. The operation of this system provided a continuous supply of lactate/nutrients into the subsurface. Following completion of the pilot study, it was concluded that anaerobic biostimulation can effectively treat the Site contaminants.

Qualitative Human Health Exposure Assessment

A qualitative exposure assessment was completed as part of the RI. Evaluation of the exposure pathways concluded the following:

- Groundwater: There are no current or proposed uses for onsite groundwater; therefore, an exposure pathway does not exist. While the presence of private wells downgradient of the Site cannot be ruled out, it is highly unlikely that groundwater downgradient of the Site would be used for drinking water purposes since all of Queens County is on the New York City public water system, which gets its water from upstate reservoirs. While the use of these private downgradient wells (if any exist) for other purposes (e.g. lawn watering, car washing) also cannot be completely ruled out, it is highly unlikely that such wells would be installed into the same strata where elevated levels were identified (i.e., the silt layer) due to poor yields.
- Soil: Soils impacted by Site contaminants are present within the 15’ to 35’ below grade interval. Physical contact with these impacted soils is not possible due to the depth; therefore, an exposure pathway does not exist. In addition, the majority of the surface is covered with an asphalt parking lot.
- Soil Gas: Soil gas sampling indicated that VOC-impacted soil gas had migrated to the north (beneath the Site building) and east (across 77th Street). Based on this, the Site building as well as nine (9) adjacent residential structures were identified for precautionary soil vapor intrusion (SVI) testing. Results of the SVI testing determined that vapor intrusion had not occurred at either the Site building or at any of the adjacent residences.

Summary of the Proposed Remedy

The proposed remedy is as follows:

1. Composite Cover System: The existing composite cover cap in the vicinity of the former underground storage tanks and area of the plume will be maintained;
2. Treatment System: An *in-situ* bioremediation system will be constructed and operated to reduce contaminant levels;
3. Recording of Deed Restrictions to be executed prior to approval of the Final Engineering Report. Included in the Deed Restrictions will be the following:
   - Prohibition of vegetable gardens and farming at the Site;
   - Prohibition of using groundwater underlying the Site without treatment rendering it safe for its intended purpose;
   - Prohibition of using the Site other than for commercial purposes;
   - Prohibition of using the Site for a higher level of use, such as restricted residential, without an amendment or extinguishment of the Deed Restrictions with NYSDEC approval;
   - All future activities that will disturb residual contaminated material within the treatment area are prohibited without NYSDEC approval; and
   - Grantor agrees to submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property at any time in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow. This statement must be certified by an expert that the NYSDEC finds acceptable. If controls are no longer required, certifications can be discontinued following NYSDEC approval.

4. Development of an approvable Site Management Plan that defines Site management practices following during implementation of the remedy, including 1) an Engineering Control Plan; 2) a Monitoring Plan; 3) an Operation and Maintenance Plan; and 4) a Reporting Plan; and
5. Submission of a Final Engineering Report documenting all elements of the Remedy.

1.0 Introduction

Pursuant to the Voluntary Cleanup Agreement (VCA) and on behalf of Bulova Corporation (Bulova), Shaw Environmental and Infrastructure, Inc. (Shaw) has prepared this Remedial Action Work Plan (RAWP) covering remedial activities at the 75-20 Astoria Boulevard Site, Jackson Heights, Queens, New York (the Site). This work has been completed pursuant to VCA # W2-0854-9906 between the New York State Department of Environmental Conservation (NYSDEC), Bulova, and LaGuardia Corporate Center Associates, LLC (LaGuardia). This RAWP summarizes the investigative work performed at the site, presents pertinent conclusions on the nature and extent of the contamination, and presents a work plan for the selected remedial alternative. In developing this RAWP, Shaw reviewed all available environmental investigation reports for the Site. Shaw recently completed a Remedial Investigation Report (RIR, November, 2004) to update the characterization of the nature and extent of Site groundwater contamination; completed computer modeling and laboratory treatability studies in February 2005; and performed a biostimulation pilot demonstration from November 2005 to October 2006. Based on the RIR conclusions/recommendations and recent data obtained from the laboratory treatability studies and field pilot test, Shaw has proposed an aggressive remedial strategy that will remediate contamination such that residual DNAPL sources are eliminated and groundwater impacts are reduced to acceptable levels as determined by NYSDEC.

1.1 Purpose and Organization of Work Plan

This RAWP was prepared to summarize the historical and recent environmental quality data on the Site and provide a plan for Site remediation. Sections 1 through 3 provide the background for the proposed remedy. Sections 4 and 5 provide a remedial action scope of work and implementation schedule, respectively. Section 6 summarizes the governing remedial documents. Sections 7 through 9 discuss the Engineering and Institutional Controls. Section 10 discusses the Final Engineering Report, and Section 11 summarizes the remedy.

1.2 Site Location

The Site is located at 75-20 Astoria Boulevard, Jackson Heights, Queens County, New York City, New York (Figure 1). Jackson Heights is located near the north shore of Queens County. The property is listed as block number 1027 and lot number 50. The site is bordered to the south by 25th Avenue, to the east by 77th Street, to the north by Astoria Boulevard and Grand Central Parkway, and to the west by the Brooklyn-Queens Expressway and a retail center.

The site encompasses approximately 17 acres and contains one building. The building is multi-story, measuring approximately 350 feet by 450 feet. Parking lots are located on all sides of the building. A site map depicting the voluntary cleanup area is presented as Figure 2.

The surrounding area includes residential and commercial properties. A retail center is located to the west, residential properties and a park to the east and south, and the Grand Central Parkway to the north.

The closest body of water to the site is Bowery Bay, located approximately 3,000 feet to the north-northeast. Flushing Bay and the East River are located approximately 8,000 feet to the northeast and north-northwest, respectively.

1.3 Site History

In 1951, Bulova purchased the Site from Mow Bray Realtor. At that time, the Site was undeveloped. In 1952, Bulova developed the Site with a two-story building and a parking lot. Between 1952 and 1986, Bulova occupied the Site as its corporate headquarters, for research and development activities, and for the manufacturing of watch movements. In late 1985, the Site was sold to LaGuardia, which later developed the existing building by constructing a third floor and renovating the existing two floors into a multi-tenant office complex. LaGuardia has owned and operated the Site as an office complex since 1986.

1.4 Site Geology

There has been a considerable number of subsurface investigations completed at the site since the late 1990s. Based on these investigations, the subsurface can be generally characterized as fill material consisting of soil (sands and silts) and construction debris (i.e. brick, concrete, wood) in the upper 10-15 feet; underlying these fill materials is a low permeability silt layer which is approximately 20 feet thick. This silt layer is underlain by fine sands to the maximum depth of 60 feet below ground surface. One deep sample suggests that a silt layer underlies these fine sands.

Shallow groundwater flow in the fill material (overlying the silt layer) is in a generally southeasterly direction across the site. Depth to groundwater is approximately 15 feet below ground surface and is first encountered either in the fill as minor perched zones on top of the silt layer, or within the silt layer.

2.0 Site Characterization Activities

2.1 Previous (Through 2001) Remedial Investigations

Investigations have been conducted at the Site since the late 1990s. Thirty one monitoring wells and over 50 borings have been completed to date across the Site. The following is a list of previously prepared reports, data and correspondence regarding this Site.

- Groundwater Sampling-February 1995, MAC Consultants, Inc.
- Monitoring Well Installation and Groundwater Sampling, MAC Consultants, July 20, 1995.
- Groundwater Sampling, Groundwater Technology, Inc., April 1996.
- Draft Voluntary Cleanup Site Assessment Report and Additional Investigation and Remediation Workplan, Fluor Daniel GTI, March 5, 1997.
- Draft Voluntary Cleanup Supplemental Site Assessment Report, IT Corporation, February 21, 2002.

A summary of findings from these investigations is presented below. Historical sampling locations referenced are depicted on Figure 3.

2.1.1 MAC Consultants Investigations

In February 1995, MAC Consultants, Inc. (MAC) performed a soil and groundwater investigation in the shallow fill material. MAC collected soil and groundwater samples from monitoring wells MW-1 through MW-9/9A for analysis of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Total benzene, toluene, ethylbenzene and xylene (BTEX) concentrations in groundwater ranged from non-detect (ND) to 15 µg/l (ppb). Total chlorinated VOCs in groundwater ranged from 21 ppb to 2,777 ppb. Total SVOCs in groundwater ranged from ND to 8.8 ppb.

In June 1995, MAC installed four additional shallow (fill) monitoring wells (MW-10, MW-11, MW-12 and MW-13); sampled six (6) monitoring wells (MW-2, MW-9/9A, MW-10, MW-11, MW-12 and MW-13); and collected soil samples from MW-13. Total VOCs in groundwater were detected at concentrations of 13 ppb, 3 ppb, and 2 ppb from MW-11, MW-12, and MW-13, respectively. No VOCs were detected in MW-10. Wells MW-2 and MW-9/9A were not sampled for VOCs. Total SVOCs in groundwater were detected at concentrations of 7 ppb, 708 ppb, and 2 ppb from MW-11, MW-12, and MW-13, respectively. Samples from wells MW-2, MW-9/9A and MW-10 did not contain any SVOCs.

2.1.2 Groundwater Technology Investigation

Groundwater Technology, Inc. (GTI) conducted a Site investigation for groundwater in the shallow fill material during March 1996. The results of this investigation were as follows:

- No measurable liquid phase hydrocarbons (free product) were present in site wells;
- Groundwater flow in the fill was to the east-southeast;
- VOC concentrations exceeded NYSDEC class GA standards in MW-1 through MW-5, and MW-9/9A with the highest concentration being DCA;
- SVOC concentrations were within NYSDEC class GA standards; and
- Benzene at a concentration of 3.2 ppb in MW-4 was the only petroleum hydrocarbon above class GA standards.

2.1.3 Fluor Daniel GTI Investigation

Fluor Daniel GTI conducted an additional Site investigation in the shallow fill materials during November 1996. Based upon the results of this investigation, Fluor Daniel GTI concluded the following:

- The soil at the Site consists of fill material containing silty and clayey sand, medium sand, gravel and construction debris (i.e.: concrete, brick and wood) overlying marsh deposits and silt/clay from approximately 16 to 20 feet below grade, underlain by sand;
- The groundwater may be perched or partially perched above the silt/clay layer. This is likely since groundwater flow beneath the site is apparently to the southeast and easterly direction, while regional groundwater flow is to the north.
- All soil samples were below state standards with the exception of two samples, B-8 (12’-17’ below grade surface (bgs)) and B-10 (15’-18’ bgs), that contained elevated levels of DCA;
- No source locations for VOCs were obvious in the area around the former underground storage tanks (USTs), except for an area in the vicinity of the former supply line location;
- Along the downgradient side of the property and off site, concentrations of DCA exceeded Class GA standards in MW-14, MW-15, MW-16, MW-17 and MW-18 and TCA concentrations exceeded class GA standards in MW-14, MW-15, and MW-16. All other parameters were below Class GA standards in the downgradient wells.

2.1.4 IT Corporation Investigation

A report entitled, “Voluntary Cleanup Supplemental Site Assessment Report”, (February 21, 2002) was submitted to NYSDEC describing the results of additional investigations at the Site.

A soil boring program was conducted in February 2001 to delineate VOCs in the shallow fill materials in the vicinity of the suspected chemical storage supply lines. The supply lines consisted of underground piping that distributed product from the former chemical storage underground storage tanks to the rear of the building. Replacement of monitoring wells MW-6, MW-7 and MW-8 due to groundwater recharge issues was also completed. Groundwater samples were also obtained from the soil borings and from monitoring wells across the Site as part of the supplemental assessment.

The soil borings did not indicate levels of VOCs above Recommended Soil Cleanup Objectives (RSCO). SVOCs and metals were detected above RSCO but these were determined to be unrelated to the presence of chemical USTs at the Site.

In the groundwater samples, elevated levels of chlorinated VOCs were reported. SVOCs, pesticides and PCBs were either not detected or were below groundwater standards. Metals were also determined to be unrelated to the presence of USTs at the site, but were related to sediment loading in the groundwater samples.

As part of the assessment, a well search was completed at the NYSDEC office to locate surrounding public wells and industrial or private water supply wells. No public supply wells are located in this part of Queens County. Public water is supplied by reservoirs located in upstate New York. Several industrial wells were located upgradient and crossgradient to the property at a minimum distance of approximately 1/5 of a mile. It is unknown if these wells are still in operation. There were no records of private wells on file at the NYSDEC office. Three industrial wells were installed on the property itself, but they were never utilized and have been properly removed and abandoned due to poor yields.

Based on the results of the investigation, IT Corporation recommended quarterly sampling and reporting for VOCs to allow for trend analysis and determination of the stability of the plume.

On April 29, 2002, the NYSDEC sent a comment letter on the above investigation requiring additional investigative activities at the Site, including additional boring/monitoring well installation; soil gas sampling; and the preparation of a qualitative exposure assessment. A subsequent meeting was held with the NYSDEC to discuss the Department’s requirements. Based on those discussions, additional activities have been conducted, which are described in the following sections of this report.

2.2 Recent Site Investigations (2002 to 2006)

Since the completion of the February 2002 Supplemental Site Assessment Report and discussions with the NYSDEC, additional investigative activities have been conducted at the Site to provide a more focused assessment on the nature and extent of contamination. In particular, soil and groundwater in the silt and sand layers that underlie the fill materials have been investigated. The NYSDEC has been kept apprised in monthly progress reports, quarterly status reports, and investigation work plans that have summarized Site activities and results. The following describes the Site activities and the results of the recent investigations at the Site.

2.2.1 Soil and Groundwater Sampling

A groundwater-sampling event was conducted on April 15, 2003. During this sampling event groundwater samples were collected from all existing monitoring wells, including MW-23 through MW-27, which were installed in January, 2003. Groundwater samples were analyzed for VOCs.

Laboratory analysis identified significantly elevated concentrations within monitoring well MW-26 (deep well, screened in the underlying sand) relative to the concentrations detected in the shallow wells. In particular, a concentration of 11,000 ppb of DCA was detected in MW-26, which was several times greater than concentrations detected in the shallow wells across the site. Resampling of this well was conducted during May 2003, which confirmed the elevated concentration.

During the original drilling of MW-26, the silt layer was penetrated by the advancement of drill augers through the stratum. The high concentrations identified based on the April 2003 and May 2003 sampling suggested a potential for the presence of Dense Non Aqueous Phase Liquids (DNAPLs) and a concern that a pathway for DNAPL to migrate beneath the silt layer may have been created. Accordingly, MW-26 was properly abandoned on June 24, 2003.

Following the abandonment of MW-26, a replacement well, MW-26R, was installed on October 22, 2003, as a double-cased monitoring well to eliminate the possibility of creating a pathway through the silt layer. MW-26R was installed upgradient of MW-26 to eliminate concerns of being within the zone of influence of MW-26.

Concurrent with the installation of MW-26R, an additional well MW-28 was installed on top of the silt layer adjacent to MW-26R. The purpose of this installation was to determine the presence or absence of a DNAPL on top of the silt layer. Measurements were taken with a free product interface probe and samples were collected for VOC analysis before and after purging. The interface probe did not indicate the presence of free product, and concentrations of VOCs before and after purging were similar (i.e. several hundred parts per billion) indicating that no measurable DNAPL existed on the top of the silt layer at that location.

VOC levels in MW-26R were found to be comparable to those in MW-26 which indicated that the previous drilling of MW-26 through this layer did not result in the migration of contamination from the shallow to deeper groundwater regimes. This led to the conclusion that the silt layer was not serving as a barrier for dissolved DNAPL components, and was not preventing the migration of dissolved VOCs to the underlying sandy aquifer.

Based on the above, additional investigations were initiated during March, April and May 2004 to delineate the horizontal and vertical extent of contamination within and beneath the silt layer. The scope of work that was approved by the Department called for the collection of groundwater samples from borings beneath the silt layer at approximately 25 foot intervals, north, east, and west of MW-26R.

During the March 2004 investigation, nine borings (GW-1 through GW-9) were completed north, east and west of MW-26R at 25-foot intervals for the purpose of delineating the contamination. The borings were completed in such a manner as to avoid cross contamination from the upper groundwater aquifer to the lower groundwater aquifer. Soil and groundwater samples were collected from each boring for analysis of VOCs in accordance with EPA Method 8260.

During drilling activities through the silt layer, elevated PID readings (>2,000 parts per million) were detected. In addition, there were olfactory indications of soil impacts within the silt. Accordingly, soil and groundwater samples were obtained from within this unit in addition to groundwater samples beneath the silt as originally proposed. A groundwater sample was collected from within the silt layer through the use of a two-inch temporary well with the well screen residing completely in the clay strata, utilizing a disposable bailer.

A soil sample obtained from the installation of GW-8 at 25 feet bgs (corresponding to 10 feet into the silt layer) contained total VOCs of 2,127,000 μg/kg; of this total, the concentration of TCA was 2,100,000 μg/kg. A groundwater sample obtained from GW-8 within the silt layer (15-25 feet bgs or 0-10 feet into the silt) exhibited total VOCs of over 315,000 μg/L with TCA comprising the majority of the contamination (310,000 μg/L). These elevated detections coupled with high PID readings (>2,000 ppm) and odor indicated a potential source area of the VOC contamination (i.e., residual DNAPL) at the Site. Table 1 summarizes the detections of VOCs in the silt and underlying sand layers across the Site.

Cross sectional perspectives of the relative distribution of VOCs are provided in Figures 4 through 6. Figure 4 presents the locations of geologic cross sections A-A' which traverses the Site in an east west direction; B-B' provides a north to south cross sectional perspective. The continuity and stratigraphic correlations of the fill, silt, and underlying fine sand deposits as well as the distribution of DCA and TCA, are shown in Figures 5 (cross section A-A^1) and 6 (cross section B-B^1). The vast majority of the contaminant mass resides in the silt layer (15'-35' bgs) which, although not impermeable, does appear to hinder the downgradient migration of DNAPL into the deeper groundwater regime. Thus, residual DNAPL sources appear to reside within the silt zone.

Based on these initial results, additional investigations were conducted during the April and May 2004 investigation; 22 borings (GW-10 through GW-31) were completed. The borings were completed in 25-foot increments in all directions until the extent of the impact was delineated. This investigation again concentrated on the soil and groundwater impacts within the silt layer and underlying sand layer.

2.2.2 Soil and Groundwater Sampling Results

2.2.2.1 Soil

The primary VOC contaminants in the soil at the Site, based on concentrations detected and the number of locations where RSCO values were exceeded, are DCA and TCA. There were also sporadic detections of other VOCs (e.g., 1,1-Dichloroethene (1,1-DCE), Trichloroethene (TCE), and Tetrachloroethene (PCE)) that exceeded RSCOs but concentrations were generally substantially lower than the DCA and TCA levels. Detections of these other VOCs occurred at those locations where DCA and TCA were most elevated.

Table 1 summarizes the detections of VOCs in the silt soil unit across the Site. The highest soil concentrations of DCA and TCA were detected at locations GW-3, GW-8 and GW-17. DCA concentrations at these 3 boring locations ranged from 6,300 μg/kg at GW-3 to 11,000 μg/kg at GW-8. TCA concentrations were highest in GW-8 where 2,100,000 μg/kg of this constituent was detected. GW-3 and GW-17 exhibited TCA concentrations of 170,000 μg/kg and 1,000,000 μg/kg, respectively. These concentrations were well in excess of the RSCOs, and are indicative of the presence of residual DNAPL.

2.2.2.2 Groundwater

Tables 2 and 3 summarize the detections of VOCs in the silt groundwater and deep groundwater, respectively, across the Site. Within the context of this investigation, the silt groundwater refers to the zone encountered within the silt unit and generally at a depth of 15-25 feet below ground surface. The deep groundwater refers to the sandy zone beneath the silt layer where groundwater samples were obtained at 47-49 feet below ground surface. (The groundwater from GW-6 was obtained from 49-51 feet below ground surface.) Similar to the soil analytical results, the highest VOC detections were associated with DCA and TCA. With few exceptions, the silt and deep groundwater samples exhibited DCA and TCA concentrations above groundwater quality standards. Other VOCs detected above groundwater quality standards included CA, 1,1-DCE and TCE. Elevated detections of these constituents were generally associated with the most contaminated groundwater sample locations for DCA and TCA.

In general, both DCA and TCA concentrations in the deep groundwater were orders of magnitude less than in corresponding silt groundwater. For example in GW-25, DCA concentrations decreased from 55,000 μg/L in the silt groundwater sample to 89 μg/L in the underlying deep sample. Likewise TCA concentrations decreased in GW-25 from 280,000 μg/L in the silt groundwater to 10 μg/L in the underlying deep groundwater. Soil concentrations were also generally lower in the underlying sand than in the silt layer. These data are consistent with the presence of a residual DNAPL source contained in the low permeability silt layer.

In addition to obtaining groundwater from the 47-49 foot bgs interval, additional groundwater samples were collected at greater depths at two locations (GW-8 and GW-11) to vertically delineate the contamination. At GW-8, additional samples were collected at 57-59 feet bgs and 66-68 feet bgs. Samples collected in the 57-59 feet bgs interval suggested that contaminant concentrations were decreasing substantially with depth, as DCA concentrations decreased from 4,200 μg/L (47’-49’ bgs) to 26 μg/L (57’-59’ bgs) and TCA concentrations decreased from 2,800 μg/L (47’-49’ bgs) to 27 μg/L (57’-59’ bgs). However, DCA and TCA concentrations increased to 5,200 μg/L and 6,500 μg/L (respectively) in the underlying 66-68 feet bgs interval. Despite these elevated DCA and TCA groundwater concentrations, based on soil concentrations of DCA and TCA at this depth (27 μg/kg and 17 μg/kg, respectively), a DNAPL source does not appear to be present in this deep sand layer.

During this investigation, laboratory analysis of groundwater samples collected at GW-16 identified groundwater impacts in both the silt/clay layer zone as well as in the underlying sandy zone that would be indicative of DNAPL being present; however, soil VOC concentrations were minimal. Additionally, USTs or associated lines have never been present within this area, thereby adding to the unlikelihood that a DNAPL source would exist. Based on this information, it was decided to resample GW-16 to confirm the results. On December 2, 2006, a Geoprobe® was mobilized to the Site to resample GW-16. Groundwater was collected from the silt/clay zone (19’-23’ bgs) and the underlying sandy zone (45’-49’ bgs), and a soil sample was collected from the silt/clay zone (30’-35’ bgs). Analysis of the groundwater samples identified dramatically reduced concentrations in the groundwater, and the soil analysis confirmed a DNAPL source does not exist. The results of the soil and groundwater samples have been included in Tables 1 through 3.

2.2.3 Hydrogeologic Evaluation & Contaminant Transport

In October 2004, a total of three monitoring well clusters were installed, designated as monitoring wells MW-29S,D, MW-30S,D, and MW-31S,D. These clusters, located proximate to GW-8, GW-17 and GW-18 (see Figure 7), each contained two monitoring wells, one screened within the silt layer, and one screened in the underlying sandy zone. Appendix A contains soil boring and well construction logs for these monitoring locations.

Each monitoring well was drilled using hollow stem augers. To install the monitoring wells set into the silt layer, 4½” augers were advanced to approximately two-feet above the lower extent of the silt/clay layer. Split spoon soil samples were collected continuously in the area in which the monitoring well screen would be installed. All split spoon soil samples were screened with a photo-ionization detector (PID), inspected and logged.

Upon obtaining the required depth, a 4” Sch. 40 PVC monitoring well containing a 5-foot well screen was inserted into the borehole. Well sand was then placed around the well screen to approximately three feet above the top of the well screen, followed by three feet of bentonite.

Grout was then injected under pressure from the top of the bentonite to a depth above the silt layer. Sand was then filled to the surface and a flush-mounted roadbox installed.

To install the monitoring wells set into the underlying sandy zone, 4½“ augers were advanced to a depth in which the silt layer was identified (approximately 25 to 30 feet below grade). Following identification of the silt layer, the 4½” augers were removed and 10¼” augers were drilled into the silt layer. The 4½”augers were then advanced inside the 10½” augers to the required depth. This auger-in-auger method was completed to avoid cross contamination from the upper groundwater aquifer to the lower groundwater aquifer. Split spoon soil samples were collected continuously in the area in which the monitoring well screen would be installed. All split spoon soil samples were screened with a photo-ionization detector (PID), inspected and logged.

After obtaining the required depth, a 2” Sch. 40 PVC monitoring well containing 10-foot of well screen was inserted into the borehole. Sand, bentonite and grout were then added to the borehole in a manner similar to the wells installed in the silt layer.

Recovery tests were performed at each of the newly installed monitoring well clusters in November 2004. Results indicated that the hydraulic conductivity in the silt zone was approximately 0.014 ft/day, and that the hydraulic conductivity in the sand zone was approximately 0.072 ft/day. The hydraulic conductivity in the silt zone was higher than expected, and is likely due to the presence of interbedded sands within the silt. A pump test was performed at MW-29D in May, 2005 to confirm the hydraulic conductivity value in the sand measured by the recovery test. Pump test results indicated that the hydraulic conductivity of the sand zone was approximately 0.3 ft/day, which is in reasonable (factor of approximately 4) agreement with the recovery test data.

Groundwater flow velocity was calculated by using Darcy’s Law (assuming a porosity of 0.3) and by measuring the hydraulic gradient in both the sand and the silt zones. The measured hydraulic gradient in the silt was 0.015 to the southeast, resulting in a calculated groundwater flow of 0.25 ft/yr to the southeast. The measured hydraulic gradient in the sand was 0.0084 to the northeast, resulting in a calculated groundwater flow of 0.70 ft/yr to the northeast.

Rates of lateral DCA and TCA migration through the silt groundwater and sand groundwater were conservatively estimated by dividing the groundwater velocity by the contaminant retardation factor. The contaminant retardation factor (R) for both DCA and TCA was calculated as follows:

$$R = 1 + \frac{\rho K}{\varepsilon} \qquad \text{Eq. 1}$$

where ε is the porosity (estimated at 0.3), ρ is the soil bulk density (estimated at 1.4 kg/L), and K is the soil-water sorption coefficient (L/kg). Values of K were calculated based on data from the laboratory treatability study (Appendix B). Values of K for DCA in the silt and sand were 1.3 L/kg and 0.28 L/kg, respectively; values of K for TCA in the silt and sand were 1.1 L/kg and 0.49 L/kg, respectively. Using these K values in Equation 1, rates of dissolved DCA and TCA migration through the silt are less than one inch per year; rates of convective DCA and TCA migration through the sand are on the scale of approximately two inches per year. Thus, contaminant sources on-Site are not expected to migrate towards downgradient receptors at any appreciable rate. *NOTE: These migration estimates do not take into account any additional attenuation mechanisms, such as dilution, diffusion/dispersion, abiotic/biotic degradation mechanisms, or volatilization.*

3.0 Remedial Action Selection (RAS)

The purpose of the RAS is to identify and evaluate the most appropriate remedial action for a particular site. In developing the remedial strategy, the selected remedial alternative needs to satisfy a set of remedial action objectives (RAOs). The proposed RAOs are described below.

1. **Protection of Public Health and the Environment – Ensure that on-site contaminant levels in soil and groundwater do not pose unacceptable risks to the public health:**

   The selected remedial approach should not create a exposure pathway. Currently there is no use of groundwater at the Site and no other potential for the building occupants to contact subsurface contaminants. The only potential exposure pathway of concern is vapor intrusion into indoor air. This has been shown not to be a concern, based on indoor air sampling previously conducted at the Site and at nearby residences (see Shaw's letter reports entitled "Soil Vapor Study – 75-20 Astoria Boulevard" and "Soil Vapor Study – Various Residential Dwellings", both dated June 6, 2005, for sampling details and results).

2. **Standards, Criteria & Guidance (SCGs):**

   To the extent practical, the objective is to achieve applicable SCGs; however, at a minimum, the goal of the remedial action will be the elimination of the DNAPL sources, reduction of dissolved-phase contaminant mass to an extent acceptable to NYSDEC and preventing future exposure to residual impacts by implementation of Deed Restrictions. For evaluation of the data the following SCGs will be used: Soil: NYSDEC's TAGM 4046 - Recommended Soil Cleanup Objectives (RSCOs); Groundwater: NYSDEC's Class GA standards; and Vapor: NYSDOH's Guidance for Evaluating Soil Vapor Intrusion in the State of New York.

3. **Short-term Effectiveness:**

   The selected remedial approach should be able to achieve significant short-term (i.e. within 2 years) reductions.

4. **Long-term Effectiveness and Permanence:**

   The remedial approach selected must have the ability to achieve permanent results following completion of the remedial action.

5. **Reduction of Toxicity, Mobility or Volume with Treatment:**

   The remedial approach must have the ability to reduce the toxicity, mobility or volume of the contaminants for each media (i.e. soil, groundwater, etc.)

6. **Implementability:**

The remedial approach must be technically and economically feasible for all aspects of the project, including construction, maintenance and monitoring.

3.1 Technology Screening

During the RAS process the following remedial technologies were reviewed:

Technology	**Pro**	**Con**	**Selected for Further Evaluation (Y/N)**
AS/SVE	• Proven technology • TCA/DCA/CA can be easily stripped	• Difficult to implement in site geology	N
Pump & Treat	• Proven technology	• Long time frame • Low well yield rates	N
Thermal-SVE (ERH)	• Effective in saturated zone • Effective for target VOCs	• Vapor recovery may be difficult in site geology • Cost prohibitive	N
Permanganate	• Easy to distribute	• Not effective for chlorinated ethanes • High soil oxidant demands (SOD) can impede	N
Fenton's Reagent	• Relatively quick reaction	• High SOD can impede • Fast CO_2 generation • Health & Safety considerations	N
Surfactant / Co-solvent Flushing	• Enhances removal of DNAPL • Can stimulate biodegradation	• Potential spread of DNAPL • Ex situ treatment required	N
Excavation	• Effective for soil impacts	• Does not address groundwater impacts • Potential creation of pathway for silt-layer groundwater impacts to migrate into underlying sandy zone • Disruptive to Site operations • Cost prohibitive	No; however, is being considered as a contingency

Technology	Pro	Con	Selected for Further Evaluation (Y/N)
Biostimulation	• Easy to distribute • Low-cost • Sustained activity • Treats dissolved and sorbed contaminants	• Possible slow/incomplete dechlorination needs to be evaluated in treatability studies	**Y**
Persulfate	• Easy to distribute • Rapid reaction	• High pH activation • High SOD can impede	**Y**

3.2 Laboratory Treatability Studies

In-situ biostimulation and chemical oxidation were the two treatment approaches that were considered for the Site. The effectiveness of these approaches in the subsurface depends on several site-specific factors, including soil/groundwater geochemistry, the presence of additional organic or inorganic compounds (e.g., non-target or unidentified compounds), and dissolved target compound concentrations. Laboratory treatability studies were conducted using site materials (soil and groundwater) to screen these potential treatment technologies for implementability at the Site. Appendix B contains the complete treatability study report. Highlights of the report are presented in the following subsections.

3.2.1 Biostimulation Treatment Options for TCA and DCA

In-situ biostimulation involves stimulating the degradative activity of indigenous microbial populations by introducing oxygen, a co-metabolite, electron donors, and/or nutrients into the subsurface. The assumption with this approach is that the indigenous microbial population is competent to degrade the target compounds at a site, but is unable to maintain high levels of degradative activity due to unfavorable redox or other geochemical conditions.

Biodegradation of TCA has been reported under aerobic conditions via co-metabolism, utilizing propane or ethane as the co-substrate[1]. This removal mechanism has not been studied as frequently or as thoroughly as has anaerobic degradation, but it appears to be an effective treatment option in some circumstances.
However, the groundwater characteristics within the silt layer indicate that conditions are mildly reducing, with oxidation-reduction potential (ORP) values ranging from -50 mV to -

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[1] Yagi, O., Hashimoto, A., Iwasaki, K., and Nakajima, M. "Aerobic Degradation of 1,1,1-Trichloroethane by Mycobacterium spp. Isolated from Soil", *Appl. Environ. Micro*., 65, 4693-4696, 1999.

150 mV. The presence of DCA and CA indicate that anaerobic biodegradation of TCA is likely occurring. The presence of cis-1,2-dichloroethene (1,2-DCE), a daughter product of PCE and TCE anaerobic biodegradation, further indicates that reducing conditions are present within the silt source area. The presence of 1,1-DCE, a dechlorination product of *abiotic* degradation of TCA[2], suggests that abiotic transformation of TCA is also occurring at the Site. The presence of VC is likely due to the anaerobic biodegradation of PCE and TCE, and/or the abiotic degradation of TCA and 1,1-DCE.

In addition, distribution of oxygen in low permeability soil can be difficult. Thus, for this Site, anaerobic biostimulation is preferred as a treatment approach in lieu of aerobic biostimulation. Several studies have shown that TCA is amenable to anaerobic biodegradation[3]. Use of biostimulation to enhance the naturally occurring biodegradation rates has the potential to accelerate DNAPL removal and mitigate release of dissolved contaminants to the underlying aquifer. Bioremediation, in general, has been shown to be an effective *in situ* treatment technology for DNAPL source zones[4]. Shaw has extensive experience with the application of electron donors (e.g., lactate, ethanol) for anaerobic biostimulation for treatment of chlorinated organic contaminants. The use of a “slow release” electron donor (e.g., vegetable oil) has been shown to be effective at creating biological barriers to prevent the downgradient migration of chlorinated compounds. This “slow release” electron donor approach was considered for the sandy aquifer zone. Thus, an anaerobic biostimulation treatability study was proposed and implemented for both the silt zone and the underlying sandy aquifer.

3.2.2 Chemical Oxidation Treatment Options for TCA and DCA

Despite the use of biostimulation, anaerobic biodegradation rates (in some cases) may prove insufficient for removal of DNAPL sources within a reasonable timeframe. This may be due to limited microbial population, DNAPL toxicity effects, and/or geochemical conditions. In these instances, *in situ* chemical oxidation is often an effective alternative for treatment of DNAPL-contaminated soils. *In-situ* chemical oxidation is an abiotic treatment option that involves the use of chemical oxidants to chemically degrade the target compounds.

Several oxidants have been used to successfully treat volatile organic contamination in soil and groundwater by chemical rather than biological means, including hydrogen peroxide, Fenton’s reagent (hydrogen peroxide and iron catalyst), persulfate, permanganate, ozone, and ultraviolet (UV) oxidation. Typically, abiotic oxidation treats target contaminants much more rapidly than biological treatment, especially in the presence of DNAPL sources. Several instances of advanced oxidation of chlorinated ethanes using a combination of hydrogen

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[2] Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., and Michalenko, E.M., *Handbook of Environmental Degradation Rates*, Lewis Publishers, 1991.

[3] Reviewed in: Dobson, S. and Jensen, A.A., *International Program on Chemical Safety – 1,1,1-Trichloroethane*. World Health Org., 1990.

[4] The Interstate Technology and Regulatory Council (ITRC). “Overview of In Situ Bioremediation of Chlorinated Ethene DNAPL Source Zones”, October, 2005.

peroxide and ultraviolet (UV) radiation have been reported in the literature, but application of UV treatment requires that the groundwater be pumped to the surface and treated by UV and would not be an effective *in situ* option. Distribution of ozone in low permeability soils would be difficult. Permanganate oxidation is not an effective treatment for chlorinated ethanes.

For the treatment of chlorinated ethanes, numerous successful applications of Fenton's oxidation have been reported by vendors of commercially available Fenton's reagents. Treatment can occur at neutral pH if a chelated iron is used. However, gaseous CO_2 is produced from this reaction, which will likely be difficult to mitigate within the silt and interbedded sands in a field-scale application. Persulfate oxidation at high pH, elevated temperatures, or in the presence of hydrogen peroxide has also been demonstrated as an effective treatment for TCA. Use of persulfate at elevated pH is not expected to result in rapid CO_2 production. Thus, a treatability study using persulfate was also conducted for the silt source area.

3.2.3 Implementation of Treatability Studies

The following approaches were tested in the treatability studies:

- Anaerobic biostimulation (silt source area soil and underlying sandy aquifer soil)
- Chemical oxidation (silt source area soil only)

Both studies were performed at Shaw's Laboratory in Lawrenceville, NJ. The laboratory studies were performed as microcosm studies, prepared by adding site soil, groundwater and amendments to glass serum bottles. As such, the microcosms represented fully mixed conditions and were used in order to screen site-specific treatment technologies.

3.2.4 Conclusions Derived from the Treatability Studies

Results of the laboratory treatability studies indicate the following:

- Chemical oxidation of TCA in the Source Area soil via persulfate with heat or caustic activation was ineffective, as high dosages of NaOH and persulfate (relative to the soil mass) were needed to obtain even a 60% TCA mass removal. The ineffectiveness of this treatment is due primarily to the buffering capacity and oxidant demand of the soil;
- TCA and DCA biodegradation rates in the Source Area (silt) soil were enhanced by addition of lactate and nutrients. No accumulation of CA (or any other detectable VOC) was observed;
- Using a simple first-order decay expression, and using the rate constants measured in this laboratory study, the time needed for TCA and DCA groundwater concentrations in the GW-8 Source Area to decrease to 5 µg/L is estimated at roughly 6 to 10 years

(conservatively assuming initial TCA and DCA groundwater concentrations of 500 mg/L and 30 mg/L, respectively);

- Use of Emulsified Oil Substrate (EOS) was effective at enhancing biodegradation of TCA and DCA in the Underlying Sand. A sequential biodegradation pathway of TCA to DCA to CA was identified. However, CA accumulation was observed, and CA degradation to ethane proceeded slowly, at best.

Overall, biostimulation using lactate and nutrients showed the potential to degrade TCA and DCA in the Source Area soil without accumulation of CA, thereby serving as a viable remedial option for evaluation in a pilot scale demonstration. However, due to the relatively long (6 to 10 year) time frame, additional laboratory studies using microorganisms enriched from the Site were performed. These organisms could, if needed, be used to supplement a biostimulation remedy (thereby becoming a bioaugmentation remedy). Use of bioaugmentation could potentially increase the rate of TCA, DCA, and CA biodegradation, thus reducing the overall treatment time. However, as discussed in the following section, results from the pilot test show that the estimated time frame for an *in-situ* biostimulation remedy is on the order of two years, and that bioaugmentation will not be necessary.

3.3 Anaerobic Biostimulation Pilot Test

Based on the treatability study findings, a biostimulation pilot test using lactate as the electron donor was performed between October 2005 and October 2006. Details of the pilot test are discussed in the following sections.

3.3.1 Anaerobic Biostimulation Pilot Test Objectives

The overall goal of the pilot test was to determine if progression to full-scale biostimulation treatment is feasible and practical. The specific objectives of the anaerobic biostimulation pilot test were as follows:

- <u>Confirm that anaerobic biostimulation effectively remediates Site soils and groundwater at the Site</u> – As previously stated, the primary goal of the remedial project is to treat DNAPL sources. As such, groundwater monitoring and soil sampling during the pilot test were used to confirm that this remedial objective was achieved in the pilot test, thereby serving as a tool to evaluate the potential for project success at full-scale;

- <u>Demonstrate that CA accumulation does not occur as a result of TCA and DCA degradation</u> - During the biostimulation laboratory treatability study, TCA and DCA were biodegraded in the silty soil without accumulation of CA. However, accumulation of CA was observed in treatments using emulsified vegetable oil as an electron donor, and in treatment performed at elevated (30 degrees C) temperature. In these latter two treatments, subsequent degradation of

CA proceeded slowly (at best). Thus, data collected during the pilot test was used to assess CA accumulation concerns;

- Estimate contaminant biodegradation rates – Rates of contaminant degradation were measured. These rates were used to estimate the site-wide remedial timeframe, and facilitate development of the most appropriate monitoring frequency;

- Verify the ability to effectively deliver the amendment solution – Performance of the pilot test was used to confirm our ability to sufficiently distribute biological amendments in the subsurface;

- Determine the proper injection well spacing – Due to the relatively low permeability of source area soil, injection well spacing was expected to be relatively close. Thus, determining the radius of influence during the pilot test provided essential information for full scale design and implementation;

- Estimate the required amendment dosage and consumption rate – The rate of electron donor consumption measured during the pilot test was used to design the most appropriate amendment delivery system for full-scale treatment.

3.3.2 Test Plot Layout

The pilot test location (as presented on Figure 9) was selected based on the following:

- High contaminant levels – Substantial contaminant reduction (including reduction of residual DNAPL sources) was expected during the pilot test.

- Nearby monitoring wells screened in the targeted treatment zone and monitoring zones – This mitigated the upfront capital costs of drilling/installing new wells.

- Site accessibility – The pilot test location was selected so as to limit disruption to site activities.

The test area was approximately 16 feet by 16 feet, oriented as shown on Figure 9. The treatment zone was assumed to be the bottom 10 feet of the silt layer, corresponding to the location of suspected residual DNAPL sources. Therefore, the test plot injection and monitoring wells were screened appropriately based on the geology, as described in the following paragraphs.

The first phase of the pilot test consisted of well installations. Each monitoring well location was drilled using 4½” ID hollow stem augers. Split spoon samples were collected in the area in which the monitoring well screen would reside. All split spoon samples were screened with a PID, inspected and logged.

Two (2) amendment injection wells (PSIW-1 & PSIW-2) were installed approximately 8 feet apart, down to a total depth of approximately 29 feet below ground surface (2 feet above the bottom of the silt layer (see Figure 10). The screen/sand pack interval was from approximately 21-29 feet below ground surface, insuring that the top of the interval is at least 2 feet below the top of the silt layer. Keeping the screen/sand pack at least 2 feet from the top and bottom of the silt layer would help limit short-circuiting of amendment as it is injected into the well. The target zone for the amendment (lactate & nutrients) was the silt layer, not the sandy material above or below. The injection wells were constructed of 4-inch Schedule 40 PVC.

Nine (9) additional pilot test monitoring locations were drilled within the test plot area as shown on Figure 9. Four of these locations (PSMW-1, 4, 5, & 6) contained nested monitoring points (2 wells per borehole) to monitor two distinct intervals within the target treatment zone (silt layer). The monitoring wells were constructed of 2-inch Schedule 40 PVC, as presented on Figure 10. Pilot test monitoring well PSMW-9, screened within the sandy layer below the silt, was monitored for amendment seepage (short-circuiting) during injection activities as well as to evaluate groundwater quality within the underlying sandy zone throughout the pilot test.

Pilot test well construction logs are included in Appendix A.

3.3.3 Baseline Groundwater Monitoring

Following well installation, Shaw performed baseline groundwater monitoring to characterize the current chemical, biological, and geochemical conditions within the pilot test treatment zone. Two sampling events were performed, one four weeks prior to amendment injection and one two weeks prior to amendment injection. A round of synoptic groundwater levels were measured prior to commencement of each sampling event. Sixteen (16) wells (MW-29S, MW-29D, PSMW-1 through PSMW-9, and PSIW-2) were sampled during each event using standard low flow purge sampling techniques. A multi-parameter sampling meter (YSI 6820) was used in the field to measure groundwater geochemical parameters including:

Dissolved Oxygen
Turbidity
pH
Temperature
Oxidation-Reduction Potential (ORP)
Conductivity

These readings not only were used to characterize the geochemistry of the groundwater at each well, but their stability was also used to serve as criteria for sample collection. Samples from each location were analyzed for VOCs, natural attenuation parameters (NAPs), and volatile fatty acids (VFAs, including lactate). NAPs to be analyzed for include the following:

Total Dissolved Solids
Chloride
Methane
Sulfate

Total Phosphorus	Nitrate	Ethane	Sulfide
Alkalinity	Nitrite	Ethene	

One trip blank was analyzed for VOCs for each cooler. For the first baseline sampling event, Chemtech Laboratories, located in Mountainside, New Jersey, conducted the VOC analyses, while Shaw's in-house laboratory located in Lawrenceville, New Jersey, conducted all other analyses. For the second baseline sampling event and all future sampling rounds, Shaw's in-house laboratory conducted all analyses.

Pilot test baseline groundwater sampling results have been included as part of Table 4.

3.3.4 Pilot Test Implementation Procedures

Between October 1 and 16, 2005, approximately 2,800-gallons of groundwater was collected into a tank and subsequently amended with electron donor (sodium lactate to a concentration of approximately 2,500 mg/L) and nutrients (yeast extract and diammonium phosphate to concentrations of approximately 200 mg/L each). Injection of the amended groundwater into PSIW-1 was then initiated on October 17, 2005 and continued until October 31, 2005. Following the completion of the injection, three rounds of post-amendment injection groundwater sampling was performed. These sampling events commenced on November 7, November 14, and November 21, 2005.

As will be discussed in Section 3.3.5, the observed rate of electron donor consumption during this initial phase of the pilot test was substantially greater than the rate of electron donor consumption observed during the laboratory microcosm testing. To maintain an electron donor supply sufficient to facilitate biodegradation of the chlorinated ethanes, the pilot test methodology was modified to include a continuous groundwater injection-extraction approach. The re-injected groundwater was amended with electron donor and nutrients at concentrations similar to the initial batch injection. Design and installation of the injection/extraction system was completed in the first week of February 2006. Photographs of the pilot test continuous injection system has been included as Appendix D.

Starting February 10 through March 30, 2006, the continuous flow recirculation system operated utilizing MW-29D as the extraction well and PSIW-1 as the injection well. The groundwater recirculation flow rate was approximately 0.1 gpm. Groundwater monitoring events during this phase were conducted on March 1, March 15, and March 29, 2006.

Between April 4 and June 1, 2006, monitoring well MW-6D was utilized as the extraction well, and PSIW-1 continued as the injection well. This modification was made to limit decreases in chlorinated ethane concentrations in the source area due to dilution, as chlorinated ethane concentrations in MW-29D were relatively low compared to pilot test area wells. The groundwater recirculation flow rate extracted from MW-6D (and subsequently injected into

PSIW-1) was approximately 0.06 gpm. Groundwater monitoring events were conducted on April 12, April 27, May 10 and May 25, 2006.

Between June 1 and July 19, 2006, monitoring well MW-29S was utilized as the extraction well, and PSIW-1 continued as the injection well. This modification was made to limit VOC loading into the bioreactive zone, as MW-6D was located outside the bioreactive zone and thus was not being influenced during the pilot study activities. The groundwater recirculation flow rate was approximately 0.04 gpm. Groundwater monitoring events were conducted on June 7, June 22, July 5, and July 19, 2006.

Following shutdown of the groundwater recirculation system on July 19, 2006, three post-injection groundwater sampling events were performed to evaluate potential contaminant rebound, and/or to evaluate chlorinated ethane decay in the absence of active recirculation. These sampling events were conducted on August 1, September 6 and October 17, 2006.

A summary of the pilot treatment schedule and operating conditions is presented in Table 6.

On September 5, 2006, two soil borings (GW-32 and GW-33) were completed for the collection and analysis of soil samples. These borings were collected to confirm that chlorinated ethanes were effectively treated in the soil and/or undissolved phase. Soil cores were collected from the approximate center of the pilot test area (Figure 9). Two soil samples from each soil boring were selected for laboratory VOC analysis (EPA Method 8260), and were selected based on PID readings or, in the absence of elevated PID readings, the screened zones of the nested monitoring wells. At GW-32, soil samples were collected from 10’-15’ bgs and 20’-25’ bgs, and at GW-33 soil samples were collected at 20’-25’ bgs and 25’-30’ bgs.

3.3.5 Results

Groundwater monitoring results for each phase of the pilot test are summarized in Table 4. Depth-to-water measurements measured at baseline, and at 24 and 72 hours after commencing batch injection, are summarized in Table 7. Observations for each phase are discussed in the sub-sections below.

Initial Batch Injection

Results of the initial batch injection showed the following:

- A radius of influence of at least 9 feet, as indicated by elevated water table levels and/or the presence of lactate fermentation products (e.g., acetic, propionic, formic, or butyric acids), was observed. In addition, amendments were effectively delivered radially and vertically throughout the targeted treatment zone, as only two monitoring locations (PSIW-2 and MW-8) did not have any detectable levels of VFAs during the first phase of injections.

- Elevated water table levels and VFA concentrations at MW-9 indicate that amendments were also delivered in the shallow sandy zone (immediately below the targeted interval) at a rate similar to the silt source area.

- ORP and sulfate concentrations decreased, indicating that biological activity (facilitated by the addition of the electron donor) was creating reducing conditions in the aquifer.

- CA concentrations increased at several monitoring locations, likely due to dechlorination of TCA and DCA.

- Lactate concentrations were below the analytical detection limit in all monitored wells, presumably due to rapid consumption of this readily-biodegradable electron donor. In addition, concentration of the other fermentable VFAs were generally low (i.e., <100 mg/L). These data suggest that electron donor demand in the aquifer was greater than anticipated, and that a constant supply of lactate was required to maintain the needed biogeochemical conditions. The reason for the increased rate of lactate consumption, relative to the laboratory data, is not readily explained, but may be due to increased microbial growth in the natural aquifer compared to the closed microcosm system.

Recirculation from MW-29D, MW-6D, and MW-29S into PSIW-1

Groundwater monitoring during groundwater extraction from MW-29D, MW-6D, and MW-29S (Phases 2 through 4, respectively) confirmed the observations identified during the initial batch injection. Injection of the electron donor resulted in a continued decrease in sulfate concentrations, generation of methane, decreases in TCA and DCA, and transient increases in CA. These observations are all consistent with a sequential reductive dechlorination process. As suggested by the laboratory microcosm studies, as well as by published chlorinated ethane studies (Galli and McCarty, 1989; Chen et al., 1999), the biodegradation end-product was likely acetic acid (and ultimately CO2). However, these end products were also generated due to the lactate fermentation, so evaluation of a chlorinated ethane mass balance was not possible. As such, a quantitative interpretation of the varying chlorinated ethane concentrations throughout the course of the pilot test was performed using a three-dimensional numerical groundwater flow and transport model, as discussed in Section 3.3.6.

It is noted that monitoring well MW-31S, which is located far outside of the pilot test area, had measurable concentrations of acetic acid. Elevated chlorinated ethane levels are also present at this location. This observation suggests that (consistent with the studies cited in the previous paragraph) naturally occurring biodegradation of chlorinated ethanes to acetic acid may be occurring at the site, and that biostimulation likely accelerated this process.

Post-Injection Rebound Monitoring

Post-injection monitoring provided an opportunity to observe the fate of DCA and CA in the absence of any substantial groundwater flow (based on the low natural groundwater flow velocities discussed in Section 2.2.2, contaminant migration due to groundwater flow over the duration of the rebound phase was expected to be negligible). Monitoring results during the post-injection period showed that, at locations where sulfate reducing conditions were maintained and electron donor was still present (e.g., monitoring well MW-5S, MW-29S), decreases in DCA and CA continued. These decreases are likely due to the continued dechlorination of the chlorinated ethanes. In comparison, post-injection monitoring at PSIW-2, MW-6S, and MW-6D showed VFA concentrations below the analytical detection limit, and sulfate concentrations greater than 200 mg/L; no substantial chlorinated ethane degradation was observed at these locations during the post-injection monitoring.

Soil Sampling

A summary of soil analytical results for GW-32 and GW-33 are included as part of Table 1. Soil boring logs for these locations have also been included in Appendix A. Post-treatment soil results show that chlorinated ethane sources are likely not present within the core (i.e., between PSIW-1 and PSIW-2) of the pilot test area.

3.3.6 Data Evaluation

Due to the simultaneous fate and transport processes (e.g., groundwater flow, dispersion, sorption, biodegradation) that were occurring during the pilot test, confirmation of complete chlorinated ethane biodegradation and estimation of degradation rates during active injection/extraction is difficult. As such, a three-dimensional conceptual model was developed using the widely-implemented and commercially available MODFLOW and RT3D models (US Geological Survey, 1996; Clement, 1997). Model development, including key assumptions and parameters, are presented in Appendix C. Hydraulic parameters were estimated based on slug test data and measured water table elevations during pilot test start-up. TCA, DCA, and CA biodegradation rates were estimated based on both the laboratory data, as well as the degradation rates observed during the post-injection monitoring (discussed in Appendix C). Estimated first-order biodegradation rate constants for TCA, DCA, and CA were 0.35, 0.35, and 0.1/day, respectively.

Simulated and measured groundwater DCA concentrations are shown for the four monitoring wells in the core of the pilot test treatment area (i.e., monitoring wells MW-29S, PSMW-4S, PSMW-4D and PSMW-5S) in Figures 11 through 14. Results show that the simulated concentrations are in reasonable agreement with the measured values, confirming that the simulated first-order DCA biodegradation rate constant of 0.35/day is an appropriate estimate of the DCA decay rate. NOTE: Monitoring well MW-5D was excluded from the analysis because this well appeared to have a short-circuit pathway to the injection well (PSIW-1), as indicated by the relatively large increase in water table elevation during active injection.

Simulated and measured groundwater CA concentrations are shown for the same four monitoring wells in Figures 15 through 18. To facilitate evaluation, simulated first-order CA biodegradation rate constants of 0.0, 0.05, and 0.1/day are presented. Results show that simulated concentrations using a biodegradation rate constant between 0.05 and 0.1/day provide a reasonable estimate of the measured values; this estimated range of the first-order biodegradation rate constant is consistent with the measured CA degradation rate during the post-injection period, as discussed in Appendix C.

TCA groundwater concentrations within the core treatment area were generally less than 5 mg/L at baseline, as (presumably) most of the TCA present had already degraded to DCA prior to the pilot demonstration. After the initial batch injection, TCA levels generally decreased to below or near the analytical detection limit in all monitoring locations.

Simulated TCA, DCA, and CA concentrations in the pilot test area are shown in Figures 19A through 21C. These simulation results are provided at t=2 days (start of pilot study) and 146 days (completion of pilot study), and illustrate the biodegradation of the TCA and DCA during the pilot test. Decreases in TCA and DCA concentrations over the duration of the treatment period are evident. However, during the pilot study, increases in CA concentrations were observed, as illustrated in Figure 21A and 21B. To determine if CA biodegradation was occurring, a simulation was run under the assumption that NO biodegradation of CA would occur. The result of this simulation is included as Figure 21C. A comparison of Figures 21B and 21C demonstrate that CA concentrations did decrease during the pilot demonstration as a result of biodegradation. Thus, simulation results presented in these figures are consistent with the results shown in Figures 15 through 18.

3.3.7 Conclusions Derived from the Pilot Test

Overall conclusions derived from the pilot test are as follows:

- Using a single injection well, at least a 9-foot radius of influence was attained
- Amendment distribution was observed in both the silt and sand directly below the silt layers
- In situ TCA, DCA, and CA biodegradation rate constants of approximately of 0.35, 0.35, and 0.1/day were attained using lactate-enhanced biostimulation
- Degradation of CA is occurring. Evidence of this fact is demonstrated in the observed decreases in CA concentrations (and corresponding model simulations) shown in Figures 15 through 18, and the continued decay in CA concentrations during the post-injection monitoring in locations maintaining sulfate reducing conditions (e.g., monitoring locations MW-29S and MW-5S in Table 4)

The pilot test was also used to verify a site conceptual model, describing both groundwater flow and chlorinated ethane fate.

The estimated first-order rate constants provide a basis for calculating the treatment timeframe for full-scale implementation, as described in Appendix C. Assuming the following:

- an initial soil concentration of 2,100 mg/kg TCA (maximum value, measured at soil boring location GW-8);
- an initial groundwater concentration in the DNAPL source area of 300 mg/L (average of groundwater monitoring locations in the DNAPL source area);
- sorption and kinetic parameters, as well as DNAPL dissolution kinetics, presented in Appendix C; and
- a CA degradation rate constant of 0.1/day,

A treatment time frame of 1.9 years is calculated for dissolving the DNAPL sources and reducing the total chlorinated ethane (TCA + DCA + CA) mass by 99%. Thus, based on the parameters used in this simulation, the extent and rate of TCA, DCA, and CA degradation observed during the pilot test are sufficient for treating the full-scale system within a reasonable timeframe.

3.4 Comparison of Anaerobic Biostimulation to RAOs

Since anaerobic biostimulation will remediate the contaminants *in-situ*, exposure to the contaminated soil and groundwater does not occur, thus protecting public health. Additionally, there are no special issues regarding protection of human health and the environment since the amendments being injected into the subsurface are non-toxic.

The applicable SCGs for this project include the NYSDEC’s TAGM 4046 RSCOs for soil, NYSDEC’s Class GA standards for groundwater, and NYSDOH’s Guidance for Evaluating Soil Vapor Intrusion in the State of New York for soil vapor. To the extent practical, the objective is to achieve these applicable SCGs; however, at a minimum, the goal of the remedial action will be the elimination of the residual DNAPL sources and a 99% reduction in overall chlorinated ethane contaminant mass.

Based on the laboratory and pilot study data, this goal of eliminating the residual DNAPL and achieving a 99% reduction in overall chlorinated ethane contaminant mass is possible. Furthermore, this goal can be achieved in a timeframe of approximately 1.9 years, and is therefore a very effective short-term remedial alternative. Since the remediation occurs *in-situ* and the amendments are non-toxic, there are no risks to the community, workers or the environment during operation of the remedial system. However, during construction of the remedial system, workers will follow strict OSHA requirements to minimize the possibility of accidents, and air monitoring will be completed to protect the community. If necessary, dust suppressant measures (i.e., misting) will be used to control particulates.

Because an active microbial population will remain, biostimulation will continue to occur, resulting in long-term and permanent results. The remedy does not rely on containment. As with any remedial technology, rebound monitoring should be completed following post-system operation. If concentrations rebound to levels above the RAOs goals, system reactivation can occur. Following completion of the remedy, there will be no significant threats to the public health or environment. Any remaining residual impacts will be addressed through a Site Management Plan.

Anaerobic biostimulation both reduces the toxicity of the contaminants through reductive dechlorination and reduces the volume by increasing the dissolution rate of the DNAPL into the aqueous phase where reductive dechlorination occurs. It is anticipated that a complete removal of the DNAPL sources and a 99% reduction in overall chlorinated ethane contaminant mass will occur. Because the contaminants are dechlorinated, the process is not reversible. The installation of extraction wells along the perimeter of the treatment area will serve to maintain hydraulic containment, thus preventing the mobilization of contaminants beyond the treatment zone during injection activities.

Finally, anaerobic biostimulation is technically and economically feasible and achievable. There are no anticipated construction or O&M difficulties, and the materials necessary are readily available. There are no permitting requirements for construction or operation of the remedy.

4.0 Remedial Action Scope of Work

4.1 Full-Scale Area

The treatment system will focus biostimulation amendment delivery over the extent of the residual DNAPL source area. The DNAPL source area is conservatively defined as the region where the sum of TCA and DCA soil concentrations exceed 100,000 µg/kg. This concentration is based on contaminant partitioning between the groundwater and soil phases, as measured during the laboratory treatability testing, where total “soil” concentrations less than 100,000 µg/kg indicate that the chlorinated ethane mass resides in the aqueous and soil phases. Concentrations in excess of 100,000 µg/kg suggest that undissolved TCA and DCA (i.e., residual DNAPL) likely exist. A detailed discussion of the mass balance approach used for this analysis is provided in Schaefer et al. (1998).

Full scale treatment also will address the area of elevated groundwater impacts (defined as total TCA and DCA concentrations greater than 500 µg/L).

Vertically, the treatment zone is assumed to be the silt layer. This full-scale treatment area is depicted on Figure 22. *NOTE: Groundwater sampling will be performed during installation of extraction well locations on the western boundary of the treatment area to improve delineation of the DNAPL zone between GW-17 and GW-27. If elevated chlorinated ethane concentrations (>500 µg/L) are detected at these locations, additional injection/extraction well pairs will be added to extend the treatment area.*

4.2 Full-Scale Well Network

The first step in the implementation of the full-scale system will be well installation activities. Each monitoring well location will be drilled using 10¼” ID hollow stem augers. Split spoon samples will be collected in the interval in which the monitoring well screen would reside. All split spoon samples will be screened with a PID, inspected and logged.

A total of forty-eight (48) extraction wells (EW-1 through EW-48) and thirty-three (33) amendment injection well locations (IW-1 through IW-33) will be installed throughout the treatment area.

The extraction and amendment injection wells will be constructed of 4” Sch 40 PVC with eight (8) feet of 0.20-slot screen. The wells will be installed down to a total depth of approximately 2 feet above the bottom of the silt layer. The screen/sand pack interval will be from approximately 2 to 10 feet above the bottom of the silt layer, insuring that the top of the interval is at least 2 feet below the top of the silt layer. Keeping the screen/sand pack at least 2 feet from the top and bottom of the silt layer will help limit short-circuiting of amendments into the underlying sandy zone as it is injected into the well.

Eight (8) additional monitoring locations (MW-26S and MW-32 through MW-38) will be installed within or surrounding the treatment area as shown on Figure 23. All but three of these locations (MW-26S, MW-33S and MW-38D) will contain nested monitoring points (2 wells per borehole) to monitor both the groundwater contained in the silt layer and the groundwater contained in the underlying sand. MW-26S will be installed next to MW-26R to monitor groundwater conditions within the silt layer in this area. MW-33S will be installed in the silt layer to monitor groundwater conditions downgradient (groundwater flow within the silt is to the southeast) of the DNAPL area, while MW-38D will be installed in the underlying sand layer to monitor groundwater downgradient (groundwater flow within the underlying sand is to the northeast) of the treatment area. The nested monitoring wells will be constructed of 2-inch Schedule 40 PVC with eight (8) feet of 0.10-slot screen set in the silt layer zone, and five (5) feet of 0.10-slot screen set in the underlying sandy zone.

A layout of the extraction, injection and monitoring wells is presented as Figure 23, and construction details are presented as Figure 24.

4.3 Full Scale Conceptual System Design

The continuous amendment injection system will operate by extracting groundwater from the extraction wells (EWs), amending the extracted groundwater with electron donor and nutrients, and re-injecting the amended groundwater into the amendment injection wells (IWs). Full scale system design is based on the groundwater flow and contaminant transport model developed for the pilot test (Appendix C). Specifically, the model was used to determine the following:

- Number and spacing of injection/extraction wells
- Rate of chlorinated ethane biodegradation

The injection/extraction well layout for the full-scale design is shown in Figure 23. The model was used to ensure that perimeter extraction well spacing was sufficient for maintaining hydraulic capture within the treatment area, and to ensure injection/extraction well spacing was sufficient for amendment delivery.

Groundwater will be extracted from each extraction well using bladder pumps at an approximate rate of 0.04 gpm per extraction well (conservatively estimated based on pump and pilot test data), for a total system extraction rate of approximately 2.0 gpm. Water level sensors placed within each extraction well will monitor for low level groundwater conditions. If a low-level condition were to occur within an EW, a relay will active a solenoid valve stopping the bladder pump until the low-level condition no longer exists. The purpose of the low-level monitoring is to assure that groundwater levels do not decrease to the point in which air enters the bladder pump. If this were to occur, the anaerobic conditions of the extracted groundwater could be altered.

Each EW is directed back to the system enclosure where the individual EWs are manifolded to a common header pipe. A chemical metering pump would then feed amendments into the common header pipe at a rate variable to the influent flow rate to achieve consistent lactate, diammonium phosphate (DAP) and yeast concentrations of 3,000 mg/L, 150 mg/L and 150 mg/L, respectively within the amendment stream. Immediately following the injection feed point will be a static mixer to assure adequate mixing of the amendments with the groundwater stream. The amended water stream will then be split and directed to the IWs at an approximate injection rate of 0.0625 gpm each, for a total injection rate of approximately 2.0 gpm. Rotameters will be used to control the flow of amended water to each of the IWs. Water level sensors placed within each extraction well will monitor for high-level groundwater conditions. If a high level condition were to occur, relays will active a solenoid valve closing off the IW until the high-level condition no longer exists.

A conceptual process diagram has been included as Figure 25.

As discussed in Section 3.3.7, the expected duration of active treatment is approximately 1.9 years.

4.4 Full-scale Monitoring

4.4.1 System Monitoring

Data collected from the remedial system (extraction and injection flow rates, amendment levels, water levels, etc.) will be recorded on monitoring forms specifically prepared for the Site, which will be retained and summarized in a quarterly report. A description of critical maintenance activities is included below.

Bladder Pumping System: Monitoring will consist of collecting pumping rates from the individual EWs and injection rates into the individual IWs, and confirming bladder pump control settings including charge, exhaust and pressure settings. On a periodic basis, the bladder pumps will be pulled from the EWs to conduct a visual inspection of the bladders, and if necessary, replacement of the bladder. Interim indications of the bladder conditions will be determined based on individual pumping rates from visit to visit.

The objective of the bladder pumping system is to extract and inject approximately the same volume of groundwater from each area of the treatment zone, thereby limiting the possibility of mobilizing DNAPL/groundwater impacts into areas outside of the treatment zone. In addition, groundwater extracted from the DNAPL area will only be reinjected in the DNAPL zone, thus eliminating the potential to distribute DNAPL outside of the DNAPL zone.

Amendment Metering System: Monitoring of the amendment metering system will consist of measuring the total combined flow rate and inspecting the metering pump for settings and prime. In addition, the amendment tank will be checked for volume and, if necessary, the amendment tank will be replenished with additional amendment.

The objective of the amendment metering system is to supply a continuous consistent supply of lactate, DAP and yeast into the subsurface to facilitate biological activity.

4.4.2 Groundwater Monitoring

4.4.2.1 Baseline Groundwater Sampling

Prior to activation of the continuous-injection system, Shaw will perform full-scale baseline groundwater monitoring to characterize the chemical, biological, and geochemical conditions within and around the treatment zone. Similar to the pilot test monitoring, two sampling events will be performed, one four weeks prior to amendment injection and one two weeks prior to amendment injection. A round of synoptic groundwater levels will be measured prior to commencement of sampling during each event. Each of the monitoring wells will be sampled during each event using standard low flow purge sampling techniques. A multi-parameter sampling meter (e.g., YSI 6920 or equivalent) will be implemented in the field to measure groundwater geochemical parameters including:

ORP
Turbidity
DO
Temperature
pH
Conductivity

These readings will not only be used to characterize the geochemistry of the groundwater at each well, but their stability will also serve as criteria for sample collection. Samples from each location will be analyzed for VOCs, NAPs and VFAs (including lactate). NAPs to be analyzed for include the following:

Chloride
Phosphate
Nitrate
Nitrite
Methane
Ethane
Ethane
Sulfate

One trip blank will be analyzed for VOCs for each cooler.

A NYSDOH ELAP-certified laboratory will conduct the VOC analysis, while Shaw’s in-house analytical laboratory will conduct the NAP and VFA analyses.

4.4.2.2 Full-scale Groundwater Monitoring

Monitoring of the twenty (20) wells within and around the full-scale treatment area will be implemented following activation of the continuous-injection system, and will occur based on the following frequency:

- Months 1 through 6 – sample monthly;
- Months 7 through 12 – sample bi-monthly;
- Months 12 through system deactivation – sample quarterly; and
- Post-system monitoring – sample quarterly.

During each sampling event, the groundwater samples will be collected and analyzed for the following:

VOCs	Chloride	Nitrate	Methane	Ethane
VFAs	Sulfate	Nitrite	Ethane	Phosphate

Sample analyses will be performed by Shaw's in-house analytical laboratory, with the exception of VOC sample analyses conducted for decision making purposes, which will be analyzed by a NYSDOH ELAP-certified laboratory. *NOTE: Sampling frequency, locations, and parameters will be re-evaluated throughout the full-scale operational period and changes will be subject to NYSDEC approval.*

4.4.3 Air Quality Monitoring

Although laboratory analytical data demonstrate that levels of VOCs inside and outside the Site building are below the NYSDOH guidelines, which NYSDOH established after an extensive evaluation of scientific information about health effects, some VOCs were identified in limited areas beneath the building under the concrete slab. To confirm future migration of these VOCs into the building does not occur, monitoring of the sub-slab, indoor and outdoor air will be completed.

A total of four (4) sub-slab sampling locations, four (4) indoor air sampling locations, and two (2) outdoor air sampling locations will be monitored during the heating season. The proposed sub-slab and indoor sampling locations are depicted on Figure 26. Air Toxics Ltd. of Folsom, CA, an ELAP-certified analytical laboratory, will report selected chlorinated VOCs in accordance with EPA Method TO-15. Collection of the samples will be completed as follows:

4.4.3.1 Sub-Slab Sampling

To collect the sub-slab samples, a 5/8-inch diameter hole will be drilled through the concrete slab using an electric drill. The drill bit will be advanced approximately 3-inches into the sub-slab material to create an open cavity. The vapor probe will consist of a length of 3/8-inch diameter Teflon™ tubing, which will then be inserted no farther than 2-inches into the sub-slab material. The tubing will be sealed to the surface with a non-VOC containing material consisting of permagum grout or beeswax or equivalent.

Prior to collection of the sub-slab soil vapor samples, the tubing will be purged of 1-3 volumes to eliminate air within the tubing. During purging, a tracer gas (helium) will be used to verify the integrity of the seal. Purged air will not be discharged to the indoor air. Following purging, the tubing will be attached to a 6L Summa canister fitted with an in-line filter and an 8-hour flow regulator. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. Based on the sample volume of 6L and a sample period of 8 hours, the sub-slab samples will be collected at a flow rate of approximately 0.0125 liters per minute.

Following collection of the sub-slab foundation, the drilled hole in the foundation will be sealed with concrete slurry.

4.4.3.2 Indoor Air Sampling

Prior to the collection of indoor air samples, a pre-sampling inspection of each area to be sampled will be performed. These pre-sampling inspections will include the completion of a product inventory survey and an evaluation of the physical layout and conditions of the building. This information will be used to help identify conditions that may interfere with the proposed sampling study.

The four (4) indoor air samples will be collected as close to sub-slab sampling points as possible. At each sampling point, a 6L Summa canister fitted within an in-line filter and an 8-hour flow regulator will be placed at a level approximately three feet above the floor. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. During this 8-hour sampling period, all windows will remain closed and the facility’s HVAC systems will operate as normal. Based on the sample volume of 6L and a sample period of 8 hours, the indoor air samples will be collected at a flow rate of approximately 0.0125 liters per minute.

4.4.3.3 Outdoor Air Sampling

Two (2) outdoor air samples will be collected concurrently with the indoor and sub-slab sampling. One sample will be collected near the HVAC air intake located on the north side of the building and one sample will be collected near the HVAC air intake located on the south side of the building. Samples will be collected away from wind obstructions and obvious sources of VOCs and at a height above the ground to represent typical breathing zones (i.e. 3 to 5 feet).

To collect the outdoor air samples, 6L Summa canisters fitted within an in-line filter and an 8-hour flow regulator will be used. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. Based on the sample volume of 6L and a sample period of 8 hours, the outdoor air samples will be collected at a flow rate of approximately 0.0125 liters per minute.

4.4.4 Soil Monitoring

Once groundwater concentrations decrease to a point indicative of DNAPL no longer being present, soil sampling activities will commence. The purpose of the soil sampling activities is to confirm the DNAPL has been successfully remediated. A criterion that will be considered by the NYSDEC to determine if DNAPL sources have been effectively removed is TCA groundwater concentrations less than 1,000 µg/L and DCA groundwater concentrations less than 5,000 µg/L in the source area. These concentrations are equivalent to less than 0.1% of TCA and DCA solubilities, and are 10-times lower than the 1% solubility "rule of thumb" used to indicate the potential presence of DNAPL (ITRC, 2005). The 0.1% solubility criterion serves as a conservative marker of DNAPL removal (i.e. by an order of magnitude). In addition, the soil analytical results will be compared to NYSDEC TAGM 4046 soil guidance values.

Soil samples will be collected within the silt layer at locations and depths approximate to the soil samples collected at GW-3, GW-8 and GW-17. These locations represent the highest impacted areas identified during the Site investigation.

4.5 Achievement of Remedial Goals

As previously discussed in the RAO's, the specific goals for the Site remediation include the complete removal of the DNAPL sources; reduction of dissolved-phase chlorinated ethane mass to NYSDEC groundwater standards or until implementation of a MNA program is acceptable, and the implementation of Deed Restrictions to prevent future exposure to residual impacts.

A criterion that will be considered by NYSDEC to verify that DNAPL sources have been effectively removed is TCA groundwater concentrations less than 1,000 µg/L and DCA groundwater concentrations less than 5,000µg/L in the source area. These concentrations are equivalent to less than 0.1% of TCA and DCA solubility's, and are 10-times lower than the 1% solubilities "rule of thumb" used to indicate the potential presence of DNAPL (ITRC, 2005). The 0.1% solubility criterion serves as a conservative marker of DNAPL removal (i.e. by an order of magnitude). It is anticipated that the timeframe to complete the DNAPL removal is approximately 23 months.

Thereafter, the continuous amendment injection system will continue to operate until NYSDEC groundwater standards are achieved or until asymptotic groundwater conditions occur as determined by NYSDEC. If asymptotic conditions occur at levels above NYSDEC groundwater standards, then a monitored natural attenuation (MNA) program will be implemented to track these remaining residual impacts as demonstrated through groundwater sampling.

5.0 Schedule

5.1 Remedy Implementation Schedule

The anticipated schedule for implementation of the proposed remedy, following NYSDEC approval, is as follows:

Activity	Timeframe
Treatment System Construction	Months 1-6
Site Management Plan	Months 3-8
Recording of Deed Restrictions	Months 7-8
Final Engineering Report	Months 7-8
Total Timeframe	**8 months**

The monitoring program to track the expected reductions has been summarized in Section 4.4. During implementation of the remedy, progress reports will be submitted monthly. Following completion of the remedy (i.e., startup of the *in-situ* bioremediation system), progress reports will be submitted quarterly.

5.2 Post-Remedy Implementation Schedule

Activity	Timeframe
Continuous-Injection System Operation (23 months)	Months 9-31
Groundwater Monitoring (24 months following system deactivation, 47 months total)	Months 9-55
Final Data Analysis and Reporting (3 months)	Months 56-58
Total Timeframe	**4 years, 2 months**

Following commencement of system operation, it is anticipated that a 50% reduction in chlorinated ethane mass will occur after approximately 9 months, a 75% reduction after 15 months and a 99% reduction after 23 months. Although it is currently anticipated that the system will operate for a timeframe of 23 months, if the remedial goals are not achieved within the anticipated timeframe, system operation will continue until the remedial goals are met.

5.3 Contingency

After a period of two (2) years following completion of the remedy (i.e., startup of the *in-situ* bioremediation system), an evaluation report will be prepared and submitted to the NSYDEC. This evaluation report will compare the progress which the remedy has achieved versus the original anticipated reductions, provide an updated remedial timeframe (if necessary), as well as make recommendations on future remedial actions (if necessary). If a contaminant reduction of 99% is not achieved, continued biostimulation may be required by NYSDEC. If significant progress, defined as chlorinated ethane mass reduction of more than approximately 50%, has not been achieved, then an alternative remedial action may be implemented. Alternative remedial actions that may be required by the NYSDEC include source-zone (i.e., DNAPL) excavation, bioaugmentation or another remedial technology as approved by the NYSDEC.

6.0 Remedial Action Program

6.1 Governing Documents

6.1.1 Site Specific Health & Safety Plan (HASP)

All remedial work performed under this plan will be in full compliance with governmental requirements, including Site and worker safety requirements mandated by Federal OSHA.

The Volunteers and associated parties preparing the remedial documents submitted to the State and those performing the construction work, are completely responsible for the preparation of an appropriate Health and Safety Plan and for the appropriate performance of work according to that plan and applicable laws.

The Health and Safety Plan (HASP) and requirements defined in this Remedial Action Work Plan pertain to all remedial and invasive work performed at the Site until the issuance of a Certificate of Completion.

The Site Safety Coordinator will be Mr. Garrett Passarelli. A resume will be provided to NYSDEC prior to the start of remedial construction.

6.1.2 Quality Assurance Project Plan (QAPP)

A QAPP has been prepared and is included as Appendix G. Sampling procedures for soil, groundwater, sub-slab vapor and indoor and outdoor air are described in Section 4.4.

6.1.3 Construction Quality Assurance Plan (CQAP)

A CQAP has been prepared and is included as Appendix H.

6.1.4 Soil/Materials Management Plan (SoMP)

6.1.4.1 Soil Screening Methods

Visual, olfactory and PID soil screening and assessment will be performed by a qualified environmental professional during installation of the injection, extraction and monitoring wells.

All wells installed as part of the remedial action will be surveyed by a surveyor licensed to practice in the State of New York. This information will be provided on maps in the Final Engineering Report.

Screening will be performed by qualified environmental professionals. Resumes will be provided for all personnel responsible for field screening (i.e. those representing the Remedial Engineer) of invasive work for unknown contaminant sources during remediation and development work.

6.1.4.2 Stockpile Methods

Stockpiling of soils will not be necessary during construction activities. All soil drill cuttings will be contained within DOT-approved 55-gallon steel drums for transportation and disposal.

6.1.4.3 Materials Load Out

The Remedial Engineer or a qualified environmental professional under his/her supervision will oversee the load-out of all drummed materials.

The Volunteers and their contractors are solely responsible for safe execution of all invasive and other work performed under this Plan.

The presence of utilities and easements on the Site has been investigated by the Remedial Engineer. It has been determined that no risk or impediment to the planned work under this Remedial Action Work Plan is posed by utilities or easements on the Site.

Loaded vehicles leaving the Site will be appropriately manifested and placarded in accordance with appropriate Federal, State, local, and NYSDOT requirements (and all other applicable transportation requirements).

Development-related grading cuts and fills will not be performed without NYSDEC approval and will not interfere with, or otherwise impair or compromise, the performance of remediation required by this plan.

Mechanical processing of historical fill and contaminated soil on-Site is prohibited.

All wells installed during the remedial action will be surveyed by a surveyor licensed to practice in the State of New York. The survey information will be shown on maps to be reported in the Final Engineering Report.

6.1.4.4 Materials Transport Off-Site

All transport of materials will be performed by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

6.1.4.5 Materials Disposal Off-Site

The disposal facility for both the soil and water is Vexor Technology, Inc., located at 955 West Smith Road, Medina, Ohio. Any disposal location(s) established at a later date will be reported to the NYSDEC Project Manager. The wastes will be transported by Freehold Cartage, Inc. of Freehold, New Jersey.

The total quantity of material expected to be disposed off-Site is approximately 77 yd3 soil cuttings and approximately 1,100 gallons of development/decon water. It is anticipated that the wastes will be characterized as non-hazardous wastes.

All soil/fill/solid waste removed from the Site will be treated as contaminated and regulated material and will be disposed in accordance with all local, State (including 6NYCRR Part 360) and Federal regulations. If disposal of soil/fill from this Site is proposed for unregulated disposal (i.e. clean soil removed for development purposes), a formal request with an associated plan will be made to NYSDEC's Project Manager. Unregulated off-Site management of materials from this Site is prohibited without formal NYSDEC approval.

Material that does not meet unrestricted use, as identified Table 375-6.8(a) of 6NYCRR Part 375, is prohibited from being taken to a New York State recycling facility (6NYCRR Part 360-16 Registration Facility).

The following documentation will be obtained and reported by the Remedial Engineer for each disposal location used in this project to fully demonstrate and document that the disposal of material derived from the Site conforms with all applicable laws: (1) a letter from the Remedial Engineer or Volunteer to the receiving facility describing the material to be disposed and requesting formal written acceptance of the material. This letter will state that material to be disposed is contaminated material generated at an environmental remediation Site in New York State. The letter will provide the project identity and the name and phone number of the Remedial Engineer. The letter will include as an attachment a summary of all chemical data for the material being transported (including Site Characterization data); and (2) a letter from all receiving facilities stating it is in receipt of the correspondence (above) and is approved to accept the material. These documents will be included in the FER.

Non-hazardous historic fill and contaminated soils taken off-Site will be handled, at minimum, as a Municipal Solid Waste per 6NYCRR Part 360-1.2.

Historical fill and contaminated soils from the Site are prohibited from being disposed at Part 360-16 Registration Facilities (also known as Soil Recycling Facilities).

Soils that are contaminated but non-hazardous and are being removed from the Site are considered by the Division of Solid & Hazardous Materials (DSHM) in NYSDEC to be Construction and Demolition (C/D) materials with contamination not typical of virgin soils. These soils may be sent to a permitted Part 360 landfill. They may be sent to a permitted C/D processing facility without permit modifications only upon prior notification of NYSDEC Region 2 DSHM. This material is prohibited from being sent or redirected to a Part 360-16 Registration Facility. In this case, as dictated by DSHM, special procedures will include, at a minimum, a letter to the C/D facility that provides a detailed explanation that the material is derived from a DER remediation Site, that the soil material is contaminated and that it must not be redirected to on-Site or off-Site Soil Recycling Facilities. The letter will provide the project identity and the name and phone number of the Remedial Engineer. The letter will include as an attachment a summary of all chemical data for the material being transported.

The Final Engineering Report will include an accounting of the destination of all material removed from the Site during this Remedial Action, including excavated soil, contaminated soil, historic fill, solid waste, and hazardous waste, non-regulated material, and fluids.

Documentation associated with disposal of all material must also include records and approvals for receipt of the material. This information will also be presented in a tabular form in the FER.

Bill of Lading system or equivalent will be used for off-Site movement of non-hazardous wastes and contaminated soils. This information will be reported in the Final Engineering Report.

Hazardous wastes derived from on-Site will be stored, transported, and disposed of in full compliance with applicable local, State, and Federal regulations.

Appropriately licensed haulers will be used for material removed from this Site and will be in full compliance with all applicable local, State and Federal regulations.

Waste characterization will be performed for off-Site disposal in a manner suitable to the receiving facility and in conformance with applicable permits. Sampling and analytical methods, sampling frequency, analytical results and QA/QC will be reported in the FER. All data available for soil/material to be disposed at a given facility must be submitted to the disposal facility with suitable explanation prior to shipment and receipt.

6.1.4.6 Materials Reuse On-Site

The reuse of materials on-Site will not necessary for this project.

Concrete crushing or processing on-Site is prohibited.

Organic matter (wood, roots, stumps, etc.) or other solid waste derived from clearing and grubbing of the Site is prohibited for reuse on-Site.

Contaminated on-Site material, including historic fill and contaminated soil, removed for grading or other purposes will not be reused within a cover soil layer, within landscaping berms, or as backfill for subsurface utility lines. This will be expressed in the final Site Management Plan.

6.1.4.7 Fluids Management

All liquids to be removed from the Site, including decontamination water and well development water will be handled, transported and disposed in accordance with applicable local, State, and Federal regulations. Liquids will be contained within DOT-approved 55-gallon steel drums.

6.1.5 Community Air Monitoring Plan

A CAMP has been prepared and is included as Appendix I. Odor, dust and nuisance controls have been included as part of the CAMP.

6.1.6 Contractors Site Operations Plan (SOP)

Construction of the *in-situ* bioremediation system is being completed by Shaw as part of a design-build project. Specifications on the design will be forward to the NYSDEC under separate cover.

6.1.7 Community Participation Plan

A certification of mailing will be sent by the Volunteers to the NYSDEC project manager following the distribution of all Fact Sheets and notices that includes: (1) certification that the Fact Sheets were mailed, (2) the date they were mailed; (3) a copy of the Fact Sheet, (4) a list of recipients (contact list); and (5) a statement that the repository was inspected on (specific date) and that it contained all of applicable project documents.

No changes will be made to approved Fact Sheets authorized for release by NYSDEC without written consent of the NYSDEC. No other information, such as brochures and flyers, will be included with the Fact Sheet mailing.

Document repositories have been established at the following locations and contain all applicable project documents:

Queens Borough Public Library
Jackson Heights Branch
35-51 81st Street
Jackson Heights, NY 11372

Or

Community Board No. 3
82-11 37th Avenue, Suite 606
Jackson Heights, NY 11372

Or

NYSDEC Region 2
47-40 21st Street
Long Island City, NY 11101
Attn: Sondra Martinkat

6.2 General Remedial Construction Information

6.2.1 Project Organization

An organization chart is included in Figure 27.

Resumes of key personnel involved in the Remedial Action are included in Appendix F.

6.2.2 Remedial Engineer

The Remedial Engineer for this project will be Mr. August Arrigo. The Remedial Engineer is a registered professional engineer licensed by the State of New York. The Remedial Engineer will have primary direct responsibility for implementation of the remedial program for the 75-20 Astoria Boulevard Site (NYSDEC VCA Index No. W2-0854-9906, Site No. 002453). The Remedial Engineer will certify in the Final Engineering Report that the remedial activities were observed by qualified environmental professionals under his supervision and that the remediation requirements set forth in the Remedial Action Work Plan and any other relevant provisions of ECL 27-1419 have been achieved in full conformance with that Plan. Other Remedial Engineer certification requirements are listed later in this RAWP.

The Remedial Engineer will coordinate the work of other contractors and subcontractors involved in all aspects of remedial construction, including soil excavation, stockpiling, characterization, removal and disposal, air monitoring, emergency spill response services, import of back fill material, and management of waste transport and disposal. The Remedial Engineer will be responsible for all appropriate communication with NYSDEC and NYSDOH.

The Remedial Engineer will review all pre-remedial plans and will certify compliance in the Final Engineering Report.

The Remedial Engineer will provide the certifications listed in Section 10.1 in the Final Engineering Report.

6.2.3 Remedial Action Construction Schedule

6.2.3.1 Work Hours

The hours for operation of remedial construction will conform to the New York City Department of Buildings construction code requirements or according to specific variances issued by that agency. DEC will be notified by the Applicant of any variances issued by the Department of Buildings. NYSDEC reserves the right to deny alternate remedial construction hours.

6.2.3.2 Site Security

Site security is provided by security personnel for the Bulova Corporate Center operations. In addition, the Site is completely fenced.

6.2.3.3 Traffic Control

Traffic control will only be required on-Site. Traffic control will be handled through the use of fencing and safety cones/barrels.

6.2.3.4 Worker Training

All construction, operation, maintenance and monitoring activities will be performed by health and safety trained personnel in accordance with 29 CFR 1910.

6.2.3.5 Agency Approvals

Local, regional or national governmental permits, certifications or other approvals or authorization are not required for this scope of this remedial action.

The current use for the Site is in conformance with the current zoning for the property as determined by New York City Department of Planning

6.2.4 Pre-Construction Meeting with NYSDEC

Notification of the construction “kick-off meeting” will be made to the NYSDEC.

6.2.5 Emergency Contact Information

An emergency contact sheet with names and phone numbers is included in Table 8. That document will define the specific project contacts for use by NYSDEC and NYSDOH in the case of a day or night emergency.

6.2.6 Remedial Action Costs

The total estimated cost of the Remedial Action is $2,500,000. Of this, approximately $1,100,000 is for the remedial system construction and approximately $1,400,000 for operation, maintenance and monitoring activities. This will be revised based on actual costs and submitted as an Appendix to the Final Engineering Report.

6.3 Site Preparation

6.3.1 Mobilization

Equipment that will be mobilized to the Site include a hollow-stem auger (HSA) drill rig(s) and a small backhoe.

6.3.2 Utility Marker and Easements Layout

The Volunteers and their contractors are solely responsible for the identification of utilities that might be affected by work under the RAWP and implementation of all required, appropriate, or necessary health and safety measures during performance of work under this RAWP. The Volunteers and their contractors are solely responsible for safe execution of all invasive and other work performed under this RAWP. The Volunteers and their contractors must obtain any local, State or Federal permits or approvals pertinent to such work that may be required to perform work under this RAWP. Approval of this RAWP by NYSDEC does not constitute satisfaction of these requirements.

The presence of utilities and easements on the Site has been investigated by the Remedial Engineer. It has been determined that no risk or impediment to the planned work under this Remedial Action Work Plan is posed by utilities or easements on the Site.

6.3.3 Equipment and Material Staging

All equipment and materials that need to be staged onsite will be staged within secured areas.

6.3.4 Site Fencing

Existing fencing bordering the Site include 6’ chain-link fencing and 6’ stockade fencing. In addition, the Site has 24-hour security personnel.

6.3.5 Demobilization

Prior to demobilizing from the Site, restoration of areas that have been disturbed will be completed. This restoration includes, but is not limited to, the asphalt parking area, concrete walkways and grass area.

6.4 Reporting

All daily and monthly reports will be included in the Final Engineering Report.

6.4.1 Daily Reports

During periods of active construction, daily reports will be submitted to NYSDEC and NYSDOH Project Managers by the end of each day following the reporting period and will include:

- An update of progress made during the reporting day;
- A summary of any and all complaints with relevant details (names, phone numbers);
- A summary of CAMP finding, including excursions; and
- An explanation of notable Site conditions.

Daily reports are not intended to be the mode of communication for notification to the NYSDEC of emergencies (accident, spill), requests for changes to the RAWP or other sensitive or time critical information. However, such conditions must also be included in the daily reports. Emergency conditions and changes to the RAWP will be addressed directly to NYSDEC Project Manager via personal communication.

The NYSDEC assigned project number will appear on all reports.

6.4.2 Monthly Reports

Monthly reports will be submitted to NYSDEC and NYSDOH Project Managers within one week following the end of the month of the reporting period and will include:

- Activities relative to the Site during the previous reporting period and those anticipated for the next reporting period, including a quantitative presentation of work performed (i.e. tons of material exported and imported, etc.);
- Description of approved activity modifications, including changes of work scope and/or schedule;
- Sampling results received following internal data review and validation, as applicable; and,

- An update of the remedial schedule including the percentage of project completion, unresolved delays encountered or anticipated that may affect the future schedule, and efforts made to mitigate such delays.

6.4.3 Other Reporting

Photographs will be taken of all remedial activities and submitted to NYSDEC in digital (JPEG) format. Photos will illustrate all remedial program elements and will be of acceptable quality. Representative photos of the Site prior to any Remedial Actions will be provided. Representative photos will be provided of each contaminant source, source area and Site structures before, during and after remediation. Photos will be submitted to NYSDEC on CD or other acceptable electronic media and will be sent to NYSDEC's Project Manager (2 copies) and to NYSDOH's Project Manager (1 copy). CD's will have a label and a general file inventory structure that separates photos into directories and sub-directories according to logical Remedial Action components. A photo log keyed to photo file ID numbers will be prepared to provide explanation for all representative photos. For larger and longer projects, photos should be submitted on a monthly basis or another agreed upon time interval.

Job-site record keeping for all remedial work will be appropriately documented. These records will be maintained on-site at all times during the project and be available for inspection by NYSDEC and NYSDOH staff.

6.4.4 Complaint Management Plan

Upon receipt of any complaints, verbal or written, the NYSDEC Project Manager will be immediately notified.

6.4.5 Deviations from the Remedial Action Work Plan

If any deviations from this RAWP are necessary, the NYSDEC Project Manager will be immediately notified. In addition, deviations will be noted in the daily and monthly reports.

7.0 Engineering Controls

7.1 Composite Cover System

Exposure to residual contaminated soils will be prevented by the existing composite cover system at the Site. This composite cover system is comprised of the asphalt parking lot, concrete covered sidewalks, and the Site building. This composite cover system will be maintained in the vicinity of the former USTs and over the plume.

7.2 Treatment System

An *in-situ* bioremediation system will be constructed and operated to reduce contaminant levels. This *in-situ* bioremediation system will operate by pumping groundwater via the extraction wells back to the equipment shed. There, the extracted groundwater will be amended with lactate, DAP and yeast to make a consistent solution of 3,000 mg/L, 150 mg/L and 150 mg/L, respectively. The amended groundwater will then re-enter the subsurface via the injection wells.

As the amended groundwater passes through the subsurface, the degradative capabilities of the existing microbial population will increase.

A detailed description of the in-situ bioremediation system is discussed in Sections 4.0 through 4.3.

As-built drawings and process diagrams will be presented in the FER.

7.2.1 Criteria for Completion of Remediation/Termination of Remedial Systems

7.2.1.1 Composite Cover System

The composite cover system is a permanent control and the quality and integrity of this system will be inspected at defined, regular intervals.

7.2.1.2 In-situ Bioremediation System

The in-situ bioremediation system will not be discontinued without written approval by NYSDEC and NYSDOH. A proposal to discontinue the system may be submitted after residual contamination concentrations in groundwater: (1) are cleaned up to levels below NYSDEC standards, (2) have become asymptotic over an extended period of time as mandated by the NYSDEC and the NYSDOH, or (3) if NYSDEC has determined that the in-situ bioremediation system has reached the limit of its effectiveness. This assessment will be based in part on post-remediation contaminant levels in groundwater collected from monitoring wells located throughout the Site. The system will remain in place and operational until permission to discontinue its use is granted in writing by NYSDEC and

NYSDOH. These sampling/monitoring activities will adhere to stipulations outlined in the Monitoring Plan section of the SMP.

7.2.1.3 Monitored Natural Attenuation

Groundwater monitoring activities to assess natural attenuation will continue, as determined by NYSDOH and NYSDEC, until residual groundwater concentrations are found to be below NYSDEC standards or have become asymptotic over an extended period. Monitoring will continue until permission to discontinue is granted in writing by NYSDEC and NYSDOH. Monitoring activities will be outlined in the Monitoring Plan of the SMP.

8.0 Deed Restrictions

Deed Restrictions will be implemented to address any residual contamination that is left on-Site after the Remedial Action is complete. As part of this remedy, Deed Restrictions approved by NYSDEC will be filed and recorded with the Queens County Clerk. The proposed Deed Restrictions will be submitted as part of the draft Final Engineering Report and will be executed and recorded prior to approval of the Final Engineering Report.

The Deed Restrictions render the Site a Controlled Property. The Deed Restrictions must be recorded with the Queens County Clerk before the Release of Liability can be issued by NYSDEC. The Deed Restrictions will limit the use of the Site to commercial use only.

The Site restrictions that may apply to the Controlled Property are:

- Vegetable gardens and farming on the Controlled Property are prohibited;
- Use of groundwater underlying the Controlled Property is prohibited without treatment rendering its safe for intended purpose;
- The Controlled Property may be used for commercial use only;
- The Controlled Property may not be used for a higher level of use, such as restricted residential use, without an amendment or extinguishment of the Deed Restrictions with NYSDEC approval;
- All future activities that will disturb residual contaminated material within the treatment area are prohibited without NYSDEC approval; and
- Grantor agrees to submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property at any time in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow. This statement must be certified by an expert that the NYSDEC finds acceptable. If controls are no longer required, certifications can be discontinued following NYSDEC approval.

9.0 Site Management Plan

The Site Management Plan (SMP) is intended to provide a detailed description of the procedures required during implementation of the Remedial Action in accordance with the VCA with the NYSDEC. This includes: (1) development, implementation, and management of the in-situ bioremediation system; (2) development and implementation of monitoring systems and a Monitoring Plan; (3) submittal of Site Management Reports, performance of inspections and certification of results, and demonstration of proper communication of Site information to NYSDEC; and (4) defining criteria for terminating operation of the in-situ bioremediation system, or implementing a contingency plan.

To address these needs, this SMP will include four plans: (1) an Engineering Plan for implementation and management of the in-situ bioremediation system; (2) a Monitoring Plan for implementation of Site Monitoring; (3) an Operation and Maintenance Plan for implementation of the in-situ bioremediation system; and (4) a Site Management Reporting Plan for submittal of data, information, recommendations, and certifications to NYSDEC. The SMP will be prepared in accordance with the requirements in NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation, dated December 2002, and the guidelines provided by NYSDEC.

Certified Site management reporting will be scheduled on an annual basis. The Site Management Plan will be based on a calendar year and will be due for submission to NYSDEC by March 1 of the year following the reporting period.

The Site Management Plan will include a monitoring plan for groundwater at the down-gradient Site perimeter to evaluate Site-wide performance of the remedy. Appropriately placed groundwater monitor wells will also be installed immediately down-gradient of all VOC remediation areas for the purpose of evaluation of the effectiveness of the remedy that is implemented.

10.0Final Engineering Report

A Final Engineering Report (FER) will be submitted to NYSDEC following implementation of the Remedial Action defined in this RAWP. The FER provides the documentation that the remedial work required under this RAWP has been completed and has been performed in compliance with this plan. The FER will provide a comprehensive account of the locations and characteristics of all material removed from the Site including the surveyed map(s) of all sources. The Final Engineering Report will include as-built drawings for all constructed elements, certifications, manifests, bills of ladings as well as the complete Site Management Plan (formerly the Operation and Maintenance Plan). The FER will provide a description of the changes in the Remedial Action from the elements provided in the RAWP and associated design documents. The FER will provide a tabular summary of all performance evaluation sampling results and all material characterization results and other sampling and chemical analysis performed as part of the Remedial Action. The FER will provide test results demonstrating that all mitigation and remedial systems functioned properly. The FER will be prepared in conformance with DER-10.

The Final Engineering Report will include written and photographic documentation of all remedial work performed under this remedy.

The FER will provide a thorough summary of any contamination that remains and will be addressed after the remedy is implemented at the Site. This summary will include all VOC contamination that exceeds Unrestricted Use as identified in Table 375-6.8(a) of 6NYCRR Part 375. A table and figure summarizing the locations of impacts that exceed Table 375-6.8(a) unrestricted use values will be included with the FER.

The Final Engineering Report will include an accounting of the destination of all material removed from the Site, including excavated contaminated soil, historic fill, solid waste, hazardous waste, non-regulated material, and fluids. Documentation associated with disposal of all material must also include records and approvals for receipt of the material. It will provide an accounting of the origin and chemical quality of all material imported onto the Site.

Before approval of a FER and issuance of a Certificate of Completion, all project reports must be submitted in digital form on electronic media (PDF).

10.1 Certifications

The following certification will appear in front of the Executive Summary of the Final Engineering Report. The certification will be signed by the Remedial Engineer who is a Professional Engineer registered in New York State. This certification will be appropriately signed and stamped. The certification will include the following statements:

I, ________________________, am currently a registered professional engineer licensed by the State of New York. I had primary direct responsibility for implementation of the remedial program for the 75-20 Astoria Boulevard Site (NYSDEC VCA Index No. W2-0854-9906, Site No. 002453).

I certify that the Site description presented in this FER is identical to the Site description presented in the Voluntary Cleanup Agreement for 75-20 Astoria Boulevard Site and related amendments.

I certify that the Remedial Action Work Plan dated [month day year] and approved by the NYSDEC was implemented and that all requirements in that document have been substantively complied with.

I certify that the remedial activities were observed by qualified environmental professionals under my supervision and that the remediation requirements set forth in the Remedial Action Work Plan and any other relevant provisions of ECL 27-1419 have been achieved.

I certify that all use restrictions, Institutional Controls, Engineering Controls, and all operation and maintenance requirements applicable to the Site are referenced in deed restrictions recorded with the Queens County Clerk. A Site Management Plan has been submitted by the Applicant for the continual and proper operation, maintenance, and monitoring of all Engineering Controls employed at the Site, including the proper maintenance of all remaining monitoring wells, and that such plan has been approved by the NYSDEC.

I certify that the export of all contaminated soil, fill, water or other material from the property was performed in accordance with the Remedial Action Work Plan, and were taken to facilities licensed to accept this material in full compliance with all Federal, State and local laws.

I certify that all import of soils from off-Site, including source approval and sampling, has been performed in a manner that is consistent with the methodology defined in the Remedial Action Work Plan.

I certify that all invasive work during the remediation and all invasive development work were conducted in accordance with the CAMP.

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as Class “A” misdemeanor, pursuant to Section 210.45 of the Penal Law.

It is a violation of Article 130 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 130, New York State Education Law.

11.0 Summary of the Remedy

A summary of the proposed remedy contained within this RAWP is as follows:

1. Composite Cover System: The existing composite cover cap in the vicinity of the former underground storage tanks and area of the plume will be maintained;
2. Treatment System: An in-situ bioremediation system will be constructed and operated to reduce contaminant levels;
3. Recording of Deed Restrictions to be executed prior to approval of the Final Engineering Report. Included in the Deed Restrictions will be the following:
    - Prohibition of vegetable gardens and farming at the Site;
    - Prohibition of using groundwater underlying the Site without treatment rendering it safe for its intended purpose;
    - Prohibition of using the Site other than for commercial purposes;
    - Prohibition of using the Site for a higher level of use, such as restricted residential, without an amendment or extinguishment of the Deed Restrictions with NYSDEC approval;
    - All future activities that will disturb residual contaminated material within the treatment area are prohibited without NYSDEC approval; and
    - Grantor agrees to submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property at any time in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow. This statement must be certified by an expert that the NYSDEC finds acceptable. If controls are no longer required, certifications can be discontinued following NYSDEC approval.

4. Development of an approvable Site Management Plan that defines Site management practices during implementation of the remedy, including 1) an Engineering Control Plan; 2) a Monitoring Plan; 3) an Operation and Maintenance Plan; and 4) a Reporting Plan; and
5. Submission of a Final Engineering Report documenting all elements of the Remedy.

12.0 Signatures of Environmental Professionals

Shaw Environmental and Infrastructure, Inc. (Shaw) has prepared this Remedial Action Work Plan (RAWP) for the 75-20 Astoria Boulevard Site located at 75-20 Astoria Boulevard, in Jackson Heights, Queens County, New York.

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

Erik Gustafson
Client Program Manager

Charles Schaefer, PH.D.
Senior Technology Applications Engineer

Graig Lavorgna
Project Engineer

August Arrigo, P.E.
Business Line Manager

STATE OF NEW YORK
AUGUST ANTHONY ARRIGO
No. 070843
LICENSED PROFESSIONAL ENGINEER

References

Chen, C., B.S. Ballapragada, J.A. Puhakka, S.E. Strand, J.F. Ferguson. Anaerobic transformation of 1,1,1-trichloroethane by municipal digester sludge. *Biodegradation* 10, 297-305, 1999.

Clement, T. P. A modular computer model for simulating reactive multi-species transport in three-dimensional groundwater systems. PNNL-SA-28967, Pacific Northwest National Laboratory, Richland, WA, 1997.

Galli, P.; P. McCarty. Biotransformation of 1,1,1-trichloroethane, trichloromethane, and tetrachlromethane by a *Clostridium* sp. *Appl. Environ. Microbiol*. 55, 837-844, 1989.

Meylan, W.M., P.H. Howard, R.S. Boethling. Molecular topology/fragment contribution method for predicting soil sorption coefficients. *Environ. Sci. Technol*., 26, 1560-1567, 1992.

Schaefer, C.E., Unger, D.R., and Kosson, D.S., "Partitioning of Hydrophobic Contaminants in the Vadose Zone in the Presence of a Nonaqueous Phase", *Water Resour. Res*., 34, 2529-2537, 1998.

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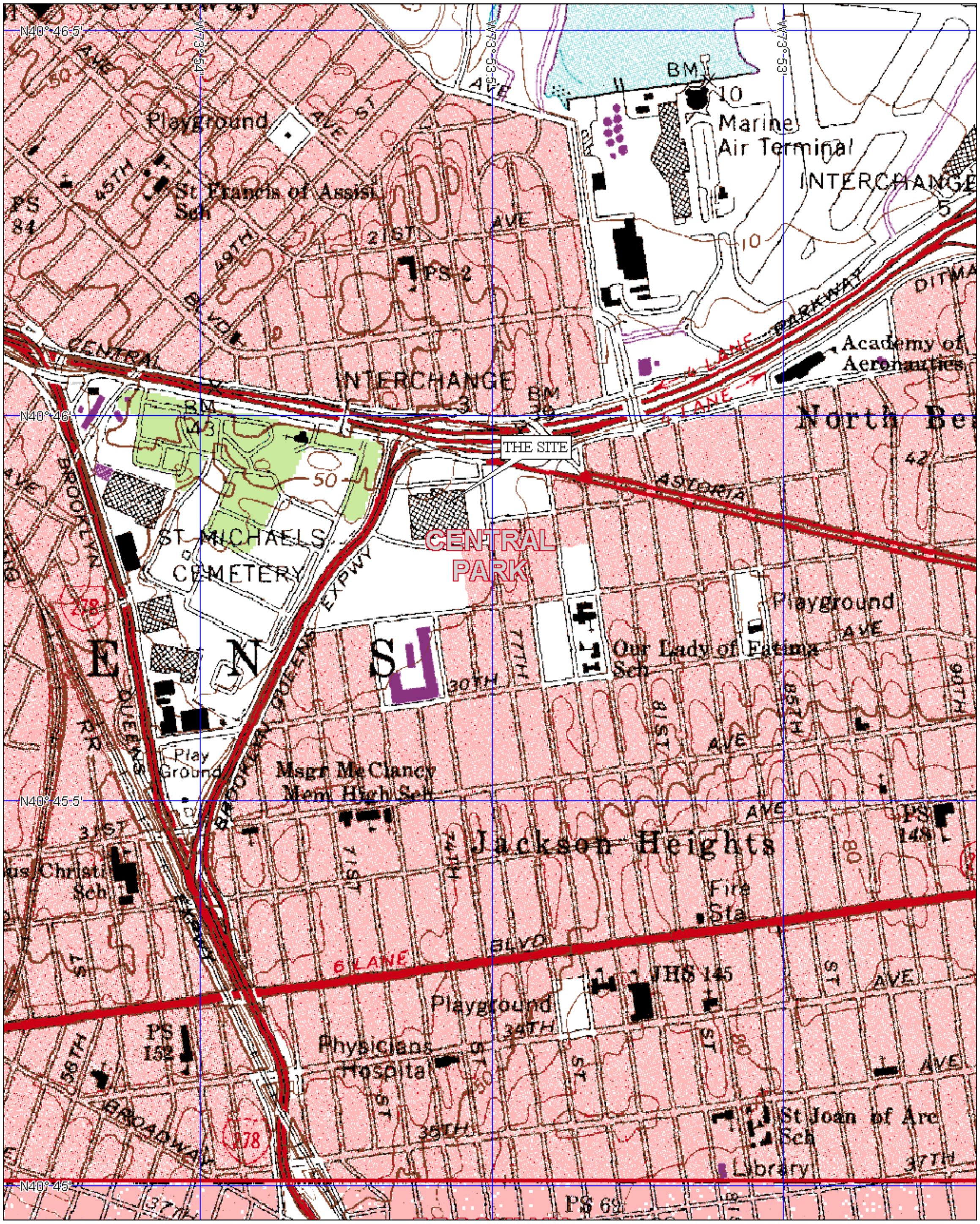
Schaefer, C.E., "Laboratory Treatability Study Report to Assess Treatment Approaches for 1,1,1-TCA and 1,1-DCA at the Jackson Heights, NY Site", Shaw Environmental, Inc., 2005.

FIGURES



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS

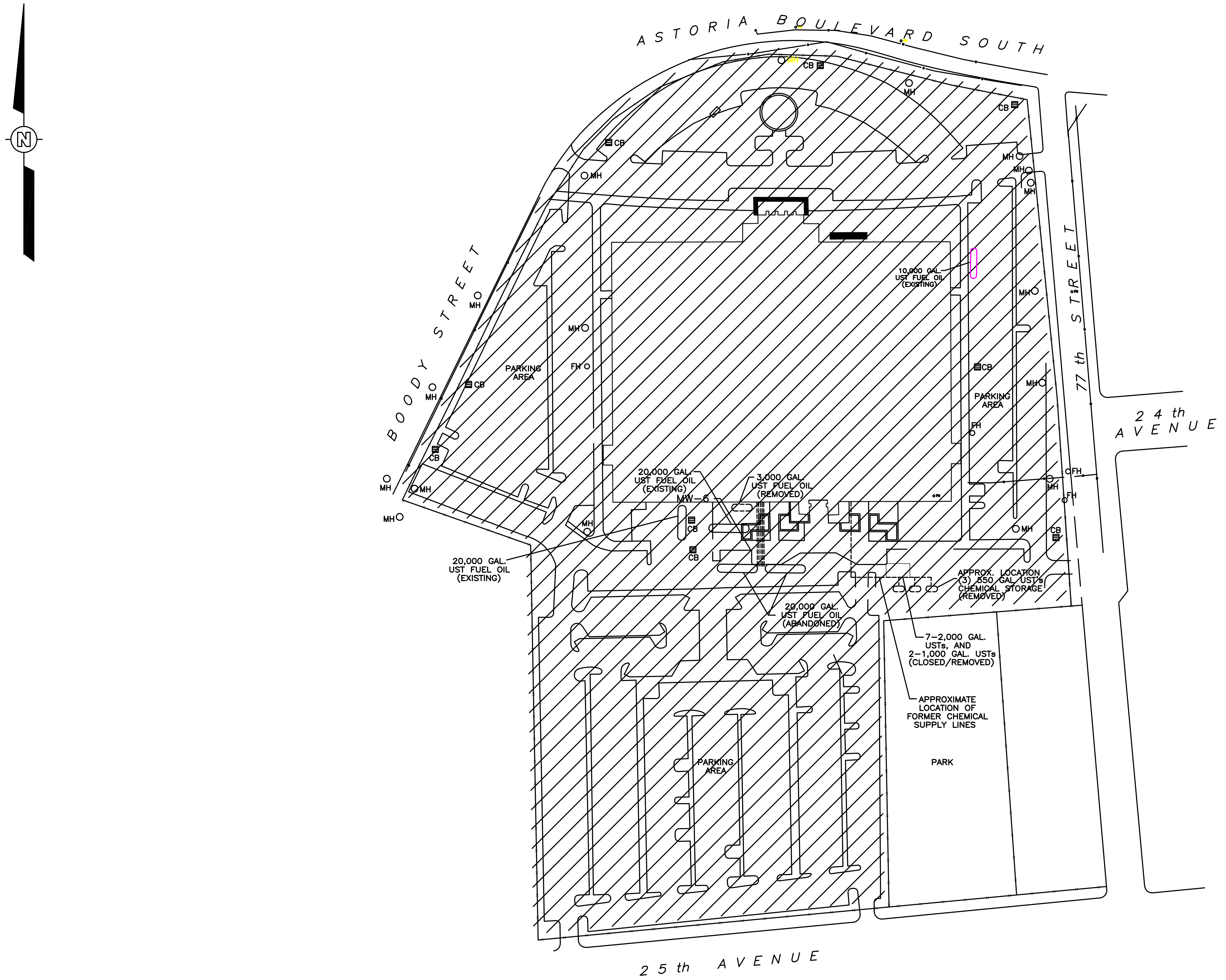
350 ft Scale: 1 : 12,000 Detail: 13-5 Datum: WGS84

Scale: 1:12,000

Reference:
DeLorme 3-D Topo Quads
Yarmouth, Me.
1999
Datum WGS84

Figure 1
Site Location Map

75-20 Astoria Blvd.
Jackson Heights, New York



LEGEND

▤ CB	CATCH BASIN
○ MH	MANHOLE
○ FH	FIRE HYDRANT
—×—×—	CHAIN LINK FENCE
▨	AREA COVERED UNDER THE VOLUNTARY CLEANUP APPLICATION
—×—×—	PROPERTY BOUNDARY (APPROXIMATE) *(CHAIN LINK FENCE)*

SCALE

0 140 280 FEET

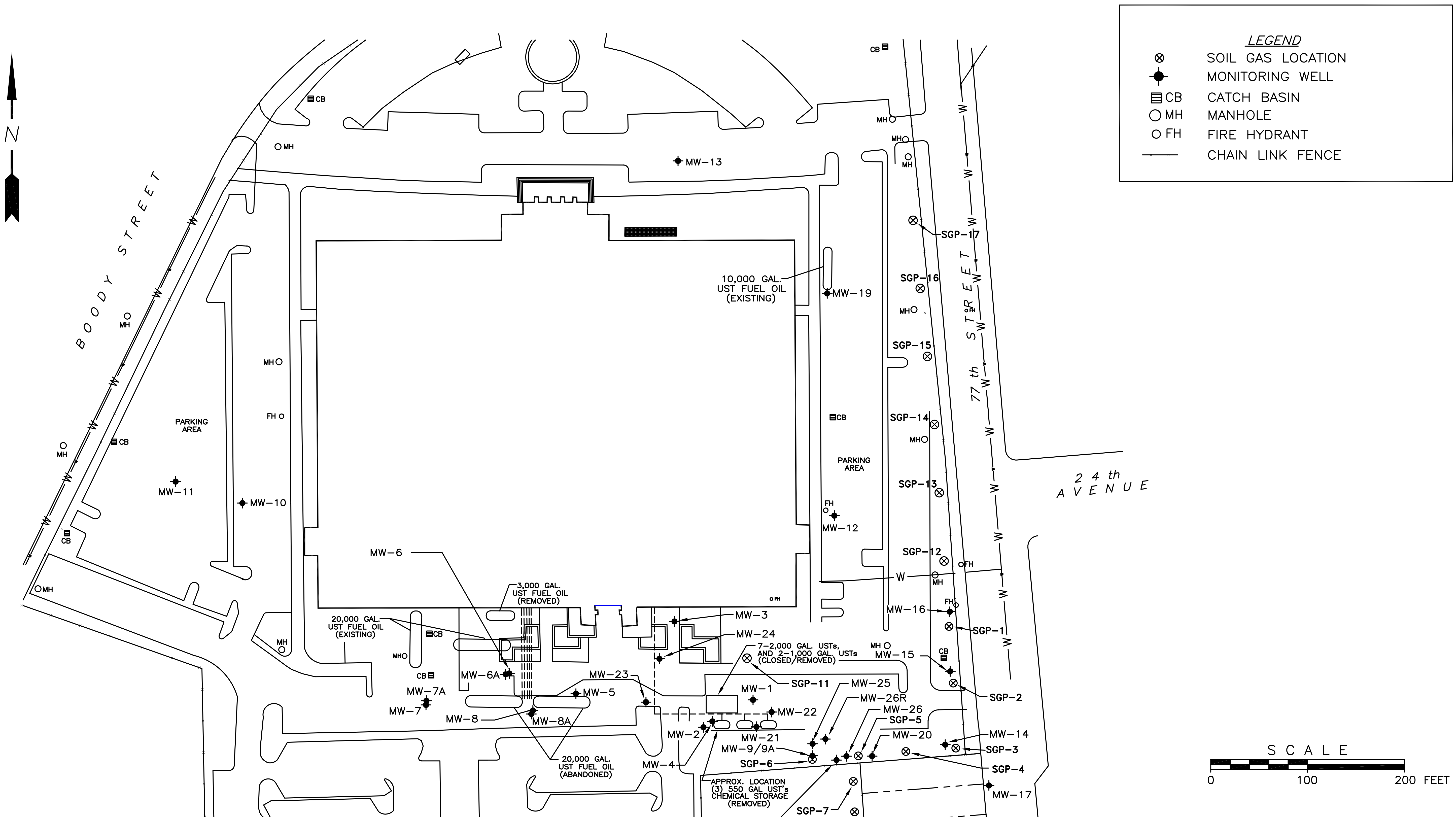
Shaw
Shaw E & I, Inc.

101-1 COLIN DRIVE
HOLBROOK, N.Y. 11741
(631) 472 4000

FIGURE 2
VOLUNTARY CLEANUP AREA

75-20 ASTORIA BOULEVARD
JACKSON HEIGHTS, NEW YORK

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
New Rochelle, NY	*TS/ED/SSH* 12-20-01	*E. Gustafson* 07/21/04	*E. Gustafson* 11/10/04	821687-FIG2



LEGEND

⊗ SOIL GAS LOCATION
⌖ MONITORING WELL
▤ CB CATCH BASIN
○ MH MANHOLE
○ FH FIRE HYDRANT
—— CHAIN LINK FENCE

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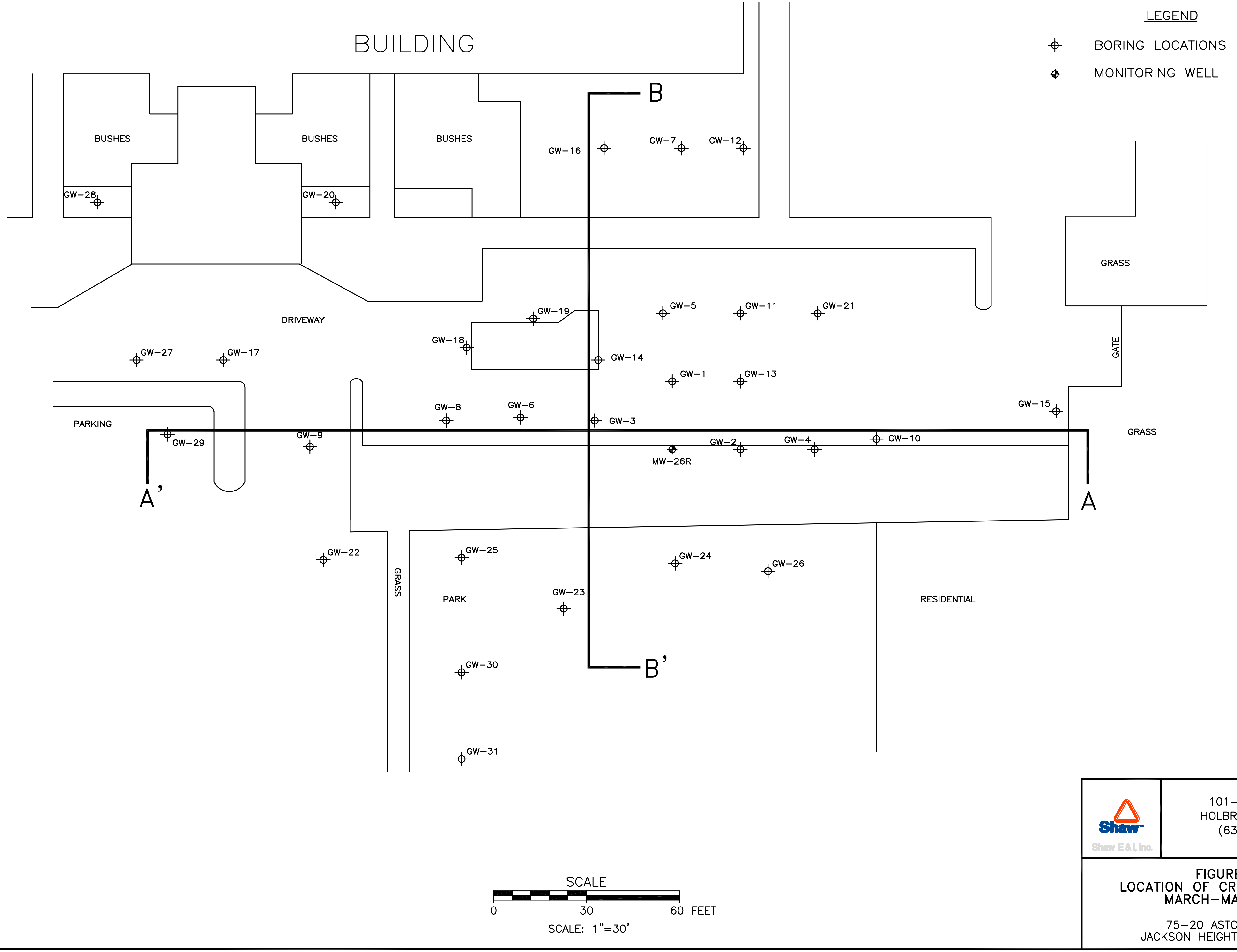
(631) 472 4000

FIGURE 3
HISTORICAL SAMPLING LOCATIONS

75-20 ASTORIA BOULEVARD
JACKSON HEIGHTS, NEW YORK

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
Holbrook, NY	D. Downing 4/18/05	E. Gustafson 4/18/05	E. Gustafson 4/18/05	821687-FIG3

821687-FIG4
DRAWING NUMBER
Appvd. By E. Gustafson
PM E. Gustafson
JOB No. 821687
DRAWN BY E. Dunseath 7/014/04
OFFICE Holbrook
X-REF ---

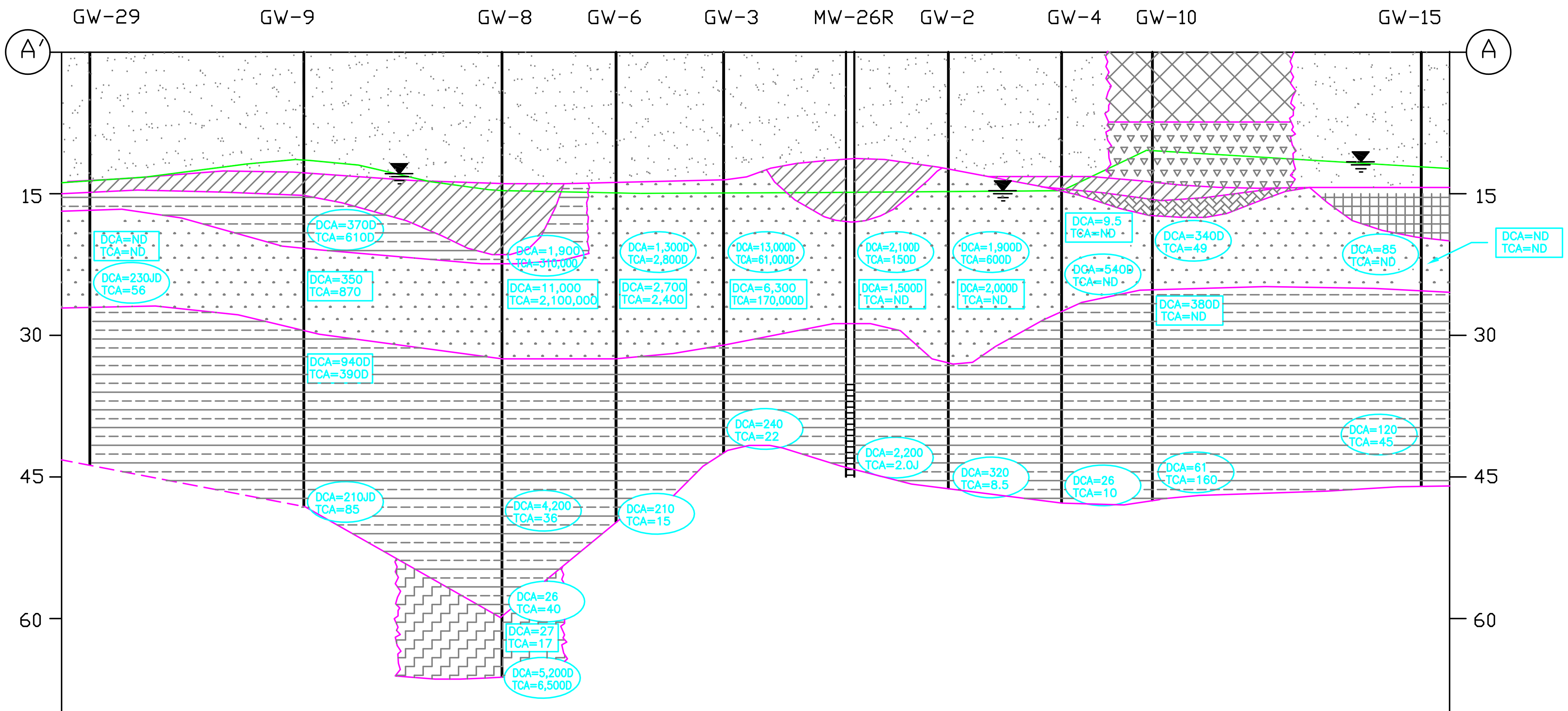


Shaw
Shaw E & I, Inc.

101-1 COLIN DRIVE
HOLBROOK, N.Y. 11741
(631) 472-4000

FIGURE 4
LOCATION OF CROSS SECTIONS
MARCH-MAY 2004

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK



HORIZONTAL SCALE

0 30 60 FEET

VERTICAL SCALE

0 15 30 FEET

LEGEND

- ░ FILL: BROWN OR ORANGE/BROWN MEDIUM TO FINE SAND, SOME SILT AND GRAVEL. CONTAINS BRICK AND GRAVEL.
- ▨ BLACK OR GRAY/BLACK CLAYEY SILT.
- ☰ GRAYISH BROWN OR GREENISH GRAY FINE SAND, SOME SILT.
- ▩ BROWN FINE SAND WITH SOME SILT.
- ⁘ GRAYISH BROWN SILT WITH SOME CLAY.
- ▦ GREENISH GRAY AND ORANGE/BROWN INTERBEDDED SILT.
- ⊠ DARK YELLOW/BROWN FINE SAND.
- ▽ GRAYISH BROWN SILT WITH SOME SAND.
- ▧ GREENISH GRAY SILT, SOME CLAY.
- DCA=2,700 TCA=2,400 SOIL ANALYTICAL DATA.
- DCA=340D TCA=49 GROUNDWATER ANALYTICAL DATA.
- GW-10 SOIL BORING LOCATION
- ▼ GROUNDWATER TABLE
- – – – INFERRED
- GROUNDWATER MONITORING WELL LOCATION

DCA=1,1-DICHLOROETHANE
TCA=1,1,1-TRICHLOROETHANE
J=ESTIMATED CONCENTRATION
ND=NOT DETECTED
D=CONCENTRATION REPORTED FROM DILUTED SAMPLE.
ALL RESULTS IN PARTS PER BILLION (ppb).

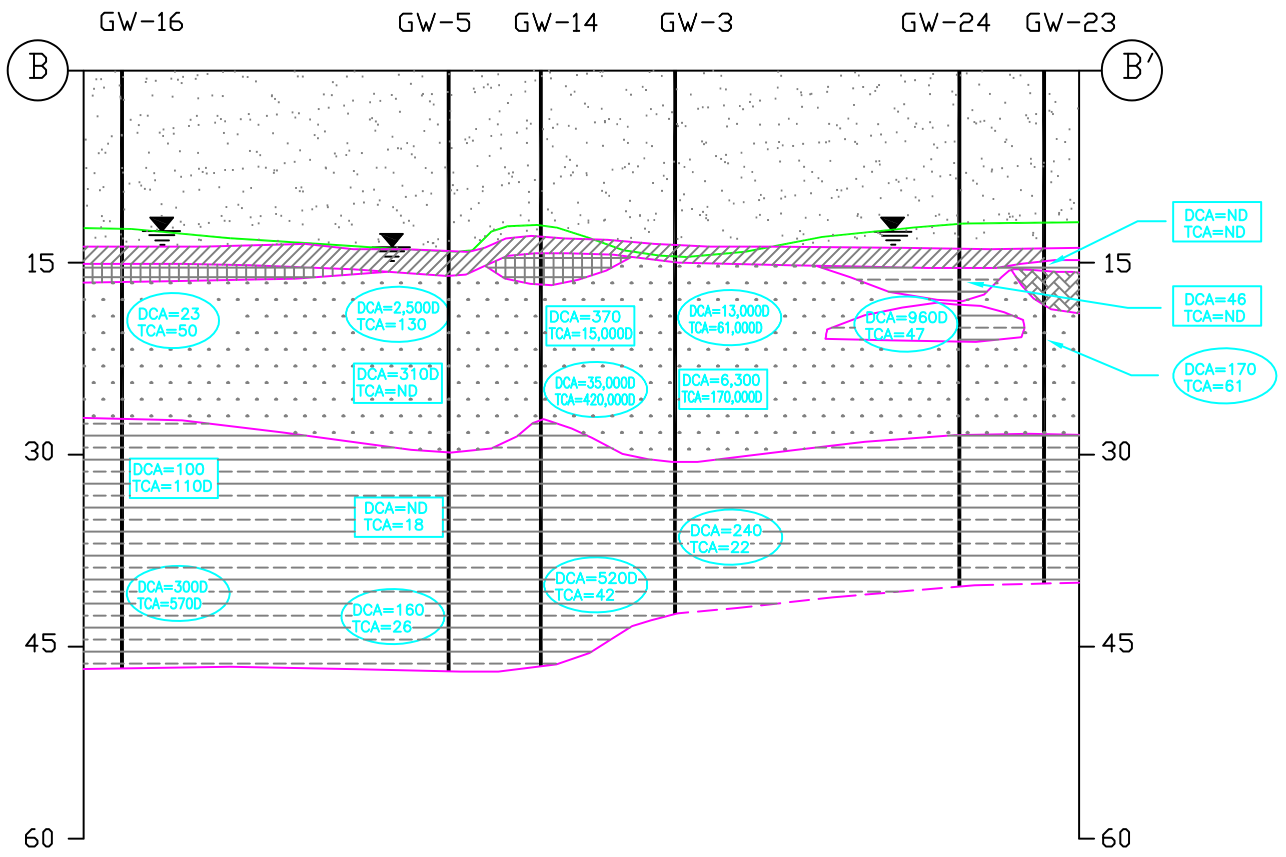
Shaw
Shaw E & I, Inc.

101-1 COLIN DRIVE
HOLBROOK, N.Y. 11741
(631) 472-4000

FIGURE 5
STRATIGRAPHIC CROSS SECTION A-A'
MARCH-MAY 2004

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

DRAWING NUMBER 821687-FIG5
Appvd. By E. Gustafson
PM E. Gustafson
JOB No. 821687
DRAWN BY 5/31/05 D. Downing
OFFICE Holbrook
X-REF ---



LEGEND

⛶	FILL: BROWN OR ORANGE/BROWN MEDIUM TO FINE SAND, SOME SILT AND GRAVEL. CONTAINS BRICK AND GRAVEL.
▨	BLACK OR GRAY/BLACK CLAYEY SILT.
▤	GRAYISH BROWN OR GREENISH GRAY FINE SAND, SOME SILT.
▩	BROWN FINE SAND WITH SOME SILT.
⛶	GRAYISH BROWN SILT WITH SOME CLAY.
▦	GREENISH GRAY AND ORANGE/BROWN INTERBEDDED SILT.
⊠	DARK YELLOW/BROWN FINE SAND.
▽	GRAYISH BROWN SILT WITH SOME SAND.
▧	GREENISH GRAY SILT, SOME CLAY.
DCA=2,700 TCA=2,400	SOIL ANALYTICAL DATA.
DCA=340D TCA=49	GROUNDWATER ANALYTICAL DATA.
– – – – –	INFERRED
▼	GROUNDWATER TABLE
GW-14	SOIL BORING LOCATION

DCA=1,1-DICHLOROETHANE
TCA=1,1,1-TRICHLOROETHANE
J=ESTIMATED CONCENTRATION
ND=NOT DETECTED
D=CONCENTRATION REPORTED FROM DILUTED SAMPLE.
ALL RESULTS IN PARTS PER BILLION (ppb).

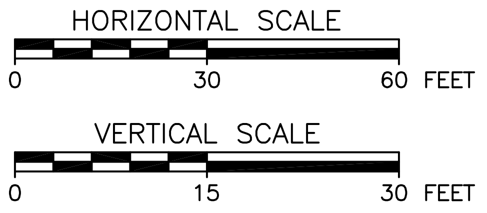


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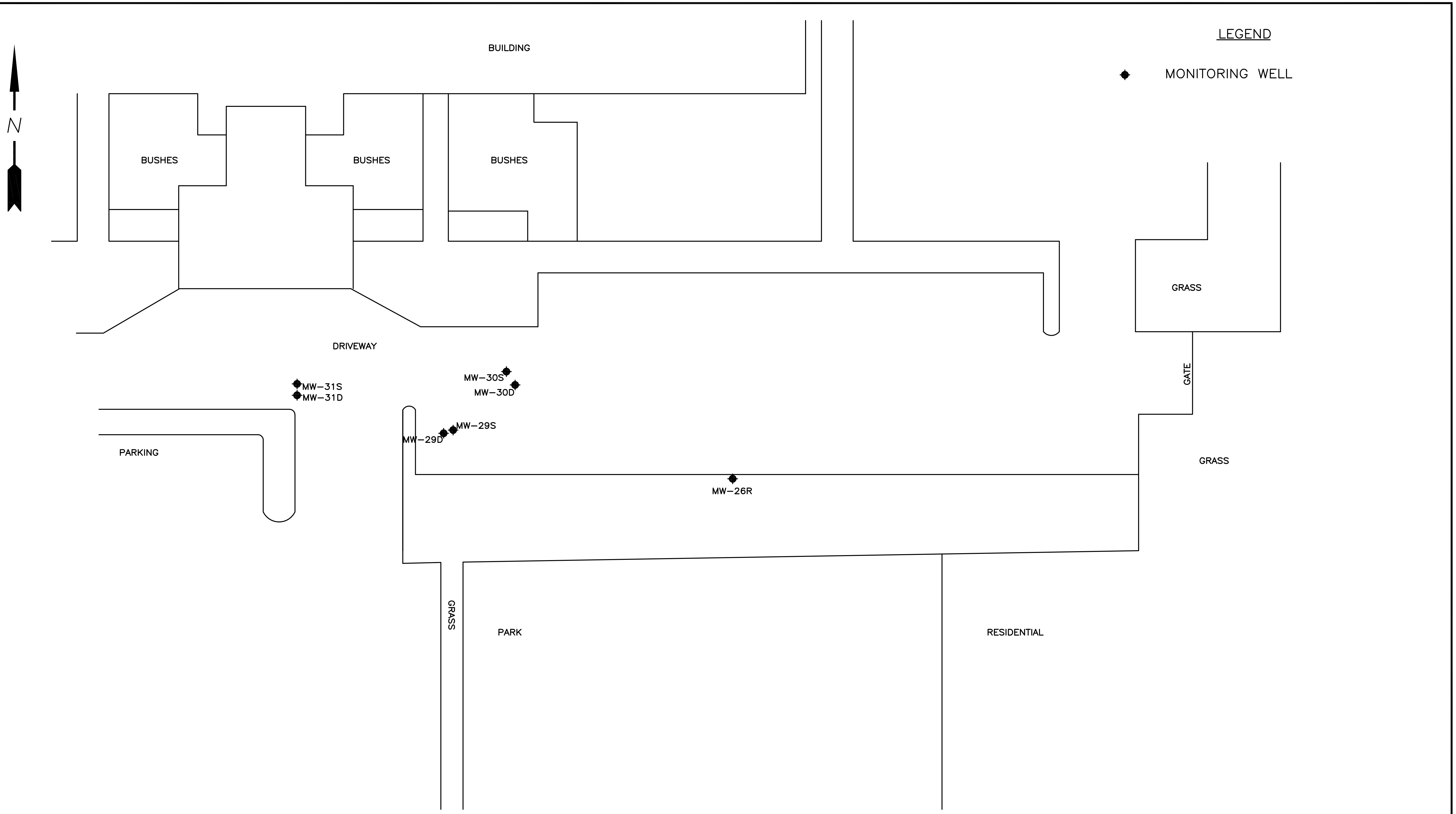
FIGURE 6
STRATIGRAPHIC CROSS SECTION B-B'
MARCH-MAY 2004

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

X-REF	OFFICE	DRAWN BY		JOB No.	PM	Appvd. By	DRAWING NUMBER
---	Holbrook	*D. Downing*	*5/31/05*	*821687*	*E. Gustafson*	*E. Gustafson*	821687-FIG6



SCALE
0 30 60 FEET
SCALE: 1"=30'

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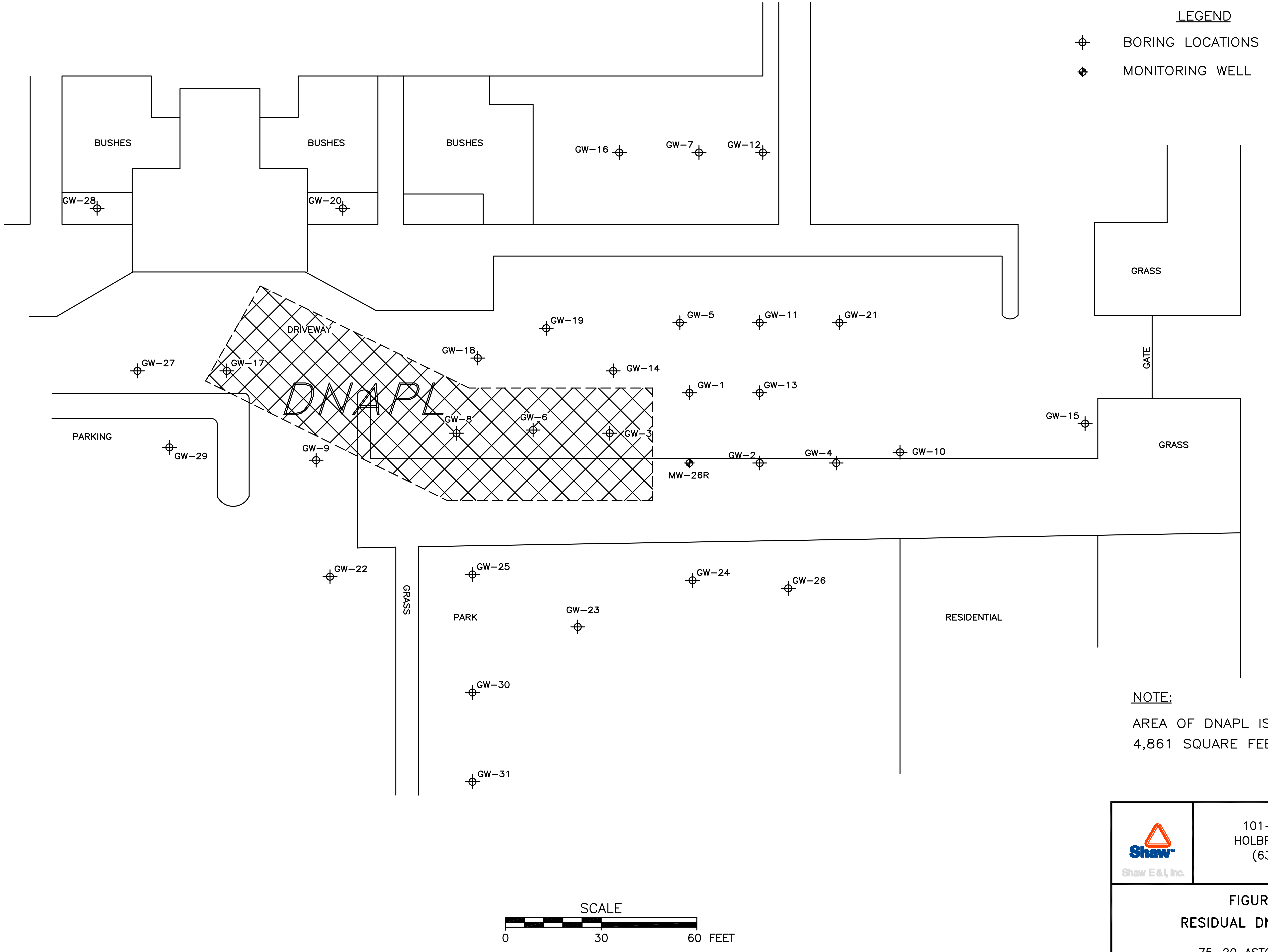
(631) 472-4000

FIGURE 7
NEWLY INSTALLED MONITORING WELL LOCATIONS

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

X-REF	---
OFFICE	Holbrook
DRAWN BY	D. Downing 5/24/05
JOB No.	821687
PM	E. Gustafson
Appvd. By	E. Gustafson
DRAWING NUMBER	821687-FIG7



NOTE:

AREA OF DNAPL IS APPROXIMATELY 4,861 SQUARE FEET.

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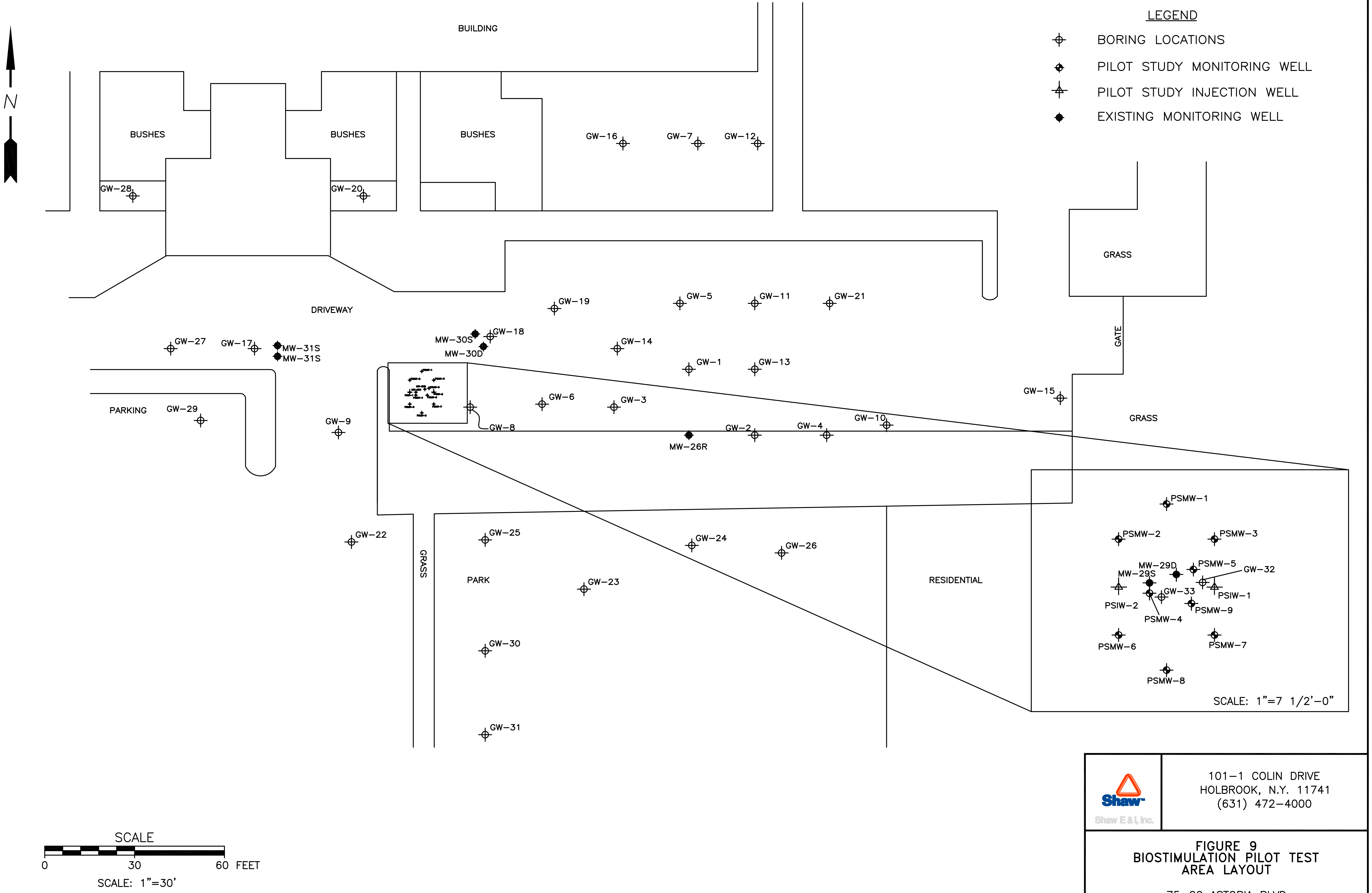
FIGURE 8
RESIDUAL DNAPL AREA

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

X-REF	OFFICE	DRAWN BY	JOB No.	PM	Appvd. By	DRAWING NUMBER
---	Holbrook	D. DOWNING 5/31/05	821687	E. Gustafson	E. Gustafson	821687-FIG8



X–REF	OFFICE	DRAWN BY		JOB No.	PM	Appvd. By	DRAWING NUMBER
–––	Holbrook	*D. Downing*	*5/24/05*	*821687*	*E. Gustafson*	*E. Gustafson*	821687–FIG9

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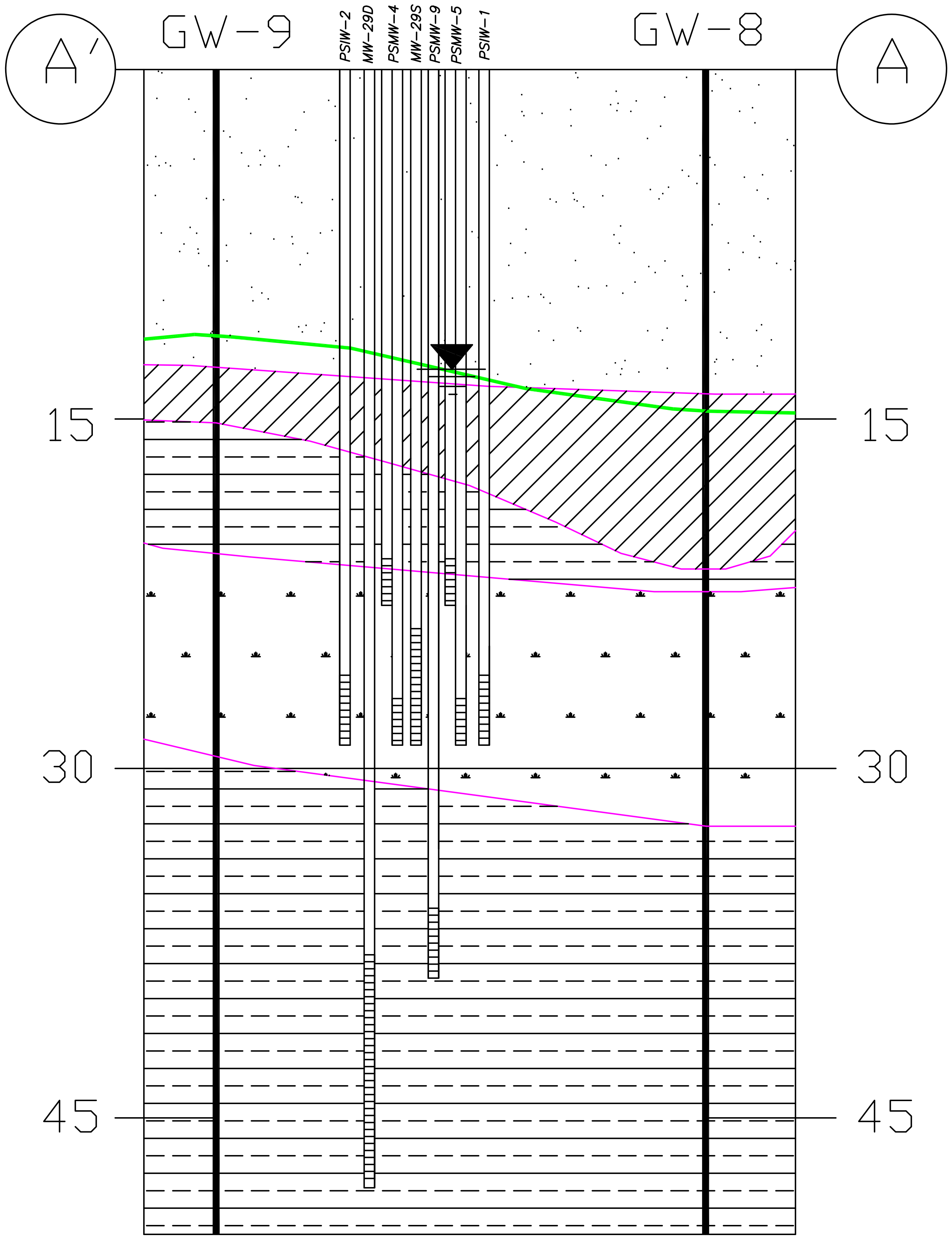
FIGURE 9
BIOSTIMULATION PILOT TEST AREA LAYOUT

75–20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK



LEGEND

- ☐ FILL: BROWN OR ORANGE/BROWN MEDIUM TO FINE SAND, SOME SILT AND GRAVEL. CONTAINS BRICK AND GRAVEL.
- ▨ BLACK OR GRAY/BLACK CLAYEY SILT.
- ☰ GRAYISH BROWN OR GREENISH GRAY FINE SAND, SOME SILT.
- ⠿ GRAYISH BROWN SILT WITH SOME CLAY.
- GW-10 │ SOIL BORING LOCATION
- ▼ GROUNDWATER TABLE
- ║ WELL LOCATION

NOTE:

PSMW-4 AND 5 ARE CLUSTER WELLS (TWO WELLS IN THE SAME BOREHOLE)

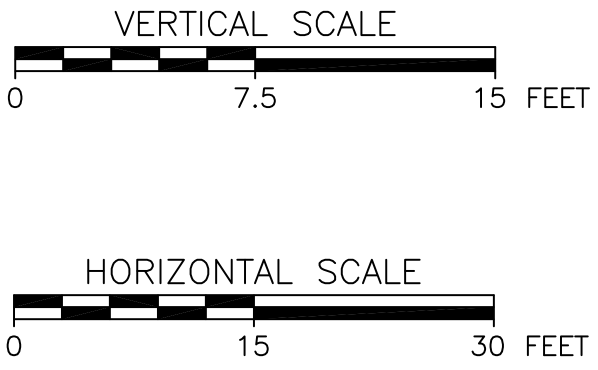


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FIGURE 10
CROSS SECTION OF PILOT TEST TREATMENT ZONE

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

DRAWING NUMBER	821687-FIG10
Appvd. By	E. Gustafson
PM	E. Gustafson
JOB No.	821687
DRAWN BY	D. Downing 5/31/05
OFFICE	Holbrook
X-REF	---

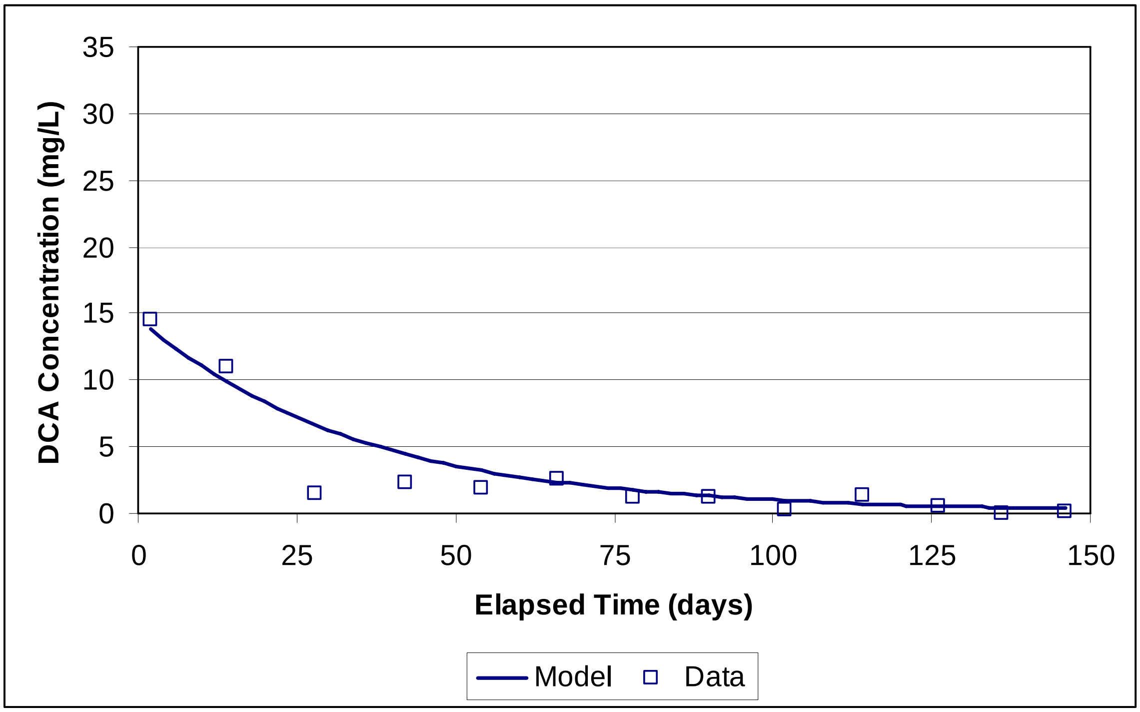


Figure 11. Simulated versus measured groundwater DCA concentrations at MW-29S. The DCA first-order biodegradation rate constant used in the model is 0.35/day.

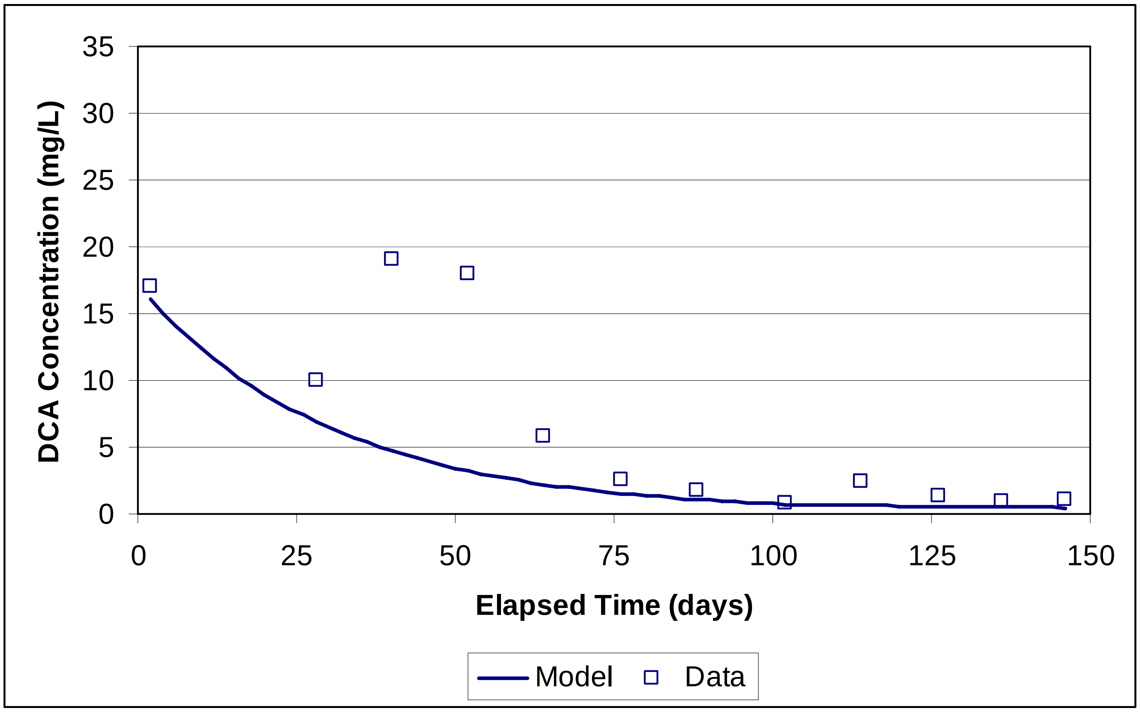


Figure 12. Simulated versus measured groundwater DCA concentrations at MW-4S. The DCA first-order biodegradation rate constant used in the model is 0.35/day.

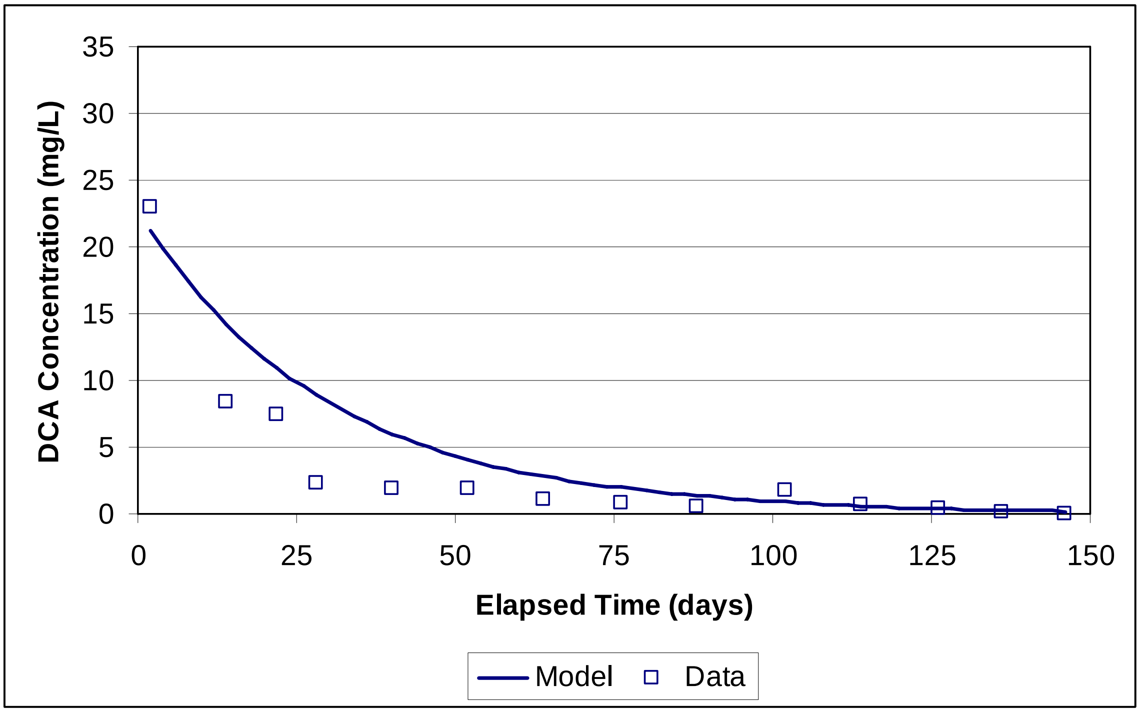


Figure 13. Simulated versus measured groundwater DCA concentrations at MW-4D. The DCA first-order biodegradation rate constant used in the model is 0.35/day.

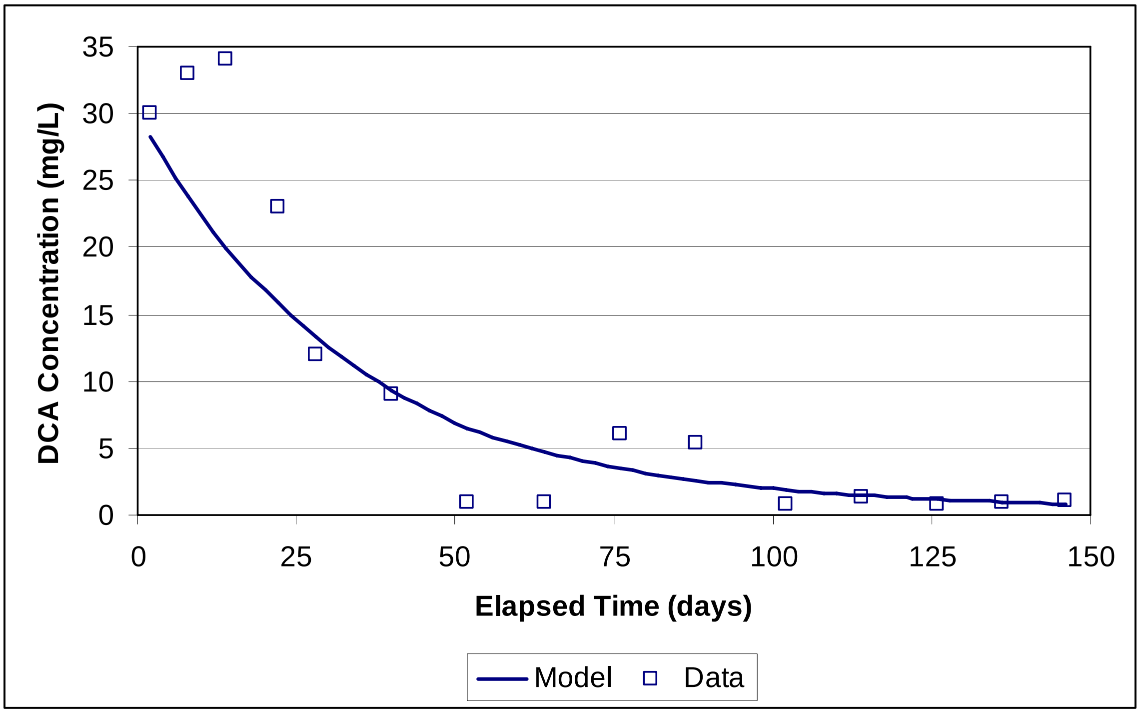


Figure 14. Simulated versus measured groundwater DCA concentrations at MW-5S. The DCA first-order biodegradation rate constant used in the model is 0.35/day.

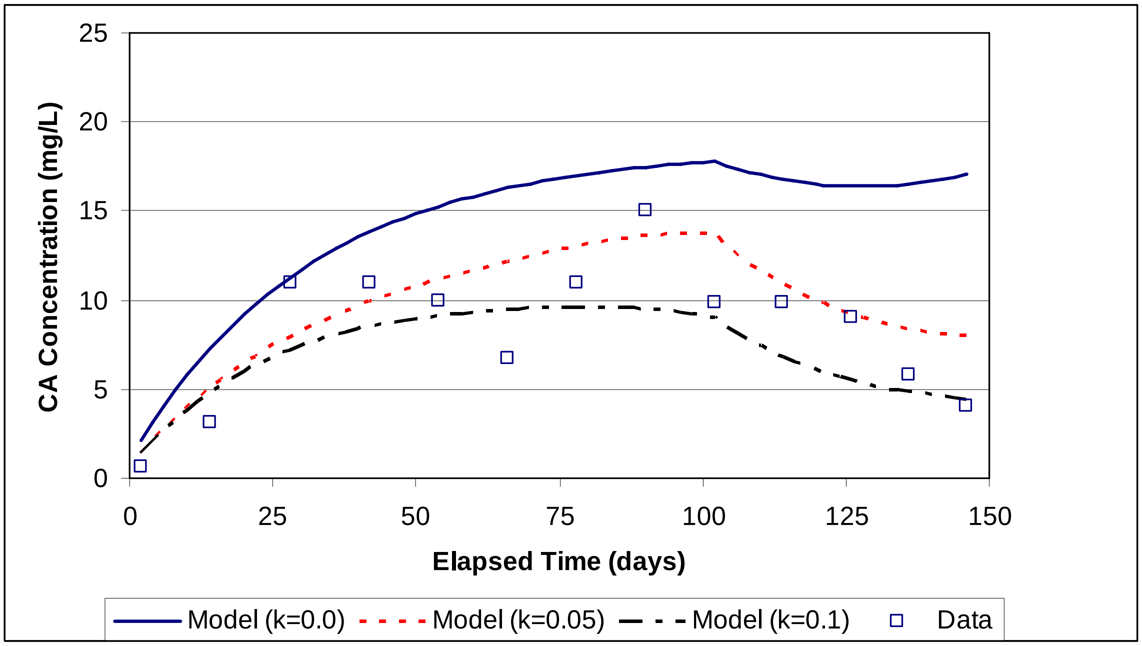


Figure 15. Simulated versus measured groundwater CA concentrations at MW-29S. CA first-order biodegradation rate constants of 0.0, 0.05, and 0.1/day are evaluated in the model.

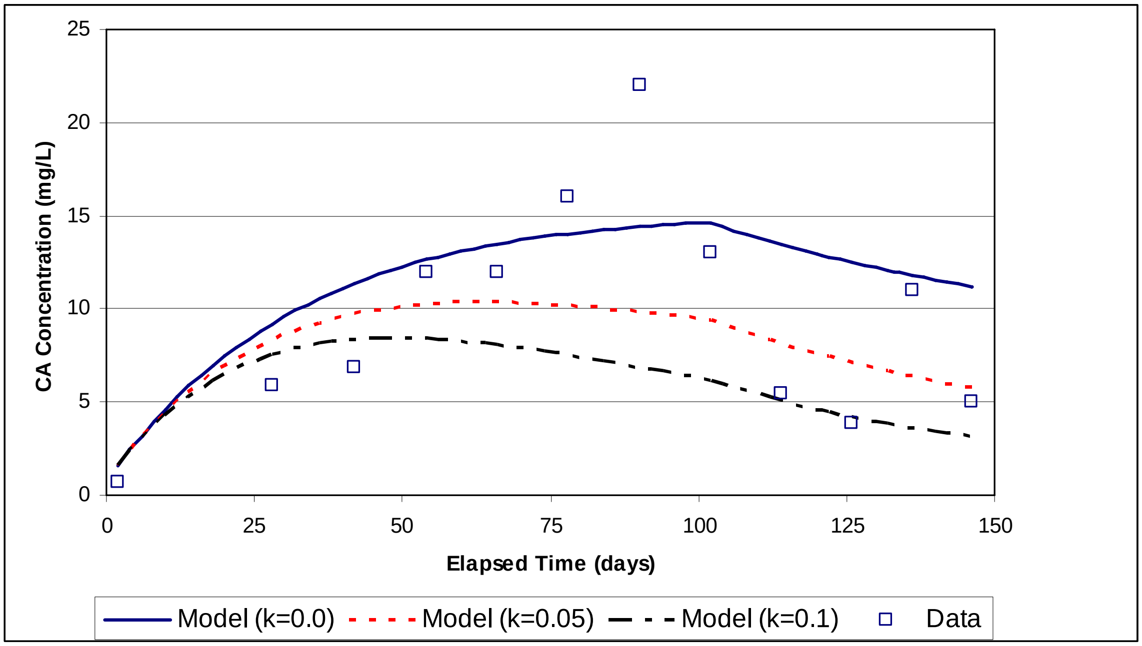


Figure 16. Simulated versus measured groundwater CA concentrations at MW-4S. CA first-order biodegradation rate constants of 0.0, 0.05, and 0.1/day are evaluated in the model.

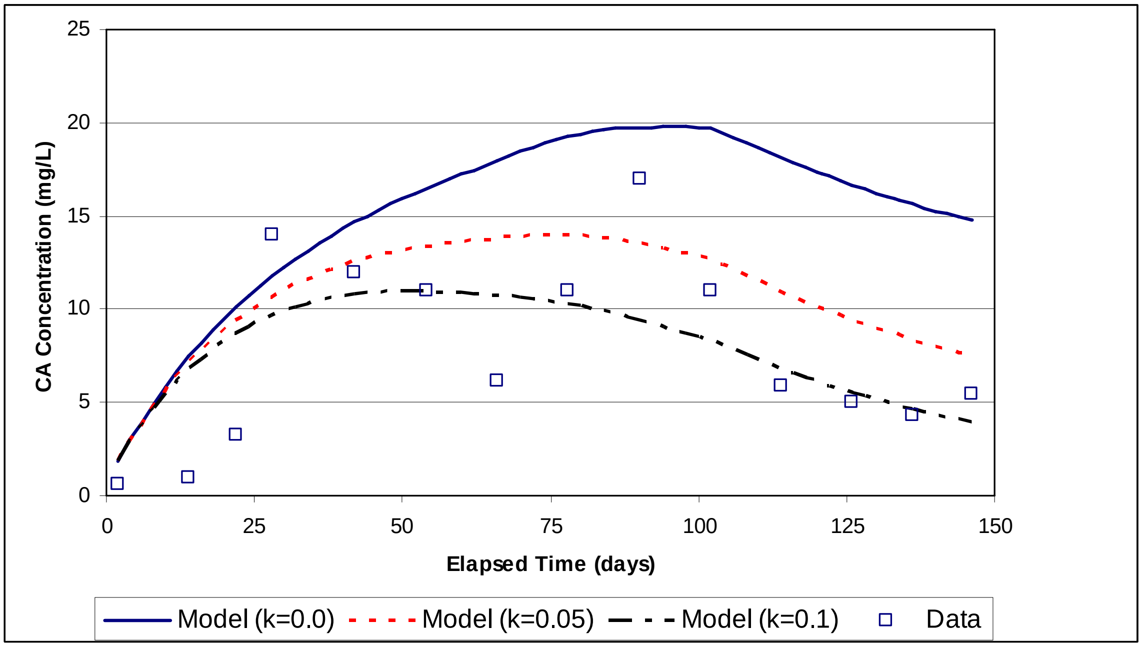


Figure 17. Simulated versus measured groundwater CA concentrations at MW-4D. CA first-order biodegradation rate constants of 0.0, 0.05, and 0.1/day are evaluated in the model.

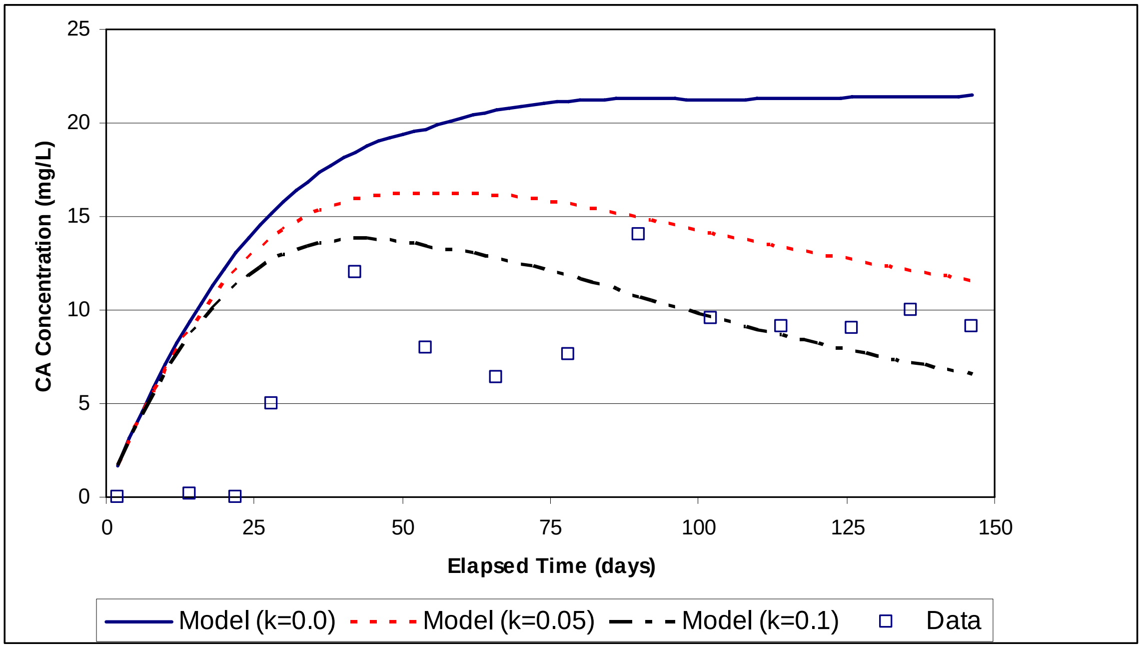


Figure 18. Simulated versus measured groundwater CA concentrations at MW-5S. CA first-order biodegradation rate constants of 0.0, 0.05, and 0.1/day are evaluated in the model.

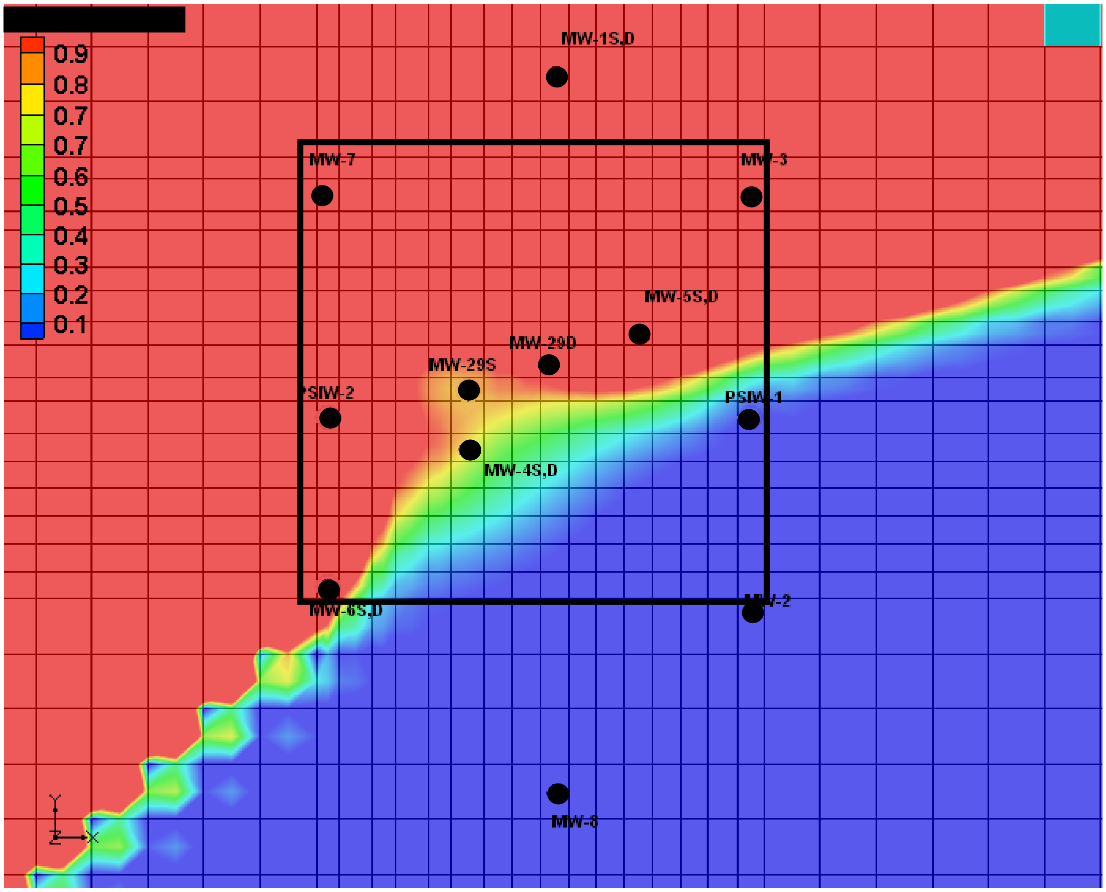

[redacted]

Figure 19A. TCA biodegradation during the pilot test at t=2 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.

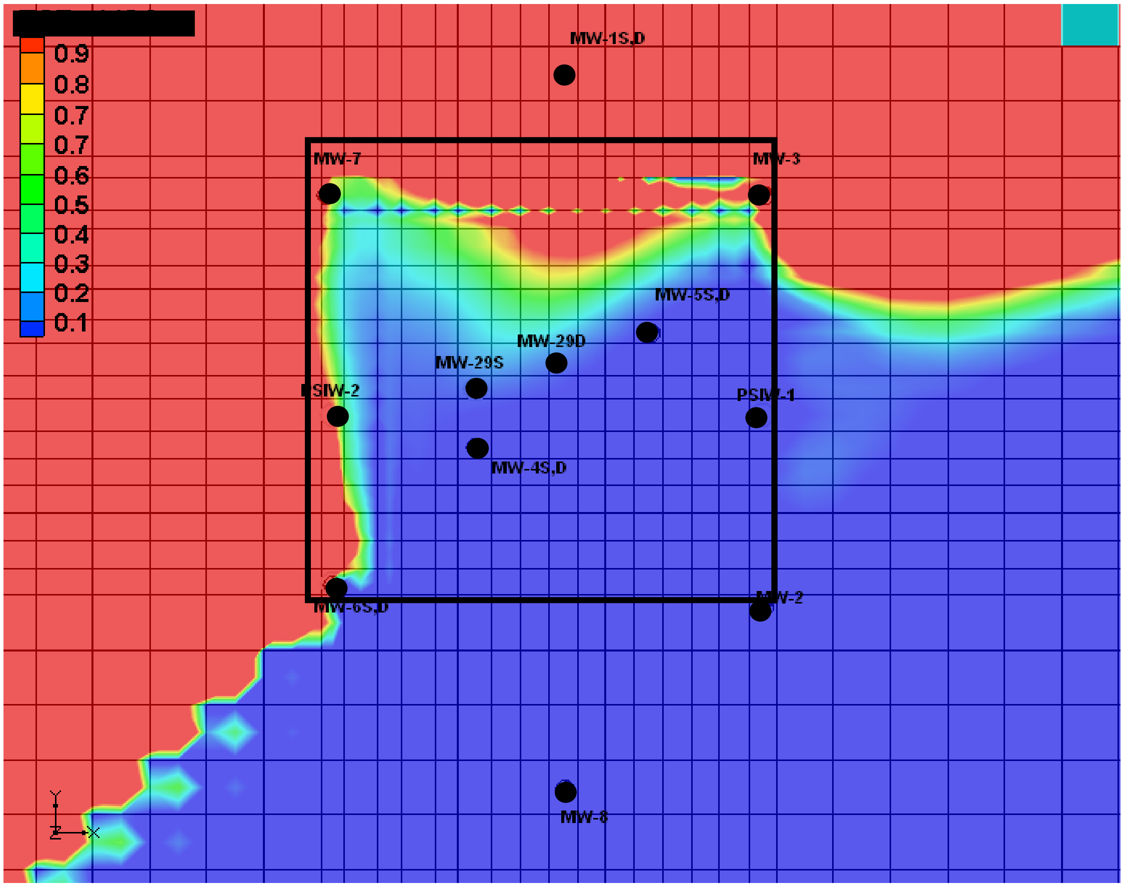
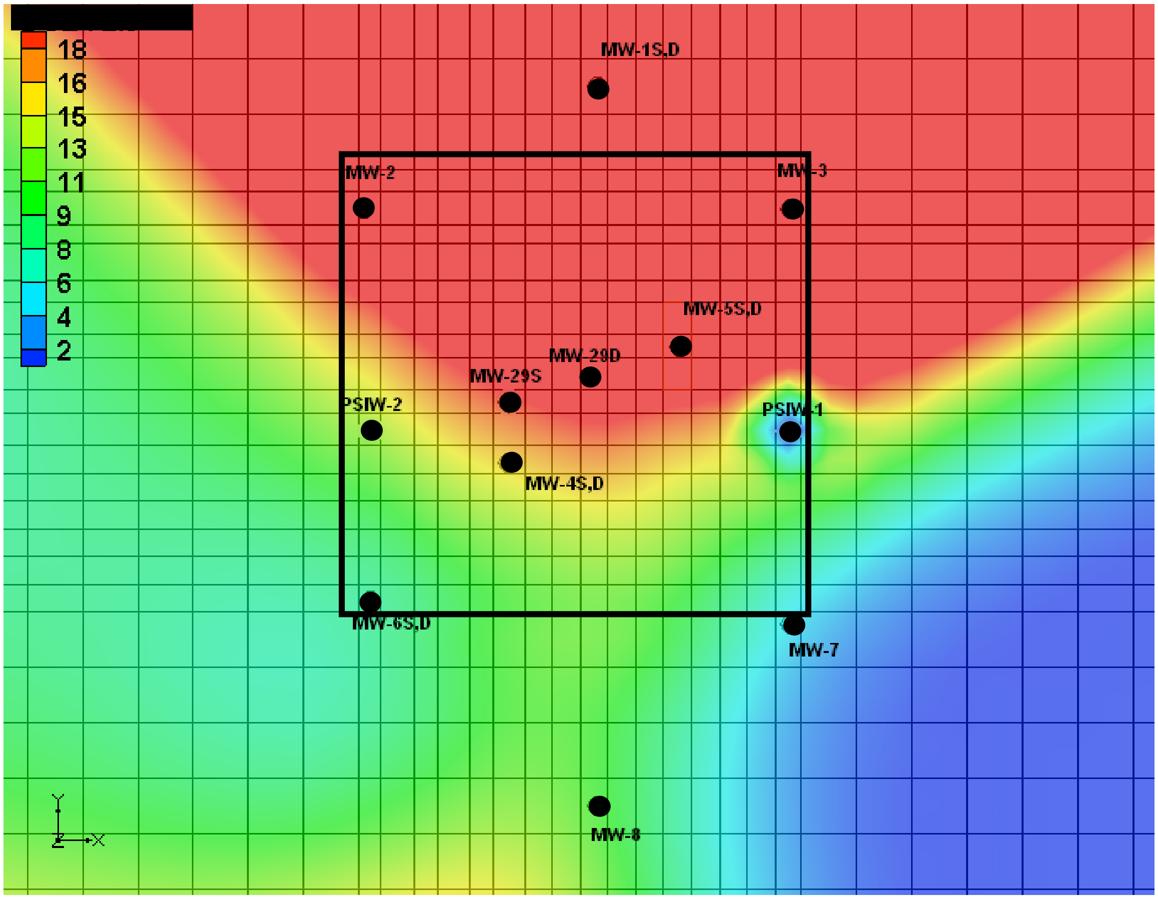


Figure 19B. TCA biodegradation during the pilot test at t=146 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.



[redacted]

Figure 20A. DCA biodegradation during the pilot test at t=2 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.

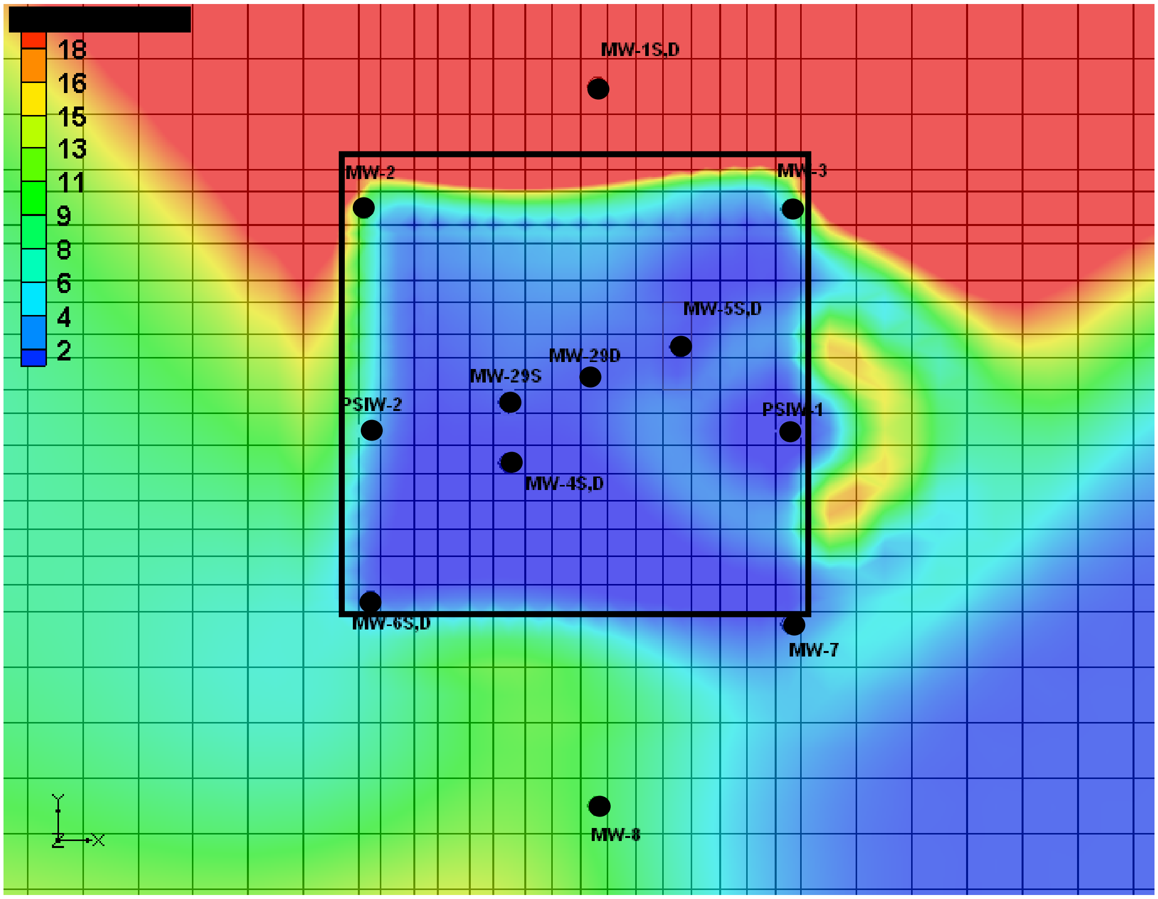


Figure 20B. DCA biodegradation during the pilot test at t=146 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.

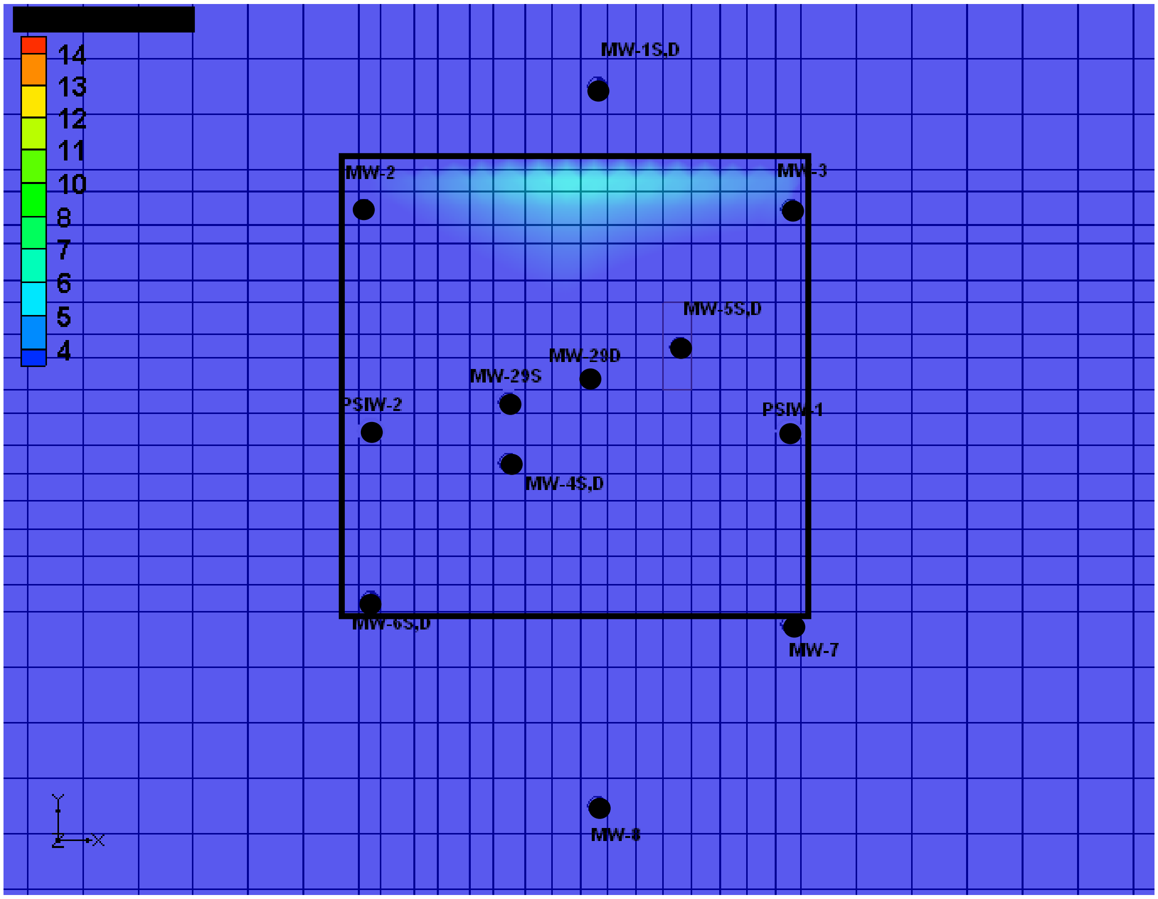


Figure 21A. CA biodegradation during the pilot test at t=2 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.

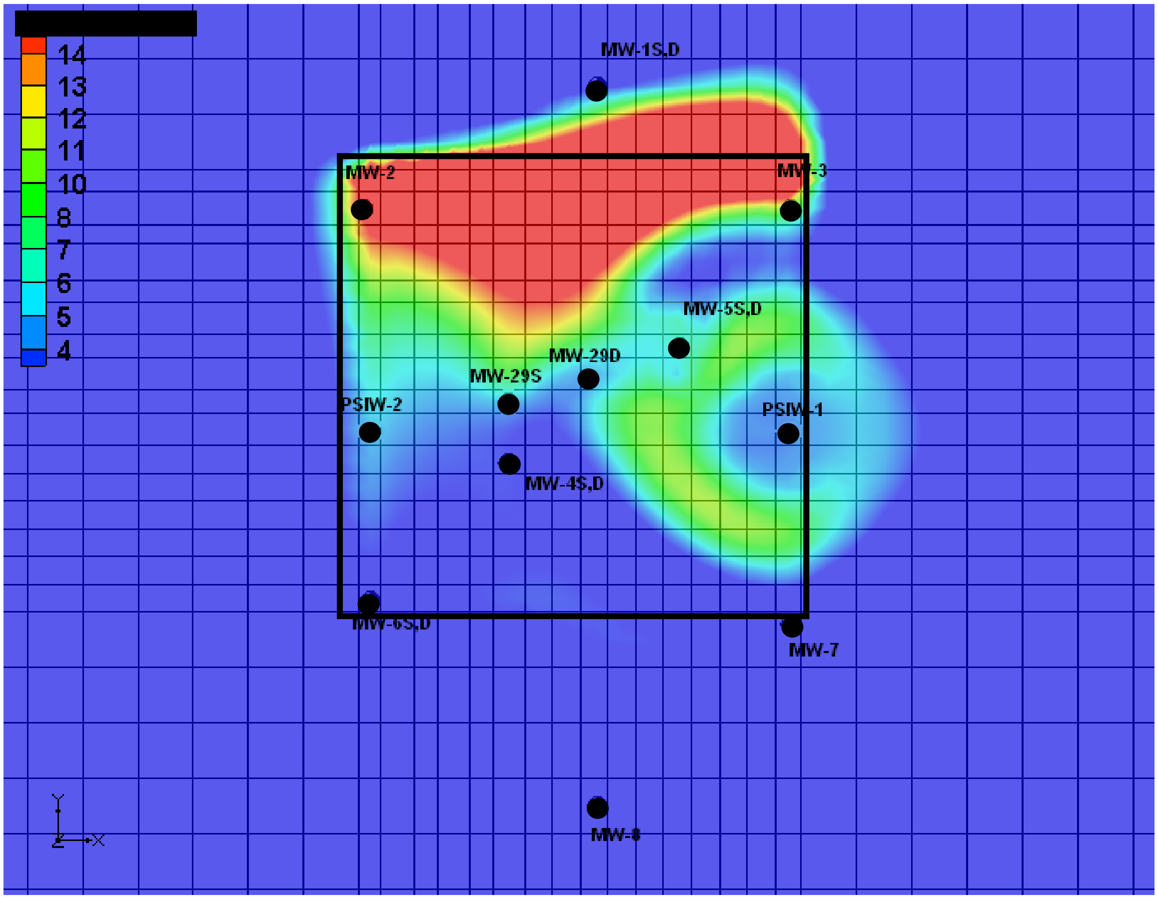


Figure 21B. CA biodegradation during the pilot test at t=146 days. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.

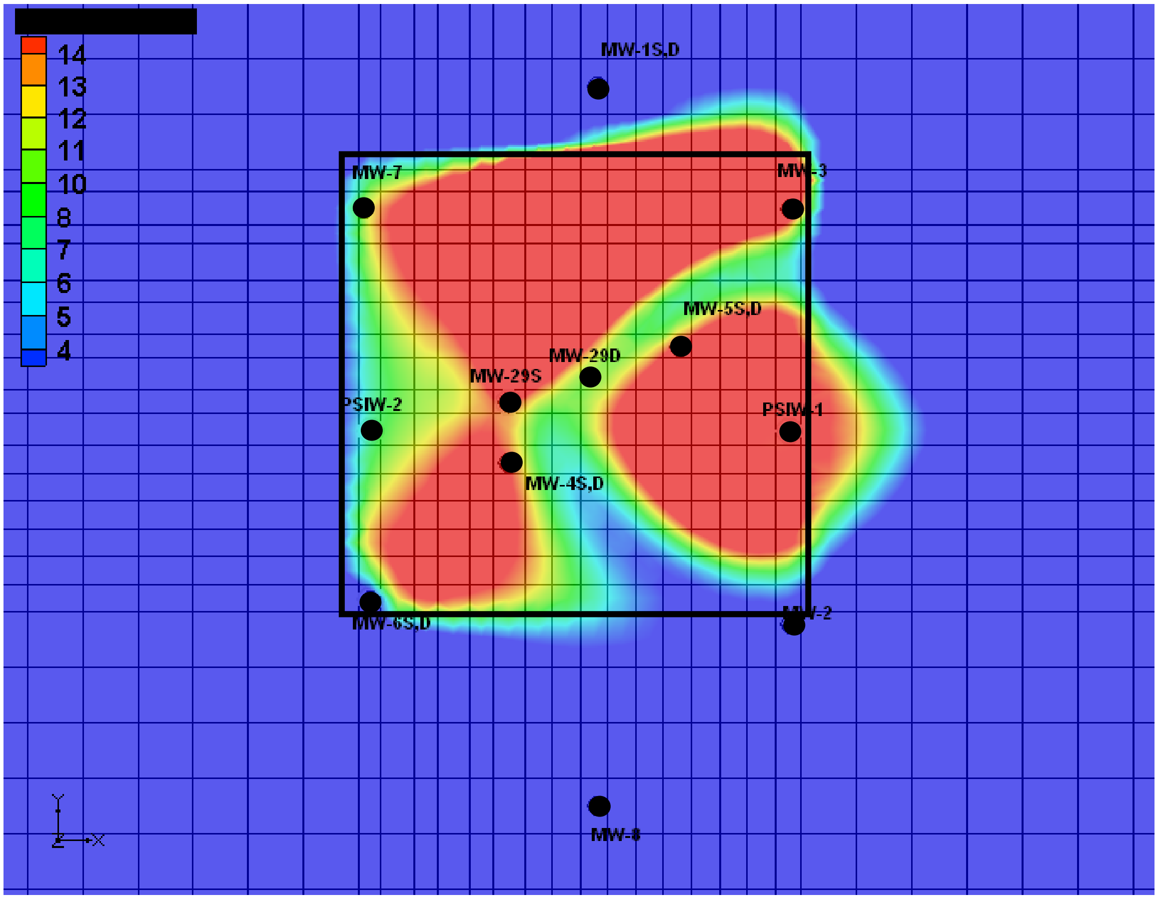
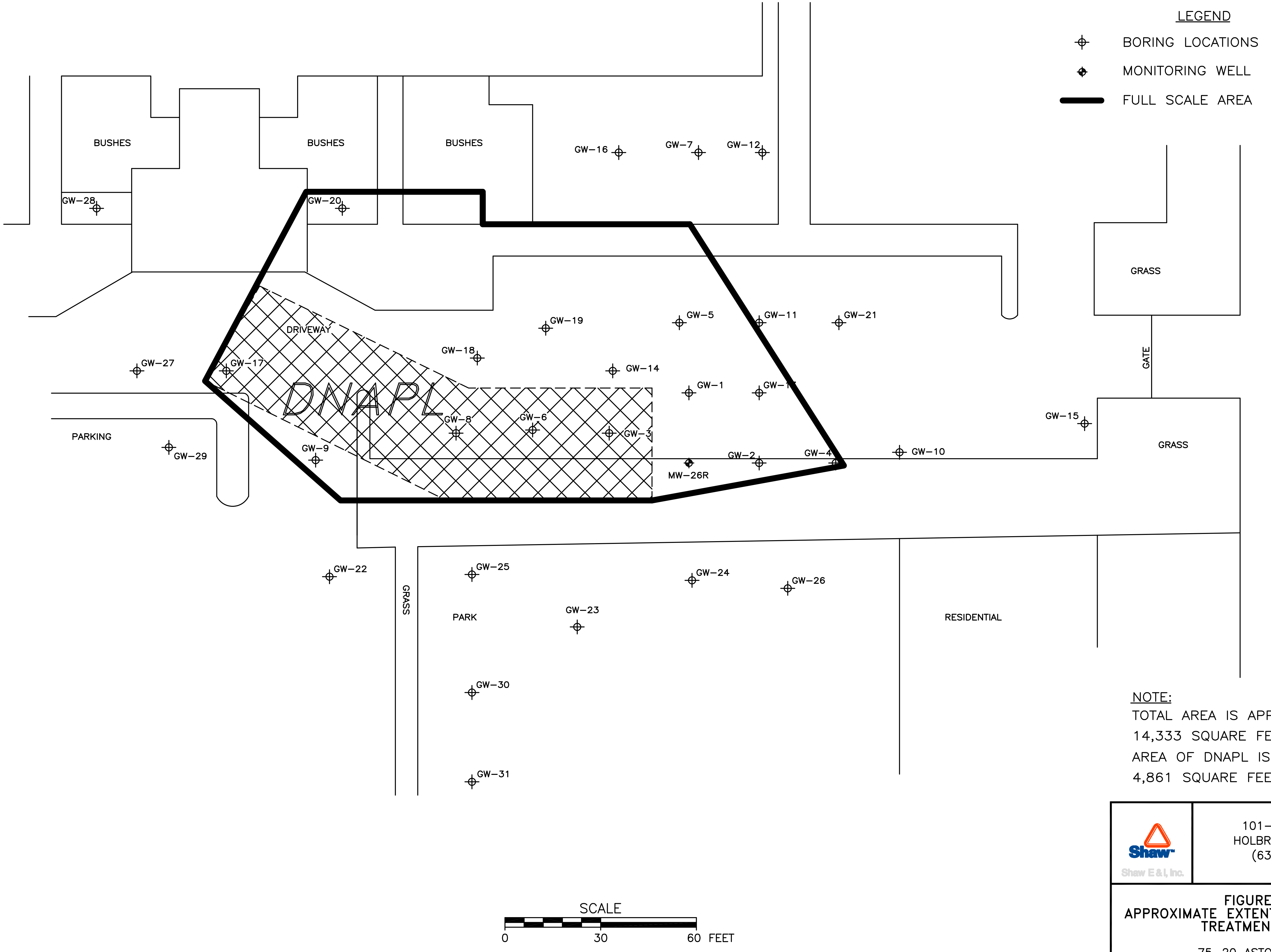


Figure 21C. CA biodegradation during the pilot test at t=146 days, assuming ZERO CA biodegradation. The decreased CA concentrations depicted in Figure 21B (actual conditions) compared to amount of CA depicted here (assuming zero CA biodegradation) confirms that biodegradation of CA is occurring. The boxed-in area represents the region in which biodegradation was occurring (as discussed in Appendix C). Gridblocks within the boxed-in region are 0.5 ft. x 0.5 ft.



LEGEND

BORING LOCATIONS

MONITORING WELL

FULL SCALE AREA

NOTE:

TOTAL AREA IS APPROXIMATELY
14,333 SQUARE FEET.
AREA OF DNAPL IS APPROXIMATELY
4,861 SQUARE FEET.

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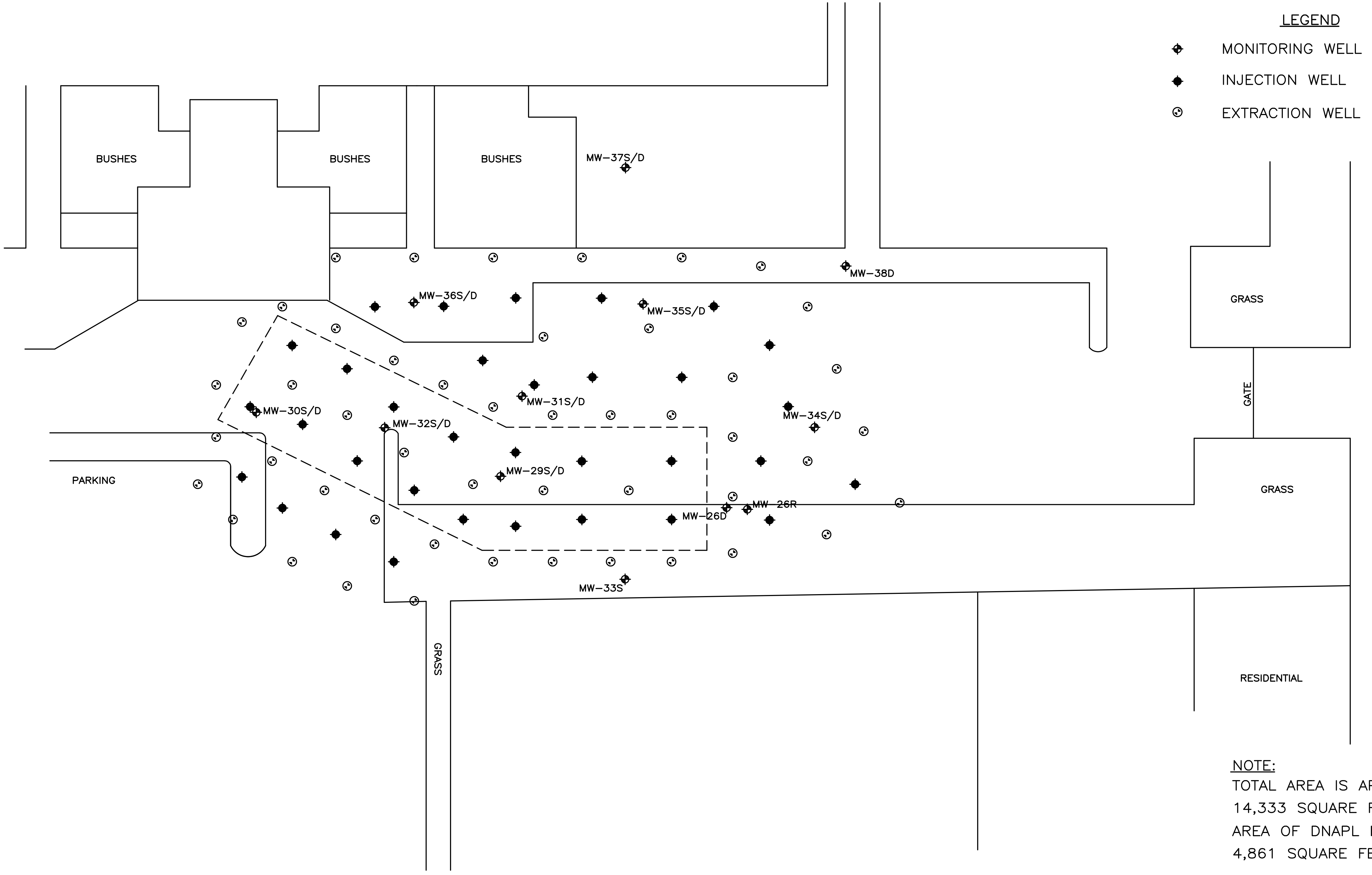
FIGURE 22
APPROXIMATE EXTENT OF FULL–SCALE TREATMENT AREA

75–20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

DRAWING NUMBER	821687–FIG22
Appvd. By	E. Gustafson
PM	E. Gustafson
JOB No.	821687
DRAWN BY	D. DOWNING 5/31/05
OFFICE	Holbrook
X–REF	---

DRAWING NUMBER	821687–FIG23
Appvd. By	E. Gustafson
PM	E. Gustafson
JOB No.	821687
DRAWN BY	D. DOWNING 11/16/06
OFFICE	Holbrook
X–REF	---



NOTE:
TOTAL AREA IS APPROXIMATELY 14,333 SQUARE FEET.
AREA OF DNAPL IS APPROXIMATELY 4,861 SQUARE FEET.

SCALE
0 30 60 FEET
SCALE: 1"=30'

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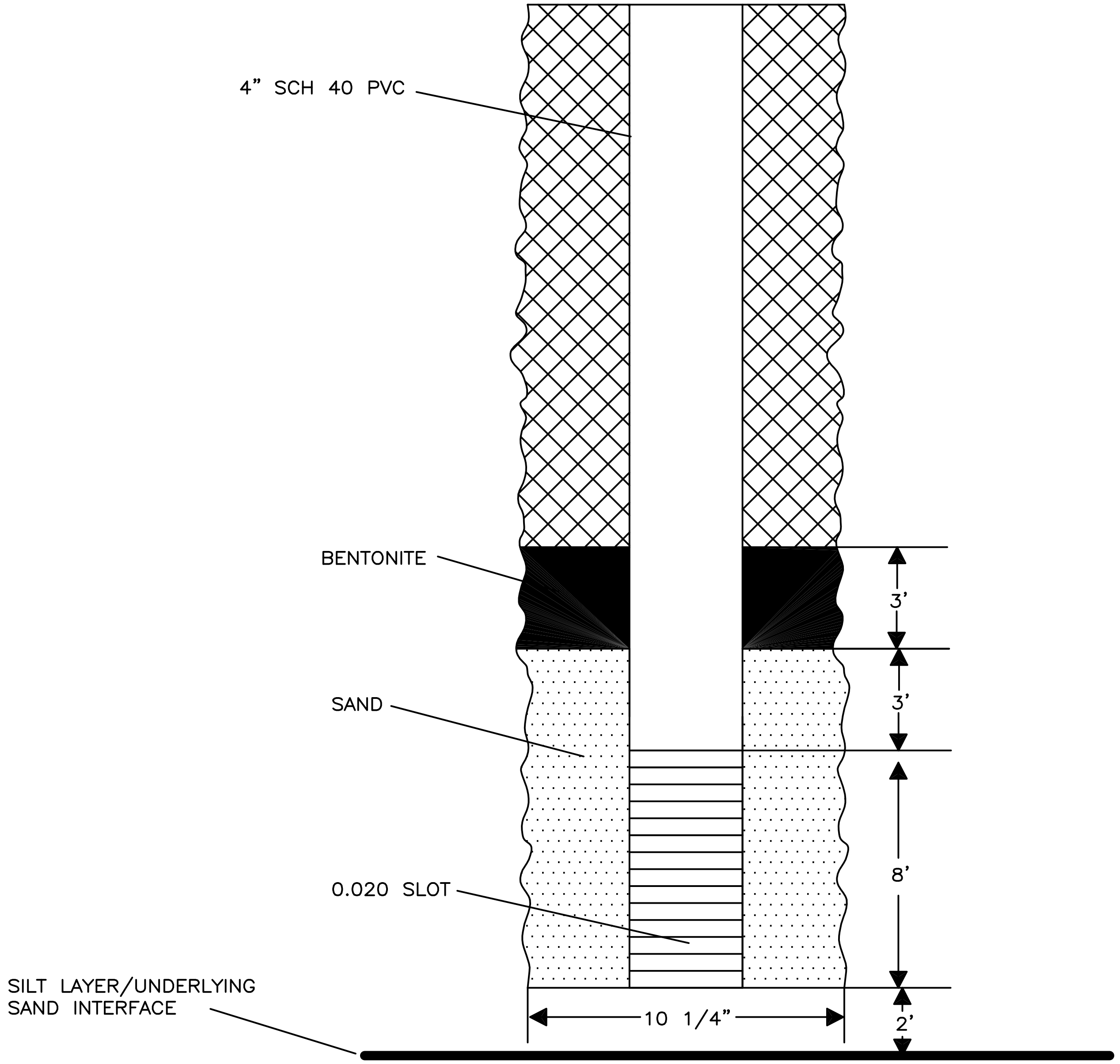
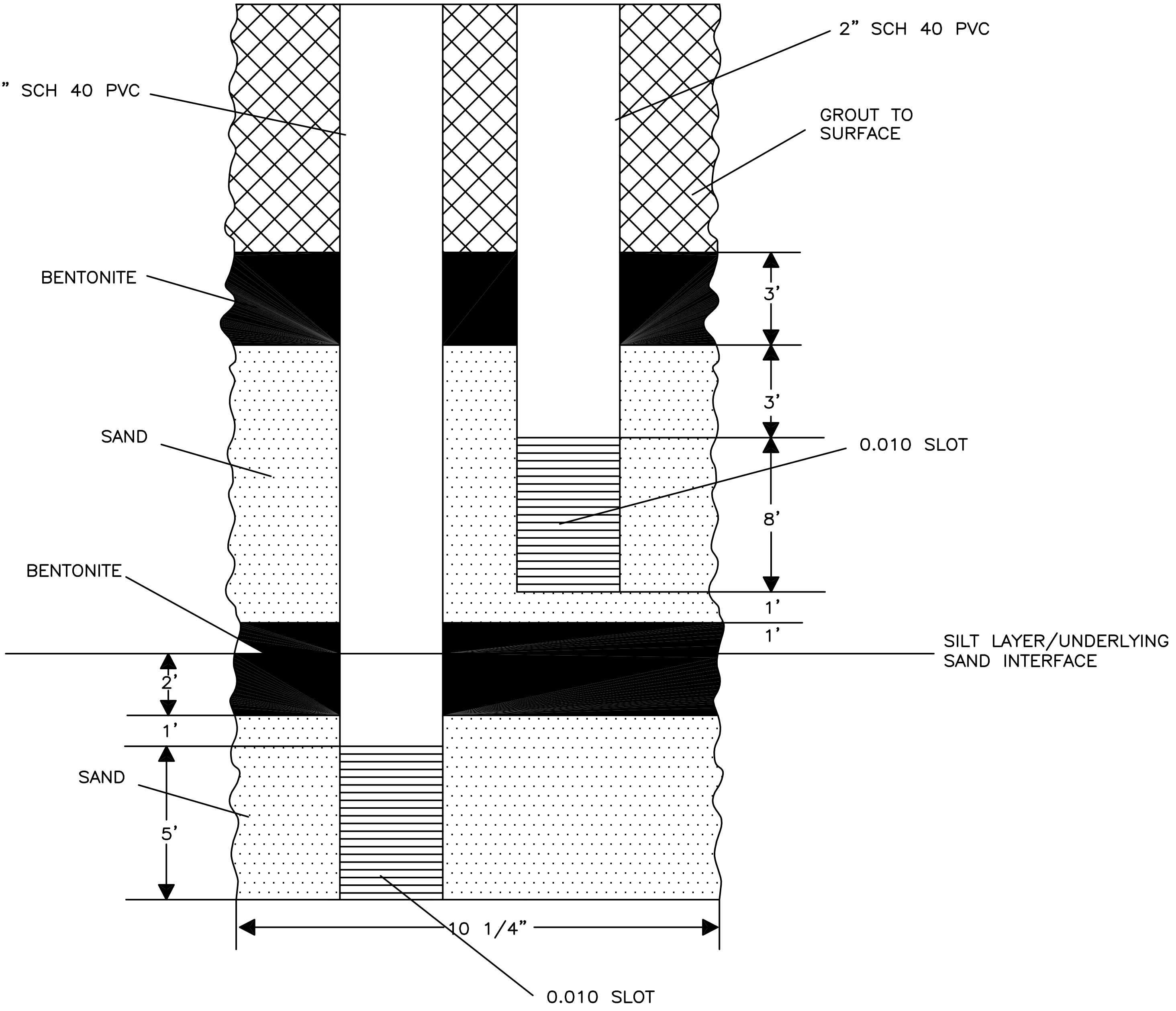
FIGURE 23
WELL LAYOUT OF CONCEPTUAL
FULL–SCALE TREATMENT ZONE

75–20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

INJECTION AND EXTRACTION WELLS
(FOR SILT LAYER)



NESTED MONITORING WELLS
(FOR SILT AND SAND LAYERS)



LEGEND

▨ CEMENT/BENTONITE GROUT

■ BENTONITE SEAL

░ SAND

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FIGURE 24
FULL SCALE WELL
CONSTRUCTION DETAILS

75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

X-REF	---
OFFICE	Holbrook
DRAWN BY	D. DOWNING 5/31/05
JOB No.	821687
PM	E. Gustafson
Appvd. By	E. Gustafson
DRAWING NUMBER	821687-FIG24

X-REF	OFFICE	DRAWN BY	JOB No.	PM	Appvd. By	DRAWING NUMBER
---	Holbrook	D. Downing 11/16/06	821687	E. Gustafson	E. Gustafson	821687-FIG25

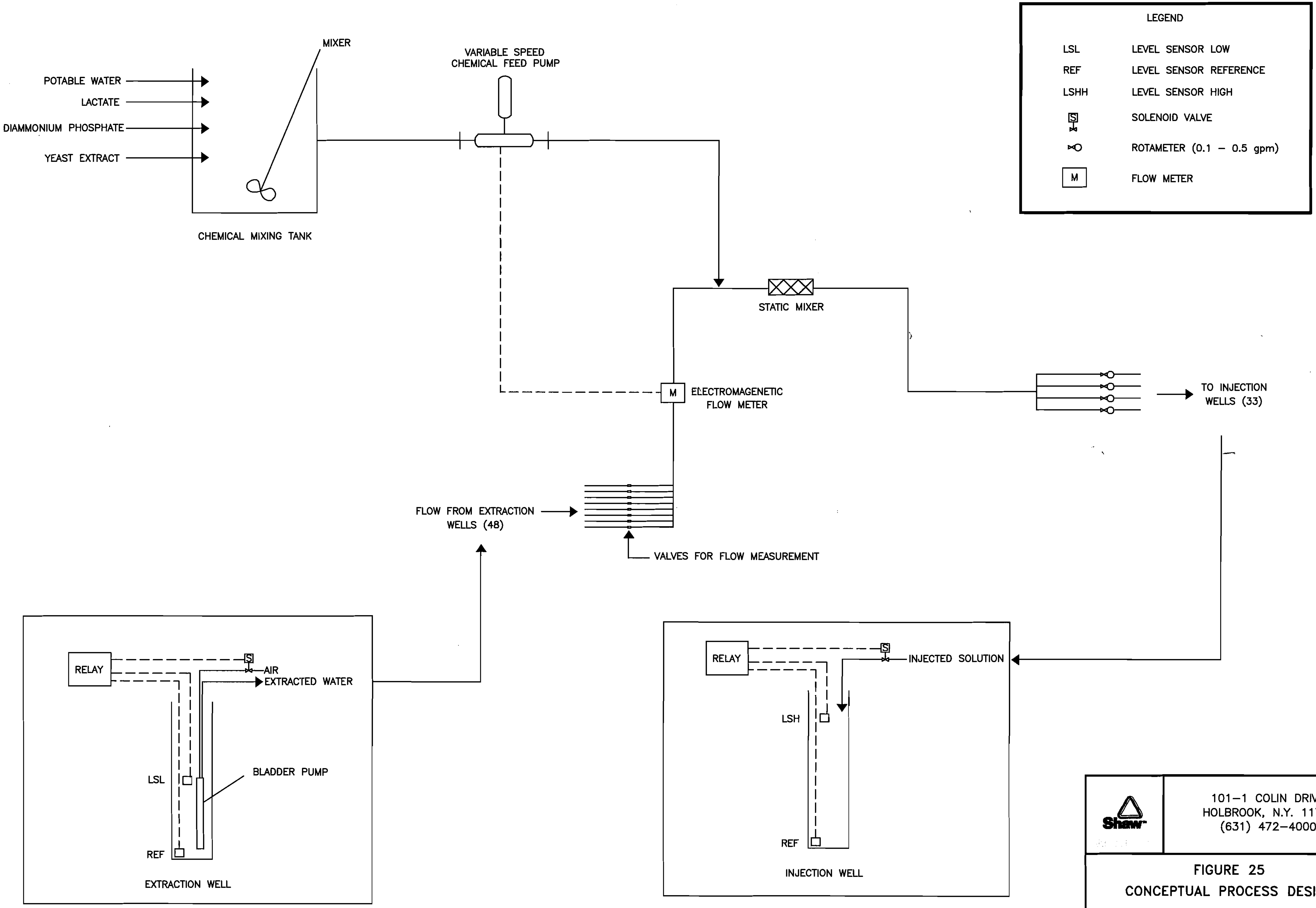

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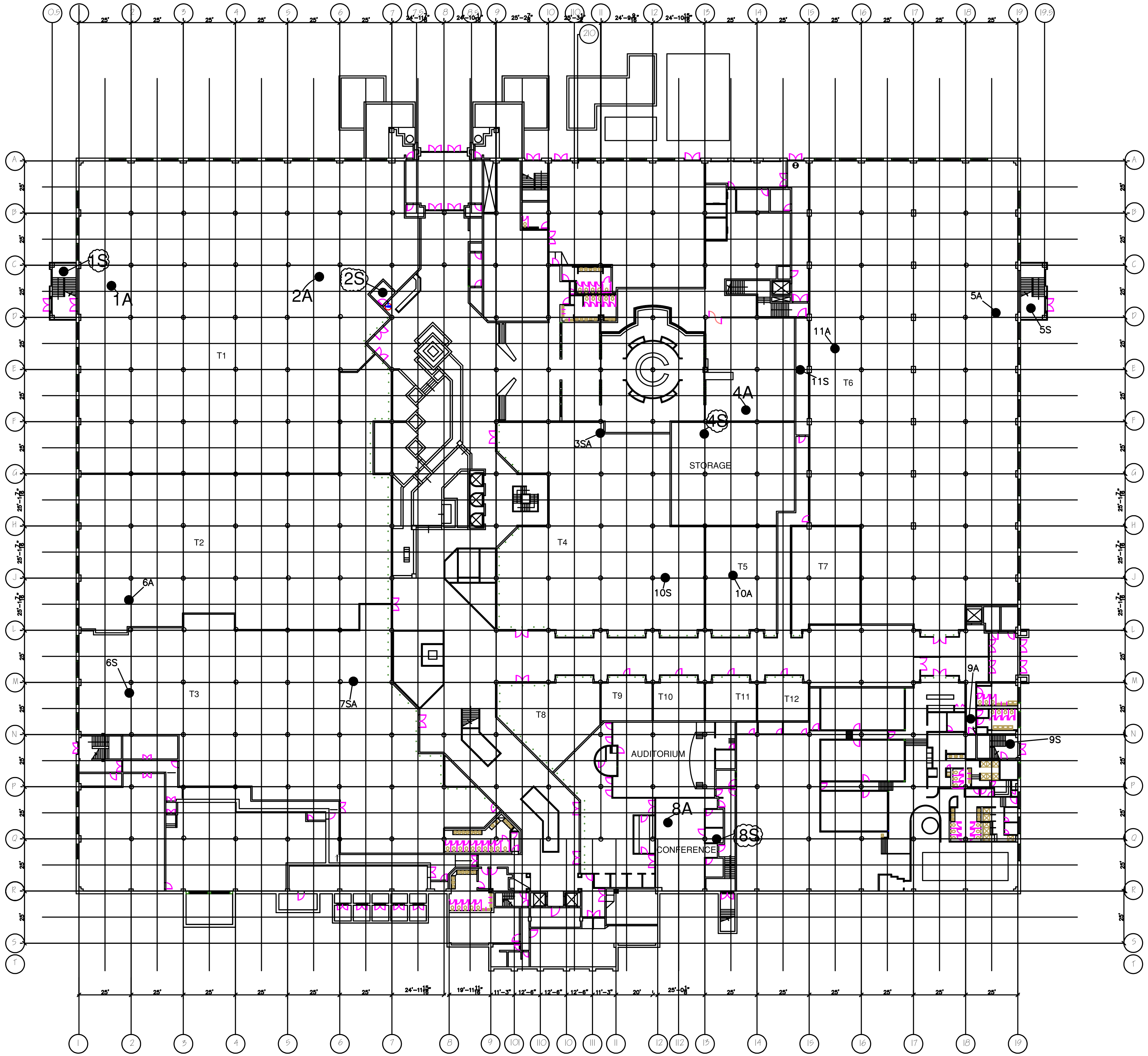
FIGURE 25
CONCEPTUAL PROCESS DESIGN

75–20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK



SOURCE: BLUMENFIELD DEVELOPMENT GROUP FLOOR PLAN FOR 75-20 ASTORIA BLVD; DATE 5/10/04

PROPOSED ANNUAL MONITORING LOCATIONS		
NUMBER	EW COLUMN	NS COLUMN
1–S	0.75	C 1/4
2–S	6 3/4	C 1/2
4–S	13	F 1/4
8–S	13 3/8	Q

FORMER MONITORING LOCATIONS (MARCH 2005)		
NUMBER	EW COLUMN	NS COLUMN
1–S	0.75	C 1/4
2–S	6 3/4	C 1/2
3–SA	11	F 1/4
4–S	13	F 1/4
5–S	19 1/4	C 3/4
6–S	2	M 1/4
7–SA	6 1/4	M
8–S	13 3/8	Q
9–S	18 3/4	N 1/4
10–S	12 1/4	J
11–S	13 3/4	E

NOTES:
A = INDOOR AIR
S = SUB SLAB

SCALE
0 50 100 FEET
SCALE: 1"=50'

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FIGURE 26
AIR MONITORING LOCATIONS

75–20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

X–REF	OFFICE	DRAWN BY		JOB No.	PM	Appvd. By	DRAWING NUMBER
---	Holbrook	R. Tagoff	7/21/05	821687	E. Gustafson	E. Gustafson	821687–FIG26

TABLES

TABLE 1
SOIL ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

Compound	**NYS Soil Guidance Value**	**MW-26R**	**GW-1**	**GW-2**	**GW-3**	**GW-4**	**GW-5**		**GW-6**	**GW-7**	**GW-8**		**GW-9**		**GW-10**
		25'	**20'-22'**	**25'**	**25'**	**15'-17'**	**25'-27'**	**35'-37'**	**25'**	**25'-27'**	**25'**	**60'-62'**	**25'**	**30'-32'**	**25'-27'**
		03/23/04	**04/12/04**	**03/23/04**	**03/18/04**	**04/12/04**	**04/14/04**	**04/15/04**	**03/18/04**	**04/19/04**	**03/15/04**	**05/18/04**	**03/17/04**	**03/22/04**	**04/13/04**
Chloromethane															
Vinyl Chloride	200	17	6.7	3.5 J			12			10					
Bromomethane															
Chloroethane	1900	92	140	40	750		150								11
1,1-Dichloroethene	400	190	120	66	230		77				**7100**		22 J	23	14
Acetone	200					**550**		20 J		25 J				180	
Carbon Disulfide	2700	2.6 J		2.1 J		2.6 J								9.1	
Methylene Chloride	100	3.7 J	3.9 J			3.7 J	2.6 J			2.5 J				8.1	2.3 J
trans-1,2-Dichloroethene							2.8 J								
1,1-Dichloroethane	200	**1500 D**	**1300 D**	**2000 D**	**6300**	**9.5**	**310 D**		**2700**	8.5	**11000**	27	**350**	**940 D**	**380 D**
2-Butanone						170									
Carbon Tetrachloride															
cis-1,2-Dichloroethene	**	190	64	31			53							3.1 J	20
Chloroform	300													3.0 J	
1,1,1-Trichloroethane	800		130		**170000 D**			18	**2400**		**2100000**	17	**870**	**390 D**	
Benzene	60	2.6 J	2.6 J	1.5 J											
1,2-Dichloroethane	100	5.2 J					6.8							14	
Trichloroethene	700	2.4 J	52	13				2.2 J			**6200**			**7.5**	
1,2-Dichloropropane															
Bromodichloromethane															
4-Methyl-2-Pentanone															
Toluene	1500		7.0											3.2 J	
t-1,3-Dichloropropene															
cis-1,3-Dichloropropene															
1,1,2-Trichloroethane															
2-Hexanone															
Dibromochloromethane															
Tetrachloroethene	1400		35	2.8 J				2.9 J			**2700**		30 J	3.2 J	
Chlorobenzene															
Ethyl Benzene	5500		5.3 J											8	
m/p-Xylenes	1200		8.8											30	
o-Xylene	1200		10											21	
Styrene															
Bromoform															
1,1,2,2-Tetrachloroethane															
TOTAL	10000	2005.5	1885.3	2159.9	177280	735.8	614.2	43.1	5100	46	2127000	44	1272	1643.2	427.3

Notes:
Soil guidance values for NYSDEC TAGM 4046, Table 1, Rec. Soil Cleanup Objective
**: No soil guidance value identified for compound
Results in ug/Kg (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
NS = Not sampled.
ND = Not detected at laboratory detection limit.

J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
NI= Not Installed
(Before) - Before Purging
(After) - After Purging

TABLE 1
SOIL ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

	NYS Soil	GW-11		GW-12	GW-13	GW-14	GW-15	GW-16		GW-17	GW-18	GW-19		GW-20	GW-21
	Guidance	30'-32'	50'-52'	29'-31'	30'-32'	20'-22'	24'-26'	30'-32	30'-35'	20'-22'	20'-22'	5'-7'	28'-30'	24'-26'	30'-32'
Compound	**Value**	**04/19/04**	**05/05/04**	**04/16/04**	**04/19/04**	**04/21/04**	**04/22/04**	**04/23/04**	**12/02/06**	**04/26/04**	**04/29/04**	**04/30/04**	**04/30/04**	**05/03/04**	**05/04/04**
Chloromethane															
Vinyl Chloride	200														
Bromomethane															
Chloroethane	1900				4.0 J	230					210		63		
1,1-Dichloroethene	400	7.0 J			5.8	300 D			3.3 J	**4900**	**420 D**		72		
Acetone	200	70 J			100				120		59		**310**	**300**	73
Carbon Disulfide	2700				3.8 J							2.6 J			
Methylene Chloride	100	7.3 J			1.6 J	8.1			1.8 J		3.1 JB		6.8 B		
trans-1,2-Dichloroethene															
1,1-Dichloroethane	200	34			83	**370 D**		32	100	**8700**	**670 D**		**2000 D**	**540 D**	
2-Butanone					37				6.5 J						20 J
Carbon Tetrachloride															
cis-1,2-Dichloroethene	**				3.5 J	96					41		24		
Chloroform	300					15									
1,1,1-Trichloroethane	800	45			36	**15000 D**		330 D	110 D	**1000000 D**	**4400 D**		**8700 D**	210	
Benzene	60					4.5 J									
1,2-Dichloroethane	100					45					8.9		20		
Trichloroethene	700				4.6 J	**1200 D**		18	9.0 J	**10000**	**820 D**	23	**980 D**	56	
1,2-Dichloropropane															
Bromodichloromethane															
4-Methyl-2-Pentanone															
Toluene	1500											13			
t-1,3-Dichloropropene															
cis-1,3-Dichloropropene															
1,1,2-Trichloroethane						9.8									
2-Hexanone															
Dibromochloromethane															
Tetrachloroethene	1400					230 D		26	4.9 J	**7900**	300 JD		120	22	
Chlorobenzene															
Ethyl Benzene	5500											60			
m/p-Xylenes	1200											90			
o-Xylene	1200											170			
Styrene												26			
Bromoform															
1,1,2,2-Tetrachloroethane															
TOTAL	10000	163.3	0	0	279.3	17508.4	0	406	355.5	1031500	6932	384.6	12295.8	1128	93

Notes:
Soil guidance values for NYSDEC TAGM 4046, Table 1, Rec. Soil Cleanup Objective
**: No soil guidance value identified for compound
Results in ug/Kg (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
NS = Not sampled.
ND = Not detected at laboratory detection limit.

J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
NI= Not Installed
(Before) - Before Purging
(After) - After Purging

TABLE 1
SOIL ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

Compound	NYS Soil Guidance Value	GW-22	GW-23	GW-24	GW-25	GW-26	GW-27	GW-28	GW-29	GW-30	GW-31	GW-32		GW-33	
		22'-24' 05/10/04	16'-18' 05/11/04	18'-20' 05/11/04	26'-28' 05/12/04	20'-22' 05/13/04	16'-18' 05/14/04	22'-24' 05/19/04	18'-20' 05/20/24	26'-28' 05/20/04	26'-28' 05/21/04	10'-15' 08/09/06	20'-25' 08/09/06	20'-25' 08/09/06	25'-30' 08/09/06
Chloromethane															
Vinyl Chloride	200														
Bromomethane															
Chloroethane	1900													47	
1,1-Dichloroethene	400			4.2 J							10				
Acetone	200											360 B	470 B	200 B	410 B
Carbon Disulfide	2700										6.7 J	20 J	6.5 J	7.6 J	16 J
Methylene Chloride	100		16	15		5.8 J					5.2 J	13 J			
trans-1,2-Dichloroethene															
1,1-Dichloroethane	200	87		46	**310**						**850 D**		47	260	18 J
2-Butanone												64 JB	150 B	58 JB	1200 B
Carbon Tetrachloride															
cis-1,2-Dichloroethene	**			3.9 J										10 J	
Chloroform	300														
1,1,1-Trichloroethane	800				**1500**						32		11 J	13 J	
Benzene	60														
1,2-Dichloroethane	100										12		6.1 J		
Trichloroethene	700										13		15 J	24 J	
1,2-Dichloropropane															
Bromodichloromethane															
4-Methyl-2-Pentanone															
Toluene	1500														
t-1,3-Dichloropropene															
cis-1,3-Dichloropropene															
1,1,2-Trichloroethane															
2-Hexanone															
Dibromochloromethane															
Tetrachloroethene	1400											34	37	45	
Chlorobenzene															
Ethyl Benzene	5500														
m/p-Xylenes	1200														
o-Xylene	1200														
Styrene															
Bromoform															
1,1,2,2-Tetrachloroethane															
TOTAL	10000	87	16	69.1	1810	5.8	0	0	0	0	928.9	67	122.6	406.6	34

Notes:
Soil guidance values for NYSDEC TAGM 4046, Table 1, Rec. Soil Cleanup
**: No soil guidance value identified for
Results in ug/Kg (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
NS = Not sampled.
ND = Not detected at laboratory detection limit.

J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
NI= Not Installed
(Before) - Before Purging
(After) - After Purging

TABLE 2
SILT/CLAY GROUNDWATER ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

Compound	NYS GW Standard	MW-26R 15'-25' 03/23/04	GW-1 15'-25' 04/12/04	GW-2 15'-25' 03/23/04	GW-3 15'-25' 03/18/04	GW-4 15'-25' 04/12/04	GW-5 15'-25' 04/14/04	GW-6 15'-25' 03/18/04	GW-7 15'-25' 04/19/04	GW-8 15'-25' 03/15/04	GW-9 15'-25' 03/17/04	GW-10 15'-25' 04/13/04	GW-11 15'-25' 04/14/04	GW-12 15'-25' 04/16/04	GW-13 16'-26' 04/19/04	GW-14 16'-26' 04/21/04	GW-15 16'-26' 04/22/04
Chloromethane	**																
Vinyl Chloride	2	**29**	**24**	**42**	**67 J**	**6.6**	**36**	**10**	**5.6**		**7.3**		**6.2**	**7.9**	**34**	**66 D**	**2.1 J**
Bromomethane	5 POS																
Chloroethane	5 POS	**570 D**	**1100 D**	**480 D**	**3300**	**36**	**1900 D**	**98**		**300 J**	**85**	**61**	**110**	**180**	**1100 D**	**12000 D**	
1,1-Dichloroethene	5 POS	**120**	**100**	**190 D**	**550**	**27**	**56**	**32**		**2000**	**19**	**18**	**14**	4.3 J	**80**	**27000 D**	0.90 J
Acetone	50 GV																5.6 J
Carbon Disulfide	**																
Methylene Chloride	5 POS		1.2 J									1.9 J			4.1 J		
trans-1,2-Dichloroethene	5 POS								1.2 J								
1,1-Dichloroethane	5 POS	**2100 D**	**1800 D**	**1900 D**	**13000 D**	**540 D**	**2500 D**	**1300 D**	**7.0**	**1900**	**370 D**	**340 D**	**190 D**	**290 D**	**2700 D**	**35000 D**	**85**
2-Butanone	**																
Carbon Tetrachloride	5					29											
cis-1,2-Dichloroethene	5 POS	**75**	**41**	**79**	**230**		**39**	**14**	**19**		15	7.1	**12**	**8.9**	**88**	**640 D**	3.9 J
Chloroform	7											0.74 J				**110 JD**	
1,1,1-Trichloroethane	5 POS	**150 D**	**170**	**600 D**	**61000 D**		**130**	**2800 D**		**310000**	**610 D**	**49**	**37**	**61**	**61**	**420000 D**	
Benzene	1	**2.7 J**	**3.8 J**	**5.1**			**4.5 J**	**8.1**									
1,2-Dichloroethane	0.6						**3.3 J**					2.4 J			**5.6**		
Trichloroethene	5 POS	**9.0**	**10**	**20**	**530**		**8.2**	**52**	**6.0**	**1200**	**20**	1.6 J	3.6 J	**16**	**6.2**	**3800 D**	
1,2-Dichloropropane	1																
Bromodichloromethane	50 GV																
4-Methyl-2-Pentanone	**																
Toluene	5 POS						2.4 J									**18**	
t-1,3-Dichloropropene	0.4*																
cis-1,3-Dichloropropene	0.4*																
1,1,2-Trichloroethane	1															**45**	
2-Hexanone	50 GV																
Dibromochloromethane	50 GV																
Tetrachloroethene	5 POS	2.4 J	2.7 J	3.7 J	**270**			**5.5**	**0.59 J**	**260 J**	**7.2**			1.9 J	1.6 J	**1800 D**	
Chlorobenzene	5 POS																
Ethyl Benzene	5 POS															4.4 J	
m/p-Xylenes	5 POS										1.5 J					**7.9**	
o-Xylene	5 POS										1.2 J					**5.8**	
Styrene	5 POS										1.2 J						
Bromoform	50 GV																
1,1,2,2-Tetrachloroethane	5 POS																
TOTAL	**	3058.1	3252.7	3319.8	78947	638.6	4679.4	4319.6	39.39	315660	1137.4	481.74	372.8	570	4080.5	500497.1	97.5

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.

TABLE 2
SILT/CLAY GROUNDWATER ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

	NYS GW	**GW-16**		**GW-17**	**GW-18**	**GW-19**	**GW-20**	**GW-21**	**GW-22**	**GW-23**	**GW-24**	**GW-25**	**GW-26**	**GW-27**	**GW-28**	**GW-29**	**GW-30**	**GW-31**
		16'-26'	**19'-23'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**16'-26'**	**14'-24'**	**12'-22'**	**16'-26'**	**16'-26'**	**16'-26'**
Compound	**Standard**	**04/23/04**	**12/02/06**	**04/26/04**	**04/29/04**	**04/30/04**	**05/03/04**	**05/04/04**	**05/10/04**	**05/11/04**	**05/11/04**	**05/12/04**	**05/13/04**	**05/14/04**	**05/19/04**	**05/20/24**	**05/20/04**	**05/21/04**
Chloromethane	**	880																
Vinyl Chloride	2	**760**	**2.5 J**	**140**			**18**		**3.5 J**	1.7	**12**			**6.7**			**12**	
Bromomethane	5 POS																	
Chloroethane	5 POS			**1000 JD**	**3700**	**6200**	**580 D**	**13**	**13**	**37**	**110**					**110**		
1,1-Dichloroethene	5 POS	**3400 D**	3.2 J	**770 JD**	**3200**	**14000**	**170**	2.2 J	**28**	**32**	**43**	**16000 D**	3.1 J	**80**		**67**	**2300 JD**	**12**
Acetone	50 GV						42	5.4 J		9.2 J	13 J	1600		14 J			470	
Carbon Disulfide	**																	
Methylene Chloride	5 POS			**67**			2.3 J					110 J					36	
trans-1,2-Dichloroethene	5 POS						1.8 J							1.9 J				
1,1-Dichloroethane	5 POS	**16000 D**	**23**	**3300 D**	**13000**	**9200**	**2000 D**	**32**	**110**	**170**	**960 D**	**55000 D**	**54**	**330 D**	3.9 J	**230 JD**	**4600 JD**	
2-Butanone	**						8.7 J										40	
Carbon Tetrachloride	5																	
cis-1,2-Dichloroethene	5 POS		1.8 J	**1100 JD**	**330 J**		**55**	1.7 J	3.5 J	**7.5**	40		5.9	56		**7.2**	**27**	2.3 J
Chloroform	7	**320**		**65**		**59 J**	2.9 J	**7.9**				**72 J**					**56**	
1,1,1-Trichloroethane	5 POS	**600000 D**	**50**	**40000 D**	**22000 D**	**110000 D**	**1100 D**	2.3 J	**100 D**	**61**	47	280000 D	5.0	**48**	**5.2**	56	**72000 D**	2.4 J
Benzene	1												**4.3 J**					
1,2-Dichloroethane	0.6						**7.1**							5.0		1.5 J	**41**	
Trichloroethene	5 POS	**6100 D**	0.97 J	**620 JD**	**740**	**430 J**	**82**		4.2 J	4.1 J	**6.1**	**1600**	0.74 J	**5.7**	1.9 J	**3.6 J**	**110 D**	1.6 J
1,2-Dichloropropane	1																	
Bromodichloromethane	50 GV																	
4-Methyl-2-Pentanone	**																	
Toluene	5 POS	**32 J**											3.6 J	1.1 J				
t-1,3-Dichloropropene	0.4*																	
cis-1,3-Dichloropropene	0.4*																	
1,1,2-Trichloroethane	1			**3.5 J**			**1.1 J**											
2-Hexanone	50 GV																	
Dibromochloromethane	50 GV																	
Tetrachloroethene	5 POS	**570 D**		**220 JD**	**290 J**	**260 J**	**8.1**			0.79 J		2000				1.0 J	**110**	
Chlorobenzene	5 POS																	
Ethyl Benzene	5 POS												0.91 J					
m/p-Xylenes	5 POS												3.3 J	1.2 J				
o-Xylene	5 POS												2.2 J	0.71 J				
Styrene	5 POS																	
Bromoform	50 GV																	
1,1,2,2-Tetrachloroethane	5 POS																	
TOTAL	**	628062	81.47	47285.5	43260	140149	4079	64.5	262.2	323.29	1231.1	356382	83.05	550.31	11	475.3	79911	18.3

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.

TABLE 3
DEEP GROUNDWATER ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

	NYS GW	**MW-26R**		**GW-1**	**GW-2**	**GW-3**	**GW-4**	**GW-5**	**GW-6**	**GW-7**	**GW-8**		
				49'-51'	**47'-49'**	**49'-51'**	**47'-49'**	**47'-49'**	**49'-51'**	**47'-49'**	**47'-49'**	**57'-59'**	**66'-68'**
Compound	**Standard**	**10/28/03**	**03/08/04**	**03/02/04**	**03/03/04**	**03/04/04**	**03/08/04**	**03/09/04**	**03/11/04**	**03/12/04**	**03/16/04**	**05/18/04**	**05/18/04**
Chloromethane	**	47	49										
Vinyl Chloride	2	**24**	**3.2 J**		**2.4 J**					**3.3 J**	1.6 J		5.8
Bromomethane	5 POS												
Chloroethane	5 POS	**670**	**99**	**9.8**	**17**	**11**		**25**	2.6 J				21
1,1-Dichloroethene	5 POS	**68**	**19**	**13**	**36**	**11**	**16**	**16**	**6.2**	**44**	**110**	**5.6**	**730 D**
Acetone	50 GV	**270**							21 J		**720**		**260**
Carbon Disulfide	**												
Methylene Chloride	5 POS	**19**	**8.4**								**51**		**35**
trans-1,2-Dichloroethene	5 POS												0.95 J
1,1-Dichloroethane	5 POS	**9500**	**2200**	**190**	**320**	**240**	**26**	**160**	**210**	**570**	**4200**	**26**	**5200 D**
2-Butanone	**	4500							18 J		85		57
Carbon Tetrachloride	5												
cis-1,2-Dichloroethene	5 POS	**96**	**22**	**6.7**	**13**	4.3 J	**5.7**	4.9 J	4.7 J	**5.4**	**41**	**1.7 J**	**46**
Chloroform	7					1.0 J		0.64 J	2.4 J		**18**	**0.84 J**	**23**
1,1,1-Trichloroethane	5 POS			**31**	**30**	**240**		**300**	**410**	**29**	**2800**	**27**	**6500 D**
Benzene	1	**2.6 J**											
1,2-Dichloroethane	0.6	**25**				**1.2 J**			**2.2 J**		**82**		**54**
Trichloroethene	5 POS	**9.0 J**	**2.0 J**	**11**	**8.5**	**22**	**10**	**26**	**15**	**15**	**36**	**40**	**79**
1,2-Dichloropropane	1												
Bromodichloromethane	50 GV												
4-Methyl-2-Pentanone	**												
Toluene	5 POS												2.6 J
t-1,3-Dichloropropene	0.4*												
cis-1,3-Dichloropropene	0.4*												
1,1,2-Trichloroethane	1										**5.4**		
2-Hexanone	50 GV										2.6 J		
Dibromochloromethane	50 GV												
Tetrachloroethene	5 POS	1.8 J						0.86 J	1.2 J		4.3 J		38
Chlorobenzene	5 POS												
Ethyl Benzene	5 POS												0.95 J
m/p-Xylenes	5 POS	1.9 J											
o-Xylene	5 POS	1.9 J											
Styrene	5 POS												
Bromoform	50 GV												
1,1,2,2-Tetrachloroethane	5 POS												
TOTAL	**	15189.2	2353.6	261.5	426.9	530.5	57.7	533.4	693.3	666.7	8156.9	101.14	13053.3

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.

TABLE 3
DEEP GROUNDWATER ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

	NYS GW	**GW-9**	**GW-10**	**GW-11**				**GW-12**	**GW-13**	**GW-14**	**GW-15**	**GW-16**	
		49'-51'	**47'-49'**	**47'-49'**		**60'-62'**	**68'-70'**	**47'-49'**	**47'-49'**	**47'-49'**	**47'-49'**	**47'-49'**	**45'-49'**
Compound	**Standard**	**03/22/04**	**04/13/04**	**04/19/04**	**05/05/04**	**05/05/04**	**05/06/04**	**04/16/04**	**04/20/04**	**04/21/04**	**04/22/04**	**04/23/04**	**12/02/06**
Chloromethane	**												
Vinyl Chloride	2			**39**	1.3 J			1.9 J	**1.5 J**		1.0 J		1.4 J
Bromomethane	5 POS												
Chloroethane	5 POS			**160 JD**					**31**	**99**			
1,1-Dichloroethene	5 POS	**10**	**16**	**1200 D**	**22**	**9.0**		**42**	**33**	**76**	**82**	**2400 D**	**14**
Acetone	50 GV												**80**
Carbon Disulfide	**				12		10						
Methylene Chloride	5 POS			**73**					**1.7 J**	**2.8 J**			
trans-1,2-Dichloroethene	5 POS												
1,1-Dichloroethane	5 POS	**210 JD**	**61**	**10000 D**	**75**	**63**	**31**	**130**	**290 D**	**520 D**	**120**	**1500 D**	**300 D**
2-Butanone	**			260									15 J
Carbon Tetrachloride	5												
cis-1,2-Dichloroethene	5 POS	**8.6**	**4.4 J**	**120**	**4.8 J**	**2.6 J**		**6.8**	**11**	**12**	**7.9**	43 J	**5.5 J**
Chloroform	7		0.68 J	**120**	**1.0 J**				1.5 J	3.5 J	0.67 J	**9.2 J**	
1,1,1-Trichloroethane	5 POS	**85**	**160**	**71000 D**	**190**	**190**	**28**	**11**	**97**	**4600 D**	**45**	**20000 D**	**570 D**
Benzene	1												
1,2-Dichloroethane	0.6			**77**					**2.9 J**		**1.2 J**		
Trichloroethene	5 POS		**34**	**430**	**19**	**25**		**11**	**7.8**	**42**	**41**	**850**	**12**
1,2-Dichloropropane	1												
Bromodichloromethane	50 GV												
4-Methyl-2-Pentanone	**												
Toluene	5 POS			2.9 J						1.7 J			1.3 J
t-1,3-Dichloropropene	0.4*												
cis-1,3-Dichloropropene	0.4*												
1,1,2-Trichloroethane	1			**6.5**									
2-Hexanone	50 GV												
Dibromochloromethane	50 GV												
Tetrachloroethene	5 POS		1.6 J	**190**	1.8 J	1.7 J				16	2.2 J	**270**	1.4 J
Chlorobenzene	5 POS												
Ethyl Benzene	5 POS			1.1 J									3.7 J
m/p-Xylenes	5 POS			2.9 J									
o-Xylene	5 POS			1.2 J									
Styrene	5 POS	1.3 J											
Bromoform	50 GV												
1,1,2,2-Tetrachloroethane	5 POS												
TOTAL	**	314.9	277.68	83683.6	326.9	291.3	69	202.7	477.4	5373	300.97	25072.2	1004.3

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.

TABLE 3
DEEP GROUNDWATER ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

Compound	**NYS GW Standard**	**GW-17 47'-49' 05/07/04**	**GW-18 47'-49' 04/29/04**	**GW-19 47'49' 04/30/04**	**GW-20 47'-49' 05/03/04**	**GW-21 49'-51' 05/04/04**	**GW-22 47'-49' 05/10/04**	**GW-25 47'-49' 05/12/04**	**GW-26 47'-49' 05/13/04**	**GW-27 47'-49' 05/14/04**
Chloromethane	**									
Vinyl Chloride	2						**3.6 J**			
Bromomethane	5 POS									
Chloroethane	5 POS			14	**6.4**	2.9 J				
1,1-Dichloroethene	5 POS	3.2 J	**3.4 J**	**54**	2.7 J	**15**		**13**	**32**	**9.3**
Acetone	50 GV				25 J	48				28
Carbon Disulfide	**						8.9			
Methylene Chloride	5 POS					1.3 J				
trans-1,2-Dichloroethene	5 POS									
1,1-Dichloroethane	5 POS	**13**	**11**	**77**	**47**	**93**	**170**	**89**	**26**	**53**
2-Butanone	**		4.3 J		3.4 J	8.7 J				
Carbon Tetrachloride	5									
cis-1,2-Dichloroethene	5 POS	2.6 J	3.5 J	4.8 J	2.8 J	3.8 J		2.7 J	10	**9.8**
Chloroform	7		0.75 J	1.5 J		2.2 J				
1,1,1-Trichloroethane	5 POS	**19**	**6.2**	**430 D**	**17**	**79**	**1.8 J**	**10**		**24**
Benzene	1									
1,2-Dichloroethane	0.6					**1.1 J**				**1.6 J**
Trichloroethene	5 POS	**37**	**13**	**20**	**7.9**	**7.9**				**8.9**
1,2-Dichloropropane	1									
Bromodichloromethane	50 GV									
4-Methyl-2-Pentanone	**		7.0 J							
Toluene	5 POS									1.2 J
t-1,3-Dichloropropene	0.4*									
cis-1,3-Dichloropropene	0.4*									
1,1,2-Trichloroethane	1									
2-Hexanone	50 GV		7.3 J			4.1 J				
Dibromochloromethane	50 GV									
Tetrachloroethene	5 POS		0.86 J	1.1 J	1.2 J					
Chlorobenzene	5 POS									
Ethyl Benzene	5 POS							2.9 J		1.9 J
m/p-Xylenes	5 POS									
o-Xylene	5 POS									0.79 J
Styrene	5 POS		0.95 J							
Bromoform	50 GV									
1,1,2,2-Tetrachloroethane	5 POS									
TOTAL	**	74.8	58.26	602.4	113.4	267	184.3	117.6	68	138.49

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-1S																		
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				**Post Injection Monitoring**		
		9/12/05	**9/26/05**	**11/8/05**	**11/14/05**	**11/21/05**	**3/1/06**	**3/15/06**	**3/29/06**	**4/12/06**	**4/26/06**	**5/10/06**	**5/25/06**	**6/7/06**	**6/22/06**	**7/5/06**	**7/19/06**	**8/1/06**	**9/6/06**	**10/17/06**
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Vinyl Chloride	2	100 J	230 JD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	770 D	-	-
Bromomethane	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Chloroethane	5 POS	800 J	1200 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2300 JD	-	-
1,1-Dichloroethene	5 POS	10000	1700 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	960 JD	-	-
Acetone	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Carbon Disulfide	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Methylene Chloride	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-	64 JD	-	-
trans-1,2-Dichloroethene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1-Dichloroethane	5 POS	20000 JD	21000 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62000 D	-	-
2-Butanone	**		420 JD	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Carbon Tetrachloride	5			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,2-Dichloroethene	5 POS	390 J	480 JD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	660 D	-	-
Chloroform	7			-	-	-	-	-	-	-	-	-	-	-	-	-	-	46 JD	-	-
1,1,1-Trichloroethane	5 POS	290000 D	240000 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140000 D	-	-
Benzene	1			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dichloroethane	0.6			-	-	-	-	-	-	-	-	-	-	-	-	-	-	150 D	-	-
Trichloroethene	5 POS	1100	970 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	400 D	-	-
1,2-Dichloropropane	1			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromodichloromethane	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
4-Methyl-2-Pentanone	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Toluene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
t-1,3-Dichloropropene	0.4*			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,3-Dichloropropene	0.4*			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2-Trichloroethane	1			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
2-Hexanone	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromochloromethane	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrachloroethene	5 POS	460 J	270 JD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	360 D	-	-
Chlorobenzene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Ethyl Benzene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
m/p-Xylenes	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
o-Xylene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Styrene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromoform	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2,2-Tetrachloroethane	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
MTBE	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrahydrofuran	50 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromomethane	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,3-Dichloropropane	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dibromoethane	**			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichloropropane	0.04			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,4-Trichlorobenzene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Naphthalene	10 GV			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichlorobenzene	5 POS			-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
TOTAL	**	322850	266270	-	-	-	-	-	-	-	-	-	-	-	-	-	-	207710	-	-
Chloride (mg/L)		492 D	479 D	620 D	-	-	-	-	-	-	-	-	-	-	-	-	-	590 D	-	-
Sulfate (mg/L)		456 D	349 D	120 D	-	-	-	-	-	-	-	-	-	-	-	-	-	81.4 D	-	-
Sulfide (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Phosphate (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Nitrate (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Alkalinity (mg/L)		419 D	419 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		485 D	645 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	509 D	-	-
Ethane (ug/L)		67.3 D	96.5 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.5 D	-	-
Ethene (ug/L)		46.6 D	64.4 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.9 D	-	-
Total Dissolved Solids (mg/L)		2160	1880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.058	0.290	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		81.2	ND	42.8	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Acetic Acid (mg/L)		ND	ND	532 D	-	-	-	-	-	-	-	-	-	-	-	-	-	117 D	-	-
Propionic Acid (mg/L)		ND	ND	168 D	-	-	-	-	-	-	-	-	-	-	-	-	-	4.38	-	-
Formic Acid (mg/L)		ND	ND	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Butyric Acid (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Pyruvic Acid (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Valeric Acid (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
ORP		-75.5	-111.9	-257.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-223.8	-	-
Dissolved Oxygen (mg/L)		0.45	0.28	0.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.01	-	-
pH		6.45	6.53	3.57	-	-	-	-	-	-	-	-	-	-	-	-	-	6.58	-	-
Turbidity (NTU)		51.9	0.8	-3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-4.4	-	-
Temp (Degree-C)		18.77	18.73	18.7	-	-	-	-	-	-	-	-	-	-	-	-	-	18.17	-	-
Conductivity		2.687	2.651	3.431	-	-	-	-	-	-	-	-	-	-	-	-	-	2.903	-	-

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-1D																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/12/05	9/26/05	11/8/05	11/15/05	11/21/05	3/1/06	3/15/06	3/29/06	4/12/06	4/26/06	5/10/06	5/25/06	6/7/06	6/22/06	7/5/06	7/19/06	8/1/06	9/6/06	10/17/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Vinyl Chloride	2		210 JD	-	260 JD	-	-	-	-	-	-	-	-	-	-	-	-	540 D	-	-
Bromomethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Chloroethane	5 POS	640 J	1000 D	-	840 JD	-	-	-	-	-	-	-	-	-	-	-	-	2000 D	-	-
1,1-Dichloroethene	5 POS	14000	2400 D	-	2600 D	-	-	-	-	-	-	-	-	-	-	-	-	2800 ED	-	-
Acetone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Carbon Disulfide	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Methylene Chloride	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-	79 JD	-	-
trans-1,2-Dichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1-Dichloroethane	5 POS	35000	26000 D	-	40000 D	-	-	-	-	-	-	-	-	-	-	-	-	61000 D	-	-
2-Butanone	**		500 JD	-		-	-	-	-	-	-	-	-	-	-	-	-	230 D	-	-
Carbon Tetrachloride	5			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,2-Dichloroethene	5 POS		570 D	-	890 JD	-	-	-	-	-	-	-	-	-	-	-	-	920 D	-	-
Chloroform	7			-		-	-	-	-	-	-	-	-	-	-	-	-	58 JD	-	-
1,1,1-Trichloroethane	5 POS	300000 D	360000 D	-	280000 D	-	-	-	-	-	-	-	-	-	-	-	-	180000 D	-	-
Benzene	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dichloroethane	0.6		140 JD	-		-	-	-	-	-	-	-	-	-	-	-	-	190 D	-	-
Trichloroethene	5 POS	970 J	1300 D	-	1200 D	-	-	-	-	-	-	-	-	-	-	-	-	540 D	-	-
1,2-Dichloropropane	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromodichloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
4-Methyl-2-Pentanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Toluene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
t-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2-Trichloroethane	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
2-Hexanone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromochloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrachloroethene	5 POS	390 J	390 JD	-	600 JD	-	-	-	-	-	-	-	-	-	-	-	-	560 D	-	-
Chlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Ethyl Benzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
m/p-Xylenes	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
o-Xylene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Styrene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromoform	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2,2-Tetrachloroethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-	48 JD	-	-
MTBE	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrahydrofuran	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromomethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,3-Dichloropropane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dibromoethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichloropropane	0.04			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,4-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Naphthalene	10 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
TOTAL	**	351000	392510	-	326390	-	-	-	-	-	-	-	-	-	-	-	-	248965	-	-
Chloride (mg/L)		669 D	550 D	612 D	-	712 D	-	-	-	-	-	-	-	-	-	-	-	634 D	-	-
Sulfate (mg/L)		482 D	390 D	162 D	-	87.5 D	-	-	-	-	-	-	-	-	-	-	-	112 D	-	-
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Alkalinity (mg/L)		519 D	440 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		278 D	508 D	-	393 D	-	-	-	-	-	-	-	-	-	-	-	-	545 D	-	-
Ethane (ug/L)		25.4	69.8 D	-	70.9 D	-	-	-	-	-	-	-	-	-	-	-	-	27.3 D	-	-
Ethene (ug/L)		16	64.8 D	-	44.2 D	-	-	-	-	-	-	-	-	-	-	-	-	25.6 D	-	-
Total Dissolved Solids (mg/L)		2590	2030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.056	0.051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	109 D	25	1.9	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Acetic Acid (mg/L)		ND	77.1 *	458 D	454 D	365 D	-	-	-	-	-	-	-	-	-	-	-	175 D	-	-
Propionic Acid (mg/L)		ND	ND	200 D	123 D	54.9	-	-	-	-	-	-	-	-	-	-	-	34.3	-	-
Formic Acid (mg/L)		ND	ND	2.3	1.47	0.59 J	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Pyruvic Acid (mg/L)		ND	ND	ND	ND	0.50 J	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
ORP		-52.4	-62.5	-297.8	-260.5	-180.4	-	-	-	-	-	-	-	-	-	-	-	-164.6	-	-
Dissolved Oxygen (mg/L)		0.40	0.23	0.02	1.13	0.26	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-
pH		6.35	6.45	6.4	5.58	6.14	-	-	-	-	-	-	-	-	-	-	-	6.45	-	-
Turbidity (NTU)		41.2	10.3	1.8	-3.9	3.8	-	-	-	-	-	-	-	-	-	-	-	-0.3	-	-
Temp (Degree-C)		18.00	18.00	17.42	16.86	16.38	-	-	-	-	-	-	-	-	-	-	-	18.19	-	-
Conductivity		2.952	2.956	3.653	3.592	3.233	-	-	-	-	-	-	-	-	-	-	-	3.240	-	-

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-2																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
Compound		9/13/05 Pre #1	9/26/05 Pre #2	11/7/05 Post #1	11/16/05 Post #2	11/21/05 Post #3	3/1/06 CI #1	3/15/06 CI #2	3/29/06 CI #3	4/12/06 CI #4	4/26/06 CI #5	5/10/06 CI #6	5/25/06 CI #7	6/7/06 CI #8	6/22/06 CI #9	7/5/06 CI#10	7/19/06 CI #11	8/1/06 Reb #1	9/6/06 Reb #2	10/18/06 Reb #3
Chloromethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Vinyl Chloride	2	58 J	250 JD	-	220 JD	-	-	-	-	-	-	-	-	-	-	-	-	1200 D	990 D	1200 D
Bromomethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Chloroethane	5 POS	140 J	460 JD	-	340 JD	-	-	-	-	-	-	-	-	-	-	-	-	5200 JD	1300 D	1100 D
1,1-Dichloroethene	5 POS	300 J	610 D	-	710 D	-	-	-	-	-	-	-	-	-	-	-	-	33 JD		
Acetone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Disulfide	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Methylene Chloride	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-	57 JD		
trans-1,2-Dichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1-Dichloroethane	5 POS	8000	14000 D	-	35000 D	-	-	-	-	-	-	-	-	-	-	-	-	17000 D	21000 D	17000 D
2-Butanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Tetrachloride	5			-		-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,2-Dichloroethene	5 POS	280 J	780 D	-	980 D	-	-	-	-	-	-	-	-	-	-	-	-	23 JD		
Chloroform	7			-		-	-	-	-	-	-	-	-	-	-	-	-		310 JD	
1,1,1-Trichloroethane	5 POS	4600	3200 D	-	3000 D	-	-	-	-	-	-	-	-	-	-	-	-	3900 JD	580 D	350 JD
Benzene	1			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloroethane	0.6			-		-	-	-	-	-	-	-	-	-	-	-	-	70 JD		
Trichloroethene	5 POS	160 J	360 JD	-	420 JD	-	-	-	-	-	-	-	-	-	-	-	-	30 JD		
1,2-Dichloropropane	1	1700		-		-	-	-	-	-	-	-	-	-	-	-	-			
Bromodichloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
4-Methyl-2-Pentanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Toluene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
t-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2-Trichloroethane	1			-		-	-	-	-	-	-	-	-	-	-	-	-			
2-Hexanone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Dibromochloromethane	50 GV		100 JD	-		-	-	-	-	-	-	-	-	-	-	-	-			
Tetrachloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Chlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Ethyl Benzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
m/p-Xylenes	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
o-Xylene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Styrene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Bromoform	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
MTBE	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Tetrahydrofuran	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Dibromomethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,3-Dichloropropane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dibromoethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichloropropane	0.04			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,4-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Naphthalene	10 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
TOTAL	**	15238	19760	-	40670	-	-	-	-	-	-	-	-	-	-	-	-	27513	24180	19650
Chloride (mg/L)		224 D	314 D	498 D	-	552 D	-	-	-	-	-	-	-	-	-	-	-	459 D	427 D	447 D
Sulfate (mg/L)		454 D	618 D	492 D	-	232 D	-	-	-	-	-	-	-	-	-	-	-	39.5 D	180 D	238 D
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		306 D	393 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		153 D	314 D	-	117	-	-	-	-	-	-	-	-	-	-	-	-	488 D	195 D	288 D
Ethane (ug/L)		13.2	34.5	-	15.2	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND	6.52 D
Ethene (ug/L)		11.9	40.1	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	67.8 D	17.5 D	34.8 D
Total Dissolved Solids (mg/L)		1420	1910	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.033	0.590	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	120 D	168 D	114 D	-	-	-	-	-	-	-	-	-	-	-	179 D	ND	ND
Propionic Acid (mg/L)		ND	ND	131 D	13.1	ND	-	-	-	-	-	-	-	-	-	-	-	52.2	ND	ND
Formic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Pyruvic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
ORP		-49.1	-105.1	-150.5	-246	-251.4	-	-	-	-	-	-	-	-	-	-	-	-241.0	-194.3	-165.3
Dissolved Oxygen (mg/L)		1.02	0.28	4.11	0.78	0.32	-	-	-	-	-	-	-	-	-	-	-	-0.32	0.60	-0.70
pH		6.79	6.57	6.36	3	3.28	-	-	-	-	-	-	-	-	-	-	-	6.64	10.02	6.77
Turbidity (NTU)		10.9	1017.2	35.7	17.6	135.2	-	-	-	-	-	-	-	-	-	-	-	168.3	29.5	35.7
Temp (Degree-C)		22.94	19.24	18.69	17.92	16.52	-	-	-	-	-	-	-	-	-	-	-	20.62	17.89	18.74
Conductivity		1.843	2.520	3.115	3.211	3.108	-	-	-	-	-	-	-	-	-	-	-	2.942	2.848	2.805

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-3																		
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				**Post Injection Monitoring**		
		9/12/05	**9/27/05**	**11/8/05**	**11/15/05**	**11/21/05**	**3/1/06**	**3/15/06**	**3/29/06**	**4/12/06**	**4/26/06**	**5/10/06**	**5/25/06**	**6/7/06**	**6/22/06**	**7/5/06**	**7/19/06**	**8/1/06**	**9/7/06**	**10/18/06**
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**						-	-	-	-	-	-	-	-	-	-	-	25 JD		
Vinyl Chloride	2		110 JD		220 JD	590 JD	-	-	-	-	-	-	-	-	-	-	-	750 D	220 JD	
Bromomethane	5 POS						-	-	-	-	-	-	-	-	-	-	-			
Chloroethane	5 POS	380 J	700 D	380 JD	670 JD	1500 D	-	-	-	-	-	-	-	-	-	-	-	27000 D	23000 D	23000 D
1,1-Dichloroethene	5 POS	2800	1400 D		4400 D	2600 D	-	-	-	-	-	-	-	-	-	-	-	83 JD		
Acetone	50 GV						-	-	-	-	-	-	-	-	-	-	-			
Carbon Disulfide	**						-	-	-	-	-	-	-	-	-	-	-			
Methylene Chloride	5 POS			330 JD	260 D	480 JD	-	-	-	-	-	-	-	-	-	-	-	86 JD		
trans-1,2-Dichloroethene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
1,1-Dichloroethane	5 POS	25000 D	9900 D	60000 D	55000 D	48000 D	-	-	-	-	-	-	-	-	-	-	-	11000 D	3200 D	1700 D
2-Butanone	**			1000 JD			-	-	-	-	-	-	-	-	-	-	-			
Carbon Tetrachloride	5						-	-	-	-	-	-	-	-	-	-	-			
cis-1,2-Dichloroethene	5 POS	130 J		330 JD	340 JD	510 JD	-	-	-	-	-	-	-	-	-	-	-			
Chloroform	7						-	-	-	-	-	-	-	-	-	-	-		520 D	
1,1,1-Trichloroethane	5 POS	46000 D	22000 D	48000 D	42000 D	31000 D	-	-	-	-	-	-	-	-	-	-	-	760 D		
Benzene	1						-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloroethane	0.6			360 JD		520 JD	-	-	-	-	-	-	-	-	-	-	-	110 D		
Trichloroethene	5 POS	530 J	360 JD	620 JD	860 JD	830 JD	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloropropane	1						-	-	-	-	-	-	-	-	-	-	-			
Bromodichloromethane	50 GV						-	-	-	-	-	-	-	-	-	-	-			
4-Methyl-2-Pentanone	**						-	-	-	-	-	-	-	-	-	-	-			
Toluene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
t-1,3-Dichloropropene	0.4*						-	-	-	-	-	-	-	-	-	-	-			
cis-1,3-Dichloropropene	0.4*						-	-	-	-	-	-	-	-	-	-	-			
1,1,2-Trichloroethane	1					380 JD	-	-	-	-	-	-	-	-	-	-	-			
2-Hexanone	50 GV						-	-	-	-	-	-	-	-	-	-	-			
Dibromochloromethane	50 GV						-	-	-	-	-	-	-	-	-	-	-			
Tetrachloroethene	5 POS	110 J					-	-	-	-	-	-	-	-	-	-	-			
Chlorobenzene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
Ethyl Benzene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
m/p-Xylenes	5 POS					400 JD	-	-	-	-	-	-	-	-	-	-	-			
o-Xylene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
Styrene	5 POS						-	-	-	-	-	-	-	-	-	-	-			
Bromoform	50 GV						-	-	-	-	-	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS					440 JD	-	-	-	-	-	-	-	-	-	-	-			
MTBE	**					400 JD	-	-	-	-	-	-	-	-	-	-	-			
Tetrahydrofuran	50 GV						-	-	-	-	-	-	-	-	-	-	-			
Dibromomethane	**					300 JD	-	-	-	-	-	-	-	-	-	-	-			
1,3-Dichloropropane	5 POS					370 JD	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dibromoethane	**					380 JD	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichloropropane	0.04					410 JD	-	-	-	-	-	-	-	-	-	-	-			
1,2,4-Trichlorobenzene	5 POS					510 JD	-	-	-	-	-	-	-	-	-	-	-			
Naphthalene	10 GV					750 JD	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichlorobenzene	5 POS					550 JD	-	-	-	-	-	-	-	-	-	-	-			
TOTAL	**	74950	34470	111020	103750	90920	-	-	-	-	-	-	-	-	-	-	-	39814	26940	24700
Chloride (mg/L)		548 D	365 D	899 D	-	691 D	-	-	-	-	-	-	-	-	-	-	-	648 D	552 D	624 D
Sulfate (mg/L)		458 D	318 D	142 D	-	168 D	-	-	-	-	-	-	-	-	-	-	-	3.60 D	7.44 D	0.93 D
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		471 D	373 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		243 D	500 D	-	300 D	267 D	-	-	-	-	-	-	-	-	-	-	-	1470 D	1120 D	544 D
Ethane (ug/L)		32.9 D	74.9 D	-	43.0 D	20.9	-	-	-	-	-	-	-	-	-	-	-	ND	26.0 D	16.8 D
Ethene (ug/L)		22.5 D	47.0 D	-	24.2 D	15.5	-	-	-	-	-	-	-	-	-	-	-	108 D	68.3 D	91.3 D
Total Dissolved Solids (mg/L)		2610 D	1470 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.85	0.120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		74.9	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		ND	11.2 *	674 D	419 D	168 D	-	-	-	-	-	-	-	-	-	-	-	560 D	208 D	185 D
Propionic Acid (mg/L)		ND	ND	181 D	23.7	6.7	-	-	-	-	-	-	-	-	-	-	-	490 D	110 D	67.7 D
Formic Acid (mg/L)		ND	ND	0.98 J	ND	ND	-	-	-	-	-	-	-	-	-	-	-	5.37	ND	ND
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	10.4	ND	ND
Pyruvic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	4.55	ND	ND
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	3.52	ND	ND
ORP		-87.5	-176.1	-197.6	-230.3	-157.1	-	-	-	-	-	-	-	-	-	-	-	-147.7	-144.0	-175.9
Dissolved Oxygen (mg/L)		0.51	0.34	1.14	2.13	0.51	-	-	-	-	-	-	-	-	-	-	-	-0.06	0.15	-0.73
pH		6.63	6.92	3.82	6.61	6.39	-	-	-	-	-	-	-	-	-	-	-	6.91	10.08	6.82
Turbidity (NTU)		1115	24.5	18.4	176.2	2.3	-	-	-	-	-	-	-	-	-	-	-	20.2	9.7	7.9
Temp (Degree-C)		18.99	18.12	17.89	17.46	16.54	-	-	-	-	-	-	-	-	-	-	-	21.73	17.65	18.59
Conductivity		3.021	2.262	4.189	3.991	3.41	-	-	-	-	-	-	-	-	-	-	-	4.418	3.144	3.269

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-4S																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/13/05	9/26/05	11/8/05	11/14/05	11/21/05	3/1/06	3/15/06	3/29/06	4/12/06	4/26/06	5/10/06	5/25/06	6/7/06	6/22/06	7/5/06	7/19/06	8/1/06	9/6/06	10/17/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-	-	-														
Vinyl Chloride	2		310 JD	-	-	-	210 JD	360 JD	200 D	84 JD	66 JD						110 JD			
Bromomethane	5 POS			-	-	-														
Chloroethane	5 POS	590 J	850 D	-	-	-	5900 D	6900 D	12000 D	12000 D	16000 D	22000 D	13000 D	5500 D	3900 D	11000 ED	5000 D	4700 D	4700 D	3300 D
1,1-Dichloroethene	5 POS	650 J	500 JD	-	-	-		220 JD	33 JD											
Acetone	50 GV			-	-	-														
Carbon Disulfide	**			-	-	-														
Methylene Chloride	5 POS			-	-	-				54 JD										
trans-1,2-Dichloroethene	5 POS			-	-	-														
1,1-Dichloroethane	5 POS	17000	17000 D	-	-	-	10000 ED	19000 D	18000 D	5800 D	2600 D	1700 D	850 D	2400 D	1300 D	1000 D	1100 D	550 D		
2-Butanone	**			-	-	-					210 D									
Carbon Tetrachloride	5			-	-	-														
cis-1,2-Dichloroethene	5 POS		210 JD	-	-	-			100 D											
Chloroform	7			-	-	-													160 JD	
1,1,1-Trichloroethane	5 POS	1100 J	490 JD	-	-	-		180 JD	52 JD											
Benzene	1			-	-	-														
1,2-Dichloroethane	0.6			-	-	-		100 JD	120 D	84 JD	62 JD									
Trichloroethene	5 POS			-	-	-														
1,2-Dichloropropane	1			-	-	-														
Bromodichloromethane	50 GV			-	-	-														
4-Methyl-2-Pentanone	**			-	-	-														
Toluene	5 POS			-	-	-														
t-1,3-Dichloropropene	0.4*			-	-	-														
cis-1,3-Dichloropropene	0.4*			-	-	-														
1,1,2-Trichloroethane	1			-	-	-														
2-Hexanone	50 GV			-	-	-														
Dibromochloromethane	50 GV			-	-	-														
Tetrachloroethene	5 POS			-	-	-														
Chlorobenzene	5 POS			-	-	-														
Ethyl Benzene	5 POS			-	-	-														
m/p-Xylenes	5 POS			-	-	-														
o-Xylene	5 POS			-	-	-														
Styrene	5 POS			-	-	-														
Bromoform	50 GV			-	-	-														
1,1,2,2-Tetrachloroethane	5 POS			-	-	-														
MTBE	**			-	-	-														
Tetrahydrofuran	50 GV			-	-	-														
Dibromomethane	**			-	-	-														
1,3-Dichloropropane	5 POS			-	-	-														
1,2-Dibromoethane	**			-	-	-														
1,2,3-Trichloropropane	0.04			-	-	-														
1,2,4-Trichlorobenzene	5 POS			-	-	-					49 JD									
Naphthalene	10 GV			-	-	-					150 D									
1,2,3-Trichlorobenzene	5 POS			-	-	-					58 JD									
TOTAL	**	19340	19360	-	-	-	16110	26760	30505	18022	19195	23700	13850	7900	5200	12000	6210	5250	4860	3300
Chloride (mg/L)		323 D	352 D	400 D	-	-	370 D	410 D	339 D	372 D	389 D	420 D	380 D	393 D	317 D	395 D	360 D	238 D	230 D	327 D
Sulfate (mg/L)		359 D	404 D	184 D	-	-	276 D	227 D	86.1 D	57.8 D	ND	ND	ND	298 D	213 D	141 D	99.1 D	0.42 D	301 D	2.14 D
Sulfide (mg/L)		ND	ND	ND	-	-	ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.16	5.26 D	65.9 D	24.7 D	15.4 D
Nitrate (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)		350 D	403 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		290 D	530 D	-	-	-	-	-	2260 D	4560 D	4700 D	2690 D	3710 D	6640 D	4580 D	4830 D	1890 D	2960 D	3540 D	7190 D
Ethane (ug/L)		20.4	62.2 D	-	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)		16.8	59.4 D	-	-	-	-	-	232 D	334 D	225 D	141 D	256 D	561 D	298 D	60.8 D	90.3 D	68.1 D	ND	ND
Total Dissolved Solids (mg/L)		1720	1650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.17	0.072	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	-	-	2.08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetic Acid (mg/L)		ND	4.1	39.1	-	-	1.07	221 D	515 D	550 D	525 D	409	371 D	172 D	107 D	279 D	650 D	1450 D	1650 D	529 D
Propionic Acid (mg/L)		ND	ND	7.79	-	-	ND	133 D	343 D	339 D	346 D	297	265 D	111 D	196 D	603 D	1280 D	3190 D	2650 D	872 D
Formic Acid (mg/L)		ND	ND	ND	-	-	ND	0.85 J	4.76	5.12	4.46	0.55 J	1.73	052 J	ND	ND	5.35	46.3	42.7 D	13.4 D
Butyric Acid (mg/L)		1.88	ND	ND	-	-	ND	ND	17.1	16.1	14.6	10	5.64	4.23	62.7 D	210 D	430 D	1530 D	525 D	17.4
Pyruvic Acid (mg/L)		ND	ND	ND	-	-	ND	0.88 J	2.56	2.48	1.96	5.57	2.20	ND	ND	1.5	ND	26.4	44.5	3.39
Valeric Acid (mg/L)		ND	ND	ND	-	-	ND	0.32 J	1.49	1.82	2.62	1.77	1.92	0.69 J	1.81	7.1	11.7	87.6	61.9	19.7
ORP		-165.0	-313.0	-352.8	-	-	-239.5	-324.6	-367.8	-333.6	-163.2	-228.2	-144.7	-290.3	-366.2	-355.9	-353.9	-361.2	-186.5	-176.0
Dissolved Oxygen (mg/L)		0.93	0.34	-0.16	-	-	1.13	1.20	0	0.42	1.10	-0.98	2.58	2.14	0.00	0.51	4.43	0.65	0.13	-1.05
pH		6.53	6.69	6.91	-	-	6.66	7.09	7.05	7.69	6.60	6.78	6.79	6.87	7.08	7.01	6.96	7.01	9.82	7.08
Turbidity (NTU)		198.6	32	7.9	-	-	33.7	91.7	10.5	7.0	23.8	2.7	5.3	52.0	7.3	43.1	28.1	80.1	54.4	36.4
Temp (Degree-C)		21.64	20.71	17.39	-	-	14.41	13.82	18.12	17.17	16.93	17.92	17.18	16.81	20.12	19.13	20.64	20.55	17.72	17.61
Conductivity (mS/cm3)		2.229	2.360	2.471	-	-	2.670	3.133	3.609	3.595	3.094	3.062	2.790	2.657	2.856	3.155	2.936	8.793	8.130	5.494

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-4D																		
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				Post Injection Monitoring		
Compound		**9/13/05 Pre #1**	**9/26/05 Pre #2**	**11/8/05 Post #1**	**11/15/05 Post #2**	**11/21/05 Post #3**	**3/1/06 CI #1**	**3/15/06 CI #2**	**3/29/06 CI #3**	**4/12/06 CI #4**	**4/26/06 CI #5**	**5/10/06 CI #6**	**5/25/06 CI #7**	**6/7/06 CI #8**	**6/21/06 CI #9**	**7/5/06 CI#10**	**7/19/06 CI #11**	**8/1/06 Reb #1**	**9/6/06 Reb #2**	**10/17/06 Reb #3**
Chloromethane	**			-																
Vinyl Chloride	2		460 JD	-	250 JD			330 JD	63 JD	31 JD							110 JD			
Bromomethane	5 POS			-																
Chloroethane	5 POS	400 J	940 JD	-	1000 D	3300 D	14000 D	12000 D	11000 D	6200 D	11000 D	17000 D	11000 D	5900 D	5000 D	4300 D	5500 D	4400 D	4200 D	2800 D
1,1-Dichloroethene	5 POS	600 J	780 JD	-																
Acetone	50 GV			-																
Carbon Disulfide	**			-																
Methylene Chloride	5 POS			-																
trans-1,2-Dichloroethene	5 POS			-																
1,1-Dichloroethane	5 POS	22000	24000 D	-	8400 D	7400 D	2300 D	1900 D	1900 D	1100 D	800 D	580 D	1800 D	720 D	420 D	170 JD				
2-Butanone	**			-	510 JD						350 D					2000 D				
Carbon Tetrachloride	5			-																
cis-1,2-Dichloroethene	5 POS			-																
Chloroform	7			-																
1,1,1-Trichloroethane	5 POS	1100 J	440 JD	-		5900 D														
Benzene	1			-																
1,2-Dichloroethane	0.6			-					76 JD	40 JD	43 JD									
Trichloroethene	5 POS			-																
1,2-Dichloropropane	1			-																
Bromodichloromethane	50 GV			-																
4-Methyl-2-Pentanone	**			-																
Toluene	5 POS			-																
t-1,3-Dichloropropene	0.4*			-																
cis-1,3-Dichloropropene	0.4*			-																
1,1,2-Trichloroethane	1			-																
2-Hexanone	50 GV			-																
Dibromochloromethane	50 GV			-																
Tetrachloroethene	5 POS			-																
Chlorobenzene	5 POS			-																
Ethyl Benzene	5 POS			-																
m/p-Xylenes	5 POS			-																
o-Xylene	5 POS			-																
Styrene	5 POS			-																
Bromoform	50 GV			-																
1,1,2,2-Tetrachloroethane	5 POS			-																
MTBE	**			-																
Tetrahydrofuran	50 GV			-																
Dibromomethane	**			-																
1,3-Dichloropropane	5 POS			-																
1,2-Dibromoethane	**			-																
1,2,3-Trichloropropane	0.04			-																
1,2,4-Trichlorobenzene	5 POS			-																
Naphthalene	10 GV			-																
1,2,3-Trichlorobenzene	5 POS			-																
TOTAL	**	24100	26620	-	10160	16600	16300	14230	13039	7371	12193	17580	12800	6620	5420	6470	5610	4400	4200	2800
Chloride (mg/L)		376 D	374 D	272 D	-	287 D	428	332 D	262 D	290 D	287 D	447 D	366 D	259 D	350 D	334 D	217 D	192 D	257 D	354 D
Sulfate (mg/L)		314 D	308 D	69.7 D	-	71.6 D	ND	22.2	60.3 D	ND	ND	ND	ND	123 D	221 D	109 D	6.12 D	5.58 D	12.9 D	2.02 D
Sulfide (mg/L)		ND	ND	ND	-		ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	71.7 D	136 D	141 D	26.1 D	36.3 D	20.1 D
Nitrate (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)		498 D	466 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		186 D	485 D	-	174 D	335 D	-	-	2840 D	8550 D	6860 D	6630 D	4650	9045 D	1120 D	3670 D	3380 D	3680 D	3060 D	7030 D
Ethane (ug/L)		24.7 D	69.4 D	-	14.7 D	22.5	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)		11.8 JD	69.1 D	-	32.0 D	66.6 D	-	-	335 D	ND	ND	ND	321 D	645 D	ND	ND	ND	ND	ND	ND
Total Dissolved Solids (mg/L)		1780	1710	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.085	0.110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	832 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	735 D	1160 D	1026 D	514 D	759 D	716 D	1360 D	1760 D	1250 D	777 D	778 D	1950 D	2900 D	1190 D	2640 D	1290 D	615 D
Propionic Acid (mg/L)		ND	ND	729 D	1069 D	930 D	384 D	686 D	ND	1670 D	2250 D	1490 D	887 D	1040 D	4770 D	8600 D	2950 D	6270 D	3650 D	313 D
Formic Acid (mg/L)		ND	ND	ND	7.9	7.47	5.28	13.9	8.11	25.7	ND	ND	8.3	8.48	34.7 JD	70.3 D	74.6 D	65.3 D	44.7 D	18.1 D
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	41.7	19.1	83.7 D	74.9 D	26.1	69.2	2070 D	2720 D	917 D	2450 D	130 D	130 D
Pyruvic Acid (mg/L)		ND	ND	ND	ND	11.1	4.19	5.22	4.38	11.6	11.7	10	4.35	8.15	ND	48.2 JD	83.0 D	74.2 D	62.5 D	8.17 D
Valeric Acid (mg/L)		ND	ND	ND	ND	2.91	ND	2.80	3.55	6.57	6.67	6.12	4.68	6.28	59.7 D	115 D	127 D	118 D	92.3 D	11.2 D
ORP		-134.0	-281.2	-296.3	-272.4	-375.9	-271.4	-358.6	-347	-275.7	-128.8	-300.0	-105.6	-329.7	-375.8	-303.6	-273.5	-225.5	-201.6	-178.2
Dissolved Oxygen (mg/L)		1.05	0.24	0.04	0.32	0.25	0.71	0.81	0.54	0.75	0.55	-1.84	2.20	2.57	0.00	0.90	13.98	0.48	-0.03	-0.65
pH		6.32	6.80	6.67	6.66	3.7	6.45	6.98	6.88	7.42	6.26	6.57	6.72	6.45	6.52	6.51	6.34	6.92	10.86	7.23
Turbidity (NTU)		49.9	1.3	-2.8	638	-2	110.5	73.9	22.5	18.4	20.9	22.7	105.6	75.9	56.9	111.1	193.3	242.8	72.3	64.3
Temp (Degree-C)		18.92	17.75	16.7	16.46	16.41	15.13	15.93	16.74	16.43	17.43	16.39	18.26	16.45	19.73	18.42	21.14	22.25	16.76	16.63
Conductivity (mS/cm3)		2.278	2.320	3.393	3.973	4.04	3.540	3.874	3.871	4.678	4.680	4.245	3.300	3.303	10.21	14.46	14.1	12.46	8.803	7.450

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-5S																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/13/05	9/26/05	11/8/05	11/15/05	11/21/05	3/1/06	3/15/06	3/29/06	4/12/06	4/26/06	5/10/06	5/25/06	6/7/06	6/22/06	7/5/06	7/19/06	8/1/06	9/6/06	10/18/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**																			
Vinyl Chloride	2				300 JD		280 D	380 JD	57 JD	45 JD	45 JD									
Bromomethane	5 POS																			
Chloroethane	5 POS		210 JD		200 JD		5000 JD	12000 D	8000 D	6400 D	7600 D	14000 D	9600 D	9100 D	9000 D	10000 D	9100 D	6200 D	5500 D	4600 D
1,1-Dichloroethene	5 POS	870 J	830 D	1200 D	1000 D	1100 D	89 JD													
Acetone	50 GV																			
Carbon Disulfide	**																			
Methylene Chloride	5 POS				170 JD		66 JD													
trans-1,2-Dichloroethene	5 POS																			
1,1-Dichloroethane	5 POS	37000	23000 D	33000 D	34000 D	23000 D	12000 D	9000 D	970 D	1000 D	6000 D	5400 D	750 D	1400 D	800 D	1000 D	1100 D	560 D	440 D	
2-Butanone	**			1000 JD	380 JD			1400 JD			260 D									
Carbon Tetrachloride	5																			
cis-1,2-Dichloroethene	5 POS		230 JD		280 JD		76 JD													
Chloroform	7																			
1,1,1-Trichloroethane	5 POS	7600	6500 D	6400 D	4000 D	5800 D	640 D		76 JD	120 D	100 D						140 JD		87 JD	
Benzene	1																			
1,2-Dichloroethane	0.6				230 JD		97 JD		53 JD	43 JD	54 JD									
Trichloroethene	5 POS		210 JD	370 JD	400 JD		49 JD													
1,2-Dichloropropane	1																			
Bromodichloromethane	50 GV																		78 JD	
4-Methyl-2-Pentanone	**																			
Toluene	5 POS																			
t-1,3-Dichloropropene	0.4*																			
cis-1,3-Dichloropropene	0.4*																			
1,1,2-Trichloroethane	1																			
2-Hexanone	50 GV																			
Dibromochloromethane	50 GV																			
Tetrachloroethene	5 POS																			
Chlorobenzene	5 POS																			
Ethyl Benzene	5 POS																			
m/p-Xylenes	5 POS																			
o-Xylene	5 POS																			
Styrene	5 POS																			
Bromoform	50 GV																			
1,1,2,2-Tetrachloroethane	5 POS																			
MTBE	**																			
Tetrahydrofuran	50 GV																			
Dibromomethane	**																			
1,3-Dichloropropane	5 POS																			
1,2-Dibromoethane	**																			
1,2,3-Trichloropropane	0.04																			
1,2,4-Trichlorobenzene	5 POS																			
Naphthalene	10 GV																			
1,2,3-Trichlorobenzene	5 POS																			
TOTAL	**	45470	30980	41970	40960	29900	18297	22780	9156	7608	14059	19400	10350	10500	9800	11000 D	10340	6760	6105	4600
Chloride (mg/L)		508 D	533 D	279 D	-	394 D	387 D	396 D	255 D	260 D	262 D	361 D	336 D	211 D	303 D	390 D	334 D	304 D	278 D	285 D
Sulfate (mg/L)		470 D	514 D	264 D	-	469 D	73.3 D	ND	ND	ND	ND	ND	ND	479 D	ND	ND	ND	ND	ND	ND
Sulfide (mg/L)		ND	ND	ND	-		ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)		505 D	730 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		499 D	437 D	-	270 D	453 D	-	-	1580 D	4830 D	677 D	1940 D	3790 D	1310 D	1420 D	1910 D	334 D	2160 D	1330 D	5300 D
Ethane (ug/L)		66.0 D	52.5 D	-	29.8 D	29.7	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)		36.3 D	50.9 D	-	16.1 D	21.1	-	-	160 D	279 D	54.0 D	75.4 D	169 D	123	106 D	46.0 D	18.7	28.9 D	ND	ND
Total Dissolved Solids (mg/L)		2380	2220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.062	0.059	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	981 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	112	189 D	88.4 D	177 D	393 D	947 D	1030 D	1049 D	893 D	1200 D	1470 D	1480 D	1190 D	2520 D	1660 D	1430 D	1530 D
Propionic Acid (mg/L)		ND	ND	16.6	32.3	17.9	56.9	235 D	ND	1060 D	1310 D	1080 D	1940 D	2200 D	2580 D	2090 D	4870 D	3220 D	2690 D	2180 D
Formic Acid (mg/L)		ND	ND	ND	ND	ND	1.32	2.23	2.72	17.0	ND	ND	25.9 D	15.5	11.8 JD	20.9 D	23.2 D	22.8 D	25.5 D	29.1 D
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	57.1	10.8	68.6	38.5	83.9 D	92.8 D	148 D	129 D	480 D	470 D	273 D	154 D
Pyruvic Acid (mg/L)		ND	ND	ND	ND	0.59 J	1.47	2.96	7.09	6.62	7.88	5.74	14.4	9.89	12.5 D	6.82 D	ND	14.8 D	15.8 D	7.39 D
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	ND	0.85 J	4.41	3.97	5.57	4.32	8.61	13.5	15.3 D	11.8 D	20.3 D	27.9 D	24.7 D	28.3 D
ORP		-107.5	-194.0	-207.7	-178.1	-176.8	-358.8	-171.5	-234.8	-244.6	-96.2	-111.4	-88.1	-66.4	-107.6	-205.6	-98.7	-201.5	-130.3	-110.7
Dissolved Oxygen (mg/L)		0.60	0.78	1.03	0.54	0.5	0.54	0.47	0.56	0.81	0.65	-0.91	2.75	4.37	0.95	1.16	3.44	0.97	0.10	-1.13
pH		6.76	6.75	4.38	6.22	6.42	7.57	7.36	7.14	7.59	6.26	6.21	6.38	6.29	6.28	6.22	6.35	6.75	9.27	6.66
Turbidity (NTU)		320	39.5	34.3	101.3	16.1	38.5	50.7	7.8	12.1	35.8	11.3	45.6	38.7	14.1	23.7	13.6	44.1	14.5	12.9
Temp (Degree-C)		19.83	21.70	17.84	16.72	16.81	12.38	12.59	17.69	19.32	17.39	15.62	18.80	16.26	22.81	19.27	21.84	21.51	18.09	18.75
Conductivity (mS/cm3)		2.827	2.953	2.881	3.106	3.205	2.953	3.460	3.81	4.341	4.136	4.45	4.938	5.139	5.452	6.586	5.127	7.149	6.034	5.734

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

PSMW-5D																				
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				Post Injection Monitoring		
		9/12/05	**9/26/05**	**11/8/05**	**11/14/05**	**11/21/05**	**3/1/06**	**3/15/06**	**3/29/06**	**4/12/06**	**4/27/06**	**5/10/06**	**5/25/06**	**6/7/06**	**6/21/06**	**7/5/06**	**7/19/06**	**8/1/06**	**9/6/06**	**10/18/06**
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**				-	-														
Vinyl Chloride	2				-	-			3 J	79 JD	97 JD	210 JD	240 JD							
Bromomethane	5 POS				-	-														
Chloroethane	5 POS				-	-	360 D	5 JD	20	1500 D	2400 D	5300 D	3300 D	5100 D	5600 D	3700 D	2100 D	990 D	1100 D	610 D
1,1-Dichloroethene	5 POS	840 J	1200 D	55 JD	-	-		6 JD	6	140 D	63 JD	320 JD								
Acetone	50 GV				-	-														
Carbon Disulfide	**				-	-														
Methylene Chloride	5 POS		200 JD		-	-				39 JD										
trans-1,2-Dichloroethene	5 POS				-	-														
1,1-Dichloroethane	5 POS	49000 D	42000 D	2500 D	-	-	720 D	43 D	79	13000 D	16000 D	29000 D	27000 D	6900 D	1500 D	460 JD	140 JD	78 JD		
2-Butanone	**			98 JD	-	-					500 D									
Carbon Tetrachloride	5		560 D		-	-														
cis-1,2-Dichloroethene	5 POS	190 J	270 JD		-	-		6 JD		62 JD	38 JD									
Chloroform	7				-	-														
1,1,1-Trichloroethane	5 POS	5200	3300 D	34 JD	-	-		6 JD	6	100 D			180 JD							
Benzene	1				-	-														
1,2-Dichloroethane	0.6	250 J	240 JD		-	-					65 JD									
Trichloroethene	5 POS	160 J	200 JD		-	-		13 D		33 JD										
1,2-Dichloropropane	1				-	-														
Bromodichloromethane	50 GV				-	-														
4-Methyl-2-Pentanone	**				-	-														
Toluene	5 POS				-	-														920 D
t-1,3-Dichloropropene	0.4*				-	-														
cis-1,3-Dichloropropene	0.4*				-	-														
1,1,2-Trichloroethane	1				-	-														
2-Hexanone	50 GV				-	-														
Dibromochloromethane	50 GV				-	-														
Tetrachloroethene	5 POS				-	-														
Chlorobenzene	5 POS				-	-														
Ethyl Benzene	5 POS				-	-														
m/p-Xylenes	5 POS				-	-														
o-Xylene	5 POS				-	-														
Styrene	5 POS				-	-														
Bromoform	50 GV				-	-														
1,1,2,2-Tetrachloroethane	5 POS				-	-														
MTBE	**				-	-														
Tetrahydrofuran	50 GV				-	-														
Dibromomethane	**				-	-														
1,3-Dichloropropane	5 POS				-	-														
1,2-Dibromoethane	**				-	-														
1,2,3-Trichloropropane	0.04				-	-														
1,2,4-Trichlorobenzene	5 POS				-	-														
Naphthalene	10 GV				-	-														
1,2,3-Trichlorobenzene	5 POS				-	-														
TOTAL	**	55640	47970	2687	-	-	1080	79	114	13953	19163	34830	30720	12000	7100	4160	2240	1068	1100	1530
Chloride (mg/L)		490 D	504 D	162 D	-	-	141 D	136 D	123 D	266 D	370 D	414 D	400 D	586 D	271 D	475 D	163 D	51.7 D	38.7 D	20.1 D
Sulfate (mg/L)		289 D	310 D	150 D	-	-	246 D	275 D	185 D	69.2 D	ND	214 D	66 D	460 D	ND	ND	11.6 D	ND	0.61 D	3.26 D
Sulfide (mg/L)		ND	ND	ND	-	-	ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	-	42.7 D	ND	ND	6.74	139 D	46.5	ND	188 D	140 D	224 D	600 D	128 D	56.7 D	19.9 D
Nitrate (mg/L)		ND	ND	ND	-	-	ND	0.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)		435 D	494 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		253 D	697 D	-	-	-	-	-	7590 D	5160	1300 D	8.68	3850 D	681 D	1510 D	3340 D	7890 D	2930 D	6830 D	10400 D
Ethane (ug/L)		50.4	79.3 D	-	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)		41.9	81.2 D	-	-	-	-	-	ND	220 D	39.7 D	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Dissolved Solids (mg/L)		1430	1750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.051	0.083	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		3.27	ND	ND	-	-	2200 D	ND	ND	ND	8470 D	ND	ND	ND	ND	ND	14800 D	ND	ND	ND
Acetic Acid (mg/L)		ND	2.68	3.19	-	-	1900 D	52.8	162 D	974 D	4170 D	484 D	1030 D	2620 D	3350 D	4930 D	7700 D	2460 D	944 D	21.2 D
Propionic Acid (mg/L)		ND	ND	0.45 J	-	-	2540 D	86.7 D	ND	1200 D	7780 D	2010 D	1900 D	6970 D	8880 D	12300 D	20900 D	6620 D	2260 D	242 D
Formic Acid (mg/L)		ND	ND	ND	-	-	73.8 D	2.79 D	ND	15.70	75.5 D	ND	10.8 JD	159 D	64.9 D	ND	180 JD	49.0 D	36.0 D	ND
Butyric Acid (mg/L)		ND	ND	ND	-	-	ND	ND	3.42	7.22	694 D	111 D	58.9 D	3500 D	3450 D	5280 D	9640 D	3890 D	174 D	ND
Pyruvic Acid (mg/L)		ND	ND	ND	-	-	ND	ND	1.29	4.71	550 D	160 D	9.52	NA	11.2 JD	114 D	ND	60.6 D	57.7 D	ND
Valeric Acid (mg/L)		ND	ND	ND	-	-	ND	0.76 J	ND	2.54	8.83	18.4	3.95	71.3 D	67.9 D	190 D	358 D	176 D	74.6 D	1.17 JD
ORP		-115.2	-220.1	-223.3	-	-	-197.3	-284.5	-350.4	-352.6	-294.9	-301.5	-321.7	-300.6	-334.8	-302.1	-277.6	-245.8	-164.0	-260.9
Dissolved Oxygen (mg/L)		0.52	0.28	0.63	-	-	0.18	1.18	0	0	0.62	-1.46	-1.27	2.84	0.00	1.10	10.05	0.32	-0.02	-0.90
pH		6.70	6.73	3.79	-	-	6.59	7.15	7.04	7.16	6.14	6.29	6.71	6.25	6.38	6.54	6.53	7.02	10.07	6.85
Turbidity (NTU)		21.6	55	80.4	-	-	41.6	29.4	25.3	35.4	46.8	107.2	78.4	34.6	579.8	514.9	62.8	243.6	90.6	58.6
Temp (Degree-C)		19.45	17.91	16.87	-	-	13.23	14.57	16.5	16.66	16.93	15.71	17.41	16.13	20.61	18.64	20.22	22.55	17.66	18.18
Conductivity (mS/cm3)		2.843	2.685	1.426	-	-	5.120	1.703	1.75	4.265	15.74	6.053	5.103	15.21	12.74	20.3	23.58	13.20	5.932	2.198

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

PSMW-6S																				
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				**Post Injection Monitoring**		
Compound		**9/13/05 Pre #1**	**9/26/05 Pre #2**	**11/7/05 Post #1**	**11/15/05 Post #2**	**11/21/05 Post #3**	**3/1/06 CI #1**	**3/15/06 CI #2**	**3/29/06 CI #3**	**4/12/06 CI #4**	**4/26/06 CI #5**	**5/10/06 CI #6**	**5/25/06 CI #7**	**6/7/06 CI #8**	**6/22/06 CI #9**	**7/5/06 CI#10**	**7/19/06 CI #11**	**8/2/06 Reb #1**	**9/6/06 Reb #2**	**10/17/06 Reb #3**
Chloromethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Vinyl Chloride	2		150 JD	-	330 JD	-	-	-	-	-	-	-	-	-	-	-	-	390 JD	480 D	520 D
Bromomethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Chloroethane	5 POS	95 J	280 JD	-	270 JD	-	-	-	-	-	-	-	-	-	-	-	-	880 D	1100 D	960 D
1,1-Dichloroethene	5 POS	180 J	850 D	-	940 D	-	-	-	-	-	-	-	-	-	-	-	-	470 JD	700 D	770 D
Acetone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Disulfide	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Methylene Chloride	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
trans-1,2-Dichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1-Dichloroethane	5 POS	5600	11000 D	-	15000 D	-	-	-	-	-	-	-	-	-	-	-	-	8900 D	10000 D	9700 D
2-Butanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Tetrachloride	5			-		-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,2-Dichloroethene	5 POS	78 J	330 JD	-	330 JD	-	-	-	-	-	-	-	-	-	-	-	-	240 JD	260 D	270 JD
Chloroform	7			-		-	-	-	-	-	-	-	-	-	-	-	-		160 JD	
1,1,1-Trichloroethane	5 POS		2400 D	-	340 JD	-	-	-	-	-	-	-	-	-	-	-	-	170 JD	220 JD	260 JD
Benzene	1			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloroethane	0.6			-		-	-	-	-	-	-	-	-	-	-	-	-			
Trichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloropropane	1			-		-	-	-	-	-	-	-	-	-	-	-	-			
Bromodichloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
4-Methyl-2-Pentanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Toluene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
t-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2-Trichloroethane	1			-		-	-	-	-	-	-	-	-	-	-	-	-			
2-Hexanone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Dibromochloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Tetrachloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Chlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Ethyl Benzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
m/p-Xylenes	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
o-Xylene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Styrene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Bromoform	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
MTBE	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
Tetrahydrofuran	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
Dibromomethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,3-Dichloropropane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dibromoethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichloropropane	0.04			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,4-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
Naphthalene	10 GV			-		-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-			
TOTAL	**	5953	15010	-	17210	-	-	-	-	-	-	-	-	-	-	-	-	11050	12920	12480
Chloride (mg/L)		360 D	429 D	436 D	-	450 D	-	-	-	-	-	-	-	-	-	-	-	389 D	403 D	436 D
Sulfate (mg/L)		1000 D	865 D	1600 D	-	890 D	-	-	-	-	-	-	-	-	-	-	-	545 D	525 D	493 D
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		466 D	1230 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		290	457 D	-	215 D	-	-	-	-	-	-	-	-	-	-	-	-	1350 D	965 D	1660 D
Ethane (ug/L)		11.8	62.5 D	-	19.7 D	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Ethene (ug/L)		9.72	69.4 D	-	15.7 D	-	-	-	-	-	-	-	-	-	-	-	-	110 D	43.8 D	92.6 D
Total Dissolved Solids (mg/L)		2640 D	2500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		1.55	2.28 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	6.04	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	6.84	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Propionic Acid (mg/L)		ND	ND	6.71	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Formic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Pyruvic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
ORP		-59.0	-166.4	-176.2	-129.3	-217.4	-	-	-	-	-	-	-	-	-	-	-	-86.3	-71.7	-53.7
Dissolved Oxygen (mg/L)		3.72	0.21	2.35	1.71	0.93	-	-	-	-	-	-	-	-	-	-	-	1.60	0.57	-0.69
pH		6.52	6.76	6.96	6.74	3.84	-	-	-	-	-	-	-	-	-	-	-	6.77	10.08	6.88
Turbidity (NTU)		33.6	428.4	541.7	183	185.2	-	-	-	-	-	-	-	-	-	-	-	4.8	13.3	5.3
Temp (Degree-C)		23.34	20.41	16.99	17.18	16.43	-	-	-	-	-	-	-	-	-	-	-	19.95	18.25	17.79
Conductivity		1.046	3.389	4.777	3.222	3.173	-	-	-	-	-	-	-	-	-	-	-	3.136	2.961	2.949

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-6D (System Extraction Well from 4/14/06 to 6/1/06)																			
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**					**Post Injection Monitoring**		
		9/13/05	**9/26/05**	**11/7/05**	**11/14/05**	**11/21/05**	**3/1/06**	**3/15/06**	**3/29/06**	**4/5/06**	**4/13/06**	**4/26/06**	**5/11/06**	**5/25/06**	**6/7/06**	**6/22/06**	**7/5/06**	**7/19/06**	**8/2/06**	**9/6/06**	**10/17/06**
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**O&M evnt**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-	-	-	-	-	-		-	-			-	-	-	-			
Vinyl Chloride	2			-	-	-	-	-	-	190 D	-	-		230 JD	-	-	-	-	130 JD		220 JD
Bromomethane	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Chloroethane	5 POS			-	-	-	-	-	-	4700 D	-	-	3500 D	3300 D	-	-	-	-	11000 D	13000 D	11000 D
1,1-Dichloroethene	5 POS	490 J	1000 JD	-	-	-	-	-	-	490 D	-	-		240 JD	-	-	-	-			
Acetone	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
Carbon Disulfide	**			-	-	-	-	-	-		-	-			-	-	-	-			
Methylene Chloride	5 POS			-	-	-	-	-	-	96 JD	-	-			-	-	-	-			
trans-1,2-Dichloroethene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
1,1-Dichloroethane	5 POS	32000	43000 D	-	-	-	-	-	-	26000 D	-	-	39000 D	28000 D	-	-	-	-	19000 D	29000 D	36000 D
2-Butanone	**			-	-	-	-	-	-		-	-			-	-	-	-	560 JD		
Carbon Tetrachloride	5			-	-	-	-	-	-		-	-			-	-	-	-			
cis-1,2-Dichloroethene	5 POS			-	-	-	-	-	-	140 D	-	-			-	-	-	-			
Chloroform	7			-	-	-	-	-	-		-	-			-	-	-	-			
1,1,1-Trichloroethane	5 POS	1800 J	2800 D	-	-	-	-	-	-	100 D	-	-		340 JD	-	-	-	-			
Benzene	1			-	-	-	-	-	-		-	-			-	-	-	-			
1,2-Dichloroethane	0.6			-	-	-	-	-	-	180 D	-	-			-	-	-	-			
Trichloroethene	5 POS			-	-	-	-	-	-	80 JD	-	-			-	-	-	-			
1,2-Dichloropropane	1			-	-	-	-	-	-		-	-			-	-	-	-			
Bromodichloromethane	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
4-Methyl-2-Pentanone	**			-	-	-	-	-	-		-	-			-	-	-	-			
Toluene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
t-1,3-Dichloropropene	0.4*			-	-	-	-	-	-		-	-			-	-	-	-			
cis-1,3-Dichloropropene	0.4*			-	-	-	-	-	-		-	-			-	-	-	-			
1,1,2-Trichloroethane	1			-	-	-	-	-	-		-	-			-	-	-	-			
2-Hexanone	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
Dibromochloromethane	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
Tetrachloroethene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Chlorobenzene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Ethyl Benzene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
m/p-Xylenes	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
o-Xylene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Styrene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Bromoform	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
MTBE	**			-	-	-	-	-	-		-	-			-	-	-	-			
Tetrahydrofuran	50 GV			-	-	-	-	-	-		-	-			-	-	-	-			
Dibromomethane	**			-	-	-	-	-	-		-	-			-	-	-	-			
1,3-Dichloropropane	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
1,2-Dibromoethane	**			-	-	-	-	-	-		-	-			-	-	-	-			
1,2,3-Trichloropropane	0.04			-	-	-	-	-	-		-	-			-	-	-	-			
1,2,4-Trichlorobenzene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
Naphthalene	10 GV			-	-	-	-	-	-		-	-			-	-	-	-			
1,2,3-Trichlorobenzene	5 POS			-	-	-	-	-	-		-	-			-	-	-	-			
TOTAL	**	34290	46800	-	-	-	-	-	-	31976	-	-	42500	32110	-	-	-	-	30690	42000	47220
Chloride (mg/L)		442 D	556 D	528 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	567 D	691 D	709 D
Sulfate (mg/L)		368 D	418 D	264 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	186 D	222 D	234 D
Sulfide (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		495 D	603 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		536 D	700 D	-	-	-	-	-	-	-	-	-	2000 D	2780 D	-	-	-	-	1530 D	977 D	5340 D
Ethane (ug/L)		60.5 D	85.5 D	-	-	-	-	-	-	-	-	-	ND	ND	-	-	-	-	ND	ND	16.6 D
Ethene (ug/L)		28.6 D	64.5 D	-	-	-	-	-	-	-	-	-	101 D	148 D	-	-	-	-	190 D	80.5 D	110 D
Total Dissolved Solids (mg/L)		1940	2220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.17	0.088	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	-	-	-	-	-	12	ND	ND	ND	ND	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	280 D	-	-	-	-	-	1.5	138 D	88.3	95.9 D	122 D	-	-	-	-	ND	ND	ND
Propionic Acid (mg/L)		ND	ND	350 D	-	-	-	-	-	ND	34.2	ND	33	32.5	-	-	-	-	ND	ND	ND
Formic Acid (mg/L)		ND	ND	ND	-	-	-	-	-	ND	ND	ND	ND	ND	-	-	-	-	ND	ND	ND
Butyric Acid (mg/L)		ND	ND	ND	-	-	-	-	-	ND	ND	ND	ND	ND	-	-	-	-	ND	ND	ND
Pyruvic Acid (mg/L)		ND	ND	ND	-	-	-	-	-	ND	ND	ND	ND	ND	-	-	-	-	ND	ND	ND
Valeric Acid (mg/L)		ND	ND	ND	-	-	-	-	-	ND	ND	ND	ND	ND	-	-	-	-	ND	ND	ND
ORP		-76.2	-89.9	-265.3	-	-	-	-	-	-	-304.4	-	-373.3	-	-	-	-	-	-290.4	-236.5	-113.8
Dissolved Oxygen (mg/L)		1.06	0.35	0.44	-	-	-	-	-	-	0.87	-	-1.55	-	-	-	-	-	1.25	-0.04	-0.61
pH		6.03	6.59	6.56	-	-	-	-	-	-	-	-	6.67	-	-	-	-	-	6.65	9.77	6.68
Turbidity (NTU)		49.3	61	-1.8	-	-	-	-	-	-	29.7	-	12	-	-	-	-	-	23.9	14.7	9.2
Temp (Degree-C)		20.20	19.03	17.33	-	-	-	-	-	-	20.65	-	15.93	-	-	-	-	-	19.78	16.81	16.56
Conductivity (mS/cm3)		2.484	3.143	3.404	-	-	-	-	-	-	2.843	-	2.479	-	-	-	-	-	3.094	3.421	3.752

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-7																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
Compound		9/12/05 Pre #1	9/27/05 Pre #2	11/8/05 Post #1	11/15/05 Post #2	11/21/05 Post #3	3/1/06 CI #1	3/15/06 CI #2	3/29/06 CI #3	4/12/06 CI #4	4/26/06 CI #5	5/10/06 CI #6	5/25/06 CI #7	6/7/06 CI #8	6/22/06 CI #9	7/5/06 CI#10	7/19/06 CI #11	8/2/06 Reb #1	9/7/06 Reb #2	10/18/06 Reb #3
Chloromethane	**					-	-	-	-	-	-	-	-	-	-	-	-			
Vinyl Chloride	2		24 JD			-	-	-	-	-	-	-	-	-	-	-	-			
Bromomethane	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Chloroethane	5 POS	29 J	63 JD		260 JD	-	-	-	-	-	-	-	-	-	-	-	-	6800 D	4600 D	2800 D
1,1-Dichloroethene	5 POS	26 J	77 JD	200 JD		-	-	-	-	-	-	-	-	-	-	-	-			
Acetone	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Disulfide	**					-	-	-	-	-	-	-	-	-	-	-	-			
Methylene Chloride	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
trans-1,2-Dichloroethene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
1,1-Dichloroethane	5 POS	1100	1500 D	15000 D	8200 D	-	-	-	-	-	-	-	-	-	-	-	-			
2-Butanone	**			610 JD		-	-	-	-	-	-	-	-	-	-	-	-			
Carbon Tetrachloride	5					-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,2-Dichloroethene	5 POS	18 J	39 JD			-	-	-	-	-	-	-	-	-	-	-	-			
Chloroform	7					-	-	-	-	-	-	-	-	-	-	-	-		280 JD	
1,1,1-Trichloroethane	5 POS	12 J				-	-	-	-	-	-	-	-	-	-	-	-			
Benzene	1					-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloroethane	0.6					-	-	-	-	-	-	-	-	-	-	-	-			
Trichloroethene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloropropane	1					-	-	-	-	-	-	-	-	-	-	-	-			
Bromodichloromethane	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
4-Methyl-2-Pentanone	**					-	-	-	-	-	-	-	-	-	-	-	-			
Toluene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
t-1,3-Dichloropropene	0.4*					-	-	-	-	-	-	-	-	-	-	-	-			
cis-1,3-Dichloropropene	0.4*					-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2-Trichloroethane	1					-	-	-	-	-	-	-	-	-	-	-	-			
2-Hexanone	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
Dibromochloromethane	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
Tetrachloroethene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Chlorobenzene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Ethyl Benzene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
m/p-Xylenes	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
o-Xylene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Styrene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Bromoform	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
MTBE	**					-	-	-	-	-	-	-	-	-	-	-	-			
Tetrahydrofuran	50 GV					-	-	-	-	-	-	-	-	-	-	-	-			
Dibromomethane	**					-	-	-	-	-	-	-	-	-	-	-	-			
1,3-Dichloropropane	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
1,2-Dibromoethane	**					-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichloropropane	0.04					-	-	-	-	-	-	-	-	-	-	-	-			
1,2,4-Trichlorobenzene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
Naphthalene	10 GV					-	-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichlorobenzene	5 POS					-	-	-	-	-	-	-	-	-	-	-	-			
TOTAL	**	1185	1703	15810	8460	-	-	-	-	-	-	-	-	-	-	-	-	6800	4880	2800
Chloride (mg/L)		298 D	348 D	340 D	-	384 D	-	-	-	-	-	-	-	-	-	-	-	422 D	416 D	452 D
Sulfate (mg/L)		300 D	314 D	127 D	-	168 D	-	-	-	-	-	-	-	-	-	-	-	74.2 D	82.1 D	116 D
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		199 D	210 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		410 D	1215 D	-	491 D	-	-	-	-	-	-	-	-	-	-	-	-	3370 D	2320 D	7030 D
Ethane (ug/L)		50.4 D	158 D	-	91.7 D	-	-	-	-	-	-	-	-	-	-	-	-	ND	68.6 D	101 D
Ethene (ug/L)		25.6 D	142 D	-	53.0 D	-	-	-	-	-	-	-	-	-	-	-	-	77.1 D	ND	ND
Total Dissolved Solids (mg/L)		1300	1350	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.035	0.042	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		ND	ND	362 D	229 D	56.9	-	-	-	-	-	-	-	-	-	-	-	77.7	28.2	ND
Propionic Acid (mg/L)		ND	ND	215 D	36.3	6.86	-	-	-	-	-	-	-	-	-	-	-	29.8	ND	ND
Formic Acid (mg/L)		ND	ND	1.31	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Pyruvic Acid (mg/L)		ND	ND	ND	1.84	0.70 J	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
ORP		-192.8	-212.2	-279	-317	-336.7	-	-	-	-	-	-	-	-	-	-	-	-203.7	-327.9	-321.3
Dissolved Oxygen (mg/L)		2.86	0.21	0.19	0.85	0.23	-	-	-	-	-	-	-	-	-	-	-	-0.01	-0.12	-1.14
pH		8.23	7.11	5.01	7.16	4.77	-	-	-	-	-	-	-	-	-	-	-	7.35	10.90	7.12
Turbidity (NTU)		1.3	10.6	9.9	-1.9	-0.29	-	-	-	-	-	-	-	-	-	-	-	-2.6	4.9	4.5
Temp (Degree-C)		19.32	18.32	17.4	17.7	17.7	-	-	-	-	-	-	-	-	-	-	-	19.95	17.28	17.84
Conductivity		1.710	1.868	2.305	2.376	2.198	-	-	-	-	-	-	-	-	-	-	-	2.832	2.666	2.682

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-8																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/12/05	9/27/05	11/7/05	11/15/05	11/21/05	3/1/06	3/15/06	3/29/06	4/12/06	4/26/06	5/10/06	5/25/06	6/7/06	6/22/06	7/5/06	7/19/06	8/2/06	9/6/06	10/17/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Vinyl Chloride	2		170 JD	-	180 JD	-	-	-	-	-	-	-	-	-	-	-	-	350 JD	-	-
Bromomethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Chloroethane	5 POS			-	230 JD	-	-	-	-	-	-	-	-	-	-	-	-	500 D	-	-
1,1-Dichloroethene	5 POS		670 JD	-	670 D	-	-	-	-	-	-	-	-	-	-	-	-	750 D	-	-
Acetone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Carbon Disulfide	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Methylene Chloride	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
trans-1,2-Dichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1-Dichloroethane	5 POS	27000	34000 D	-	47000 D	-	-	-	-	-	-	-	-	-	-	-	-	26000 D	-	-
2-Butanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Carbon Tetrachloride	5			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,2-Dichloroethene	5 POS			-	220 JD	-	-	-	-	-	-	-	-	-	-	-	-	320 JD	-	-
Chloroform	7			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,1-Trichloroethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Benzene	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dichloroethane	0.6			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Trichloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dichloropropane	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromodichloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
4-Methyl-2-Pentanone	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Toluene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
t-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
cis-1,3-Dichloropropene	0.4*			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2-Trichloroethane	1			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
2-Hexanone	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromochloromethane	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrachloroethene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Chlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Ethyl Benzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
m/p-Xylenes	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
o-Xylene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Styrene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Bromoform	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,1,2,2-Tetrachloroethane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
MTBE	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Tetrahydrofuran	50 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Dibromomethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,3-Dichloropropane	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2-Dibromoethane	**			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichloropropane	0.04			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,4-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
Naphthalene	10 GV			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
1,2,3-Trichlorobenzene	5 POS			-		-	-	-	-	-	-	-	-	-	-	-	-		-	-
TOTAL	**	27000	34840	-	48300	-	-	-	-	-	-	-	-	-	-	-	-	27920	-	-
Chloride (mg/L)		312 D	428 D	508 D	-	769 D	-	-	-	-	-	-	-	-	-	-	-	462 D	-	-
Sulfate (mg/L)		342 D	472 D	501 D	-	260 D	-	-	-	-	-	-	-	-	-	-	-	384 D	-	-
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Nitrate (mg/L)		ND	ND	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Alkalinity (mg/L)		398 D	592 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		294 D	552 D	-	420 D	-	-	-	-	-	-	-	-	-	-	-	-	830 D	-	-
Ethane (ug/L)		39.6	73.0 D	-	59	-	-	-	-	-	-	-	-	-	-	-	-	60.3 D	-	-
Ethene (ug/L)		16.3	70.8 D	-	37.8	-	-	-	-	-	-	-	-	-	-	-	-	52.3 D	-	-
Total Dissolved Solids (mg/L)		1550	2100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.043	2.600 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Acetic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Propionic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Formic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Pyruvic Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	-	-
ORP		-99.5	-110.1	-188.6	-163.5	-90.4	-	-	-	-	-	-	-	-	-	-	-	-96.6	-	-
Dissolved Oxygen (mg/L)		6.16	0.58	0.44	-0.92	1.72	-	-	-	-	-	-	-	-	-	-	-	0.57	-	-
pH		7.14	6.44	6.65	6.63	3.64	-	-	-	-	-	-	-	-	-	-	-	6.73	-	-
Turbidity (NTU)		10.7	592.7	19.5	9.2	4.9	-	-	-	-	-	-	-	-	-	-	-	15.7	-	-
Temp (Degree-C)		19.44	17.61	16.74	16.95	14.95	-	-	-	-	-	-	-	-	-	-	-	18.69	-	-
Conductivity		2.011	2.634	2.868	3.392	3.442	-	-	-	-	-	-	-	-	-	-	-	2.701	-	-

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSMW-9																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/13/05	9/27/05	11/8/05	11/16/05	11/21/05	3/1/06	3/15/06	3/30/06	4/13/06	4/27/06	5/11/06	5/25/06	6/7/06	6/21/06	7/6/06	7/20/06	8/2/06	9/6/06	10/17/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-														-	-	-
Vinyl Chloride	2			-	5 J	3 JD			6 JD	10 D	17 D		8		7		5 JD	-	-	-
Bromomethane	5 POS			-														-	-	-
Chloroethane	5 POS	11 J		-	88	53 D	160 D	79 D	100 D	89 D	200 D	500 D	140 E	120 E	95	61 D	130 D	-	-	-
1,1-Dichloroethene	5 POS	16 J		-	36	25 D												-	-	-
Acetone	50 GV			-	28													-	-	-
Carbon Disulfide	**			-							14 D							-	-	-
Methylene Chloride	5 POS			-	5													-	-	-
trans-1,2-Dichloroethene	5 POS			-														-	-	-
1,1-Dichloroethane	5 POS	1800	720 D	-	1200 D	1300 D	480 D	180 D	94 D	160 D	430 D	2500 D	350 JD	230 JD	170 JD	95 D	120 D	-	-	-
2-Butanone	**			-	85	69 D				69 D	62 D							-	-	-
Carbon Tetrachloride	5			-														-	-	-
cis-1,2-Dichloroethene	5 POS	10 J		-	21	14 JD			2 D									-	-	-
Chloroform	7			-														-	-	-
1,1,1-Trichloroethane	5 POS	170	48 JD	-	40	32 D			4 JD	5 JD	7 JD				4 J		6 JD	-	-	-
Benzene	1			-														-	-	-
1,2-Dichloroethane	0.6			-	9	7 JD												-	-	-
Trichloroethene	5 POS			-	20	14 JD												-	-	-
1,2-Dichloropropane	1			-														-	-	-
Bromodichloromethane	50 GV			-														-	-	-
4-Methyl-2-Pentanone	**			-														-	-	-
Toluene	5 POS			-														-	-	-
t-1,3-Dichloropropene	0.4*			-														-	-	-
cis-1,3-Dichloropropene	0.4*			-														-	-	-
1,1,2-Trichloroethane	1			-														-	-	-
2-Hexanone	50 GV			-														-	-	-
Dibromochloromethane	50 GV			-														-	-	-
Tetrachloroethene	5 POS			-														-	-	-
Chlorobenzene	5 POS			-														-	-	-
Ethyl Benzene	5 POS			-														-	-	-
m/p-Xylenes	5 POS			-														-	-	-
o-Xylene	5 POS			-														-	-	-
Styrene	5 POS			-														-	-	-
Bromoform	50 GV			-														-	-	-
1,1,2,2-Tetrachloroethane	5 POS			-														-	-	-
MTBE	**			-	2 J													-	-	-
Tetrahydrofuran	50 GV			-	14													-	-	-
Dibromomethane	**			-														-	-	-
1,3-Dichloropropane	5 POS			-														-	-	-
1,2-Dibromoethane	**			-														-	-	-
1,2,3-Trichloropropane	0.04			-														-	-	-
1,2,4-Trichlorobenzene	5 POS			-														-	-	-
Naphthalene	10 GV			-														-	-	-
1,2,3-Trichlorobenzene	5 POS			-														-	-	-
TOTAL	**	2007	768	-	1553	1517	640	259	206	333	730	3000	498	350	276	156	261	-	-	-
Chloride (mg/L)		111 D	144 D	-	-	375 D	136 D	212 D	135 D	153 D	141 D	167 D	149 D	147 D	105 D	141 D	139 D	-	-	-
Sulfate (mg/L)		269 D	388 D	-	-	356 D	21.1	ND	54.0 D	30.2 D	44.3 D	80.1 D	79.9 D	160 D	153 D	209 D	241 D	-	-	-
Sulfide (mg/L)		ND	ND	-	-		ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Phosphate (mg/L)		ND	ND	-	-	ND	ND	ND	ND	3	2.34 D	ND	ND	ND	1.23 D	ND	ND	-	-	-
Nitrate (mg/L)		ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Alkalinity (mg/L)		184 D	292 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		29.2	47.4	-	55.5	57.3	-	-	5350 D	5510	8220 D	6940 D	5680 D	3330 D	974 D	2260 D	1563 D	-	-	-
Ethane (ug/L)		3.95	10.7	-	4.58	4.63	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Ethene (ug/L)		2.31	5.75	-	2.12	2.07	-	-	ND	ND	ND	ND	ND	261 D	ND	ND	ND	-	-	-
Total Dissolved Solids (mg/L)		753	1090	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.075	0.120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		0.88 J	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Acetic Acid (mg/L)		ND	ND	-	328 D	1009 D	179 D	383 D	156 D	380 D	314 D	ND	1.22	ND	ND	ND	ND	-	-	-
Propionic Acid (mg/L)		ND	ND	-	174 D	913 D	ND	102 D	304 D	202 D	53.4	ND	ND	ND	ND	ND	ND	-	-	-
Formic Acid (mg/L)		0.27	ND	-	0.42 J	7.89	0.59	0.28 J	4.46	3.13	1.05	ND	ND	ND	ND	ND	ND	-	-	-
Butyric Acid (mg/L)		ND	ND	-	ND	ND	ND	ND	8.18	3.83	ND	ND	ND	ND	ND	ND	ND	-	-	-
Pyruvic Acid (mg/L)		ND	ND	-	2.11	12	1.58	1.45	1.83	1.53	0.84 J	ND	ND	ND	ND	ND	ND	-	-	-
Valeric Acid (mg/L)		ND	ND	-	ND	2.87	ND	0.51 J	2.27	1.59	0.75 J	ND	ND	ND	ND	ND	ND	-	-	-
ORP		-124.7	-138.4	-	-428.4	-295.7	-341.6	-388.0	-370.4	-352.4	-326.2	-394.2	-363.5	-331.8	-342.4	-333.7	-224.5	-	-	-
Dissolved Oxygen (mg/L)		0.63	0.43	-	1.11	0.12	0.79	0.77	0	0	2.72	-3.17	-0.26	1.79	0.00	0.46	19.14	-	-	-
pH		11.69	9.51	-	3.86	4.61	7.10	7.50	7.36	-	6.19	7.28	7.27	7.18	7.21	7.05	6.99	-	-	-
Turbidity (NTU)		9.8	93.3	-	-2	77.5	37.2	40.1	0	11.2	23.3	16.1	14.4	88.7	15.8	25.4	16.7	-	-	-
Temp (Degree-C)		18.72	18.72	-	16.79	15.68	14.68	14.94	18.51	19.00	17.50	15.94	16.97	15.95	17.58	17.27	17.45	-	-	-
Conductivity (mS/cm3)		1.254	1.287	-	2.13	1.868	2.025	2.430	2.634	2.514	1.801	1.674	1.664	1.632	1.341	1.562	1.476	-	-	-

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		PSIW-2																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/12/05	9/27/05	11/7/05	11/16/05	11/21/05	3/1/06	3/15/06	3/29/06	4/13/06	4/27/06	5/11/06	5/25/06	6/7/06	6/21/06	7/6/06	7/20/06	8/2/06	9/7/06	10/18/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**	-	-	-		-	-	-	-											
Vinyl Chloride	2	-	-	-		-	-	-	-	170 D	180 D	260 JD	140 JD	160 JD	170 D	140 JD				120 JD
Bromomethane	5 POS	-	-	-		-	-	-	-											
Chloroethane	5 POS	-	-	-		-	-	-	-	1100 D	2800 D	2700 D	1400 D	860 D	880 D	680 D	590 JD	600 D		320 JD
1,1-Dichloroethene	5 POS	-	-	-		-	-	-	-	530 D	320 D	410 JD	200 JD	260 JD	220 D	160 JD				
Acetone	50 GV	-	-	-		-	-	-	-						78 JD					
Carbon Disulfide	**	-	-	-		-	-	-	-											
Methylene Chloride	5 POS	-	-	-		-	-	-	-	53 JD	48 JD				18 JD					
trans-1,2-Dichloroethene	5 POS	-	-	-		-	-	-	-											
1,1-Dichloroethane	5 POS	-	-	-	38000 D	-	-	-	-	24000 D	23000 D	20000 D	8700 D	6700 D	5700 D	4200 D	3400 D	3300 D	3800 D	3800 D
2-Butanone	**	-	-	-		-	-	-	-		160 JD									
Carbon Tetrachloride	5	-	-	-		-	-	-	-											
cis-1,2-Dichloroethene	5 POS	-	-	-		-	-	-	-	230 D	210 D	210 JD			120 D					
Chloroform	7	-	-	-		-	-	-	-											
1,1,1-Trichloroethane	5 POS	-	-	-		-	-	-	-	160 D	74 JD				24 JD					
Benzene	1	-	-	-		-	-	-	-											
1,2-Dichloroethane	0.6	-	-	-		-	-	-	-	99 JD	110 D	180 JD			20 JD					
Trichloroethene	5 POS	-	-	-		-	-	-	-	250 D	160 D				130 D					
1,2-Dichloropropane	1	-	-	-		-	-	-	-											
Bromodichloromethane	50 GV	-	-	-		-	-	-	-											
4-Methyl-2-Pentanone	**	-	-	-		-	-	-	-											
Toluene	5 POS	-	-	-		-	-	-	-											
t-1,3-Dichloropropene	0.4*	-	-	-		-	-	-	-											
cis-1,3-Dichloropropene	0.4*	-	-	-		-	-	-	-											
1,1,2-Trichloroethane	1	-	-	-		-	-	-	-											
2-Hexanone	50 GV	-	-	-		-	-	-	-											
Dibromochloromethane	50 GV	-	-	-		-	-	-	-											
Tetrachloroethene	5 POS	-	-	-		-	-	-	-											
Chlorobenzene	5 POS	-	-	-		-	-	-	-											
Ethyl Benzene	5 POS	-	-	-		-	-	-	-											
m/p-Xylenes	5 POS	-	-	-		-	-	-	-											
o-Xylene	5 POS	-	-	-		-	-	-	-											
Styrene	5 POS	-	-	-		-	-	-	-											
Bromoform	50 GV	-	-	-		-	-	-	-											
1,1,2,2-Tetrachloroethane	5 POS	-	-	-		-	-	-	-											
MTBE	**	-	-	-		-	-	-	-											
Tetrahydrofuran	50 GV	-	-	-		-	-	-	-											
Dibromomethane	**	-	-	-		-	-	-	-											
1,3-Dichloropropane	5 POS	-	-	-		-	-	-	-											
1,2-Dibromoethane	**	-	-	-		-	-	-	-											
1,2,3-Trichloropropane	0.04	-	-	-		-	-	-	-											
1,2,4-Trichlorobenzene	5 POS	-	-	-		-	-	-	-											
Naphthalene	10 GV	-	-	-		-	-	-	-								320 JD			
1,2,3-Trichlorobenzene	5 POS	-	-	-		-	-	-	-											
TOTAL	**	-	-	-	38000	-	-	-	-	26592	27062	23760	10440	7980	7360	5180	4310	3900	3800	4240
Chloride (mg/L)		-	-	-	-	476 D	-	-	-	472 D	464 D	467 D	398 D	434 D	376 D	485 D	420 D	407 D	400 D	432 D
Sulfate (mg/L)		-	-	-	-	597 D	-	-	-	406 D	371 D	402 D	363 D	307 D	238 D	254 D	213 D	201 D	213 D	213 D
Sulfide (mg/L)		-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		-	-	-	-	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate (mg/L)		-	-	-	-	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate (mg/L)		-	-	-	-	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alkalinity (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		-	-	-	695 D	-	-	-	-	2950 D	10500 D	5860 D	6460 D	4370 D	1860 D	3620 D	3410 D	1810 D	2330 D	3920 D
Ethane (ug/L)		-	-	-	34.7	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	31.5 D
Ethene (ug/L)		-	-	-	1.8 J	-	-	-	-	139 D	459 D	223 D	ND	349 D	10.0 D	76.9 D	188 D	78.0 D	19.7 D	15.9 D
Total Dissolved Solids (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		-	-	-	ND	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetic Acid (mg/L)		-	-	-	ND	ND	-	-	-	28.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propionic Acid (mg/L)		-	-	-	ND	ND	-	-	-	3.95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Formic Acid (mg/L)		-	-	-	ND	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyric Acid (mg/L)		-	-	-	ND	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyruvic Acid (mg/L)		-	-	-	ND	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Valeric Acid (mg/L)		-	-	-	ND	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ORP		-	-	-	-167.9	-204.7	-	-	-	-68.7	-106.5	-179.3	-63.6	-178.6	-252.6	-79.8	-118.3	-137.6	-240.6	-218.9
Dissolved Oxygen (mg/L)		-	-	-	0.39	0.47	-	-	-	1.66	0.53	-1.73	2.26	3.01	0.17	1.10	7.7	-0.09	-0.01	-0.82
pH		-	-	-	6.49	3.73	-	-	-	-	5.60	6.74	6.69	6.73	6.75	6.80	6.75	7.07	10.35	6.97
Turbidity (NTU)		-	-	-	37.8	1220.2	-	-	-	32.5	26.0	24.0	37.0	28.9	7.1	27.2	11	6.3	9.9	7.3
Temp (Degree-C)		-	-	-	17.58	17.28	-	-	-	16.44	16.28	15.46	16.57	15.63	17.17	16.65	17.3	17.89	17.9	18.56
Conductivity (mS/cm3)		-	-	-	3.179	3.07	-	-	-	3.136	2.616	2.532	2.439	2.474	2.401	2.535	2.398	2.522	2.470	2.554

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb), unless noted.
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		MW-29S (System Extraction Well from 6/1/06 to 7/20/06)																		
		Baseline		**Phase 1 (Batch Injection)**			**Phase 2 (MW-29D)**			**Phase 3 (PSMW-6D)**				**Phase 4 (MW-29S)**				**Post Injection Monitoring**		
		9/12/05	**9/27/05**	**11/8/05**	**11/15/05**	**11/21/05**	**3/1/06**	**3/15/06**	**3/30/06**	**4/12/06**	**4/27/06**	**5/11/06**	**5/25/06**	**6/7/06**	**6/22/06**	**7/6/06**	**7/20/06**	**8/2/06**	**9/7/06**	**10/17/06**
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-		-														
Vinyl Chloride	2	250 J	210 D	-	270 JD	-			57 JD	38 JD										
Bromomethane	5 POS			-		-														
Chloroethane	5 POS	820 J	520 D	-	3100 D	-	11000 D	11000 D	10000 D	6700 D	11000 D	15000 D	9900 D	9000 D	5800 D	5200 D	4100 D	4500 D	3400 D	2900 D
1,1-Dichloroethene	5 POS	410 J	650 D	-		-														
Acetone	50 GV			-		-														
Carbon Disulfide	**			-		-														
Methylene Chloride	5 POS		98 JD	-		-														
trans-1,2-Dichloroethene	5 POS			-		-														
1,1-Dichloroethane	5 POS	15000	14000 D	-	11000 D	-	1500 D	2300 D	1900 D	2600 D	1200 D	1200 D	230 JD	1400 D	490 D		150 JD	130 JD	76 JD	
2-Butanone	**			-		-												2900 D		
Carbon Tetrachloride	5			-		-														
cis-1,2-Dichloroethene	5 POS	100 J	170 D	-		-														
Chloroform	7			-		-													140 JD	
1,1,1-Trichloroethane	5 POS	1000	710 D	-		-														
Benzene	1			-		-														
1,2-Dichloroethane	0.6		150 D	-		-			67 JD	52 JD	57 JD									
Trichloroethene	5 POS	120 J	130 D	-		-														
1,2-Dichloropropane	1			-		-														
Bromodichloromethane	50 GV			-		-														
4-Methyl-2-Pentanone	**			-		-														
Toluene	5 POS			-		-														
t-1,3-Dichloropropene	0.4*			-		-														
cis-1,3-Dichloropropene	0.4*			-		-														
1,1,2-Trichloroethane	1			-		-														
2-Hexanone	50 GV			-		-														
Dibromochloromethane	50 GV			-		-														
Tetrachloroethene	5 POS			-		-														
Chlorobenzene	5 POS			-		-														
Ethyl Benzene	5 POS			-		-														
m/p-Xylenes	5 POS			-		-														
o-Xylene	5 POS			-		-														
Styrene	5 POS			-		-														
Bromoform	50 GV			-		-														
1,1,2,2-Tetrachloroethane	5 POS			-		-														
MTBE	**			-		-														
Tetrahydrofuran	50 GV			-		-														
Dibromomethane	**			-		-														
1,3-Dichloropropane	5 POS			-		-														
1,2-Dibromoethane	**			-		-														
1,2,3-Trichloropropane	0.04			-		-														
1,2,4-Trichlorobenzene	5 POS			-		-														
Naphthalene	10 GV			-		-														
1,2,3-Trichlorobenzene	5 POS			-		-														
TOTAL	**	17700	16638	-	14370	-	12500	13300	12024	9390	12257	16200	10130	10400	6290	5200	4250	7530	3616	2900
Chloride (mg/L)		313 D	299 D	308 D	-	-	420 D	358 D	306 D	322 D	348 D	434 D	399 D	-	-	322 D	233 D	228 D	253 D	315 D
Sulfate (mg/L)		243 D	340 D	142 D	-	-	ND	34.6	ND	ND	ND	ND	ND	-	-	ND	6.82 D	ND	34.5 D	2.55 D
Sulfide (mg/L)		ND	ND	ND	-	-	ND		ND	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	-	-	ND	ND	ND	ND	ND
Phosphate (mg/L)		ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	-	-	79.5 D	181 D	61.1 D	33.0 D	17.5 D
Nitrate (mg/L)		ND	1.39	ND	-	-	ND	ND	ND	ND	ND	ND	ND	-	-	ND	ND	ND	ND	ND
Alkalinity (mg/L)		362 D	445 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		515 D	498 D	-	264 D	-	-	-	3510 D	6160 D	4110 D	7630 D	5770 D	9980 D	2590 D	3080 D	4860 D	1900 D	5570 D	1080 D
Ethane (ug/L)		61.8 D	65.3 D	-	29.3 D	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethene (ug/L)		53.1 D	53.3 D	-	60.1 D	-	-	-	324 D	314 D	140 D	ND	ND	770 D	10.0 D	ND	ND	ND	ND	ND
Total Dissolved Solids (mg/L)		1720	1480	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.087	0.072	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		9.42	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5580 D	ND	ND	ND
Acetic Acid (mg/L)		ND	53.7	562 D	912 D	-	535 D	718 D	877 D	1160 D	1097 D	1140 D	1150 D	936 D	1600 D	3170 D	3490 D	2350 D	1470 D	979 D
Propionic Acid (mg/L)		ND	ND	668 D	812 D	-	425 D	621 D	871 D	1320 D	1280 D	1320 D	1610 D	1170 D	3570 D	7330 D	8330 D	5520 D	3660 D	465 D
Formic Acid (mg/L)		ND	ND	6.63	6.6	-	6.06	13.6	16.3	20.8	ND	ND	8.5 JD	9.37 D	ND	54.5 JD	54.2 JD	62.8 D	44.1 D	13.1 D
Butyric Acid (mg/L)		ND	ND	ND	ND	-	ND	ND	10.7	14.2	65.4	70	63.8 D	81.3 D	1380 D	2790 D	3280 D	2350 D	114 D	32.8 D
Pyruvic Acid (mg/L)		ND	ND	ND	9.48	-	3.34	5.57	5.81	8.00	7.79	9.81	11.3	4.68 D	43.2 D	ND	117 D	97.8 D	70.9 D	15.4 D
Valeric Acid (mg/L)		ND	ND	ND	2.12	-	ND	2.62	3.8	4.88	5.03	5.84	7.66	7.01 D	43.8 D	101 D	95.3 D	118 D	115 D	19.8 D
ORP		-251.8	-371.0	-392.4	-319.6	-	-367.4	-383.5	-283.4	-281.6	-158.4	-177.5	-146.3	-	-	-	-	-203.5	-286.8	-193.8
Dissolved Oxygen (mg/L)		7.06	0.19	-0.05	0.33	-	0.26	0.32	0.61	0.52	0.59	-1.43	1.75	-	-	-	-	0.14	-0.10	-0.51
pH		7.09	6.80	6.65	6.06	-	7.00	7.01	7	7.49	5.54	6.63	6.57	-	-	-	-	7.00	10.96	7.41
Turbidity (NTU)		33	60.7	25.8	7.1	-	0.5	132.5	34.7	35.1	14.8	19.2	62.5	-	-	-	-	1315.2	74.9	40.6
Temp (Degree-C)		21.45	16.91	16.77	16.49	-	16.06	15.88	16.1	16.01	16.47	15.8	16.88	-	-	-	-	18.41	17.19	17.53
Conductivity (mS/cm3)		1.871	1.956	3.151	3.73	-	3.419	3.716	3.929	4.657	4.189	4.292	4.719	-	-	-	-	12.38	9.289	7.859

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		MW-29D (System Extraction Well from 2/10/06 to 3/30/06)																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/13/05	9/27/05	11/7/05	11/15/05	11/21/05	3/1/06	3/15/06	3/29/06	4/13/06	4/27/06	5/10/06	5/25/06	6/7/06	6/21/06	7/6/06	7/20/06	8/2/06	9/6/06	10/17/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**			-		-												-	-	-
Vinyl Chloride	2			-		-												-	-	-
Bromomethane	5 POS			-		-												-	-	-
Chloroethane	5 POS			-		-						10			16 JD			-	-	-
1,1-Dichloroethene	5 POS		12	-	12	-		7	8	7	7	10	6	6	82 D	4 J	6	-	-	-
Acetone	50 GV			-		-												-	-	-
Carbon Disulfide	**			-		-												-	-	-
Methylene Chloride	5 POS		18	-	2	-												-	-	-
trans-1,2-Dichloroethene	5 POS			-		-												-	-	-
1,1-Dichloroethane	5 POS	60 J	48	-	120 E	-		21	23	21	24	150 D	20	18	270 D	20	15	-	-	-
2-Butanone	**			-		-												-	-	-
Carbon Tetrachloride	5		14	-	2	-												-	-	-
cis-1,2-Dichloroethene	5 POS		7	-	7	-		5	6	6	5	7		4 J	54 D	4 J	4 J	-	-	-
Chloroform	7			-		-												-	-	-
1,1,1-Trichloroethane	5 POS		86	-	33	-		8	8	7	7	9	7	7	59 D	4 J	5 J	-	-	-
Benzene	1			-		-												-	-	-
1,2-Dichloroethane	0.6			-		-												-	-	-
Trichloroethene	5 POS	10 J	21	-	20	-		19		16	14	18	15	16	180 D	10	14	-	-	-
1,2-Dichloropropane	1			-		-												-	-	-
Bromodichloromethane	50 GV			-		-												-	-	-
4-Methyl-2-Pentanone	**			-		-												-	-	-
Toluene	5 POS			-		-												-	-	-
t-1,3-Dichloropropene	0.4*			-		-												-	-	-
cis-1,3-Dichloropropene	0.4*			-		-												-	-	-
1,1,2-Trichloroethane	1			-		-												-	-	-
2-Hexanone	50 GV			-		-												-	-	-
Dibromochloromethane	50 GV			-		-												-	-	-
Tetrachloroethene	5 POS			-		-												-	-	-
Chlorobenzene	5 POS			-		-												-	-	-
Ethyl Benzene	5 POS			-		-												-	-	-
m/p-Xylenes	5 POS			-		-												-	-	-
o-Xylene	5 POS			-		-												-	-	-
Styrene	5 POS			-		-												-	-	-
Bromoform	50 GV			-		-												-	-	-
1,1,2,2-Tetrachloroethane	5 POS			-		-												-	-	-
MTBE	**			-		-												-	-	-
Tetrahydrofuran	50 GV			-		-												-	-	-
Dibromomethane	**			-		-												-	-	-
1,3-Dichloropropane	5 POS			-		-												-	-	-
1,2-Dibromoethane	**			-		-												-	-	-
1,2,3-Trichloropropane	0.04			-		-												-	-	-
1,2,4-Trichlorobenzene	5 POS			-		-												-	-	-
Naphthalene	10 GV			-		-				3 J								-	-	-
1,2,3-Trichlorobenzene	5 POS			-		-												-	-	-
TOTAL	**	70	206	-	196	-	0	60	45	60	57	204	48	51	661	42	44	-	-	-
Chloride (mg/L)		145 D	151 D	155 D	-	148 D	-	-	-	126 D	137 D	156 D	145 D	163 D	121 D	153 D	147 D	-	-	-
Sulfate (mg/L)		323 D	365 D	350 D	-	380 D	-	-	-	362 D	377 D	380 D	370 D	358 D	287 D	306 D	299 D	-	-	-
Sulfide (mg/L)		ND	ND	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		ND	ND	ND	-	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Phosphate (mg/L)		ND	ND	ND	-	ND	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Nitrate (mg/L)		1.39	ND	1.23	-	1.64	-	-	-	ND	2.12 D	2.19	2.19	1.96	1.39 D	1.42 D	1.48 D	-	-	-
Alkalinity (mg/L)		280 D	293 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		11.9	20.7	-	8.2 J	-	-	-	-	ND	9.80	6.89	29.6	21.4	24.8	44.1 D	12.8	-	-	-
Ethane (ug/L)		ND	6.38	-	ND	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Ethene (ug/L)		ND	ND	-	ND	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Total Dissolved Solids (mg/L)		1180	1170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		0.021	0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Acetic Acid (mg/L)		ND	ND	24.4	9.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Propionic Acid (mg/L)		ND	ND	14.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Formic Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Butyric Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Pyruvic Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
Valeric Acid (mg/L)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-
ORP		7.0	-56.1	-278.9	-233.3	-140.6	-259.2	-83.5	-377.6	-223.0	80.2	-238.5	-261.1	68.1	-243.7	28.5	-29.2	-	-	-
Dissolved Oxygen (mg/L)		1.00	0.20	0.13	0.27	0.25	0.24	3.15	0.75	1.83	0.70	-1.45	-0.50	2.45	0.20	0.79	10.4	-	-	-
pH		6.80	7.02	7.01	6.82	6.76	7.39	7.27	7.46	-	5.47	6.98	7.01	6.94	7.05	7.01	6.97	-	-	-
Turbidity (NTU)		39.8	31.3	26.4	20.6	19.2	0	20.1	0	4.1	13.9	1.0	3.1	58.1	22.3	27.9	13.7	-	-	-
Temp (Degree-C)		18.91	16.40	15.93	15.7	15.58	17.42	16.89	17.75	16.52	16.93	16.15	16.65	15.97	17.22	16.81	16.63	-	-	-
Conductivity (mS/cm3)		1.475	1.485	1.521	1.495	1.547	1.492	1.524	1.516	1.547	1.375	1.336	1.457	1.458	1.291	1.527	1.445	-	-	-

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 4
PILOT TEST GROUNDWATER DATA

75-20 Astoria Boulevard
Jackson Heights, NY

		MW-31S																		
		Baseline		Phase 1 (Batch Injection)			Phase 2 (MW-29D)			Phase 3 (PSMW-6D)				Phase 4 (MW-29S)				Post Injection Monitoring		
		9/12/05	9/27/05	11/8/05	11/16/05	11/21/05	3/1/06	3/15/06	3/29/06	4/12/06	4/26/06	5/10/06	5/25/06	6/7/06	6/22/06	7/5/06	7/19/06	8/1/06	9/7/06	10/18/06
Compound		**Pre #1**	**Pre #2**	**Post #1**	**Post #2**	**Post #3**	**CI #1**	**CI #2**	**CI #3**	**CI #4**	**CI #5**	**CI #6**	**CI #7**	**CI #8**	**CI #9**	**CI#10**	**CI #11**	**Reb #1**	**Reb #2**	**Reb #3**
Chloromethane	**		-				-	-	-	-	-	-	-	-	-	-	-			
Vinyl Chloride	2	200 J	-	490 JD	510 D	920 JD	-	-	-	-	-	-	-	-	-	-	-	340 JD	370 D	900 D
Bromomethane	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
Chloroethane	5 POS	1300	-	2500 D	3700 D	4300 D	-	-	-	-	-	-	-	-	-	-	-	1800 D	1700 D	5000 D
1,1-Dichloroethene	5 POS	15000	-	17000 D		8800 D	-	-	-	-	-	-	-	-	-	-	-	10000 D	1200 D	13000 D
Acetone	50 GV		-			2000 JD	-	-	-	-	-	-	-	-	-	-	-			
Carbon Disulfide	**		-				-	-	-	-	-	-	-	-	-	-	-			
Methylene Chloride	5 POS		-	580 JD	540 D	440 JD	-	-	-	-	-	-	-	-	-	-	-	410 JD		460 JD
trans-1,2-Dichloroethene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
1,1-Dichloroethane	5 POS	15000	-	45000 D	56000 D	54000 D	-	-	-	-	-	-	-	-	-	-	-	44000 D	24000 D	45000 D
2-Butanone	**	170 J	-	1600 JD	910 JD	1100 JD	-	-	-	-	-	-	-	-	-	-	-	1200 D		940 JD
Carbon Tetrachloride	5		-				-	-	-	-	-	-	-	-	-	-	-	130 JD		
cis-1,2-Dichloroethene	5 POS		-	1200 D	2300 D	1700 D	-	-	-	-	-	-	-	-	-	-	-	1100 D	780 D	2100 D
Chloroform	7	160 J	-	600 JD	930 D	550 JD	-	-	-	-	-	-	-	-	-	-	-	590 D	160 JD	
1,1,1-Trichloroethane	5 POS	370000 D	-	900000 D	1000000 D	1000000 D	-	-	-	-	-	-	-	-	-	-	-	810000 D	1500 D	490000 D
Benzene	1		-				-	-	-	-	-	-	-	-	-	-	-			
1,2-Dichloroethane	0.6		-	1700 D		1500 D	-	-	-	-	-	-	-	-	-	-	-	1600 D		1700 D
Trichloroethene	5 POS	6800	-	12000 D	17000 D	14000 D	-	-	-	-	-	-	-	-	-	-	-	9900 JD	200 JD	15000 D
1,2-Dichloropropane	1		-				-	-	-	-	-	-	-	-	-	-	-			
Bromodichloromethane	50 GV		-		220 JD		-	-	-	-	-	-	-	-	-	-	-			
4-Methyl-2-Pentanone	**		-				-	-	-	-	-	-	-	-	-	-	-			
Toluene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
t-1,3-Dichloropropene	0.4*		-				-	-	-	-	-	-	-	-	-	-	-			
cis-1,3-Dichloropropene	0.4*		-				-	-	-	-	-	-	-	-	-	-	-			
1,1,2-Trichloroethane	1		-				-	-	-	-	-	-	-	-	-	-	-			
2-Hexanone	50 GV		-				-	-	-	-	-	-	-	-	-	-	-			
Dibromochloromethane	50 GV		-				-	-	-	-	-	-	-	-	-	-	-			
Tetrachloroethene	5 POS	400 J	-	940 JD	1000 D	630 JD	-	-	-	-	-	-	-	-	-	-	-	780 D		1500 D
Chlorobenzene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
Ethyl Benzene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
m/p-Xylenes	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
o-Xylene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
Styrene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
Bromoform	50 GV		-				-	-	-	-	-	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
MTBE	**		-				-	-	-	-	-	-	-	-	-	-	-			
Tetrahydrofuran	50 GV		-				-	-	-	-	-	-	-	-	-	-	-			
Dibromomethane	**		-				-	-	-	-	-	-	-	-	-	-	-			
1,3-Dichloropropane	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
1,2-Dibromoethane	**		-				-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichloropropane	0.04		-				-	-	-	-	-	-	-	-	-	-	-			
1,2,4-Trichlorobenzene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
Naphthalene	10 GV		-				-	-	-	-	-	-	-	-	-	-	-			
1,2,3-Trichlorobenzene	5 POS		-				-	-	-	-	-	-	-	-	-	-	-			
TOTAL	**	409030	-	983610	1083110		-	-	-	-	-	-	-	-	-	-	-	881850	29910	575600
Chloride (mg/L)		-	-	1008 D	-	1820 D	-	-	-	-	-	-	-	-	-	-	-	930 D	479 D	2000 D
Sulfate (mg/L)		-	-	256 D	-	464 D	-	-	-	-	-	-	-	-	-	-	-	132 D	59.8 D	201 D
Sulfide (mg/L)		-	-	ND	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (mg/L)		-	-	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Phosphate (mg/L)		-	-	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Nitrate (mg/L)		-	-	ND	-	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Alkalinity (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methane (ug/L)		-	-	-	74	202 D	-	-	-	-	-	-	-	-	-	-	-	510 D	1440 D	390 D
Ethane (ug/L)		-	-	-	19	34.4	-	-	-	-	-	-	-	-	-	-	-	68.9 D	145 D	38.6 D
Ethene (ug/L)		-	-	-	28	67.6 D	-	-	-	-	-	-	-	-	-	-	-	51.5 D	61.2 D	125 D
Total Dissolved Solids (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (mg/L)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lactic Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Acetic Acid (mg/L)		-	-	706 D	554 D	539 D	-	-	-	-	-	-	-	-	-	-	-	608 D	ND	559 D
Propionic Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Formic Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Butyric Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Pyruvic Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
Valeric Acid (mg/L)		-	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND
ORP		-30.4	-	-58.4	-1.3	55	-	-	-	-	-	-	-	-	-	-	-	-25.0	-135.7	-107.4
Dissolved Oxygen (mg/L)		1.32	-	3.23	2.48	0.39	-	-	-	-	-	-	-	-	-	-	-	0.30	2.47	-0.47
pH		6.21	-	6.24	5.85	5.69	-	-	-	-	-	-	-	-	-	-	-	5.92	9.80	6.13
Turbidity (NTU)		-0.5	-	7.3	8.8	9.8	-	-	-	-	-	-	-	-	-	-	-	17.9	56.6	15.2
Temp (Degree-C)		23.00	-	18.92	19.12	17.51	-	-	-	-	-	-	-	-	-	-	-	19.85	19.79	20.26
Conductivity		3.447	-	2.544	6.427	6.65	-	-	-	-	-	-	-	-	-	-	-	6.537	2.334	6.218

Notes:
Groundwater standards from NYSDEC TOGS 1.1.1, GA standards.
**: No standard referenced.
Results in ug/L (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
- = Analysis not completed.

TABLE 5
PILOT TEST SOIL ANALYTICAL RESULTS

75-20 Astoria Boulevard
Jackson Heights, NY

Compound	**NYS Soil Guidance Value**	**GW-8**		**GW-32**		**GW-33**	
		25' 03/15/04	**60'-62' 05/18/04**	**10'-15' 08/09/06**	**20'-25' 08/09/06**	**20'-25' 08/09/06**	**25'-30' 08/09/06**
Chloromethane							
Vinyl Chloride	200						
Bromomethane							
Chloroethane	1900					47	
1,1-Dichloroethene	400	**7100**					
Acetone	200			360 B	470 B	200 B	410 B
Carbon Disulfide	2700			20 J	6.5 J	7.6 J	16 J
Methylene Chloride	100			13 J			
trans-1,2-Dichloroethene							
1,1-Dichloroethane	200	**11000**	27		47	260	18 J
2-Butanone				64 JB	150 B	58 JB	1200 B
Carbon Tetrachloride							
cis-1,2-Dichloroethene	**					10 J	
Chloroform	300						
1,1,1-Trichloroethane	800	**2100000**	17		11 J	13 J	
Benzene	60						
1,2-Dichloroethane	100				6.1 J		
Trichloroethene	700	**6200**			15 J	24 J	
1,2-Dichloropropane							
Bromodichloromethane							
4-Methyl-2-Pentanone							
Toluene	1500						
t-1,3-Dichloropropene							
cis-1,3-Dichloropropene							
1,1,2-Trichloroethane							
2-Hexanone							
Dibromochloromethane							
Tetrachloroethene	1400	**2700**		34	37	45	
Chlorobenzene							
Ethyl Benzene	5500						
m/p-Xylenes	1200						
o-Xylene	1200						
Styrene							
Bromoform							
1,1,2,2-Tetrachloroethane							
TOTAL	10000	2127000	44	67	122.6	406.6	34

Notes:
Soil guidance values for NYSDEC TAGM 4046, Table 1, Rec. Soil Cleanup Objective
**: No soil guidance value identified for compound
Results in ug/Kg (ppb)
Bold = Exceeds the applicable NYS groundwater standard/GV.
NS = Not sampled.
ND = Not detected at laboratory detection limit.
J = Concentration identified is estimated.
D = Concrentration identifed is from diluted sample.
B = Analyte Found in Blank Sample

TABLE 6
PILOT TEST TREATMENT SCHEDULE

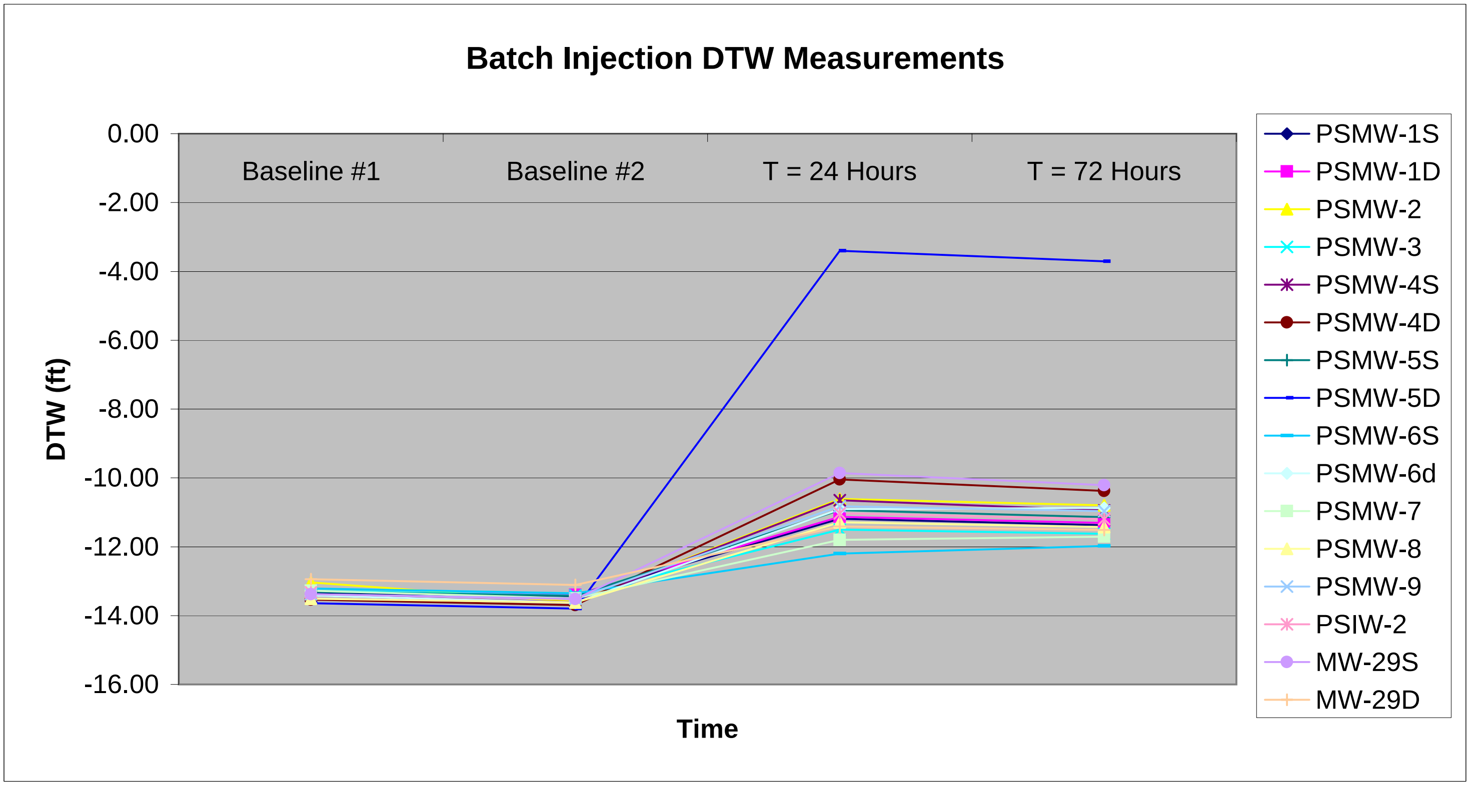
75-20 Astoria Boulevard
Jackson Heights, NY

Pilot Treatment Phase	**Timeframe**	**Injection Rate**	**Groundwater Monitoring Dates**
Basline Monitoring	September 2005	-	9/12/05 and 9/26/05
Phase 1 - Initial Batch Injection	October 2005 through November 2005	2,800 gallons between 10/17/05 and 10/31/05	11/8/05, 11/14/05 and 11/21/05
Phase 2 - Recirculation from MW-29D into PSIW-1	February 10, 2006 through March 30, 2006	0.10 gpm	3/1/06, 3/15/06 and 3/28/06
Phase 3 - Recirculation from PSMW-6D into PSIW-1	April 4, 2006 through June 1, 2006	0.06 gpm	4/12/06, 4/28/06, 5/1/06 and 5/25/06
Phase 4 - Recirculation from MW-29S into PSIW-1	June 1, 2006 through July 19, 2006	0.04 gpm	6/7/06, 6/22/06, 7/5/06 and 7/19/06
Post-Injection Monitoring	August 2006 through October 2006	-	8/1/06, 9/6/06 and 10/17/06

TABLE 7
BATCH INJECTION DEPTH TO WATER MEASUREMENTS

75-20 Astoria Boulevard
Jackson Heights

Well ID / Time	**Baseline #1**	**Baseline #2**	**T = 24 Hours**	**T = 72 Hours**
PSMW-1S	13.34	13.44	11.19	11.37
PSMW-1D	13.30	13.40	11.13	11.31
PSMW-2	13.04	13.60	10.61	10.80
PSMW-3	13.28	13.42	11.50	11.62
PSMW-4S	13.42	13.61	10.65	10.95
PSMW-4D	13.54	13.70	10.04	10.38
PSMW-5S	13.31	13.43	10.94	11.14
PSMW-5D	13.64	13.80	3.40	3.71
PSMW-6S	13.21	13.35	12.20	11.98
PSMW-6d	13.42	13.62	10.91	10.87
PSMW-7	13.28	13.50	11.80	11.71
PSMW-8	13.51	13.62	11.29	11.43
PSMW-9	13.38	13.51	10.82	10.96
PSIW-2	13.32		11.03	11.20
MW-29S	13.38	13.52	9.86	10.21
MW-29D	12.94	13.11	11.41	11.51



APPENDIX A

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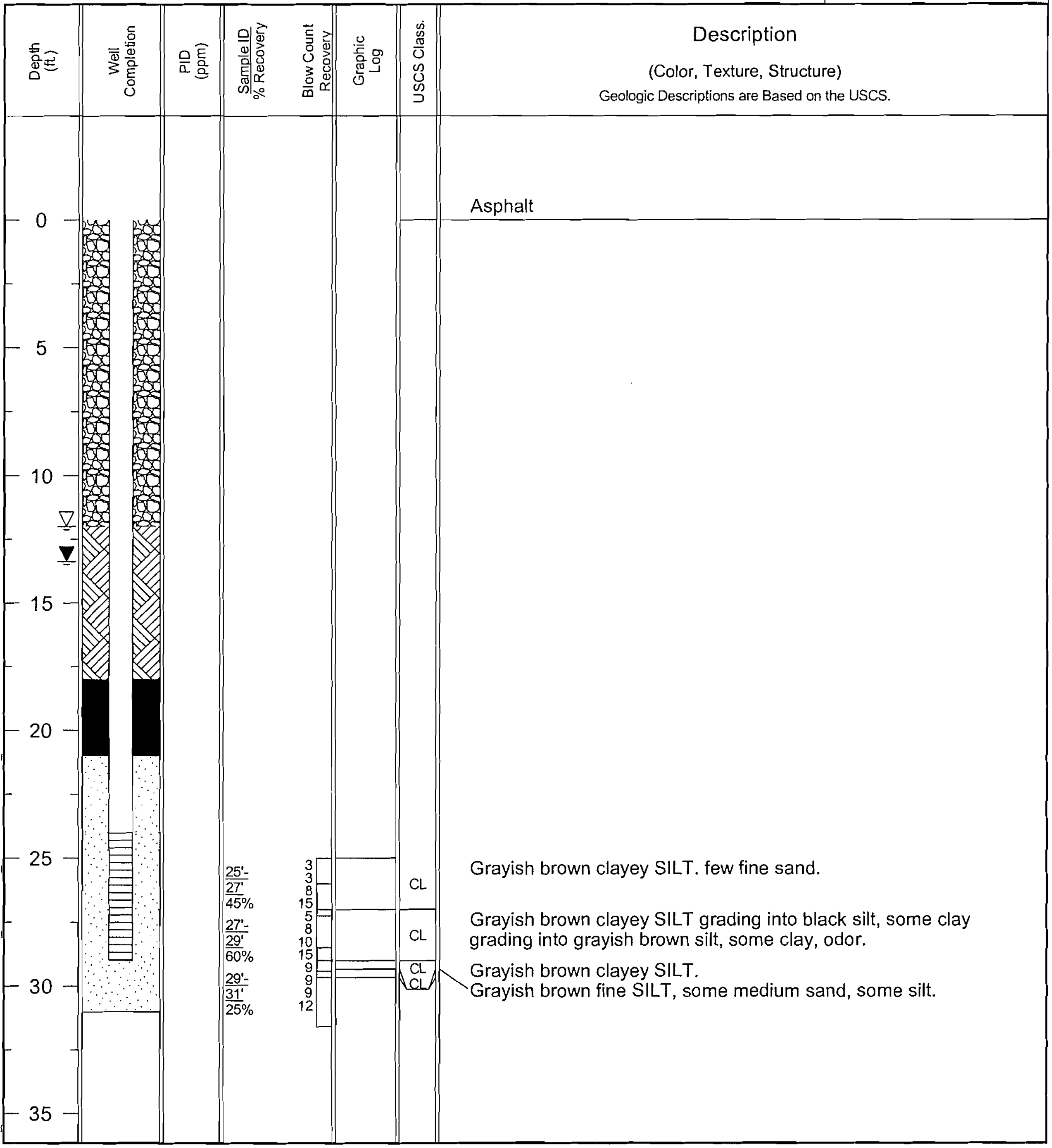
Drilling Log

Monitoring Well **MW-29S**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *31.0 ft.* North ____ East ____
Top of Casing *NA* Water Level Initial ∇ *12.0 ft.* Static ▼ *13.4 ft.* Diameter *9 in.*
Screen: Dia *4 in.* Length *5 ft.* Type/Size *20 Slot*
Casing: Dia *4 in.* Length *24 ft.* Type *PVC*
Fill Material *Grout/Sand* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *J. Ferngren* Date *10/12/04* Permit # *NA*
Checked By *E. Gustafson* License No. ____

COMMENTS



Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt
25			25'- 27' 45%	3 3 8 15		CL	Grayish brown clayey SILT. few fine sand.
			27'- 29' 60%	5 8 10 15		CL	Grayish brown clayey SILT grading into black silt, some clay grading into grayish brown silt, some clay, odor.
30			29'- 31' 25%	9 9 9 12		CL CL	Grayish brown clayey SILT. Grayish brown fine SILT, some medium sand, some silt.

IT_COMMERCIAL Rev. 2/23/00 B_JACKSON_HEIGHTS.GPJ IT_CORP.GDT 11/16/06

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Drilling Log

Monitoring Well **MW-29D**

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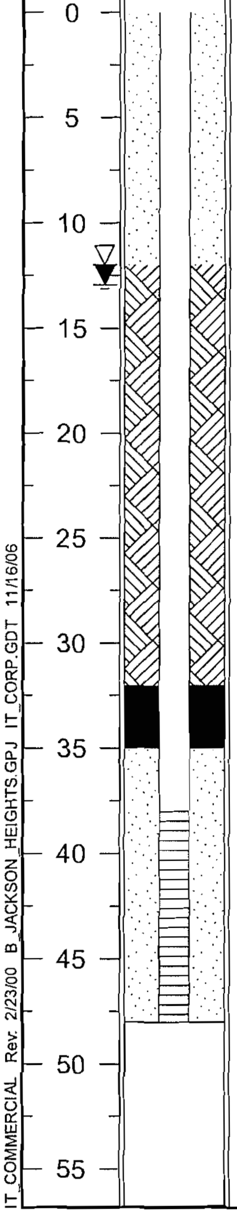
Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *48.0 ft.* North ____ East ____
Top of Casing *NA* Water Level Initial ∇ *12.0 ft.* Static ▼ *12.9 ft.* Diameter *16"/9" in.*
Screen: Dia *2 in.* Length *10 ft.* Type/Size *20 Slot*
Casing: Dia *2 in.* Length *38 ft.* Type *PVC*
Fill Material *Grout/Sand* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *J. Ferngren* Date *10/14/04* Permit # *NA*
Checked By *E. Gustafson* License No. ____

COMMENTS



Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt
38-40		0.0	38'-40' 40%	8 22 10 15		SM	Grayish brown fine and medium SAND, some silt, little coarse sand.
40-42		0.0	40'-42' 50%	12 14 16 22		SM	Same as above.
42-44		0.0	42'-44' 25%	8 5 12 20		SM	Same as above.
44-46		0.0	44'-46' 50%	12 46 12 20		SM	Same as above.
46-48		0.0	46'-48' 25%	8 8 15 30		SM	Same as above.

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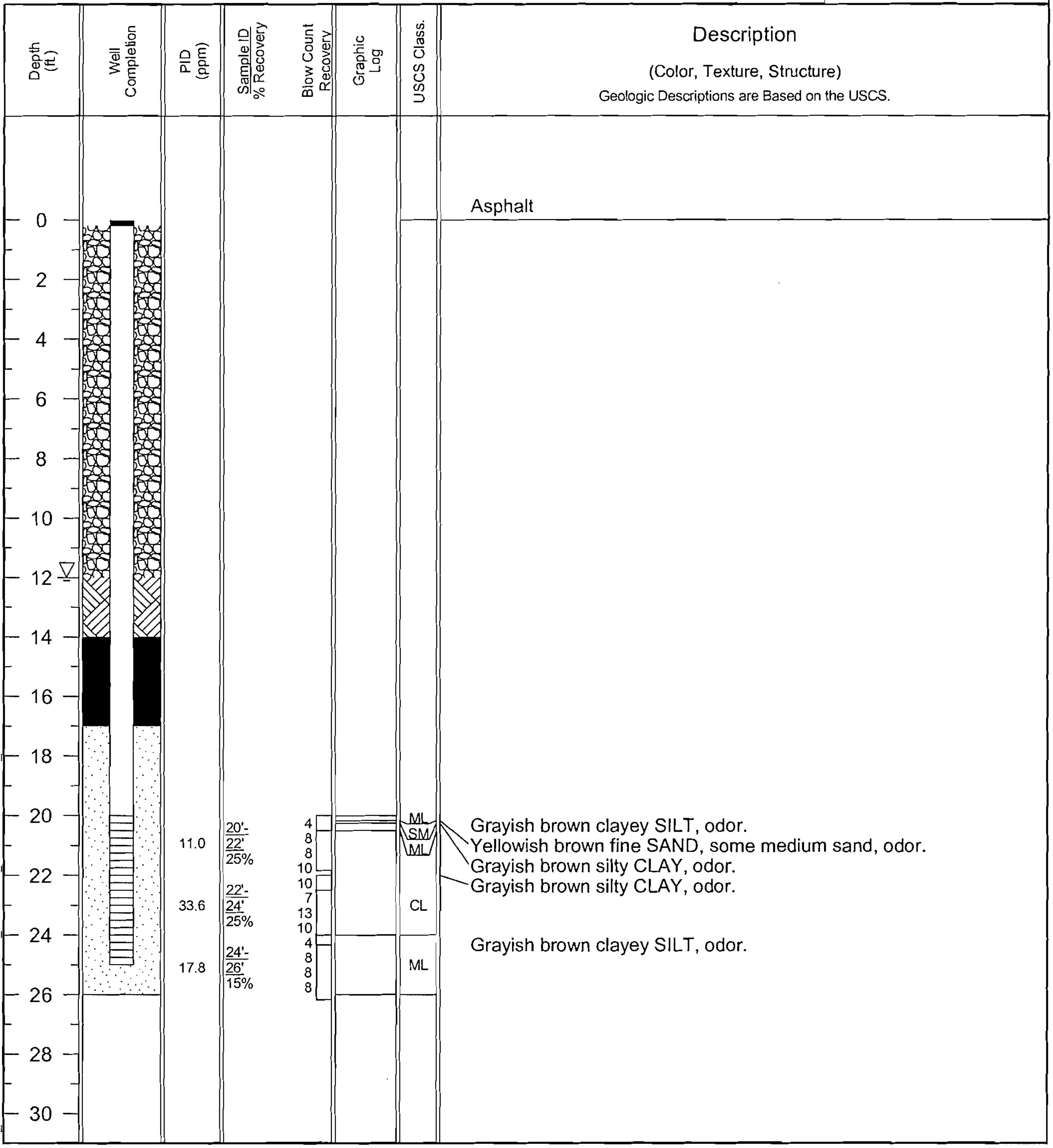
Drilling Log

Monitoring Well **MW-30S**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *26.0 ft.* North East
Top of Casing *NA* Water Level Initial ▽ *12.0 ft.* Static *NA* Diameter *9 in.*
Screen: Dia *4 in.* Length *5 ft.* Type/Size *20 Slot*
Casing: Dia *4 in.* Length *20 ft.* Type *PVC*
Fill Material *Grout/Sand* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *J. Ferngren* Date *10/13/04* Permit # *NA*
Checked By *E. Gustafson* License No.

COMMENTS



Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
20	11.0	20'-22' 25%	4 8 8 10	ML SM ML	Grayish brown clayey SILT, odor. Yellowish brown fine SAND, some medium sand, odor. Grayish brown silty CLAY, odor.
22	33.6	22'-24' 25%	10 7 13 10	CL	Grayish brown silty CLAY, odor.
24	17.8	24'-26' 15%	4 8 8 8	ML	Grayish brown clayey SILT, odor.

Shaw E & I, Inc.

Drilling Log

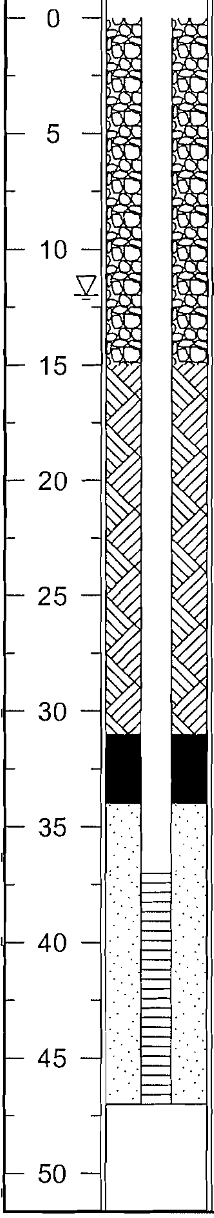
Monitoring Well **MW-30D**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *48.0 ft.* North East
Top of Casing *NA* Water Level Initial ∇ *12.0 ft.* Static *NA* Diameter *16"/9" in.*
Screen: Dia *2 in.* Length *10 ft.* Type/Size *20 Slot*
Casing: Dia *2 in.* Length *37 ft.* Type *PVC*
Fill Material *Grout/Sand* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *J. Ferngren* Date *10/19/04* Permit # *NA*
Checked By *E. Gustafson* License No.

COMMENTS

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Asphalt



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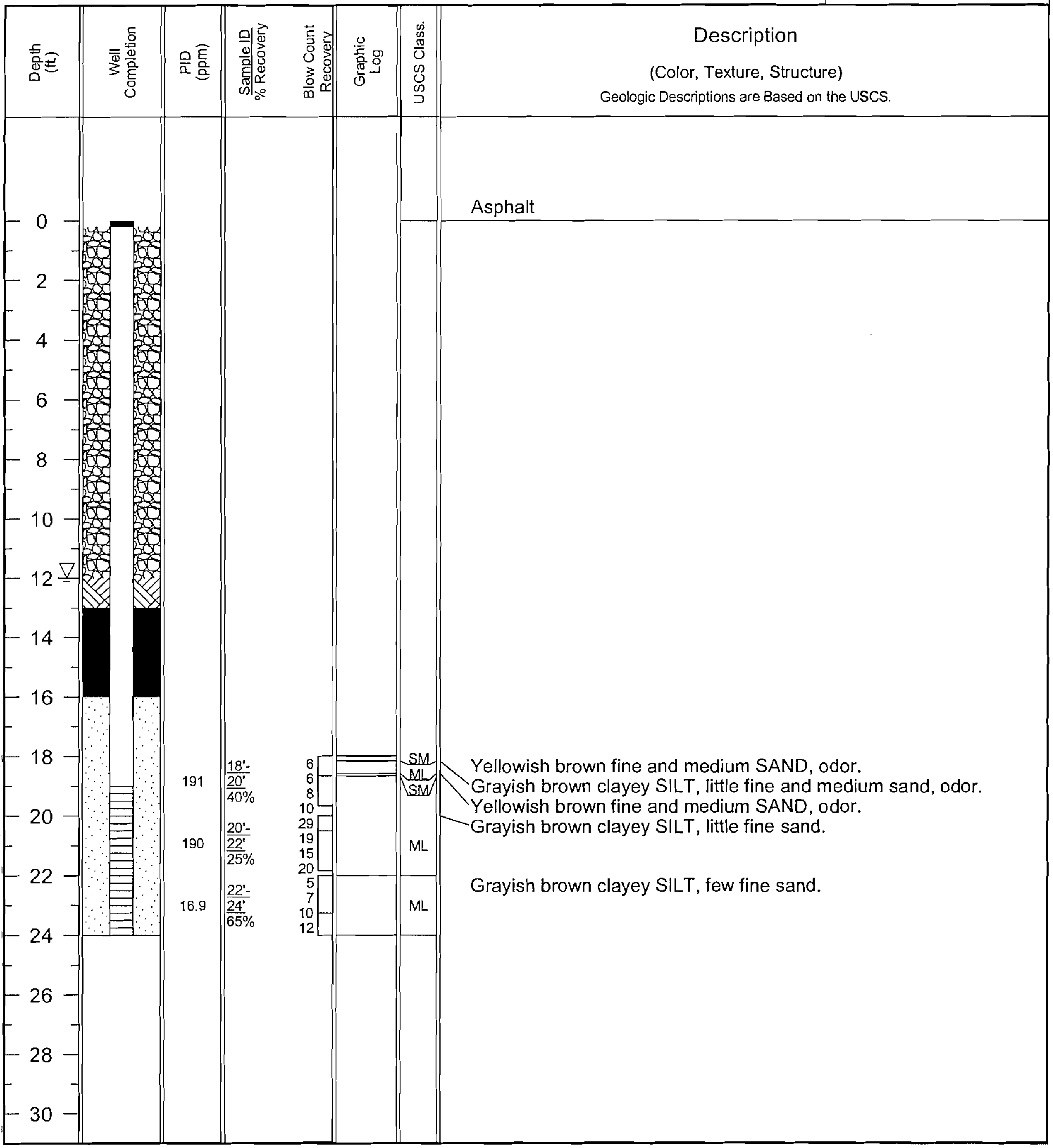
Drilling Log

Monitoring Well **MW-31S**

Page: 1 of 1

Project: *Bulova Corporate Center*
Owner: *Blumenfeld Development Group, Ltd.*
Location: *75-20 Astoria Blvd., Jackson Heights, NY 11370*
Proj. No.: *821687*
Surface Elev.: *NA*
Total Hole Depth: *24.0 ft.*
North:
East:
Top of Casing: *NA*
Water Level Initial: ∇ *12.0 ft.*
Static: *NA*
Diameter: *9 in.*
Screen: Dia: *4 in.*
Length: *5 ft.*
Type/Size: *20 Slot*
Casing: Dia: *4 in.*
Length: *19 ft.*
Type: *PVC*
Fill Material: *Grout/Sand*
Rig/Core: *Canterra*
Drill Co.: *Fenley & Nicol Enviro, Inc.*
Method: *HSA*
Driller: *C. Guzzardo*
Log By: *J. Ferngren*
Date: *10/13/04*
Permit #: *NA*
Checked By: *E. Gustafson*
License No.:

COMMENTS



Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
18'-20'	191	18'-20' 40%	6 6 8 10	SM ML SM ML	Yellowish brown fine and medium SAND, odor. Grayish brown clayey SILT, little fine and medium sand, odor. Yellowish brown fine and medium SAND, odor. Grayish brown clayey SILT, little fine sand.
20'-22'	190	20'-22' 25%	29 19 15 20	ML	
22'-24'	16.9	22'-24' 65%	5 7 10 12	ML	Grayish brown clayey SILT, few fine sand.

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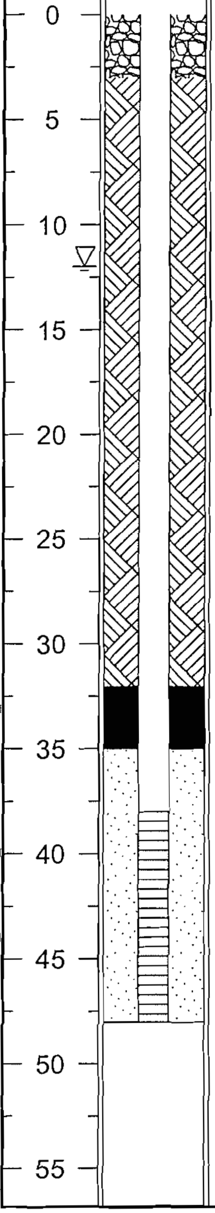
Drilling Log

Monitoring Well **MW-31D**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *48.0 ft.* North ____ East ____
Top of Casing *NA* Water Level Initial ∇ *12.0 ft.* Static *NA* Diameter *9 in.*
Screen: Dia *2 in.* Length *10 ft.* Type/Size *20 Slot*
Casing: Dia *2 in.* Length *38 ft.* Type *PVC*
Fill Material *Grout/Sand* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *J. Ferngren* Date *10/15/04* Permit # *NA*
Checked By *E. Gustafson* License No. ____

COMMENTS



Depth (ft)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
							Asphalt
		1.7	38'-40' 10%	7 10 15 25		SM	Grayish brown fine and medium SAND. some silt, little coarse sand.
		0.0	40'-42' 10%	20 28 15 20		SM	Same as above.
		57.9	42'-44' 15%	20 40 50 65		SM	Same as above.
		0.0	44'-46' 15%	20 32 20 35		SM	Same as above.
		118.0	46'-48' 25%	24 18 38 60		SM	Same as above. odor.

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Drilling Log

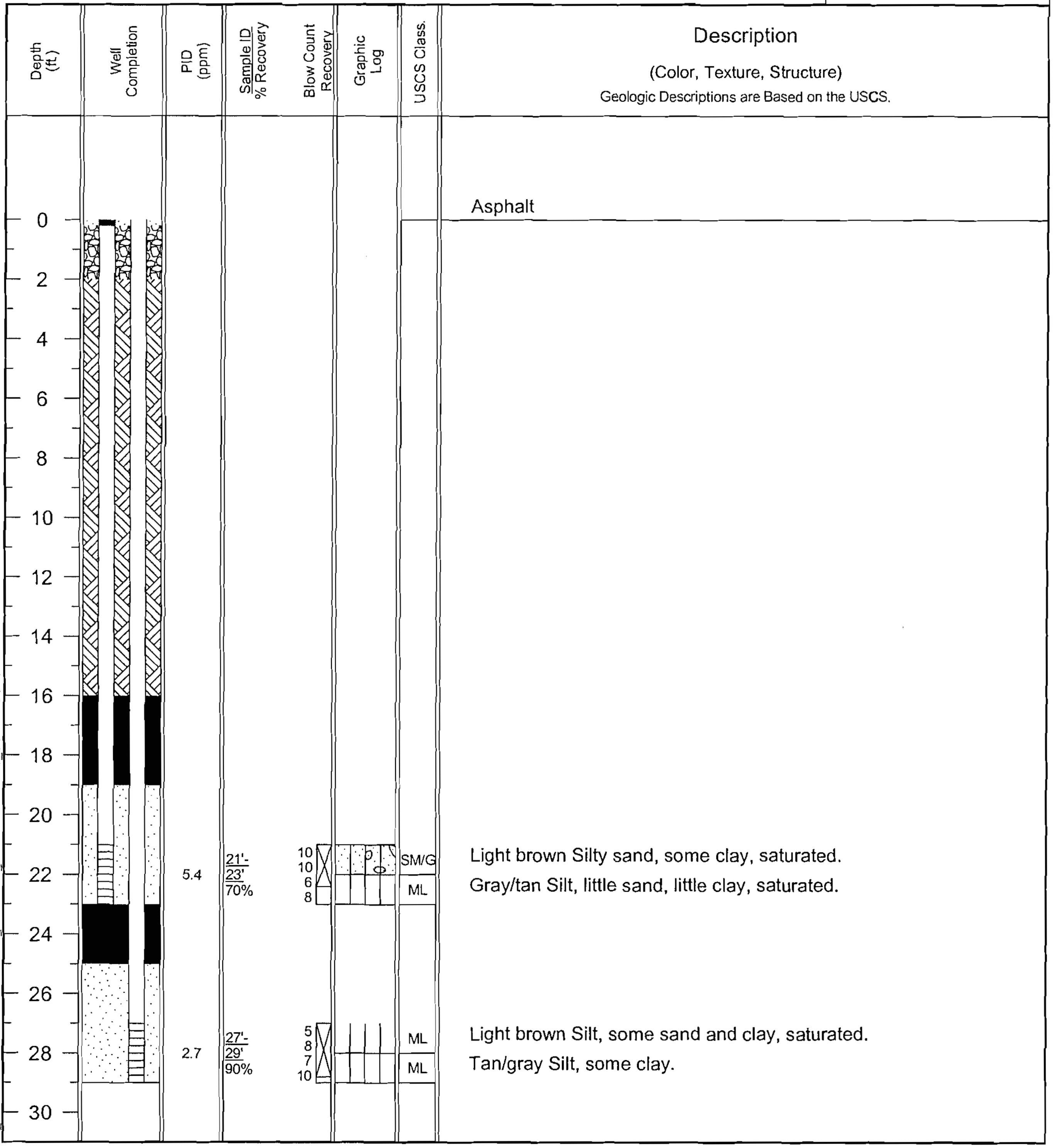
Shaw E & I, Inc.

Monitoring Well **PSMW-1**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *29.0 ft.* North East
Top of Casing *NA* Water Level Initial *NA* Static *13.34/13.30* Diameter *9 in.*
Screen: Dia *2 in.* Length *2'/2' ft.* Type/Size *10 Slot/2 in.*
Casing: Dia *2 in.* Length *21'/27' ft.* Type *PVC*
Fill Material *Sand/Bentonite/Grout* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *M. Bernstein* Date *8/23/05* Permit # *NA*
Checked By *E. Gustafson* License No.

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
21–23	5.4	21'- 23' 70%	10 10 6 8	SM/G	Light brown Silty sand, some clay, saturated.
				ML	Gray/tan Silt, little sand, little clay, saturated.
27–29	2.7	27'- 29' 90%	5 8 7 10	ML	Light brown Silt, some sand and clay, saturated.
				ML	Tan/gray Silt, some clay.

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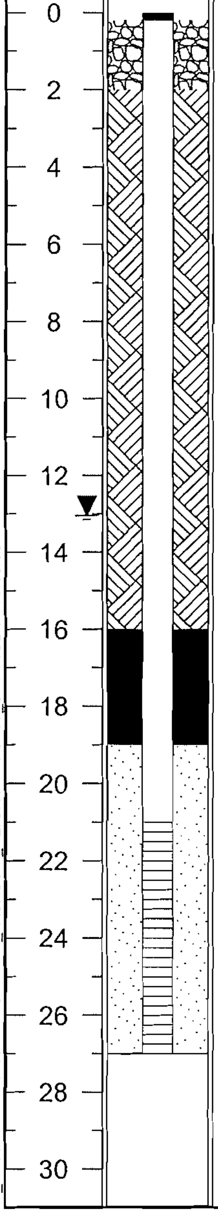
Drilling Log

Monitoring Well **PSMW-2**

Page: 1 of 1

Project Bulova Corporate Center
Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370
Proj. No. 821687
Surface Elev. NA
Total Hole Depth 27.0 ft.
North
East
Top of Casing NA
Water Level Initial NA
Static ▼ 13.0 ft.
Diameter 9 in.
Screen: Dia 2 in.
Length 6 ft.
Type/Size 10 Slot/2 in.
Casing: Dia 2 in.
Length 21 ft.
Type PVC
Fill Material Sand/Bentonite/Grout
Rig/Core Canterra
Drill Co. Fenley & Nicol Enviro, Inc.
Method HSA
Driller C. Guzzardo
Log By M. Bernstein
Date 8/23/05
Permit # NA
Checked By E. Gustafson
License No.

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
22	4.0	21'-23' 85%		MLS	Dark brown sand, some silt, some clay, saturated, slight odor.
				ML	Tan/gray Silt, some clay, saturated.
24	1.8	23'-25' 90%		ML	Dark brown Silt, some sand, some clay, saturated.
				ML	Tan/gray Silt, some clay.
26	0.5	25'-27' 90%		ML	Gray/tan Sil, some clay, little sand.

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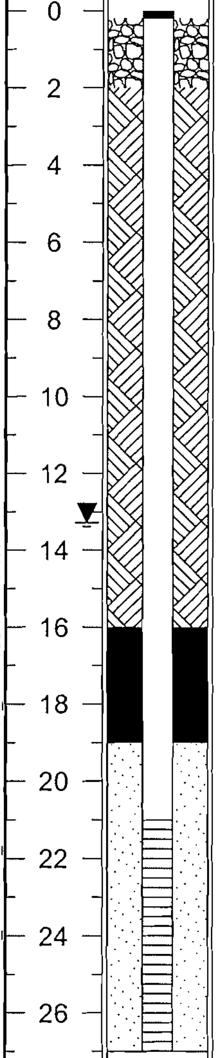
Drilling Log

Monitoring Well **PSMW-3**

Page: 1 of 1

Project Bulova Corporate Center Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370 Proj. No. 821687
Surface Elev. NA Total Hole Depth 27.0 ft. North East
Top of Casing NA Water Level Initial NA Static ▼ 13.3 ft. Diameter 9 in.
Screen: Dia 2 in. Length 6 ft. Type/Size 10 Slot/2 in.
Casing: Dia 2 in. Length 21 ft. Type PVC
Fill Material Sand/Bentonite/Grout Rig/Core Canterra
Drill Co. Fenley & Nicol Enviro, Inc. Method HSA
Driller C. Guzzardo Log By M. Bernstein Date 8/24/05 Permit # NA
Checked By E. Gustafson License No.

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
13.3 ▼					
21		21'-23' 75%		SC/CL	Dark brown Silty Sand, some clay, saturated.
22	2.1			ML	Tan/gray Silt, some clay, saturated.
23		23'-25' 70%	8 15	ML	Dark brown Sand, some silt, some clay, saturated.
24	3.7		23 30	ML	Tan/gray Silt, some clay, saturated.
25		25'-27' 70%	4 6	ML	Dark brown Silt, some sand, some clay, saturated.
26	4.0		10 15	ML	Gray/tan Silt, some clay, saturated.

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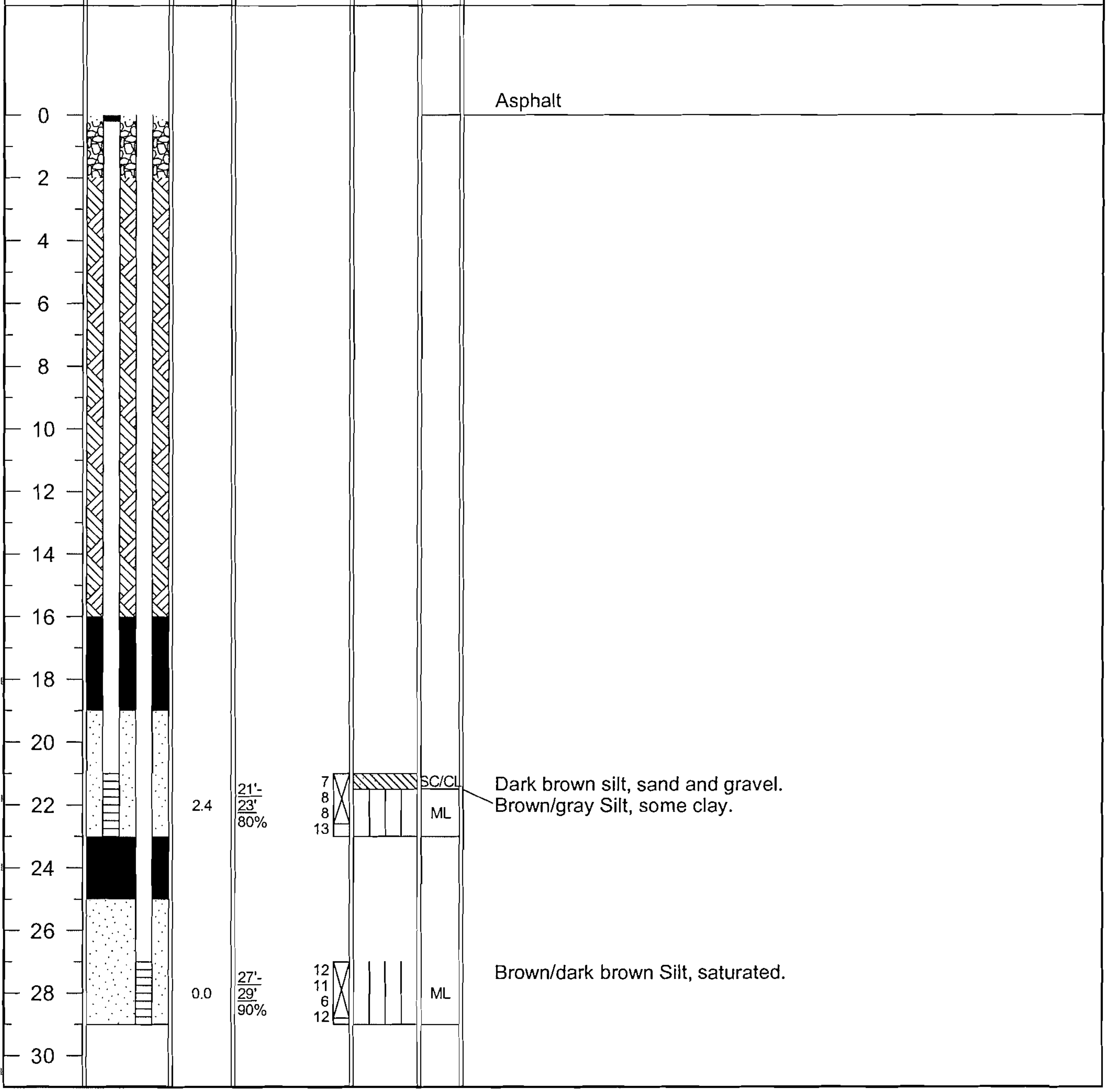
Drilling Log

Monitoring Well **PSMW-4**

Page: 1 of 1

Project Bulova Corporate Center Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370 Proj. No. 821687
Surface Elev. NA Total Hole Depth 29.0 ft. North East
Top of Casing NA Water Level Initial NA Static 13.42/13.54 Diameter 9 in.
Screen: Dia 2 in. Length 2'/2' ft. Type/Size 10 Slot/2 in.
Casing: Dia 2 in. Length 21'/27' ft. Type PVC
Fill Material Sand/Bentonite/Grout Rig/Core Canterra
Drill Co. Fenley & Nicol Enviro, Inc. Method HSA
Driller C. Guzzardo Log By M. Bernstein Date 8/26/05 Permit # NA
Checked By E. Gustafson License No.

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
21			7	SC/CL	Dark brown silt, sand and gravel.
22	2.4	21'-23' 80%	8 8 13	ML	Brown/gray Silt, some clay.
28	0.0	27'-29' 90%	12 11 6 12	ML	Brown/dark brown Silt, saturated.

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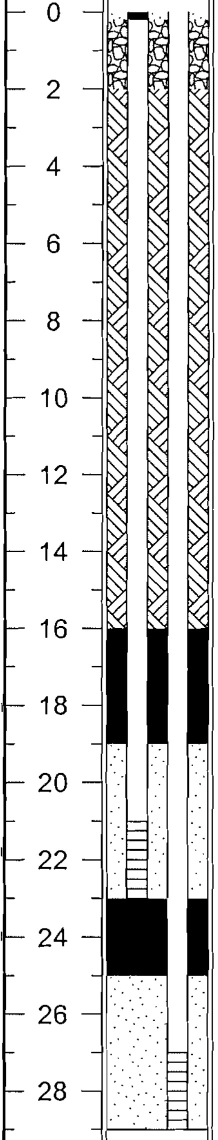
Drilling Log

Monitoring Well **PSMW-5**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *29.0 ft.* North East
Top of Casing *NA* Water Level Initial *NA* Static *13.31/13.64* Diameter *9 in.*
Screen: Dia *2 in.* Length *2'/2' ft.* Type/Size *10 Slot/2 in.*
Casing: Dia *2 in.* Length *21'/27' ft.* Type *PVC*
Fill Material *Sand/Bentonite/Grout* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *M. Bernstein* Date *8/26/05* Permit # *NA*
Checked By *E. Gustafson* License No.

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0						Asphalt
22	5.7	21'-23' 85%	8 6 10 16	ǀǀǀ	ML	Brown/gray Clay, some silt.
28	0.6	27'-29' 100%	9 5 6 14	ǀǀǀ	ML	Brown/dark brown/black Clay, some silt, trace gravel.

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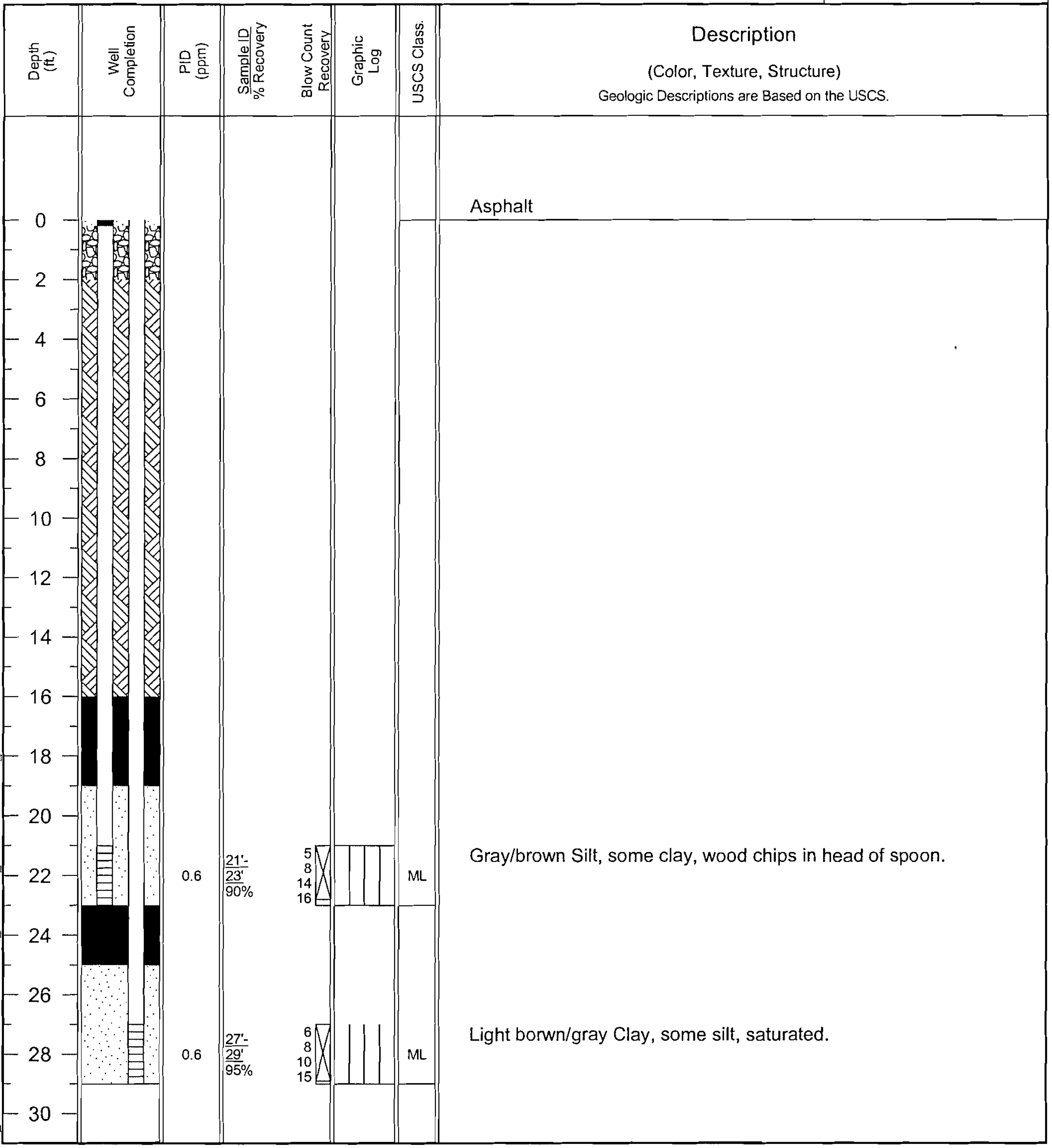
Drilling Log

Monitoring Well **PSMW-6**

Page: 1 of 1

Project	*Bulova Corporate Center*			Owner	*Blumenfeld Development Group, Ltd.*		
Location	*75-20 Astoria Blvd., Jackson Heights, NY 11370*			Proj. No.	*821687*		
Surface Elev.	*NA*	Total Hole Depth	*29.0 ft.*	North		East	
Top of Casing	*NA*	Water Level Initial	*NA*	Static	*13.21/13.42*	Diameter	*9 in.*
Screen: Dia	*2 in.*	Length	*2'/2' ft.*	Type/Size	*10 Slot/2 in.*		
Casing: Dia	*2 in.*	Length	*21'/27' ft.*	Type	*PVC*		
Fill Material	*Sand/Bentonite/Grout*			Rig/Core	*Canterra*		
Drill Co.	*Fenley & Nicol Enviro, Inc.*	Method	*HSA*				
Driller	*C. Guzzardo*	Log By	*M. Bernstein*	Date	*8/25/05*	Permit #	*NA*
Checked By	*E. Gustafson*	License No.					

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
22	0.6	21'-23' 90%	5 8 14 16	ML	Gray/brown Silt, some clay, wood chips in head of spoon.
28	0.6	27'-29' 95%	6 8 10 15	ML	Light borwn/gray Clay, some silt, saturated.

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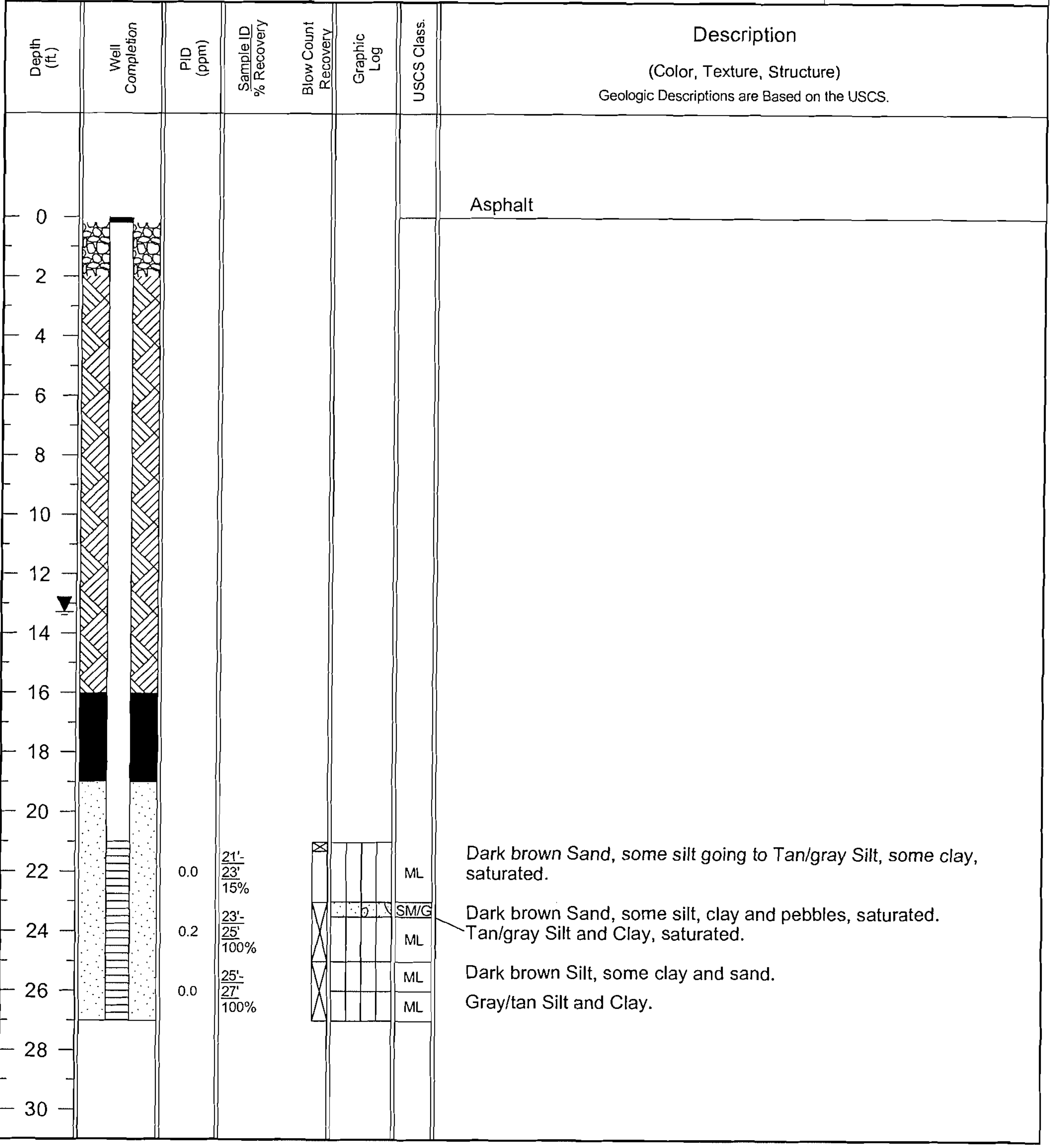
Drilling Log

Monitoring Well **PSMW-7**

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *27.0 ft.* North East
Top of Casing *NA* Water Level Initial *NA* Static ▼ *13.3 ft.* Diameter *9 in.*
Screen: Dia *2 in.* Length *6 ft.* Type/Size *10 Slot/2 in.*
Casing: Dia *2 in.* Length *21 ft.* Type *PVC*
Fill Material *Sand/Bentonite/Grout* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *M. Bernstein* Date *8/22/05* Permit # *NA*
Checked By *E. Gustafson* License No.

COMMENTS



Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt
22		0.0	21'-23' 15%			ML	Dark brown Sand, some silt going to Tan/gray Silt, some clay, saturated.
						SM/G	Dark brown Sand, some silt, clay and pebbles, saturated.
24		0.2	23'-25' 100%			ML	Tan/gray Silt and Clay, saturated.
						ML	Dark brown Silt, some clay and sand.
26		0.0	25'-27' 100%			ML	Gray/tan Silt and Clay.

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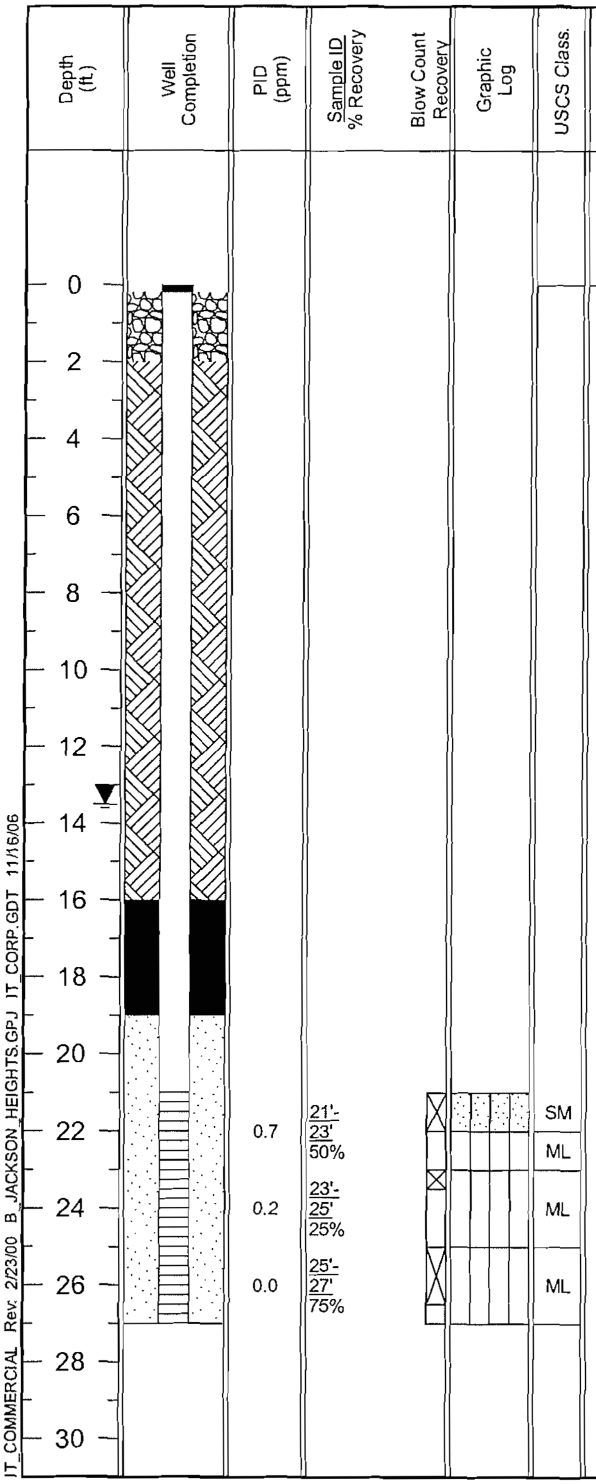
Drilling Log

Monitoring Well **PSMW-8**

Page: 1 of 1

Project *Bulova Corporate Center* Owner *Blumenfeld Development Group, Ltd.*
Location *75-20 Astoria Blvd., Jackson Heights, NY 11370* Proj. No. *821687*
Surface Elev. *NA* Total Hole Depth *27.0 ft.* North ____ East ____
Top of Casing *NA* Water Level Initial *NA* Static ▼ *13.5 ft.* Diameter *9 in.*
Screen: Dia *2 in.* Length *6 ft.* Type/Size *10 Slot/2 in.*
Casing: Dia *2 in.* Length *21 ft.* Type *PVC*
Fill Material *Sand/Bentonite/Grout* Rig/Core *Canterra*
Drill Co. *Fenley & Nicol Enviro, Inc.* Method *HSA*
Driller *C. Guzzardo* Log By *M. Bernstein* Date *8/22/05* Permit # *NA*
Checked By *E. Gustafson* License No. ____

COMMENTS



Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
21		21'-23' 50%		SM	Dark brown/black Silty Sand, saturated.
22	0.7			ML	Tan Clay, some silty sand, saturated.
23		23'-25' 25%		ML	Fine Sand and Silt to Dark brown Silty Clay, saturated.
24	0.2				
25		25'-27' 75%		ML	Dark brown Clay with fine sand to Silty Clay, saturated.
26	0.0				

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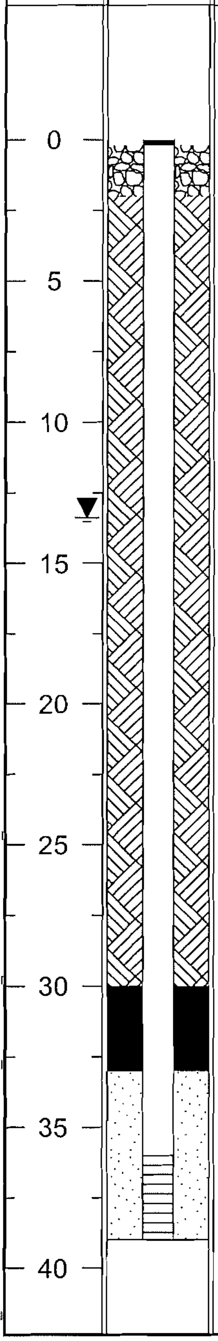
Drilling Log

Monitoring Well **PSMW-9**

Page: 1 of 1

Project Bulova Corporate Center
Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370
Proj. No. 821687
Surface Elev. NA
Total Hole Depth 40.0 ft.
North
East
Top of Casing NA
Water Level Initial NA
Static ▼ 13.4 ft.
Diameter 9 in.
Screen: Dia 2 in.
Length 3 ft.
Type/Size 10 Slot/2 in.
Casing: Dia 2 in.
Length 36 ft.
Type PVC
Fill Material Sand/Bentonite/Grout
Rig/Core Canterra
Drill Co. Fenley & Nicol Enviro, Inc.
Method HSA
Driller C. Guzzardo
Log By M. Bernstein
Date 8/29/05
Permit # NA
Checked By E. Gustafson
License No.

COMMENTS



Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt
		0.0	36'-38' 50%	22 11 18 20		SM	Light brown Silty Sand, saturated.
		0.0	38'-40' 10%	12 8 11 20		SM	Light brown Silty Sand, saturated.

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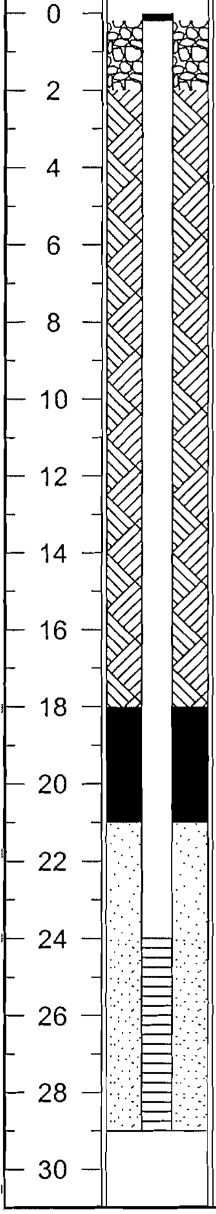
Drilling Log

Monitoring Well **PSIW-1**

Page: 1 of 1

Project: Bulova Corporate Center
Owner: Blumenfeld Development Group, Ltd.
Location: 75-20 Astoria Blvd., Jackson Heights, NY 11370
Proj. No.: 821687
Surface Elev.: NA
Total Hole Depth: 30.0 ft.
North:
East:
Top of Casing: NA
Water Level Initial: NA
Static: NA
Diameter: 9 in.
Screen: Dia: 4 in.
Length: 5 ft.
Type/Size: 20 Slot/4 in.
Casing: Dia: 4 in.
Length: 24 ft.
Type: PVC
Fill Material: Sand/Bentonite/Grout
Rig/Core: Canterra
Drill Co.: Fenley & Nicol Enviro, Inc.
Method: HSA
Driller: C. Guzzardo
Log By: M. Bernstein
Date: 8/24/05
Permit #: NA
Checked By: E. Gustafson
License No.:

COMMENTS



Depth (ft)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					Asphalt
24				MLS	Dark brown Sand with silt and clay.
24	1.6	24'-26' 100%	13 8 18 20	ML	Gray/tan Silt, some clay.
26	0.3	26'-28' 65%	7 9 12 20	ML	Gray/tan Silt, some clay, little sand, saturated.
28	0.4	28'-30' 15%	5 8 27 18	ML	Gray/tan Silt, some clay, saturated.

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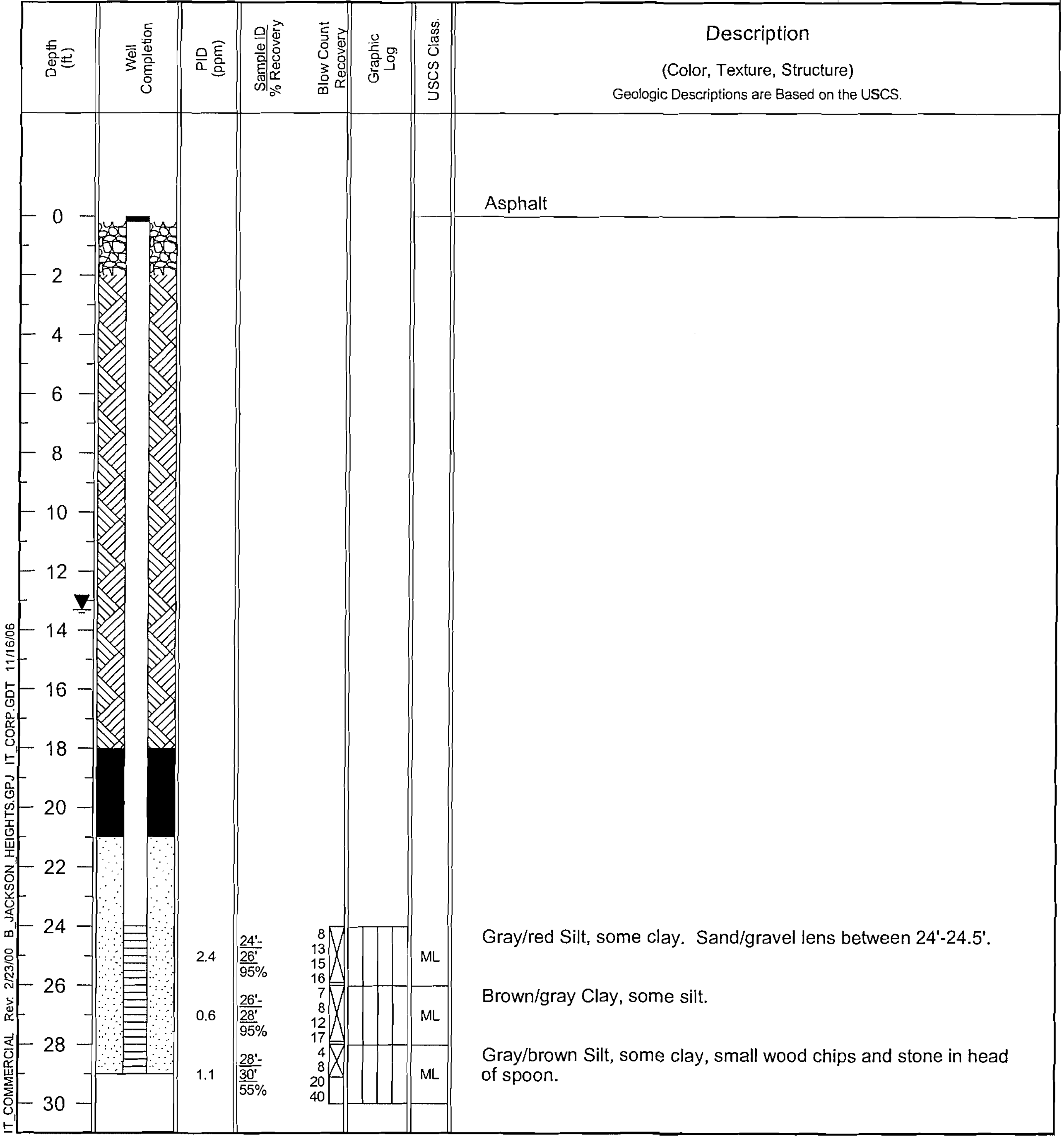
Drilling Log

Monitoring Well **PSIW-2**

Page: 1 of 1

Project Bulova Corporate Center
Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370
Proj. No. 821687
Surface Elev. NA
Total Hole Depth 30.0 ft.
North
East
Top of Casing NA
Water Level Initial NA
Static ▼ 13.3 ft.
Diameter 9 in.
Screen: Dia 4 in.
Length 5 ft.
Type/Size 20 Slot/4 in.
Casing: Dia 4 in.
Length 24 ft.
Type PVC
Fill Material Sand/Bentonite/Grout
Rig/Core Canterra
Drill Co. Fenley & Nicol Enviro, Inc.
Method HSA
Driller C. Guzzardo
Log By M. Bernstein
Date 8/25/05
Permit # NA
Checked By E. Gustafson
License No.

COMMENTS



Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt
24		2.4	24'-26' 95%	8 13 15 16		ML	Gray/red Silt, some clay. Sand/gravel lens between 24'-24.5'.
26		0.6	26'-28' 95%	7 8 12 17		ML	Brown/gray Clay, some silt.
28		1.1	28'-30' 55%	4 8 20 40		ML	Gray/brown Silt, some clay, small wood chips and stone in head of spoon.

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Drilling Log

Soil Boring **GW-32**

Page: 1 of 1

Project	Bulova Corporate Center	Owner	Blumenfeld Development Group, Ltd.				
Location	75-20 Astoria Blvd., Jackson Heights, NY 11370	Proj. No.	821687				
Surface Elev.	NA	Total Hole Depth	30.0 ft.	North		East	
Top of Casing	NA	Water Level Initial	NA	Static	NA	Diameter	3 in.
Screen: Dia	NA	Length	NA	Type/Size	NA		
Casing: Dia	NA	Length	NA	Type	NA		
Fill Material	Native	Rig/Core	Truck-Mounted				
Drill Co.	Fenley & Nicol Enviro, Inc.	Method	Geoprobe				
Driller		Log By	D. Downing	Date	8/9/06	Permit #	NA
Checked By	E. Gustafson	License No.					

COMMENTS
Sampled 10'-15' and 20'-25' for laboratory analysis.

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Asphalt
0						
2						
4						
6						
8						
10						Brick and fill material, some gray silty clay.
12	2000+	10'- 15' 70%			Fill	
14						
16						Gray Silt and Clay, little black silt.
18	5.0	15'- 20' 40%			ML	
20						Gray-brown clayey Silt.
22	7.6	20'- 25' 75%			ML	
24						
26						Grey Silt, little clay.
28	0.0	25'- 30' 80%			ML	
30						
32						

Shaw E & I, Inc.

Drilling Log

Soil Boring **GW-33**

Page: 1 of 1

Project Bulova Corporate Center
Owner Blumenfeld Development Group, Ltd.
Location 75-20 Astoria Blvd., Jackson Heights, NY 11370
Proj. No. 821687
Surface Elev. NA
Total Hole Depth 30.0 ft.
North
East
Top of Casing NA
Water Level Initial NA
Static NA
Diameter 3 in.
Screen: Dia NA
Length NA
Type/Size NA
Casing: Dia NA
Length NA
Type NA
Fill Material Native
Rig/Core Truck-Mounted
Drill Co. Fenley & Nicol Enviro, Inc.
Method Geoprobe
Driller
Log By D. Downing
Date 8/9/06
Permit # NA
Checked By E. Gustafson
License No.

COMMENTS
Sampled 20'-25' and 25'-30' for laboratory analysis.

Depth (ft.)	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Asphalt
0						
2						
4						
6						
8						
10						Brown and gray/black Silt and Fill material.
12	0.1	10'-15' 20%			Fill	
14						
16						Gray Silt and Clay.
18	0.0	15'-20' 75%			ML	
20						Gray and brown Clayey Silt.
22	0.0	20'-25' 75%			ML	
24						
26						Gray to Black Clayey Silt.
28	0.0	25'-30' 75%			ML	
30						
32						

APPENDIX B

Shaw® Shaw Environmental, Inc.

To: Mr. Robert Weber, Bulova Corporation

From: Charles Schaefer, Ph.D., Shaw Environmental, Inc.

Date: February 2, 2005

Subject: Laboratory Treatability Study Report to Assess Treatment Approaches for 1,1,1-TCA and 1,1-DCA at the Jackson Heights, NY Site

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Executive Summary

Laboratory treatability studies were performed to evaluate the use of anaerobic biostimulation and persulfate chemical oxidation for the treatment of TCA and DCA in Site soil and groundwater. Results are summarized as follows:

Persulfate Chemical Oxidation

Persulfate addition with heat and caustic activation was ineffective for treatment of TCA in the Source Area soil. The high soil oxidant demand and buffering capacity appear to have reduced the efficacy of this treatment approach.

Anaerobic Biostimulation

Source Area Soil

Lactate and nutrient amendments were effective for stimulating biological degradation of TCA and DCA in the Source Area soil. No accumulation of CA, a potential TCA and DCA dechlorination daughter product, was observed in the study. However, the TCA and DCA degradation pathway(s) were not determined, and final degradation products could not be identified. Based on TCA and DCA degradation rates measured in the laboratory , roughly 6 to 10 years of treatment would be needed to attain remedial objectives of 5 µg/L TCA and 5 µg/L DCA in the Source Area.

Lactate and nutrient amendments at elevated (30 degrees C) temperature in the Source Area soil resulted in relatively rapid degradation of TCA and DCA. However, CA accumulated in the treatment, as TCA and DCA degraded via reductive chlorination to CA. It is unclear why the TCA and DCA degradation mechanisms at 30°C differed from those observed in the 15°C study, and the rate at which CA was degrading to ethane was not determined.

Underlying Sand

EOS (an emulsified vegetable oil product) was effective for stimulating biological degradation of TCA and DCA in the underlying sand. However, TCA and DCA degradation resulted in accumulation of CA, as CA degradation to ethane proceeded slowly (at best).

I. Introduction

A laboratory treatability study was performed on soil and groundwater collected from the Site located at 75-20 Astoria Boulevard in Jackson Heights, New York (the Site). The treatability study was performed by Shaw Environmental, Inc. (Shaw) in their Biotechnology Center located in Lawrenceville, New Jersey.

The overall goal of the study was to evaluate the use of persulfate chemical oxidation and anaerobic biostimulation for treatment of 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA). Treatment of chloroethane (CA), a potential daughter product of TCA degradation, and chlorinated ethenes (e.g., tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride (VC)) were also evaluated.

The following tasks were performed as part of the laboratory treatability study:

- Anaerobic biostimulation screening study (30 degrees C)
- Chemical oxidation using persulfate
- Anaerobic biostimulation study (15 degrees C)

The above listed tasks were performed on soil and groundwater collected between approximately 26 ft. bgs and 31 ft. bgs near soil boring GW-8. This location corresponds to a clayey-silt zone where elevated TCA and DCA soil concentrations have been observed (i.e., the Source Area). In addition, the anaerobic biostimulation study (15 degrees C) also was performed on underlying (same borehole) soil and groundwater collected from approximately 32 ft. bgs to 48 ft. bgs. All soil and groundwater samples were collected in May, 2004[1].

The following sections of this technical memorandum describe initial soil and groundwater homogenization and testing, provide details of the laboratory methods, present results and conclusions of the study, and briefly discuss potential implications to pilot and/or full-scale implementation.

II. Laboratory Methods

Sample Homogenization and Initial Characterization

Homogenization of collected groundwater was performed in a Coy Anaerobic Chamber. Groundwater was poured from the sample collection bottles into two 4L glass flasks. Once all of the groundwater was transferred to the 2 flasks, the water within the flasks was agitated gently by hand to facilitate mixing. The homogenized groundwater was then poured into 1L amber glass sample bottles with Teflon-lined caps and stored at 4°C until microcosm setup. Homogenized groundwater were taken at this time for initial VOC analysis via EPA Method 8260. This initial analysis was performed to ensure VOC levels were sufficient to perform the treatability study.

Homogenization was performed in the same manner for groundwater collected from both the Source Area soils and the Underlying Sand.

Homogenization of the collected Site soils was also performed in the Coy Anaerobic Chamber. Metal pans were sterilized with ethanol and dried prior to placement in the anaerobic chamber. Sediments were removed from the sample collection bottles and placed on to the metal pans. Sediments were then thoroughly mixed by hand until the soils were visibly homogeneous. The homogenized soils were then placed into a 4L glass jar sealed with a Teflon-lined cap and stored at 4°C until microcosm setup. Three separate samples (approximately 10 g each) of the homogenized sediments were collected for initial VOC analysis.

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[1] Groundwater samples were, to the extent possible, collected under a nitrogen blanket in order to limit the intrusion of air into the sample. Soil cores, collected in Shelby tubes, were sealed in the field to limit intrusion of air into the soil prior to initiation of the laboratory study.

Homogenization was performed in the same manner for both the Source Area soils and the Underlying Sand.

Anaerobic Biostimulation of Source Area (clayey silt) Soil - 15° C
Microcosms were prepared in glass serum bottles (approximate volume, 160 mL). All microcosm preparation and sampling was performed in an anaerobic chamber. Thirty grams of homogenized Source Area soil and 110-mL of groundwater were added to each of the bottles. Based on VOC analysis of the homogenized soil and groundwater, no contaminant spike was necessary. The bottles were sealed with Teflon®-lined butyl rubber stoppers and crimp caps. Three additional microcosm bottles were prepared for initial microcosm groundwater and soil analysis.

Four sets of microcosm treatments were prepared in triplicate as follows:

Treatment 1: KILLED CONTROL - These bottles were amended with a formaldehyde solution (final concentration in groundwater approximately 1% by volume) to inhibit microbial activity, and were used to evaluate abiotic loss of VOCs;

Treatment 2: LIVE CONTROL - These bottles did not receive any amendments except for 1 ml of deionized water (to simulate addition of amendments performed for the other treatments). This treatment served as a control to monitor VOC loss in the absence of any amendments;

Treatment 3: ETHANOL (Biostimulation treatment) - 2 ml of an inorganic nutrient solution (nitrogen and phosphorous) was added to eliminate potential nutrient limitations. Bottles were also be amended with ethanol to serve as the electron donor. Ethanol was added such that a final concentration of 250 mg/L was attained. This treatment was used to evaluate the effects of anaerobic biostimulation on contaminant biodegradation; and

Treatment 4: LACTATE (Biostimulation treatment) - 2 ml of inorganic nutrient solution (nitrogen and phosphorous) was added eliminate potential nutrient limitations. Bottles were also amended with lactate to serve as the electron donor. Lactate was added such that a final concentration of 1000 mg/L was attained. This treatment was used to evaluate the effects of anaerobic biostimulation on contaminant biodegradation.

The three additional bottles (no amendments) prepared for initial analysis were analyzed for VOCs. Microcosm bottles were shaken for approximately 24 hours at 15°C to thoroughly mix soil and groundwater, then the bottles prepared for initial analysis were removed from the shaker and placed in the anaerobic chamber and allowed to settle. Aqueous samples were subsequently collected for VOC analysis. The sediment in the bottles was extracted twice with methanol and analyzed for VOCs. These initial analyses were used to evaluate baseline conditions and to determine the mass of undissolved TCA and DCA present in the microcosms.

Aqueous samples from Treatments 1 through 4 were periodically analyzed for VOCs throughout the duration of the study. Samples were collected from all bottles and analyzed at three subsequent time points (t= 4 weeks, 10 weeks, 21, and 31 weeks). In addition, a parallel set of bottles was prepared (4 bottles total) and sampled throughout the study to measure pH and DO . These bottles were sampled by transferring the bottles from the shaker to the anaerobic chamber, then allowing the sediment to settle (to the extent possible within a 2 hour time period). The crimp seal was removed, and approximately 8 mL liquid was removed to a clean VOA vial preserved with hydrochloric acid. The sample vial was then immediately sealed with zero headspace and submitted to the analytical laboratory for VOC analysis via EPA-8260. Glass beads were then placed in each microcosm to replace the volume of liquid removed so as to keep the amount of headspace in each microcosm essentially constant throughout the study. The microcosms were then resealed and returned to the 15°C shaker. For the microcosms designated for pH/ORP, sampling was conducted in the same manner, except that the 8 mL sample was removed to a 50 mL conical centrifuge tube. pH and ORP were measured in the anaerobic chamber using wand-style probes.

At the t=21 week sampling event, VOC soil concentrations were measured. Supernatant water was removed, then the soil remaining in each bottle was extracted with 30 mL of methanol.

Between weeks 21 and 31, the ethanol and lactate treatments were both re-dosed with lactate (1,000 mg/L final concentrations) on a bi-weekly basis. In addition, each of these treatments were dosed (bi-weekly) with 0.01% yeast extract. Equal volume injections of deionized water were injected bi-weekly into the control.

At the final two sampling events (i.e., weeks 21 and 31), additional aqueous samples were also collected for ethane and ethene analysis.

Anaerobic Biostimulation of Underlying Sandy Soil - 15° C

This Task was set up in a fashion identical to Task 2 with the following exceptions:

- Soil and groundwater from the sandy aquifer was used;
- Only one biostimulation treatment was evaluated. EOS, a commercially available product consisting of emulsified vegetable oil, was used as the electron donor at a concentration of 5000 mg/L. The EOS treatment was re-amended with EOS (5000 mg/L dosage) bi-weekly during the last 9 weeks of the study; and
- The final two sampling events occurred at 20 and 30 weeks

Anaerobic Biostimulation Screening - 30° C

This screening study was performed to evaluate TCA and DCA biodegradation, in the presence of lactate and yeast extract, at elevated (30° C) temperature. A single microcosm was prepared in a glass serum bottle (approximate volume, 160 mL). Microcosm preparation and sampling was performed in an anaerobic chamber. Twenty grams of homogenized source area soil and 100-mL of groundwater was added to the bottle. Based on VOC analysis of the homogenized soil and groundwater, no contaminant spike was necessary. The bottle was then amended with 5mM (560 mg/L) sodium lactate and 0.01% yeast extract, sealed with a Teflon®-lined butyl rubber stopper and crimp cap, and placed in a shaker at approximately 30°C. Groundwater was periodically analyzed for VOCs during the study period. A “Killed Control” microcosm bottle was also prepared to evaluate abiotic losses during the duration of this study. Killed Control treatments were amended with hydrochloric acid (pH<2) to inhibit microbial activity.

Chemical Oxidation using Persulfate

Chemical oxidation of the underlying sand and groundwater using persulfate was evaluated in this phase of the treatability study. Oxidation via persulfate requires use of an activator. Two activators were evaluated: heat and elevated pH (caustic).

Field data and data from the initial analysis performed in Task 1 were used to assess the need for a contaminant spike. Five µL of neat TCA was added to each microcosm bottle in order to attain TCA concentrations representative of source area TCA levels observed in the field. Microcosms were prepared in triplicate in 50-mL glass serum bottles. Approximately 5 grams of soil and 10 ml of groundwater was transferred to each microcosm bottle, and the bottles were sealed with Teflon®-lined rubber septa and aluminum crimp caps.

Four sets of microcosm treatments were prepared as follows:

Treatment 1: CAUSTIC CONTROL – Nine hundred milligrams of carbonate was added to these microcosms to raise the pH to approximately 9.0. *NOTE: Buffering capacity tests were performed to determine the mass of carbonate needed to raise the pH of the soil-water slurry to 9.*

Treatment 2: CAUSTIC PERSULFATE – Nine hundred milligrams of carbonate was added to these microcosms to raise the pH to approximately 9.0. Two mL of a 20,000 mg/L sodium persulfate solution was also added to these microcosms.

Treatment 3: HOT CONTROL – Two milliliters of 40°C deionized water was added to these microcosms.

Treatment 4: HOT PERSULFATE – Two milliliters of a 40°C sodium persulfate solution (20,000 mg/L) was added to these microcosms.

Samples were shaken at 15°C after amendment addition.

Table 1 summarizes the schedule of the incremental persulfate and caustic additions that were performed to evaluate the persulfate and caustic dosages needed for treatment. TCA levels were analyzed 5 days and 12 days after initial setup via headspace analysis (sufficient time was given to allow samples to equilibrate to room temperature prior to headspace sampling). Headspace was analyzed using a gas chromatograph with an ECD detector. After 12 days, an additional 4 mL of either persulfate solution (20,000 mg/L) or deionized water were added to the microcosms. Amendments were added at room temperature for the caustic microcosms and at 40°C for the hot microcosms.

Nine days later (21 days total), Treatments 1 and 2 were terminated, and the pH of Treatments 3 and 4 was raised by amending with 50 μL of a 10N NaOH solution, resulting in a final pH of between 11 and 12. Treatments 3 and 4 were tested for TCA levels and pH five days later (26 days total), at which time an additional 400 μL of 10N NaOH was added to Treatments 3 and 4. Two days and seven days after the additional NaOH addition (28 and 33 days total, respectively), bottles were sampled again for TCA and pH levels. On the seventh day after the additional base addition (33 days total), an additional 4 mL of 20,000 mg/L sodium persulfate solution was added to Treatment 4. One and two weeks after this addition, bottles were again tested for TCA levels. On day 47, 2 weeks after the previous persulfate addition, an additional 4 mL of 20,000 mg/L sodium persulfate solution was added to Treatment 4. One week later, on day 54, TCA levels were measured a final time. *NOTE: Control microcosms were dosed with deionized water whenever Treatments 2 and 4 were dosed with persulfate solution.*

III. Results

Anaerobic Biostimulation of Source Area (clayey silt) Soil - 15° C

Groundwater TCA and DCA concentrations measured throughout the study for each treatment are shown in Figures 1 and 2. These data, along with measured CA groundwater concentrations, are also summarized in Table 2. TCA concentrations in the Killed and Live controls exhibit a significant (about 70%) decrease in concentration throughout the duration of the study. These decreases are likely due to slow uptake of the TCA into the soil matrix, abiotic degradation mechanisms, volatilization (i.e., leakage) losses, and/or biodegradation of the TCA (the kill agent may not have been completely effective at inhibiting microbial activity). DCA concentrations in the Killed and Live controls remained essentially constant throughout the study, although about a 19% decrease in concentration was observed for the week 31 sampling event.

TCA concentrations in the lactate-amended treatments decreased to non-detect within 21 weeks. TCA concentrations in the ethanol-amended treatments show no decreases through 21 weeks, but a 90% decrease is observed at week 31. This relatively large decrease between weeks 21 and 31 may be due to the bi-weekly lactate and yeast extract amendments, as TCA biodegradation was stimulated by addition of lactate but not ethanol.

The rate of TCA decrease relative to the controls was quantified using a first-order rate expression. After an initial lag period of four weeks, TCA biodegradation could be described by an apparent first-order rate constant of 0.012/day, where the apparent first order rate constant includes retardation due to sorption on to the soil. This biodegradation rate constant value is within the range of those measured in previous studies[2]. It is noted that this regressed rate constant assumes that losses in the controls were not due to biodegradation. If control losses were due, even in part, to biodegradation, then the apparent biodegradation rate constant would be greater than the value currently calculated.

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[2] World Health Organization, 1992. Environmental Health Criteria 136: 1,1,1-Trichloroethane.

DCA in the lactate-amended treatment exhibits approximately a 25% decrease in concentration relative to the Killed and Live controls. DCA concentration decreases relative to the controls in the ethanol treatment after week 21. This decrease is likely due to the addition of lactate, indicating that ethanol is not a suitable electron donor for facilitating DCA biodegradation.

In the absence of DCA degradation, and assuming that DCA is the first daughter product of TCA anaerobic biodegradation, a 15% (approximately) *increase* in DCA concentrations would have been expected. Thus, the measured decreases in DCA concentrations in the lactate and ethanol treatments indicate that DCA is being biodegraded.

The rate of DCA decrease in the lactate-amended treatment relative to the controls was quantified using a first-order rate expression. DCA biodegradation could be described by an apparent first-order rate constant of 0.0024/day. However, if the biodegradation of TCA generated any DCA, this apparent first order rate constant would underestimate the actual DCA biodegradation. In addition, If DCA losses in the controls were due to biodegradation, than this rate constant would also underestimate actual DCA biodegradation.

CA groundwater concentrations in all treatments were non-detect throughout the duration of the study. Thus, anaerobic biodegradation of DCA did not result in any measured accumulation of CA. Based on the stoichiometric biodegradation of DCA alone, a concentration of approximately 3,000 μg/L of CA would have been expected.

Table 3 summarizes the dissolved ethane/ethene concentrations measured at the final two sampling events. Results show that no measurable ethane or ethene was formed via the biological dechlorination of TCA, DCA, or CA, as ethane/ethene levels in the lactate and ethanol treatments are less than those measured in the controls.

Table 4 summarizes TCA, DCA, and CA soil concentrations measured at t=0 and t= 21 weeks. Results indicate that TCA soil concentrations decrease in all treatments during the study. DCA soil concentrations also generally show a decrease, particularly for the lactate- and ethanol-amended treatments.

Table 5 summarizes pH and ORP readings. Results indicate that ORP readings were extremely variable throughout the duration of the study. These variable readings are likely the result of electrochemical interference in the soil slurries due to the presence of soil minerals. Low ORP readings in the Killed Control suggests that reductive processes facilitating TCA dechlorination may have occurred despite addition of the microbial inhibitor. pH values ranged from 6.8 to 8.2. It is unclear why the pH in the ethanol-amended treatment showed an increase of approximately 1 pH unit during the study.

The absence of CA or ethane generation in the lactate- and ethanol-amended treatments is unexpected given the apparent biodegradation of DCA, and the fact that reductive dechlorination of TCA to CA is the most likely biological degradation pathway. Possibilities for this observation are as follows:

- Anaerobic biodegradation of DCA may have proceeded via alternate pathways that did not include formation of CA or ethane. Such pathways have been reported in the literature, where TCA biodegradation to products such as acetic acid and 2-hydroxy-DCA has been suggested.[3] Elevated (~200 mg/L) acetic acid levels were measured in the lactate-amended treatment at t=21 weeks via volatile fatty acid (VFA) analysis. However, the presence of acetic acid could be attributed to fermentation of the lactate. Thus, confirmation of acetic acid as a final TCA degradation product was not possible.

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[3] R. Galli and P. McCarty, 1989. "Biotransformation of 1,1,1-trichloroethane, trichloromethane, and tetrachloromethane by a *Clostridium sp.*", *Appl. Environ. Microbiol.*, 55, 837-844.

- CA may have been degraded via abiotic mechanisms, forming ethanol and/or CO_2 as final products[4]. Neither ethanol nor CO_2 are detectable via VOC analysis (EPA 8260), so formation of these end products could not be verified.

Regardless of the mechanism(s) controlling TCA and DCA biodegradation, results indicate that TCA and DCA were both notably degraded without measurable accumulation of CA or other chlorinated ethanes.

Because elevated TCA and DCA concentrations required substantial dilution prior to analysis on the mass spectrometer, quantitative evaluation of the fate of chlorinated ethenes (e.g., PCE, TCE, DCE, VC) in response to the biostimulation treatments was not possible. These chlorinated ethenes were present at relatively low concentrations and were typically below the analytical detection limit.

Anaerobic Biostimulation of Underlying Sandy Soil - 15° C

Groundwater TCA and DCA concentrations measured throughout the study for each treatment are shown in Figures 3 and 4. These data, along with measured CA groundwater concentrations, are also summarized in Table 6. Similar to results of the Source Area study, TCA concentrations in the Killed and Live controls exhibit a significant (about 65%) decrease in concentration throughout the duration of the study. These decreases are likely due to slow uptake of the TCA into the soil matrix, abiotic degradation mechanisms, volatilization (i.e., leakage) losses, and/or biodegradation of the TCA (the kill agent may not have been completely effective at inhibiting microbial activity). DCA concentrations in the Killed and Live controls decreased by approximately 30% during the first 20 weeks of the study, then decreased an additional 30% to 40% during the last 10 weeks of the study. The likely mechanisms for these DCA losses in the controls are identical to the potential loss mechanisms discussed for TCA.

TCA groundwater concentrations in the EOS-amended treatments decreased to non-detect within 10 weeks. DCA concentrations in the EOS treatment increased in weeks 10 and 20 relative to the controls, then decreased relative to the controls by week 30; CA concentrations in the EOS treatment increased (relative to controls) throughout the study.

Table 7 summarizes TCA, DCA, and CA soil concentrations measured at t=0 and t= 20 weeks. Results indicate that TCA soil concentrations decreased slightly for the controls, and decreased to non-detect for the EOS-amended treatment. This result is consistent with the groundwater data. For DCA, soil concentrations remained essentially unchanged in the controls, but increased by roughly a factor of two in the EOS treatment. This result is also consistent with the groundwater data through week 20. For CA, soil concentrations decreased in the controls, but remained essentially unchanged in the EOS treatment. This result is not readily explained, but may be due to sorption and/or abiotic degradation of the CA in the controls, and generation of CA (via biological degradation of TCA and DCA) in the EOS treatment.

Table 8 summarizes pH and ORP readings. Results indicate that ORP readings were, as was the case in the Source Area soil, extremely variable throughout the duration of the study. These variable readings are likely the result of electrochemical interference in the soil slurries due to the presence of soil minerals. Low ORP readings in the controls suggest that reductive processes facilitating TCE dechlorination may have occurred. pH values ranged from 6.7 to 8.3. It is unclear why the pH in the Live and Killed controls treatment showed an increase of approximately 1.5 pH units during the study.

Results of the Underlying Sand microcosm study suggest that TCA was anaerobically biodegraded to DCA and CA during the study. This pathway explains the observed increases in DCA concentrations relative to the controls in weeks 10 and 20, and the increases in CA in weeks 10 through 30, as biodegradation of TCA resulted in formation of daughter products in the EOS treatment. After depletion of the TCA, DCA concentrations in the EOS treatment began to decrease relative to the controls.

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[4] J. deBest, H. Jongema, A. Weijling, H. Doddema, D. Janssen, and W. Harder, 1997. "Transformation of 1,1,1-trichloroethane in an aerobic packed-bed reactor at various concentrations of 1,1,1-trichloroethane, acetate and sulfate", *Appl. Microbio. Biotech*. 48, 417-423.

Evaluation of the system mass balance indicates that roughly 56% of the measured TCA and DCA losses (relative to controls) were accounted for in CA accumulation. Table 9 shows that trace amounts of ethane and ethene were present in the EOS-amended treatments, suggesting that relatively slow biodegradation of CA to ethane or ethene may have been occurring. However, due to the low concentrations of ethane/ethene in the EOS-amended treatments, it is difficult to verify this degradation pathway.

The rate of TCA decrease relative to the controls was quantified using a first-order rate expression. TCA biodegradation could be described by an apparent first-order rate constant of 0.020/day, where the apparent first order rate constants includes retardation due to sorption on to the soil. This value is similar to the rate constant measured in the Source Area soil study. The measured DCA first-order rate constant was calculated at 0.0057/day, which is on the same order of magnitude as the DCA rate constant measured in the Source Area soil.

Unlike the results of the Source Area microcosm study, the Underlying Sand study shows a relatively clear sequential biodegradation pathway from TCA to DCA to CA. However, it is also possible that alternate biotic and abiotic TCA and DCA degradation mechanisms, as described for the Source Area soil, are occurring simultaneously. Such mechanisms could potentially account for the TCA and DCA mass that was not transformed to CA. Regardless of the TCA and DCA degradation mechanisms, the fate of CA is currently unknown, as degradation of CA to daughter products (e.g., ethane/ethene, CO_2) could not be verified.

Because elevated TCA and DCA concentrations required substantial dilution prior to analysis on the mass spectrometer, quantitative evaluation of the fate of chlorinated ethenes (e.g., PCE, TCE, DCE, VC) in response to the EOS biostimulation treatment was not possible. These chlorinated ethenes were present at relatively low concentrations and were typically below the analytical detection limit.

Anaerobic Biostimulation Screening - 30° C

Table 10 summarizes results of the anaerobic screening study performed at 30° C on the Source Area soil. Parallel microcosm bottles serving as the Killed Controls indicated that TCA abiotic losses were roughly 15% during the duration of this study (data not shown). Evaluation of the contaminant mass balance indicates that nearly all of the TCA and DCA in the lactate/yeast extract-amended treatment were biodegraded to CA, as approximately 83% of the TCA and DCA losses are accounted for in CA accumulation. Ethane and ethene were detected in the samples, but it is unclear whether or not the ethane and ethene were generated from dechlorination of the CA. The TCA and DCA rates of degradation were greater in the 30°C study than in the 15°C study.

For the Source Area soil, the TCA degradation pathway observed at 30°C is notably different than the TCA degradation pathway observed at 15°C. At 30°C, CA is produced relatively rapidly, and on a stoichiometric basis with respect to TCA and DCA decay; at 15°C, TCA and DCA dechlorination appears to proceed through an alternate pathway and no formation of CA is observed. The reason for this discrepancy is currently unclear, but may be due to increased growth and activity of indigenous microorganisms at the elevated temperature. These microorganisms may favor a degradation pathway that takes TCA to CA, and possibly ethane. It is also possible that various abiotic degradation processes are impacted by temperature, as TCA losses in the 30°C Killed Controls (~15%) are significantly less than TCA abiotic losses in the 15°C experiments (~50%) through four months of incubation.

Chemical Oxidation using Persulfate

Results of the persulfate oxidation study using heat activation and carbonate pH adjustment resulted in negligible (<10% reduction) in TCA concentrations. Thus, mild heating and pH adjustment to approximately 9 were insufficient for treatment of TCA in the source area soil.

Results of the persulfate oxidation study using high pH adjustment via sodium hydroxide addition are summarized in Figure 5. TCA concentrations show about a 60% decrease after adding approximately 0.18g of NaOH and 0.28g of sodium persulfate. These masses of amendments are relatively large considering that only 5g of soil were used in the microcosm experiments. The decrease in pH during treatment is likely due to the persulfate reaction, which typically lowers solution pH. The relatively high NaOH and persulfate dosages required to reduce TCA concentrations are likely the result of soil buffering capacity and soil oxidant demand. The Source Area soil contains substantial amounts of clay and/or fine silts. These materials likely contain complex mineral and organic complex that hinder TCA treatment via chemical oxidation, causing most of the persulfate and caustic materials to react with the soil matrix rather than the target contaminants.

IV. Conclusions and Discussion

Results of this laboratory treatability study indicate the following:

- Chemical oxidation of TCA in the Source Area soil via persulfate with heat or caustic activation was ineffective, as high dosages of NaOH and persulfate (relative to the soil mass) were needed to obtain even a 60% TCA mass removal. The ineffectiveness of this treatment is due primarily to the buffering capacity and oxidant demand of the soil;

- TCA and DCA biodegradation rates in the Source Area soil (15°C study) were enhanced by addition of lactate and nutrients. Final TCA and DCA degradation products for the Lactate treatment were not identified, and the TCA and DCA degradation pathways were not determined. However, no accumulation of CA (or any other detectable VOC) was observed;

- Using a simple first-order decay expression, and using the rate constants measured in this study, the time needed for TCA and DCA groundwater concentrations in the Source Area to decrease to 5 µg/L is estimated at roughly 6 to 10 years (conservatively assuming initial TCA and DCA groundwater concentrations of 500 mg/L and 30 mg/L, respectively);

- CA accumulation and a sequential biodegradation pathway of TCA to DCA to CA were observed in the 30°C study for the Source Area soil, but degradation of CA to ethane proceeded slowly (at best). It is currently unclear why the apparent degradation pathways and daughter products differed between the 15°C and 30°C study;

- Use of EOS was effective at enhancing biodegradation of TCA and DCA in the Underlying Sand. A sequential biodegradation pathway of TCA to DCA to CA was identified. However, CA accumulation was observed, and CA degradation to ethane proceeded slowly, at best.

Overall, biostimulation using lactate and nutrients has potential to degrade TCA and DCA in the Source Area soil without accumulation of CA, thereby serving as a viable remedial option for evaluation in a pilot scale demonstration. However, additional laboratory studies using bioaugmentation should also be considered. Use of bioaugmentation could potentially increase the rate of chlorinated ethane biodegradation, and reduce the potential for CA accumulation groundwater. Furthermore, bioaugmentation in the Source Area soil could potentially result in a TCA degradation pathway that proceeds to ethane (via sequential dechlorination of TCA), thereby eliminating degradation pathway uncertainties and confirming formation of innocuous end products. Bioaugmentation in the Source Area could also result in more rapid degradation of TCA and DCA, ultimately reducing remedial timeframes and project costs.

Tables

Table 1. Schedule for persulfate treatability study.

Date	Elapsed days	Measure TCA	Measure pH	Add base	Add persulfate
6/21/2004	5	X,Y			
6/28/2004	12	X,Y			X,Y
7/7/2004	21	X,Y	X	X	
7/12/2004	26	X	X	X	
7/14/2004	28	X	X		
7/19/2004	33	X	X		X
7/26/2004	40	X			
8/2/2004	47	X			X
8/9/2004	54	X	X		

X indicates that the indicated activity was performed on Treatments 3 and 4.
Y indicates that the indicated activity was performed on Treatments 1 and 2.

Table 2. Summary of TCA, DCA, and CA groundwater concentrations measured in the Source Area microcosm study. All concentrations are in **mg/L**, with standard deviation shown as ±. For week 0, collected after 24 hours of mixing, a parallel set of bottles was analyzed to determine the initial concentration. For week 31, triplicate analyses were not performed due to sacrificing of microcosm bottles for soil analyses during week 21.

	1,1,1-Trichloroethane				**1,1-Dichloroethane**				**Chloroethane**			
Weeks	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol
0	8.0 ± 0.99				16.3 ± 1.2				<0.50			
4	5.6 ± 0.70	6.4 ± 0.46	6.0 ± 1.6	6.6 ± 2.1	18.3 ± 2.5	20.3 ± 0.6	16.0 ± 3.0	16.3 ± 3.8	<2.5	<2.5	<2.5	<2.5
10	3.7 ± 0.13	3.1 ± 0.48	.84 ± 0.23	4.0 ± 1.3	16.6 ± 2.2	15.2 ± 1.6	13.1 ± 2.7	13.6 ± 1.5	<1.0	<1.0	<1.0	<1.0
21	2.3 ± 0.34	1.9 ± 0.005	<1.0	2.4 ± 0.97	16.1 ± 2.4	16.0 ± 1.1	11.8 ± 2.3	14.1 ± 1.7	<1.0	<1.0	<1.0	<1.0
31		2.9	0.81	0.67		13.0	10.0	9.7		<0.50	<0.25	<0.50

Table 3. Measured ethane & ethene concentrations in the Source Area microcosm study. All concentrations are in **µg/L**, with standard deviations shown as ±.

	Ethane				**Ethene**			
Week	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol
21	2.1 ± 0.8	2.3 ± 0.4	<2.0	<2.0	0.9 ± 0.6	1.8 ± 0.3	<2.0	<2.0
31		0.78	<2.0	<2.0		0.4	<2.0	<2.0

Table 4. Summary of TCA, DCA, and CA soil concentrations measured in the Source Area microcosm study. All concentrations are in **mg/Kg wet soil**, with standard deviation of average values (analyzed in duplicate) shown as ±. For week 0, collected after 24 hours of mixing, a parallel set of bottles was analyzed to determine the initial concentration.

	1,1,1-Trichloroethane				**1,1-Dichloroethane**				**Chloroethane**			
Weeks	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol
0	24.2 ± 2.2				21.0 ± 2.3				<4.1			
21	3.2 ± 2.4	4.4 ± 0.1	3.9 + 0.7	3.2 ± 0.5	14.1 ± 0.8	14.1 ± 0.4	22.8 ± 13.8	14.9 ± 2.9	<1.5	<1.5	<1.5	<1.5

Table 5. pH and ORP values measured in the Source Area soil microcosm study.

	pH (standard units)				**ORP (mV)**			
Weeks	Killed Control	Live Control	Lactate	Ethanol	Killed Control	Live Control	Lactate	Ethanol
0	7.60							
4	7.13	7.12	7.17	7.19	-35	15	-102	-107
10	6.83	7.44	7.24	7.19	-122	-116	-140	-144
21	6.78	7.96	7.17	8.18	147	123	-59	30

Table 6. Summary of TCA, DCA, and CA groundwater concentrations measured in the Underlying Sand microcosm study. All concentrations are in **mg/L**, with standard deviation shown as ±. For week 0, collected after 24 hours of mixing, a parallel set of bottles was analyzed to determine the initial concentration. For week 30, triplicate analyses were not performed due to sacrificing of microcosms bottles for soil analyses during week 20.

	1,1,1-Trichloroethane			**1,1-Dichloroethane**			**Chloroethane**		
Weeks	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS
0	22.0 ± 1.0			13.0 ± 1.0			0.041 ± 0.015		
4	20.7 ± 0.58	20.3 ± 0.58	11.3 ± 0.58	12.7 ± 0.58	11.7 ± 0.58	10.3 ± 0.64	<1.0	<1.0	<1.0
10	17.1 ± 1.5	14.4 ± 1.9	<1.0	14.8 ± 3.3	11.4 ± 2.0	22.9 ± 6.6	<0.2	<1.0	1.4 ± 1.2
20	11.2 ± 0.72	11.3 ± 0.70	<1.0	10.0 ± 0.22	9.64 ± 0.82	17.3 ± 1.4	<1.0	<1.0	1.6 ± 0.5
30	5.5	8.7	<0.5	4.6	7.0	3.0	<0.5	<0.5	5.9

Table 7. Summary of TCA, DCA, and CA soil concentrations measured in the Underlying Sand microcosm study. All concentrations are in **mg/Kg wet soil**, with standard deviation of average values (analyzed in duplicate) shown as ±. For week 0, collected after 24 hours of mixing, a parallel set of bottles was analyzed to determine the initial concentration.

	1,1,1-Trichloroethane			**1,1-Dichloroethane**			**Chloroethane**		
Weeks	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS
0	10.8 + 3.1			3.7 + 1.0			<0.8		
20	7.0 ± 2.2	6.2 ± 0.8	<0.1	4.6 ± 1.6	3.8 ± 0.4	8.4 ± 1.0	<0.1	<0.1	<0.1

Table 8. pH and ORP values measured in the Underlying Sand microcosm study.

	pH (standard units)			**ORP (mV)**		
Weeks	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS
0						
4	6.84	6.55	6.70	-89	-91	-91
10	7.09	7.17	6.49	51	50	-77
20	8.34	8.17	7.07	-165	-80	-96

Table 9. Measured ethane & ethene concentrations in the Underlying Sand microcosm study. All concentrations are in **µg/L**, with standard deviations shown as ±.

	Ethane			**Ethene**		
Weeks	Killed Control	Live Control	EOS	Killed Control	Live Control	EOS
20	<2.0	<2.0	<2.0	1.5 + 0.8	<2.0	<2.0
30	<2.0	<2.0	0.93	<2.0	<2.0	0.5

Table 10. Results of the 30°C screening study on the Source Area soil. Concentrations are in **mg/L**.

Weeks	**1,1,1-Trichloroethane**	**1,1-Dichloroethane**	**Chloroethane**	**Ethane**	**Ethene**
0	NA				
3	3.3	5.3	6.6	NA	
6	<1.0	0.7	10.4	0.017	0.040

NA=Not Analyzed

Figures

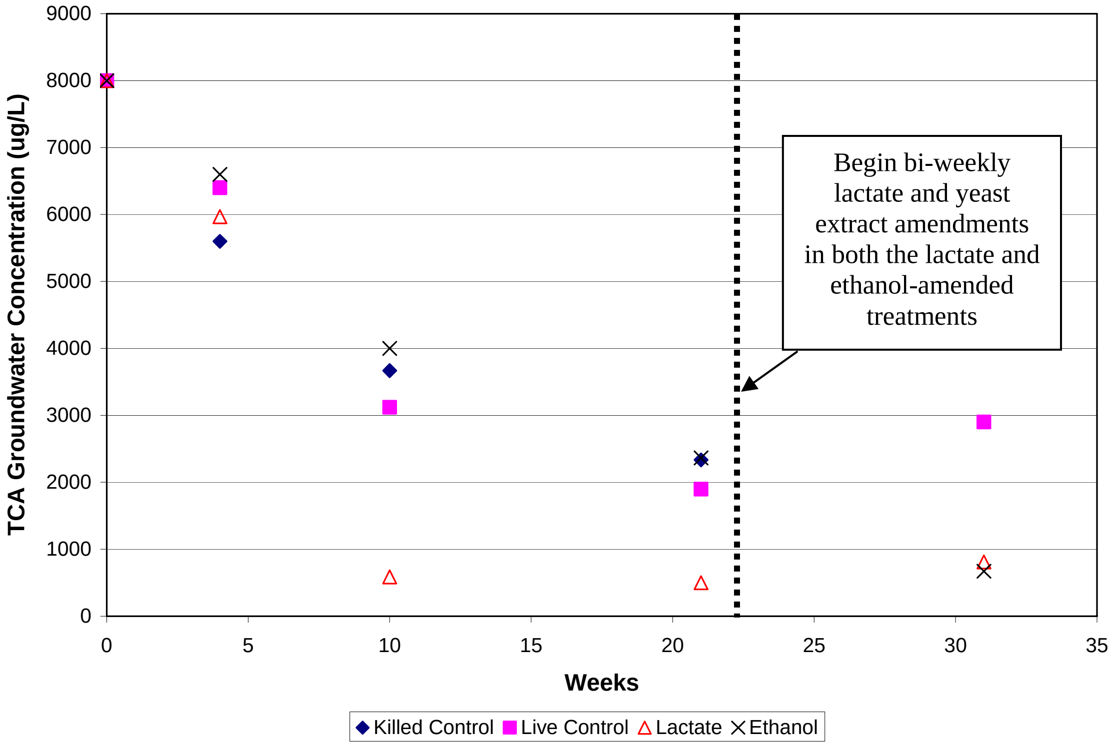

Figure 1. Dissolved TCA concentration measured in the Source Area soil microcosm study. Average values are shown. Non-detect readings were plotted as one-half the detection limit. Visibly outlying data were excluded.

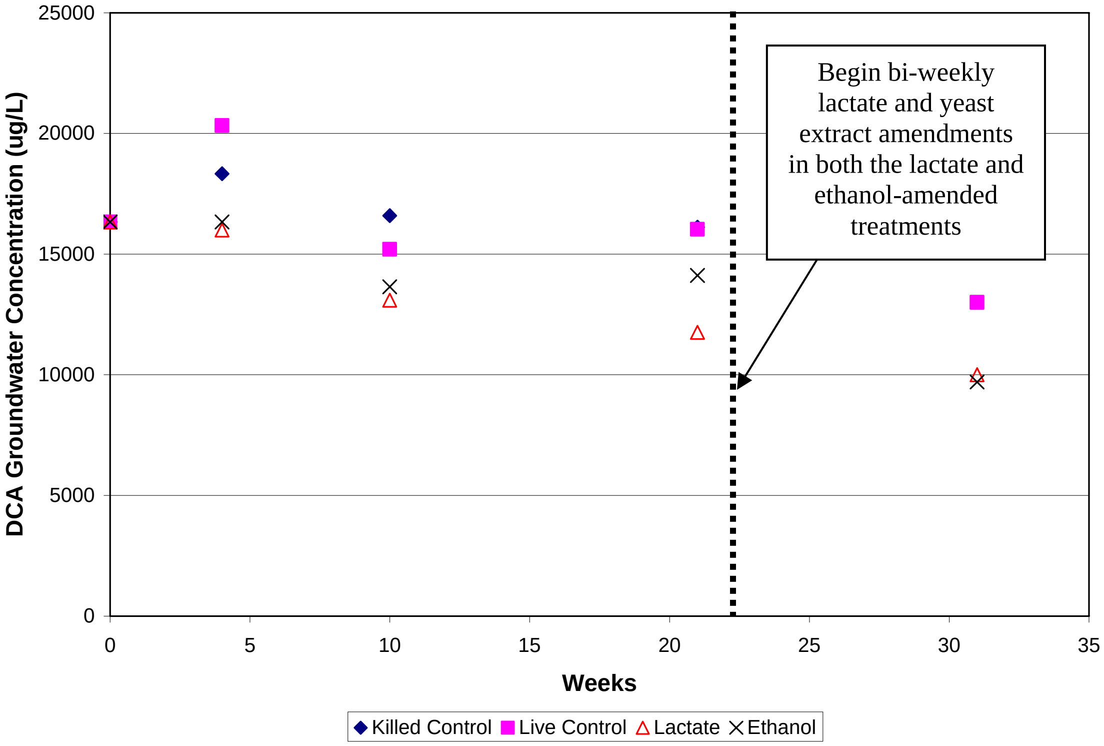

Figure 2. Dissolved DCA concentration measured in the Source Area soil microcosm study. Average values are shown. Visibly outlying data were excluded.

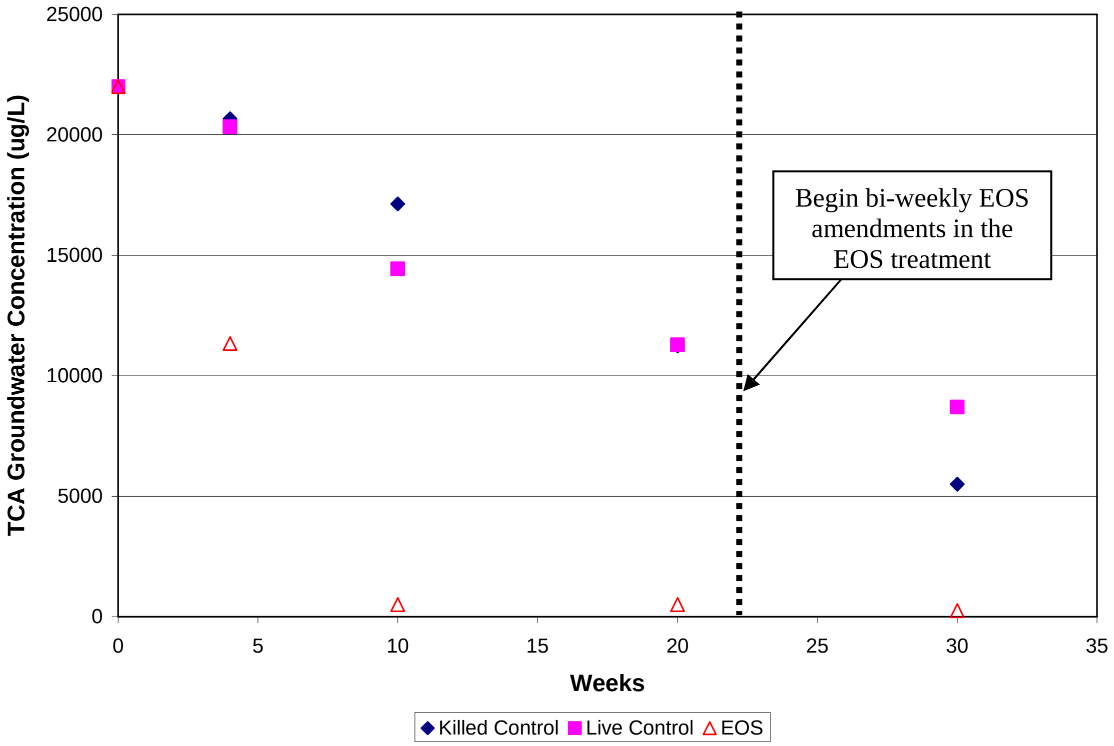

Figure 3. Dissolved TCA concentration measured in the Underlying Sand microcosm study. Average values are shown. Non-detect readings were plotted as one-half the detection limit. Visibly outlying data were excluded.

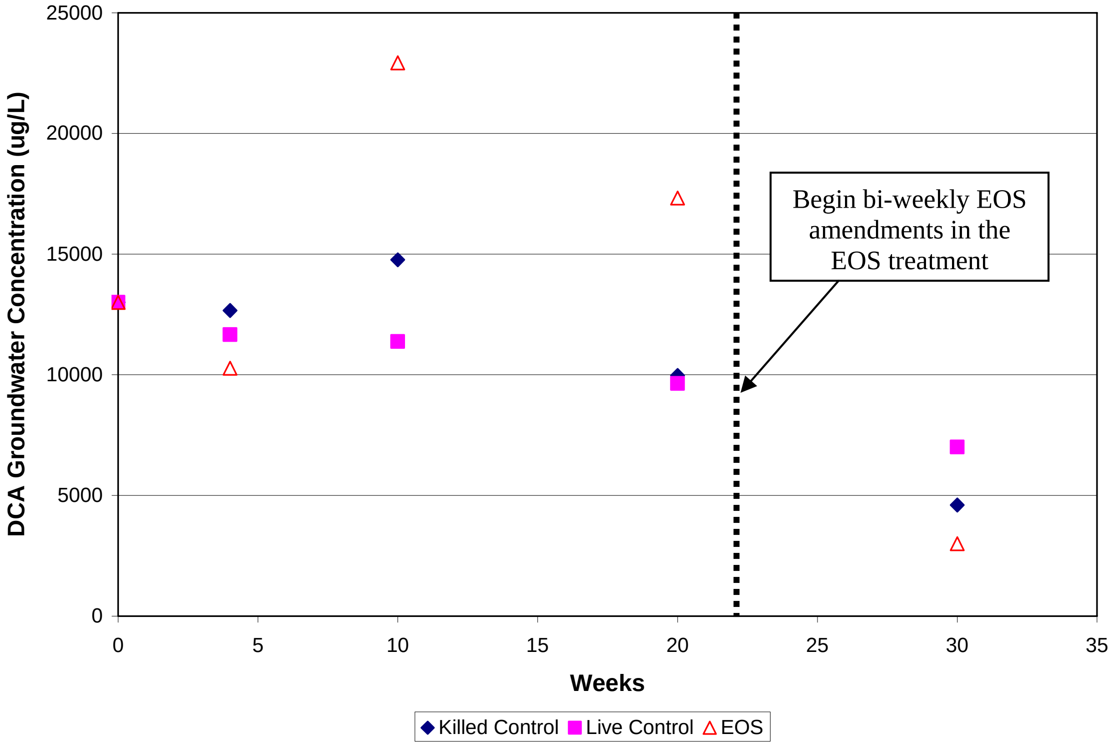

Figure 4. Dissolved DCA concentration measured in the Underlying Sand microcosm study. Average values are shown. Visibly outlying data were excluded.

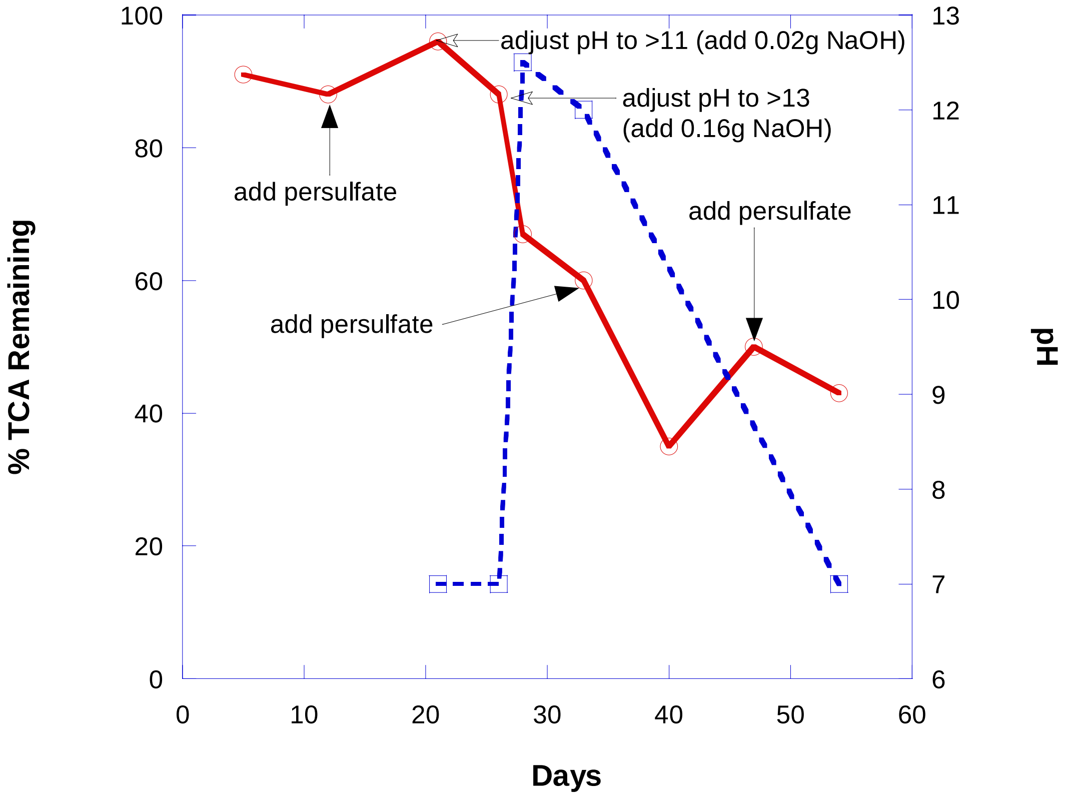

Figure 5. Results of the persulfate oxidation study – high pH adjustment. Circles represent the % TCA remaining, and squares represent the measured pH. Data through the first 21 days correspond to the Hot Persulfate treatment, prior to amending with NaOH solution, as described in Table 1.

APPENDIX C

Appendix C- Fate and Transport Model for Pilot Study

MODFLOW Hydrogeologic Model

The hydrogeologic conceptual model was constructed using MODFLOW. The MODFLOW numerical model was used to simulate 3-dimensional subsurface groundwater flow in the test area due to natural hydraulic gradients and operation of the injection and extraction wells. The model consisted of 5 grid layers, with a total model thickness of 28 feet. Layer 1 was three feet thick, layers 2 and 3 were each five feet thick, and layers 4 and 5 were each 7.5 feet thick. The simulated area of each grid ranged from 4 ft^2 along the edges to 0.25 ft^2 in the center of the model domain within the actual simulated test plot. The total area of the model domain was approximately 1,600 ft^2 (40 ft x 40 ft).

Transient simulations were performed to simulate the hydraulic heads and groundwater flow for each phase (i.e., each batch or re-circulation injection) of the pilot test. The critical assumptions and parameters used in the development of the MODFLOW hydraulic model were as follows:

- The simulated horizontal hydraulic conductivity was 0.05 ft/day in the three silty layers (layers 1 through 3), and 0.29 ft/day in the sandy layers (layers 4 and 5). These values were based on slug testing and a short term pumping test at MW-29D and MW-29S. The assumed ratio of horizontal to vertical hydraulic conductivity was 3.

- The specific yield was estimated at 0.3

- Based on the data presented in Section 2.2.2, the natural hydraulic gradient across the pilot test area was assumed to be 0.015 to the east. This resulted in negligible groundwater flow across the simulated site.

- Injection well flow was distributed evenly among model layers 2 and 3. This simulated distribution is based on observed hydraulic heads and electron donor distribution measured during the pilot test.

- Measured hydraulic heads and electron donor distribution at start-up indicated that monitoring well MW-5S had limited hydraulic connectedness to the injection well (PSIW-1). To simulate this observed effect, a 0.5 ft. x 1.5 ft. hydraulic barrier (having a hydraulic conductivity of zero) was simulated around MW-5S in model layer 2. Groundwater flow was still able to reach MW-5S from model layers above and below.

Comparison of simulated and observed hydraulic heads during the batch injection showed that the simulated heads were generally within approximately one foot of the measured values. The notable exception is monitoring well MW-5D, where the simulated increase in head (~ 3 feet) was substantially less that the measured head (~9 feet). This discrepancy is likely due to a hydraulic "short-circuit" between the injection well and MW-5D. This short-circuit might also explain the relatively low flow to overlying monitoring well MW-5S, as the preferential flow path was towards the deeper MW-5D well.

RT3D Model to Simulate Contaminant Fate and Transport

Solute fate and transport was simulated using RT3D, which interfaces with the MODFLOW hydraulic model. Specific constituents simulated in the RT3D model include TCA, DCA, and

CA. The sequential dechlorination package was used in the RT3D program to simulate the reductive dechlorination of these chlorinated ethanes. Key model assumptions and input parameters were as follows:

- The porosity (ε) was estimated at 0.3, and the soil bulk density (ρ) was estimated at 1.8 g/mL.

- The longitudinal dispersivity was estimated at 0.1 ft.

- Baseline TCA, DCA, and CA concentrations were determined based on an inverse distance weighted interpolation method of chlorinated ethane concentrations, which were measured during the baseline groundwater sampling events. Baseline distributions for each of these compounds with the pilot test area (layer 2) are shown in Figures C1 through C3.

- Linear equilibrium sorption between the water and soil phases was assumed. Based on laboratory measurements during the microcosms study, linear sorption coefficients (K_d) for TCA and DCA were 3.0 and 1.5 L/kg, respectively. For CA, the value of K_d (1.2 L/kg) was estimated based on its K_{oc} value relative to DCA (Melan *et al.*, 1992; USEPA, 1995)

- The retardation factors, defined as ($1 + \rho K_d/\varepsilon$), for TCA, DCA, and CA are 19, 10, and 7.2, respectively.

- Biodegradation of TCA, DCA, and CA was simulated using sequential first order degradation kinetics. The simulated biodegradation rate constant of 0.35/day for DCA was based on measured decay rates obtained during post injection monitoring at MW-4S and MW-5S. For CA, a rate constant of 0.1/day was calculated based on the measured decay at MW-5S and MW-5D. Post-injection DCA and CA groundwater data for monitoring well MW-5S, along with the corresponding first-order rate regressions, are presented in Figure C-4. The biodegradation rate constant for TCA could not be estimated from the post-injection field data because TCA concentrations were below the analytical detection limit before the end of the recirculation phase. However, the laboratory studies showed that the rate of TCA biodegradation was greater than the rate of DCA biodegradation. Thus, for the model, a first order rate constant of 0.35/day was conservatively assumed for TCA. ***NOTE:*** *only a 7 ft. x 7 ft. zone centered around the pilot test area and in layers 2 and 3 was considered to be biologically active (i.e., chlorinated ethane degradation rate constants greater than zero). Within this region, electron donor and nutrient levels were assumed to be sufficient to maintain degradation of the target compounds.*

The RT3D model was run for 146 days to evaluate the impacts of electron donor addition on TCA, DCA, and CA within the test area.

It should be noted that the simulated contaminant concentrations injected into the injection well were assumed to be equal to the concentrations from the appropriate extraction well. For MW-29D and MW-6D, these concentrations remained approximately constant while the well was used as the extraction well. However, DCA and CA concentrations for MW-29S decreased over time while this well was employed as the extraction well. To account for this within the model, injection concentration were adjusted every 11 days (out of 44 days total) to compensate for these varying concentrations. An iterative trial-and-error method was employed so that the injection concentrations matched the concentrations at MW-29S.

DNAPL Dissolution

The time required for DNAPL dissolution during full-scale treatment was calculated using a spreadsheet model where incremental time steps were used to simulate DNAPL dissolution (and corresponding changes in DNAPL mole fraction) during aqueous phase biodegradation. The following equation, based on Raoult's Law, was employed to conservatively estimate this value:

$$0 = \sum_{\Delta t} \sum_{i} \frac{C_{s,i}\rho}{M_i} - M_i x_i S_i K_i \Delta t \qquad \text{Eq. C-1}$$

where Δt is the time increment [day], ρ is the soil bulk density [kg/L], M_i is the retardation factor for contaminant i (TCA, DCA, or CA) [mg/mmole], X_i is the DNAPL mole fraction of contaminant i [dimensionless], K_i is the first-order biodegradation rate constant for each contaminant [day^{-1}], and S_i is the aqueous solubility of each contaminant [mg/L]. $C_{s,i}$ [mg/kg] is the initial soil concentration of contaminant i that is associated with the DNAPL phase (i.e., not sorbed to the soil or dissolved in groundwater), which is calculated using the mass balance approach described by Schaefer et al. (1998).

Full Scale Remedial Time Frame

Equation C-1 calculates the time needed to dissolve the DNAPL only. Subsequent decreases in aqueous phase chlorinated ethane concentrations are simulated using the MODFLOW/RT3D model described in the previous sections. Thus, the simulated time needed to reduce total chlorinated ethane concentrations to less than 6,000 µg/L is calculated by adding the time needed to dissolve the DNAPL (Equation C-1) to the time needed to reduce total chlorinated ethane dissolved concentrations to below 6,000 µg/L in the MODFLOW/RT3D model.

Model Figures

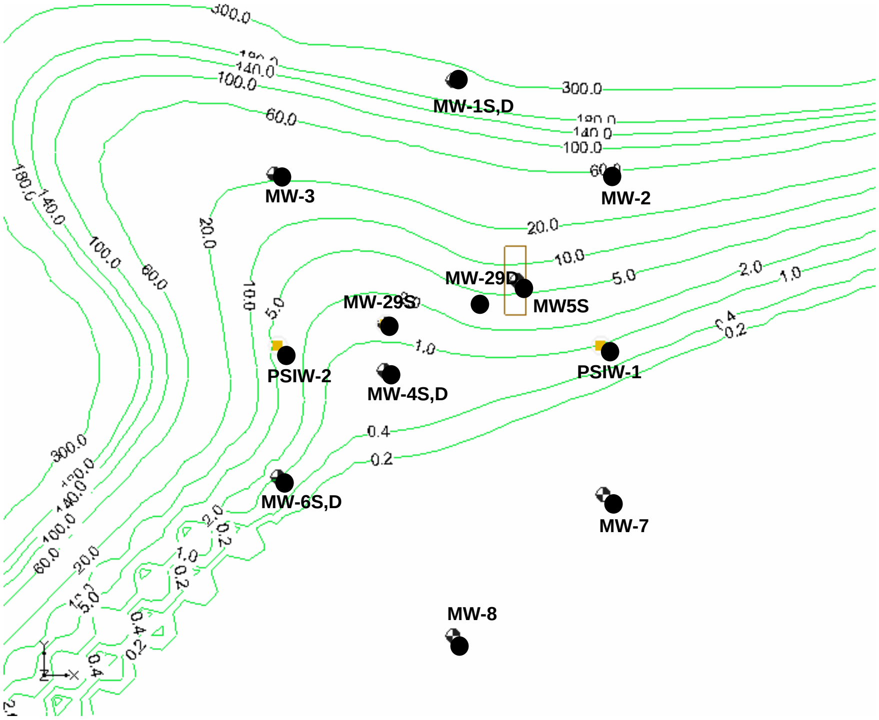

Figure C-1. Baseline TCA distribution in groundwater. Model layer 2 is shown. Concentration contours are in mg/L.

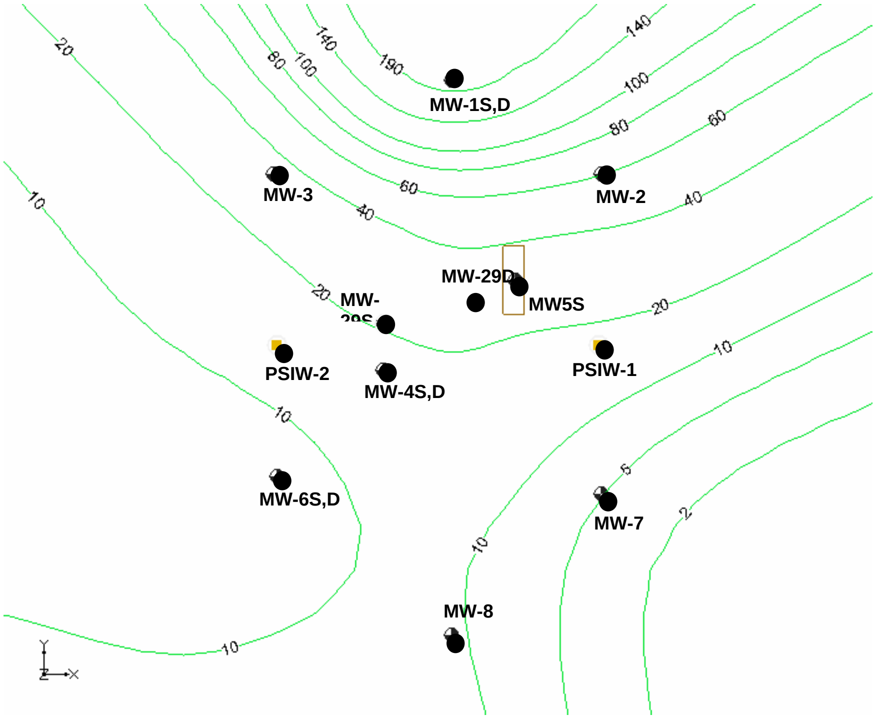

Figure C-2. Baseline DCA distribution in groundwater. Model layer 2 is shown. Concentration contours are in mg/L.

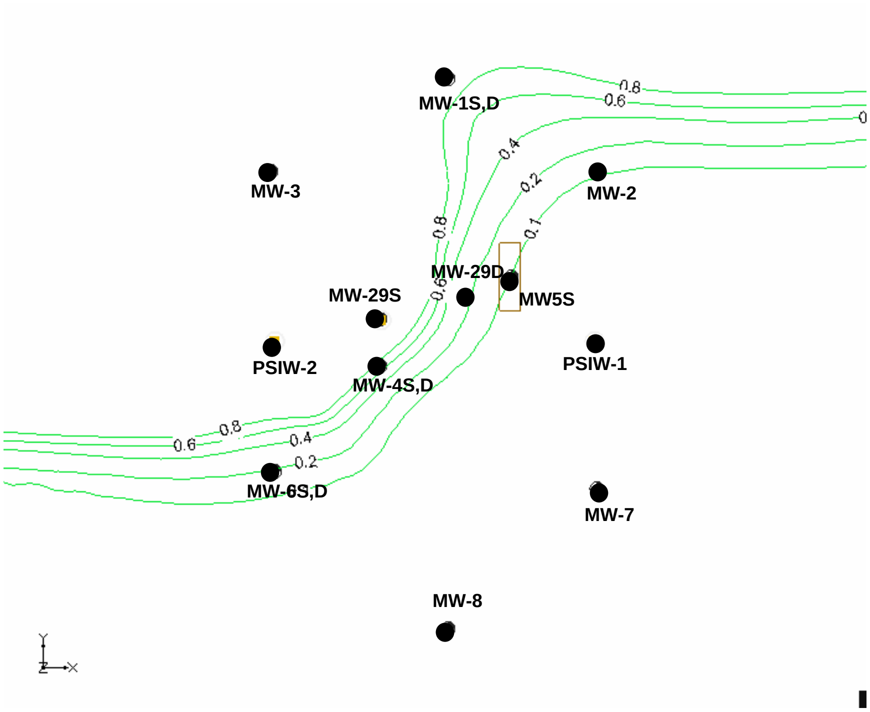

Figure C-3. Baseline CA distribution in groundwater. Model layer 2 is shown. Concentration contours are in mg/L.

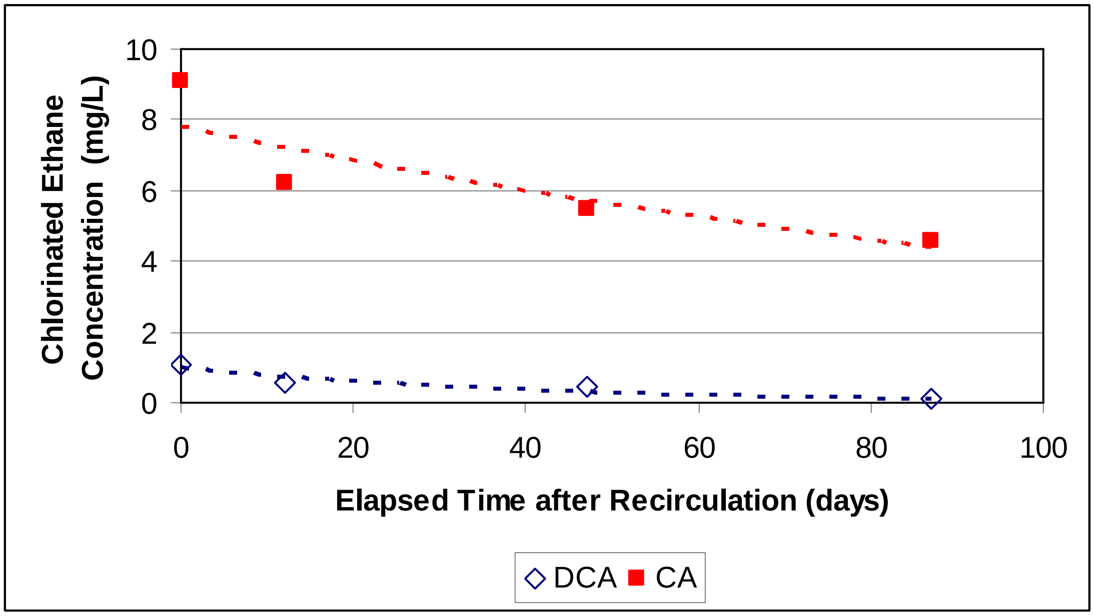

Figure C-4. Post injection DCA and CA groundwater concentrations at MW-5S. Due to the low rate of advective contaminant migration, observed decreases are due to biodegradation. Dashed lines represent first-order decay regressions.

APPENDIX D

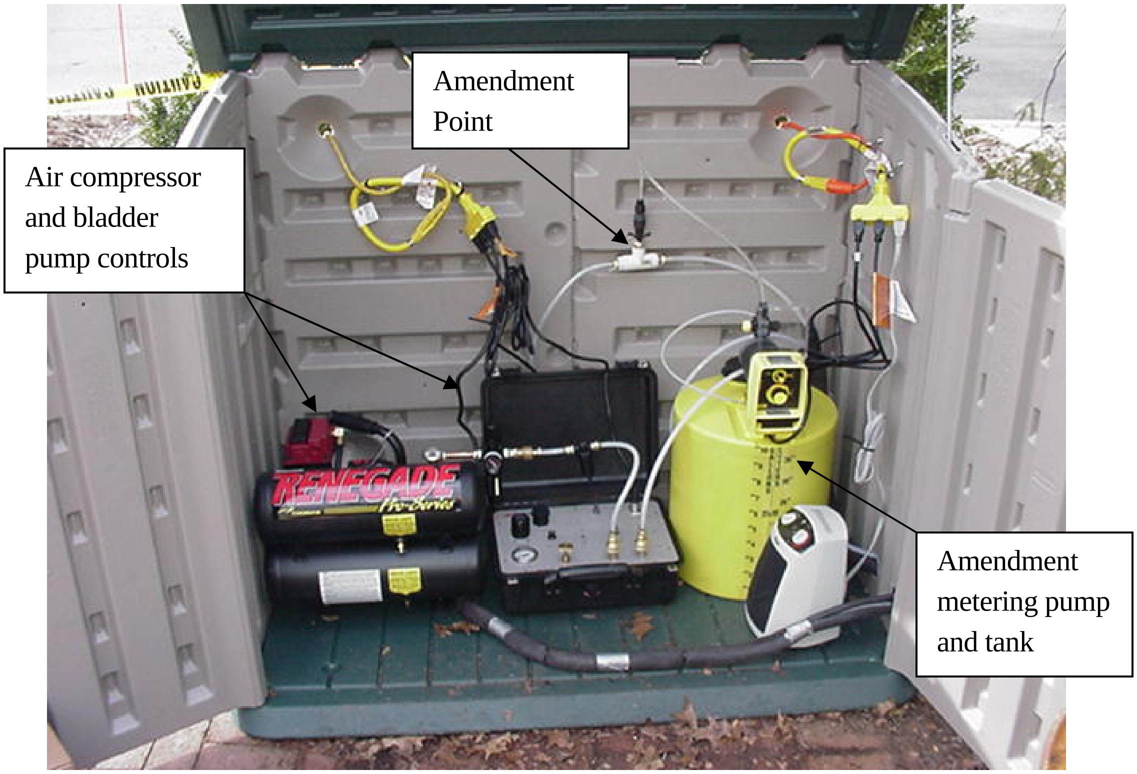

Photo 1: Pilot test system.

Photo 2: Extraction and Injection points (Phase 2, extraction from MW-29D, Injection into PSIW-1.

APPENDIX E

CHEMTECH 284 Sheffield Street • Mountainside, NJ 07092 Phone: 908.789.8900 Fax: 908.789.8922

ANALYTICAL RESULTS SUMMARY

PROJECT NAME: Bulova Jackson Heights

SHAW E & I, INC.
101-1 COLIN DRIVE
HOLBROOK, NY 11741
6314724000

CHEMTECH PROJECT NO.	**X5722**
ATTENTION:	**Erik Gustafson**

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(30-35)

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): SOIL Lab Sample ID: X5722-01

Sample wt/vol: 5.0 (g/mL) g Lab File ID: VK012451.D

Level (low/med): LOW Date Received: 12/5/06

% Moisture: not dec. 26 Date Analyzed: 12/8/06

GC Column: RTXVMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/Kg	Q
74-87-3	Chloromethane	13	U
75-01-4	Vinyl chloride	13	U
74-83-9	Bromomethane	13	U
75-00-3	Chloroethane	13	U
75-35-4	1,1-Dichloroethene	3.3	J
67-64-1	Acetone	120	
75-15-0	Carbon disulfide	13	U
75-09-2	Methylene Chloride	1.8	J
156-60-5	trans-1,2-Dichloroethene	13	U
75-34-3	1,1-Dichloroethane	100	
78-93-3	2-Butanone	6.5	J
56-23-5	Carbon Tetrachloride	13	U
156-59-2	cis-1,2-Dichloroethene	13	U
67-66-3	Chloroform	13	U
71-55-6	1,1,1-Trichloroethane	140	E
71-43-2	Benzene	13	U
107-06-2	1,2-Dichloroethane	13	U
79-01-6	Trichloroethene	9.0	J
78-87-5	1,2-Dichloropropane	13	U
75-27-4	Bromodichloromethane	13	U
108-10-1	4-Methyl-2-Pentanone	67	U
108-88-3	Toluene	13	U
10061-02-6	t-1,3-Dichloropropene	13	U
10061-01-5	cis-1,3-Dichloropropene	13	U
79-00-5	1,1,2-Trichloroethane	13	U
591-78-6	2-Hexanone	67	U
124-48-1	Dibromochloromethane	13	U
127-18-4	Tetrachloroethene	4.9	J
108-90-7	Chlorobenzene	13	U
100-41-4	Ethyl Benzene	13	U
126777-61-2	m/p-Xylenes	13	U
95-47-6	o-Xylene	13	U
100-42-5	Styrene	13	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(30-35)

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM

Case No.: X5722

SAS No.: X5722

SDG No.: X5722

Matrix (soil/water): SOIL

Lab Sample ID: X5722-01

Sample wt/vol: 5.0 (g/mL) g

Lab File ID: VK012451.D

Level (low/med): LOW

Date Received: 12/5/06

% Moisture: not dec. 26

Date Analyzed: 12/8/06

GC Column: RTXVMS ID: 0.18 (mm)

Dilution Factor: 1.0

Soil Extract Volume: ______ (uL)

Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/Kg	Q
75-25-2	Bromoform	13	U
79-34-5	1,1,2,2-Tetrachloroethane	13	U

1E

SOIL VOLATILE ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

BJH-GW-16(30-35)

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM

Case No.: X5722

SAS No.: X5722

SDG No.: X5722

Matrix (soil/water): SOIL

Lab Sample ID: X5722-01

Sample wt/vol: 5.0 (g/mL) g

Lab File ID: VK012451.D

Level (low/med): LOW

Date Received: 12/5/2006

% Moisture: not dec. 26

Date Analyzed: 12/8/2006

GC Column: RTXVMS ID: 0.18

Dilution Factor: 1.0

Soil Extract Volume:

Soil Aliquot Volume:

Number TICS found: 1

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/Kg

	CAS NO.	COMPOUND	RT	EST. CONC.	Q
1.	002257-46-7	Methyl 3,3-dichloropropenoat	9.27	490	J

Comments:

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(30-35)DL

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): SOIL Lab Sample ID: X5722-01DL

Sample wt/vol: 1.0 (g/mL) g Lab File ID: VK012452.D

Level (low/med): LOW Date Received: 12/5/06

% Moisture: not dec. 26 Date Analyzed: 12/8/06

GC Column: RTXVMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/Kg	Q
74-87-3	Chloromethane	66	U
75-01-4	Vinyl chloride	66	U
74-83-9	Bromomethane	66	U
75-00-3	Chloroethane	66	U
75-35-4	1,1-Dichloroethene	66	U
67-64-1	Acetone	170	JD
75-15-0	Carbon disulfide	66	U
75-09-2	Methylene Chloride	66	U
156-60-5	trans-1,2-Dichloroethene	66	U
75-34-3	1,1-Dichloroethane	59	JD
78-93-3	2-Butanone	330	U
56-23-5	Carbon Tetrachloride	66	U
156-59-2	cis-1,2-Dichloroethene	66	U
67-66-3	Chloroform	66	U
71-55-6	1,1,1-Trichloroethane	110	D
71-43-2	Benzene	66	U
107-06-2	1,2-Dichloroethane	66	U
79-01-6	Trichloroethene	11	JD
78-87-5	1,2-Dichloropropane	66	U
75-27-4	Bromodichloromethane	66	U
108-10-1	4-Methyl-2-Pentanone	330	U
108-88-3	Toluene	66	U
10061-02-6	t-1,3-Dichloropropene	66	U
10061-01-5	cis-1,3-Dichloropropene	66	U
79-00-5	1,1,2-Trichloroethane	66	U
591-78-6	2-Hexanone	330	U
124-48-1	Dibromochloromethane	66	U
127-18-4	Tetrachloroethene	4.7	JD
108-90-7	Chlorobenzene	66	U
100-41-4	Ethyl Benzene	66	U
126777-61-2	m/p-Xylenes	66	U
95-47-6	o-Xylene	66	U
100-42-5	Styrene	66	U
75-25-2	Bromoform	66	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(30-35)DL

Lab Name: Chemtech
Contract: SHAW03

Lab Code: CHEM
Case No.: X5722
SAS No.: X5722
SDG No.: X5722

Matrix (soil/water): SOIL
Lab Sample ID: X5722-01DL

Sample wt/vol: 1.0 (g/mL) g
Lab File ID: VK012452.D

Level (low/med): LOW
Date Received: 12/5/06

% Moisture: not dec. 26
Date Analyzed: 12/8/06

GC Column: RTXVMS ID: 0.18 (mm)
Dilution Factor: 1.0

Soil Extract Volume: (uL)
Soil Aliquot Volume: (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/Kg	Q
79-34-5	1,1,2,2-Tetrachloroethane	66	U

1E

SOIL VOLATILE ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

BJH-GW-16(30-35)DL

Lab Name: Chemtech
Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): SOIL
Lab Sample ID: X5722-01DL

Sample wt/vol: 1.0 (g/mL) g
Lab File ID: VK012452.D

Level (low/med): LOW
Date Received: 12/5/2006

% Moisture: not dec. 26
Date Analyzed: 12/8/2006

GC Column: RTXVMS ID: 0.18
Dilution Factor: 5.0

Soil Extract Volume:
Soil Aliquot Volume:

Number TICS found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/Kg

CAS NO.	COMPOUND	RT	EST. CONC.	Q
031702-33-7	1-Propene, 1,1,3-trichloro-2	9.27	2900	J

Comments:

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(19-23)

Lab Name: Chemtech
Contract: SHAW03

Lab Code: CHEM
Case No.: X5722
SAS No.: X5722
SDG No.: X5722

Matrix (soil/water): WATER
Lab Sample ID: X5722-02

Sample wt/vol: 5.0 (g/mL) ml
Lab File ID: VG005602.D

Level (low/med):
Date Received: 12/5/06

% Moisture: not dec. 100
Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm)
Dilution Factor: 1.0

Soil Extract Volume: (uL)
Soil Aliquot Volume: (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS No.	Compound	ug/L	Q
74-87-3	Chloromethane	10	U
75-01-4	Vinyl chloride	2.5	J
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-35-4	1,1-Dichloroethene	3.2	J
67-64-1	Acetone	50	U
75-15-0	Carbon disulfide	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	10	U
75-34-3	1,1-Dichloroethane	23	
78-93-3	2-Butanone	50	U
56-23-5	Carbon Tetrachloride	10	U
156-59-2	cis-1,2-Dichloroethene	1.8	J
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	50	
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U
79-01-6	Trichloroethene	0.97	J
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	10	U
10061-02-6	t-1,3-Dichloropropene	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	10	U
127-18-4	Tetrachloroethene	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethyl Benzene	10	U
126777-61-2	m/p-Xylenes	10	U
95-47-6	o-Xylene	10	U
100-42-5	Styrene	10	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(19-23)

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-02

Sample wt/vol: 5.0 (g/mL) ml Lab File ID: VG005602.D

Level (low/med): Date Received: 12/5/06

% Moisture: not dec. 100 Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
75-25-2	Bromoform	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U

1E

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

BJH-GW-16(19-23)

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-02

Sample wt/vol: 5.0 (g/mL) mL Lab File ID: VG005602.D

Level (low/med): Date Received: 12/5/2006

% Moisture: not dec. 100 Date Analyzed: 12/7/2006

GC Column: RTX624 ID: 0.18 Dilution Factor: 1.0

Soil Extract Volume: Soil Aliquot Volume:

Number TICS found: 0 CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND	RT	EST. CONC.	Q

Comments:

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(45-49)

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-03

Sample wt/vol: 5.0 (g/mL) ml Lab File ID: VG005603.D

Level (low/med): Date Received: 12/5/06

% Moisture: not dec. 100 Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS No.	Compound	ug/L	Q
74-87-3	Chloromethane	10	U
75-01-4	Vinyl chloride	1.4	J
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-35-4	1,1-Dichloroethene	14	
67-64-1	Acetone	80	
75-15-0	Carbon disulfide	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	10	U
75-34-3	1,1-Dichloroethane	410	E
78-93-3	2-Butanone	15	J
56-23-5	Carbon Tetrachloride	10	U
156-59-2	cis-1,2-Dichloroethene	5.5	J
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	910	E
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U
79-01-6	Trichloroethene	12	
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	1.3	J
10061-02-6	t-1,3-Dichloropropene	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	10	U
127-18-4	Tetrachloroethene	1.4	J
108-90-7	Chlorobenzene	10	U
100-41-4	Ethyl Benzene	3.7	J
126777-61-2	m/p-Xylenes	10	U
95-47-6	o-Xylene	10	U
100-42-5	Styrene	10	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(45-49)

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM

Case No.: X5722

SAS No.: X5722

SDG No.: X5722

Matrix (soil/water): WATER

Lab Sample ID: X5722-03

Sample wt/vol: 5.0 (g/mL) ml

Lab File ID: VG005603.D

Level (low/med):

Date Received: 12/5/06

% Moisture: not dec. 100

Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm)

Dilution Factor: 1.0

Soil Extract Volume: (uL)

Soil Aliquot Volume: (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
75-25-2	Bromoform	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U

1E

VOLATILE ORGANICS ANALYSIS DATA SHEET

TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

BJH-GW-16(45-49)

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER

Lab Sample ID: X5722-03

Sample wt/vol: 5.0 (g/mL) mL

Lab File ID: VG005603.D

Level (low/med):

Date Received: 12/5/2006

% Moisture: not dec. 100

Date Analyzed: 12/7/2006

GC Column: RTX624 ID: 0.18

Dilution Factor: 1.0

Soil Extract Volume:

Soil Aliquot Volume:

Number TICS found: 1

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

	CAS NO.	COMPOUND	RT	EST. CONC.	Q
1.		Unknown14.77	14.77	14.52	J

Comments:

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(45-49)DL

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-03DL

Sample wt/vol: 5.0 (g/mL) ml Lab File ID: VG005614.D

Level (low/med): Date Received: 12/5/06

% Moisture: not dec. 100 Date Analyzed: 12/8/06

GC Column: RTX624 ID: 0.18 (mm) Dilution Factor: 10.0

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
74-87-3	Chloromethane	100	U
75-01-4	Vinyl chloride	100	U
74-83-9	Bromomethane	100	U
75-00-3	Chloroethane	100	U
75-35-4	1,1-Dichloroethene	100	U
67-64-1	Acetone	500	U
75-15-0	Carbon disulfide	100	U
75-09-2	Methylene Chloride	100	U
156-60-5	trans-1,2-Dichloroethene	100	U
75-34-3	1,1-Dichloroethane	300	D
78-93-3	2-Butanone	500	U
56-23-5	Carbon Tetrachloride	100	U
156-59-2	cis-1,2-Dichloroethene	100	U
67-66-3	Chloroform	100	U
71-55-6	1,1,1-Trichloroethane	570	D
71-43-2	Benzene	100	U
107-06-2	1,2-Dichloroethane	100	U
79-01-6	Trichloroethene	8.7	JD
78-87-5	1,2-Dichloropropane	100	U
75-27-4	Bromodichloromethane	100	U
108-10-1	4-Methyl-2-Pentanone	500	U
108-88-3	Toluene	100	U
10061-02-6	t-1,3-Dichloropropene	100	U
10061-01-5	cis-1,3-Dichloropropene	100	U
79-00-5	1,1,2-Trichloroethane	100	U
591-78-6	2-Hexanone	500	U
124-48-1	Dibromochloromethane	100	U
127-18-4	Tetrachloroethene	100	U
108-90-7	Chlorobenzene	100	U
100-41-4	Ethyl Benzene	100	U
126777-61-2	m/p-Xylenes	100	U
95-47-6	o-Xylene	100	U
100-42-5	Styrene	100	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BJH-GW-16(45-49)DL

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM

Case No.: X5722

SAS No.: X5722

SDG No.: X5722

Matrix (soil/water): WATER

Lab Sample ID: X5722-03DL

Sample wt/vol: 5.0 (g/mL) ml

Lab File ID: VG005614.D

Level (low/med):

Date Received: 12/5/06

% Moisture: not dec. 100

Date Analyzed: 12/8/06

GC Column: RTX624 ID: 0.18 (mm)

Dilution Factor: 10.0

Soil Extract Volume: (uL)

Soil Aliquot Volume: (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
75-25-2	Bromoform	100	U
79-34-5	1,1,2,2-Tetrachloroethane	100	U

1E

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

BJH-GW-16(45-49)DL

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-03DL

Sample wt/vol: 5.0 (g/mL) mL Lab File ID: VG005614.D

Level (low/med): Date Received: 12/5/2006

% Moisture: not dec. 100 Date Analyzed: 12/8/2006

GC Column: RTX624 ID: 0.18 Dilution Factor: 10.0

Soil Extract Volume: Soil Aliquot Volume:

Number TICS found: 0 CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND	RT	EST. CONC.	Q

Comments:

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

TRIPBLANK

Lab Name: Chemtech Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER Lab Sample ID: X5722-04

Sample wt/vol: 5.0 (g/mL) ml Lab File ID: VG005601.D

Level (low/med): ____ Date Received: 12/5/06

% Moisture: not dec. 100 Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: ____ (uL) Soil Aliquot Volume: ____ (uL)

CAS No.	Compound	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
74-87-3	Chloromethane	10	U
75-01-4	Vinyl chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-35-4	1,1-Dichloroethene	10	U
67-64-1	Acetone	50	U
75-15-0	Carbon disulfide	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	10	U
75-34-3	1,1-Dichloroethane	10	U
78-93-3	2-Butanone	50	U
56-23-5	Carbon Tetrachloride	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U
79-01-6	Trichloroethene	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	10	U
10061-02-6	t-1,3-Dichloropropene	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	10	U
127-18-4	Tetrachloroethene	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethyl Benzene	10	U
126777-61-2	m/p-Xylenes	10	U
95-47-6	o-Xylene	10	U
100-42-5	Styrene	10	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

TRIPBLANK

Lab Name: Chemtech

Contract: SHAW03

Lab Code: CHEM

Case No.: X5722

SAS No.: X5722

SDG No.: X5722

Matrix (soil/water): WATER

Lab Sample ID: X5722-04

Sample wt/vol: 5.0 (g/mL) ml

Lab File ID: VG005601.D

Level (low/med):

Date Received: 12/5/06

% Moisture: not dec. 100

Date Analyzed: 12/7/06

GC Column: RTX624 ID: 0.18 (mm)

Dilution Factor: 1.0

Soil Extract Volume: (uL)

Soil Aliquot Volume: (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS No.	Compound	ug/L	Q
75-25-2	Bromoform	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U

1E

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

TRIPBLANK

Lab Name: Chemtech
Contract: SHAW03

Lab Code: CHEM Case No.: X5722 SAS No.: X5722 SDG No.: X5722

Matrix (soil/water): WATER
Lab Sample ID: X5722-04

Sample wt/vol: 5.0 (g/mL) mL
Lab File ID: VG005601.D

Level (low/med):
Date Received: 12/5/2006

% Moisture: not dec. 100
Date Analyzed: 12/7/2006

GC Column: RTX624 ID: 0.18
Dilution Factor: 1.0

Soil Extract Volume:
Soil Aliquot Volume:

Number TICS found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND	RT	EST. CONC.	Q

Comments:

Summary Sheet
SW-846

SDG No.: **X5722** Order ID: X5722

Client: **Shaw E & I, Inc.** Project ID: SHAW03

Sample ID	Client ID	Matrix	Parameter	Concentration	C	RDL	MDL	Units
Client ID:	**BJH-GW-16(19-23)**							
X5722-02	BJH-GW-16(19-23)	WATER	Vinyl chloride	2.5	J	10	0.50	ug/L
X5722-02	BJH-GW-16(19-23)	WATER	1,1-Dichloroethene	3.2	J	10	0.50	ug/L
X5722-02	BJH-GW-16(19-23)	WATER	1,1-Dichloroethane	23		10	0.50	ug/L
X5722-02	BJH-GW-16(19-23)	WATER	cis-1,2-Dichloroethene	1.8	J	10	0.50	ug/L
X5722-02	BJH-GW-16(19-23)	WATER	1,1,1-Trichloroethane	50		10	0.50	ug/L
X5722-02	BJH-GW-16(19-23)	WATER	Trichloroethene	0.97	J	10	0.50	ug/L
			Total VOC's:	81.47				
			Total TIC's:	0.00				
			Total VOC's and TIC's:	81.47				
Client ID:	**BJH-GW-16(30-35)**							
X5722-01	BJH-GW-16(30-35)	SOIL	1,1-Dichloroethene	3.3	J	13	1.5	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	Acetone	120		67	4.8	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	Methylene Chloride	1.8	J	13	1.7	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	1,1-Dichloroethane	100		13	1.3	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	2-Butanone	6.5	J	67	7.2	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	1,1,1-Trichloroethane	140	E	13	1.4	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	Trichloroethene	9.0	J	13	1.3	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	Tetrachloroethene	4.9	J	13	1.6	ug/Kg
X5722-01	BJH-GW-16(30-35)	SOIL	Methyl 3,3-dichloropropenoat *	490	J	0	0	ug/Kg
			Total VOC's:	385.50				
			Total TIC's:	490.00				
			Total VOC's and TIC's:	875.50				
Client ID:	**BJH-GW-16(30-35)DL**							
X5722-01DL	BJH-GW-16(30-35)D	SOIL	Acetone	170	JD	330	23	ug/Kg
X5722-01DL	BJH-GW-16(30-35)D	SOIL	1,1-Dichloroethane	59	JD	66	6.2	ug/Kg
X5722-01DL	BJH-GW-16(30-35)D	SOIL	1,1,1-Trichloroethane	110	D	66	6.8	ug/Kg
X5722-01DL	BJH-GW-16(30-35)D	SOIL	Trichloroethene	11	JD	66	6.5	ug/Kg
X5722-01DL	BJH-GW-16(30-35)D	SOIL	Tetrachloroethene	4.7	JD	66	7.8	ug/Kg
			Total VOC's:	354.70				
			Total TIC's:	0.00				
			Total VOC's and TIC's:	354.70				

Note: The asterisk "*" flag next to a parameter signifies a TIC parameter.

Summary Sheet
SW-846

SDG No.:	**X5722**	Order ID:	X5722
Client:	**Shaw E & I, Inc.**	Project ID:	SHAW03

Sample ID	Client ID	Matrix	Parameter	Concentration	C	RDL	MDL	Units
Client ID:	**BJH-GW-16(45-49)**							
X5722-03	BJH-GW-16(45-49)	WATER	Vinyl chloride	1.4	J	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	1,1-Dichloroethene	14		10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	Acetone	80		50	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	1,1-Dichloroethane	410	E	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	2-Butanone	15	J	50	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	cis-1,2-Dichloroethene	5.5	J	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	1,1,1-Trichloroethane	910	E	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	Trichloroethene	12		10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	Toluene	1.3	J	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	Tetrachloroethene	1.4	J	10	0.50	ug/L
X5722-03	BJH-GW-16(45-49)	WATER	Ethyl Benzene	3.7	J	10	0.50	ug/L
			Total VOC's:	1454.30				
			Total TIC's:	0.00				
			Total VOC's and TIC's:	1454.30				
Client ID:	**BJH-GW-16(45-49)DL**							
X5722-03DL	BJH-GW-16(45-49)D	WATER	1,1-Dichloroethane	300	D	100	5.0	ug/L
X5722-03DL	BJH-GW-16(45-49)D	WATER	1,1,1-Trichloroethane	570	D	100	5.0	ug/L
X5722-03DL	BJH-GW-16(45-49)D	WATER	Trichloroethene	8.7	JD	100	5.0	ug/L
			Total VOC's:	878.70				
			Total TIC's:	0.00				
			Total VOC's and TIC's:	878.70				

Note: The asterisk "*" flag next to a parameter signifies a TIC parameter.

APPENDIX F

August Arrigo, PE

District Manager/ Project Director

District Manager and Sr. Project Director

Has successfully managed as many as 100 environmental remediation projects from design to construction and system start-up.

August Arrigo, PE, is a District Manager and SR. Project Director with Shaw Environmental & Infrastructure, Inc.'s Holbrook, New York, office. As a District Manager, Mr. Arrigo is responsible to manage the offices, staff, clients relationships, business development activity and operations of the New York Metro District, which consists of the Holbrook, New York City, New Rochelle, Harriman and Edison offices. The NY Metro District typically has annual revenues exceeding $20.0 million dollars and a staff of over 120 professionals in various engineering and other technical disciplines.

As a Project Director, Mr. Arrigo has successfully managed as many as 100 environmental remediation and infrastructure projects from design to construction and system start-up. His management responsibilities include defining work scopes, allocating resources, overseeing the project team, supporting technical design, and managing construction. His experience and knowledge in this area amounts to a recognized cost savings for clients.

Mr. Arrigo is also an experienced engineer with over 20 years of engineering design experience for environmental, infrastructure, water and wastewater treatment systems. He has worked for numerous public authorities on designing new and upgraded facilities.

Before joining Shaw Environmental & Infrastructure in 1998, Mr. Arrigo worked for H2M Group Consulting Engineers as a Senior Project Manager. There, he acquired an expertise in the design of power distribution and mechanical systems, instrumentation, and controls for municipal, institutional, and commercial facilities. Previous work experience also includes employment for Grumman Aerospace Corporation as an Instrumentation Engineer responsible for defining instrumentation requirements for the structural ground tests of aircraft.

Education

MBA, Management Concentration, Adelphi University, 1991
BT, Engineering Technology, State University of New York at Binghamton, 1985
AAS, Engineering Technology, State University of New York at Farmingdale, 1983

Registrations and Certifications

Professional Engineer (PE), New York, No. 070843

Academic and Professional Affiliations

American Water Works Association, Instrument Society of America

Experience and Background

Program Manager, Design/Construction, New York City Department of Design & Construction – Contract PW348-33 & PW 348-45

Managing investigations, design, contract preparation and construction activities of more than 130 sites throughout NYC related to capital improvements of a NYC-wide UST program. Responsibilities include subsurface investigation form both an environmental and a geotechnical prospective. Environmental Phase II and associated site delineation, evaluations and reporting is performed requires to establish environmental liability and recommendation for remedial actions. Geotechnical subsurface investigation work is performed to evaluate soil conditions and determine recommended type of subsurface foundation for the associated capital improvement.

Program Manager, Design/Construction, Operations and Maintenance, New York City Department of Design & Construction Contract PW348-21

Managing design, contract preparation, construction and operations and maintenance (O&M) activities of various remediation sites throughout NYC related to remediation of a NYC-wide UST program.

Program Manager, Construction, Operations and Maintenance, New York City Department of Design & Construction Contract PW348-23, PW348-24, PW348-25

Managing construction and operations and maintenance (O&M) activities of various remediation sites throughout NYC related to remediation of a NYC-wide UST program. Including installation of subsurface remediation borings, monitoring wells, recovery wells, injection wells and subsurface sampling using boring and direct push technologies.

Project Director, Investigation, Compliance, Remedial Design and Management of an Environmental Consulting Call Contract for New York City School Construction Authority

Managing investigations, design, contract preparation, client liaison and personnel resources for various NYC sites to support property evaluation, prepurchase audits and remedial recommendations. This program is a multiyear term contract requiring prompt response and proactive management. Coordination and negotiations between NYCSCA, Property Owner and NYSDEC is required to establish cleanup criteria.

Project Manager, Design/Construction, Operations and Maintenance, New York City Transit Authority

Managing design, construction and operations and maintenance (O&M) activities of several product recovery and groundwater treatment systems related to capital improvements to the UST program.

Project Manager, Design and Construction Management of a Large-Scale Groundwater Treatment Facility, Satellite Fuel Farm, Major Airport

Managing design and construction of a dual-phase high vacuum extraction treatment system for the recovery of jet fuel released from a bulk storage facility of a major New York Airport. System is designed and constructed to recovery total fluids and free phase product, provide separation and treatment to discharge standards. Total design and construction cost $2.6M.

Project Manager, Operations and Maintenance, Airport Terminal, NY

Managing operations and maintenance (O&M) activities of soil vapor extraction (SVE) and air sparge system for treatment of jet fuel released into the subsurface from a leaking hydrant fueling system.

Project Manager, Operations and Maintenance, Bulk Fuel Farm, Major Airport

Managing operations and maintenance (O&M) activities of high-vacuum extraction treatment of jet fuel released from a Bulk Fuel Farm facility of a major New York Airport. Total free product recovered to date exceeds 800,000 gallons.

Project Manager, Design and Construction Management of Two Large Scale Groundwater Treatment Facilities, Bulk Fuel Farm, Major Airport

Managing design and construction of two dual-phase high-vacuum extraction treatment systems for the recovery of jet fuel released from a Bulk Fuel Farm facility of a major New York Airport. System is designed and constructed to recover approximately 3.0 million gallons of free-phase product over a 3-year period. Total design and construction cost $8M.

Project Manager, Investigation, Design and Construction Management of environmental Remediation projects for Major Airlines at NYC Airports & Terminals

Managing Investigation, design and construction of a number of Remediation projects for Major Airlines at NYC airports and terminals ranging from UST remediation, Jet fuel hydrant systems, jet fuel storage systems, facility condition studies and implementation of remedial actions, Compliance audits and corrective actions, engineering support related to claims against terminal users, operators, owners and insurance companies.

Project Manager, H2M Group Consulting Engineers

- Managed and designed over 75 UST and AST petroleum storage facilities for various public municipalities.
- The systems included double-walled underground storage tanks complete with foundation and appropriate stability measures, primary and secondary piping, remote fill stations, dispenser stations, leakage and overfill alarms and remote alarm annunciators. The aboveground systems were designed with secondary containment, above- and below-ground single and double wall piping, leakage and overfill alarms and inventory control systems.
- The petroleum storage systems were primarily used by the municipalities for heating, primary fueling for emergency generators and fleet dispensing.
- Typical installations were for fire districts, water districts, wastewater districts, school districts, village and town public works departments.
- Managed and designed various public water treatment systems
- Designed public water supply treatment systems to treat VOC contamination with flow capacities up to 6000 gallons per minute (gpm). Technologies utilized included packed tower air strippers and Granular Activated carbon (GAC) responsibilities included definition of scope, cost, and finances. Managed engineering team, determined manpower allocation, provided technical and administrative leadership during design and construction.

- **Groundwater Remediation System Design, Petroleum Marketer, RI -** Designed groundwater remediation system for perimeter containment. Design included instrumentation and PLC control system, power distribution network, and mechanical design of piping and control valves.

- **Groundwater Remediation System Design, Petroleum Marketer, NY (Mobil Oil) -** Designed remediation system and off-site recovery for free product. Design included instrumentation and PLC control system design, power distribution network, and mechanical design of pumps, piping, tanks, and product storage tanks.

- **Design, Public Water Treatment System, Hicksville Water District, NY -** Designed public water supply treatment system to treat VOC contamination with flow capacity of 6000 gallons per minute (gpm). Defined scope, cost, and finances. Managed engineering team, determined manpower allocation, provided technical and administrative leadership during design and construction. System was constructed and initiated ahead of project schedule, directly correlating to cost savings for client.

- **Water Pump Station Design, Riverhead Water District, NY -** Designed water pump station, chemical feed system, and backup generator. Managed design of building, fuel tank, electrical distribution, instrumentation and control systems, and emergency power generator, as well as mechanical design of booster pumps, piping, and valves.

- **Booster Station Upgrade Design, Bethpage Water District, NY -** Designed electrical distribution network, as well as mechanical pump design and miscellaneous building and site renovations.

- **Water Storage and Booster Station Design, St. Albins Veterans Medical Center, NY -** Designed water storage and booster station, as well as accompanying buildings, tank and pump system, electrical distribution network, instrumentation and control systems, and emergency power generator.

- **Filtration System Design, Northport Veterans Medical Center, NY -** Designed public water supply filtration system, including accompanying buildings, electrical distribution network, and instrumentation and control systems.

- **Design of Supervisory Control and Data Acquisition System, Village of Garden City, NY -** Designed and constructed supervisory control and data acquisition system for entire public water supply system, which was comprised of pump stations and distribution systems. Managed engineering personnel, prepared bid documents, designed system, and managed all construction through operational testing. System was designed and constructed for less money than originally was anticipated. System was installed without impact to current operations and was brought on-line as scheduled. Enabled client to reassign resources to more important tasks on a daily basis.

Erik Gustafson

Professional Qualifications

Erik Gustafson is currently a Project Manager with Shaw Environmental & Infrastructure's Holbrook, New York office. As a Project Manager, Mr. Gustafson has successfully managed UST removals, hydraulic lift removals, Phase I ESA and Phase II ESA involving gasoline, fuel oil (nos. 2, 4 and 6), diesel, chlorinated organics, metals and PCBs. He has managed pilot testing, construction, and operation and maintenance of more than 20 remedial systems. His management responsibilities include defining work scopes, creating project teams, managing construction and investigational activities, serve as client liaison, and interact with environmental regulators.

Education

B.S., Environmental Science, Springfield College
M.S., Environmental and Waste Management, State University of New York at Stony Brook

Health and Safety Training

OSHA 40-Hour Hazardous Waste Activities Training (December 1997)
OSHA 8-Hour Waste Activities Refresher Training (annual)
OSHA 8-Hour Supervisor Training for Hazardous Waste Activities (June 2000)
OSHA 8-Hour Excavation and Trenching Safety Training (June 2000)
OSHA 8-Hour Supervisor Training for Confined Space Entry (June 2000)
Red Cross First Aid/CPR Certification (August 2006)

Experience and Background

July 1998 – Present
Project Manager, Shaw Environmental & Infrastructure, Inc., Holbrook, New York

Project Manager, Class 2 Inactive Hazardous Waste Site, Bulova Corporation, Sag Harbor, NY: Managed design and construction of an air sparge/soil vapor extraction system for the remediation of trichloroethylene-impacted soils and groundwater, and created and managed subsurface investigations including soil, groundwater, soil gas delineation and vapor intrusion into off-site buildings. Provided oversight of soil excavation within a confined area requiring guzzler extraction, shoring and air monitoring. Work is being completed as part of a NYSDEC Order on Consent.

Project Manager, Voluntary Cleanup Program Site, Bulova Corporation, Jackson Heights, NY: Project includes the completion a Remedial Investigation to assess the extent of chlorinated impacts to soil, soil gas, groundwater, and vapor intrusion into on- and off-site buildings; completion various treatability studies including an anaerobic biostimulation study, a bioaugmentation study, a chemical oxidation study, and a zero-valent iron study; completion of a biostimulation pilot study, preparation of a Remedial Action Work Plan, and the design of a biostimulation injection/recirculation system. This bioremediation system includes 48 extraction wells, 33 injection wells, and the remediation system enclosure. Work is being completed as part of a NYSDEC VCP Agreement.

Project Manager, Cortese Landfill, Narrowsburg, NY: Managed persulfate treatability study project. Activities included the development of a treatability study work plan for submission to the USEPA, collection of samples, and completion of persulfate bench scale testing.

Project Manager, Various Projects, AIG Consultants, Inc: Provided technical review of various projects involving the use of hydrogen peroxide, permanganate, biostimulation, bioaugmentation, duel-phase extraction, groundwater pump and treat, AS/SVE and others.

Project Manager, Trump New World Diesel Fuel Remediation Project, Manhattan, NY: Managed and conducted duel-phase high vacuum extraction remediation project. Activities included subsurface investigations, tidal effect study to determine effects of Hudson River tide on diesel fuel thickness levels within monitoring wells, and recovery of diesel fuel via vacuum truck extractions. Coordination required between client, regulatory agency, local unions, and NYC Department of Parks and Recreation. Work was completed as part of a NYSDEC Order on Consent.

Project Manager, Smithtown Cleaners, Smithtown, NY: Managed drywell excavation project with subsequent subsurface investigations and groundwater monitoring for tetrachloroethylene-impacted groundwater issue. Provided testimony as part of a civil suit against responsible party. Interacted with regulatory agencies and client’s attorney and insurance provider.

Project Manager, Retail Petroleum Sites: Managed tasks for 32 retail petroleum sites on Long Island, NY. Tasks include remedial investigations, preparation of remedial action workplans, corresponding with NYSDEC and remedial action.

Environmental Scientist, New York City Transit Authority Remediation Projects: Activities included oversight of construction activities and management of operations and maintenance (O&M) activities for several product recovery and groundwater treatment systems related to capital improvements to the UST program.

Environmental Scientist, Various PCB Investigations, KeySpan Corporation: Activities included the creation of work plans and implementation of PCB investigations for surficial and subsurface soils.

Project Manager, #7 IRT Extension Phase I Environmental Site Assessment, New York City Transit Authority: Managed and conducted Phase I ESA associated with the extension of the #7 subway line to the westside of Manhattan. Area of assessment included the area between 28th Street and 42nd Street and 8th Avenue to 12th Avenue.

Environmental Scientist and Project Manager, Various Phase I Environmental Site Assessments, Various Clients: Conducted and/or managed approximately 85 Phase I ESAs.

Environmental Scientist and Project Manager, Various Phase II Environmental Site Assessments, Various Clients: Conducted and/or managed approximately 35 Phase II ESAs. These Phase II sites include former manufactured petroleum gas (MGP) sites, NYSDEC Class 2 Inactive Hazardous Waste sites, Voluntary Cleanup Program (VCP) sites, dry cleaning facilities and retail petroleum. Media investigated include indoor air, groundwater, soil, soil gas, sludge, and river sediment samples. Types of contaminations investigated include volatile and semi-volatile organic compounds, metals (dissolved and total), PCBs, pesticides, herbicides and ethylene glycol.

Garrett Passarelli

Professional Qualifications

Garrett Passarelli is currently an Engineer with Shaw Environmental & Infrastructure's Holbrook, New York office and holds a Engineer in Training (EIT) certification through the state of Rhode Island. As an Engineer , Mr. Passarelli has been involved variety of Shaw's projects. His responsibilities range from the field to the office; which have included groundwater, soil, and air sampling, soil classification, air monitoring, in situ soil density testing via Troxler's nuclear density gauge, two and three dimensional AutoCADD drafting, reporting, and various envelope calculations.

Education

Bachelor of Science in Civil and Environmental Engineering, University of Rhode Island, Kingston, RI, June 2007

Professional and Honorary Affiliations

- Member, American Society of Civil Engineers (ASCE) (2004-2007)
- Member, Institute of Transportation Engineers (2005-2008)
- President of Chi Epsilon National Civil Engineering Honor Society (2006-2007)

Registrations/Certifications

- EIT Engineer in Training Certification, Rhode Island
- 40-Hour HAZWOPER
- Troxler Nuclear Gauge Safety Training

Experience and Background

June 2007- Present ***Shaw Environmental and Infrastructure Inc. Holbrook, NY***

Project Engineer:

Bulk Fuel Farm and Satellite Fuel Farm Long Term Remediation System Expansion at John F. Kennedy International Airport (August 2007 – Present): Responsible for all submittals to the Port Authority of New York and New Jersey that required per the projects specification manual. Submittals require information ranging from manufacturer specification sheets, various two and three dimensional CADD drafting, and envelope calculations. Accountable for writing the monthly operation and maintenance reports for the three remediation plants under this project. These reports summarize the plant performance through quantitative and qualitative data provided by plant operators, as well as report monthly sampling results.

Field Experience: Performed groundwater and soil sampling at Shaw project sites including John F. Kennedy Airport; the New York State Waste

Management Building in Hillburn, New York; and the Bulova Watch Factory located in Woodside, New York. Sampling was performed in conjunction with Geoprobes and hollow stem auger drill rigs.

Summer 2006 GZA GeoEnvironmental Inc. New York, NY

Engineering Internship:

Performed a variety of office and field tasks, including report preparation, CADD two and three dimensional drafting, length development calculations excavation volume estimation, pre-construction surveys, test pits, geophysical survey monitoring, and installation of inclinometers, strain gages, and crack gages.

Summer 2005 Alfonse Pesce Land Surveying, Holbrook, NY

Crew Member:

Responsible for several types of surveys including locating construction offsets, centerlines of steel columns, construction, as built, final, and topographical surveys for both commercial and residential clients.

Charles E. Schaefer Jr., Ph.D.

Professional Qualifications

Dr. Schaefer is a chemical engineer with experience in fate and transport of organic contaminants in saturated and unsaturated porous media. In particular, his studies have focused on pore-scale and interfacial phenomena. Dr. Schaefer has carried out bench-scale laboratory experiments and developed physically based numerical models to describe processes such as diffusion, sorption, interfacial mass transfer, and microbial growth and transport. Much of Dr. Schaefer's work has included work with NAPL systems, where he has worked on issues ranging from rate limited dissolution of chlorinated solvents, to co-solvent/surfactant flooding, to thermodynamic models that predict activity coefficients of hydrocarbon mixtures.

Since joining Shaw E&I, Dr. Schaefer has developed the conceptual design for AS/SVE systems, oxygen biosparging systems, and *in situ* bioremediation systems, and has developed several groundwater fate and transport simulations focusing on the natural attenuation of chlorinated and hydrocarbon compounds. Recently, he has performed several laboratory studies to evaluate the catalytic reduction of chlorinated and energetic compounds.

Education

Post-Doctoral Research Assistant**,** Petroleum and Environmental Engineering**, Stanford University,** CA, 1998

Ph.D.	Chemical and Biochemical Engineering, **Rutgers University**, NJ, October 1997
M.S.	Chemical and Biochemical Engineering, **Rutgers University**, NJ, January 1997
B.S.	Chemical and Biochemical Engineering, **Rutgers University**, NJ, May, 1993, honors program

Additional Training

- OSHA 40-hr. Hazardous Materials training
- OSHA Site Supervisor training

Continuing Education

2002 Land Recycling Program Client Workshop, Pennsylvania Department of Environmental Protection, Valley Forge, PA

Experience and Background

2001 -Present
Senior Engineer, Shaw E&I (formerly Envirogen, Inc.)
Lawrenceville, NJ
Responsible for technical oversight on several projects, and design of laboratory experiments. Responsibilities also include numerical fate and transport modeling, proposal writing, and research and development activities. Lead engineer in the conceptual design of Phase II air sparging, oxygen biosparging, and soil vapor extraction system at the Woodlands Superfund Site in Woodlands Township, NJ. Currently is the project manager for the Delaware Sand & Gravel Superfund Site in New Castle, DE.

1998 - 2000
Research Associate, Petroleum/Environmental Engineering Departments, Stanford University
Palo Alto, CA
Performed research in several areas, including evaluation of fluid-fluid interfacial areas in porous media, desorption of chlorinated compounds, diffusion through NAPL, and diffusion of CO_2 through hydrates. Managed several graduate and undergraduate students in the laboratory. Taught two graduate classes entitled "Groundwater Pollution and Oil Spills" and "Mass Transfer Processes in Environmental Systems". Obtained research grants from the DOE and EPA totaling over $230,000.

Professional Affiliations

American Chemical Society

Patents

"System & Method for Catalytic Treatment of Contaminated Groundwater or Soil", filed Nov., 2005 (*patent pending*)

Peer Review Publications

Schaefer, C.E., Condee, C.W., Vainberg, S., and Steffan, R.J., Transport, Growth, and Activity of *Dehalococcoides sp.* in Saturated Soil during Bioaugmentation of Chlorinated Ethenes, submitted to *Environ. Sci. Technol*

Schaefer, C.E. and Steffan, R., Use of a 1-Dimensional Diffusion Model to Estimate Mass Removal Rates in a Full-Scale Bioventing System, submitted to *J. Contam. Hydrol.*

Schaefer, C.E., Condee, C., and Steffan, R., Combined Treatment of N-Nitrosodimethylamine, Trichloroethene, and Nitrate in Groundwater using Nickel Catalysts, submitted to *Environ. Sci. Technol.*

Schaefer, C.E., Topoleski, C., and Fuller, M.E., "Effectiveness of Zero Valent Iron and Nickel Catalysts for Degrading Mixtures of Chlorinated Solvents and n-Nitrosodimethylamine in Groundwater", *Wat. Environ. Res*. 79, 57-62, 2007.

Schaefer, C.E., Fuller, M. Condee, C., Lowey, J,. and Hatzinger, P., "Comparison of Biotic and Abiotic Treatment Approaches for the Co-mingled Perchlorate, Nitrate, and Nitramine Explosives in Groundwater", *J. Contam. Hydrol*. 89, 231-250, 2007.

Fuller, M.E. Schaefer, C.E., and Lowey, J.M., "Degradation of explosive compounds using nickel catalysts", *Chemosphere* 67, 419-427, 2007.

Schaefer, C.E., Fuller, M.E., Lowey, J.M., and Steffan, R.J., "Use of Peat Moss Amended with Soybean Oil for Mitigation of Dissolved Explosive Compounds Leaching into the Subsurface: Insight into Mass Transfer Mechanisms", *Environ. Engineering Science,* 22:337-349, 2005.

Fuller, M.E., Lowey, J.M., Schaefer, C.E., and Steffan, R.J., "A peat moss-based technology for mitigating residues of the explosives TNT, RDX, and HMX in soil", *Soil & Sediment Contam.*, 14:373-385,2005.

Schaefer, C.E., Schuth, C., Werth, C.J., and Reinhard, M., "Binary Desorption Isotherms of TCE and PCE from Silica Gel and Natural Solids", *Environ. Sci. Technol.*, 34, 4341-4347, 2000.

Schaefer, C.E., DiCarlo, D., and Blunt, M.J., "Determination of Water-Oil Interfacial Area During Three-Phase Gravity Drainage in Porous Media", *J. Colloid Interface Sci*., 221, 308-312, 2000.

Schaefer, C.E. and Kosson, D.S., "Effect of a Trapped NAPL on the Diffusive Release of Organic Contaminants from Saturated Soils", *Environ. Engineer. Sci.*, 17, 129-138, 2000.

Schaefer, C.E., DiCarlo, D.A., and Blunt, M.J., "Experimental Measurement of Air-Water Interfacial Area during Gravity Drainage and Secondary Imbibition in Porous Media", *Water Resour. Res*., 36, 885-890, 2000.

Schaefer, C.E., Arands, R.R, and Kosson, D.S., "Measurement of Pore Connectivity to Describe Diffusion through a Nonaqueous Phase in Unsaturated Soils", *J. Contam. Hydrol*., 40, 221-238, 1999.

Schaefer, C.E., Roberts, P.V., and Blunt, M.J., "Measurement and Prediction of Effective Diffusivities through Spreading and Nonspreading Oils in Unsaturated Porous Media", *Environ. Sci. Technol*., 33, 2879-2884, 1999.

Schaefer, C.E., Unger, D.R., and Kosson, D.S., "Partitioning of Hydrophobic Contaminants in the Vadose Zone in the Presence of a Nonaqueous Phase", *Water Resour. Res*., 34, 2529-2537, 1998.

Schaefer, C.E., Arands, R.R, and Kosson, D.S., “Modeling of the Gaseous Diffusion Coefficient in the Presence of NAPL”, *J. Contam. Hydrol*., 33, 145-166, 1998.

Schaefer, C.E., Arands, R.R, van der Sloot, H.A., and Kosson, D.S., “Modeling of the Gaseous Diffusion Coefficient through Unsaturated Soil Systems”, *J. Contam. Hydrol*., 29, 1-21, 1997.

Unger, D.R., Lam, T.T., Schaefer, C.E., and Kosson, D.S., “Predicting the Effect of Moisture on Vapor-Phase Sorption of Volatile Organic Compounds to Soil”, *Environ. Sci Technol*, 30, 1081-1089, 1996.

Schaefer, C.E., Arands, R.R., van der Sloot, H.A., and Kosson, D.S., “Prediction and Experimental Validation of Liquid-Phase Diffusion Resistance in Unsaturated Soil”, *J. Contam. Hydrol*., 20, 145-166, 1995.

Steve Spates

Professional Qualifications

Mr. Spates is an Environmental Technician with over 17 years of experience. His technical experience involves the design, installation and maintenance of remediation systems including SVE, AS/SVE, and groundwater pump and treat systems.

Education

St. John Baptist H.S., Graduate 1975
Allan Bradley Electrical Training and P.L.C. Classes
Completed DuPont OSHA Safety Lock-Out/Tag-Out Course
Completed NEC Electrical Course

Registrations/Certifications

40-Hour OSHA Health and Safety Training
8-Hour OSHA Refresher, Annual
Confined Space Entry Certification

Experience and Background

January 2005 - Present, Sr. Environmental Technician, Shaw Environmental & Infrastructure, Inc.

- Oversee installation and complete maintenance of environmental remediation systems including groundwater depression/product recovery systems
- Developed control strategies for processes and drafted instrumentation diagrams and specifications detailing them.
- Created automation programming tools utilizing various platforms in order to automate information transfer processes.
- Sr. Technician, Kingsbridge Bus Depot, MTA New York City Transit Authority Construction, startup and operation and maintenance of a Pump and Treat remediation system.
- Sr. Technician, Jamaica Bus Depot, MTA New York City Transit Authority Construction, startup and operation and maintenance of a Pump and Treat remediation system.
- Sr. Logic Control Technician, JFK International Airport, Bulk and Satellite Fuel Farm
  PLC logic QC / QA, system startup, equipment functionality testing.

June 2003 – November 2004, Senior Field Technician, Roux Associates, Inc.

- Design, install and maintain remediation systems
- Underground storage tank removal
- Knowledge of PIDs and hand augers
- Soil and gas sampling

September 2001 – May 2003, Field Technician, Geologic Services Corp.

- Purchase, install and maintain remediation systems, including SVE, Air Sparge, Cat-Ox units, and GWPT systems
- Oversee contractors during trenching, directional drilling, well drilling and system installation
- Conduct pilot test and EFR events
- Remediation system with remote monitoring and complete data logging

March 1999 – November 2002, Neff-Perkins Corp.

- Technical consultant for Senior Engineer
- Troubleshooting

January 1988 – December 1998, Facilities/Equipment Maintenance Manager, T.R.W. Automotive Systems

- Specified, purchased, installed and maintained cooling towers, HVAC systems, pollution control systems, Hi/Low voltage, AC/DC electrical systems, roof repairs, foundation/support systems, chemical metering units, pumping stations, single and multistage filtering systems and parking area construction
- Interact with various government agencies to procure operation permits
- Manage multiple maintenance departments, including coordination of construction and maintenance with production scheduling for efficient operations
- Managed various facilities and equipment service contracts
- Researched, arranged and scheduled various technical training classes for up to 41 engineers, technicians and mechanics
- Assisted set-up of automated manufacturing facility in Chihuahua, Mexico

DOUGLAS W. WATT

POSITION SUMMARY

SHAW TITLE

Senior Consultant 1

LOCATION

Trenton, NJ, Lawrenceville, NJ

CONTRACT ASSIGNMENT

TBD

CONTRACT AVAILABILITY

TBD

TENURE WITH SHAW

13 years

TOTAL YEARS OF EXPERIENCE

30 years

EDUCATION

BS, Chemical Engineering, Drexel University; 1975

TRAINING

- 40 Hours of Classroom Health and Safety Training for Hazardous Materials/Waste Activities as required by OSHA 29 CFR Part 1910.120.
- 8 Hours Supervisor's Health and Safety Course for Hazardous Materials/Waste Activities as required by OSHA 29 CFR Part 1910.120.
- Supervisor's Training for Safe Transportation of Hazardous Materials as required by the Research and Special Programs Administration Rule HM-126P.

REGISTRATION

- Licensed Professional Engineer in the States of New Jersey (1981) 27394: New York (1989) 067824; and Pennsylvania, (1994), 42160-R.
- Certified by the New Jersey Department of Environmental Protection and Energy for Underground Storage Tank Closures and Subsurface Evaluations, 12835.

Qualifications Summary:

Mr. Watt possesses a total of 31 years experience in the design, development, and management of chemical processes and environmental remediation systems. Mr. Watt has seventeen years experience with environmental remediation, and his expertise includes hazardous waste and groundwater remediation design and management, and chemical/environmental engineering. He manages HTRW projects and specializes in systems design which implement mandated remedial actions. The remediation systems also include the design of treatment systems for recovered fluids like groundwater and extracted soil vapor. At the conclusion of plant construction, Mr. Watt commissions the groundwater and soil vapor extraction and treatment plants. Mr. Watt has worked in the United States, Canada, England, Scotland, Holland, and Kuwait.

Selected Relevant Experience:

1994 – PRESENT, ENGINEER, SHAW ENVIRONMENTAL & INFRASTRUCTURE, INC. (FORMERLY IT CORPORATION), TRENTON, NJ

- Revised the design of the Lockheed Martin biological Fluid Bed Reactor Treatment System to meet ANSI/NSF-61 drinking water standards. This is the first biological process to be used to treat perchlorate contaminated groundwater in the production of drinking water in the State of California. The ammonium perchlorate that was released was used as an oxidizer for solid rocket propellant.
- Improved the oxygen injection system design between the anerobic and aerobic fluid bed biological reactors at the North Island Treatment System, San Diego, California.
- Contributed to the design of multiple biological Fluid Bed Reactor Treatment Systems, meeting ANSI/NSF-61 drinking water standards. The biological processes are being used to treat perchlorate contaminated groundwater in the production of drinking water in the State of California.
- Updated the process control system of the USPS heat and ventilation system at Hamilton, New Jersey. The revised control system included a computer-based graphic display operator station. The updated control system was used to distribute chlorine dioxide throughout the USPS facility during the anthrax fumigation project.
- Engineer of Record for the remedial action treatment system designed to recover MTBE and gasoline constituents from the drinking water aquifer at Lehman, PA for the Pennsylvania Department of

Environmental Protection. The treatment system was designed to reduce the concentration of dissolved iron by dosing the influent groundwater with aluminum chlorhydrate. A low-profile air stripper was used to reduce the concentration of petroleum based contaminants from the groundwater. MTBE contaminants were recovered from the groundwater stream through contact with a mixed GAC and zeolite media.

- Engineer of Record for the remediation system designed to recover Navy Special Fuel Oil (a heavy No. 5 fuel oil) from the subsurface at the Navy's Fleet Industrial Supply Center at Yorktown, VA.

  A boiler produced steam to heat the subsurface to make the heavy oil easier to flow to the recovery wells. A number of steam heating and condensate return pipes were installed 30 feet below grade using horizontal drilling techniques to introduce heat from the steam to the oil. Groundwater was recovered from wells in the contaminated area to create an enhanced water table gradient. This gradient was used to increase the recovery rate of the heavy oil, as well as help direct the oil to the recovery well network. A portion of the groundwater that was recovered was clarified, reheated, and injected into the well-field, to magnify the water table gradient that was being used to direct the heavy oil to the recovery wells. Water that was not injected into the well field was cooled to meet the York River thermal discharge requirements.
- The treatment system includes a demineralization step to remove water hardness compounds. A dissolved air floatation vessel is also included to separate oil, biomass, and the precipitated metals from the demineralization reactions from the recovered groundwater. The treatment process completed with water polishing steps to recover remaining traces of oil and solids, VOC treatment, and thermal treatment of the treated discharge for infiltration back into the aquifer or to surface discharge.
- Technical contributions to this project included the design of the process from a clean sheet of paper to the final process drawings, process design calculations, process flow diagrams, process and instrumentation diagrams, equipment layout diagrams, equipment and piping materials of construction, complete process equipment, instrumentation, and process control specifications, and equipment procurement packages. 30%, 60%, 90%, and Final Design documents were also prepared, which included the Basis of Design Report, the Design Criteria Report, and the Remedial Action Work Plans.
- Task management duties were provided to additional process design engineers, and guidance to the Civil, Structural, Mechanical, and Electrical Design Engineers.
- As the Treatment Plant construction activities were being completed, plant-commissioning activities were begun. Process instruments were configured and calibrated, data communication between the programmable logic controller and the process instruments were verified, and the functionality of the supervisory control and data acquisition system (the operator's station) was verified. "As-built" documentation was provided.
- The treatment plant was brought on-line on-schedule, was technologically proven, and achieved an on-line availability in excess of 93% during the first month of operations.
- Engineer of Record / Task Manager for the for the Multiple-Phase Vacuum Extraction Remedy at the Lake City Army Ammunition Plant in Independence, MO. The remedial action addressed the concentration reduction of chlorinated solvents, light oil, aromatic and aliphatic compounds, ketones, and metals in the source area.
- The vacuum extraction system was designed to maximize the VOC concentration in the extracted vapor stream by operating the extraction wells in concert with molecular diffusion. This concept was

implemented by sequencing the extraction of soil vapor from one sixth of the wells at a time. Groundwater was recovered from the extraction wells with controllerless pneumatic well pumps.

- The groundwater treatment system addressed water hardness compounds so that the evaporative acid-gas scrubber process could use it and as boiler feed water. The boiler produced steam to heat the subsurface to increase the volatility of the organics and shorten the duration of the remedial action. The groundwater treatment process used sequencing batch reactors with activated sludge to reduce the VOC concentrations for compliance with the discharge criteria. The vapor treatment process used a thermal-catalytic oxidizer to reduce the VOC concentration to meet the air discharge permit requirements.
- Technical contributions to this project included the design of the process from a clean sheet of paper to the final process drawings, process design calculations, process flow diagrams, process and instrumentation diagrams, equipment layout diagrams, equipment and piping materials of construction, complete process equipment, instrumentation, and process control specifications, and equipment procurement packages. 30%, 60%, 90%, and Final Design documents were also prepared, which included the Basis of Design Report, the Design Criteria Report, and the Remedial Action Work Plans.
- Task management duties for technical, schedule, and budget were provided. Technical management was provided to the Process, Civil, Structural, Mechanical, and Electrical Design Engineers.
- The USACE issued a letter of commendation for this design effort.
- Designed the Dual Phase Vacuum Extraction Skid used for the Pilot Test at the U.S. Navy's Camp Allen Landfill in Norfolk, VA. Mr. Watt then collected the site data needed to establish the database for the scale-up to the full scale Dual Phase Vacuum Extraction Remediation System. Mr. Watt proceeded with and completed the design of the full scale Dual Phase Vacuum Extraction System. The full-scale process design included equipment selection and specification, materials of construction, and assembly details. Mr. Watt also designed the process instrumentation package, which included electrical power distribution details, process ladder logic, component layout and wiring details, instrument selection, installation procedures, and a detailed description of the enhanced process control logic algorithms.
- Provided detailed cost estimates, process optimization, and process design to implement the soil vapor extraction/air sparging system at Naval Submarine Base New London. This project was performed under IT's LANTDIV RAC. The soil vapor extraction/air sparging system was designed to recover chlorinated and non-chlorinated volatile organic compounds from the subsurface. The SVE systems included a total of 81 air sparge wells and 16 horizontal vacuum extraction laterals. The process optimization effort improved the effectiveness of the treatment system, and saved the U.S. Navy approximately $100,000 in equipment costs.
- Prepared the final specifications for the programmable logic controller (PLC) for the Groundwater Treatment Processes at the U.S. Navy's Camp Allen Landfill in Norfolk, VA, Allegany Ballistics Laboratory in Keyser, WV, the Fleet Industrial Supply Center in Yorktown, VA, and the Lake City Army Ammunition Plant in Independence, MO. The PLC for each groundwater treatment process was designed for automatic operation, which allowed for short visits by the plant operators. The sand filters and carbon treatment vessels for one project were designed to automatically detect the need for a backwash cycle, initiate the cycle, and return online to process by the control algorithms programmed in the PLC. Dilution of concentrated chemical feedstocks is also controlled by the PLC based on process demand.

- Provided project cost estimates for the process equipment and process instrumentation and control system at the U.S. Navy's Camp Allen Landfill in Norfolk, VA. This project was performed under IT's LANTDIV RAC. Mr. Watt developed the procurement specifications for the process instrumentation and control system, the chemical feed systems, and the Dual Phase Vacuum Extraction process. He managed the soil vapor extraction and groundwater process unit operations for the 300 gpm plant that included dissolved metal removal, sludge handling, and groundwater treatment.
- Designed a wastewater treatment system to remove dioxins and furans under a USACE contract at the Baird and McGuire Superfund site in Holbrook, MA. System components included metals precipitation; bag filtration with oil absorbing bags; and sand and carbon filtration. The 120 gpm system treated contaminated wastewater discharged from the on-site incinerator.
- Prepared the final process and instrumentation design for the sodium hydroxide, polymer, and sulfuric acid feed systems for the groundwater treatment process at the U.S. Navy's Camp Allen Landfill in Norfolk, VA. The final process design included equipment selection, materials of construction, and assembly details. The final instrumentation design included instrument selection, installation procedures, and a detailed description of the enhanced process control logic algorithms.
- Completed the conceptual and final process design and process implementation and control system for the groundwater treatment system at the Naval Amphibious Base, Little Creek, in Norfolk, VA. The site remediation system was designed to recover Navy Special Fuel Oil floating on the groundwater table adjacent to the ship piers. This project was performed under IT's LANTDIV RAC. Mr. Watt evaluated the most cost-effective process to either remove dissolved iron from groundwater or sequester the dissolved iron and keep it dissolved through the entire treatment process. He designed the remedial system based on the results of this study. Mr. Watt also prepared the process flow diagram, process and instrument diagram, and detailed construction drawings which are necessary to build the groundwater recovery and treatment system.
- Designed, installed, and calibrated the PLC based process control system for the groundwater treatment system at the Naval Air Warfare Center in West Trenton, NJ. Programmed and configured the GE Fanuc PLC. Calibrated the field instruments: pH sensors, differential pressure switches, etc. The PLC based process control system worked flawlessly on plant start-up. The process included a chemical pretreatment system, sludge handling systems, and water treatment system.
- Responsible for the Computer Monitoring and Control System (CMCS) for the 150 gpm groundwater treatment system at the Naval Air Warfare Center in Warminster, PA. An industrial PC based software program, Genesis for Windows, was configured for use as the process control system. This program, which was specified by the Navy, implemented control algorithms without the use of PLC hardware, which is typically used elsewhere in the process control industry.
- Led the plant commissioning effort for the groundwater treatment system at the Naval Air Warfare Center, Warminster, PA. The major challenge that was addressed during the plant start-up was to reduce the impact of damage cause by lightning strikes. The computer monitoring and control system included instruments and control functions a remote well field and pumping station 4,400 ft away from the treatment building. The computer control cable leading out to this area and the sensors, electronic modules, and control devices that were connected to it were easily damaged by lightning hits.
- Designed, installed, and commissioned the instrumentation system for the leachate collection system at the U.S. Navy's Russell Road Landfill in Quantico, VA. The automated instrument system was designed to notify base personnel of out-of-limits operation, which required their interaction.

- Responsible for final design activities for installation of a treatment process at the Allegheny Ballistics Laboratory in West Virginia. The design includes separation and dewatering of solids, UV oxidation, and carbon filtration to remediate approximately 5 acres of soil contaminated with metals and VOCs. Led the plant commissioning team which was responsible for instrument calibration, PLC data line communication verification, and unit operation performance testing. The plant commissioning activities allowed for an "armchair" plant start-up from the computer based Operator's Station that was on-schedule and on-budget, in terms of the budget and schedule established at the beginning of the project.

APRIL 1992 - APRIL 1994, SENIOR CHEMICAL ENGINEER, DAMES AND MOORE

- Designed a vacuum extraction and groundwater recovery/treatment system to remediate soil and groundwater contaminated with chlorinated and non-chlorinated volatile organic compounds in Rahway, NJ. Most of the contaminants present at the site were beneath the foundation of active process buildings. The processes were installed with minimal interference to on-going operations.
- Prepared the full scale vacuum extraction and groundwater treatment process design for the removal of perchloroethylene at several SJCC/GSC Superfund sites in Buena Borough, NJ. Mr. Watt also designed the instrument and process control system for the plant. The groundwater treatment system included chemical pre-treatment for dissolved iron, iron sludge filters and press, water treatment by stripping and activated carbon, and groundwater re-injection back into the aquifer. The vacuum extraction system included rotary lobe compressors, vapor dehumidification, and vapor treatment with activated carbon. The process control system included a PLC based algorithm designed to accommodate the buffering capacity of the groundwater as well as adjust its pH. Output to the chemical metering pumps combined a flow pace signal and pH trim signal based on the measured pH.
- Designed, installed, and implemented a turnkey vacuum extraction field investigation at a site in Monaca, Pennsylvania with complex geology. The field program evaluated the effectiveness of single-phase vacuum extraction in shallow soils with low permeability, two-phase vacuum extraction in deeper (30 feet) soils with high permeability, and two-phase vacuum extraction enhanced with air sparging near the groundwater table.
- Designed, installed, and operated a vacuum extraction system at a site in LaCrosse, WI. When stricter drinking water standards were adopted by the Wisconsin DNR, several municipal drinking water wells were no longer in compliance with the newly adopted standards. The vacuum extraction process, in conjunction with many piezometers located in varied radial directions, was used as an investigative tool to help identify a source or sources of trichloroethylene in the subsurface. Trichloroethylene sources were identified, and a clean-up timeframe between 6 and 12 months has been estimated to achieve site closure.
- Designed, installed, and operated an on-site, ex-situ bioventing system at a site in Hamilton Township, NJ to remediate benzene contaminated soil. The bioventing system utilized vacuum extraction equipment to sequentially extract soil vapor from ten vapor headers.
- Installed and operated a groundwater pump and treat system enhanced with two-phase vacuum extraction process to clean the soils and groundwater at a former machine tool manufacturing facility in Hamilton Township, NJ. The soil and groundwater at the site were contaminated with cutting oil, fuel oil, and chlorinated solvents. The two-phase vacuum extraction system performance in recovering the floating oil product exceeded expectations, negating the need to install a pneumatic product-only pumping system.

- Designed, installed, and operated a vacuum extraction and groundwater recovery/treatment system to remediate gasoline-contaminated soil and groundwater in St. Michaels, MD. The remedial system included air sparging, a complementary technology to vacuum extraction, for recovering the gasoline contaminants from groundwater. The remedial system is designed to recover the contaminants in the source area, as well as the contaminants that have migrated off-site.

JUNE 1989 - APRIL 1992, SENIOR CHEMICAL ENGINEER, TERRA VAC

- Designed, installed, and operated a full-scale remediation system at a gasoline service station in New Jersey. The system remediated the soils in the source area, and the groundwater plume, which had migrated off site. The groundwater recovery system was designed to capture the entire plume with an on site recovery well, including the portion of the plume which had migrated off site.
- Designed, installed, and operated a single-phase vacuum extraction system to remediate soils beneath a drum storage pad contaminated with paint lacquers and solvents at a manufacturing facility in Burlington, NJ. Clean-up goals were achieved after one year of operation.
- Prepared a detailed technical evaluation of 1,000 cfm vacuum extraction and groundwater recovery/treatment systems for the full scale remediation system for a site in Bridgewater, NJ. The full scale system was designed to cost-effectively remediate soil and groundwater contaminated with chlorinated volatile organic compounds. Vapor treatment technologies examined included granular activated carbon with carbon reactivation on-site with steam or inert gas, or carbon reactivation at an off-site location, thermal oxidation with acid gas scrubbing, and chloro-catalatic oxidation with acid gas scrubbing. Groundwater treatment systems considered included granular activated carbon as either primary treatment or as a polishing step, air stripping, and UV oxidation.
- Designed, constructed and operated an extensive computer-based process instrumentation package for a trailer-mounted soil vapor extraction remediation system. The mobile vacuum extraction system was manufactured for a client in Washington. Subsurface soils at this facility were contaminated with carbon tetrachloride. The computer-based process instrumentation package was capable of remote process operation and logged process data to disk. The process instrumentation monitored temperature, pressure, flow, VOC concentrations, and detectors for alpha, beta, and gamma particles.

MARCH 1982 - JUNE 1989, SUPERVISOR, PROCESS SIMULATION ENGINEERING / PROCESS ENGINEER, AUTODYNAMICS, INC.

- Completed real time, computer-based, dynamic process simulations for naphtha reformers, superheated steam generation, propane-butane distillation, ammonia synthesis, and hydrogen generation plants.
- Extensive process control experience and familiarity with Honeywell TDC 3000, Foxboro, Hartmann & Braun, and Taylor MOD 300 distributed control systems.

Professional Affiliations:

Instrument Society of America

American Chemical Society

New Jersey Society of Professional Engineers

APPENDIX G

QUALITY ASSURANCE PROJECT PLAN
75-20 ASTORIA BOULEVARD SITE
JACKSON HEIGHTS, QUEENS, NEW YORK
JANUARY 16, 2008

Consultant Project No.: 821687 **Revision: 0**

Reviewed/
Approved by: ______________________ Date: 4/14/08
Erik Gustafson
Shaw Environmental, Inc. Program Manager

Reviewed/
Approved by: ______________________ Date: 4/14/08
August Arrigo, P.E.
Shaw Environmental, Inc. Remedial Engineer

Reviewed/
Concurred by: ______________________ Date: 4/14/08
Michelle Henderson, CQA
Shaw Environmental, Inc. Quality Manager

TABLE OF CONTENTS

APPENDICIES

List of Acronyms

COC	Chain-of-Custody
CWP	Camilla Wood Preserving
EPA	Environmental Protection Agency
LRPCD	Land Remediation and Pollution Control Division
MnO_2	manganese dioxide
PAH	polyaromatic hydrocarbons
PCP	pentachlorophenol
MnO_4^-	permanganate ion
PL	Project Leader
PM	Project Manager
PO	Project Officer
PQAM	Program Quality Assurance Manager
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
R	Range
RSD	Relative Standard Deviation
SD	Standard Deviation
SOP	Standard Operating Procedure
TAG	Technology Applications Group
µg/L	micrograms per liter
U.S.	United States
WAM	Work Assignment Manager

A. Project Management

A.1 Distribution List

Sondra Martinkat	NYSDEC Project Officer	smmartin@gw.dec.state.ny.us
Erik Gustafson	Shaw Program Manager	erik.gustafson@shawgrp.com
August Arrigo, P.E.	Shaw Remedial Engineer	august.arrigo@shawgrp.com
Michelle Henderson	Shaw QAM, EPA Programs	michelle.henderson@shawgrp.com
	Shaw Laboratory	
	Chemtech Laboratory	
	Air Toxics, Ltd. Laboratory	

1.0 Scope

A.2 Project/Task Organization

Sondra Martinkat, is the New York State Department of Environmental Conservation's (NYSDEC) Project Manager. Ms. Martinkat will review and provide concurrence with project documents. Work will not begin before concurrence with this quality assurance project plan (QAPP) is provided.

Erik Gustafson, is the Shaw Project Manager (PM) and key contact for this Shaw contract. Mr. Gustafson's QA responsibilities will be responsible for day-to-day project activities, coordinating activities with the NYSDEC, LaGuardia Corporate Center Associates, Bulova Corporation, and Shaw project staff regarding project priorities, tasks, planning, and scheduling and overseeing test runs including calibration, data documentation, instrument servicing, data collection and personnel coordination.

Michelle Henderson, CQA, is the Shaw Manager of Quality. Ms. Henderson is responsible for the review of planning documents and assuring those documents meet or exceed the necessary QA requirements for the project.

August Arrigo, P.E., Shaw's Remedial Engineer. Mr. Arrigo's QA responsibilities include peer review and approval of documents and design plans.

Chemtech, Air Toxics, Ltd., and Shaw's Analytical Laboratories, will submit verified data reports to Mr. Gustafson and will be responsible for all subcontracted laboratory analyses.

Figure A-1 depicts the organizational chart for this project.

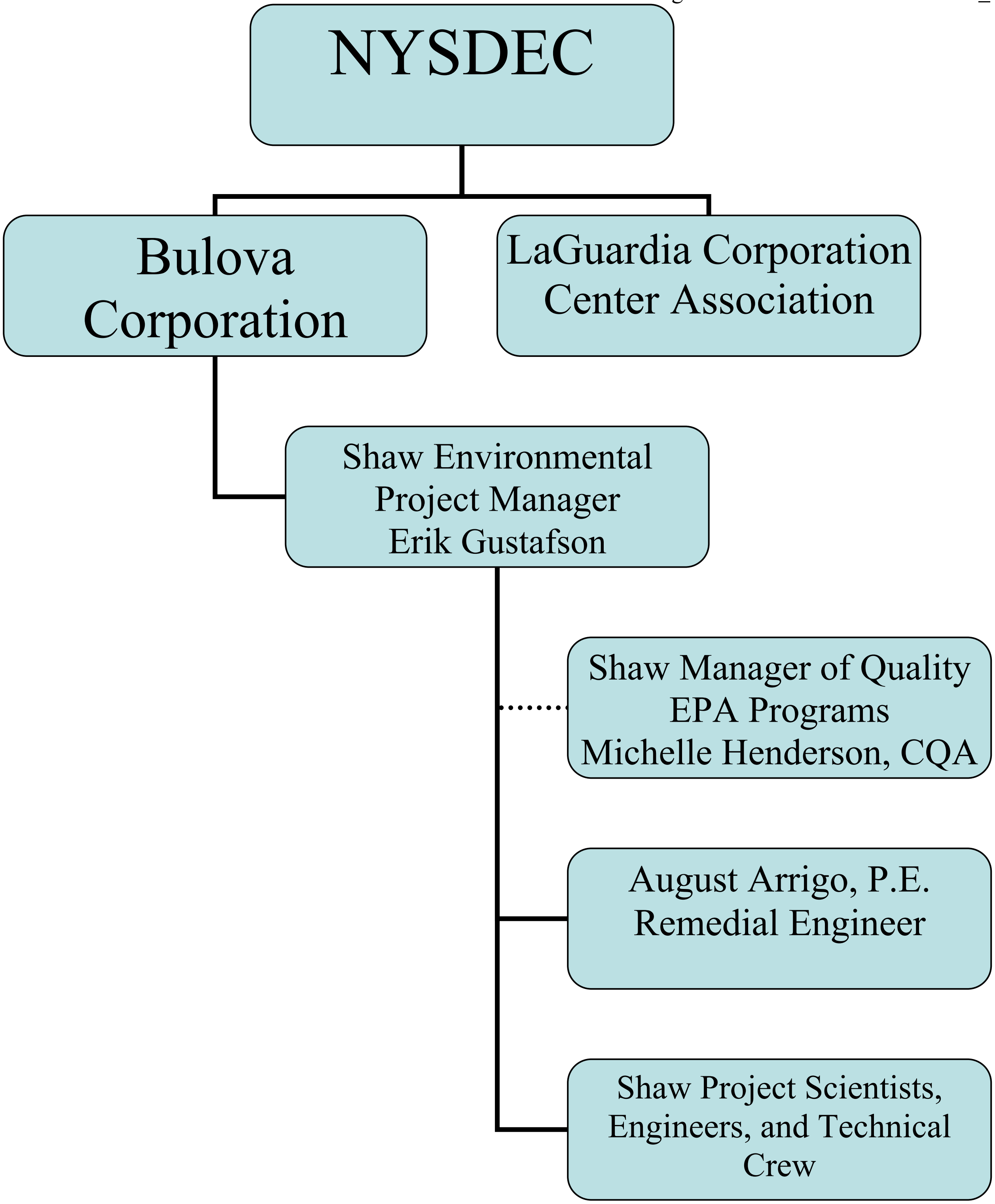

Figure A-1. 75-20 Astoria Boulevard Site Project Organization Chart

A.3 Problem Definition/Background

The Site is located at 75-20 Astoria Boulevard, Jackson Heights, Queens County, New York City, New York (Remedial Action Work Plan (RAWP), Figure 1).

In 1951, Bulova purchased the Site from Mow Bray Realtor. At that time, the Site was undeveloped. In 1952, Bulova developed the Site with a two-story building and a parking lot. Between 1952 and 1986, Bulova occupied the Site as its corporate headquarters, for research and development activities, and for the manufacturing of watch movements. In late 1985, the Site was sold to LaGuardia, which later developed the existing building by constructing a third floor and renovating the existing two floors into an office complex. LaGuardia has owned and operated the Site as an office complex since 1986.

During Bulova's occupancy chemicals were stored within underground storage tanks. The tanks have since been removed. Previous investigations completed at the Site have identified impacted soils and groundwater in the area approximate to the locations of those former tanks.

A.4 Project/Task Description

The purpose of this project is the reduction of Site contaminants as well as the implementation of engineering and institutional controls to protect public health from residual impacts that remain. A summary of the proposed remedy contained within the RAWP is as follows:

1. Composite Cover System: The existing composite cover cap in the vicinity of the former underground storage tanks and area of the plume will be maintained;

2. Treatment System: An in-situ bioremediation system will be constructed and operated to reduce contaminant levels;

3. Recording of Institutional and Engineering Controls within Deed Restrictions to be executed following approval of the Final Engineering Report. Included in the Deed Restrictions are the following:

    - Prohibition of vegetable gardens and farming at the Site;

- Prohibition of using groundwater underlying the Site without treatment rendering it safe for its intended purpose;
- Prohibition of using the Site other than for commercial purposes; and
- Prohibition of using the Site for a higher level of use, such as restricted residential, use without an amendment or extinguishment of the Deed Restrictions with NYSDEC approval.

4. Development of an approvable Site Management Plan that defines long-term Site management practices following implementation of the remedy, including 1) an Engineering Control Plan; 2) a Monitoring Plan; 3) an Operation and Maintenance Plan; and 4) a Reporting Plan; and

5. Submission of a Final Engineering Report documenting all elements of the Remedy.

A.5 Special Training Requirements/Certifications

Quality-related activities will be performed by personnel qualified on the basis of education, experience, and training. No special training or certifications are required for this project. Mr. Erik Gustafson will assure that the all personnel involved in this remedial action have documented training on this QAPP, the HASP and other methodology as needed.

A.6 Documentation and Records

Raw data from on-site remedial action activities will be contained in bound notebooks containing archival quality paper and/or logsheets as appropriate to the task. Analytical raw data will be contained on handwritten data sheets and/or bound laboratory notebooks, as analytical reports from Shaw's Laboratory or outside analytical laboratories, or computer-generated print-outs from computer-controlled equipment.

A.6.1 Data in Bound Notebooks

All entries in bound notebooks will be made in black ink and will be considered raw data. At the end of each day/page, the initials of the laboratory personnel responsible and date must be entered. All corrections must be initialed and dated at the time of correction. A note explaining the correction should be included, if the reason is not apparent.

A.6.2 Analysis Reports

All analytical reports from Shaw's analytical laboratory or subcontracted analytical laboratories will be maintained as raw data. Any corrections or additions to analytical reports previously received must be accompanied by a written explanation from the analytical laboratory. Only qualified Shaw personnel are allowed to make corrections to analytical reports from the Shaw Laboratory.

A.6.3 Computer Print-outs

Computer printouts from computer-controlled equipment will be maintained as raw data. The initials of the equipment operator and the date of generation will be added to each page of all such computer printouts. Regenerated printouts will be identified as such and any corrections noted.

B. DATA GENERATION AND ACQUISITION

B.1 Sample Collection and Quality Controls

B.1.1 Groundwater Sample Collection

B.1.1.1 Baseline Groundwater Sampling

Prior to activation of the in-situ bioremediation system, Shaw will perform full-scale baseline groundwater monitoring of twenty (20) monitoring wells to characterize the chemical, biological, and geochemical conditions within and around the treatment zone. Similar to the pilot test monitoring, two sampling events will be performed, one four weeks prior to amendment injection and one two weeks prior to amendment injection. A round of synoptic groundwater levels will be measured prior to commencement of sampling during each event. Each of the monitoring wells will be sampled during each event using standard low flow purge sampling techniques. A multi-parameter sampling meter (e.g., YSI 6920 or equivalent) will be implemented in the field to measure groundwater geochemical parameters including: ORP, DO, pH, turbidity, temperature, and conductivity.

These readings will not only be used to characterize the geochemistry of the groundwater at each well, but their stability will also serve as criteria for sample collection. Samples from each location will be analyzed for VOCs, Natural Attenuation Parameters (NAPs), and Volatile Fatty Acids (VFAs, including lactate). NAPs to be analyzed for include: Chloride, Nitrate, Methane, Ethane, Phosphate, Nitrite, Ethane, and Sulfate.

One trip blank will be analyzed for VOCs for each cooler.

A NYSDOH ELAP-certified laboratory, Chemtech, will conduct the VOC analysis, while Shaw’s in-house analytical laboratory will conduct the NAP and VFA analyses.

B.1.1.2 Full-scale Groundwater Monitoring

Monitoring of the twenty (20) monitoring wells within and around the full-scale treatment area will be implemented following activation of the in-situ bioremediation system, and will occur based on the following frequency:

- Months 1 through 6 – sample monthly;
- Months 7 through 12 – sample bi-monthly;
- Months 12 through system deactivation – sample quarterly; and

- Post-system monitoring – sample quarterly.

During each sampling event, the groundwater samples will be collected and analyzed for VOCs, Chloride, Nitrate, Methane, Ethane, VFAs, Sulfate, Nitrite, Ethane, and Phosphate. Sample analyses will be performed by Shaw's in-house analytical laboratory, with the exception of VOC sample analyses conducted for decision making purposes, which will be analyzed by Chemtech, a NYSDOH ELAP-certified laboratory.

NOTE: Sampling frequency, locations, and parameters will be re-evaluated throughout the full-scale operational period.

B.1.2 Air Quality Sample Collection

Although laboratory analytical data demonstrate that levels of VOCs inside and outside the Site building are below the NYSDOH guidelines, which NYSDOH established after an extensive evaluation of scientific information about health effects, some VOCs were identified in limited areas beneath the building under the concrete slab. To confirm future migration of these VOCs into the building does not occur, annual monitoring of the sub-slab, indoor and outdoor air will be completed.

A total of four (4) sub-slab sampling locations, four (4) indoor air sampling locations, and two (2) outdoor air sampling locations will be monitored on an annual basis, during the heating season. The proposed sub-slab and indoor sampling locations are depicted on Figure 26 of the RAWP. Air Toxics Ltd. of Folsom, CA, an ELAP-certified analytical laboratory, will report selected chlorinated VOCs in accordance with EPA Method TO-15.

B.1.2.1 Sub-Slab Air Sampling

To collect the sub-slab air samples, a 5/8-inch diameter hole will be drilled through the concrete slab using an electric drill. The drill bit will be advanced approximately 3-inches into the sub-slab material to create an open cavity. The vapor probe will consist of a length of 3/8-inch diameter Teflon™ tubing, which will then be inserted no farther than 2-inches into the sub-slab material. The tubing will be sealed to the surface with a non-VOC containing material consisting of permagum grout or beeswax or equivalent. Prior to collection of the sub-slab soil vapor samples, the tubing will be purged of 1-3 volumes to eliminate air within the tubing. During purging, a tracer gas (helium) will be used to verify the integrity of the seal. Purged air will not be discharged to the indoor air.

Following purging, the tubing will be attached to a 6L Summa canister fitted with an inline filter and an 8-hour flow regulator. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. Based on the sample volume of 6L and a sample period of 8 hours, the sub-slab samples will be collected at a flow rate of approximately 0.0125 liters per minute.

Following collection of the sub-slab foundation, the drilled hole in the foundation will be sealed with concrete slurry.

B.1.2.2 Indoor Air Sampling

Prior to the collection of indoor air samples, a pre-sampling inspection of each area to be sampled will be performed. These pre-sampling inspections will include the completion of a product inventory survey and an evaluation of the physical layout and conditions of the building. This information will be used to help identify conditions that may interfere with the proposed sampling study.

The four (4) indoor air samples will be collected as close to sub-slab sampling points as possible. At each sampling point, a 6L Summa canister fitted within an in-line filter and an 8-hour flow regulator will be placed at a level approximately three feet above the floor. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. During this 8-hour sampling period, all windows will remain closed and the facility's HVAC systems will operate as normal. Based on the sample volume of 6L and a sample period of 8 hours, the indoor air samples will be collected at a flow rate of approximately 0.0125 liters per minute.

B.1.2.3 Outdoor Air Sampling

Two (2) outdoor air samples will be collected concurrently with the indoor and sub-slab sampling. One sample will be collected near the HVAC air intake located on the north side of the building and one sample will be collected near the HVAC air intake located on the south side of the building. Samples will be collected away from wind obstructions and obvious sources of VOCs and at a height above the ground to represent typical breathing zones (i.e. 3 to 5 feet).

To collect the outdoor air samples, 6L Summa canisters fitted within an in-line filter and an 8-hour flow regulator will be used. Prior to opening the Summa canister, the initial vacuum will be noted. After 8 hours, the Summa canister will be closed and the final vacuum noted. Based on the sample volume of 6L and a sample period of 8 hours, the outdoor air samples will be collected at a flow rate of approximately 0.0125 liters per minute.

B.1.3 Soil Sampling

Once groundwater concentrations decrease to a point indicative of DNAPL no longer being present, soil sampling activities will commence. The purpose of the soil sampling activities is to confirm the DNAPL has been successfully remediated.

Soil samples will be collected within the silt layer at locations and depths approximate to the soil samples collected at GW-3, GW-8 and GW-17 via a Geoprobe® macro-core soil sampler. These locations represent the highest impacted areas identified during the Site investigation.

B.2 Sample Handling and Custody

A Shaw representative present at the site during sample collection activities will confirm that samples are collected, labeled, and shipped in accordance with the procedures specified in Appendix A.

Analysis of soil and groundwater samples, with the exception of some VOC samples to be analyzed by Chemtech, Mountainside, NJ, will be analyzed in-house at the Shaw Laboratory. Analysis of all air samples will be conducted by Air Toxics, Ltd of Folsom, CA. Packaging and shipping of samples will be conducted by staff specifically trained in DOT and IATA shipping regulations. Shaw formal chain of custody will be used for all samples.

B.3 Analytical Methods

All samples with the exception of the air analysis and some VOC samples will be analyzed at the Shaw Laboratory. Air samples will be submitted for analysis to Air Toxics, Ltd. The VOC analyses will be submitted to Shaw and Chemtech Laboratories for GC/MS analysis.

B.4 Quality Control

Table B-1 describes specific QA/QC activities for the various testing methods, including:

- Soil and water VOC analysis by EPA method 8260B, as performed by Chemtech and Shaw Laboratories;
- Air analysis using EPA Method TO-15 as performed by Air Toxics, Ltd;
- Water analysis for volatile fatty acids (VFAs), Chloride, Nitrate, Methane, Ethane, Phosphate, Nitrite, Ethane, and Sulfate analyses as performed by the Shaw Laboratory; and
- Dissolved oxygen (DO), turbidity, temperature, pH, oxidation-reduction potential (ORP) and specific conductivity collected during field activities through the use of a YSI 6820 water quality meter.

Table B-1. QA/QC Activities

Method	Type	Purpose	Frequency	Acceptance Criteria	Corrective Action
EPA Method SW-846, 8260B	Tune Check	Tune instrument prior to use	Each 12-hour shift	EPA Method 8260B criteria	Conduct mass calibration
	Initial Calibration (6 calibration standards)	Establish linearity	At beginning of analyses or when CCV indicates recalibration is needed	Linear regression with r ≥ 0.995 for each analyte	Re-calibrate, re-tune if necessary.
	Continuing Calibration (contains all compounds of interest)	Verify calibration is valid	Each sample batch	All targets ≤ 20%	Re-run (one-time), re-calibrate or re-tune if necessary.
	Blank	Verify no contamination	Daily or each 20 samples of same matrix	No target compounds detected above reporting limit	Investigate source of contamination. Re-extract and re-analyze.
	LCS (second source)	Verify accuracy	Daily or each 20 samples of like matrix	All targets ≤ 20%	Re-run (once), re-calibrate, if necessary.
	Surrogate Compounds	Verify that efficient extraction of samples has occurred	Spiked in each sample or run	Use SW-846 Method 8260B criteria	Investigate source of contamination. Re-extract and re-analyze.
	Matrix Spike	Verify ability to recover target compounds from matrix	Spiked one per 20 samples of like matrix	80-120% R for spiked compounds	Investigate source of contamination. Re-extract and re-analyze.
	Matrix Spike Duplicate	Determine precision	Spiked one per 20 samples of like matrix	20% RSD of MS	Investigate source of contamination. Re-extract and re-analyze.

Method	Type	Purpose	Frequency	Acceptance Criteria	Corrective Action
EPA Method SW-846, 8260B	Replicate samples	Determine accuracy	Every 20 samples	80-120% R	Investigate source of contamination. Re-extract and re-analyze.
EPA Method TO-15	GC/MS tuning with 4-bromofluoro-benzene (BFB)	Instrument tuning	Beginning of each 12 hour period during which standards and samples are analyzed.	Ion abundance criteria in Table 3 of Method TO-15	1. Identify the problem 2. MS tune criteria must be met before calibration.
	Initial Calibration (minimum blank = 5 points for each analyte)	Instrument calibration	Initially; whenever required, due to failure of CCV	RRFs ≥ 0.05 for each analyte; RSD for RRFs ≤ 30%	1. Terminate analysis 2. Recalibrate and verify before sample analysis
	Continuing calibration Verification (middle of the calibration range)	Verification of calibration	Following ICV, every 12 hours, and end of run	RRFs ≥ 0.05 for each analyte; %D between RRF of CCV and avg. RRFs from ICAL ≤ 30%	1. Recalibrate and verify 2. Reanalyze samples back to last good CCV
	CQRL Standard	Verification of calibration	Every 12 hours	65-135% of the expected value	1. Identify the problem 2. MS tune criteria must be met before calibration.
	Internal Standards (bromochloromethane, 1,4-Difluroro benzene, and chlorobenzene-d5	Verification of calibration	Every standard, sample, blank, and QC sample	IS area within ±40% of the IS area in the associated CCV	1. Investigate the system 2. Re-analyze all samples analyzed during a system malfunction

Method	Type	Purpose	Frequency	Acceptance Criteria	Corrective Action
EPA Method TO -15	Retention time evaluation	System check	Each analysis	± 0.50 minute of the IS retention time in the associated CCV	1. Re-calibrate and verify 2. Reanalyze samples back to last good CCV
Dissolved Oxygen, EPA Method 360.1 (Instrument YSI 6820)	Determine % Saturation by Barometric pressure method	Calibration of membrane electrode probe	At beginning and end of batch of analyses of same matrix	90-110% R	Prepare a fresh standard solution
	Replicate analysis	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Turbidity, EPA Method 180.1 (Instrument YSI 6820)	4-point calibration using HACH StablCal formazin in sealed vials	Instrument/ Method Calibration	At beginning of analyses or when QC indicates recalibration is needed	80-120% R	Recalibrate or obtain new meter.
	Blank	Verify no contamination	Daily or each 20 samples of same matrix	Turbidity not detected above reporting limit	Investigate source of contamination. Re-analyze.
	LCS (second source)	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 20%	Re-run (one-time), re-calibrate, if necessary.
	Replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Temper-ature EPA Method 170.1	Calibrate at least 3 points over range of expected use using a NIST traceable thermistor	Instrument calibration	Daily at the beginning and end of the analysis batch	± 0.3 ºC	Obtain new meter.

Method	Type	Purpose	Frequency	Acceptance Criteria	Corrective Action
	replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of problem, re-analyze.
pH, EPA Method 150.1 (Instrument YSI 6820)	2 point calibration	Establish linearity	At beginning of analyses or when CC indicates recalibration is needed	Instrument okays calibration and slope is r ≥ 0.995	Prepare fresh standard solutions and repeat
	LCS (second source)	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 20%	Re-run (one-time), re-calibrate, if necessary.
	Replicate analysis	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Oxygen Reduction Potential (ORP), Standard Method 2580 A (Instrument YSI 6820)	1-point calibration with Zobell solution	Calibration of Instrument	At beginning and end of batch or when QC indicates recalibration is needed	95-105 %R	Prepare a fresh standard solution
	replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Specific Conduct-ance, Standard Method 2510 A (Instrument YSI 6820)	Calibration with 1000 µS/cm standard	Instrument calibration	At beginning of analyses and end of batch or when QC indicates recalibration is needed	Accuracy ≥ 95%	Prepare a fresh standard solution
	LCS (second source 444 µS/cm standard)	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 10%	Re-run (one-time), re-calibrate, if necessary.
	replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Total Dissolved Solids,	Blank	Verify no contamination	Daily or each 20 samples of same matrix	No dissolved solids above reporting limit	Investigate source of contamination. Re-analyze.

Method	Type	Purpose	Frequency	Acceptance Criteria	Corrective Action
EPA Method 160.1	LCS	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 20%	Re-run (one-time), re-calibrate, if necessary.
	Replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Anions by IC EPA Method 300.0 (Total Phosphorus chloride, Nitrate, Nitrite, Sulfate)	Calibration	Method verification	At beginning of analyses or when CC indicates recalibration is needed	Accuracy ≥ 90%	Prepare a fresh standard solution and titrate again
	Laboratory Reagent Blank	Verify no contamination	Daily or each 20 samples of same matrix	No target compound detected above reporting limit	Investigate source of contamination. Re-analyze.
	Laboratory Fortified Blank	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 20%	Re-run (one-time), re-calibrate, if necessary.
	replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.
Alkalinity, EPA Method 310.1	Titration of standard persulfate solution	Method verification	At beginning of analyses or when CC indicates recalibration is needed	Accuracy ≥ 90%	Prepare a fresh standard solution and titrate again
	Blank	Verify no contamination	Daily or each 20 samples of same matrix	No target compound detected above reporting limit	Investigate source of contamination. Re-analyze.
	LCS (second source)	Verify accuracy	Daily or each 20 samples of like matrix	Targets ≤ 20%	Re-run (one-time), re-calibrate, if necessary.
	replicate	Verify accuracy	Daily or each 20 samples	80-120% R	Investigate source of contamination, re-analyze.

B.5 Instrument/Equipment Testing, Inspection, and Maintenance

Preventative and planned inspection and maintenance of sampling and laboratory equipment will be documented in the appropriate field and laboratory notebooks.

B.6 Instrument/Equipment Calibration and Frequency

Table B-1 describes specific calibration type and frequency for VOC analysis by EPA method 8260B performed by Chemtech and Shaw Laboratories, and VFA, Chloride, Nitrate, Methane, Ethane, Phosphate, Nitrite, Ethane, and Sulfate analyses at the Shaw Laboratory, and air analysis using EPA Method TO-15 by Air Toxics, Ltd.

B.7 Inspection/Acceptance for Supplies and Consumables

The procurement of the necessary items and services will be performed by authorized Shaw staff in accordance with Shaw Procurement Procedures and Federal Acquisition Regulations. The project staff, under direction of the Project Manager (PM), begins the procurement process by filling out a Procurement Requisition. The Procurement Requisition forms will be reviewed and approved by the Shaw PM or designee to ensure that the items or services meet the technical and quality standard and that they are provided by qualified vendors. Upon receiving of procured items or services, it is the PM or designee's responsibility to check and ensure that the items or services are of acceptable quality. This check is documented by signature and date on the packing slip. A hard copy of all procurement documents will be kept in the project folder.

B.8 Data Management

Records that furnish documentary evidence of procedural compliance (e.g., sample data, chain of custody, personnel training records, procurement documents) shall be specified, prepared, and maintained. Records shall be legible, identifiable, retrievable, and protected against damage, deterioration, and loss.

Sample data is stored in Excel format. Excel files and instrument laboratory data are backed up on CD monthly. Hard copy data and the CD are stored in a test data package in Central Files. A hard and a CD copy and of the final report will also be stored in Central Files.

C. Assessment and Oversight

C.1 Assessments and Response Actions

No internal audits have been scheduled by Shaw during the course of this project.

Corrective actions to any instruments will be the responsibility of the individual analyst. Any corrective actions needed to study procedures will be documented by the project team member, brought to the attention of the PM and the QAM. Procedures will be followed to ensure that corrective actions are documented, approved and implemented in a timely manner.

C.2 Reports to Management

Reports of corrective action will be submitted to the PM and the QAM. If issues negatively impact data or the project objectives the issue will be reported by the PM to the client.

D. Data Validation and Usability

D.1 Data Review, Verification, and Validation

Prior to issuing a final report, all pertinent raw data must be reviewed to ensure the data quality. The Laboratory Manager or appropriate designee must review all relevant laboratory notebook pages, computer printouts, and analytical reports. Any discrepancies in the raw data uncovered in this or any review must be immediately brought to the attention of the appropriate laboratory personnel and corrected. Data review begins with a review by the bench technician or laboratory analyst, as appropriate.

D.2 Data Verification and Validation

The PM or designee will conduct a verification of the raw data, calculations and QC requirements. The date and reviewer’s initials are placed on the reviewed data. Sample results are then entered into a Microsoft Excel spreadsheet and peer reviewed for transcription accuracy. It is not anticipated that formal data validation for calculations and transcription are required beyond the verification/peer review described.

D.3 Reconciliation with User Requirements

Results of analytical data will be reviewed against project objectives.

References

EPA Requirements for Quality Management Plans, EPA/240/B-01/002, March 2001

Quality Management System Plan (rev.2), Shaw Environmental and Infrastructure, February 2004

Standard Operation Procedure: Project Quality Plans, SOP-Q-003, Shaw Environmental and Infrastructure, May 2003

Draft DER-10 Technical Guidance for Site Investigation and Remediation, New York State Department of Environmental Conservation, December 2002

APPENDIX A

SHAW SAMPLING SOPs

EI-FS001: Field Log Book
EI-FS002: Field Log Sheet
EI-FS003: Chain of Custody Documentation-Paper
EI-FS005: Custody Seals
EI-FS006: Sample Labeling
EI-FS012: Shipping and Packaging of Non Hazardous Samples
EI-FS014: Decontamination of Contact Sampling Equipment
EI-FS020: Data Usability Review
EI-FS103: Soil Sampling using a Soil Probe or Core-Type Sampler
EI-FS110: Well Purging and Sample Preparation
EI-FS111: Low-Flow Sampling/Micro-Purge
EI-FS204: Water Quality Meter Use

STANDARD OPERATING PROCEDURE

Subject: **Field Logbook**

1. PURPOSE

This procedure is intended to communicate the requirements for selection, use, and maintenance of all field logbooks. Field logbooks are often used to document observations, sampling information, and other pertinent information on project sites. They are considered legal documents and should be maintained and documented accordingly as part of the project file.

2. SCOPE

This procedure is applicable to all Shaw E & I site operations where field logbooks are utilized to document all site activities and pertinent information.

3. REFERENCES

- Nielsen Environmental Field School, 1997, *Field Notebook Guidelines*

4. DEFINITIONS

- **Significant detail**—Any piece and/or pieces of information or an observation that can be considered pertinent to the legal reconstruction of events, description of conditions, or documentation of samples and/or sampling procedures.
- **Significant event**—Any event or events that could influence or be considered pertinent to a specific task or function and therefore require documentation in the Field Logbook.
- **Field Logbook**—Logbooks used at field sites that contain detailed information regarding site activities that must include dates, times, personnel names, activities conducted, equipment used, weather conditions, etc. Field logbooks can be used by a variety of different field personnel and are part of the project file.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (i.e. checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 General

Each site or operation, as applicable, will have one current Logbook, which will serve as an index of all activities performed at the site or in the task performance. The Logbook is initiated at the start of the first applicable activity. Summary entries are made for every day that covered activities take place. Multiple field logbooks may be used depending upon the number of different types of field personnel conducting work and the various activities at the site. These field logbooks and the site logbooks shall be made part of the project files.

Information recorded in field logbooks includes observations (significant events and details), data, calculations, time, weather, and descriptions of the data collection activity, methods, instruments, and results. Additionally, the field logbook may contain descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

6.2 Equipment and Materials

- Logbook(s), bound with numbered pages, hard-covered, waterproof preferred. One per project or separate significant task (example-treatment residual composite collection).
- Indelible black or dark blue ink pen
- Other items needed to perform required tasks: compass, ruler, calculator, etc.

6.3 Preparation

Site personnel responsible for maintaining field logbooks must be familiar with the SOPs for all tasks to be performed.

Field logbooks are project files and should remain with project documentation when not in use. *Personnel should not keep Field logbooks in their possession when not in use. Field logbooks should only leave the project site for limited periods, and they should always be returned to the site files or the designated on-site location (Sampler's Trailer, etc.)*.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the field logbook.

The front cover shall include the following information:

- Project Number
- Project Name and Task(s) included in logbook
- Dates covered by logbook—the starting date must be entered on the first day of use
- Logbook number—if more than one logbook will be needed to cover project/task(s)

The inside front cover shall contain a listing and sign-off of each person authorized to make entries and/or review the logbook. All persons who make entries or review/approve such entries must signify their authority to enter into the logbook via their signature and the date of their signing on the inside front cover. If initials are used for entries instead of full names, the initials must be entered beside the full name on the inside cover.

6.4 Operation

The following requirements must be met when using a field logbook:

- Record significant details and/or events, work, observations, material quantities, calculations, drawings, and related information directly in the field logbook. If data-collection forms are in use, the information on the form need not be duplicated in the field logbook. However, any forms used to record site information *must be referenced* in the field logbook.
- Information must be factual and unbiased.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Write in black or dark blue indelible ink.
- Do not erase, scribble over, or blot out any entry. Do not use White-Out or like correction items. Before an entry has been signed and dated, changes may be made; however, care must be taken not to obliterate what was written originally. Indicate any deletion by a single line through the material to be deleted. Any change shall be initialed and dated. Error codes (Attachment 1) should be added to the end of the deleted entry. All error codes should be circled.
- Do not remove any pages from the book.
- Do not use loose paper and copy into the field logbook later.
- Record sufficient information to completely document field activities and all significant details/events applicable to the project/task(s) covered by the logbook.
- All entries should be neat and legible.

Specific requirements for field logbook entries include the following:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial, date, and if used, code all changes properly.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
  a) Date and time
  b) Name of individual making entry
  c) Detailed description of activity being conducted including well, boring, sampling, location number as appropriate
  d) Unusual site conditions
  e) Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction and speed) and other pertinent data
  f) Sample pickup (chain-of-custody form numbers, carrier, time)
  g) Sampling activities/sample log sheet numbers
  h) Start and completion of borehole/trench/monitoring well installation or sampling activity

i) Health and Safety issues, such as PPE upgrades, monitoring results, near-misses, and incidents associated with the logbook areas

j) Instrumentation calibration details

Entries into the field logbook shall be preceded with the time of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In such cases, the field logbook must reference the automatic data record or form.

While sampling, make sure to record observations such as color and odor. Indicate the locations from which samples are being taken, sample identification numbers, the order of filling bottles, sample volumes, and parameters to be analyzed. If field duplicate samples are being collected, note the duplicate pair sample identification numbers. If samples are collected that will be used for matrix spike and/or matrix spike/matrix spike duplicate analysis, record that information in the field logbook.

A sketch of the station location may be warranted. All maps or sketches made in the field logbook should have descriptions of the features shown and a direction indicator. There must be at least one fixed point with measurements on any map drawn. Maps and sketches should be oriented so that north is towards the top of the page.

Other events and observations that should be recorded include (but are not limited to) the following:

- Changes in weather that impact field activities
- Visitors to the site associated with the covered task(s). Note their time of arrival and departure and provide a brief summary of their purpose on site.
- Subcontractor activities applicable to the covered task(s)
- Deviations from procedures outlined in any governing documents, including the reason for the deviation. Deviations from procedures must be accompanied with the proper authorization.
- Significant events that may influence data, such as vehicles in the vicinity of VOC sampling efforts
- Problems, downtime, or delays
- Upgrade or downgrade of personal protective equipment

6.5 Post-Operation

To guard against loss of data due to damage or disappearance of field logbooks, all original completed logbooks shall be securely stored by the project. All field logbooks will be copied at the end of each work shift and attached to the daily reports.

At the conclusion of each activity or phase of site work, the individual responsible for the field logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information, initialed, coded, and dated). The completed field logbook shall be submitted to the project records file.

6.6 Restrictions/Limitations

Field logbooks constitute the official record of on-site technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by Shaw personnel and their subcontractors. They are documents that may be used in court to indicate and defend dates, personnel, procedures, and techniques employed during site activities. Entries made in these notebooks should be factual, clear, precise, and as non-subjective as possible. Field logbooks, and entries within, are not to be utilized for personal use.

7. ATTACHMENTS

- Attachment 1, Common Data Error Codes

8. FORMS

None.

Attachment 1
Common Data Error Codes

COMMON DATA ERROR CODES

RE	Recording Error
CE	Calculation Error
TE	Transcription Error
SE	Spelling Error
CL	Changed for Clarity
DC	Original Sample Description Changed After Further Evaluation
WO	Write Over
NI	Not Initialed and Dated at Time of Entry
OB	Not Recorded at the Time of Initial Observation

All Error Codes should be circled.

STANDARD OPERATING PROCEDURE

Subject: Field Logsheet

1. PURPOSE

This procedure is intended to communicate the requirements for proper use and completion of Field Logsheets to document sample collection and data gathering activities. Field Logsheets are often utilized to document single location/event information. Examples include boring logs and drum/container logs. This procedure also provides several templates that *may* be utilized or modified to a particular need.

2. SCOPE

This procedure is applicable to all Shaw E & I projects where Field Logsheets are utilized to document data and/or sample collection information. This procedure does **not** mandate the use of Field Logsheets on all Shaw E & I data/sample collection efforts, and projects/programs are free to utilize other means (Field Logbooks, direct data entry, etc.) to document sample collection and other pertinent data gathering activities.

3. REFERENCES

- U.S. Environmental Protection Agency, 1998, *EPA Guidance for Quality Assurance Project Plans*, EPA/600/R-98/018, Washington, D.C.
- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, EM200-1-3, Washington, D.C.

4. DEFINITIONS

None

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (i.e. checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

Field Logsheets can be prepared to address the specific needs of each project and they can even be converted to laptop data entry forms. Field Logsheets are considered legally defensible, and all appropriate requirements must be observed.

6.1 Required Information

All Field Logsheets must contain entry lines for the following in addition to whatever sample/data gathering-specific information is desired:

- Site/Project Name
- Project Number
- Date (including time if required to properly document)
- Comments or Issues area to record any non-specified information pertinent to the sample/data collection effort
- Initial or signature line for person responsible for completion

6.2 Proper Completion/Use

Whenever Field Logsheets are utilized, the following requirements must be strictly followed and enforced:

- Field Logsheets are to be completed in **real-time.** They should not be filled out by transcription from another source.
- All corrections **must** be single-line cross-out with the initials of the person making the correction.
- All data/information areas **must** be completed. If an entry line/block is not applicable to a particular sample/data gathering effort, this must be indicated on the form by either a single line cross-out or the letters “NA” being written in the data line/block.

7. ATTACHMENTS

None.

8. FORMS

- Container Field Logsheet
- Soil/Sediment Field Logsheet
- Surface Water Field Logsheet
- Air Field Logsheet

Container Field Logsheet

(FS002.1_0)

Date: Time:

Site:

Container Number:

Project #:

Container Size:

Weather:

Container Location:

Photograph:

Container material of construction:			plastic	glass	metal	fiberboard
Container condition:		intact	bulging	leaking		
Lid type:	screw	bung	ring			
Lid material of construction:			plastic	glass	metal	fiberboard
Labels:	manufacturer:					
	address:					
	content name:					
	chemical name:					
	chemical formula:					
	other:					
Hazard	flammability:					
Label:	reactivity:					
	health:					
	other:					
PID:			Calibration Date:			
O2/LEL:			Calibration Date:			
Sampling Device:			Decontamination technique:			
Contents Description:						
	Amount:	1/4	1/2	3/4	full	
	Color:					
	State:	solid	liquid	paste	other:	
Sample Number:				Preservative:		
QC Samples:						
Analyses requested:						
Analytical Laboratory:						
Field Technician (Print):						
Comments:						

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Soil/Sediment Field Logsheet

(FS002.2_0)

Site Name: Project #:

Sample ID:	Sample Location Sketch:
Sample Type*:	
*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite	
Date Sampled:	
Time Sampled:	
Depth (ft bgs):	
Physical description:	
Analyses requested:	Photograph Log #:
PID:	Calibration Date:
O2/LEL:	Calibration Date:

Weather:

Temperature: ° F

Sampling Equipment:

Equipment Decontamination Technique:

QC Samples:

Analytical Laboratory:

Comments:

Field Technician: (Print) Date:

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Surface Water Field Logsheet

(FS002.3_0)

Site Name:

Project #:

Sample ID:

Date Sampled:

Time Sampled:

Depth (ft below surface):

Analysis	Preservative

Field Reading	Calibration Date
Sp cond:	
pH:	
Temp:	
D.O.:	
Turbidity:	

Sample Location Sketch:

Photograph Log #:

Weather:

Temperature: ° F

Sampling Equipment:

Equipment Decon Technique:

QC Samples:

Analytical Laboratory:

Comments:

Field Technician: (Print) Date:

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Air Field Logsheet

(FS002.4_0)

Site Name: Project #:

Sample ID:

Date Sampled:

Time Sampled:

Sampling Technique:

Analyses:

Field Reading	Calibration Date

Sample Location Sketch:

Photograph Log #:

Weather:

Temperature: ° F

Sampling Equipment:

Equipment Decon Technique:

QC Samples:

Analytical Laboratory:

Comments:

Field Technician: (Print) Date:

STANDARD OPERATING PROCEDURE

Subject: **Chain of Custody Documentation - Paper**

1. PURPOSE

The purpose of this procedure is to provide the requirements for completion of written Chain of Custody (COC) documentation and to provide a suggested Chain of Custody Form for project use.

2. SCOPE

This procedure is applicable to all Shaw E & I efforts where samples are transferred among parties, including to off-site testing facilities. Adherence to this procedure is not required whenever the same individual/team is performing the sampling and testing within the same workday, and transfer to the testing process is being documented by other means, e.g. sampling and then field-screening in a mobile laboratory.

3. REFERENCES

- U.S. Environmental Protection Agency, 1986, *Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846*, Third Edition.
- U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans*, EM200-1-3.
- Shaw E & I, 2002, *Sampler's Training Course Handout*.

4. DEFINITIONS

- **Custody**—The legal term used to define the control and evidence traceability of an environmental sample. A sample is considered to be in an individual's custody when it is in actual physical possession of the person, is in view of the person, is locked in a container controlled by the person, or has been placed into a designated secure area by the person.
- **Chain of Custody Form**—A form used to document and track the custody and transfers of a sample from collection to analysis or placement in a designated secure area within the testing facility.
- **COC Continuation Page**—Additional page(s) that may be included with a Chain of Custody form. The continuation page(s) contain the information on additional samples contained within the *same* cooler/shipping container associated with the cooler/shipping container Chain of Custody form.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw E & I employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 Documentation

All Chain of Custody documentation must be completed in indelible ink. All corrections must be performed using standard single-line cross-out methods, and the initials of the individual making the change must be included beside the corrected entry.

6.2 Continuation Pages

Continuation pages may be utilized for shipping containers/coolers with sufficient samples/sample containers that all of the lines of the Chain of Custody form are used before the documentation of the cooler/shipping container is complete. The number of pages in total must be filled out. *All samples entered onto a Continuation Page must be included in the same cooler/shipping container as those on the Chain of Custody form itself.*

6.3 Header Information

- Each Chain of Custody form must be assigned a unique Reference Document Number–use the Project/proposal number followed by a unique numeric sequence or current date (if only one cooler sent per day). Continuation Pages should contain the same Document Reference Number as the Chain of Custody form that they are associated with. The project team should maintain a log of Chain of Custody Reference Document Numbers.
- The page identifier and total page count section must be completed. Total pages include the Chain of Custody form and any attached Continuation Pages.
- Project number, name, and location information must be completed for all forms.
- If available, the laboratory Purchase Order Number should be included on the appropriate line.
- The name and phone number of the *Project Contact* should be included; the Project Contact should be a responsible individual that the laboratory may access to address analytical issues. This person is usually the analytical lead for the project.
- The *Shipment Date* should be provided on the applicable lines.
- If shipping by carrier, the *Waybill/Airbill Number* must be included. Note: couriers will not sign custody documents. Therefore, inclusion of the waybill/airbill number on the Chain of Custody is the *only* means of documenting the transfer to the carrier.
- Laboratory Destination and Contact information should be provided.

- The Sampler(s) names should be provided on the appropriate line. This line should include all persons whose initials appear on any of the sample containers, to provide the laboratory a means of cross-referencing containers.

- The “Send Report To” information should be completed. If multiple reports/locations are needed, the information should be provided on a separate page included with the Chain of Custody documents.

6.4 Sample Information Section–Including on Continuation Page(s)

During actual sampling, each sample must be entered on the COC form at the time of collection in order to document possession. The sampler must not wait until sampling is completed before entering samples on the COC.

- Complete the *Sample ID Number* for each line. If there are multiple container types for a sample, use additional lines to indicate the needed information.

- Ensure that the *Sample Description* matches the description on the sample label–the laboratory will use this information for cross-referencing.

- Provide the *Collection Date* and *Time*. These must match those on the sample label and Field Logbook/Logsheets.

- Indicate whether the sample is a Grab or Composite sample.

- Indicate the *Matrix* of the sample. Use the Matrix Codes listed on the Chain of Custody form.

- Indicate the *Number of Containers* and the *Container Type*. If a sample has multiple container types, use multiple lines and cross-out the information spaces to the left of the container blocks. *Failure to do this may cause the laboratory to log-in each container type as a separate sample/lab-ID, resulting in a confused report and invoice.*

  - Alternatively, if each sample has the same number/type container types, use “various” in the *Container Type* block and provide detail in the *Special Instructions* section, e.g., “Each sample consists of one 16-oz jar, two pre-weighed VOC w/DI water, and one pre-weighed VOC w/Methanol.”

- Check the appropriate *Preservative* box for each line/container type.

- Write in and check the *Analyses Requested* boxes for each line/container type. The appropriate method number (e.g., EPA Method 8260C) must be written as well as the method name.

- Indicate the *Turn-around Time Requested* for each sample.

- Use the *Special Instructions* section to provide important information to the laboratory, e.g., samples that may require dilution or samples that will need to be composited by the laboratory. This section may also be used to inform the laboratory of additional information contained in attachments to the Chain of Custody package.

- Circle the appropriate *QC/Data Package Level* requested.

6.5 Custody Transfer Section

- The first *Relinquished By* space must be completed by the individual who will either transfer the samples or seal the shipping container.

- If the samples will be transferred to a courier, write the courier/carrier company in the *Received By* box and enter the Date and Time that the shipping container was closed.
- All other transfers must be performed in person, and the Relinquisher must witness the signing by the Receiver.
- A copy of the Chain of Custody form and all associated Continuation Pages should be maintained in the project files.

7. ATTACHMENTS

None.

8. FORMS

- Shaw E & I Chain of Custody Form
- Shaw E & I COC Continuation Page

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FS003.1_0

Ref. Document # ____________________

Page _______ of ___

Shaw E & I Chain of Custody Form

Project Number: ____________________

Project Name / Location: ____________________

Purchase Order #: ____________________

Project Contact: ____________________
(Name & phone #)

Shipment Date: ____________________

Waybill/Airbill Number: ____________________

Lab Destination: ____________________

Lab Contact Name / ph. #: ____________________

Send Report To: ____________________

Phone/Fax Number: ____________________

Address: ____________________

City:

Sampler's Name(s): ____________________

		Collection Information						Preservative						Analyses Requested									
Sample ID Number	**Sample Description**	**Date**	**Time**	**G/C**	**Matrix**	**# of containers**	**Container type**	**HCL**	**NaOH**	HNO_3	H_2SO_4	**Ice**											**Turn Around Time Requested**

Special Instructions:

QC/Data Package Level Required:
I II III IV/Project Specific: ____________________

Relinquished By: Date: Time:	Received By: Date: Time:
Relinquished By: Date: Time:	Received By: Date: Time:
Relinquished By: Date: Time:	Received By: Date: Time:

G/C Codes

C = Composite
G = Grab

Matrix Codes

DW = Drinking Water
SO =Soil
GW = Ground Water
SL = Sludge
WW = Waste Water
CP = Chip Samples
SW = Surface Water
WP = Wipe Samples
LIQ = Other Liquid
SOL = Other Solid
AS = Air Sample
SED = Sediment

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Shaw E & I COC Continuation Page

COC Ref. Document # ____________________ **Page** ______ **of** ______

Project Number: ____________________ **Shipment Date:** ____________________

Project Name / Location: ____

		Collection Information						Preservative						Analyses Requested										
Sample ID Number	Sample Description	Date	Time	G/C	Matrix	# of containers	Container type	HCL	NaOH	HNO_3	H_2SO_4	Ice												Turn Around Time Requested

STANDARD OPERATING PROCEDURE

Subject: Custody Seals

1. PURPOSE

The purpose of this procedure is to provide the requirements for completion and attachment of Custody Seals on environmental samples and shipping containers.

2. SCOPE

This procedure is applicable to all Shaw E & I efforts where sample legal defensibility and custody integrity is desired. Adherence to this procedure is not required whenever the same individual/team is performing the sampling and testing within the same workday, and transfer to the testing process is being documented by other means, i.e. sampling and then field-screening in a mobile laboratory.

3. REFERENCES

- U.S. Environmental Protection Agency, 1986, *Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846*, Third Edition.
- U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans, EM200-1-3*
- Shaw E & I, 2002, Sampler's Training Course Handout.

4. DEFINITIONS

- **Custody**—The legal term used to define the control and evidence traceability of an environmental sample. A sample is considered to be in one's custody if it is in actual physical possession of the person, is in view of the person, has been locked in a container controlled by the person, or has been placed into a designated secure area by the person.
- **Custody Seal**—Commercially available thin strips of adhesive paper with write-in lines for the date/time and identification of the using party. Custody seals are placed over the caps of sample containers and along the cover seals of shipping containers as a means to detect tampering before arrival at the testing facility. All Shaw E & I strategic alliance laboratories provide Custody Seals in their sample container supply kits.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw E & I employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw E & I employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (i.e. checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 Completing the Custody Seal Information

- All Custody Seals must be completed in indelible ink. All corrections must be made using standard single-line cross-out methods, and the initials of the individual making the change must be included beside the corrected entry.
- Each Custody Seal attached must be completed by writing the *Date*, at a minimum, and signing with *full signature* by the person responsible for the sealing of the sample.
- If a space is provided, the *Time* should also be added.

6.2 Attaching the Custody Seals

Whenever possible, custody seals should be attached over the sample container lids during actual sampling and not when the samples are packaged for shipment. This will provide confidence in legal custody and will demonstrate non-tampering during the sample collection process.

Do not attach custody seals to VOC sample containers, as contamination may occur. For these samples, the custody seal should be used to seal the folded plastic zip bag that holds the sample containers.

- For sample jars, the completed Custody Seal should be placed across the top of the lid with the edges below the lid/jar interface and attached to the jar material. This will require the visible breaking of the seal in order to open the container.
- Sample coolers and shipping containers should have Custody Seals attached in such a manner that the seal extends lengthwise from the top edge of the lid to the side of the cooler/container.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Sample Labeling

1. PURPOSE

The purpose of this procedure is to provide the requirements for completion and attachment of sample labels on environmental sample containers.

2. SCOPE

This procedure is applicable to all Shaw E & I projects/proposals where samples will be collected.

3. REFERENCES

- U.S. Environmental Protection Agency, 1986, *Test Methods for Evaluating Solid Waste; Physical/Chemical Methods*, SW-846, Third Edition.
- U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans*, EM200-1-3
- Shaw E & I, 2002, Sampler's Training Course Handout.

4. DEFINITIONS

- **Sample Label**—Any writing surface with an adhesive backing that can be used to document sample identification information. The sample label is attached to the sample container as a means of identification and, in some commercially available or laboratory-supplied containers, may be pre-attached. All Shaw E & I strategic alliance laboratories provide sample labels or pre-labeled containers in their sample container supply kits.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw E & I employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw E & I employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (i.e. checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

- All sample labels must be completed in indelible ink. All corrections must be performed using standard single-line cross-out methods, and the initials of the individual making the change must be included beside the corrected entry.
- Sample labels should be completed and attached as samples are collected. Do not wait until final packaging to attach and/or complete the sample labels.
- Sample labels must be attached to the non-sealing portion of the container. Do not place labels on or across sample container caps.
- If the laboratory has provided pre-labeled containers, make sure to fill one for each parameter set needed. Laboratory pre-labeled containers are often bar-coded and it is important to provide a complete container set for each sample.
- The following information must be recorded on the Sample Label:
  - Sample Identification Number
  - Date and Time collected
  - Initials of person(s) responsible for collection
- If a space is provided, the *Analysis Requested* should also be added.
- If a *Description* is provided, remember it must match that on the Chain of Custody form for cross-referencing purposes.
- Cover the completed and attached label with clear plastic tape to prevent bleeding of the ink if it becomes wetted. *Do* ***not*** *perform this step for pre-weighed VOC vials, as the final weight values will be influenced by the mass of the tape. Protect these containers by enclosing the rack/holder in a plastic bag within the cooler.*

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Shipping and Packaging of Non Hazardous Samples

1. PURPOSE

The purpose of this procedure is to provide general instructions in the packaging and shipping of non-hazardous samples. The primary use of this procedure is for the transportation of samples collected on site to be sent off site for physical, chemical, and/or radiological analysis.

2. SCOPE

This procedure applies to the shipping and packaging of all non-hazardous samples. Non-hazardous samples are those that do not meet any hazard class definitions found in 49 CFR 107-178, including materials designated as Class 9 materials and materials that represent Reportable Quantities (hazardous substances) and/or materials that are not classified as *Dangerous Goods* under current IATA regulations.

In general most soil, air, and aqueous samples, including those that are acid or caustic preserved do **not** qualify as *hazardous materials* or *dangerous goods*. An exception is methanolic soil VOC vials: these containers are flammable in any quantity and **must** be packaged, shipped, and declared as *Dangerous Goods* whenever transported by air.

The Class 9 “Environmentally Hazardous” designation should only be applied to samples if they are known or suspected (via screening) to contain a sufficient concentration of contaminant to pose a health and/ or environmental risk if spilled in transport. Samples for which screening has shown a potential hazard (i.e. flammability) or those that are derived from a known hazard, including a site/facility with confirmed contamination by an *infectious substance* must also be shipped in accordance with the applicable DOT/IATA requirements. Refer to Shaw E & I SOP FS013.

Improper shipment of hazardous materials, especially willful misrepresentation and shipment as non-hazardous materials, is a violation of federal law and is punishable by fines and possible imprisonment of the guilty parties. It is also a violation of Shaw E & I policy and can result in disciplinary action up to and including termination of employment.

3. REFERENCES

- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, EM200-1-3, Washington, D.C.
- U.S. Department of Transportation Regulations, 49 CFR Parts 108-178
- International Air Transport Association (IATA), *Dangerous Goods Regulations*, current edition.

4. DEFINITIONS

- **Cooler/Shipping Container**—Any hard-sided insulated container meeting DOT’s or IATA’s general packaging requirements.
- **Bubble Wrap**—Plastic sheeting with entrained air bubbles for protective packaging purposes.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be sent to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (i.e. checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 Packaging

- Use tape and seal off the cooler drain on the inside and outside to prevent leakage.
- Place packing material on the bottom on the shipping container (cooler) to provide a soft impact surface.
- Place a large (30-55 gallon or equivalent) plastic bag into the cooler (to minimize possibility of leakage during transit).
- Starting with the largest glass containers, wrap each container with sufficient bubble wrap to ensure the best chance to prevent breakage of the container.
- Pack the largest glass containers in the bottom of the cooler, placing packing material between each of the containers to avoid breakage from bumping.
- Double-bag the ice (chips or cubes) in gallon- or quart-sized resealable plastic freezer bags and wedge the ice bags between the sample bottles.
- Add bagged ice across the top of the samples.
- When sufficiently full, seal the inner protective plastic bag, and place additional packing material on top of the bag to minimize shifting of containers during shipment.
- Tape a gallon-sized resealable plastic bag to the inside of the cooler lid, place the completed chain of custody document inside, and seal the bag shut.
- Tape the shipping container (cooler) shut using packing tape, duct tape, or other tear-resistant adhesive strips. Taping should be performed to ensure the lid cannot open during transport.
- Place a custody seal on two separate portions of the cooler, to provide evidence that the lid has not been opened prior to receipt by the intended recipient.

6.2 Labeling

- A "This Side Up" arrow should be adhered to all sides of the cooler, especially ones without obvious handles.
- The name and address of the receiver and the shipper must be on the top of the cooler.
- The airbill must be attached to the top of the cooler.

6.3 Shipping Documentation

- A Cooler Shipment Checklist (Attachment 1) should be completed and kept in the project file.

7. ATTACHMENTS

- Attachment 1, Shaw E & I Cooler Shipment Checklist

8. FORMS

None.

Attachment 1
Shaw E & I Cooler Shipment Checklist

Shaw™
Shaw E & I, Inc.

Project Name ______________________ Project Number _______________
Address ______________________ Date ________ Time ________
City, State, Zip ______________________ Fax No. ____________________
Site Contact No. ______________________

SAMPLE CHECKLIST	YES	NO	COMMENTS
SAMPLE LIDS ARE TIGHT AND CUSTODY SEALS IN PLACE?	☐	☐	______________________
ARE ALL SAMPLE NUMBERS, DATES, TIMES AND OTHER LABEL INFORMATION LEGIBLE AND COMPLETE?	☐	☐	______________________
HAVE ALL SAMPLE NUMBERS, DATES, TIMES AND OTHER SAMPLING DATA BEEN LOGGED INTO THE SAMPLE LOG BOOK?	☐	☐	______________________
DO SAMPLE NUMBERS AND SAMPLE DESCRIPTIONS ON THE LABELS MATCH THOSE ON THE COC?	☐	☐	______________________
HAVE THE SAMPLES BEEN PROPERLY PRESERVED?	☐	☐	______________________
HAVE THE CHAIN OF CUSTODIES BEEN FILLED OUT COMPLETELY AND CORRECTLY?	☐	☐	______________________
DOES THE ANALYTICAL SPECIFIED ON THE COC MATCH THE ANALYTICAL SPECIFIED IN THE SCOPE OF WORK?	☐	☐	______________________
HAVE THE COC'S BEEN PROPERLY SIGNED IN THE TRANSFER SECTION?	☐	☐	______________________

PACKAGING CHECKLIST	YES	NO	COMMENTS
HAS EACH SAMPLE BEEN PLACED INTO AN INDIVIDUAL PLASTIC BAG?	☐	☐	______________________
HAS THE DRAIN PLUG OF THE COOLER BEEN TAPED CLOSED WITH WATER PROFF TAPE FROM THE INSIDE?	☐	☐	______________________
HAVE ALL THE SAMPLES BEEN PLACED INTO THE COOLER IN AN UPRIGHT POSITION?	☐	☐	______________________
IS THERE ADEQUATE SPACING OF SAMPLES SO THAT THEY WILL NOT TOUCH DURING SHIPMENT?	☐	☐	______________________
HAVE AN ADEQUATE NUMBER OF BLUE ICE PACKS OR WATER ICE BEEN PLACED AROUND AND ON TOP OF THE SAMPLE?	☐	☐	______________________
HAS FRESH BLUE ICE OR WATER ICE BEEN ADDED TO THE COOLER THE DAY OF THE SHIPMENT?	☐	☐	______________________
HAS THE COOLER BEEN FILLED WITH ADDITIONAL CUSHIONING MATERIAL?	☐	☐	______________________
HAS THE COC BEEN PLACE IN A ZIPLOCK BAG AND TAPED TO THE INSIDE OF THE LID OF THE COOLER?	☐	☐	______________________
HAVE CUSTODY SEALS BEEN PLACED ONTO THE LID?	☐	☐	______________________
HAS THE COOLER BEEN LABELED "THIS SIDE UP"?	☐	☐	______________________
IF REQUIRED, HAS THE COOLER BEEN LABELED WITH THE DOT PROPER SHIPPING NAME, UN NUMBER AND LABEL?	☐	☐	______________________
HAS THE LABORATORY PERFORMING THE ANALYSES BEEN NOTIFIED OF THE SHIPMENT OF SAMPLES?	☐	☐	______________________

PROBLEMS/RESOLUTIONS: ____

____

____

PREPARED BY: ____________________________ SIGNATURE ______________________________

STANDARD OPERATING PROCEDURE

Subject: Decontamination of Contact Sampling Equipment

1. PURPOSE

This procedure is intended to provide minimal guidelines for the decontamination of contact sampling equipment. Contact sampling equipment is equipment that comes in direct contact with the sample or the portion of a sample that will undergo chemical analyses or physical testing.

2. SCOPE

This procedure applies to all instances where non-disposable direct contact sampling equipment is utilized for sample collection and no project-specific procedure is in place. This procedure is not intended to address decontamination of peristaltic or other sampling pumps and tubing. The steps outlined in this procedure must be executed between each distinct sample data point.

3. REFERENCES

- U.S. Environmental Protection Agency, Region 4, 2001, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, 980 College Station Road, Athens, Georgia. November.
- US Army Corp of Engineers, Washington, D.C., 2001, Requirements for the Preparation of Sampling and Analysis Plans (EM-200-1-3), February.

4. DEFINITIONS

- **Soap**—A standard brand of phosphate-free laboratory detergent, such as Liquinox®.
- **Organic Desorbing Agent**—A solvent used for removing organic compounds. The specific solvent would depend upon the type of organic compound to be removed. See Attachment 1 for recommendations.
- **Inorganic Desorbing Agent**—An acid solution for use in removing trace metal compounds. The specific acid solution would depend upon the type of inorganic compound to be removed. See Attachment 1 for recommendations.
- **Tap water**—Water obtained from any municipal water treatment system. An untreated potable water supply can be used as a substitute for tap water if the water does not contain the constituents of concern.
- **Distilled Water**—Water that has been purified via distillation. Distilled water can be purchased in most stores and is acceptable as a final rinse in non-trace analytical decontamination processes. Examples would include disposal profiling, HazCat, and other gross screening applications.
- **Analyte-free water**—Water that has been treated by passing through a standard deionizing resin column, and for organics either distillation or activated carbon units. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds, and/or no detectable organic compounds (i.e., at or above analytical detection limits). Type I and Type II Reagent Grade Water meet this definition as does most laboratory-supplied blank water.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be sent to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

Wear appropriate eye protection including safety goggles when working with corrosive liquids, especially when diluting concentrated materials to create low-percentage solutions and follow all project Health and Safety requirements. Decontamination wastes are to be recovered and handled as impacted project waste materials and must be disposed of in accordance with regulatory requirements.

A decontamination area should be established. Implements can either be immersed in a 5-gallon bucket containing each solution/rinse or the solutions can be contained in hand-held units made of an inert and compatible material; such as a Teflon™ wash bottle. The analyte-free water needs to be placed in a container that will be free of any compounds of concern.

Consult Attachment 1 for the decontamination solutions/solvents appropriate to the task. The minimum steps for decontamination are as follows:

1. Remove particulate matter and other surface debris by brushing and/or dipping in the soap solution.
2. Rinse thoroughly with tap water.
3. If necessary, rinse with other applicable solutions/solvents. If hexane is used, be sure to follow it with isopropyl alcohol to allow for the final water rinses to properly mix and contact the surface.
4. Final rinse three times to make sure all residual solutions/solvents are removed.
5. Place decontaminated equipment on a clean surface appropriate for the compounds of concern and allow to air dry.

7. ATTACHMENTS

- Attachment 1, Recommended Decontamination Procedures.

8. FORMS

None.

Attachment 1
Recommended Decontamination Procedures

Compound	Detergent Wash	Tap Water	Inorganic Desorbing Agent	Tap Water	Organic Desorbing Agent[1]	Final Water Rinse[4]	Air Dry
Organic Constituents							
Volatile Organic Compounds	✓	✓			Methanol Purge & Trap grade	✓	✓
Base Neutrals/Acid Extractables/PCBs/Pesticides	✓	✓			Hexane followed by Isopropyl Alcohol	✓	✓
Organic Bases[2]	✓	✓	1% nitric acid	✓	Isopropyl Alcohol	✓	✓
Organic Acids[3]	✓	✓	1% nitric acid		Isopropyl Alcohol	✓	✓
Inorganic Constituents							
Trace Metals and Radio Isotopes	✓	✓	10% Nitric acid -Trace metals grade	✓		✓	✓
Cations/Anions	✓	✓				✓	✓
Acidic Compounds	✓	✓				✓	✓
Basic Compounds (caustic)	✓	✓	1% nitric acid	✓		✓	✓

1 – All organic solvents must be Pesticide Grade or better. The selection of appropriate solvent rinses should first consider if a *known or suspected* contaminant requires removal from sampling equipment. Secondly, identify whether the subsequent analytical protocol would be impacted by the proposed solvent or an impurity thereof (e.g., residual acetone present in isopropyl alcohol would be measured with certain volatile organics analysis).
2 - Organic bases include amines, hydrazines.
3 - Organic acids include phenols, thiols, nitro and sulfonic compounds.
4- Use a grade of water appropriate to the application. For trace level analysis this must be Analyte Free Water. For non-trace applications store-bought distilled water is sufficient

Adapted from: Appendix E, Requirements for the Preparation of Sampling and Analysis Plans (EM-200-1-3), February 2001. US Army Corp of Engineers, Washington, D.C.

Revision 1- 3/2006

STANDARD OPERATING PROCEDURE

Subject: **Data Usability Review**

1. PURPOSE

The purpose of this procedure is to establish the means by which all subcontracted environmental analytical data will be reviewed for completeness and usability based upon comparison to the project action/decision levels and Data Quality Objectives before use in the intended decision-making processes.

2. SCOPE

This procedure applies to all subcontracted analytical data including faxed or e-mailed preliminary reports.

By way of its requirements, this procedure prohibits verbal communication of analytical results and establishes minimum deliverable standards that must be provided for all subcontracted analytical data reports–including faxed or e-mailed preliminary reports. These minimum standards include the following:

- Sample Results
- Chain of Custody – unless already available to the reviewer
- Sample Receipt Documentation – unless already available to the reviewer
- QC Summary – Laboratory Control Blank, Laboratory Control Spike, Matrix Spike, Matrix Spike Duplicate, Post-digest Spike
- Surrogate Summary – (if applicable)
- Hold-time Compliance Summary – or signed certification that all requirements were met
- Initial and Continuing Calibration Information – or signed certification that it meets prescribed requirements
- GC/MS Tuning Information – (if applicable) or signed certification that it meets prescribed requirements

This procedure should be performed only by or under the oversight of properly qualified individuals. Oversight may be accomplished through provision of a project-specific and well-defined checklist, training in its use, regular QA checks, and real-time availability for issue resolution.

3. REFERENCES

- U.S. Environmental Protection Agency, *National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94-013.
- U.S. Environmental Protection Agency, *National Functional Guidelines for Organic Data Review*, EPA 540/R-94-012.

- U.S. Department of Defense, 2002, Department of Defense Quality Systems Manual for Environmental Laboratories, Final, June.
- U.S. Army Corps of Engineers, Requirements for the Preparation of Sampling and Analysis Plans, EM-200-1-3.

4. DEFINITIONS

- **Data Usability Review (DUR)**—The cursory review of an analytical data package for completeness and compliance with the ordered analysis, specified quality, and method/project-specific protocols before the data is used as input to a particular project decision-making process. The DUR process identifies any potential data quality issues and informs the data users of the effect on the data usability.
- **Data Quality Objectives**—The empirical statements and quantitative measures necessary for a given set of measurements to be usable in the planned decision.
- **Data Quality Indicators**—Field and laboratory measures for which compliance with specified requirements or limits can be construed to support attainment of the Data Quality Objectives in a given data set.
- **Analytical Data Package**—The manner in which analytical results are provided from subcontractor laboratories. Analytical Data Packages can be received via fax, e-mail, or postal mail.
- **QC Summary**—A summary table of laboratory QC sample results.
- **Laboratory Control Blank (LCB)**—Reagent Water or Clean Solid Matrix analyzed in the same manner as a sample to determine the Target Analyte concentration contribution due to contamination in the entire analytical system.
- **Laboratory Control Spike (LCS)**—Reagent Water or Clean Solid Matrix spiked with a known concentration of target analytes and analyzed as a sample to determine the method accuracy of the analytical system.
- **Matrix Spike**—A sample spiked with a known concentration of target analyte and analyzed along with the rest of the analytical batch. The percent recovery of the target analytes is used to determine the effect on accuracy due to the sample matrix.
- **Matrix Spike Duplicate**—A duplicate of the Matrix Spike used to determine the analytical precision, expressed as Relative Percent Difference (RPD) of the analytical system.
- **Surrogate Compound**—In several organic methods, a compound similar in structure and chemical behavior to the target analytes, which is added to each Sample and QC Sample at a known concentration before the analysis begins. The surrogate recovery is used to approximate the recovery of the target compounds based upon the behavior of chemically similar analytes.
- **Post-digest Spike**—In metals analyses, used to determine the possibility of chemical interferences and digestion deficiencies. If the normal QC results are unacceptable, a known concentration of the target analyte is added to the sample digestate. The recovery is then used to determine if reanalysis or data qualification is warranted.
- **QC Acceptance Range**—The limits that define QC results demonstrating compliant accuracy and precision.
- **Qualified Person**—An individual capable through knowledge, education, formal training, and/or experience in the establishment and verification of analytical Data Quality Objectives. The

Qualified Person is usually a chemist or environmental professional with several years of environmental analytical experience.

- **Trip Blank**—In VOC analysis, a container of Reagent Grade Water that is included in the sample cooler and analyzed by the laboratory to determine if cross-contamination may have occurred in shipping.
- **Ambient or Field Blank**—Reagent Grade Water containerized during sample collection activities and analyzed at the laboratory. The results are used to determine if sample results may be biased by site environmental factors.
- **Equipment Blank**—Final rinseate collected during sample equipment decontamination and analyzed by the laboratory. The results indicate the effectiveness of the decontamination procedure.
- **Field Duplicate**—An additional sample aliquot or, in some cases, a collocated sample that is collected and analyzed. The results are compared with the original samples as an indication of the overall precision of the entire sampling and analytical process.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that the activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 First-Level Review of the Data Package

Verify that the package contains all of the required elements listed in Section 2. If any items are missing, contact the laboratory immediately and correct the situation.

Compare the reported results to the Chain of Custody request, and verify that all expected samples and analyses results were reported. If results are missing, contact the laboratory and correct the situation. If the “missing” data is not available yet, perform partial review of the data provided and hold the package for follow-up once the non-reported results are provided.

6.2 Second-Level Review

Consult the project Chemical Quality Plan (SAP, QAPP, etc.) for information concerning sample types and analysis requirements.

Compare the reported analytes, methods, and detection limits to those in the project plan for the specific analyses. Be sure to account for indicated and reasonable increased reporting limits due to dilutions or sample effects. Address any discrepancies with the laboratory directly.

Compare the results to project action-levels, and circle or otherwise mark all results above the limits.

6.3 QC Level Review

Consult the project Data Usability Review Checklists and/or the project Chemical Quality Plan and evaluate all provided QC results against project acceptance limits.

Mark or flag any results that are outside of the project limits and note on the applicable checklist (if using one).

Also evaluate any Field QC results such as Duplicates and Trip Blanks against requirements and note any issues.

6.4 Usability Review

If all QC results for all samples are within the acceptance ranges, complete the appropriate section of the checklist and then date and sign the completed checklist.

If all QC is acceptable and you are not using a checklist, you must indicate data usability directly on the data package itself or on a separate cover sheet. To do this, date and initial the QC Summary pages and write "QC acceptable data OK for use" on the cover sheet or QC Summary page.

If any QC is non-compliant, review its impact to use as project data by referencing the QC Results Impact Table attached to this SOP and consult with the Qualified Person to determine final acceptability. Note on the Data Report itself or checklist all discrepancies and the reasons for data acceptance, qualification, or rejection. If a Qualified Person has made the decision, this should also be noted.

If any of the data is determined to be unusable, immediately notify the Project Manager and project site personnel.

6.5 Reporting of Usability Review Results

Project personnel must be provided either a spreadsheet summary of the results with an attached, signed and dated Statement of Usability, or the complete Data Package with the project-specific Data Usability Review documentation. At **no time** are results to be communicated verbally.

7. ATTACHMENTS

- Attachment 1, Project QC Impact Table

8. FORMS

None.

Attachment 1
Project QC Impact Table

QC Data Discrepancy	Result Non-detect	Result >10% Below Action-level	Result Within 10% of or Above Action-level	Result Greater than 10% Above Action-level
DISPOSAL				
Trip Blank Contaminated	No effect	No effect	No effect	No effect
LCB Contaminated	No effect on data	No effect on data	No effect unless contamination is >10% of action-level→reject	No effect unless contamination is =/> the difference between result and action-level
LCS Low Recovery	If MS/MSD are acceptable or Surrogates are acceptable and the RL is at most 20% of action-level→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted Otherwise, flag and qualify that results may in fact be greater than action-level	If MS/MSD are acceptable or Surrogates are acceptable and LCS is within 10% of acceptance limit and result is above action-level→Data accepted Otherwise, flag and qualify result as suspected to be above action-level	No effect on data
LCS High Recovery	No effect on data	No effect on data	If MS/MSD are acceptable or Surrogates are acceptable evaluate potential bias in QC and accept data	No effect on data
Matrix Spike Low %R	If MSD and LCS acceptable and Surrogates or Post-spike within range Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range Data is accepted with precision qualifier	No effect on data	No effect on data
Matrix Spike High %R	No effect on data	No effect on data	No effect on data	No effect on data
MS/MSD RPD High	No effect on data	No effect on data	No effect on data	No effect on data
Surrogate %R Low	If surrogate %R values are at least 70% of acceptance limit, Data is acceptable	If surrogate %R values are at least 70% of acceptance limit, Data is acceptable	No effect on data	No effect on data
Surrogate %R High	No effect on data	No effect on data	If surrogate %R values are within 30% of acceptance limit→Data is acceptable	No effect on data

QC Data Discrepancy	Result Non-detect	Result >10% Below Action-level	Result Within 10% of or Above Action-level	Result Greater than 10% Above Action-level
REMEDIATION or TREATMENT MONITORING				
Trip Blank Contaminated	No effect	No effect	If TB is greater than 10% of action-level or result→reject data	No effect
Duplicate Precision outside limits	No effect unless Duplicate is either above or within 50% of action-level - in this case qualify sample data and report with Duplicate result as "highest probable value"	No effect unless Duplicate is either above or within 30% of action-level - in this case qualify result as "assumed above action-level"	If Duplicate is either above or within 20% of action-level→qualify result as "assumed above action-level"	No effect-report result even if Duplicate is below action-level
LCB Contaminated	No effect on data	No effect on data	If LCB is greater than 10% of action-level or sample result→Data is unacceptable	No effect on data
LCS Low Recovery	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	No effect on data
LCS High Recovery	No effect on data	No effect on data	If MS/MSD are acceptable or Surrogates are acceptable evaluate for bias→Data accepted	No effect on data
Matrix Spike Low %R	If %R>50 and LCS acceptable-Data accepted	If %R>50 and LCS acceptable-Data accepted	If %R>50 LCS acceptable→Data accepted (evaluate potential low bias in results below action-level)	No effect
Matrix Spike High %R	No effect on data	No effect on data	If MSD and LCS acceptable and Surrogates or Post-spike within range→Data is accepted with precision qualifier	No effect on data
MS/MSD RPD High	No effect on data unless perceived native concentration in MS or MSD result would be above action-level. In this case, reject data as highly suspect and advise review of sampling and lab sub-sampling procedures	No effect on data unless perceived MS or MSD native concentration would be above action-level. In this case, qualify results as potentially above action-level	If the perceived native result of either the MS or MSD is greater than 110% of action-level→qualify data as being above action-level	No effect on data

QC Data Discrepancy	Result Non-detect	Result >10% Below Action-level	Result Within 10% of or Above Action-level	Result Greater than 10% Above Action-level
Surrogate %R Low	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable	No effect on data	No effect on data
Surrogate %R High	No effect on data	No effect on data	If Surrogate %R is greater than 120% of acceptance limit, Data is unacceptable	No effect on data
VERIFICATION or CLOSURE ANALYSIS				
LCB Contaminated	No effect on data Comment LCB contamination	No effect on data Comment LCB contamination	If LCB is greater than 10% of action-level or sample result, Data is unacceptable	If LCB is greater than 10% of action-level or sample result, Data is unacceptable
LCS Low Recovery	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted
LCS High Recovery	No effect on data	No effect on data	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted (evaluate potential bias in reported result)	If MS/MSD are acceptable or Surrogates are acceptable→Data accepted
Matrix Spike Low %R	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier
Matrix Spike High %R	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier	If MSD and LCS acceptable and Surrogates or Post-spike within range, Data is accepted with precision qualifier
MS/MSD RPD High	No effect on data	If sample result is greater then 90% of action-level, Data is unacceptable	If RPD is greater than 110% of acceptance limit, Data is unacceptable	If RPD is greater than 110% of acceptance limit, Data is unacceptable

QC Data Discrepancy	Result Non-detect	Result >10% Below Action-level	Result Within 10% of or Above Action-level	Result Greater than 10% Above Action-level
Surrogate %R Low	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are at least 80% of acceptance limits, Data is acceptable
Surrogate %R High	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are within 20% of acceptance limits, Data is acceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are within 20% of acceptance limits and other QC is within acceptance limits, Data is acceptable	If any Surrogate %R is greater than 110% of acceptance limit, Data is unacceptable	1) If confined to one Surrogate in a fraction, Data is acceptable 2) If surrogate %R values are within 20% of acceptance limits, Data is acceptable

STANDARD OPERATING PROCEDURE

Subject: Soil Sampling using a Soil Probe or Core-Type Sampler

1. PURPOSE

The purpose of this document is to provide the methods and procedure for sampling of soils and other solids using soil probes and core-type devices. These samplers can be used when matrices are composed of relatively soft and non-cemented formations. They are utilized to collect near-surface core samples and can also be placed into boreholes at specified depths. Soil probe/corer samplers provide an intact depth-specific sample for geotechnical, chemical, radiological, or biological analysis

2. SCOPE

This procedure is applicable to all Shaw E & I projects where soil samples will be collected via hand-operated soil probe/corer methods and no project-specific procedure exists. This procedure is not applicable to drilling or direct push methods.

3. REFERENCES

- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, EM-200-1-3.
- American Society for Testing and Materials, *Standard Practice for Soil Investigation and Sampling by Auger Borings*, D1452-80 (re-approved 2000).
- U.S. Environmental Protection Agency, 1994, *Soil Sampling*, EPA/ERT SOP 2012, November.

4. DEFINITIONS

- **Soil Corer**—A sample collection device consisting of extension rods, a T-handle, and a sampling head. The sampling head is a thin-walled two-piece metal tube, split lengthwise, into which a metal or plastic sleeve is placed. The tube halves are held together with screw-locked ends, the bottom one having a point. The sleeve fills with material as the sampler is forced downward, allowing for an undisturbed core to be collected
- **Soil Probe**—A core sample collection device consisting of a thin-walled metal tube with a cutting edge on the bottom. The tube is cut-away from its tip to approximately one-third of the way to its top to allow material to enter. The top of a soil probe is removable, and a plastic or metal sleeve is inserted through the top and is held in place by the reduced diameter of the tube at the top of the cutout. Soil probes can be attached to extension rods and T-handles or may be of one-length construction. Samples collected from a soil probe are almost always submitted to the laboratory intact.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

The sampling procedure is as follows:

1. Assemble the sampler by inserting the appropriate sample tube and close the ends. If using extension rods, attach the sampler by its top to the bottom rod. Attach the T-handle either to the extension rod or directly to the sampler head.
2. If desired, place plastic sheeting around the targeted location to keep sampled material in place. Use a knife to cut an access hole for the sample location.
3. Don a pair of clean sample gloves.
4. Remove any surficial debris (e.g. vegetation, rocks, twigs) from the sample location and surrounding area.
5. If the sample will be collected from a depth beyond the surface, use a hand-auger to remove the overburden and expose the “target” sample depth. Measure the depth of the hole with a rule or stiff tape to confirm that the target depth has been reached.
6. If the sampling depth is below where the sampling device can be seen while sampling, measure the distance from the tip to top of the sampler and mark the extension rod at this distance plus the depth of the hole with tape as a reference.
7. Change sample gloves just prior to collecting the sample, especially if an auger was used to expose the target depth
8. To collect the sample using a Soil Corer, place the point of the assembled corer directly on the ground or in the auger hole and, while holding it vertical, push straight down into the soil. Do not twist. A slide hammer may be required for hard or stiff materials.
9. A Soil Probe should be placed into the location and pushed downward with a twisting motion to allow the cutting edge to work. Do not drive or hammer the sampler as this will damage the cutting tip.

10. Continue to force the sampler downward until either the top joint is touching the ground or the reference mark is even with the top of the auger hole. This will ensure that the entire sleeve is filled with material.
11. Extract the sampler by pulling upward with a slight rocking or twisting motion until the head is fully out of the hole.
12. Wipe the sampler head with a cloth or towel and remove it from the T-handle or extension rod.
13. Disassemble the sampler and remove the sleeve. Also perform any field screening desired (e.g., PID screen).
14. For a Soil Probe sample, the sleeve will most likely be submitted intact. Wipe the outside of the sleeve and use a knife to cut off any material sticking from the end so that the ends are even. Place Teflon™ tape over the ends and cap both ends. Be sure to label the top and bottom of the sample interval.
15. A Soil Corer sample may be submitted intact, especially for geotechnical parameters. If this is the case, wipe the outside of the sleeve and use a knife to cut off any material sticking from the end so that the ends are even. Place Teflon™ tape over the ends and cap, labeling the sleeve and marking the top and bottom of the sample interval.
16. If the Soil Corer sample will be aliquotted into other containers, use a knife to split the sleeve lengthwise and remove the top section to expose the sample.
17. If sampling for Volatile Organic Compounds (VOCs), collect sample aliquots from the intact core first using an EnCore™ or other syringe-type device.
18. Place the remaining material directly into sample jars or into a mixing bowl for homogenization and containerization. Cap the sample container(s), label it/them, complete the documentation, and place the sample container(s) into the sample cooler.
19. Decontaminate the sampler.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Well Purging and Sampling Preparation

1. PURPOSE

This procedure is intended to provide the methods to be used for preparing groundwater wells for sampling. Preparation includes accessing the well, screening for VOCs (if required), measuring depth and water column height, determining the well volume, and purging the stagnant groundwater from the monitoring well. This procedure presents methods for purging using both bailer and pump techniques. This procedure does not address low-flow or micro-purging, which is covered in Procedure No. EI-FS111.

2. SCOPE

This procedure is applicable to all Shaw E & I projects where groundwater samples will be collected from a monitoring well and where no project/program-specific procedure is in place. Unless specifically directed in project/program plans, well purging will be considered complete when 3 to 5 well volumes have been removed from the well and/or the well water quality parameters (pH, specific conductivity, temperature, dissolved oxygen) collected during purging have stabilized for three consecutive readings.

3. REFERENCES

- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, Appendix C, Section C.2, EM200-1-3, Washington, D.C.
- American Society for Testing and Materials, D6634-01, *Standard Guide for Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells*, West Conshohocken, PA.
- American Society for Testing and Materials, D4448-01, *Standard Guide for Sampling Ground-Water Monitoring Wells*, West Conshohocken, PA.

4. DEFINITIONS

- **Bailer**—A device used to collect water typically consisting of a long tube with a check valve system attached to a rope or cable. The bailer is lowered into the water, and once the desired depth is reached, the check valve is set by causing an upward motion on the bailer. Bailers are constructed of stainless steel, polyethylene plastic, or Teflon™. Bailers made of polyethylene and Teflon™ may be considered disposable.
- **Pump**—An electric, compressed air, or inert gas driven device that raises liquids by means of pressure or suction. The types of pumps used for well purging should be chosen based on the well size and depth, the type of contaminants, and the specific factors affecting the overall performance of the sampling effort. Pump types that may be used include centrifugal, peristaltic, centrifugal submersible, gas displacement, and bladder pumps.
- **Well Purging**—The action of removing stagnant groundwater using mechanical means from a monitoring well. Well purging is performed prior to collecting groundwater samples from a well for purposes of attaining representative samples from the groundwater zone where the monitoring well is screened.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure and utilizing materials of a construction specified in the project plans or applicable to the contaminants of concern and other aspects of the sampling effort. These aspects may include well diameter, well construction materials, depth to water, and the presence of DNAPL or LNAPL contaminants. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 Considerations

When planning for the well sampling task, the following variables should be reviewed to determine which well purging method to use:

- **Recharge capacity of each well:** The recharge capacity of a well will determine how fast the well should be purged. The purge rate should be the same as the recharge rate of the groundwater zone to prevent drawing the water table down and creating a cascading effect of groundwater entering the well along the well screen. If recharge rates are greater than 0.5 gallons per minute, bailers or pumps may be used to remove water from the well. Wells with slow recharge rates (<0.5 gpm) may need to be sampled using other methods such as low-flow or micro-purge techniques that do not agitate the well and therefore do not require full purging.

- **Well construction details, including well depth, diameter, screened interval, screen size, material of construction, and depth to water table:** The diameter and well depth will determine the size of the pump or bailer that will be required to remove water. The screen opening size will limit the rate at which water can be removed from the well due to high flow rates through the screen creating turbulent flow.

- **Groundwater quality, including type and concentration of chemical compounds present:** Choose a device that is constructed of materials compatible with the chemicals in the groundwater. Chemical contaminants can also dictate the rate at which the water can be removed from the well. Whenever possible, wells that contain VOCs should be purged using low-flow purging methods to prevent volatilization.

- **Presence of LNAPL or DNAPL:** If LNAPL or DNAPL are present, it is not recommended that the well be purged, due to the potential for creating a contaminated smear zone.

6.2 Equipment

The following equipment is recommended for use in conducting well purging:

- Bailers and line
- Pump and discharge hose/line
- Water level indicator
- Swabbing materials
- pH meter–if desired
- Specific conductance meter–if desired
- Temperature meter or gauge–if desired
- Nephelometer-turbidity–if desired
- Dissolved Oxygen meter–if desired
- Photoionization detector (PID)
- Drums or tanks to contain the purge water
- Field log book or sheets
- Calculator
- Plastic sheeting to spread around sampling area

6.3 Pre-Purging

To prevent cross contamination of other wells on site, upgradient and background wells should be sampled first. The procedure for pre-purging is as follows:

- Prepare the area surrounding the well by placing plastic sheeting on the ground surface to prevent potential cross-contamination of the purging and sampling implements.
- Place and secure the drum, tank, or suitable purge-water container in close proximity to the well for the collection and storage of purge water. *Purge water must be containerized and disposed of in the manner specified in the project/program plan or as the client directs.* ***Never*** *return purge water to the well.* If in doubt or where requirements are not specified, handle all purge water as waste and dispose of it accordingly.
- If screening for organics, measure and record the background organic vapors in the ambient air using a PID in accordance with manufacturer recommendations.
- Open the well casing, remove the well cap, and immediately measure and record the organic vapor levels from the head space within the well casing using a PID, if required, in accordance with manufacturer recommendations.
- Measure the depth to the static water level and the depth to the bottom of the well using the water level indicator in accordance with Procedure EI-FS108, *Water Level Measurements.*
- Calculate the volume of water within the well casing and screen as follows:

$$V = [\pi(di/2)^2\ (TD-H)]\ (7.48)$$

Where:

V = volume of groundwater in the casing, gallons

di = inside diameter of casing, feet

TD = total well depth, feet

H = depth to the static water level, feet

Alternatively, for typical well casing diameters, the Volume can be determined as follows:

$V = CF \times (TD-H)$

Where:

V = volume of groundwater in casing, gallons

CF = Casing Factor, gallons per linear foot-from table below

Well Diameter (inches)	**Casing Factor (CF) (gallons/foot)**
2	0.16
4	0.65
6	1.47
8	2.61
10	4.08
12	5.88

6.4 Well Purging by Bailing

The well must not be bailed dry; water should be purged from the well at the same rate as it recharges to prevent loss of contaminants through degassing and to prevent agitation, which may release false levels of fine-grained particles or sediments to the groundwater zone. Water level measurements may be performed to verify that water levels remain constant during bailing.

The procedure for well purging by bailing is as follows:

- Attach new bailer line to a clean bailer or new disposable bailer. Attach the other end of the bailer line to the protective casing or your wrist allowing sufficient length to reach the well screen depth.
- Slowly lower the bailer down the well to avoid agitating the water and begin bailing groundwater by allowing water to pass through the bailer check valve into the bailer. Remove the filled bailer and empty the water into the purge-water container.
- If water quality parameters are not being used to determine stabilization, remove 5 well volumes from the well and then sample using a freshly decontaminated reusable or unused disposable bailer. **Do not sample with the same bailer used to purge.**
- If water quality parameters are being used to determine stabilization, two well volumes should be removed and the water quality parameters measured and recorded as the last bailer

amount is removed from the well. This should be done by filling measurement containers with water directly from the bailer and taking readings.

- Continue purging until 3 to 5 well volumes have been removed from the well and three consecutive water quality parameter reading sets yield results within 10 percent of each other. For pH use +/- 0.3 units as the standard.
- Once stabilization has been achieved, collect the sample using a freshly decontaminated reusable or unused disposable bailer. **Do not sample with the same bailer used to purge.**

6.5 Well Purging Using a Pump

The well must not be pumped dry; water should be purged from the well at the same rate as it recharges to prevent loss of contaminants through degassing and to prevent agitation, which may release false levels of fine-grained particles or sediments to the groundwater zone. Water level measurements may be performed to verify that water levels remain constant during pumping.

The procedure for well purging using a pump is as follows:

- Review and understand the proper operating and maintenance instruction for each type of pump that is used prior to placing the pump in the well. Each pump type has specific procedures for operation.
- Assemble the pump and discharge line in accordance with manufacturer instructions. Ensure the pump discharge line is long enough so that the pump intake can be located within the well screen area and the discharge end can reach the purge water container.
- Lower the pump into the well until it is submerged and at the desired pumping depth.
- Start the pump and begin monitoring discharge rates and volume collected.
- If water quality parameters are not being used to determine stabilization, remove 5 well volumes from the well and then sample using the appropriate method.
- If water quality parameters are being used to determine stabilization, remove 2 well volumes and measure and record the water quality parameters at regular intervals as the purging continues. This can be accomplished either by using in-line direct-reading instruments or by collecting the pump discharge into appropriate measurement containers.
- Continue purging until 3 to 5 well volumes have been removed from the well and three consecutive water quality parameter reading sets yield results within 10 percent of each other. For pH use +/- 0.3 units as the standard.
- Once the stabilization has been achieved, collect the sample using a method applicable to the well and contaminants of concern.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Low Flow/Micro-Purge Well Sampling

1. PURPOSE

This procedure is intended to provide methods for low-flow sampling of groundwater from monitoring wells. Low-flow or micro-purge sampling is a method of collecting samples from a well that does not require the removal of large volumes of water from the well and therefore does not overly agitate the water and suspended particles or potentially aspirate VOCs. The method entails the removal of water directly from the screened interval without disturbing any stagnant water above the screen by pumping the well at low enough flow rates to maintain minimal drawdown of the water column followed by in-line sample collection. Typical flow rates for low-flow sampling range from 0.1 L/min to 0.5 L/min depending on site characteristics.

2. SCOPE

This procedure is applicable to all Shaw E & I projects where groundwater samples will be collected from a monitoring well using low-flow or micro-purge methods and where no project/program specific procedure is in use.

3. REFERENCES

- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, Appendix C, Section C.2, EM200-1-3, Washington, D.C.
- American Society for Testing and Materials, D6771-02, *Standard practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations*, West Conshohocken, PA.
- American Society for Testing and Materials, D4448-01, *Standard Guide for Sampling Ground-Water Monitoring Wells*, West Conshohocken, PA .
- U.S. Environmental Protection Agency Region 1, 1996, *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, SOP GW0001, Revision 2, July 30.

4. DEFINITIONS

- **Low Flow**—Refers to the velocity that is imparted during pumping to the formation adjacent to the well screen, not necessarily the flow rate of the water discharged by the pump at the surface.
- **Micro-purge**—Another term for low-flow sampling referred to as such due to the fact that pre-sampling groundwater removal (purging) is performed at flow rates 2 to 3 orders of magnitude less than typical bailer or pump methods.
- **Pump**—An electric, compressed air, or inert gas driven device that raises liquids by means of pressure or suction. The types of pumps used for well purging should be chosen based on the well size and depth, the type of contaminants, and the specific factors affecting the overall performance of the sampling effort. Low flow/micro-purge sampling is performed using

specially constructed pumps, usually of centrifugal, peristaltic, or centrifugal submersible design, with low draw rates (<1.0L/min).

- **Well Purging**—The action of removing groundwater using mechanical means from a monitoring well prior to collecting groundwater samples. Purging removes the stagnant groundwater from the column allowing the groundwater surrounding the well screen to enter the collection zone.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure and utilizing materials of a construction specified in the project plans or applicable to the contaminants of concern and other aspects of the sampling effort. These aspects may include well diameter, well construction materials, depth to water, and the presence of DNAPL or LNAPL contaminants. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager, or designee, is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

Low-flow/micro-purge sampling involves removing water directly from the screened interval without disturbing any stagnant water above the screen or without lowering the water table. Since it is not based upon the removal of well volumes, it requires in-line monitoring of water quality parameters which may include pH, specific conductivity, temperature, dissolved oxygen, and redox potential to determine when the groundwater sample zone has stabilized. The sample is then collected using the same pump directly from the discharge tubing.

6.1 Considerations

The following variables should be reviewed in planning for low-flow purging and sampling:

- **Recharge capacity of each well:** The recharge capacity of a well will determine how fast the well should be purged. The purge rate should be no greater than the recharge rate of the groundwater zone to prevent water table drawdown.
- **Well construction details, including well depth, diameter, screened interval, screen size, material of construction, and depth to water table:** The diameter and well depth will determine the size of the pump and the location from which the pump will operate. Peristaltic and suction draw pumps are only viable at depths of less than 25 feet. The pump intake should be placed within the well screen.

- **Pump:** Low-flow purging and sampling can be used in any well that can be pumped at a constant rate of not more than 1.0 L/min. Continuous discharge and cycle discharge pumps with adjustable flow rate controls should be used to avoid causing continuous drawdown. Whenever possible, dedicated pumps should be installed to avoid disturbing the water column.
- **Groundwater quality, including type and concentration of chemical compounds present:** Low-flow methods can be used for all types of aqueous-phase contamination, including VOCs, SVOCs, metals, pesticides, PCBs, radionuclides, and microbiological constituents. Pump parts and tubing should be made of materials that are compatible with the analytes of interest.

6.2 Equipment

The following equipment is recommended for use in conducting well purging:

- Pump capable of <1.0L/min draw rates
- Discharge line constructed of material compatible with the contaminants of interest. Enough for a fresh line to be used at each well
- Water level indicator
- Flow-through Water Quality Meter (pH, specific conductance, temperature, optional Dissolved Oxygen, Redox potential)–calibrated
- Nephelometer–for turbidity measurement-calibrated (if required)
- Photoionization Detector (PID)–calibrated (if screening for VOCs is required)
- Drums or tanks to contain the purge water
- Field log book
- Calculator
- Plastic sheeting
- Sample containers and preservatives
- Ice and Ziploc-type bags

6.3 Pre-Sampling

To prevent cross-contamination of other wells on-site, upgradient and background wells should be addressed first. It is also a good idea to use fresh discharge line for each well as the low-flows make it difficult to flush contaminants between samples. The procedure for pre-sampling is as follows:

- Prepare the area surrounding the well by placing plastic sheeting on the ground surface to prevent potential cross-contamination of the pump and discharge hose or sample equipment and materials.
- Place and secure the drum, tank, or suitable purge water container in close proximity to the well for the collection and storage of purge water. *Purge water must be containerized and disposed of in the manner specified in the project/program plan or as the client directs.* ***Never*** *return purge water to the well.* If in doubt or where requirements are not specified, handle all purge water as waste and dispose of it accordingly.

- If performing VOC screening, measure and record the background organic vapors in the ambient air using a PID, in accordance with manufacturer recommendations.
- Open the well casing, remove the well cap, and immediately measure and record the organic vapor levels from the head space within the well casing using a PID, in accordance with manufacturer recommendations.
- Measure the depth to the static water level using the water level indicator in accordance with Procedure EI-FS108, *Water Level Measurements*.

6.4 Well Purging

The procedure for well purging is as follows:

- Review and understand the proper operating and maintenance instruction for each type of pump that is used prior to placing the pump in the well. Each pump type has specific operating procedures.
- Some wells may include a dedicated pump that is already placed in the well along the well screen. If this is the case, review well construction data to verify the proper placement of the pump intake. Inspect the location where the discharge line and pump support cable exit the well to determine that they are in the proper position (markings should be present at the well head to show this).
- Assemble the pump and clean discharge line in accordance with manufacturer instructions. Ensure the pump discharge line is long enough so that the pump intake can be located within the well screen area and the discharge end can reach the purge water container.
- Slowly lower the pump into the well until it is submerged and at the desired pumping depth.
- Connect the pump discharge to the flow-through water quality meter system in accordance with the manufacturer's procedure.
- Start the pump and begin monitoring discharge rates and volume collected. Adjust flows if necessary to remain in a range of 0.1 to 0.5L/min without exceeding the well discharge rate.
- Monitor and record the pH, conductivity, temperature, dissolved oxygen, redox potential, and turbidity at set intervals (2 to 10 minutes).
- Collect the sample following the procedure below when all monitored water quality parameters are stable, as indicated by three consecutive readings differing by less than 10 percent. For pH use +/-0.3 units as the standard.

6.5 Sample Collection

The procedure for sample collection is as follows:

- Prepare the sample bottles and preservatives required for the sampling.
- Don a pair of clean gloves.
- Collect the sample immediately after purging through the pump discharge line.
    - Fill VOA vials first (reduce the flow rate of the pump discharge) allowing the liquid to slowly fill the container without agitation and obtain a meniscus slightly above the top of the vial.
    - Cap and check all VOA vials for entrained air by slowly tipping and observing for bubbles. If any are present, discard the sample and collect again as above.

- Continue filling all required sample bottles.
- Add preservatives to the samples as needed, and place the sample bottles on ice. Note that most sample bottles come with preservatives already added. If such is the case, do not overfill the bottles.
- Replace the well cap, if required, and lock the cover.
- Record the sampling information.
- For a dedicated down-hole pumping system, do not decontaminate the pump but rinse the water quality meter's flow-cell and probes with distilled water.
- If using a non-dedicated pump and meter system, decontaminate the pump and meter.
    - Retrieve the pump and remove and dispose of the discharge line, including the line leading to and from the water quality meter system.
    - Rinse the water quality meter system with distilled water.
    - Attach a few feet of clean line to the pump and water quality meter system with a discharge end into the purge waste container.
    - Place the pump into a container of distilled water, adjust the flow to its maximum, and allow the entire system to flush with distilled water for at least 5 minutes or longer if the waste does not appear to be clean.
- Secure the area by removing equipment and materials, properly dispose of plastic sheeting and other disposable sampling materials, and close the purge water container(s).
- Proceed to the next well and repeat the process using clean discharge tubing for each well sampled.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Water Quality Meter Use

1. PURPOSE

This procedure is intended to provide general guidance and methods for using a field meter to measure water quality parameters from groundwater or surface water that is being purged, sampled, or monitored.

2. SCOPE

This procedure is applicable to all Shaw E & I projects where water quality monitoring is required using a water quality meter. The water quality meter may be a stand-alone meter or it may be a combined multi-probe unit used to measure temperature, pH, specific conductance, and/or other water quality parameters. The most common methods used for measuring water quality are instruments that measure in-situ parameters in one of the following two ways:

- Water is extracted from its source using a pump and measured in a flow-through cell or in some instances captured and then measured in individual aliquots. This method is preferred when monitoring wells are sampled for laboratory analysis of chemical parameters, and groundwater purging is required.
- The meter is submerged directly into the sample source, such as a monitoring well or surface water body, to collect in-situ monitoring parameters.

3. REFERENCES

- U.S. Army Corps of Engineers, 2001, *Requirements for the Preparation of Sampling and Analysis Plans*, Appendix C, EM-200-1-3, Washington, D.C.
- American Society of Testing and Materials, *Standard Guide for Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells*, D6634-01, West Conshohocken, PA.
- American Society of Testing and Materials, *Standard Guide for Sampling Ground-Water Monitoring Wells*, D4448-01, West Conshohocken, PA.

4. DEFINITIONS

- **Water Quality Meter**—A device used to measure specific field parameters indicative of water quality, such as temperature, pH, specific conductance, and/or other parameters. The meter may be stand-alone or it may be a combined multi-probe unit.
- **Pump**—An electric, compressed air, or inert gas-driven device that raises liquids by means of pressure or suction. The types of pumps that should be used for water quality monitoring should be chosen based on the well size and depth, the type of contaminants, and the specific factors affecting the overall performance of the sampling or monitoring effort. The types of pumps that may be used include centrifugal, peristaltic, centrifugal submersible, gas displacement, and bladder pumps.
- **pH**—The negative log of the hydrogen ion concentration (-log10 [H+]); a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The scale is 0 to 14.

- **Turbidity**—A measure of overall water clarity determined by measuring the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU), but may also be measured in Jackson Turbidity Units (JTU).
- **Specific Conductance (SC)**—A measure of how well water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution. The unit of conductance is expressed as microsiemens (1/1,000,000 siemen) per centimeter, or µS/cm.
- **Oxidation-Reduction (Redox) Potential**—A measure in volts of the affinity of a substance for electrons compared with hydrogen. Liquids that are more strongly electronegative than hydrogen (i.e. capable of oxidizing) have positive redox potentials. Liquids less electronegative than hydrogen (i.e. capable of reducing) have negative redox potentials.
- **Dissolved Oxygen (DO)**—Refers to the amount of oxygen expressed as mg/L that is contained in particular water. The amount of oxygen that can be held by the water depends on the water temperature, salinity, purity, and pressure.
- **Salinity**—The amount of dissolved salts in water, generally expressed in parts per thousand (ppt).

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Field Sampling Discipline Lead is responsible for maintenance, management, and revision of this procedure. Questions, comments, or suggestions regarding this technical SOP should be directed to the Field Sampling Discipline Lead.

5.2 Project Responsibility

Shaw employees performing this task, or any portion thereof, are responsible for meeting the requirements of this procedure. Shaw employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

For those projects where the activities of this SOP are conducted, the Project Manager or designee is responsible for ensuring that those activities are conducted in accordance with this and other appropriate procedures. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURE

6.1 Equipment

The following equipment is recommended for use in performing water quality measurements:

- Water Quality Meter(s)
- Spare parts such as alkaline batteries (if used) and sensor probes
- Pump and discharge hose/line for use with a flow-through cell
- Paper towels or lint-free wipes

- De-ionized water
- Sample gloves
- Calibration solutions for all parameters being measured; within expiration dates
- Plastic sheeting
- Logbook or log sheets

6.2 General Instructions

- Ensure that the measuring range of the instrument encompasses the expected sample concentration or units.
- Before going to the field, locate all necessary field supplies such as deionized water, calibration solutions, decontamination supplies, and spare parts.
- Consult the instrument's operation manual as well as the project-specific sampling plan to verify that you have prepared the proper equipment and supplies to successfully complete the work.

6.3 Calibration

Calibration ***must*** *be performed* ***at least once per day*** *during operation. Calibrate the meter according to the instrument's operating manual. If sampling and monitoring is being performed for long periods of time, periodically check the instrument calibration using the operating manual's recommended frequency.*

In order to avoid limiting the field personnel to one particular model, only general calibration instructions are presented in this procedure.

- Locate a clean, protected area in which to set up and calibrate the instrument. Ensure that sufficient supplies of de-ionized water, clean paper towels, buffer solutions, and standard solutions are available.
- Inspect the meter and probes for damage. Some of the probes are very delicate or have a thin membrane installed over the probe. Be careful when handling the meter/probes so as not to damage them. If damaged, replace probes in accordance with the instrument's operating manual or obtain a different meter.
- Turn on the meter and allow it to "warm-up" for the manufacturer-specified time (usually 15 to 30 minutes). Check the battery power to determine if the meter has sufficient power to operate for the monitoring period. Replace the batteries, if necessary.
- Calibrate the meter according to the instrument's operating manual. In general, calibration is performed by immersing the probe(s) in aliquots of calibration standard solution(s) and following certain meter keystrokes to set the calibration for each parameter. *Do not immerse the probe into the stock container of the solution. Always transfer a small amount of the solution into a separate container to calibrate the probe(s).* If calibrating for multiple parameters using more than one solution, be sure to wipe off and rinse the probe with de-ionized water between solutions.
- Recheck each parameter after calibration by immersing the probe into the calibration solution and reading it like a sample reading. If the agreement is not within 25% of the solution's known concentration, repeat the calibration process with a new solution aliquot.

- Discard the used calibration solution aliquots when finished into an appropriate waste container.

- Record the calibration data in the field logbook or log sheet.

6.4 Operation of the Instrument

- If using a flow-through cell system, attach the extraction pump and lines in accordance with the pump and meter manufacturer's instructions. Allow the lines to fill and the probes to become immersed before switching the instrument to its measurement mode.

- If using a down-hole system, allow a few minutes for the probe to stabilize before taking a reading.

- Operate the meter in accordance with the instrument's operating manual.

- Collect the field parameter reading(s) per the project requirements, and record them in a field logbook or on log sheets.

- Decontaminate the meter before collecting data from the next sample source. For a flow-through system, flush the lines with three line volumes of de-ionized water or replace with new ones between samples.

7. ATTACHMENTS

None.

8. FORMS

None.

APPENDIX H

Shaw® Shaw Environmental, Inc.

Commercial, State, & Local Business Line

Construction Quality Assurance Plan

75-20 Astoria Boulevard Site
Jackson Heights, Queens, New York

Prepared for:

Bulova Corporation
1 Bulova Ave
Woodside, NY 11377

Prepared by: CSL Director of Quality

for: Bryan Koellen 4/14/08
Date

Approved by: Project Manager

4/14/08
Date

Revision 0.0

January 7, 2008

Table of Contents

Appendices

A	Definable Features of Work
B	Matrices of Relevant Documents
C	Pre-Selected Documents—Inspection and Test Work Instructions
D	Generic Programmatic Forms

Acronyms

CAD	Computer Aided Design
CAR	Corrective Action Request
CP	Checkprint
CQA	Construction Quality Assurance
DQCR	Daily Quality Control Report
E&I	Environmental and Infrastructure
EPA	US Environmental Protection Agency
HASP	Health and Safety Plan
M&TE	Measuring and Test Equipment
NA	Not Applicable
NCR	Nonconformance Report
NIST	National Institute for Standards and Technology
NYSDEC	New York State Department of Environmental Conservation
SOP	Standard Operating Procedure
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMS	Quality Management System
QMSP	Quality Management System Plan
Shaw	Environmental & Infrastructure (E&I); Commercial, State, Local Business Line (Shaw)
SOP	Standard Operating Procedure
SRM	Standard Reference Material

1.0 Quality Management Program

1.1 Purpose

This Construction Quality Assurance (CQA) Plan, prepared by Shaw Environmental & Infrastructure (Shaw E&I); Commercial, State and Local Business Line (Shaw or CSL), presents the quality management processes and methods to be applied to work activities planned for the 75-20 Astoria Boulevard project. The content of this CQA Plan is responsive to the *Shaw E&I Quality Management System Plan (QMSP)* requirements.

1.2 Scope

The requirements contained within the scope of this CQA Plan shall be in effect for this project. The CQA Plan provides for the general controls necessary for the management of services and items directly used in, or resulting from quality-related activities.

The details of the scope of work are described by the Shaw Remedial Action Work Plan, 75-20 Astoria Boulevard Site, Jackson Heights, Queens, NY, dated April 7, 2008. This work is pursuant to the Voluntary Cleanup Agreement (W2-0854-9906) and on behalf of Bulova Corporation (Bulova).

1.3 Quality Management Program Intended Use and Organization

The Shaw E&I Quality Management Program is intended to be a user-friendly resource to support projects and allow project contributors to identify their quality-related requirements and responsibilities. As such, this document is organized by the process flow of the project, with cross references to more detailed, subject-specific information that has been endorsed by Shaw management for use (e.g., Standard Operating Procedures [SOPs], forms). The CQA Plan is formatted in a manner consistent with the Shaw E&I QMSP, so that information may be readily exchanged amongst documents.

1.3.1 CQA Plan Intended Use

The CQA Plan is intended to be the primary source of information to quality-related requirements for employees, and subcontractors involved with the design and construction-phases of the project. It has been developed to focus on the specific needs of this project, and reference applicable components of the overall Quality Management Program. The effective implementation of a Quality Management System (QMS) will further help mitigate business performance risk. The information included herein is intended to complement the Shaw E&I Project Delivery System, which includes quality, and not replace it.

1.3.2 CQA Plan Organization

The general structure of this CQA Plan is organized by Management, Work Processes, Project Support, Assessment and Appendices.

Management

- 1.0 Quality Management System. This chapter includes a brief discussion of the purpose, scope and use of the document and the relationship of the CQA Plan with Shaw E&I and the CSL Business Line documents.

- 2.0 Management and Organization. This chapter provides a general description of the roles and responsibilities for the project, to include the project management team, construction functional group, and the quality assurance team.

Work Processes

- 3.0 Work Processes—Planning. This chapter discusses the initiation of projects through work processes associated with planning.

- 4.0 Work Processes—Performance. This chapter focuses on conducting project work, project management of change, and project reporting.

- 5.0 Work Processes—Verification. This chapter discusses inspection and testing; verification of information, design review, technical review, completion of project objectives, and process validation.

Project Support

- 6.0-11.0 Key Support Activities. These chapters discuss key project support activities, to include: documents and records; purchasing; design; training, qualification, and competence; communications; and measuring & monitoring devices.

Assessment

- 12.0-13.0 Assessment and Improvement. This chapter discusses continual improvement, independent assessment, identification and control of nonconformances, corrective and preventive action.

Appendices

- Specific information relevant to the execution of the project.

1.3.3 Project General Quality Objectives

The goal of this CQA Plan is to ensure that required actions will be completed as stated within the contract documents and are done so to the satisfaction of Bulova and the New York State Department of Environmental Conservation (NYSDEC). These goals will be met by implementing this CQP and by following the applicable specifications, plans and procedures. Documentation will be prepared and maintained during and after the completion of work activities so that it can be demonstrated that the work has been completed and performance requirements of the plan have been met, along with any variances.

Project specific objectives include:

- Construction of an *In-Situ* Bioremediation System.

1.3.4 Individual Expectations and Commitments

Each individual assigned to support this project is expected to fulfill their assigned task to the best of their professional ability. If at any time, an individual does not feel qualified to complete the assigned task, they should notify their supervisor, who will make provisions for re-assignment, training, or assistance. Each individual assigned to the project shall be committed to the overall success of the project through their personal contribution.

1.3.5 Supply Chain Relationships

The Shaw Group, in support of the CSL Business Line establishes business relationships to support the best overall value to our clients. Involvement of these organizations will typically be formally accessed through the procurement process.

1.3.5.1 Pre-qualified Contractors

Shaw E&I maintains a cadre of prequalified subcontractors, vendors, and suppliers who have been screened for basic service delivery capabilities. The procurement organization maintains a list of prequalified contractors. Additional information is included in Chapter 7.0, Procurement. Contractors for this project include:

- Naeva Geophysics for utility locating
- Municipal Land Survey for surveying activities
- Fenley and Nicol Environmental, Inc. for trenching and well installation activities

1.3.5.2 Laboratories

Laboratories identified for use for this project include:

- Chemtech Laboratories for analytical services
- Air Toxics, Ltd. for analytical services
- Shaw Technology Laboratory (Lawrenceville, NJ) for analytical services

1.4 Relationship with Shaw E&I

The Shaw E&I QMS has been developed in a four tiered format, to accommodate the breadth of quality needs for all of E&I. Tier 1 are requirements for all of Shaw E&I and includes the overall quality approach. Tier 2 are standard operating procedures that provide the foundation of operating requirements. Tier 3 includes business line quality plans and procedures, such as those for the CSL Business Line. Tier 4 is focused on program/project-specific plans and procedures. This CQA Plan is considered a Tier 4 document under this framework.

1.4.1 Project-specific Plans

Project-specific plans represent documents which are statements of the technical and management practices to be implemented for this project. Their development and use is a function of contractual and technical requirements of the work to be performed.

1.4.2 Technical Drawings

Technical specifications may be illustrated through drawings. Version control of technical drawings shall be through configuration management controls. Their development and use is a function of contractual and technical requirements of the work to be performed, and will be managed through the requirements for surveys and as-built drawings and submittals.

1.4.3 Specifications

The Shaw Bulova Corporation Remedial Action Work Plan for the 75-20 Astoria Boulevard Site, Jackson Heights Queens, New York, dated April 7, 2008 provides detailed instructions that outline performance expectations. The work plan provides the initial and primary source of expectations for which work shall be completed to.

1.4.4 Records (Tier 4)

Records shall provide the objective evidence to demonstrate the work that has been done and to support the project objectives. Records encompass both hardcopy records as well as electronic records. Records may include completed forms, documents, reports, regulatory applications, maps, designs, calculations, drawings, figures, tables, logs, field documentation, as-built drawings, data, computer output, analytical results, etc. Provisions shall be taken to ensure records are generated and protected from damage, deterioration, or loss.

2.0 Management and Organization

Management provides direction for the execution of work, to include quality performance. This section provides a brief discussion of the roles and responsibilities of key positions with specific quality-affecting duties or can influence quality performance. This includes support from the Business Line and Project Management, Equipment, and Quality Management Functional Groups.

2.1 Project Management

2.1.1 Project Managers

The Project Manager, Mr. Erik Gustafson, is the primary point of contact for all matters involving project performance. The Project Manager is ultimately responsible for the overall quality, administration and performance of project work, consistent with the Shaw Project Delivery System. This system provides a framework for Project Managers to lead a project through its entire lifecycle: initiating, planning, executing, monitoring, and control and closing. Additional responsibilities are described in the QMSP.

2.1.2 Project Engineer

Mr. August Arrigo, PE, is assigned as the Project Engineer. The Project Engineer is responsible for defining the means and methods by which work will be completed, in accordance with project requirements.

2.1.3 Site Superintendent

The Site Superintendent is Mr. Garrett Passarelli. He will coordinate with the Project Manager and is responsible for supervising the day-to-day performance of field activities performed by Shaw, and its subcontractors. He shall ensure the consistent implementation of applicable SOPs and specifications.

2.1.4 Field Personnel

Field personnel complete their assigned duties in a manner consistent with the requirements of the work plan, procedures, and specifications. All personnel are responsible to notify an appropriate level of management if work cannot be completed as described by procedures or if existing requirements may compromise project quality objectives. Field personnel complete project documentation in sufficient detail to be able to reconstruct project events by individuals other than the originator. Field personnel offer recommendations for project improvement to a responsible level of management. Field personnel are empowered to stop work on a project or task, as described in Section 4.1.1. Additional responsibilities may be included within project-specific plans and SOPs.

2.1.5 Equipment

The Equipment Services Group provides high quality, well maintained Shaw-owned equipment to Shaw projects. This may include heavy construction equipment, electronic hand held monitoring equipment, and tools. The group is responsible for performing acquisition, maintenance, specialty fabrication, deployment, and disposition of Shaw-owned equipment assets and assisting projects with acquiring outside equipment as needed. Additional information regarding the Equipment Services Group may be found on the ShawNet Portal.

2.2 Project Quality Management

The Shaw E&I Quality Functional Group supports the CSL Business Line. Quality Assurance/Quality Control support may be assigned, as needed to meet objectives. Assigned quality control tasks (e.g., inspection, test) shall report through the Project Engineer or Project Manager. Quality responsibilities will be in addition to their primary project duties. Additional information regarding the Quality Functional Group may be found in *SOP-Q-001, Quality Organization* and on the ShawNet Portal.

The project CQA activities will involve identifying and developing quality controls for construction-related activities for the project and associated tasks. The Project Manager is responsible for managing all quality matters for the project and is delegated the authority to act in all quality matters for Shaw. Additional responsibilities may be included within the Remedial Action Plan and SOPs.

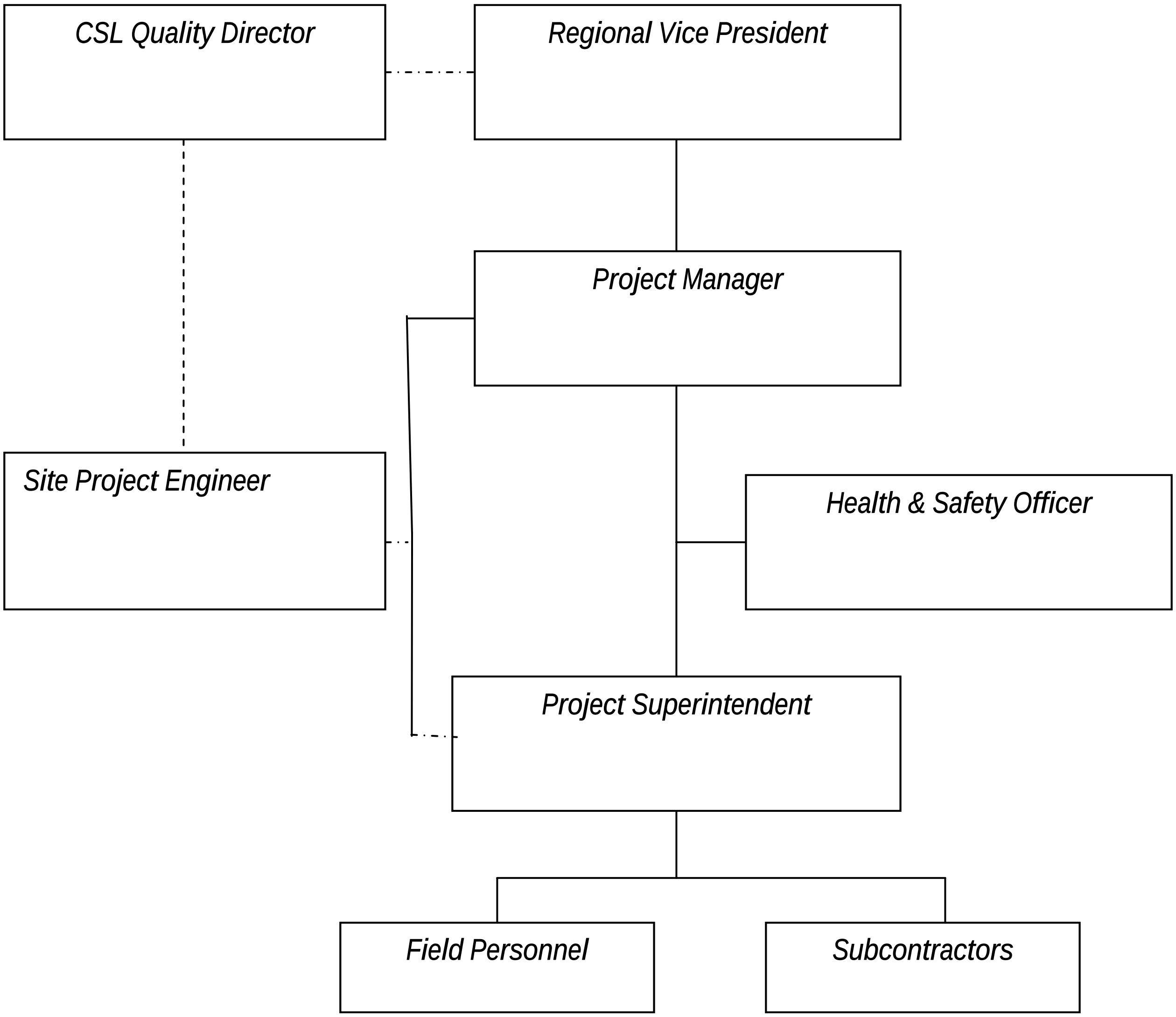


Figure 1. Project Organization

3.0 Work Processes—Project Planning

The series of activities that comprise a project are considered a work process. This chapter discusses the quality-related work processes associated with project work process planning. Quality management, as it applies to the project work process, is organized by project planning (Chapter 3.0), Project Performance (Chapter 4.0) and Verification (Chapter 5.0).

3.1 CSL Work Process Planning

The 75-20 Astoria Boulevard project shall utilize a systematic planning process to meet the project objectives. This work is in direct response to customer specified requirements, specified through the contract, and detailed within requirement specifications. Consideration shall be given to project objectives, schedules, and human and material resources, as they apply to quality performance. Special consideration shall be given to planning during the early stages of the project, however should be under continual evaluation throughout the project to ensure efficient project execution and that customers expectations are met.

The Shaw E&I Project Delivery System recognizes five-major process groups in the lifecycle of a project: Initiating, Planning, Executing, Monitoring & Control, and Closing. Project planning efforts are principally focused in the Initiating and Planning Process Groups of the Shaw E&I Project Delivery Process, described in *PM-P001, Project Delivery System*.

3.1.1 Controls

Controls shall be established to mitigate the business performance risk. Project-specific controls include plans, procedures, work instructions, specifications, and drawings and quality-affecting equipment and materials (*Appendix* B1 to B5).

3.1.2 Process Improvement Initiatives

The CSL Business Line management team is committed to continual improvement of the service delivery process. The Project Manager should be contacted for consideration of improvement initiatives. For improvement initiatives that are adopted, information will be disseminated through the project and management communication channels.

3.1.3 Regulatory and Other Requirements

All Shaw employees shall perform all work in accordance with applicable laws, regulations, and standards of conduct, as described within the Shaw Group, Inc. Code of Corporate Conduct. Regulatory requirements provide the minimum foundation for work to be performed.

Applicable standards, codes and requirements of the contract specifications shall apply as stated within the contract documents. This shall include, as a minimum, applicable provisions of:

- NYSDEC Voluntary Cleanup Agreement #W2-0854-9906
- Applicable NYSDEC regulations
    - TAGM 4046-Recommended Soil Cleanup Objectives for soil
    - Class GA Standards for groundwater
- Applicable NYSDOH regulations
    - Guidance for Evaluating Soil Vapor Intrusion in the State of New York

3.2 Project Work Process Planning

3.2.1 Project Planning and Approach

Project-specific details shall be evaluated by project management, to include quality performance. A project approach has been developed, defined through the Shaw Remedial Action Work Plan (Section 3.2.2.1). Staffing assignments shall be made by the Project Manager, with assistance by the CSL Business Line leadership.

Project-specific training shall be provided, where it is deemed necessary, by the Project Manager.

3.2.2 Identification and Management of Work Controls

The Project Manager shall identify project-specific work controls. Consideration should be given to the familiarity of the assigned staff with the project, level of expertise with the assigned work, and relative complexity of the tasks. The Project Manager shall be responsible for communicating applicable requirements to project participants. These controls may be documented, if deemed necessary by the Project Manager. These can include Shaw SOPs, contract specifications, regulations, codes and industry-accepted methods and standards. Appendices include project-specific documents.

3.2.2.1 Work Plans

The Remedial Action Work Plan for the 75-20 Astoria Boulevard Site, dated April 7, 2008 describes the project history and planned course of work.

3.2.2.2 Routine Work

Routine work that does not require a plan may be completed without the development of a work plan, at the discretion of the Project Manager. Consideration should be given to the familiarity of the assigned staff with the project, level of expertise with the assigned work, and relative complexity of the tasks. The control of work shall be controlled by existing controls (e.g., CQA Plan, SOPs).

3.2.2.3 Construction QC Plan

This CQA Plan provides a summary of design construction-related quality requirements to perform the project, in accordance with the Remedial Action Work Plan and Shaw E&I quality requirements, defined in *SOP-Q-003, Project Quality Plans*.

3.2.2.4 Procedures

SOPs (e.g., E&I, CSL, CSP) shall be implemented to provide focused guidance for completing quality-affecting activities through defining specific protocols associated with the completion of work. Applicable SOPs are identified in *Appendix B-1* through *B-3*.

3.2.2.5 Work Instructions

Work instructions provide detailed operational-level instructions. Work instructions should be considered to be developed or used if this level of detail is warranted to meet project performance objectives. Work instructions for this project are identified in *Appendix* B-4.

3.2.2.6 Technical Drawings

Technical specifications may be illustrated through drawings (e.g., construction drawings, vendor drawings, red-lines, as-builts, blueprints). Version control of technical drawings shall be through configuration management/document controls. Requirements for the management of drawings are defined within *EN002 CAD Standards* and *EN003, Engineering and Design Calculations*. *Chapter 8.0 (Design)*, provides additional information for engineering drawings. Quality-affecting drawings are identified in *Appendix B-3*.

3.2.2.7 Equipment

Equipment selection shall be based on the specific needs of the project. The use of specialized measuring and test equipment (M&TE) shall take particular care to ensure the equipment has been uniquely identified, evaluated for operability, and has been calibrated to nationally recognized standards (e.g., National Institute of Standards and Technology [NIST]). This includes M&TE that has been temporarily leased. *Chapter 11.0 (Measuring and Monitoring Devices)* provides an extended discussion. Additional information regarding the Equipment Functional Group may be found on the ShawNet Portal.

Specific quality-affecting equipment identified for the project is included in *Appendix B-5*.

3.2.3 Procurement Planning

Procurement planning of quality-affecting services, equipment and materials shall include detailed performance specifications as a condition of the purchase. This information is typically included within technical specifications and drawings. Requirements for the quality-related management of subcontractors, suppliers, and vendors is defined within procurement SOPs.

The completion and documentation of inspection results shall be considered in the planning process. Quality-affecting materials shall be inspected to confirm the inclusion of required attributes. This may be accomplished by:

1. Receipt inspection upon delivery at the site
2. Received on-site in acceptable conditions
3. Formal documentation from the vendor certifying conformance to specified requirements

Information regarding the inspection process is included in *Chapter 5.0, Verification*. Additional information regarding purchasing and subcontracting is included in *Chapter 7.0 (Purchasing)*.

3.2.4 Performance Planning and Monitoring

3.2.4.1 Technical Performance

Project technical performance shall be overseen by the Project Manager. The Project Manager may be assisted by the site engineer, superintendent, technical specialists, quality specialists, operations, and national practice leader resources to further assess the technical performance, upon request.

3.2.4.2 Project Performance

Project performance shall be overseen by the Project Manager. Deviations from cost, schedule, and fulfilling quality objectives shall be investigated, reported to a responsible level of CSL Business Line management and corrective actions initiated in a timely manner. Project financial performance objectives shall be managed through the Shaw project control systems (e.g., Shaw Vision).

4.0 Work Processes—Project Performance

This section discusses the quality-related work processes associated with project performance. It includes conducting project work, project management of change, and project reporting. Project performance efforts are principally focused in the Execution Process and Closing Groups of the Shaw E&I Project Delivery System, defined in *PM-P-001, Project Delivery System*.

4.1 Conducting Project Work

The mobilization to the field to conduct project work typically occurs after the project planning work processes have been completed. Major proposed quality affecting-activities shall include:

- Site preparation
- Utility Mark-outs
- Well Drilling
- Trenching and Well Vault Installation
- Parking Area Restoration
- Treatment Shed
- Startup

Engineering is considered in a broad context, defined as the application of science that results in the construction, performance, and operation of equipment and structures.

Additional information regarding engineering requirements and resources may be found in *Chapter 8.0 (Design)* and on the ShawNet Portal.

4.1.1 Stop-Work Authority

All Shaw employees and subcontractors are authorized to stop work, per *SOP-Q-002, Stop Work Order*, whenever continuation could result in injury or illness to personnel, damage to essential items, or significant adverse impact on quality / schedule / budget.

4.1.2 Pre-Developed Work Controls

All work controls are covered by existing SOPs.

4.1.2.1 Field Activities

Field remediation and construction work shall be the primary field activities to meet project objectives for this project. *Appendix* A provides an initial general mapping of the major definable features of work for the project.

Data collection, data reduction, and the results of field operations shall be completely documented. Field documentation shall provide the basis to provide evidence of satisfactory work performance and the foundation for subsequent activities and information transmitted external to Shaw. Information shall generally be recorded on standardized forms and/or the output recorded on automatic data acquisition systems. Additional guidance for the completion of field documentation is included in *SOP-FS-001, Field Logbook* and *SOP-FS-002, Field Logsheets*.

Verification shall be performed before the presentation of final results or the use of data in subsequent activities. If it becomes necessary to present or use unchecked results, transmittals and subsequent calculations shall be marked “preliminary,” until such time that the results are verified and determined to be correct. Additional information regarding verification is included in Chapter 5.0, Verification.

4.1.3 Engineering Design

Engineering design requirements shall be applied to all engineering services completed for this project. Design is defined as part of the practice of engineering that translates needed performance requirements and site conditions by calculations and modeling structures and equipment to meet performance requirements and site conditions. In general, this shall include calculations, drawings, specification, reports, and subsequent changes to work. The breadth of services involved by engineering design projects may include:

- Obtaining site-specific data that are used as design input
- Determining performance requirements that are used as design input
- Performing calculations and modeling to go from performance requirements or design input to specific requests (e.g., sizes, materials, operating ranges, performance behavior, etc.)
- Evaluating changes to a design to determine the impact of the change upon performance and/or safety
- Documenting as-built conditions
- Engineering design activities.

Personnel selected to complete engineering design work (both preparer and reviewer) shall be technically qualified and experienced in the disciplines required.

Shaw E&I design procedures and generally accepted engineering and technical standards shall be used in conjunction with relevant contract specifications. E&I design procedures include:

- *SOP-T-EN-001, General Requirement for Engineering*
- *SOP-T-EN-002, Computer Aided Drafting*
- *SOP-T-EN-003, Engineering Calculations*
- *SOP-T-EN-004, Engineering Drawings*
- *SOP-T-EN-005, Engineering Reports and Specifications*
- *SOP-T-EN-006, Design Reviews*
- *SOP-T-EN-007, Change Control for Engineering*
- *SOP-T-EN-008, Professional Engineer's Seal*

If there are any conflicts, the contract requirements or NYSDEC requirements shall take precedence. Work shall be completed in a manner to demonstrate that work is prepared, reviewed, and issued in a controlled manner to meet project requirements.

Engineers assigned to participate in engineering design activities shall be responsible for the preparation of design input information, calculations, design input for drawings, and required specifications. Reviewers shall be responsible for checking and reviewing the various tasks within the engineering work, including design input, calculations, drawings, specifications, change notices, etc. to verify accuracy and thoroughness. *SOP-T-EN-003, Engineering Calculations* and *EI-Q012, Verification of Calculations, Spreadsheets, and Databases* defines the requirements for the completion of calculations and related data management tools. The design review process is included in Section 5.3.

Additional information for quality-related requirements for engineering design is included in *Chapter 8.0 (Design)* and general requirements for engineering design may be found on the ShawNet Portal.

4.1.4 Remediation / Construction

Work shall be completed in manner to demonstrate that work is prepared, reviewed, and issued in a controlled manner to meet project requirements. Well installation, treatment system installation, and sampling activities (soil, water, vapor) will be completed in accordance to standard industry practices, as described in the Shaw Remedial Action Work Plan. Potentially relevant Shaw SOPs used to guide these activities are detailed in *Appendix B-1*.

4.1.5 Property and Equipment Use and Maintenance

The use of quality-affecting property and equipment will be used for this project. Anticipated M&TE to be used on the project is included in *Appendix B-5*.

The management of M&TE is defined within owners manuals for specifics pieces of equipment.

4.1.5.1 *Company-Owned Equipment*

Company owned equipment shall be managed by existing protocols for the use, handling, and maintenance of equipment, defined by *EQ007, Small Tools & Equipment*; *EQ008, Repair and Maintenance*; and *GA505, Low Value Equipment*.

4.1.5.2 *Leased Equipment*

Leased equipment shall be managed in accordance with *EQ001, Equipment Rental Procedure*.

4.1.5.3 *Customer- Supplied Equipment*

If customer-supplied equipment is used, care shall be exercised for equipment owned by the customer and used or maintained by Shaw. As appropriate, efforts shall be taken to identify, verify, protect, and safeguard customer property. If any customer property is lost, damaged, or otherwise found to be unsuitable for use, this shall be reported to the customer and records maintained. Customer property may also include intellectual property.

4.2 *Project Management of Change*

Change from the original scope of work shall be documented. Changes and opportunities for improvement, are planned improvements and variances from contractual documents and work procedures. They are based on information obtained or events that occur during work activities prior to work execution. They differ from nonconformances, which reflect unplanned or unapproved changes or deviations from requirements.

These project-specific changes shall be controlled and the resulting records retained by the project team. Completed change documentation (e.g., activity change records and contract amendments) shall be transferred to the appropriate project central file. The Shaw E&I Project Delivery System, defined by *PM-P-001, Project Delivery System* also includes requirements for project change management *(PM-G-003, Project Change Management)*. The information included herein is intended to complement the Shaw E&I Project Delivery System, which includes quality, and not replace it.

4.2.1 *Variance From Plans*

4.2.1.1 *Minor Changes*

Minor changes are considered day-to-day adjustments made to planned approaches that do not materially modify the overall project objectives. The Project Manager should be made aware of these changes before they are executed and consider the implications that the changes may have. Documentation of the changes shall be reflected within the project records. Consideration should be made if the change reflects an overall process improvement or is a one-time event to accommodate local conditions. If warranted, the planning documents or work control documents (e.g., work plan, procedures) should be modified to reflect the process improvement.

4.2.1.2 Contractual-Based Changes

Contractual-based changes are process modifications that materially change the overall project objectives and require approval from the client prior to being implemented. The modification shall be documented within contractually binding documents (e.g., change order, revised scope of work) and any other necessary supporting documentation.

4.2.2 Nonconformance

4.2.2.1 Nonconforming Process

Nonconforming processes represent the unapproved completion of work activities that do not meet established requirements for performance (e.g., procedures). The management of nonconformances shall be in accordance with *SOP-Q-007, Nonconformance*. *Chapter 12.0 Nonconformance, Corrective and Preventive Action* provides additional information on the management of the nonconformance process.

4.2.2.2 Nonconforming Items

Nonconforming items represent objects, pieces, parts, subassemblies, etc. that are either non-operational, working substandard, or somehow are not performing to their quality expectations. Nonconforming items may be part of a nonconforming process. The management of nonconforming processes is described above in 4.2.2.1.

4.3 Project Reporting

This section covers the transfer of data, results, conclusions, and recommendations obtained through data acquisition, analysis/design, and other project activities through submittals. This transfer can be accomplished using technical documents such as progress reports, informational reports, memoranda, data reports, field investigation reports, design reports, surveys, drawings and regulatory submittals. The documents can be in hard copy form or electronically. Assignments shall be made to ensure the preparation and submittal of documents that fulfill the intended scope of work and meet project requirements. Client engineering submittals shall be managed in accordance with *SOP-T-EN-005, Engineering Reports and Specifications*.

4.3.1 Reports and Deliverables

4.3.1.1 Standard Format

Standard formats adopted by Shaw E&I should be used to ensure consistency of approach and presentation. The Shaw E&I Format Manual shall be used unless otherwise directed by Bulova or the NYSDEC.

4.3.1.2 Client-Specified Format

Client-specified formats shall be used, if requested. A brief note to file should be included to explain why there is a deviation from standard formatting expectations.

4.3.1.3 Status Provisions

The status of documents shall be clearly identified to alleviate the concern for any ambiguities or mis-representations of work. Unless marked otherwise, the expectation is that documents are final presentations of work, and as such have been reviewed and approved for issuance.

Suggested status indicators include:

- Preliminary. Documents that have not been fully reviewed and approved for issuance. The release of preliminary documents should be avoided, if possible. If it does become necessary to issue preliminary documents, their incomplete status should be clearly communicated.

- Draft. Draft documents have been fully reviewed and approved for issuance by Shaw, however are awaiting client review comments to be finalized.

- Final. Final documents reflect a final presentation of work included within the submittal that has been reviewed by the client, comments resolved, and reviewed and approved by the Project Manager for release.

As a minimum, status indicators should be included on the transmittal letter and cover page of the document. This should include any restrictions or limitations that are relevant to the work (e.g., scoping assessment, conceptual design, pending review). Additional options may include providing the document status in document footer or headers, and/or through water marks.

4.3.2 Submittal Process

Shaw shall implement a submittal management system that schedules, manages and tracks all submittals required by the contract documents. Submittals shall be managed for any Shaw subcontractors, offsite fabricators, and suppliers and purchasing agents.

Submittals to Shaw from subcontractors or suppliers will be reviewed and accepted prior to transmitting the submittals to Bulova or the NYSDEC. All appropriate information will be complete and accurate prior to transmittal. Any deviations from requirements and drawings shall be clearly indicated. Submittals will be scheduled to coincide with the needed dates and to allow adequate time for review and approval in accordance with the contract documents. A Standard Document Transmittal Form (*Appendix D, Attachment D-2*) and a Submittal Register (*Attachment D-4*) provides generic formats for a submittal management. Equivalent forms may be used at the discretion of the Project Manager.

An assessment shall be made to determine the requirements (e.g., client and regulatory) for technical document submittal, including the required media (e.g., printed hard copy, electronic), the number of copies required, and to whom the copies are to be transmitted. Documents can be issued as “preliminary”, “draft”, or “final” presentations of the work. All documents for external distribution shall be reviewed and approved by a responsible level of management. Section 5.4 Technical Review, provides additional information for the technical review process.

Submittals may include, however are not limited to, shop drawings, product data, samples, test and inspection results, and written plans. Other submittals may be included upon request by Bulova or the NYSDEC.

5.0 Work Processes—Verification

This section covers the verification and validation of work completed through work processes and is the primary focus of the Construction QC function. Verification is the process of confirming that work is completed as planned and/or intended. The general process of the verification of information is discussed, along with more formal efforts through inspection and test. Validation focuses on the confirmation of the suitability of the work for the application. Verification efforts are principally focused in the Monitoring and Control Process Group, of the Shaw E&I Project Delivery System (*PM-P-001*).

5.1 Verification of Information

Project results under the control of Shaw shall be verified to determine whether quality-related activities, items, and results meet specified requirements and/or can be improved. Inspections, testing, technical, quality, and management assessments are included.

5.1.1 Checking of Data

Reasonable measures to provide for the confirmation of the validity of information should be completed for the collection of data and associated output. For all subcontracted analytical data, *SOP-FS-020, Data Usability Review* defines requirements for completeness and usability.

5.1.2 Checking of Figures, Tables, Logs, and Drawings

Figures, tables, logs, and drawings typically represent the summary or compilation of project results. As such, the accuracy of the information included within these documents is critical, and extra measures should be taken to check the integrity of the information. *SOP-T-EN004, Engineering Drawings* and *EI-Q011 Verification of Figures, Drawings, Tables, and Logs* defines the checking process for these work products. The checking of CAD drawings are controlled by *SOP-T-EN-002, Computer Aided Drafting.*

5.1.3 Checking Process

A standard checking processes should be used to ensure the integrity of reported information. Checking processes can be facilitated electronically (e.g., search, sort, query commands) or completed manually. The rigor in which data is checked should be relevant to the nature of the data collected, the means in which it was collected, and the intended use for the data. Consideration should be given to both random and systematic errors. *SOP-T-EN-003, Engineering Calculations* and *EI-Q012, Verification of Calculations, Spreadsheets, and Databases* defines the requirements for the completion of calculations and related data management tools.

5.2 Inspection and Testing

Inspections and tests shall be completed to collect data to verify conformance of a process or item to demonstrate satisfactory performance. When test control is required, it shall be planned and executed. *SOP-Q-005, Inspection* defines general requirements for inspections.

Inspections shall verify conformance of an item or activity to specified requirements or continued acceptability of items in service. Characteristics subject to inspection along with inspection methods shall be specified. Inspection and testing strategies shall consider the needs to control the work output (e.g., frequency, sample size, acceptance criteria).

Inspection and testing methods should be appropriate to the application. Inspection results shall be documented, typically on an inspection and test form designed for the activity. Pre-developed inspection/test procedures should be used whenever possible. Inspection for acceptance shall be performed by qualified persons other than those who performed or directly supervised the work being inspected.

5.2.1 Inspection and Test Plan

Inspection and test activities shall be planned and performed in accordance with the needs of the project with a focus on definable features of work. The Project Manager shall be responsible for establishing the inspection and test plan. The Project Manager shall be responsible for identifying the definable features of work for the purposes of inspection and testing that is aligned with the site work flow. *Appendix A-1, Definable Features of Work*, provides an initial listing of the definable features for this project requirements and controls associated with the work.

5.2.2 Inspection and Test Procedures

The conduct of inspection and test activities will be performed in accordance with governing plans, procedures and instructions. Tests shall be documented when performed to collect data to verify conformance, to demonstrate satisfactory performance. Relevant pre-developed inspection/test procedures shall be used, unless justification can be provided.

Inspection verification techniques may range from visual confirmation to actual dimensional measurements and readings. Test verification may range from actual performance to observing tests performed by others, and recording of test data and results. *Appendix C* identifies inspection/test work instructions for this project.

A generic QC Checklist & Inspection Report may be used or can be adapted to accommodate most inspection points, if a method-specific form is not available. Equivalent forms of the pre-developed forms may be used, at the discretion of the Project Manager.

5.2.3 Inspection and Test Reporting

Inspection and test results shall be compiled in an acceptable inspection and test report and/or activity-specific form. These reports shall be tailored to fit the work activity, process or item being inspected or tested. Each report shall include information to demonstrate compliance with applicable codes, standards, specifications, plans, drawings, procedures or instructions.

Checklists shall be used to document the performance of field tests, similar to those used for inspections. When a checklist is not advantageous for application, a narrative report may be used. In the absence of a function-specific inspection/test form, a generic form may be used. *Appendix D, Attachment D-9* provides an example. Equivalent forms may be used at the discretion of the Project Manager.

5.2.4 Daily QC Reports

A Daily QC Report (DQCR), *Appendix* D-3 may be completed to identify, summarize and document project activities where QC personnel are required on-site. Equivalent forms may be used at the discretion of the Project Manager. The report should cover both conforming and nonconforming work and where applicable, shall include a statement of acceptability that materials, supplies, and work verified therein is in conformance with the contract requirements. The Project Manager’s designee shall complete, sign and date the DQCR.

Additional documentation (e.g., inspection and test reports, and other completed checklists, subcontractor daily reports, nonconformance reports and other pertinent documentation) should be included as attachments to the DQCR, as applicable.

The DQCR reports shall be initiated and maintained by the designee of the Project Manager, filed in the project quality files and available for review.

5.2.5 Receipt Inspection

Receipt inspection involves the evaluation of incoming materials upon receipt to ensure what has been received is what was ordered through the procurement process. E&I *SOP-Q-004, Receipt Inspection* and *SOP-T-PR-004, Receipt Inspection*, provides general requirements for the management of the receipt inspection process. Project-specific requirements may be developed to accommodate the needs of the project.

The Project Manager’s qualified designee shall inspect quality related items and materials upon receipt and prior to use. Inspection aids (e.g., shipping list, checklists) shall include applicable criteria. Appropriate criteria should be established prior to receipt.

QC receipt inspections shall be documented using *Appendix D Attachment D-7* Quality Control Receiving Report. QC Receiving Reports shall be logged using *Attachment D-8*, Quality Control Receipt Inspection Log. Equivalent forms may be used at the discretion of the Project Manager.

Copies of material and item certifications shall be maintained in the project QC files.

5.2.6 Source Inspection

Source inspection may be performed at the subcontractors'/suppliers' offices or facilities. Quality characteristics of items that cannot be verified during subsequent processing may be subject to source inspection (e.g., fabrication). Source inspection may not be necessary when the quality of the item can be fully and adequately verified by review of inspection and test reports, inspection upon receipt or by other means (e.g., certificate of conformance). Additional information for the procurement process is included in this document, in *Chapter 7.0 (Purchasing)*.

5.3 Design Review Process

The design review process shall cover the performance, documentation, and verification of project-related analyses and designs. The intention is to evaluate the design work by reviewers to determine whether the design can be expected to perform as intended. This process is defined by *SOP-T-EN-006, Design Reviews*. Additional information for the engineering/design process is included in *Chapter 8.0 (Design)*.

Analyses and designs will generally include manual field calculations. Calculations supporting analyses/designs can include manipulating/managing/reducing acquired data, and the evaluation of anticipated or actual performance. The calculations shall be legible and in a form suitable for reproduction, filing, and retrieval. Documentation shall be sufficient to provide evidence of satisfactory work performance and the basis for information transmitted external to Shaw. Documentation shall also be sufficient to permit a technically qualified individual to review and understand the work and verify its results. *SOP-T-EN-003, Engineering Calculations* and *EI-Q012, Verification of Calculations, Spreadsheets, and Databases* defines the requirements for the completion of calculations and related data management tools.

Calculations that affect project results sent external to Shaw shall be verified. Regardless of the form of the calculation, verification should, whenever possible, be performed by an individual selected by the Project Manager, or designee, because of his technical expertise in the calculation subject. Verification should be conducted before external presentation of associated final results or their use in subsequent activities. If it becomes necessary to present or use unverified work, transmittals and subsequent calculations should be marked "preliminary" until such time that the work is checked and determined to be correct.

5.4 Technical Review

Technical review includes the technical/peer review of Shaw's and its subcontractors' project activities and documents (e.g., reports, work products). These reviews are performed to assist in controlling the end products of technical functions. Review responsibility shall be the Project Manager's. The Project

Manager may delegate specific elements of review, however retains the overall responsibility that reviews have been completed.

5.5 Completion of Project Objectives

The Project Manager shall maintain ultimate responsibility that the project objectives have been completed for individual tasks and activities under the project. The discussion of project objectives as defined by contract and regulatory requirements may be presented during project meetings. Results may include the discussion of inspection results. The interim progress of projects is completed through the Project Review Process. If objectives cannot be fulfilled, the Project Manager should provide an explanation to a responsible level of Shaw management as to why not. Bulova representatives should be notified to discuss and negotiate alternative provisions to satisfy performance expectations.

5.6 Process Validation

5.6.1 Equipment and Instrumentation

Results associated with equipment and instrumentation should be evaluated by appropriately knowledgeable personnel to discern the intended operability of the equipment and instrumentation along with any associated output/results. As necessary, this may require involvement by a manufacturing representatives or documentation by a third party.

6.0 Key Support Activities—Documents & Records

6.1 Document Management

The preparation, review, distribution and revision of documents affecting quality by defining how work is to be completed for the project shall be controlled so that the latest approved information is made available to workers and readily accessible at their point of work. Documents subject to document control shall include, but not be limited to specifications, drawings, procedures, plans, instructions.

Work control documents should be controlled through a system of formal review and approval, document distribution, document status, and document revision/cancellation. The extent of control shall be a function of document type and requirements/scope of the subject activities.

Controls shall be established for both hard copy documents, electronic documents, and documents of external origin (e.g., ShawNet Portal). Printed hardcopies are typically considered for reference only, unless otherwise specified. It is the responsibility of every team member to verify they are working to the most recent version of controlled documents. Reasonable efforts should be taken to notify likely users of substantive changes to work documents (e.g., notification e-mail or memorandum).

6.2 Records Management

This section discusses the identification of records generated for this project, the description of the records management system used to control and retain those records, and the disposition of the records. Record control includes indication of record status, validation, and transfer to storage. Retention covers receipt at storage areas, indexing and filing, storage and maintenance, and retrieval.

6.2.1 Project Records

Records controlled by the Shaw records management system shall be retained, as appropriate, in on-site files, and permanent storage files. Each system is designed to provide an organized approach for secure storage and record retrieval. The use of each system is based on regulatory/contractual/ Shaw requirements and the scope of work being performed. Project records management is defined in EI-G004, Records Generation, Management, and Control.

Project quality records shall be prepared to furnish documented evidence that project activities, including testing performed by others, fulfill the scope of work and are in compliance with the requirements of the contract. The records shall be consistent with applicable sections of the contract specifications and may include, but not be limited to, the following:

- Inspection & Test Reports

- Monitoring and Surveillance Activities
- Personnel Qualifications
- Testing Laboratory Analysis/Reports
- Shop Drawings
- Product Data
- Project Plans
- Training Records
- Other Specified Documents.

6.2.2 Indexing and Filing

The project records file shall be organized by various project file categories. As a minimum, this should include:

- Contract
- Project Management
- Technical
- Procurement
- Quality
- Health and Safety
- Contract Submittals

Additional categories may be added or deleted as necessary, at the discretion of the Project Manager, based on the needs of the project.

Records management and records retention for Shaw E&I is defined in *FE012,Records Management and Records Retention for Shaw E&I.*

7.0 Key Support Activities—Purchasing

This section applies to the Shaw purchase of quality-related items (e.g., equipment, materials) and services (e.g., technical-related) for this project. It supplements requirements established by the Procurement Functional Group. Procured items and services shall meet established requirements and perform as specified. Procurement activities shall be conducted in accordance with approved procedures. In general, the project team can submit technical specifications to the purchasing organization, however it is the purchasing organization that maintains all contacts with external organizations through the procurement process. Project procurement management is included as a part of *PM-P-001, Project Delivery System*. The information included herein is intended to complement the Shaw E&I Project Delivery System, not replace it.

7.1 Purchasing Documents

Procurement documents issued by Shaw can include purchase orders, bid requests, professional services agreements, contracts, design specifications, and any material attached to these documents.

The procurement of items and services shall be performed in accordance with Shaw purchasing policies and procedures.

7.1.1 Quality Affecting Purchases

Quality-affecting processes shall be the focus of quality requirements. Quality-affecting processes are generally considered any work process, activity, or item(s) that has the ability to directly or indirectly affect performance objectives or expectations from being fulfilled.

Procurement documents (including bid requests, POs, and contracts) shall be prepared, reviewed, and approved in accordance with approved procedures, by the purchasing group. The Project Manager or technically qualified designee should review the procurement requisition or other procurement documents for the inclusion of appropriate quality requirements, prior to processing procurements for quality-related items or services. Technical requirements shall either be directly included in the procurement documents or referenced to specific drawings, specifications, statements of work, procedures, or regulations (with specific revision numbers and issue dates) that describe the item or service to be furnished.

7.2 Supplier / Subcontractor Verification

The control of purchased items and services shall include, as appropriate to each individual procurement:

- Subcontractor prequalification

- Subcontractor bid evaluation
- Procurement source evaluation and selection
- Subcontractor performance verification/assessment and acceptance
- Certificate of Conformance
- Commercial Grade Items.

Control shall be provided through a joint effort of personnel involved in specifying procurement document requirements, preparing/reviewing/approving procurement documents, performing the actual purchasing, and accepting the purchased items/services. It shall be applied, as necessary, to supply (and continue to supply) items/services which conform to the procurement document requirements.

Receipt inspection shall be complete, when required (Refer to Section 5.2.5 Receipt Inspection). Acceptance criteria shall be identified. Reviews shall ensure that all technical and quality requirements are met. Items and services that do not meet requirements should not be accepted. For disputes related to quality, it shall be the responsibility of an appropriate level of management and the purchasing organization to negotiate an amicable settlement. The control and disposition of supplier nonconformances for items and services that do not meet procurement documentation requirements shall be documented.

Documentation of project-specific, purchased item/service control shall be maintained as records in the project central file (e.g., receipt inspection checklist, signed packing list).

8.0 Key Support Activities—Design

This section covers the quality-related requirements for the performance, documentation, and verification of project-related analyses and designs. It supplements requirements established by the Engineering Design Functional Group. Analyses and designs are generally performed using calculations that can vary from simple manual calculations to engineering design drawings and specifications.

Shaw E&I design procedures and generally accepted engineering and technical standards shall be used in conjunction with relevant contract specifications. Shaw E&I design procedures include:

- *SOP-T-EN-001, General Requirement for Engineering*
- *SOP-T-EN-002, Computer Aided Drafting*
- *SOP-T-EN-003, Engineering Calculations*
- *SOP-T-EN-004, Engineering Drawings*
- *SOP-T-EN-005, Engineering Reports and Specifications*
- *SOP-T-EN-006, Design Reviews*
- *SOP-T-EN-007, Change Control for Engineering*
- *SOP-T-EN-008, Professional Engineer's Seal*

If there are any conflicts, the contract and NYSDEC requirements shall take precedence. Work shall be completed in manner to demonstrate that work is prepared, reviewed, and issued in a controlled manner to meet project requirements.

Engineers assigned to participate in engineering design activities shall be responsible for the preparation of design input information, calculations, design input for drawings, and required specifications. Reviewers shall be responsible for checking and reviewing the various tasks within the engineering work, including design input, calculations, drawings, specifications, change notices, etc. to verify accuracy and thoroughness. *SOP-T-EN-003, Engineering Calculations* and *EI-Q012, Verification of Calculations, Spreadsheets, and Databases* defines the requirements for the completion of calculations and related data management tools. Additional information for the design review process is included in Section 5.3. Additional information for quality-related requirements for and general requirements for engineering design may be found on the ShawNet Portal.

9.0 Key Support Activities—Training, Qualification, & Competence

This section covers the technical/quality/administrative indoctrination, training and the formal qualification and certification, as necessary, of Shaw project and administrative personnel and selected subcontractors.

9.1 Training

Indoctrination and/or training for Shaw and selected subcontractor personnel should be performed, to achieve and maintain proficiency in the performance of quality-related activities. An orientation to the requirements of the project should be presented during the early stages of the project (i.e., kickoff meeting).

Records shall be maintained to reflect education, training, skills and experience.

9.2 Qualification, Certification, and Registration

A responsible level of management will routinely monitor performance of personnel to ensure the necessary level of knowledge and skills to meet job performance expectations. Formal qualification or certification of personnel shall be completed, as necessary.

9.3 Training Records

Records of training shall be maintained as a project record. This may include attendance records, meeting minutes to include participants, field records, or other means used for this purpose.

10.0 Key Support Activities—Communications

Project communications include the control of written and oral communications associated with the project, with the exception of the technical contract submittals, covered under technical review. A practical system of communicating shall be employed for efficient operation of the project and the effectiveness of the quality management system. The Project Manager shall be responsible for invoking communication controls, as deemed necessary. Requirements for communication controls are defined in *PM-G-004, Project Communications*.

11.0 Key Support Activities—Measuring & Monitoring Devices

Equipment shall be controlled to retain its desired operating characteristics in order to monitor and measure attributes important to achieving desired quality. These requirements are limited to measuring and test equipment (M&TE). Compliance with these requirements provides instruments of the proper type, range, accuracy, tolerance, and precision to obtain data compatible with project requirements and desired results. Certifications of calibrations and calibration test reports shall be reviewed by the equipment owner. The validity of previous results shall be assessed when equipment is not found to conform to requirements.

Owners manuals define the requirements for measuring and monitoring devices. Requirements for the management of rented equipment is included in *EQ-001, Equipment Rental Procedure*.

12.0 Nonconformance, Corrective and Preventive Action

Deviations from requirements shall be documented in order to have an accurate record that objectively reflects how work was performed. This process includes the identification of nonconformances, subsequent control of nonconforming conditions, implementation of corrective actions, and preventive actions put in place to preclude recurrence.

EI-Q-007, Nonconformance Reporting defines general requirements for managing nonconformances and associated corrective actions.

12.1 Identification of Nonconformances

Nonconforming items and activities are those which do not meet project requirements, procurement document criteria, contractual scope of work, specifications, approved work instructions, or accepted Shaw standard practices. Consideration should be given to how the nonconformance could affect other areas within the project as an opportunity for improvement.

12.2 Control of Nonconforming Conditions

12.2.1 Control of Nonconforming Items

Items, material and equipment which are found to be not conforming to the specifications, drawings, procedures, or instructions shall be identified to prevent inadvertent use and documented on Nonconformance Report (NCR), *Appendix D, Attachment D-5*. Equivalent forms may be used at the discretion of the CSL Director of Quality. Once issued, the NCR will remain open until the nonconforming condition has been suitably resolved by the responsible manager, the corrective action has been effectively implemented and the condition(s) are verified as acceptable by the Project Manager.

12.2.2 Control of Nonconforming Processes

Conditions or processes adverse to quality are generally those that are programmatic in nature. Conditions adverse to quality shall be documented and reported to the appropriate levels of management, requiring the condition to be investigated and acceptable corrective action taken in a specified timeframe.

12.3 Nonconformance Tracking and Status

Each NCR shall be documented on the NCR Tracking and Status Log, *Attachment D-6*. Equivalent forms may be used at the discretion of the Project Manager.

The Project Manager or designee shall be responsible for maintaining the NCR Tracking and Status Log and for the verification that the corrective actions were implemented and verified prior to closing the

NCR. If the Client representative identifies a noncompliance or deficiency, the NCR will be tracked and the Bulova representative will be notified in advance of verification of the corrective action.

12.4 Significant Conditions Adverse to Quality

If, during the evaluation of a nonconformance, it is determined that a significant condition adverse to quality exists, the CSL Director of Quality shall be notified. Additional nonconformance controls will likely be implemented. Significant nonconformances are those which, if undetected and not corrected, would have a high probability of causing erroneous project results and adversely affecting any decisions and conclusions based on those results.

12.5 Preventive Action

Preventive actions are intended to preclude the recurrence of the nonconforming condition. When ever possible, each corrective action shall be provided with a suitable preventive action.

Preventive actions may be identified during the planning and performance of any work phase activity. Recommendations for preventative action should be brought to the attention of the project management team for consideration. A proactive approach is encouraged to implement preventive actions before a nonconforming condition exists.

13.0 Assessment and Improvement

Planned and documented assessments may be performed to show that items and activity performance are in accordance with contractual/regulatory/Shaw quality-related requirements and/or to improve quality. Management assessments shall occur by those directly responsible for conducting work (self assessment) as well as by management, or by individuals on behalf of management not involved in the actual performance of the subject work (independent assessment).

These assessments can cover both Shaw and subcontractor items/activities. The independence of personnel monitoring the work performance shall be commensurate with the nature and importance of the activity. Any response actions as a result of these assessments shall be taken in a timely manner.

13.1.1 Management Self Assessment

Management self assessment may be performed by the Project Manager and line management to ensure the project is meeting performance objectives. Management reviews are typically completed at least quarterly, and are conducted by senior line management, through the Project Review Process.

13.1.2 Contractor Monitoring

The Project Manager or designee is responsible for monitoring and verification of subcontractor's compliance to contract quality requirements. The Project Manager may also become involved with these assessments. Subcontractor monitoring will be accomplished by periodic review and observation of subcontractor activities to ensure conformance to the required specifications. This is typically accomplished through the inspection process (Section 5.2, Inspection and Testing).

13.2 Independent Assessment

EI-Q009, Quality Audits and *EI-Q006, Surveillance,* defines the requirements for independent assessment. As necessary, the formal qualification/certification of personnel performing the assessments shall be completed, as defined by *EI-Q010, Auditor and Lead Auditor Qualification*.

APPENDIX A.

DEFINABLE FEATURES OF WORK

Attachment A-1

DEFINABLE FEATURES OF WORK

- Site preparation
- Utility Mark-outs
- Well Drilling
- Trenching and Well Vault Installation
- Parking Area Restoration
- Treatment Shed
- Startup

APPENDIX B.
MATRICES OF RELEVANT DOCUMENTS

B-1. Shaw E&I Documents

SUPPORTING DOCUMENTS		
DOCUMENT NO.	*TITLE*	*QMP Section*
	Shaw E&I Documents	
PM-P-001	Project Delivery System	5.0
PM-G-003	Project Change Management	5.2
SOP-Q-002	Stop Work Order	5.1.1
SOP-Q-007	Nonconformance	5.2.2
SOP-FS-001	Field Logbook	5.1.4
SOP-FS-002	Field Logsheet	5.1.4
SOP-FS-003	Chain of Custody Documentation	5.1.4
SOP-FS-005	Custody Seals	5.1.4
SOP-FS-012	Shipping and Packaging Non Hazardous Samples	5.1.4
SOP-FS-013	Packaging and Shipping of DOT/IATA-Hazardous Samples	5.1.4
SOP-FS-108	Measurement of Water Level and LNAPL in Monitoring Wells	5.1.4
SOP-FS-110	Well Purging and Sampling Preparation	5.1.4
SOP-FS-111	Low Flow/Micro-Purge Well Sampling	5.1.4
SOP-FS-204	Water Quality Meter Use	5.1.4
SOP-FS-020	Data Usability Review	5.1.4
SOP-GS-017	Standards for Conducting Hollow Stem Auger Drilling	5.1.4
SOP-T-GS-001	Standards for Conducting Subsurface Soil Sampling While Drilling	5.1.4
SOP-T-GS-010	Standards for Design of Field Data Collection Programs for Natural Attenuation Verification	5.1.4
SOP-T-GS-012	Non-Aqueous Phase Liquid Measurement	5.1.4
SOP-T-GS-014	Standards for Drilling Equipment, Development Equipment, Heavy Equipment, and Well Material Decontamination	5.1.4
SOP-T-GS-016	Standards for Use of Geophysics for Utility and Subsurface Hazard Location and Clearance	5.1.4
SOP-T-GS-027	Standards for Generation of Boring Logs	5.1.4
SOP-T-GS-031	Standards for Design and Installation of Groundwater Monitoring Wells	5.1.4
SOP-T-GS-032	Standards for Design and Installation of Groundwater Extraction and Injection Wells	5.1.4
SOP-T-GS-033	Standards for Filter Pack and Well Screen Selection	5.1.4
SOP-T-GS-037	Standards for Conducting Well Development	5.1.4
SOP-T-GS-040	Standards for Conducting Borehole and Well Abandonment	5.1.4
SOP-T-EN-001	General Requirement for Engineering	5.1.3
SOP-T-EN-002	Computer Aided Drafting	5.1.3
SOP-T-EN-003	Engineering Calculations	5.1.3
SOP-T-EN-004	Engineering Drawings	5.1.3

SUPPORTING DOCUMENTS		
DOCUMENT NO.	*TITLE*	*QMP Section*
	Shaw E&I Documents	
SOP-T-EN-005	Engineering Reports and Specifications	5.3
SOP-T-EN-006	Design Reviews	6.3
SOP-T-EN-007	Change Control for Engineering	5.2
SOP-T-ES-001	Air Testing	5.1.4
EI-Q012	Verification of Calculations, Spreadsheets, and Databases	6.1
EQ001	Equipment Rental Procedure	5.1.5
EQ007	Small Tools & Equipment	5.1.5
EQ008	Repair and Maintenance	5.1.5
GA505	Low Value Equipment	5.1.5

B-2. Contract Specifications

SUPPORTING DOCUMENTS		
DOCUMENT NO.	*TITLE*	*QMP Section*
	Contract Specifications	
W2-0854-9906	NYSDEC Voluntary Cleanup Agreement	4.1.3

B-3. Quality Affecting Drawings

SUPPORTING DOCUMENTS		
DOCUMENT NO.	*TITLE*	*QMP Section*
	Shaw Remedial Action Work Plan	
821687-FIG22	Approximate Extent of Full-Scale Treatment Area	Figures
821687-FIG23	Well Layout of Conceptual Full-Scale Treatment Zone	Figures
821687-FIG24	Full Scale Well Construction Details	Figures
821687-FIG25	Conceptual Process Design	Figures
821687-FIG26	Air Monitoring Locations	Figures

B-4. Project-Specific Work Instructions

SUPPORTING DOCUMENTS		
DOCUMENT NO.	*TITLE*	*QMP Section*
	Project Work Instruction	
None		

B-5. Project-specific Quality Affecting Equipment & Materials

- Photoionization Detector
- Well construction materials (e.g., 0.10 slot screen, PVC piping, sand)
- Water level sensors
- Solenoid valve
- Bladder pump
- Chemical metering pump
- Rotameters
- Biotreatment feeds (amendments; lactate, diammonium phosphate, yeast extract)
- GPS Unit
- Multi-parameter sampling meter
- Summa canister
- Helium tracer gas
- Evacuation pump
- Disposable sampling equipment
- Sample containers

APPENDIX C.

PRE-SELECTED DOCUMENTS —INSPECTION AND TEST WORK INSTRUCTIONS

C-1. Inspection and Test Work Instructions

DOCUMENT NO.	*TITLE*
	Inspection & Test Work Instructions
B02.02	Fencing
B04.01	Underground Piping Installation
B08.04	Grading and Paving
B19.01	Instrument Installation and Checkout

C-2. Inspection and Test Work Instructions Forms

DOCUMENT NO.	*TITLE*
	Inspection & Test Work Instructions
B02.02A	Fence Installation Checklist
B04.01A	Pipe Pre-Test Checklist
B08.04A	Grading and Paving
B19.01A	Instrument Field Installation Checklist
B19.01B	Instrument Pressure/Leak Test Report
B19.01C	Instrumentation Punch List Record
B19.01D	Instrumentation Calibration Report

APPENDIX D.

GENERIC QC PROGRAMMATIC FORMS

INDEX

Shaw's Quality Control Forms and Reports

Attach No.	Name of Form	Purpose	Comment
D-1	Quality Control Checklist & Inspection Report	Identify activity-specific quality control inspection criteria and record results	Generic format that may be used if pre-developed forms are not available
D-2	Standard Document Transmittal Log	Tracking, submittal and approval document	To be used for each Shaw submittal sent to Client for approval.
D-3	Daily Quality Control Report	Documents daily site conditions, weather, construction activities, safety, sub's staffing, equipment and materials on site	Prepared/submitted to Site QCM by responsible production superintendent. All items should be addressed (no blanks) to assure no item was not overlooked. Trade hours to be supported by subcontractor's field data.
D-4	Submittal Register	Documents all incoming submittals and transmittals to the client and approvals received	Be sure changes included from the Client are incorporated; Record client delays in daily reports. Track Client delays on the weekly meeting agenda.
D-5	Nonconformance Report	Identify and record deviations from requirements (e.g., plans, procedures, specifications, work instructions)	Used to track unplanned / and unapproved deviations or changes from requirements.
D-6	Nonconformance Report Tracking & Status Log	Record history of project nonconformances and status	Used to track nonconformances to closure; tool to identify trends for continual improvement
D-7	Quality Control Receiving Report	Records inspection criteria to confirm acceptance prior to receipt	Used for quality affecting materials
D-8	Quality Control Receipt Inspection Log	Summary form to record QC receipt inspections	Used to manage inventory of quality affecting materials
D-9	Testing Plan & Log	Plan, document and track materials testing actions and by whom	Ensures each required test under the contract is performed and documented to ensure compliance with applicable requirements.

Attachment D-1

Shaw
Environmental, Inc.

QUALITY CONTROL CHECKLIST & INSPECTION REPORT

Subject Item/Activity:	Date:	Report No.
Location:____. Reference Documents:______________________________________ .____. . .. ____. Responsible Organization:____________________________________	( ) Activity Monitoring Type of Verification: ( ) Construction / Installation ( ) Testing Project No.___________.	

Item No.	**Description, Details & Checklist Item by Attribute(s)**	**Sat.**	**Un-sat.**

Inspected By:____________________________________
Quality Manager

Referenced NCR No.__________.

Attachment D-2

Shaw
ENVIRONMENTAL INC.

STANDARD DOCUMENT TRANSMITTAL FORM

To:	Date	Control Distribution No:
	Attention:	
	RE:	
From:		
	Required Return Date:	

We are providing you: ☐ Attached ☐ Under separate cover via____________ the following items:

☐ Drawings ☐ Plans ☐ Samples ☐ Specifications ☐ Analytical/Test Results ☐ Reports

☐ Other ____

Copies	Date	Document No.	Revision No.	Document Title/Description

These are being transmitted (as checked below):

☐ For Approval ☐ For Information ☐ As Requested ☐ For Review & Comment

Remarks:____
____
____
____

Originator:________________________________ Date:________________

QC Certification Statement: (For Submittals Only)
I hereby certify that the equipment or material identified in this submittal is in compliance with the contract specification requirements. Inspection and test reports are correct and the equipment or material supplied is of the same quality as that identified in the submittal or test.

*Certified By:*__________________________________ *Date:* _______________
Quality Manager

Receipt Acknowledgement:

Please acknowledge receipt of this transmittal by signature and date below. Please make a copy of this transmittal for your records and mark void all superseded revisions of documents previously transmitted.

*Received by:*_____________________________ *Date:*________________

Attachment D-3

Shaw Environmental, Inc.	**DAILY QUALITY CONTROL REPORT**	Report No.
		Date:
Contract No.	Project:	Shaw Project No.
Location:	Client:	Work / Task Order No.

Weather Conditions: ρ Clear ρ Cloudy ρ Rain ρ Other (Specify)
Temperature: High _____ degrees (F) max. Low _____ degrees (F) min.

Summary of Daily Activities (incl. In-Process Phase activity checks for Continued Compliance):

-
-
-

II. Inspection Activities Performed: (Per Definable Feature of Work)

-
-
-

III. Materials & Items Received on Site:

-
-
-

IV. Test Activities Performed and Results: (Per Item or Material)

-
-
-

V. Monitoring Activities Performed: (Subcontractor's Activities)

-
-

VI. Nonconforming Conditions Identified or Corrected:

-
-
-

VII. Site Visitors:

-
-
-

VIII. Verbal Instructions Received:

-
-
-

Issued by:_______________________________ Date:_________________
Quality Manager

Attachment D-4

Shaw
Environmental, Inc.

SUBMITTAL REGISTER

Submittal No.	Spec. section	Material or Product	Planned Submittal Date	Contractor Action			Approving Authority Action		Remarks
				Action Code	Date of Action	Date Submitted to Approving Authority	Action Code	Date of Action	

Attachment D-5

Shaw
Environmental, Inc.

NONCONFORMANCE REPORT

NCR Report No.

Date:

Project:

Work Order / Purchase Order No.

Feature of Work:

Responsible Organization:
(Shaw, Subcontractor, Supplier, etc.)

References: (Specification, Drawing, Procedure, incl. rev.)

Description of Nonconforming Condition:

Organization Code:____________ Inspection Code:____________ Nonconformance Cause Code:____________

Disposition Category:
○ Rework ○ Repair ○ Use-As-Is ○ Return to Vendor ○ Scrap/Reject

Disposition & Corrective Action:

NCR Initiated By:______________________________ Date:
QC Representative

Disposition and Corrective Action Provided By:________________________ Date:___________________.
Responsible Organization

Disposition and Corrective Action Approved By:________________________ Date:_________________.
Project Manager

Disposition and Corrective Action Completed By:________________________ Date:__________________.
Responsible Organization

Disposition and Corrective Action Verified By:__________________________ Date:__________________.
Quality Manager

Attachment D-5 Cont. (Reverse side of NCR form)

Nonconformance Report Form Instructions:

Initiator: Complete the upper portion of the report by providing the following information:

NCR Report Number - Unique NCR number per procedure (e.g. 97-19656-01).
Date - Date that the Nonconforming Condition was detected.
Project - Name of the Project.
Delivery / Task Order Number - Delivery / Task Order number applicable to project work.
Feature of Work - Actual feature of work i.e. Soil/concrete placement, pump installation, etc.
Responsible Organization - Organization responsible for the nonconformance.
References - Source requirements in which the condition is nonconforming to.
Description Of Non-conforming Condition - Complete description of the condition supplemented by photographs, sketches, reports and other documents.
Organization Code - See below
Inspection Code - See Below
Cause Code - See Below

Provide signature and issue date at the bottom of the form

Organization Codes:

001 Engineering/Design
002 Vendor/Supplier
003 Operations
004 Subcontractor
005 Quality Control
006 Field Sampling/Analytical
007 Purchasing
008 Project Management
009 Health & Safety
010 Program Management

Inspection Codes:

100 Receipt Inspection
200 In-process Inspection (incl. Preparatory, Initial or Follow up)
300 Completion / Final Inspection

Nonconformance Codes:

101 Indeterminate
102 Inadequate Documentation
103 Inadequate Plan/Procedure
104 Failure to Follow Plan/Procedure
105 Fails to meet Specification
106 Fails to meet Drawing Dimensions
107 Damage
108 Improper Handling, Storage, or Shipping
109 Poor Workmanship
110 Incomplete Work Performance
111 Test Failure
112 Poor Maintenance

Disposition Category: To be checked by the individual responsible for providing both disposition and corrective action. Check the appropriate box.

Corrective Action: Provide a complete corrective action that will ensure that the condition will be made to meet the disposition requirements. Corrective action shall include identification of the cause, steps to be taken to correct the condition, and steps to be taken to preclude recurrence, where possible. Use attachments where necessary.

Responsible Organization: Complete the corrective action as describe in the corrective action portion of the form and its attachments. Sign and date the Disposition and Corrective Action Completed By line at the bottom portion of the form.

Disposition & Corrective Verification: Disposition and Corrective Action will be verified by Quality Manager. Once verification is considered complete and acceptable the Quality Manager will sign and date the Disposition and Corrective Action Verified By line at the bottom of the form indicating closure of the report.

Attachment D-6

Shaw
Environmental, Inc

NONCONFORMANCE REPORT TRACKING & STATUS LOG

NCR No.	Date Issued	Subject	Recommended Disposition Date	Disposition Approved Date	Date Completed	Date Verified

Attachment D-7

Shaw
Environmental, Inc.

QUALITY CONTROL RECEIVING REPORT

Report No.__________

Date:______________

Subject/Item:____ Project No: ___________.
Location:____ Work Order No:___________.
Vendor/Supplier:________________________________ Purchase Order No::_______________.

Reference Documents: (Specification/Drawings, incl. revisions):
____.

Details of Inspection	Sat.	Un-Sat	N/A
1. Verify required documentation and quantity received.			
2. Verify that material or equipment was properly shipped.			
3. Verify that material or equipment shows no signs of physical damage.			
4. Verify identification/marking per purchase order, specifications & shop drawings.			
5. Verify protective covers/seals, provided & meet intended purpose.			
6. Verify coatings/preservatives per purchase order, mfg's. instructions & other specified requirements.			
7. Verify cleanliness			
8. Verify dimensions per specifications & shop drawings.			
9. Visually inspect workmanship.			
10. Verify condition of packaging and desiccant, if required.			
11. Verify weld preparation per specification & shop drawings			
12. Verify the presence of lubricants/oils per purchase order & mfg's instructions.			
13. Verify chemical/mechanical/physical properties per purchase order requirements.			
14. Verify shelf life data, if applicable.			

Remarks:

Inspected By:___________________________________ Date:_______________.
Quality Manager

Attachment D-8

Shaw
Environmental, Inc.

QUALITY CONTROL RECEIPT INSPECTION LOG

Report No.	Date Inspected	Item / Material	Supplier	Date Accepted

Attachment D-9

TESTING PLAN AND LOG

CONTRACT / WORK ORDER NO:			PROJECT TITLE AND LOCATION						
SPEC. SECTION AND PARAGRAGH NUMBER	ITEM OF WORK	TEST REQUIRED	ACCREDITED/ APPROVED LAB		TESTED BY	LOCATION OF TEST		FREQUENCY	DATE COMPLETE
			YES	NO		ON SITE	OFF SITE		

Sheet ____ of ____

APPENDIX I

COMMUNITY AIR MONITORING PLAN
(CAMP)

for the

75-20 ASTORIA BOULEVARD SITE
JACKSON HEIGHTS, QUEENS, NEW YORK

VCA No.: W2-0854-9906

CONSULTANT PROJECT No.: 821687

JANUARY 16, 2008

Prepared by:

Shaw The Shaw Group Inc.™

Shaw Environmental & Infrastructure, Inc.
101-1 Colin Drive
Holbrook, New York 11741

Prepared for:

BULOVA

Bulova Corporation
1 Bulova Avenue
Woodside, New York 11377

TABLE OF CONTENTS

Section **Page**

Figures

1.0 INTRODUCTION

1.1 Project Background

Pursuant to the Voluntary Cleanup Agreement (VCA) and on behalf of Bulova Corporation, Shaw Environmental and Infrastructure, Inc. (Shaw) has prepared this Community Air Monitoring Plan (CAMP) associated with the 75-20 Astoria Boulevard Site, Jackson Heights, Queens, New York (the Site, Figure 1).

The remedial strategy for this Site has been developed to expedite the biodegradation of on-site contaminants *in situ*. The primary remedial action will be biostimulation, which consists of the addition of nutrients and electron donors to the subsurface to enhance the biodegradative capabilities of the native bacteria within the Site groundwater. Based on results obtained during the treatability study and pilot test, biostimulation using lactate and nutrients is capable of degrading the TCA and DCA in the Source Area soil and groundwater.

This CAMP has been developed to address potential dust and subsurface VOCs that may be released during installation of an in-situ bioremediation system. This CAMP was written in accordance with the NYSDEC requirements presented in Appendix 1A of the Draft DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC 2002). The CAMP requires real-time monitoring for both volatile organic compounds (VOCs) and particulates. The measures included in the CAMP will provide a level of protection from potential airborne releases, and sets forth specific action levels for determining the monitoring frequency and the appropriate corrective actions, including work shut-down.

1.2 Project Purpose and Objectives

The principal purpose of the CAMP is to monitor air quality in the vicinity of the treatment area during the remedial actions. The CAMP consists of monitoring of dusts and vapors on a real-time basis. Monitoring of this project will include all standard monitoring functions for environmental remediation projects including real-time air monitoring for particulate matter/dust and VOCs, observations for visible emissions and odors, inspection and monitoring of the contractor’s work practices, and reporting to the NYSDEC and the NYSDOH. Continuous monitoring will be performed during all ground intrusive activities.

Principal objectives of the program are as follows:

- Monitor dust as PM_{10} on a real-time basis such that dusts associated with the remedial actions are maintained below action levels
- Monitor VOC vapors on a real-time basis such that vapors associated with the remedial actions are maintained below action levels
- Monitor VOCs and visible emissions so that vapors and dust from the treatment area do not leave the 75-20 Astoria Boulevard Site
- In the event that dust or VOC levels exceed action levels, construction personnel will be immediately notified so that all necessary corrective actions can be taken

1.3 Operations to be Monitored

The remedial actions to be performed at the 75-20 Astoria Boulevard Site consist of:

1. Well installation activities; and
2. Trenching activities.

2.0 AIR MONITORING PROCEDURES

Air monitoring stations will be established at two (2) locations, one upwind of the work area, and one immediately downwind of the work area. The proposed locations for these air monitoring stations is presented in Figure 2; however, the exact locations of these stations will depend on the actual meteorological conditions for each day.

These air-monitoring activities include real-time monitoring for VOCs and particulates based on the New York State CAMP requirements. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. As a supplement, a flow chart summarizing action levels/action is provided on Figure 3.

2.1 VOC Direct Reading Monitoring

VOC monitoring equipment will consist of a photo ionization detector (PID) capable of detecting site-related VOCs. The monitoring equipment will be calibrated on a daily basis and documented in a dedicated field log book. The instrument will be capable of calculating 15-minute running average concentrations, which will be compared to the prescribed action levels.

Upwind 15 minute average background concentrations will be subtracted from the downwind 15 minute average concentrations to establish concentrations reflective of work activities during the periods between collection of background readings.

The 15-minute running average concentrations will be compared to the following:

- If the ambient air concentration of total organic vapors at the downwind perimeter of the treatment area exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If total organic vapor levels at the downwind perimeter of the treatment area persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the treatment area or half the distance to the nearest potential receptor or residential structure, whichever is less - but in no case less than 20 feet - is below 5 ppm over background for the 15-minute average.

- If the organic vapor level is above 25 ppm at the downwind perimeter of the treatment area, activities must be shutdown and the engineering controls and the site work plan re-evaluated.

2.2 Particulate (Dust) Direct Reading Monitoring

Particulate (dust) concentrations will be monitored continuously at the upwind and downwind perimeters of the treatment area. The particulate monitoring will be performed using real-time particulate monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM_{10}) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level established below. The equipment will be equipped with an audible alarm to indicate exceedance of the action level, and will be calibrated in accordance with the manufacturer's operating instructions and documented in a dedicated logbook.

The primary standards for PM_{10} are 150 micrograms per cubic meter ($\mu g/m^3$) over a 24 hour averaging time and 50 $\mu g/m^3$ over an annual averaging time. Both of these standards are averaged arithmetically. The action level will be established at 150 $\mu g/m^3$ over the integrated period not to exceed 15 minutes. While conservative, this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety.

If downwind particulate levels are detected in excess of 150 $\mu g/m^3$, the upwind background level must be measured immediately. If the downwind site particulate measurement is greater than 100 $\mu g/m^3$, but less than 150 $\mu g/m^3$, above the background level, dust suppression techniques will be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. During this time work may continue; however, if the dust suppression measures being utilized at the site do not lower particulates to an acceptable level (i.e., below 150 $\mu g/m^3$ and no visible dust from the treatment area), work will be suspended until appropriate corrective measures are implemented to remedy the situation.

3.0 AIR MONITORING RECORDKEEPING AND OBSERVATIONS

A qualified safety officer or technician will ensure that all air-monitoring data is logged in a dedicated log book. Documentation shall be made clear, concise, and provide the data, time of entry, location, personnel, weather conditions, and background concentrations for each monitoring station. Documentation will also include all observational data that has potential for impacting results, such as potential off-site interferences, on-site public interferences, damage to instruments, site equipment problems, or weather related interferences.

All pages must be numbered; no lines shall be left blank (or put a line through it), and must be initialed on each page in ink. The last entry page for the shift or day that has blank space left at the bottom shall have a line drawn diagonally across it and signed at the bottom of the page. All corrections must be made with a single line, initialed, and dated.

Onsite meteorological instrumentation shall be used to determine the wind speed (anemometer), wind direction (wind sock), barometric pressure (barometer), and relative humidity (psychrometer). These weather data shall be obtained on an hourly basis while work is progressing and documented in the dedicated field log book.

The NYSDEC and NYSDOH will be notified promptly via phone and electronic mail of any exceedance of an Action Level and of the corrective actions taken in connection with the exceedance. If an exceedance occurs, Shaw will prepare an Exceedance Summary Letter, following completion of the exceedance assessment, for submission to the NYSDEC and NYSDOH within five working days of the exceedance. This will be a 1-2 page letter stating the nature of the exceedance, cause(s) of the exceedance and the corrective actions taken.

CAMP air monitoring results and records will be maintained by Shaw for a minimum period of 6 years following completion of the project.

3.1 Equipment Operational Requirements

The air monitoring equipment must be operated by trained and qualified personnel. Personnel who perform air-monitoring functions described in this section shall be experienced in the use of field air monitoring equipment, as well as the air monitoring procedures described above. There must also be appropriate staff (chemist, industrial hygienist or environmental scientist) for assessing the results of air monitoring and advising field personnel and the construction manager of air quality considerations.

All monitoring equipment must be calibrated on a daily basis in accordance with the manufacturer’s operating instructions. A dedicated log book for each monitoring unit will be maintained that details the date, time, calibration gas, or other standard, and name of person performing the calibration.

4.0 DUST AND VOC CONTROLS

The information and procedures presented in this section may be used for dust and VOC control during activities summarized in Section 1.3. The construction manager for the project will be responsible for implementing these procedures based on the air monitoring results and required Action Levels described in Sections 2.1, 2.2 and depicted in Figure 3. The information and procedures that may be used for dust and VOC control are presented in the following sub-sections.

4.1 Dust Controls

The primary measure of preventing exposure to dust during excavation or other soil disturbance activities will be wetting techniques. The construction manager will provide for engineering controls (wet techniques) or other techniques to control dust during work tasks that have the potential for generating dust. Dust controls involving the use of water (wetting or water spraying) may be employed at potential dust generating activity areas as follows.

- Before each task is initiated
- During the tasks to keep the soils damp
- When air monitoring results dictate the need for dust control

4.2 VOC Controls

Control of VOCs during excavation work or other soil disturbance activities will consist of the construction manager implementing one or more of the following methods or measures:

- Covering stockpile areas
- Wetting excavation material
- Backfilling the excavation
- Vapor suppression, such as foaming agents

5.0 SIGNATURES OF ENVIRONMENTAL PROFESSIONALS

Shaw Environmental and Infrastructure, Inc. has completed the Community Air Monitoring Plan for the 75-20 Astoria Boulevard Site located in Jackson Heights, Queens, New York.

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

Garrett Passarelli
Project Engineer

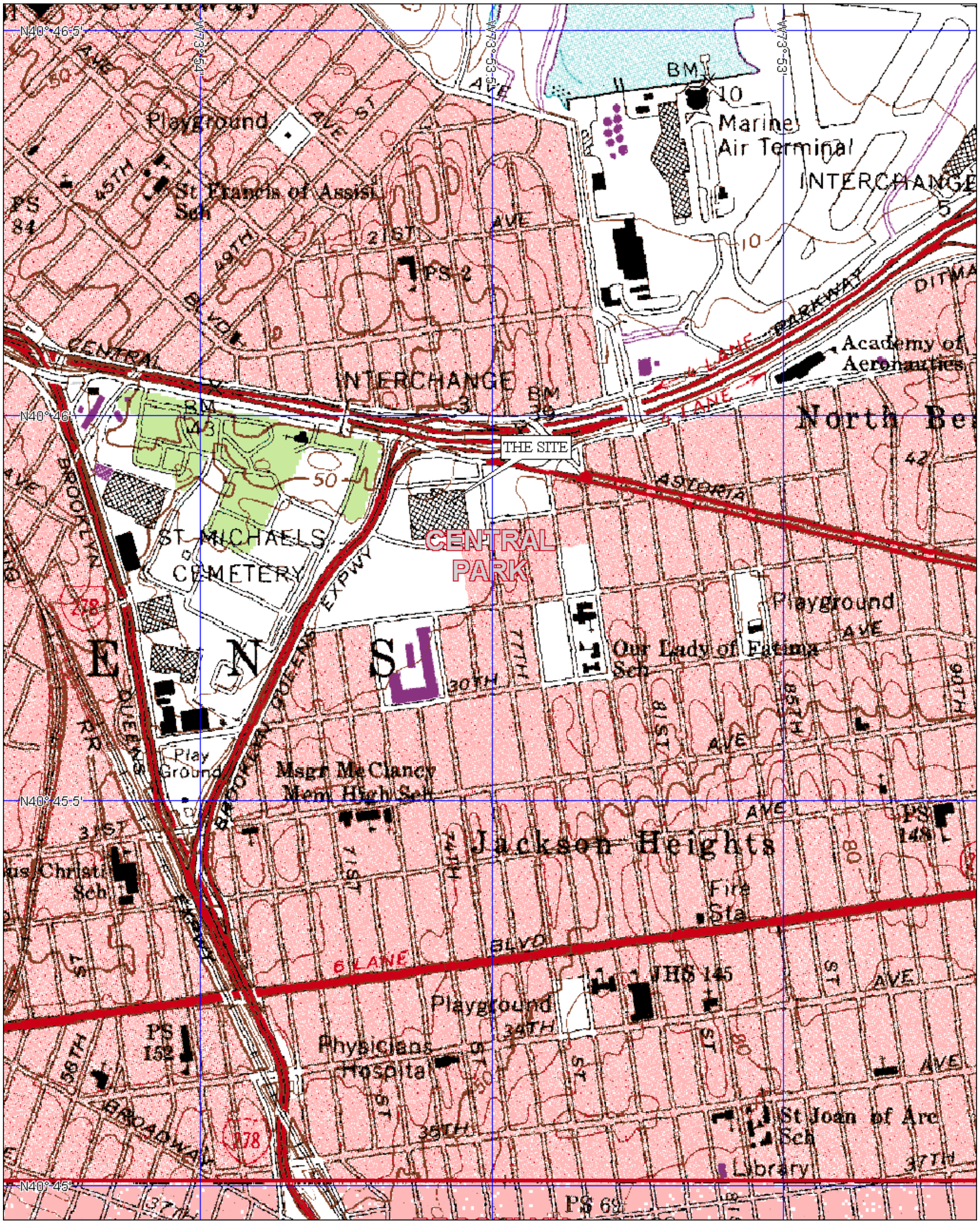
Erik Gustafson
Client Program Manager

6.0 REFERENCES

New York State Department of Environmental Conservation Division of Environmental Remediation. *Draft DER-10 Technical Guidance for Site Investigation and Remediation, Appendix 1A*, December 2002.

Shaw Environmental and Infrastructure, Inc. *Draft Remedial Action Work Plan*, December 2007.

FIGURES



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS

350 ft Scale: 1 : 12,000 Detail: 13-5 Datum: WGS84

Scale: 1:12,000

Reference:
DeLorme 3-D Topo Quads
Yarmouth, Me.
1999
Datum WGS84

Figure 1
Site Location Map

75-20 Astoria Blvd.
Jackson Heights, New York

File: N:\Bulova-Jackson Heights\CAMP FIGURE 2.dwg
XREF Files: IMAGE Files:
Plot Date/Time: Jan 07, 2008 – 3:39pm
Plotted By: garrett.passarelli

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
HOLBROOK, NY	G.PASSARELLI	1/7/08	E.GUSTAFSON	1/7/08	E.GUSTAFSON	1/7/08	821687-FIGURE 2

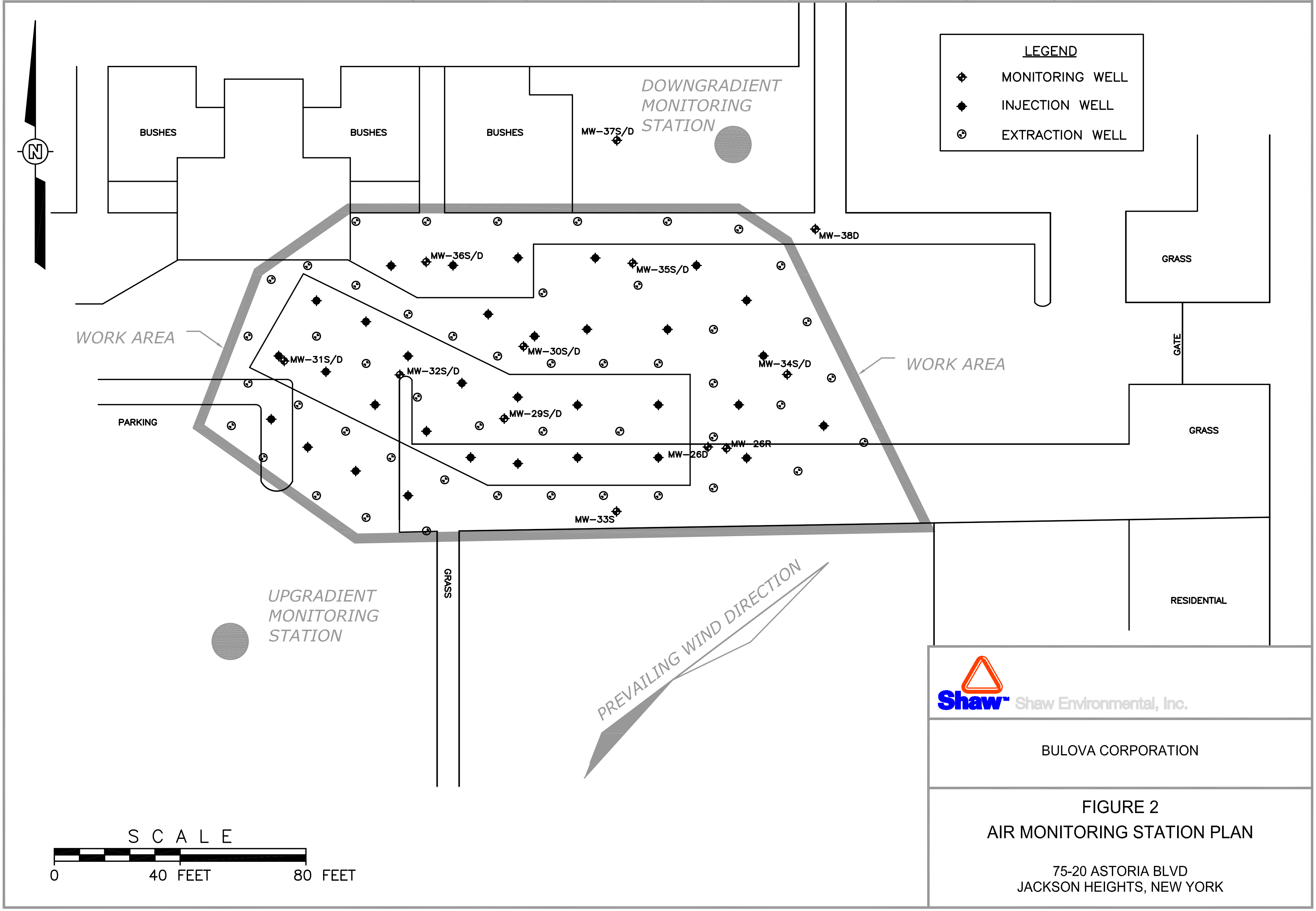


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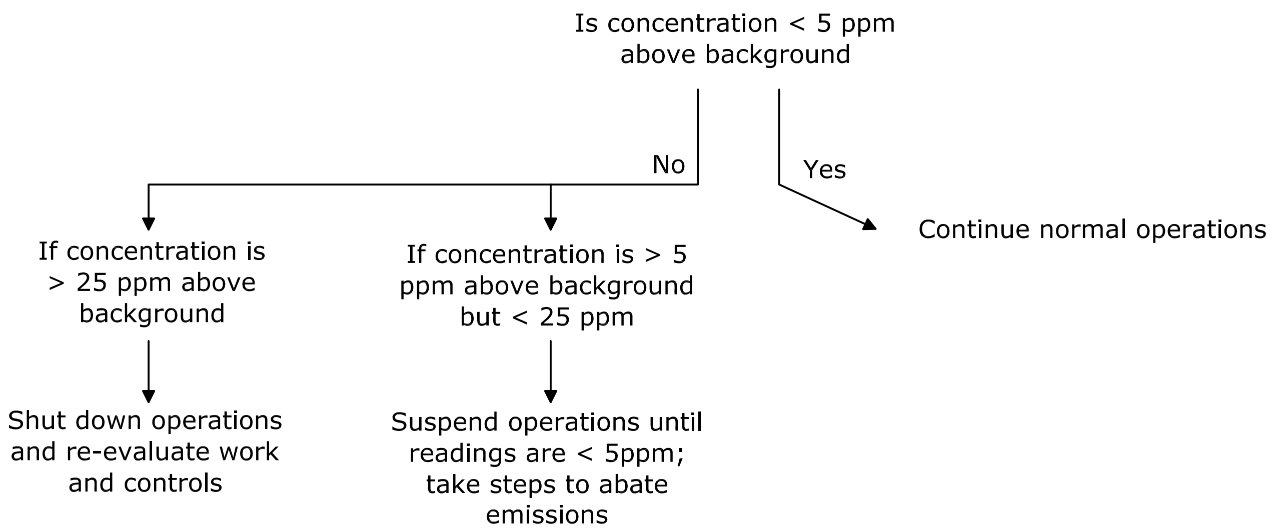
FIGURE 2
AIR MONITORING STATION PLAN

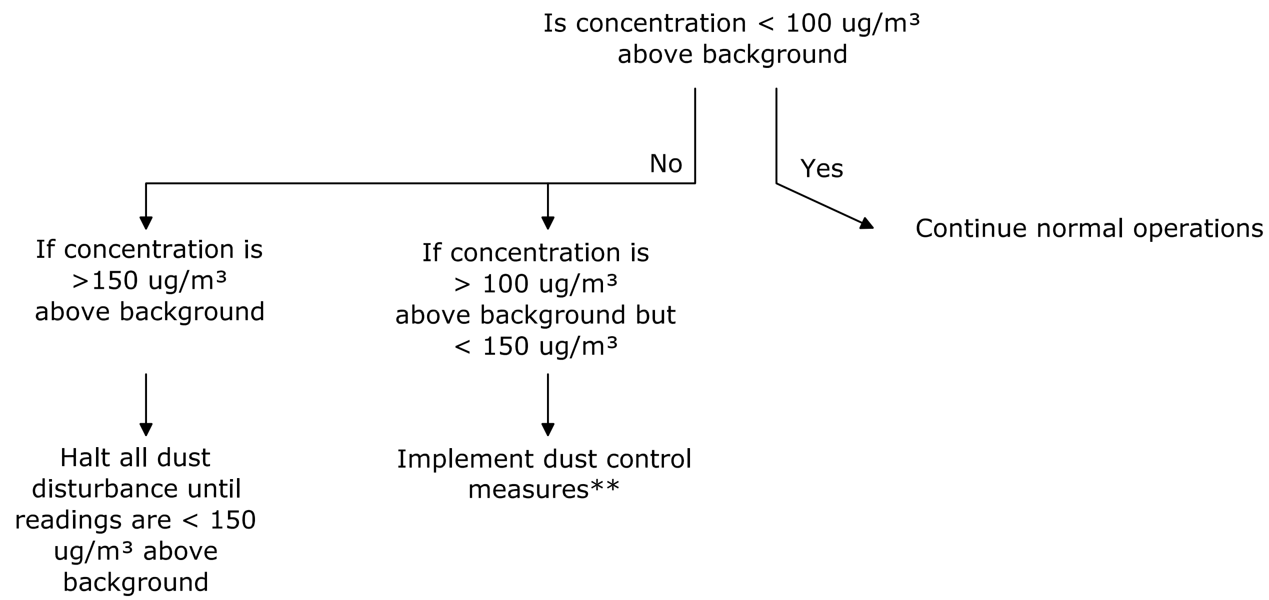
75-20 ASTORIA BLVD
JACKSON HEIGHTS, NEW YORK

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
HOLBROOK, NY	G.Passarelli	1/16/08	E.Gustafson	1/16/08	E.Gustafson	1/16/08	FIGURE 3

Volatile Organic Monitroing Downwind of VCP Area



Particulate Monitoring Downwind of VCP Area



*See VOC control section (Section 4.2)
**See dust control section (Section 4.1)
VOC and particulate readings based on 15 minute time weighted average

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FIGURE 3
FLOW CHART FOR VOC AND PARTICULATE MONITORING ACTION LEVELS
75-20 ASTORIA BLVD
JACKSON HEIGHTS, QUEENS, NEW YORK

File: N:\Bulova-Jackson Heights\CAMP-FIGURE 3.dwg
XREF Files: IMAGE Files:
Plot Date/Time: Jan 16, 2008 - 11:14am
Plotted By: garrett.passarelli