Feasibility Study Report

Former Melrose Avenue Dry Cleaner Site

(NYSDEC Site Number 203009)

NYSDEC STANDBY ENGINEERING CONTRACT

Work Assignment #D007625-18

PREPARED FOR:
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
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ACRONYMS AND ABBREVIATIONS

AS	air sparge
bgs	below ground surface
CVOC	chlorinated volatile organic compounds
DCE	cis-1,2-dichloroethene
DPE	dual phase extraction
DO	dissolved oxygen
ECL	Environmental Conservation Law
Eh	redox potential (voltage)
FDNY	Fire Department of New York
FS	feasibility study
GRA	general response action
GWQS	Groundwater Quality Standards
HDR	Henningson, Durham & Richardson, Architecture and Engineering, P.C.
IC	institutional control
ISCO	in-situ chemical oxidation
ISCR	in-situ chemical reduction
ISTT	in-situ thermal treatment
LTM	long-term monitoring
Melrose site	former Melrose Avenue Dry Cleaner site
MNA	monitored natural attenuation
NAPL	non-aqueous phase liquid
NYCDOB	New York City Department of Buildings
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

O&M	operation and maintenance
ORP	oxidation reduction potential
PCE	tetrachloroethene
PDI	pre-design Investigation
PID	photoionization detector
PRB	passive reactive barrier
RAO	remedial action objective
RCA	reinforced concrete aggregate
RI	remedial investigation
ROI	radius of influence
SCG	standards, criteria and guidance
SCO	soil cleanup objective
SSF	State Superfund Program
SVE	soil vapor extraction
SVI	soil vapor intrusion
TCE	trichloroethene
ug/kg	microgram per kilogram
μg/l	micrograms per liter
URS	URS Corporation
VC	vinyl chloride
VOC	volatile organic compounds
ZVI	zero valent iron

Executive Summary

Henningson, Durham and Richardson Architecture and Engineering P.C. (HDR) was retained by the New York State Department of Environmental Conservation (NYSDEC) to conduct a Feasibility Study (FS) for the Former Melrose Avenue Dry Cleaner site (“site”). The site (NYSDEC Site No. 203009) is located at 753 Melrose Avenue in the Melrose section of Bronx County (Borough of the Bronx, New York City). Surrounding land use is mixed-use, with a vacant lot to the north currently used as a community garden, a six-story apartment building to the south, an athletic field and school to the west (PS 29), and Melrose Avenue to the east. A commercial establishment with apartments above is east of Melrose Avenue, across from the site. Fire Department of New York (FDNY) Engine Company 71 and Ladder Company 55 and New York City Police Department Police Service Area are one block to the south of the site. Figure 2 depicts the site with surrounding features.

The site contaminants are tetrachloroethene (PCE) and its degradation products trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride (VC). The media affected by PCE and its degradation products are groundwater and soil gas. The impacted groundwater flows under unconfined conditions within material that is primarily fine to medium sand with varying amounts of silt. The groundwater flow direction is from the site to east and then to the south along Melrose Avenue. Groundwater samples that exceeded the Groundwater Quality Standards (GWQS) were reported in MW-43, which is the furthest downgradient monitoring well, located approximately 700 feet from the site. The site and surrounding area is serviced by public water supply and groundwater is not used for potable or production purposes. Therefore, there is no direct ingestion of contaminants in groundwater with contaminant levels exceeding drinking water standards. Soil vapor is impacted with PCE. During the remedial investigation (RI), no indoor air samples were collected. For discussion purposes, test results for the soil gas samples collected during the 2017 RI were evaluated using the New York State Department of Health (NYSDOH) guidance matrices. Based on the soil gas samples the NYSDOH recommended action would be either No Further Action, Monitor or Mitigate pending results of (to be collected) indoor air samples.

<u>The preliminary remediation goals for groundwater and soil vapor are:</u>

- Restore the groundwater to the pre-disposal/pre-release conditions, to the extent practicable.
- Monitor for soil vapor intrusion (SVI) in potentially impacted residential and commercial properties and install vapor mitigation systems where (to be collected) indoor air sampling results exceed the NYSDOH recommendations.

Based on a screening of technologies the following alternatives were established and evaluated based on NYSDEC criteria in DER-10.

Alternative 1 – No Action

The No Action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of NYSDEC DER-10.

Alternative 2 – Monitored Natural Attenuation; (Soil Vapor Intrusion (SVI) Monitoring and Mitigation

Alternative 2 consists of MNA for chlorinated groundwater contamination, and SVI monitoring and mitigation for the potentially impacted residential and commercial properties.

Alternative 3a – In-Situ Treatment for Total Volatile Organic Compounds (VOCs) in Groundwater > 500 µg/l; SVI Monitoring and Mitigation

Alternative 3a consists of in-situ treatment for the areas where total VOCs have been observed to be greater than 500 micrograms per liter (µg/l) in groundwater. At the conclusion of treatment, two years of quarterly groundwater monitoring will begin. Similar to Alternative 2, monitored natural attenuation (MNA) will be relied on for the groundwater contamination outside of the active treatment area, and SVI monitoring and mitigation is included for the potentially impacted residential and commercial properties.

Alternative 3b – In-Situ Treatment for Total VOCs in Groundwater > 500 µg/l and Former Source-Area; SVI Monitoring and Mitigation

Alternative 3b expands on Alternative 3a to include in-situ treatment for the former source-area, and area immediately downgradient along Melrose Avenue. At the conclusion of the treatment, the two year quarterly l groundwater MNA monitoring will begin. Similar to Alternative 2, MNA will be relied on for the groundwater contamination outside of the active treatment area, and SVI monitoring and mitigation is included for the potentially impacted residential and commercial properties.

1.0 Introduction

This FS Report for the Former Melrose Avenue Dry Cleaner site (site) was prepared by HDR as part of NYSDEC Contract D007625, Work Assignment #18. The site (NYSDEC Site No. 203009) address is 753 Melrose Avenue in the Melrose section of Bronx County, Borough of the Bronx, New York City (see Figure 1). The purpose of this FS is to identify and evaluate remedial alternatives that will address the contamination identified in the remedial investigation (RI). This FS report provides a detailed analysis of alternatives to support remedy selection for the site.

HDR has prepared this FS in general conformance with Section 4 of the Technical Guidance for site Investigation and Remediation (DER-10) (NYSDEC Division of Environmental Remediation, May 3, 2010). This FS report covers on-site and off-site contamination, identifies technologies, and evaluates alternatives that are capable of achieving the remedial action objectives (see Section 4). The FS considers remedial alternatives to support selection of an appropriate remedy.

2.0 Site Description and History

2.1 General Site Description

Tax information indicates the site is Block 2403, Lot 31, and is currently owned by the City of New York. The site is comprised of 0.066 acres on the west side of Melrose Avenue between East 156th Street to the south and East 157th Street to the north. It is zoned for residential use, but is currently a vacant lot covered with vegetation and surrounded with a chain-link fence.

Surrounding land use is mixed-use, with a vacant lot to the north currently used as a community garden, a six-story apartment building to the south, an athletic field and school to the west (PS 29) and Melrose Avenue to the east. A commercial establishment with apartments above is east of Melrose Avenue, across from the site. FDNY Engine Company 71 and Ladder Company 55 and New York City Police Department Police Service Area are one block to the south of the site. Figure 2 depicts the site with surrounding features.

2.2 Site History

Sanborn maps indicate the following site history:

- A Sanborn map dated 1909 shows the property at 753 Melrose Avenue as containing a store with a dwelling.
- A Sanborn map dated 1951 shows the site as being occupied by a dry cleaning establishment with storage tanks at the rear of the building.
- The site show was vacant from at least 1969 to the present.

Based on the New York City Department of Buildings (NYCDOB) records, a building at 753 Melrose Avenue was constructed in 1946 or earlier, as an alteration permit was issued in that year. A second alteration permit was issued in 1961. The nature of these alterations was not provided on the NYCDOB website.

The building at the site was demolished in 1968 according to NYCDOB records. A portion of the site has recently been filled with approximately 2 feet of recycled concrete aggregate (RCA). Testing of the recent fill and the material at other site locations at depth of 0 to 6 inches and 18 to 24 inches indicate the presence of barium, copper, lead, and benzo(A)pyrene at concentrations above the New York State (NYS) Commercial Soil Cleanup Objectives. Note that the site is in an area zoned for residential use and the appropriate cleanup objective has not been established for surface soils at the site.

2.3 Investigation History

As part of a petroleum spill investigation at FDNY Engine 71/Ladder 55 (720 Melrose Avenue) in 1997, groundwater samples were collected from monitoring wells installed within and adjacent to that property. Reportedly, results of the sample analyses showed concentrations of several chlorinated solvents, including PCE, TCE, and DCE, with the highest concentrations detected in samples collected from the upgradient monitoring well. Based on the analytical results, the source area was suspected to be upgradient of the FDNY property.

In an attempt to identify the suspect source of the chlorinated solvents, several investigations were conducted by URS Corporation (URS). Soil borings, soil vapor points and monitoring wells were installed to delineate the extent of the contamination and focus on the source. Reports dated February 2004, April 2005, March 2006, January 2007 and July 2007 were prepared to document the activities and investigation results. An additional groundwater sampling investigation was completed in 2014 (EnviroTrac. 2015). The results of this testing confirmed the presence of PCE, TCE, and DCE in the groundwater and soil vapor, and indicated that the source was the site.

The results from the previous investigations indicated the site presents a significant threat to public health or the environment due to the presence of contaminants above regulatory criteria in the groundwater and soil vapor. As such, NYSDEC initiated the preparation of a RI/FS for the site.

3.0 Remedial Investigation Summary

The data collected during the investigations beginning in 2006 and the RI were used to develop the conceptual site model presented below. The conceptual site model identifies potential sources of contamination, types of contaminants and affected media, release mechanisms and potential contaminant pathways and potential human receptors. Please refer to the RI report for a summary of the results of each investigation and general discussions of the site conditions.

3.1 Potential Sources of Contamination

The presumed source of the PCE observed in groundwater is the former dry cleaning operations at the site. Considering the building was demolished in 1968, the actual discharge location – such as a floor drain or septic tank discharge point – is unknown. Analytical results of soil samples collected from the on-site borings were below the Unrestricted Use Soil Cleanup Objectives (SCOs) with one exception. PCE was detected at a concentration above its Unrestricted Use SCO in a soil sample collected at a depth of 11 to 13 feet from the test boring made for MW-26 which had a PCE concentration of 2,200 micrograms per kilogram (ug/kg) (URS, January 2007). Elevated photoionization detector (PID) readings and odors were also noted in one boring, which suggests subsurface contamination remains at the site.

Groundwater data collected during the investigations indicate that a PCE source might be present at or near the site property as summarized below.

- Sampling prior to 2018 had indicated that the core of the plume with concentrations greater than 500 µg/l was limited to an area in the vicinity of the intersection of Melrose Ave and 155th Street located about 400 feet downgradient of the site. Recent data collected in 2018 and 2019 indicate the core of the plume extends closer to the site, about 200 feet downgradient. Samples from well MW-49 at this location contained PCE concentrations of 680 µg/l (2018) and 850 µg/l (2019).
- Data collected at well location MW-20, the closest downgradient well, has indicated relatively stable concentrations of PCE over the 13 years that it has been sampled as summarized below:

MW-20	
Sample Data	PCE (µg/l)
11/7/2006	180
9/23/2014	590
7/14/2017	190
8/7/2018	140
8/27/2019	300

These relatively stable concentrations are indicative of groundwater impacts in the vicinity of a source.

3.2 Types of Contaminants and Affected Media

The Melrose site contaminants are PCE and its degradation products TCE, DCE and VC. Chloroform and metals were detected in some of the samples; however, these are non-target analytes for dry cleaner sites and are not the subject of this FS. The media affected by PCE and its degradation products are groundwater and soil gas.

The impacted groundwater flows under unconfined conditions within material that is primarily fine to medium sand with varying amounts of silt. Groundwater is approximately 16 to 19 feet below ground surface (bgs) in the vicinity of the site. The groundwater flow direction is from the site to east and then to the south along Melrose Avenue. Figure 3 depicts the groundwater contours from the 2017 RI. A subsequent round of groundwater sampling was completed in 2018 and a limited subset of monitoring wells, in addition to shallow soil samples at the site property, were sampled in 2019. Figure 4 depicts isoconcentration contours of total VOCs in groundwater based on samples collected in 2018.

The impacted groundwater has also impacted the soil vapor above the plume. Figure 5 depicts isoconcentration contours of PCE in the soil gas based on samples collected in 2017.

The vertical extent of the observed contamination is limited to the uppermost water bearing zone, which occurs within the overburden soils at most locations. Bedrock is encountered at approximately 30 feet bgs beneath the site and vicinity, and has been identified as Ordovician Age Inwood Marble.

3.3 Release Mechanisms, Contaminant Pathways and Receptors

The release mechanism is the past discharge of PCE from the site. The contamination originates in the vicinity of the site and migrates southward with groundwater flow. A comparison of the PCE distribution in groundwater from prior investigations to the current investigation shows the contaminant plume has had little change. The downgradient portion of the isoconcentration map of the 2018 data is similar to the isoconcentration maps of previous investigations in 2014 indicating that the limit of the impacted groundwater plume has stabilized.

The presence of PCE degradation products (TCE, 1,2-DCE and VC) indicates the occurrence of reductive dechlorination. Anaerobic conditions that are necessary for reductive dechlorination were observed at a limited set of wells (e.g., MW-20 and MW-49). The concentration of PCE and its degradation products in groundwater samples collected over the course of the investigations at the site is presented on Figure 6. These data indicate that the concentration of PCE and its degradation products have decreased over time since sampling began in 2004. Because the concentrations PCE and its degradation products follow the same trends it appears that adsorption and dilution are the primary mechanisms impacting the groundwater plume.

Table 1 presents a summary of the range of concentrations for parameters observed in groundwater samples collected at the site and screens them against NYSDEC Class GA GWQS. This screening indicates that constituents within groundwater at the site exceed drinking water criteria at some locations. Groundwater samples with constituents that exceeded the GWQS were reported in MW-43, which is the furthest downgradient monitoring well approximately 700 feet from the site. However, the site and surrounding area are serviced by public water supply and groundwater is not used for potable or production purposes. There is, therefore, no direct ingestion of contaminants in groundwater with contaminant levels exceeding drinking water standards.

Soil vapor is primarily impacted by PCE. Similar to the groundwater results, the recent soil vapor sample results show a similar PCE distribution to the prior results. Test results for soil gas samples collected during the 2017 RI were evaluated using the NYSDOH Soil Vapor Intrusion guidance matrices. The NYSDOH recommendation matrix is based on test results for sub-slab samples and indoor air samples. For the purposes of this FS, the soil gas samples were considered “sub-slab vapor” samples. Indoor air sampling was not completed as part of this work. Based on the soil gas samples, the NYSDOH recommended action would be either No Further Action, Monitor or Mitigate pending results of (to be collected) indoor air samples (please refer to RI summary in Section 3.0 of this report).

4.0 Remedial Goals and Remedial Action Objectives

The remedial goals for actions undertaken pursuant to the New York State Inactive Hazardous Waste Disposal Site Remedial Program (State Superfund Program or SSF), are defined by Environmental Conservation Law (ECL), Article 27, Title 13. The goal of the SSF program is to complete cleanup of the site by eliminating the significant threat to human health or to the environment posed by the disposal of hazardous wastes at the site and of the imminent danger of irreversible or irreparable damage to the environment caused by such disposal[1].

Remedial action objectives (RAOs) are the levels to which site-specific concerns must be addressed to protect human health and the environment. They serve as the basis for developing remedial action alternatives and specify the goal of the cleanup action. The RAOs for groundwater and soil vapor are presented below.

Groundwater RAOs for Environmental Protection

The range of VOCs and remedial goals based on the NYSDEC GWQS are presented in Table 1. The RAO for groundwater is to:

- Restore the groundwater to the pre-disposal/pre-release conditions, to the extent practicable.

SVI RAOs

Soil gas samples were collected during the 2017 RI, and were evaluated using the NYSDOH guidance. The range of VOCs in soil gas with the NYSDOH matrix criteria is presented in Table 2. During the RI, no indoor air samples were collected. Based on the soil gas samples the NYSDOH recommended action is either No Further Action, Monitor or Mitigate pending results of to be collected indoor air samples (please refer to RI summary in Section 3.0 of this report). Exposure to contaminated soil vapor may occur if soil vapor migrates into buildings via cracks or other openings in the floors or foundations of buildings, and therefore continued soil gas and indoor air monitoring is warranted at the site.

The RAOs for soil gas are:

- Monitor for SVI in potentially impacted residential and commercial properties and compare sampling results to the NYSDOH Soil Vapor/Indoor Air Matrix tables; and
- Install vapor mitigation systems in commercial and residential properties where the combination of indoor air and sub-slab vapor sampling results exceeds NYSDOH guidelines.

1 Environmental Conservation Law, Article 27, Title 13, §27-1313 Remedial Programs.

5.0 General Response Actions

General Response Actions (GRAs) are broad categories of remedial approaches and include non-technology-specific types such as treatment, containment, extraction, disposal, institutional controls (IC) or various combinations. As described in Section 3, groundwater and soil gas have been impacted. VOCs have been detected in groundwater at concentrations exceeding standards, criteria, and guidance (SCGs).

GRAs that could be applied to address the contamination at this site include physical and chemical in-situ treatments, ex-situ treatments, disposal/ discharge, or various combinations thereof. Table 3 lists the GRAs for groundwater and soil gas. Information for each type of GRA includes an estimate of the areas and volumes of contaminated media to be addressed and remediated; the medium being addressed; the identified use of that area of the site; and whether or not the GRA category includes a Presumptive Remedy[2].

[2] "Presumptive remedy" means technologies or approaches appropriate for the remediation of specific types of contamination which, based on historical patterns of remedy selection and DEC's scientific and engineering evaluation of performance data, can be used to accelerate the remedy selection process. [see 6 NYCRR 375-1.2(ai)]

6.0 Identification and Screening of Technologies

Specific technologies associated with the GRAs are further assessed in the following sections. The technologies are screened to identify those that appear to be most appropriate to the site-specific conditions and on-site groundwater contamination, technically implementable, and capable of achieving the site's RAOs. Further, presumptive remedies are given preference. The GRAs for impacted groundwater include no action, ICs, MNA, containment, treatment, and removal. Remedial technologies are grouped by GRA and discussed in detail in the following sections.

Site-specific conditions, including contamination type, concentration, location (aerial extent and depth), geology/hydrogeology, and estimated quantity were considered during the initial screening process. The initial screening was also based on the effectiveness for treating the contaminants present at the site, implementability given site-specific conditions, and relative cost.

Remedial technologies that were deemed to be not technically appropriate or cost prohibitive were dropped from further consideration. Table 4 summarizes the technology identification and screening process for groundwater. The table is grouped by the GRA (i.e., in-situ treatment, ex-situ treatment, containment, and reduction). Technologies that may be appropriate for addressing the contaminants at the site, and that were thus retained for further evaluation, are identified on the second to last columns of Table 4. Technologies that were screened out and not retained for further analysis are designated as "no" in the second to last column of Table 4.

6.1 No Action

The No Action remedial option has been retained as a basis for comparison with other groundwater remediation technologies, as required by DER-10. This option includes no future activities to contain or remediate contaminants, provides no treatment for contaminants, or legal and administrative mechanisms for protection of human health and the environment beyond establishing cleanup criteria and recognizing those mechanisms that are in place (e.g., restrictions on well installation and use) under state and/or federal environmental regulatory program authority. This option assumes that physical conditions at the site remain unchanged.

6.2 Monitored Natural Attenuation

MNA refers to naturally occurring attenuation processes that reduce contaminant concentrations in groundwater over time, and include destructive (biodegradation and chemical reactions with other subsurface constituents) and nondestructive mechanisms (dilution, dispersion, volatilization, and adsorption). MNA requires long-term monitoring (LTM) to assess the effectiveness and protectiveness of the process.

The natural biodegradation of PCE is through reductive dechlorination. During this process, the chlorinated compound is used as an electron acceptor, not as a source of carbon, and a chlorine atom is removed and replaced with a hydrogen atom. In general, reductive dechlorination of chlorinated ethenes occurs by sequential dechlorination from PCE to TCE to DCE (primarily the cis-1,2-DCE isomer) to VC to ethene. Depending upon environmental conditions, these sequences may be interrupted by other processes such as aerobic or abiotic degradation. Therefore, reductive dechlorination of chlorinated solvents will typically result in rising concentrations of daughter products and in metabolic byproducts, such as chloride. As indicated within Section 3.3, the relative concentrations of chlorinated volatile organic compounds (CVOCs) appeared to consistent between previous investigations and groundwater sampling conducted during 2018; however, during the August 2019 MNA sampling event, elevated chloride concentrations above the GWQS of 250,000 µg/l, were detected in five of the six monitoring wells sampled. These results may be indicative of reductive dechlorination processes occurring, or they may be a result of salt water intrusion or some other explanation. The chloride data collected in August 2019 are presented below:

Monitoring Well	**Chloride Concentration, µg/l**
MW-04	**1,300,000**
MW-12	**330,000**
MW-20	220,000
MW-45	**660,000**
MW-47	**970,000**
MW-49	**1,500,000**

All samples collected 8/27/2019
Bolded concentrations exceed the chloride GWQS of 250,000 µg/l

Reductive dechlorination affects chlorinated compounds differently. Of the ethenes, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. Conversely, VC is the least susceptible to reductive dechlorination because it is the least oxidized. In general, the rate of reductive dechlorination of chlorinated solvents has been observed to decrease as the degree of chlorination decreases. It has been postulated that this rate of decrease may explain the accumulation of VC and DCE mass relative to PCE and TCE mass that is sometimes observed where reductive dechlorination is occurring. In addition to being affected by the degree of chlorination of the compound, reductive dechlorination also can be affected by the redox conditions of the groundwater system. For example, dechlorination of PCE and TCE to DCE can proceed under mildly reducing conditions such as nitrate reduction or iron (III) reduction, while the transformation of DCE to VC, or the transformation of VC to ethene requires more strongly reducing conditions. MNA is an effective remediation approach for sites where natural mechanisms can be demonstrated to limit further migration of groundwater contamination. The

RI data indicate that reductive dechlorination is occurring based on the presence of PCE degradation products TCE, 1,2-DCE and VC.

Materials and services necessary to monitor and model the contaminant dynamics are readily available. Site restrictions and/or ICs may be required as long-term control measures as part of the MNA alternative. MNA and associated modeling involves low capital cost and moderate operations and maintenance (O&M) cost. Groundwater data collected from the site suggest that natural attenuation is likely occurring to some degree and would be potentially effective over the long term. MNA will be retained for further consideration.

6.3 Containment

Containment involves remediation technologies such as physical or hydraulic barriers to slow groundwater flow and limit migration of contaminated groundwater from a source area. Subsurface physical barriers generally consist of vertically driven sheet pile walls or excavated trenches filled with low permeability material, and often are used where the waste mass in the source area is too large for treatment and where soluble and mobile constituents pose an imminent threat to a sensitive receptor. Physical barriers are more effective when geologic conditions allow for connection to a low permeability layer to enhance the containment. Hydraulic barriers consist of a series of groundwater extraction wells and associated piping to remove groundwater and create hydraulic influence to prevent the movement of groundwater downgradient.

Containment technologies are often applied when economic, technical, or site-specific conditions make it impractical to address the contaminant mass in any other way. Physical containment technologies do not provide treatment, but rather are a risk reduction technology that limits exposure and migration (CLU-IN, 2018). Containment has been screened out of consideration for use at this site due to the lack of area for the above ground treatment infrastructure, the lack of an obvious remaining contaminant source location, and considering there are more suitable remedial technologies available for treating the contamination at the site.

6.4 In-Situ Biological Treatment

Bioremediation is a process that attempts to accelerate natural biodegradation by introducing nutrients, electron acceptors, and/or competent contaminant-degrading microorganisms to the subsurface. The rate of bioremediation of PCE can be enhanced by adding a carbon substrate to support anaerobic degradation. Factors that may limit the applicability and effectiveness of these processes at the site include the time needed to remediate the plume, which may require years; and the potential incomplete degradation of CVOCs to more toxic by-products (e.g., VC).

Enhanced bioremediation would involve creating the proper conditions by adding microorganisms or nutrients to the subsurface to accelerate the biodegradation of the CVOC contamination. Under anaerobic conditions, a carbon nutrient or electron source is circulated throughout the groundwater contamination zone to enhance the natural rate and process of bioremediation. Enhanced bioremediation is a potentially viable option for use at the site. However, since the aquifer is predominantly aerobic based on available groundwater data, it would be more efficient to treat the dissolved phase contaminant mass aerobically (i.e., via oxidation) than anaerobically. In-situ bioremediation has been retained for further consideration.

6.5 In-Situ Physical/Chemical/Thermal Treatment

Air Sparging

Air sparging (AS) is an in-situ technology in which clean air is injected into a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the treatment zone, creating a subsurface "air stripper" that removes organic contaminants by volatilization. The injected air helps to flush the contaminants upward into the unsaturated zone where a soil vapor extraction (SVE) system is usually implemented together with AS to remove the vapor phase contamination. Due to the characteristics of the groundwater plume that is offsite in an urban setting that contains existing structures it is not feasibly to implement an AS remedy that is protective of the public, and therefore has been screened out of consideration.

Chemical Oxidation/Chemical Reduction

ISCO: In-Situ Chemical Oxidation (ISCO) chemically converts contaminants to less toxic compounds that are more stable, less mobile, and/or inert compared to their parent compounds. Matching the oxidant and in-situ delivery system to the contaminants of concern and the site conditions is the key to successfully implement and achieve the performance goals. ISCO is a presumptive remedy that is a viable remediation technology for mass reduction of organic contaminants in groundwater. Chemical oxidation can have a relatively rapid treatment time and can be implemented with readily available equipment.

ISCR: In-Situ Chemical Reduction (ISCR) involves introducing reducing agents into the aquifer to convert contaminants into less toxic constituents. Reducing agents, such as zero-valent iron (ZVI), or a ferrous containing mineral, are injected into the subsurface to create a reducing environment, where low reduction potential (Eh) conditions allows for rapid destruction of most CVOCs. ISCR is a presumptive remedy that is a viable remediation technology for mass reduction of organic contaminants in groundwater. Chemical reduction can have a relatively rapid treatment time and can be implemented with readily available equipment.

The effective distribution of reagents for either ISCO or ISCR in the treatment zone and the reactivity of a particular oxidant/reducing agent with the groundwater contaminants are critical to the success of this technology. Robust site characterization, screening, and feasibility testing may be required, particularly to understand subsurface heterogeneities, or preferential flow paths. Other limitations associated with chemical oxidation/reduction include: restrictions to where injection wells can be placed (i.e., limited to side walk areas away from utilities) and requirements for handling and administering large quantities of hazardous chemicals. ISCO effectiveness may be inhibited by the presence of naturally occurring organic material in the formation that can consume large quantities of oxidant. The amount of natural organic matter content and site-specific hydrogeology can impact this technology's effectiveness, making it a challenge to achieve proper mixing of groundwater and oxidants. ISCR effectiveness may be inhibited by the generally aerobic conditions of the aquifer and would require a reducing environment to be effective. However, despite potential challenges, both ISCO and ISCR have been retained for further consideration.

Dual-Phase Extraction (DPE)

Also known as multi-phase extraction or vacuum-enhanced extraction, this technology uses a vacuum system to physically remove various combinations of contaminated groundwater, separate-phase product, and soil vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal or discharge, under applicable State regulations.

DPE systems are used in low permeability or heterogeneous formations. The vacuum extraction system includes a series of wells in the treatment area that are screened in the zone crossing contaminated soils and groundwater, removing contaminants from above and below the water table. The system lowers the water table around the wells, thereby exposing more of the impacted formation and often removing groundwater at a greater rate possible than by using traditional groundwater extraction systems. Contaminants in the newly exposed vadose zone are then more amenable to vapor extraction. Once above ground, the extracted vapors or liquid-phase organics and groundwater are separated and treated (EPA, 2004d). DPE has not been retained for further analysis due to site-specific hydrogeologic conditions, and the lack of source-area with separate-phase product present at the site.

In-Situ Thermal Treatment

In-Situ Thermal Treatment (ISTT) heats impacted soil and groundwater to vaporize VOCs and non-aqueous phase liquid (NAPL). ISTT may also be used to warm the subsurface soil and groundwater to increase the rate of biodegradation under suitable conditions. The vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and the off-gases are treated. Thermal methods can be used to separate contaminants from groundwater. They employ either (a) steam injection; (b) hot air injection; (c) hot water injection; (d) electrical resistance heating; or (e) radio frequency heating to convert groundwater to steam. The efficacy of thermal treatment is heavily influenced by the presence of groundwater in a conductive environment as groundwater will remove the heat generated by the system. Costs for ISTT are often higher than other source treatment technologies, though the remedial timeframe is often condensed. Thermal treatment is not appropriate for use at the site and has been screened out of further consideration due to the lack of a NAPL source-area of contamination, the high cost to implement, and the presence of significant subsurface interferences associated with an urban environment that make this technology not feasible.

In-Well Air Stripping

Air is injected into a vertical well that has been screened at two depths. The lower screen is set in the groundwater saturated zone and the upper screen is set in the unsaturated zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen, inducing localized movement of groundwater into and up the well as contaminated groundwater is drawn into the system at the lower screen. VOCs vaporize within the well at the top of the water table. The contaminated vapors accumulating in the wells are collected via vapor extraction contained within the well. Vapor phase treatment typically occurs above grade. The partially treated groundwater is never brought to the surface; it is forced into the unsaturated zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. Contaminant concentrations are gradually reduced as groundwater circulates through the treatment system in-situ, and vapor is extracted.

A limited number of vendors are available to design and construct the remedy (DER-15, p.7) making it difficult to obtain competitive bids and evaluate this technology against others for cost effectiveness. Additionally, the above ground treatment equipment would be difficult to install in the highly urbanized site setting. Therefore, in-well air stripping has not been retained for further evaluation.

Passive/Reactive Treatment Barriers

A passive reactive barrier (PRB) is a passive in-situ treatment zone that degrades contaminants as groundwater flows through it. The reactions within the PRB depend on pH, redox potential, contaminant concentrations, and other factors. The barrier wall is constructed from a media that is more permeable than the surrounding subsurface to prevent groundwater from flowing around the barrier, and a relatively shallow confining layer beneath the barrier is needed to provide a mechanism to tie the base of the barrier into the confining layer to prevent contaminated groundwater from flowing under the barrier. A PRB is installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. PRBs may combine a passive chemical or biological treatment zone with subsurface fluid flow management. Treatment media may include ZVI, nanoscale ZVI, chelators, sorbents, or microbes. The contaminants will either be degraded or retained in a concentrated form by the barrier material, and the barrier material will require replacement once the media are fully loaded and/or fouled by the passage of contaminants. The barrier could provide permanent containment for relatively benign residues or provide a decreased volume of the more toxic contaminants for subsequent treatment. PRBs have been screened out of further evaluation due to the highly urbanized site setting that would prevent installation of a PRB.

6.6 Ex-Situ Biological Treatment

Ex-situ biological treatment involves pumping impacted groundwater out of the ground before implementing biological treatments such as bioreactors and constructed wetlands. Ex-situ biological treatment technologies are effective at treating the site contaminants; however, the urban setting of the site makes any ex-situ technology impractical due to space limitations. Ex-situ biological treatment has, therefore, been screened-out of consideration.

6.7 Ex-Situ Physical/Chemical Treatment

Ex-situ physical/chemical treatment involves pumping the impacted groundwater out of the ground and implementing physical/chemical treatment such as adsorption, advanced oxidation process, air stripping, ion exchange, precipitation/coagulation/flocculation, separation, and/or sprinkler irrigation. Ex-situ physical/chemical treatment technologies are effective at treating the site contaminants; however, the urban setting of the site makes any ex-situ technology impractical due to space limitations. Ex-situ physical/chemical treatment has, therefore, been screened-out of consideration.

6.8 Discharge/ Disposal

Groundwater discharge/disposal is generally used in combination with groundwater extraction and treatment. Since groundwater extraction and treatment has not been retained for further analysis, discharge of groundwater has not been retained.

6.9 Evaluation of Technologies and Selection of Representative Technologies

As listed in Table 4, groundwater remedial technologies under each type of GRAs were screened for potential applicability, effectiveness, and implementation at the site. In addition to no action, the following technologies pass the screening process:

- MNA
- In-Situ Biological Treatment
- In-Situ Chemical Oxidation/Reduction

7.0 Development and Analysis of Alternatives

In accordance with NYSDEC's *DER-10 Technical Guidance for Site Investigation and Remediation*, May 3, 2010 and DER-15: *Presumptive/Proven Remedial Technologies for New York State's Remedial Programs*, February 27, 2007, remedial alternatives are developed by combining the remedial technologies that have successfully passed the screening stage into a range of alternatives. NYSDEC's DER-10 requires a No Action alternative and an alternative that would restore the site to "pre-disposal conditions." Other alternatives are to be included based on:

- Current, intended, and reasonably anticipated future use of the site;
- Removal of source areas of contamination; and
- Containment of contamination.

Three groundwater remedial treatment technologies were identified based on the screening described in Section 6. SVI will be addressed in the short term through a combination of monitoring and mitigation, and in the long term through groundwater treatment. Four remedial alternatives that address groundwater and soil vapor were developed based on the retained remedial technologies and site-specific conditions, and are described in the following sections.

7.1 Alternative 1 – No Action

The No Action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of NYSDEC DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place and/or move downgradient in the direction of groundwater flow. Contaminants, particularly CVOCs, will possibly degrade via natural processes and transform to form other compounds over time. However, this alternative does not provide any monitoring or mitigation for potential SVI impacts. The No Action alternative is retained for further evaluation as required under NYSDEC DER-10 as a point of comparison to other remedial alternatives. It is assumed that land and groundwater resource use will not change over time and that any existing ICs will remain in place and enforced by other regulatory programs.

7.2 Alternative 2 – Monitored Natural Attenuation; SVI Monitoring and Mitigation

Alternative 2 consists of MNA for chlorinated groundwater contamination, and SVI monitoring and mitigation for the potentially impacted residential and commercial properties shown in Figure 7. The rational for the proposed SVI monitoring locations was based on the highest groundwater and soil gas data obtained during the 2017 RI, 2018, and 2019 investigations, and used Melrose Avenue as a starting point. The SVI monitoring and mitigation area may be expanded based on updated data obtained during the implantation of the remedy. A LTM program will be implemented to help evaluate the rate of natural attenuation of the groundwater contamination. The LTM program will utilize 20 existing monitoring wells, shown in Figure 8, and consist of quarterly groundwater sampling for VOCs, metals, and parameters used to demonstrate natural attenuation for the first two years, and annual sampling for the following 30 years. A MNA model will be prepared at the conclusion of the quarterly groundwater sampling in an effort to determine when the groundwater RAO may be achieved based on current conditions. Groundwater sampling reports will be prepared after each round of sampling.

SVI monitoring will be performed within the first two years of implementing the remedy, and if conditions warrant it, on a periodic basis thereafter. A total of 25 indoor air and 25 sub-slab soil gas samples have been assumed for initial testing, and an additional 25 samples for periodic testing every 5 years after the implementation of the remedy. Costs to install one residential and one commercial vapor mitigation system have been included as initial capital costs as well as periodic costs to inspect, repair, and install an additional system every 5 years.

Local groundwater is not used for drinking or production purposes. However, ICs, such as deed restrictions and well drilling restrictions, are included in this alternative to prevent incidental exposure to contaminated groundwater.

7.3 Alternative 3a – In-Situ Treatment for Total VOCs in Groundwater > 500 µg/l; SVI Monitoring and Mitigation

Alternative 3a consists of in-situ treatment for the areas where total VOCs have been observed to be greater than 500 µg/l in groundwater[3]. Three forms of in-situ treatment were retained based on the screening of technologies; ISCO, ISCR and enhanced bioremediation. In-situ treatment via ISCO injections is assumed for this alternative based on the generally aerobic conditions of the aquifer, and ISCO's ability to treat the higher contaminant mass the quickest. However, ISCR and enhanced bioremediation have been retained as potential treatment options, if during the pre-design investigation those technologies prove to be more effective at achieving the groundwater RAO.

A pre-design investigation (PDI) is part of this alternative to confirm the in-situ treatment design parameters and to install additional performance monitoring points. These design parameters will be used to better characterize the injection locations by understanding the native soil oxygen demand and projected injection radius of influence (ROI). Three performance monitoring wells are assumed to be installed during the PDI to be used with existing monitoring wells to evaluating the effectiveness of the in-situ treatment. During the installation of the performance monitoring wells, a geologist will log the boreholes and collect soil samples for analytical testing. The monitoring wells will be installed, developed, and sampled with groundwater quality field parameters (i.e., conductivity, dissolved oxygen (DO), pH, oxidation reduction potential (ORP), salinity, temperature, turbidity, etc.) collected as part of the PDI. The groundwater data will be

[3] Total VOCs greater than 500 ug/l based on groundwater samples collected during the 2017 RI, 2018, and 2019 groundwater sampling events.

used to determine the in-situ treatment approach, and to help understand the origin of the elevated chloride concentrations that were observed in the August 2019 groundwater data. The proposed performance monitoring wells are shown in Figure 9.

ISCO injections are proposed along the eastern side of Melrose Avenue between East 155th Street and East 156th Street adjacent to monitoring well MW-49, north of MW-05, utilizing MW-01 and MW-02 in the alley north of the fire station, and on both sides of East 155th Street adjacent to monitoring wells MW-03, MW-04, and MW-47 as shown in Figure 9. The proposed injection well layout is approximately perpendicular to groundwater flow and is intended to be protective of the nearby commercial and residential properties. For the purposes of cost estimation, 12 injections wells with an injection ROI of 7.5 feet has been assumed. The injection wells will be installed and completed similar to monitoring wells and will require appropriate permitting and well abandonment once injections are complete. The target treatment depths are from 15 feet bgs to 30 feet bgs[4]. Due to physical limitations of injection well placement – i.e., needing to install injection wells in accessible areas along sidewalks rather than optimal placement within the groundwater plume – it is assumed that multiple injection events will be required to achieve the desired results. For costing purposes, it is estimated that three ISCO injection events will be conducted over a three year period – i.e., one injection event per year. Performance monitoring will be conducted at 6-month intervals post-injection event to monitor progress.

At the conclusion of the third injection event, the two year quarterly groundwater monitoring will begin. Similar to Alternative 2, MNA will be relied on for the groundwater contamination outside of the active treatment area, and SVI monitoring and mitigation is included for the potentially impacted residential and commercial properties. For the purposes of cost estimating, it is assumed that LTM will take place after the in-situ treatment and the 2 years of MNA demonstration sampling conclude – years 5 through 30.

7.4 Alternative 3b – In-Situ Treatment for Total VOCs in GW > 500 µg/l and Former Source-Area; SVI Monitoring and Mitigation

Alternative 3b expands on Alternative 3a to include in-situ treatment for the former source-area, and area immediately downgradient along Melrose Avenue. Similar to Alternative 3a, a PDI will for this alternative to confirm design parameters. Five performance monitoring wells are proposed during the PDI for Alternative 3b and are shown in Figure 10. For the purposes of cost estimation, 20 injections wells with an injection ROI of 7.5 feet has been assumed. The inclusion of this added treatment area is due to groundwater impact observed at MW-20. Groundwater data from MW-20 collected in August 2019, reported PCE concentration of 300 µg/l – which is below the 500 µg/l hot spot threshold, but is still elevated enough to suggest potentially higher concentrations in

[4] Treatment thickness is based on information obtained during the RI and will be confirmed during the PDI.

that vicinity. Including additional injection locations is intended to treat mass concentrations prior to migrating downgradient and contributing to elevated off-site contamination levels.

The proposed injection locations are shown in Figure 10 and include the area inside the site lot and adjacent to MW-20 along the western side of Melrose Avenue, along the eastern side of Melrose Avenue between East 155th Street and East 156th Street adjacent to monitoring well MW-49, and on both sides of East 155th Street adjacent to monitoring wells MW-03, MW-04, and MW-47. Consistent with Alternative 3a, it is estimated that three ISCO injection events will be conducted over a three year period – i.e., one injection event per year. Performance monitoring will be conducted at 6-month intervals post-injection event to monitor progress.

At the conclusion of the third injection event, the two year quarterly groundwater MNA monitoring will begin. Similar to Alternative 2, MNA will be relied on for the groundwater contamination outside of the active treatment area, and SVI monitoring and mitigation is included for the potentially impacted residential and commercial properties. For the purposes of cost estimating, it is assumed that LTM will take place after the in-situ treatment and MNA sampling concluded – years 5 through 30.

8.0 Evaluation of Alternatives

This Section presents the detailed evaluation of the remedial alternatives based on criteria established under NYSDEC's *DER-10 Technical Guidance for Site Investigation and Remediation*, Section 4.2. The evaluation criteria are as follows:

Overall protection of human health and the environment: This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or ICs. The alternative's ability to achieve each of the RAOs is evaluated.

Compliance with SCGs: This criterion evaluates the compliance of the alternative with identified SCGs. The SCGs for the site will be listed along with a discussion of whether or not the remedy will achieve compliance.

Long term effectiveness and permanence: Each alternative is evaluated for its long-term effectiveness after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated:

- The magnitude of the remaining risks (i.e., will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals?);
- The adequacy of the engineering and ICs intended to limit the risk;
- The reliability of these controls, and;
- The ability of the remedy to continue to meet RAOs in the future.

Reduction of toxicity, mobility, or volume of contamination through treatment: The alternative's ability to reduce the toxicity, mobility or volume of site contamination is evaluated. Preference should be given to remedies that permanently and substantially reduce the toxicity, mobility, or volume of the wastes at the site.

Short term impacts and effectiveness: The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified potential adverse impacts to the community or workers at the site will be controlled, and the effectiveness of the controls, should be presented. Provide a discussion of engineering controls that will be used to mitigate short term impacts (i.e., dust control measures). The length of time needed to achieve the remedial objectives is also estimated.

Implementability: The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and resources are evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.

Cost effectiveness: This criterion is an evaluation of the overall cost effectiveness of an alternative or remedy. This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs. Costs are estimated and presented on a present worth basis. The costs for each alternative are presented in Appendix A and were developed using guidance provided in the DER-10 and the guidance document developed by USACE and USEPA for developing cost estimates during the feasibility study (USACE/USEPA, 2000). The costs developed in this FS are expected to be within -30 to +50% of the actual costs applicable for study or feasibility uses.

Land use: This criterion evaluates the current, intended and reasonably anticipated future use of the site and its surroundings, as it relates to an alternative or remedy, when unrestricted levels would not be achieved.

Additionally, alternatives 2, 3a, and 3b considered the NYSDEC's Green Remediation guidance (DER-31) during the conceptual development of this FS. Green remediation strategies aim to reduce energy use and increase the percentage of energy used from renewable resources; reduce air pollutants and greenhouse gas emissions; reduce water use and preserve water quality; conserve material resources and reduce waste; and protect land and ecosystem services.

The evaluation of alternatives is described below and summarized in Table 5.

8.1 Groundwater Alternative Evaluation

The four alternatives that were identified consist of the following:

- Alternative 1 – No Further Action
- Alternative 2 – Monitored Natural Attenuation; SVI Monitoring and Mitigation
- Alternative 3a – In-Situ Treatment for Total VOCs > 500 µg/l; SVI Monitoring and Mitigation
- Alternative 3b – In-Situ Treatment for Total VOCs > 500 µg/l and Former Source-Area; SVI Monitoring and Mitigation

8.2 Alternative 1 – No Action

The No Action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place.

Overall protection of human health and the environment: Alternative 1 provides no control of exposure to contaminated groundwater and no reduction in risk to human health posed by contaminated groundwater. Natural processes that reduce dissolved-phase groundwater contamination will occur over time will occur, the No Action alternative does not monitor the groundwater or soil vapor, and provides no protection to the community from potential exposure to vapor intrusion impacts. The No Action alternative does not attain the groundwater RAOs (e.g., restoration of the resource) and does not enhance the protection of human health. The alternative allows for the continued migration of the site contaminated groundwater plume.

Compliance with SCGs: Alternative 1 does not comply with any of the applicable SCGs. Contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for active groundwater remediation, and no action will be performed to monitor or mitigate SVI impacts.

Long term effectiveness and permanence: Alternative 1 does not provide a degree of long term effectiveness and permanence. Existing groundwater contamination poses potential unacceptable human health risks through its impact on soil vapors. No long term management or controls for exposure are included in this alternative. Under the No Action alternative, these risks would remain unchanged over the long term for expected groundwater uses.

Reduction of toxicity, mobility, or volume of contamination through treatment: Alternative 1 will not provide reduction in toxicity, mobility, or volume of the contaminated groundwater.

Short term impacts and effectiveness: Alternative 1 does not result in disruption of properties overlying the plume and therefore no additional risks are posed to the community, workers, or the environment as no remedial actions will occur. No remedial timeframe is associated with this alternative.

Implementability: There are no implementability concerns posed by this remedy as no remedial actions are being implemented.

Cost effectiveness: Because this is a No Action alternative, the capital, operations and maintenance, and net present value costs are estimated to be $0 and are presented in Appendix A1 and summarized in Table 6.

Land Use: Alternative 1 would result in groundwater contaminants exceeding standards. No environmental easements would be put in place. This is not consistent with the current, intended and reasonably anticipated future use of the area which is zoned for light industrial use.

8.3 Alternative 2 – MNA; SVI Monitoring and Mitigation

Overall protection of human health and the environment: Alternative 2 relies on natural processes to reduce dissolved-phase groundwater contamination over time and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater.

Compliance with SCGs: It is expected that Alternative 2 will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for groundwater remediation for a considerable time period into the future. Potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.

Long term effectiveness and permanence: Alternative 2 provides long term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.

Reduction of toxicity, mobility, or volume of contamination through treatment: Alternative 2 provides reduction in toxicity, mobility, or volume of the contaminated groundwater via natural attenuation processes.

Short term impacts and effectiveness: Alternative 2 presents a minor disruption of properties impacted by SVI through the potential installation of mitigation systems, resulting from the groundwater contamination with minimal risks posed to the community, workers, or the environment. Standard construction and health and safety measures are expected to mitigate these risks.

An estimated timeframe of 30 years is associated with this alternative.

Implementability: There are no concerns for implementing the LTM program for MNA. The monitoring wells are installed and accessible for field personnel to collect samples, and services and materials to perform the sampling are readily available. Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.

Cost effectiveness: The estimated costs for Alternative 2 are presented in Appendix A2 and summarized in Table 6, and are as follows:

- Capital Cost = $800,000
- Annual O&M Cost = $70,000
- Periodic Cost = $230,000
- Total Present Worth of Alternative 2 = $2,110,000

These costs are calculated using a base year of 2020 and are expected to be within -30 to +50% of the actual costs applicable for study or feasibility uses. The primary costs included in Alternative 2 are the initial rounds of performance groundwater sampling and MNA modeling and the SVI monitoring and mitigation. The O&M costs include annual groundwater sampling until year 30. The periodic costs include SVI monitoring and mitigation at 5 year intervals as well as site closeout costs.

Land use: Alternative 2 would result in groundwater contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated.

8.4 Alternative 3a – In-Situ Treatment for Total VOCs >500 µg/l; SVI Monitoring and Mitigation

Overall protection of human health and the environment: Alternative 3a relies on in-situ treatment to remediate the highest groundwater contamination concentration and natural processes to reduce the lower groundwater contamination over time, and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater.

Compliance with SCGs: It is expected that Alternative 3a will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for groundwater remediation for a considerable time period into the future. Potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.

Long term effectiveness and permanence: Alternative 3a provides long-term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.

Reduction of toxicity, mobility, or volume of contamination through treatment: Alternative 3a provides reduction in toxicity, mobility, or volume of the contaminated groundwater via in-situ treatment and natural attenuation processes.

Short term impacts and effectiveness: Alternative 3a presents a minor disruption of properties impacted by SVI resulting from the groundwater contamination with medium risks posed to the community, workers, or the environment while implementing the in-situ treatment. Standard construction and health and safety measures should be taken while implementing this remedy.

Standard precautions will need to be taken during the handling and injecting of oxidizing chemicals, so that the remedial contractors and the public are not exposed to unsafe conditions. Additionally, understanding the sub-surface environment, particularly the potential impacts of corrosive chemicals to utilities and other building materials, needs to be understood prior to implementing the injection events.

An estimated timeframe of 30 years is associated with this alternative.

Implementability: Potential challenges associated with implementing Alternative 3a include limitations as to where injection well and performance monitoring wells can be installed, challenges delivering the chemicals to the subsurface and coming in contact with the intended contaminant mass, and general challenges with working in a densely populated urban setting. There are no implementability concerns for the LTM component of the groundwater remedy – the monitoring wells are installed and accessible for field personnel to collect samples. Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.

Cost effectiveness: The estimated costs for Alternative 3a are presented in Appendix A3 and summarized in Table 6, and are as follows:

- Capital Cost = $1,420,000
- Annual O&M Cost = $70,000
- Periodic Cost = $350,000
- Total Present Worth of Alternative 3a = $2,910,000

These costs are calculated using a base year of 2020 and are expected to be within -30 to +50% of the actual costs applicable for study or feasibility uses. The primary costs included in Alternative 3a are the PDI, in-situ treatment, initial rounds of performance groundwater sampling and MNA modeling and the SVI monitoring and mitigation. The O&M costs include annual groundwater sampling until year 30. The periodic costs include SVI monitoring and mitigation at 5 year intervals as well as site closeout costs.

Land use: Alternative 3a would result in the highest groundwater contaminants reducing quickly as the in-situ treatment is implemented and the remaining lower concentration contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated.

8.5 Alternative 3b – In-Situ Treatment for Total VOCs >500 µg/l and Former Source-Area; SVI Monitoring and Mitigation

Overall protection of human health and the environment: Alternative 3b relies on in-situ treatment to remediate the highest groundwater contamination concentrations – including the area near the former source-area – and natural processes to reduce the lower groundwater contamination over time, and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater.

Compliance with SCGs: It is expected that Alternative 3b will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for active groundwater remediation for a considerable time period into the future. However, potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.

Long term effectiveness and permanence: Alternative 3b provides a moderate degree of long term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.

Reduction of toxicity, mobility, or volume of contamination through treatment: Alternative 3b provides reduction in toxicity, mobility, or volume of the contaminated groundwater via in-situ treatment and natural attenuation processes.

Short term impacts and effectiveness: Alternative 3b presents a minor disruption of properties impacted by SVI resulting from the groundwater contamination with medium risks posed to the community, workers, or the environment while implementing the in-situ treatment. Standard construction and health and safety measures should be taken while implementing this remedy.

Standard precautions will need to be taken during the handling and injecting of oxidizing chemicals, so that the remedial contractors and the public are not exposed to unsafe conditions. Additionally, understanding the sub-surface environment, particularly the potential impacts of corrosive chemicals to utilities and other building materials, needs to be understood prior to implementing the injection events.

An estimated timeframe of 30 years is associated with this alternative.

Implementability: Potential challenges associated with implementing Alternative 3b include limitations as to where injection well and performance monitoring wells can be installed, challenges delivering the chemicals to the subsurface and coming in contact with the intended contaminant mass, and general challenges with working in a densely populated urban setting. There are no implementability concerns for the LTM component of the groundwater remedy – the monitoring wells are installed and accessible for field personnel to collect samples. Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.

Cost effectiveness: The estimated costs for Alternative 3b are presented in Appendix A4 and summarized in Table 6, and are as follows:

- Capital Cost = $1,780,000
- Annual O&M Cost = $70,000
- Periodic Costs = $360,000
- Total Present Worth of Alternative 3b = $3,270,000

These costs are calculated using a base year of 2020 and are expected to be within -30 to +50% of the actual costs applicable for study or feasibility uses. The primary costs included in Alternative 3b are the PDI, in-situ treatment, initial rounds of performance groundwater sampling and MNA modeling and the SVI monitoring and mitigation. The O&M costs include annual groundwater sampling until year 30. The periodic costs include SVI monitoring and mitigation at 5 year intervals as well as site closeout costs.

Land use: Alternative 3b would result in the highest groundwater contaminants reducing quickly as the in-situ treatment is implemented and the remaining lower concentration contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated.

8.6 Comparative Analysis of Alternatives

In the previous sections, each of the remedial alternatives were individually evaluated with respect to the eight evaluation criteria. In this section, a comparative analysis was completed to evaluate them in relation to each other for each of the evaluation criteria.

8.6.1 Overall Protectiveness of Public Health and the Environment

Alternative 3b provides the greatest degree of protectiveness to the public health and the environment in the sense that remediating the highest contaminant concentrations aggressively will reduce the overall risk to the community and the environment. Alternative 3a is the next protective since it actively treats large areas of impacted groundwater.

In the sense of not utilizing strong oxidizing chemicals as part of the remedy while still protecting the public health through ICs and SVI controls, Alternative 2 provides a degree of protection. Considering the former dry cleaner ceased operation over 50 years ago and high concentrations are still present in the environment, the potential risks associated with using strong oxidizing chemicals might outweigh not actively treating the highest concentration areas.

Alternative 1 provides the least protection to public health and the environment since no remedial action is undertaken.

8.6.2 Compliance with SCGs

Alternative 3b followed by Alternative 3a will provide the greatest compliance to the SCGs for groundwater and soil gas. Under these alternatives, the highest groundwater concentrations will be reduced quickest. Alternatives 2, 3a, and 3b each provide the same level of compliance for SVI impacts – initial monitoring and mitigation, as needed, followed by periodic monitoring, maintenance to existing mitigation systems, and additional mitigation – has been accounted for in these alternatives.

Alternative 1 does not achieve the SCGs for groundwater or soil gas, since no action is undertaken. Regarding groundwater, natural attenuation processes will occur regardless of action taken; however, this alternative does not provide a means to monitor and assess progress. It also provides no protection for SVI impacts.

8.6.3 Long Term Effectiveness and Permanence

Alternative 3b followed by Alternative 3a provides the greatest degree of long term effectiveness and permanence for groundwater treatment and greatest reduction of potential SVI impacts. Alternatives 2, 3a, and 3b provide the same level of engineering controlled protection of SVI.

Alternative 1 does not provide long term effectiveness or permanence since no action is being taken.

8.6.4 Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 3b followed by 3a and 2, provide the greatest reduction of toxicity through treatment. Natural attenuation processes will occur under Alternative 1; however, there will be no means to monitor and assess progress, and no action is undertaken to monitor and mitigate potential SVI impacts.

8.6.5 Short Term Impacts and Effectiveness

Alternative 1 creates no short-term impacts to human health or the environment because no remedial action is conducted. Alternative 2 would result in the least disruptive short-term impacts to the workers and the community since it does not involve extensive in-situ treatment like Alternatives 3a and 3b. However, Alternatives 3a and 3b would provide a greater degree of long-term effectiveness by reducing the highest contaminated groundwater the quickest.

Alternatives 3a and 3b will need to exercise caution during the handling and injecting of oxidizing chemicals so that the remedial contractors and the public are not exposed to unsafe conditions. Additionally, understanding the sub-surface environment, particularly the potential impacts of corrosive chemicals to utilities and other building materials, needs to be understood prior to implementing the injection events.

8.6.6 Implementability

Alternative 1 is the easiest alternative to implement since no action is being performed. Of the active alternatives, Alternative 2 would be the easiest to implement, followed by Alternative 3a, and then 3b. Potential challenges for implementation include:

- Access to residential and commercial properties to collect SVI samples and install mitigation systems as necessary (Alternatives 2, 3a, and 3b);
- Ability to install injection wells and additional performance monitoring wells (Alternatives 3a and 3b); and,
- Challenges associated with performing injection events in a densely populated, urban setting (Alternatives 3a and 3b).

8.6.7 Cost Effectiveness

A summary of the costs associated with each remedial alternative is presented in Appendix A of this FS. Alternative 1 has no cost associated with it, since no action is being performed. Of the active alternatives, Alternative 2 is the least expensive option with an estimated total present value of $2,110,000, followed by Alternative 3a at $2,910,000, and Alternative 3b at $3,270,000.

8.6.8 Land Use

Alternative 1 provides no action and therefore no treatment or ICs in place to limit or control future land use. Alternatives 2, 3a, and 3b each provide varying degrees of treatment that are designed to restore the groundwater and soil gas impacts to conditions prior to contaminant release, and ICs to limit current and future land use while the remedies are in place.

9.0 Certification

I, Erich Zimmerman, certify that I am currently a NYS registered professional engineer and that this Feasibility Study Report was prepared in accordance with applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Erich Zimmerman, P.E.

10.0 References

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Tables

Table 1 – Range of VOCs in Groundwater

Detected Constituents	Concentration Range Detected (ug/l)		Remedial Goals (ug/l)	Frequency Exceeding Standard/Total # of Samples
Acetone	4.9 U	**390**	50	1/36
Bromodichloromethane	0.22 U	0.54	50	0/36
Carbon Disulfide	1.0 U	9.1 J	60	0/36
Chloroform	0.22 U	**8.4**	7	2/36
Cis-1,2-Dichloroethylene	0.15 U	**230**	5	7/36
Dichlorodifluoromethane	0.28 U	0.36 J	5	0/36
Propylene	0.13 U	3.3 J		30
Tetrachloroethylene (PCE)	0.27 U	**850**	5	21/36
Toluene	0.17 U	0.2 J	5	0/36
Trichloroethylene (TCE)	0.20 U	**12**	5	5/36

Notes:
Remedial goals are New York State Regulation 6 NYCRR Part 703: Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations
Exceedances are highlighted in bold
J - estimated value
U – non-detect
ug/l – microgram per liter

Table 2 – Range of VOCs in Soil Gas

Detected Constituents	Concentration Range Detected (ug/m3)		NYSDOH Decision Matrix Concentration Ranges (ug/m3)	Frequency Within Vapor Monitoring Guidance /Total # of Samples	Frequency Exceeding Vapor Mitigation Guidance /Total # of Samples
1,1,1-Trichloroethane (TCA)	0.38 U	10	100/1000	0/43	0/43
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.6 J	1.4 U			
1,2,4-Trimethylbenzene	0.32 U	21			
1,2-Dichloroethane	0.29 U	1.2			
1,2-Dichloropropane	0.32 U	9			
1,2-Dichlorotetrafluoroethane	0.57 U	2			
1,3,5-Trimethylbenzene (Mesitylene)	0.34 U	7.6			
1,3-Dichlorobenzene	0.36 U	8.8			
1,4-Dichlorobenzene	0.42 U	23			
2-Hexanone	0.49	26			
4-Ethyltoluene	0.32 U	6.5			
Acetone	6.6 U	380			
Benzene	0.41 U	50			
Bromodichloromethane	0.43 U	3.8			
Carbon Disulfide	0.21 U	130			
Carbon Tetrachloride	0.45 U	1.6	6/60	0/43	0/43
Chlorobenzene	0.29 U	3.4			
Chloroethane	0.22 U	8.1			
Chloroform	0.36 U	370			
Chloromethane	0.34 U	11			
Cis-1,2-Dichloroethylene	0.27 U	1.3	6/60	0/43	0/43
Cyclohexane	0.2 U	53			
Dichlorodifluoromethane	1.2	12			
Ethanol	7.5 J	180			
Ethyl Acetate	0.61 U	200			

Table 2 – Range of VOCs in Soil Gas

Detected Constituents	Concentration Range Detected (ug/m3)		NYSDOH Decision Matrix Concentration Ranges (ug/m3)	Frequency Within Vapor Monitoring Guidance /Total # of Samples	Frequency Exceeding Vapor Mitigation Guidance /Total # of Samples
Ethylbenzene	0.29 U	43			
Isopropanol	1.1 J	49			
m,p-Xylene	0.56 U	130			
Methyl Ethyl Ketone (2-Butanone)	2.9 J	180			
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	0.35 U	9.3			
Methylene Chloride	0.53 J	32	100/1000	0/43	0/43
Naphthalene	0.46 U	220			
N-Heptane	0.39 J	110			
N-Hexane	0.88 J	240			
O-Xylene (1,2-Dimethylbenzene)	0.27 U	60			
Propylene	0.53 U	19			
Styrene	0.28 U	40			
Tetrachloroethylene (PCE)	0.82 U	840	100/1000	9/43	0/43
Tetrahydrofuran	0.2 U	2.7			
Toluene	0.57 J	83			
Trichloroethylene (TCE)	0.34 U	14	6/60	1/43	0/43
Trichlorofluoromethane	0.94 U	5.5			
Vinyl Acetate	0.21 U	6.6 J			

Notes:
Sample counts include two field duplicates.
J - estimated value
ug/m3 – microgram per liter

Table 3 – General Response Actions

General Response Actions	Media	Remediation Area /Volume	Identified Use of Area	Presumptive Remedy
No Action – The no action option is included as a basis for comparison with the active groundwater remediation technologies.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	No
Institutional Controls – Effective in reducing access and exposure to site contaminants through restrictions or limitations of site use. Can be used in conjunction with, or as enhancements to a remedial technology.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	No
Monitored Natural Attenuation – Relies on natural destructive (biodegradation and chemical reactions) and nondestructive mechanisms (dilution, volatilization, adsorption) to reduce contaminant concentrations. Can be implemented with other active remedial technologies.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	No
Containment – Containment involves physical barriers to slow groundwater flow and minimize migration of contaminated groundwater off-site. Can be implemented with other remedial technologies.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	No
In-situ Treatment – Several types of in-situ treatment of groundwater are available, and include biological, physical and chemical treatment.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	**Yes** (for physical and chemical only)
Ex-situ Treatment – Involves the pumping of impacted groundwater and implementing physical/chemical treatment ex-situ. Pump and treat is an effective technology for hydraulic control and/or removal of groundwater contamination. Various technologies are available for treating organic contaminants in collected groundwater. On-site and off-site treatment/disposal options are available for the collected groundwater.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	**Yes**
Discharge/Disposal – Collection is an effective technology for hydraulic control and/or removal of groundwater contamination. Various technologies are available for treating organic contaminants in collected groundwater. On-site and off-site treatment/disposal options are available for the collected groundwater.	Groundwater	3 acres/ 3.5 X 10^6 gallons	Residential and Commercial	**Yes**
Soil Vapor Monitoring– Based on NYSDOH Soil Vapor/ Indoor Air Matrix, monitoring is *including, but not necessarily limited to sub-slab vapor, basement air, and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/ or to evaluate temporal influences.*	Soil Vapor/ Indoor Air	5 acres (approx. 3.5 city block long by 1 city block wide)	Residential and Commercial	No
Soil Vapor Mitigation – Based on NYSDOH Soil Vapor/ Indoor Air Matrix, mitigation consists of *sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring*.	Soil Vapor/ Indoor Air	5 acres (approx. 3.5 city block long by 1 city block wide)	Residential and Commercial	No

Table 4 – Identification and Screening of Technologies – Groundwater

	Presumptive Remedy	Established Technology	Complexity	Overall Cost and Performance					Availability	Treatment Effectiveness				Implementable at Site	Retained for Alternative Evaluation	Reason(s)
				O&M	Capital	Reliability/ Maintainability	Present-Worth Cost	Time		VOCs	CVOCs	SVOCs	Inorganics			
Containment																Due to the highly urban nature of the site, physical barriers and deep well injections will be complex to implement at the site to contain contaminated groundwater.
Physical Barriers	No	Yes	Medium-High	Medium	High	High	Medium-High	Medium-High	High	Effective	Effective	Effective	Effective	Yes	No	
Deep Well Injection	No	Yes	Low	Medium	Medium	Medium	Medium	High	High	Limited	Limited	Limited	Limited	No	No	
In-Situ Biological Treatment																Enhanced bioremediation involves creating the proper conditions by injecting a carbon substrate into groundwater to create anaerobic conditions, which is necessary for reductive dechlorination of CVOCs. Enhanced bioremediation maybe suitable for use at the site and has been retained for further evaluation. Monitored Natural Attenuation (MNA) and Long Term Monitoring (LTM) will be utilized in conjunction with other active treatment technologies. Based on historical data, it appears natural degradation of CVOC's is occurring at the site. Phytoremediation processes are limited to shallow groundwater and is not implementable at the site due to the depth of groundwater at the site.
Enhanced Bioremediation	No	Yes	Medium	Medium-High	Medium	Medium	Medium	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes	**YES**	
Monitored Natural Attenuation/ LTM	No	Yes	Low	Low	Medium	Medium	Low	Medium-High	High	Effective	Effective	Limited	Not Effective	Yes	**YES**	
Phytoremediation	No	Yes	Low	Low	Low	Low	Low	High	Medium	Limited	Limited	Limited	Limited	No	No	
In-Situ Physical/Chemical Treatment																Due to the highly urban site setting, AS/SVE is not feasible for implementation. Locations for AS/SVE wells, piping to a treatment plant, and above ground infrastructure are not available. ISCO/ ISCR are presumptive remedies that are effective for the treatment of CVOCs in groundwater. Based on site conditions (aerobic environment) ISCO is preferred over ISCR, but both have been retained for further evaluation. Thermal treatment is not suitable for use at the site. Traditionally thermal treatment is applied to contaminant mass within the soil matrix and not dissolved phase groundwater plume. Additionally, the urban setting and cost to implement would make thermal treatment not feasible. Similar to AS/SVE, the highly urban site setting makes implementing in-well air stripping with above ground treatment not feasible. Passive or reactive treatment will not be feasible to implement at the site.
Air Sparging	Yes	Yes	Low	Low	Low-Medium	High	Low	Low-Medium	High	Effective	Effective	Limited	Not Effective	No	No	
Chemical Oxidation/ Chemical Reduction	Yes	Yes	Medium-High	Low	Medium-High	Medium	Medium-High	Low	High	Effective	Effective	Limited	Not Effective	Yes	**YES**	
Thermal Treatment	No	Yes	High	High	High	Medium	Medium-High	Low-Medium	Medium	Effective	Effective	Effective	Not Effective	Yes	No	
In-Well Air Stripping	Yes	Yes	Medium	High	High	Medium	Medium	High	Low	Effective	Effective	Limited	Not Effective	Yes	No	
Passive/Reactive Treatment Walls	No	Yes	Medium	Medium	High	Medium-High	Medium-High	Medium-High	Medium	Effective	Effective	Effective	Limited	Yes	No	
Ex-Situ Biological Treatment																Ex-Situ biological treatment options have been screened out for consideration at the Site. See below for further explanation.
Bioreactors	No	Yes	Medium	Medium	Medium	Medium	Low	Medium	High	Effective	Effective	Limited	Not Effective	No	No	
Constructed Wetlands	No	Yes	Low-Medium	Medium	Medium	Medium-High	Medium	Medium-High	Medium	Limited	Limited	Limited	Effective	No	No	

Table 4 – Identification and Screening of Technologies – Groundwater (continued)

	Presumptive Remedy	Established Technology	Complexity	Overall Cost and Performance					Availability	Treatment Effectiveness				Implementable at Site	Retained for Alternative Evaluation	Reason(s)
				O&M	Capital	Reliability/ Maintainability	Present-Worth Cost	Time		VOCs	CVOCs	SVOCs	Inorganics			
Ex-Situ Physical/Chemical Treatment (assuming groundwater extraction)																
Granulated Activated Carbon (GAC) Adsorption	Yes	Yes	Low	Medium-High	Medium	High	Medium	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes	No	Groundwater Pump and Treat, and all associated ex-situ treatment options, have been screened out for consideration at the Site due to high containment concentrations and low permeability soils, which would result in a lengthy remediation process and significantly higher costs compared to in-situ treatment alternatives. Additionally, the highly urban nature of the site makes implementability a concern.
Air Stripping	Yes	Yes	Medium	Medium-High	Medium	High	Medium	High	High	Effective	Effective	Not Effective	Not Effective	Yes	No	
Groundwater Pumping/Pump & Treat	Yes	Yes	Medium	High	Medium-High	High	Medium-High	Medium-High	High	Effective	Effective	Limited	Effective	Yes	No	
Advanced Oxidation Processes	No	Yes	Medium	High	High	Medium	High	Medium-High	High	Effective	Effective	Effective	Not Effective	Yes	No	
Discharge/Disposal																
Disposal of treated groundwater to surface water, sanitary sewer or POTW	NA	Yes	Low	Low	Low	High	Low	NA	High	Effective	Effective	Effective	Effective	Yes	No	Ex-Situ treatment was screened out of consideration therefore there is no discharge/ disposal options needed.

O&M – relative overall cost and performance of operation and maintenance. Capital – relative overall cost and performance of capital investment. Adapted from Federal Remediation Technologies Roundtable Technology Screening Matrix, 2007. www.frtr.gov.

Table 5 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness	Land Use Criteria
1	**No Action**	- Provides no control of exposure to contaminated groundwater and no reduction in risk to human health posed by contaminated groundwater. -Does not attain the groundwater RAOs (e.g., restoration of the resource) and does not enhance the protection of human health. -Allows for the continued migration of the site contaminated groundwater plume.	- Does not comply with any of the applicable SCGs. Contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for active groundwater remediation, and no action will be performed to monitor or mitigate SVI impacts.	- Does not provide a degree of long term effectiveness and permanence. Existing groundwater contamination poses potential unacceptable human health risks under current and likely future groundwater use scenarios. No long term management or controls for exposure are included in this alternative. Under the No Action alternative, these risks would remain unchanged over the long term for expected groundwater uses.	- Does not reduce toxicity, mobility or volume of contamination present at the site.	- Does not result in disruption of site operations or pose a short term threat to public health or the environment. - No remedial timeframe is associated with this alternative.	- No technical or administrative difficulties or constraints.	Capital Cost: $0 Annual O&M Cost: $0 Periodic Cost: $0 Total Present Worth Cost: $0	- Will not comply with SCGs. - Will not restore groundwater quality and does not provide any restrictions to prevent use of groundwater at the site.

Table 5 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness	Land Use Criteria
2	**Monitored Natural Attenuation; SVI Monitoring and Mitigation**	- Alternative 2 relies on natural processes to reduce dissolved-phase groundwater contamination over time and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. -Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater. It is estimated that	- Alternative 2 will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for groundwater remediation for a considerable time period into the future. -Potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.	- Alternative 2 provides long term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.	- Alternative 2 provides reduction in toxicity, mobility, or volume of the contaminated groundwater via natural attenuation processes.	- Alternative 2 presents a minor disruption of properties impacted by SVI resulting from the groundwater contamination with minimal risks posed to the community, workers, or the environment. Standard construction and health and safety measures are expected to mitigate these risks. - Remedial time frame of 2 years. - LTM time frame of 30 years.	- There are no concerns for implementing the LTM program for MNA. The monitoring wells are installed and accessible for field personnel to collect samples, and services and materials to perform the sampling are readily available. -Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.	Capital Cost: $800,000 Annual O&M Cost: $70,000 Periodic Cost: $230,000 Total Present Worth Cost: $2,110,000	- Alternative 2 would result in groundwater contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated

Table 5 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness	Land Use Criteria
3a	**In-Situ Treatment for Total VOCs >500 ug/l; SVI Monitoring and Mitigation**	- Alternative 3a relies on in-situ treatment to remediate the highest groundwater contamination concentration and natural processes to reduce the lower groundwater contamination over time, and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. -Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater. It is estimated that	- Alternative 3a will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for groundwater remediation for a considerable time period into the future. -Potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.	- Alternative 3a provides long term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.	- Alternative 3a provides reduction in toxicity, mobility, or volume of the contaminated groundwater via in-situ treatment and natural attenuation processes.	-Alternative 3a presents a minor disruption of properties impacted by SVI resulting from the groundwater contamination with medium risks posed to the community, workers, or the environment while implementing the in-situ treatment. Standard construction and health and safety measures should be taken while implementing this remedy. -Standard precautions will need to be taken during the handling and injecting of oxidizing chemicals, so that the remedial contractors and the public are not exposed to unsafe conditions. Additionally, understanding the sub-surface environment, particularly the potential impacts of corrosive chemicals to utilities and other building materials, needs to be understood prior to implementing the injection events. -An estimated timeframe of 30 years is associated with this alternative.	- Potential challenges associated with implementing Alternative 3a include limitations as to where injection well and performance monitoring wells can be installed, challenges delivering the chemicals to the subsurface and coming in contact with the intended contaminant mass, and general challenges with working in a densely populated urban setting. -There are no implementability concerns for the LTM component of the groundwater remedy – the monitoring wells are installed and accessible for field personnel to collect samples. Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.	Capital Cost: $1,420,000 Annual O&M Cost: $70,000 Periodic Cost: $350,000 Total Present Worth Cost: $2,910,000	- Alternative 3a would result in the highest groundwater contaminants reducing quickly as the in-situ treatment is implemented and the remaining lower concentration contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated.

Table 5 – Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness	Land Use Criteria
3b	**In-Situ Treatment for Total VOCs >500 ug/l and Former Source-Area; SVI Monitoring and Mitigation**	- Alternative 3b relies on in-situ treatment to remediate the highest groundwater contamination concentrations – including the area near the former source-area – and natural processes to reduce the lower groundwater contamination over time, and SVI monitoring and mitigating to protect the community from potential exposure to vapor intrusion impacts. -Potential exposure to contaminated groundwater is not currently a risk for this site due to the existence of a public water supply; however, ICs will be in place to mitigate incidental exposure to contaminated groundwater.	- Alternative 3b will eventually comply with the applicable SCGs; however, contaminated groundwater will continue to have concentrations above the Class GA GWQS in the plume area under consideration for active groundwater remediation for a considerable time period into the future. However, potential SVI impacts will be monitored and mitigated on an initial and periodic basis, as needed.	- Alternative 3b provides a moderate degree of long term effectiveness and permanence by monitoring the groundwater contamination, and limiting public exposure to contaminated groundwater through ICs and using engineering controls to mitigate potential SVI impacts.	- Alternative 3b provides reduction in toxicity, mobility, or volume of the contaminated groundwater via in-situ treatment and natural attenuation processes.	-Alternative 3b presents a minor disruption of properties impacted by SVI resulting from the groundwater contamination with medium risks posed to the community, workers, or the environment while implementing the in-situ treatment. Standard construction and health and safety measures should be taken while implementing this remedy. -Standard precautions will need to be taken during the handling and injecting of oxidizing chemicals, so that the remedial contractors and the public are not exposed to unsafe conditions. Additionally, understanding the sub-surface environment, particularly the potential impacts of corrosive chemicals to utilities and other building materials, needs to be understood prior to implementing the injection events. -An estimated timeframe of 30 years is associated with this alternative.	- Potential challenges associated with implementing Alternative 3b include limitations as to where injection well and performance monitoring wells can be installed, challenges delivering the chemicals to the subsurface and coming in contact with the intended contaminant mass, and general challenges with working in a densely populated urban setting. - There are no implementability concerns for the LTM component of the groundwater remedy – the monitoring wells are installed and accessible for field personnel to collect samples. Accessing the residential and commercial properties within the potentially impacted area to collect indoor air and sub-slab samples is historically challenging.	Capital Cost: $1,780,000 Annual O&M Cost: $70,000 Periodic Cost: $360,000 Total Present Worth Cost: $3,270,000	- Alternative 3b would result in the highest groundwater contaminants reducing quickly as the in-situ treatment is implemented and the remaining lower concentration contaminants slowly reducing in concentration over time as natural attenuation processes occur. SVI impacts would be monitored and mitigated, as needed. The site is urban and developed for residential and commercial use. No future land use changes are anticipated.

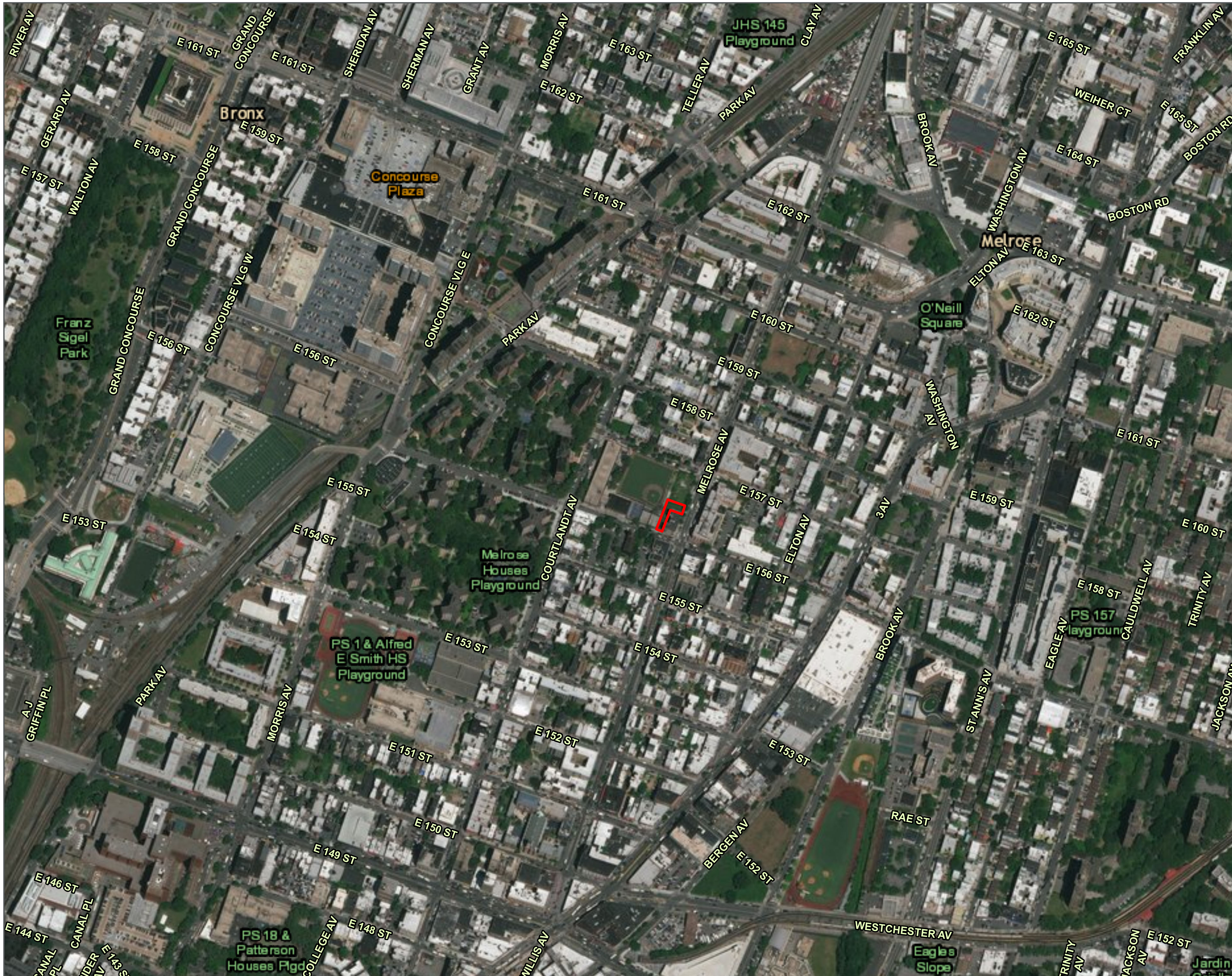
Table 6 – Summary of Remedial Cost Estimates

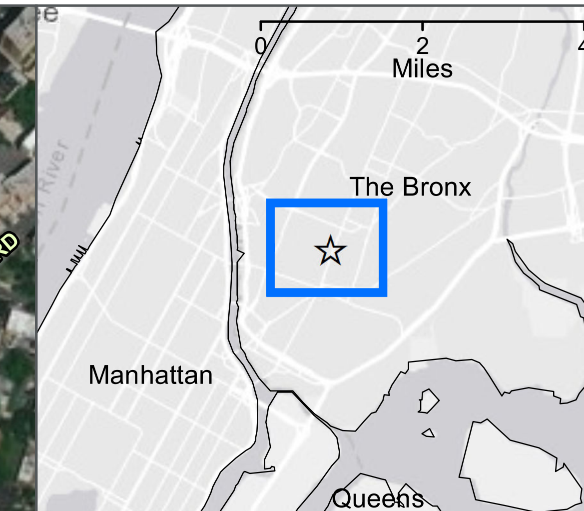
Evaluation Criterion	Alternative 1 – No Action	Alternative 2 – MNA; SVI Monitoring and Mitigation	Alternative 3a – In-Situ Treatment for Total VOCs >500 ug/l; SVI Monitoring and Mitigation	Alternative 3b – In-Situ Treatment for Total VOCs >500 ug/l and Former Source-Area; SVI Monitoring and Mitigation
Capital Cost[1,2]	$0	$800,000	$1,420,000	$1,780,000
Annual O&M Cost[1,2]	$0	$70,000	$70,000	$70,000
Periodic Costs[1,2]	$0	$230,000	$350,000	$360,000
Total Present Value for each Alternative[1,2]	$0	$2,110,000	$2,910,000	$3,270,000
Estimated Project Duration (Years)	0	2 active, 30 LTM	5 active, 30 LTM	5 active, 30 LTM

Notes:

1. The costs developed in this FS are expected to be within -30 to +50% of the actual costs applicable for study or feasibility uses.
2. Cost are calculated using a base year of 2020 with a 7% rate of return and a 4% inflation rate. All costs are rounded to the nearest $10,000.

Figures





LEGEND

Site Boundary

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

SITE LOCATION

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 500 1,000
FEET

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

FIGURE 1

PATH: \\MAHPI-FILE01\OFFICESHARE\SECTIONFOLDERS\WASTE MGMT & INDUSTRIAL\EDMT\EDMT_PROJECTS\NYSDEC\MELROSE\GIS\MXD\01_MELROSE_SITE_LOCATION.MXD - USER: HROSADO - DATE: 1/24/2018

LEGEND

Site Boundary

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

SITE MAP

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

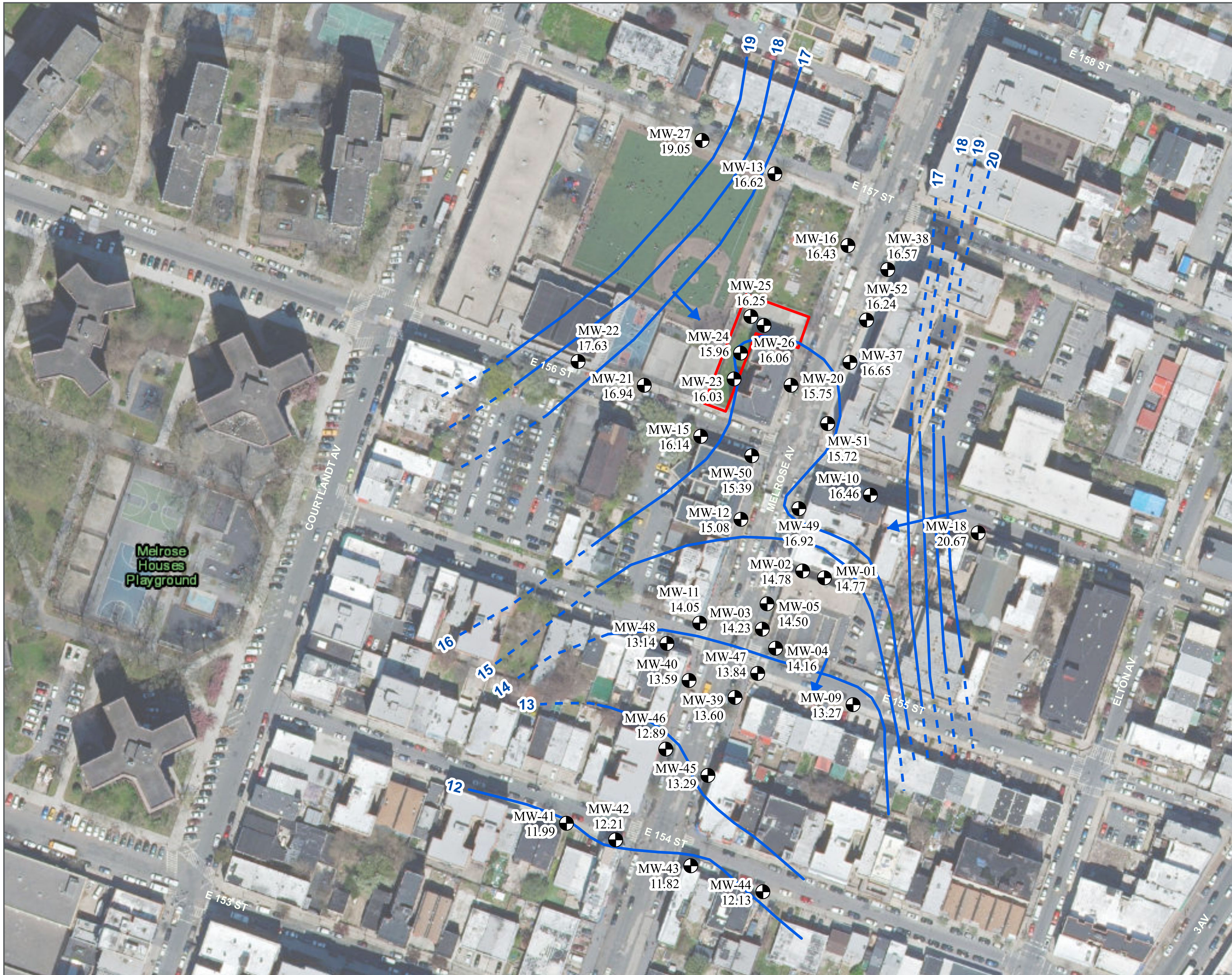
0 50 100
FEET

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

HDR

FIGURE 2

PATH: \\MAHPI-FILE01\OFFICESHARE\SECTIONFOLDERS\WASTE MGMT & INDUSTRIAL\EDMT\EDMT_PROJECTS\NYSDEC\MELROSE\GIS\MXD\02_MELROSE_SITE_MAP.MXD - USER: HROSADO - DATE: 1/24/2018



LEGEND

- Monitoring Well
- Site Boundary
- Groundwater Contours
- Estimated Groundwater Contours
- Groundwater Flow Direction

Notes:

Depth to water measurements were taken July 10, 2017.

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus

GROUNDWATER CONTOURS

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 50 100
FEET

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FIGURE 3

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\0000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\2017_REPORT\14_MELROSE_GW_CONTOURS.MXD - USER: HROSADO - DATE: 1/27/2020

LEGEND

Monitoring Well

Groundwater VOC Isoconcentrations 2018

50 ug/l

500 ug/l

Site Boundary

Total VOCs includes the sum of target VOCs (cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene).

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus

GROUNDWATER TOTAL VOC ISOCONCENTRATIONS

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 50 100
FEET

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

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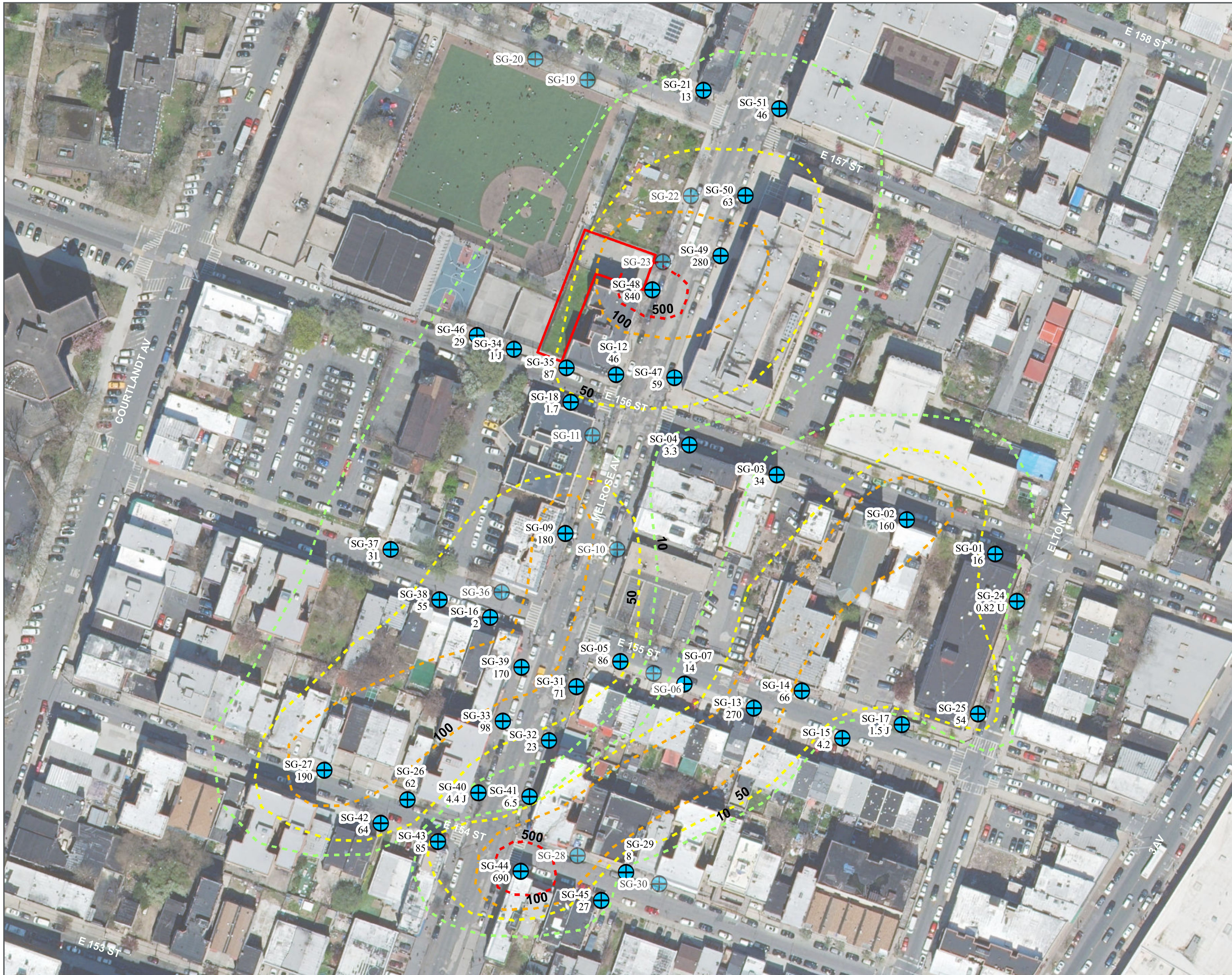
FIGURE 4

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\2019_REPORT\MELROSE_GW_ISOS_PCE_2018.MXD - USER: HROSADO - DATE: 1/30/2020



LEGEND

- Soil Gas
- Site Boundary

Soil Gas PCE Isoconcentrations

- 10 ug/m3
- 50 ug/m3
- 100 ug/m3
- 500 ug/m3

Notes:

Samples were taken July 10th, 2017 through July 18th, 2017.

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus

SOIL GAS PCE ISOCONCENTRATIONS

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 50 100
FEET

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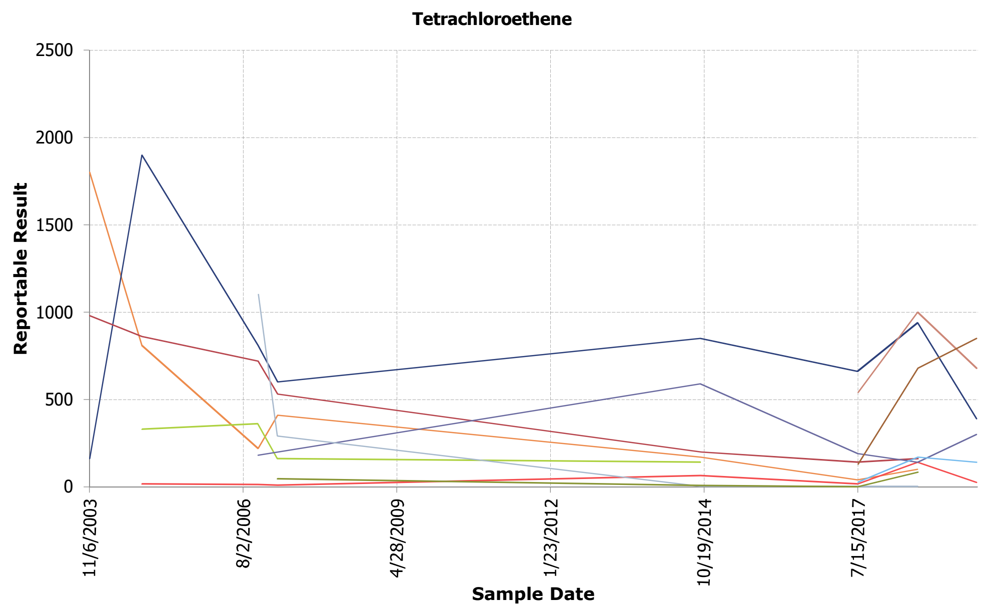
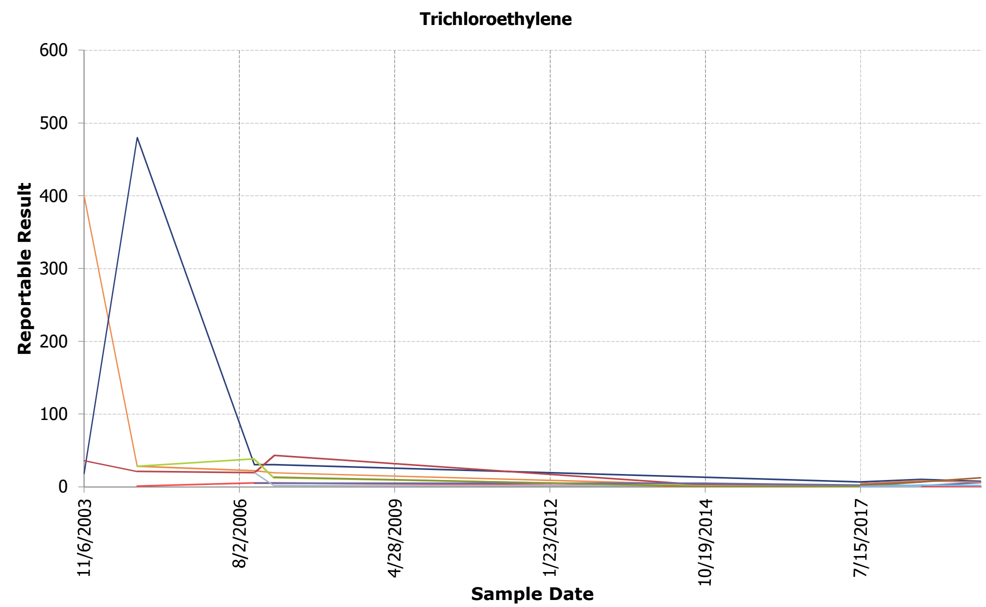
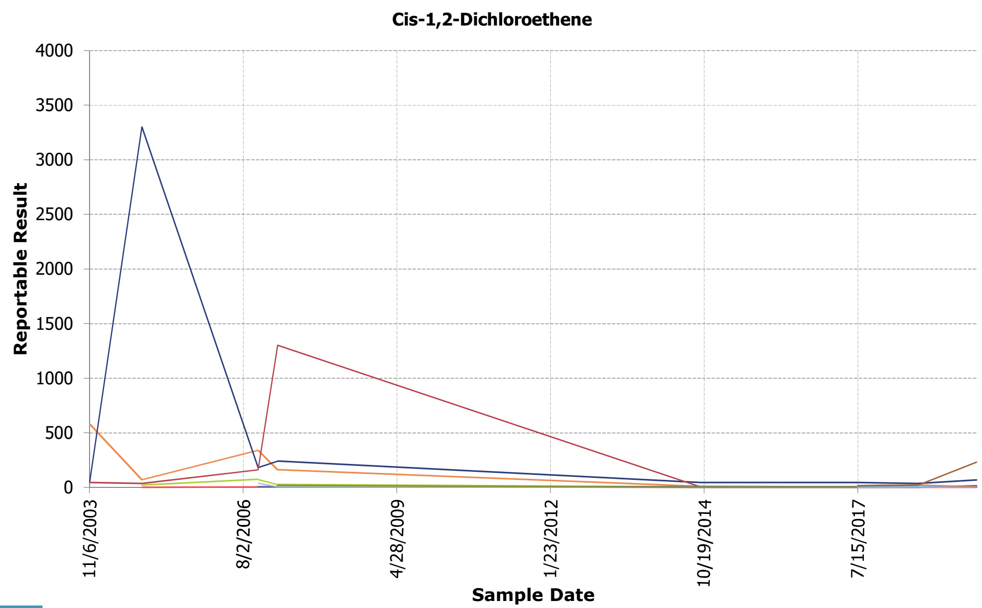
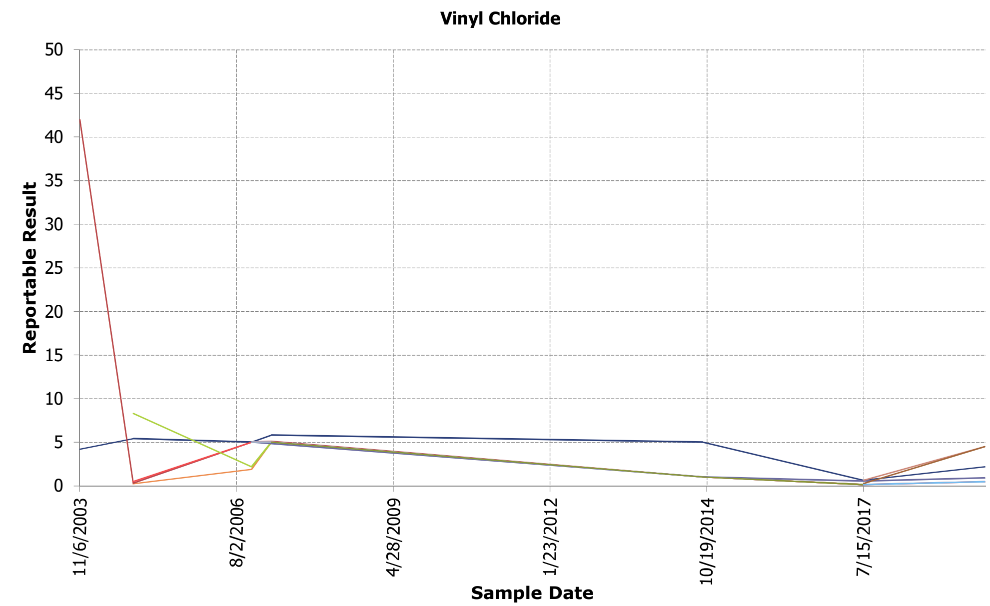
FIGURE 5

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\0000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\2017_REPORT\13_MELROSE_SG_ISOS_PCE.MXD - USER: HROSADO - DATE: 1/27/2020









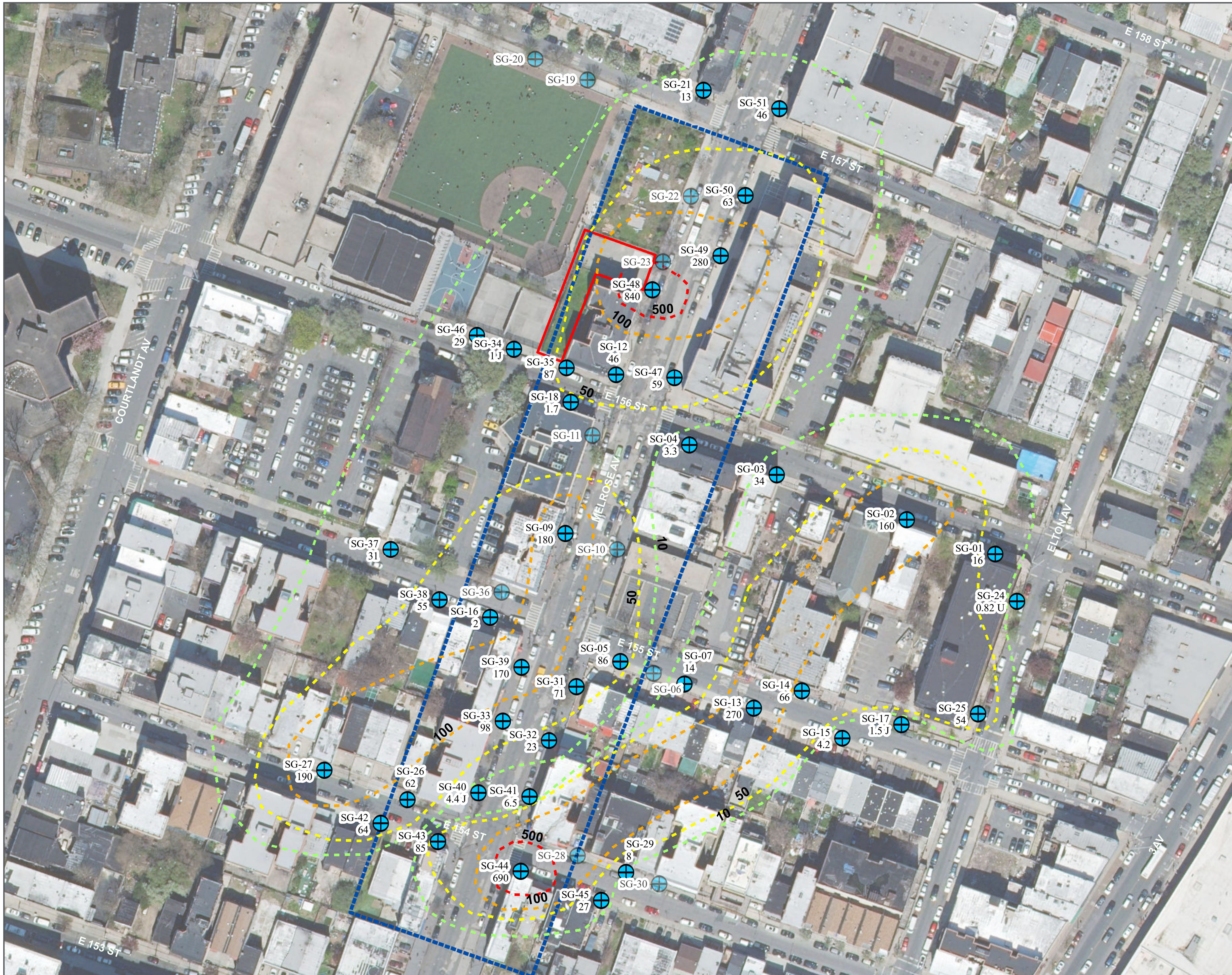
MW-03 MW-04 MW-05 MW-12 MW-14 MW-20 MW-26 MW-37 MW-45 MW-47 MW-49

Groundwater CVOC Results

Melrose

FIGURE 6

Melrose FS



LEGEND

- Soil Gas
- Site Boundary
- Proposed SVI Area

Soil Gas PCE Isoconcentrations

- 10 ug/m3
- 50 ug/m3
- 100 ug/m3
- 500 ug/m3

Notes:

Samples were taken July 10th, 2017 through July 18th, 2017.

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus

PROPOSED SVI AREA

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 50 100
FEET

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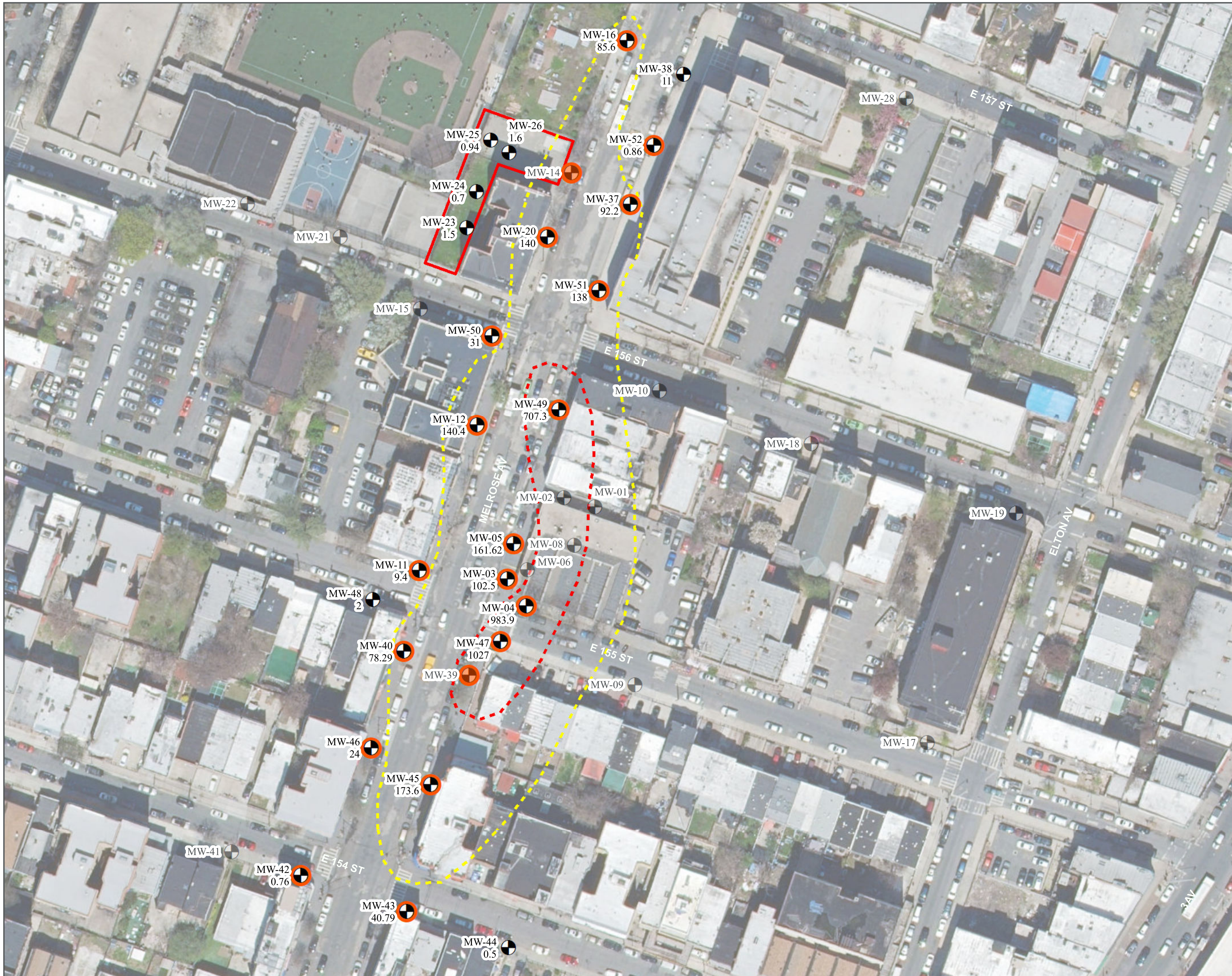
FIGURE 7

PATH: A:\202315\CON0070209\CON0095033\000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\FEASABILITY STUDY\FIGURE 7 - PROPOSED SVI AREA.MXD - USER: HROSADO - DATE: 1/27/2020



LEGEND

- Monitoring Well
- Proposed LTM MWs

Groundwater VOC Isoconcentrations 2018

- 50 ug/l
- 500 ug/l
- Site Boundary

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus

PROPOSED LTM MW LOCATIONS

FORMER MELROSE AVENUE DRY CLEANERS
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

N

0 50 100
FEET

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FIGURE 8

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\0000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\FEASABILITY STUDY\FIGURE 8 - PROPOSED LTM MW LOCATIONS.MXD - USER: HROSADO - DATE: 1/29/2020

LEGEND

- Monitoring Well
- Site Boundary
- Approximate GW flow direction
- Proposed Injection Locations
- Proposed ISCO Wells
- 7.5-ft Radius of Influence

Groundwater VOC Isoconcentrations 2018

- 50 ug/l
- 500 ug/l

Notes:

All results given in ug/l.

Results are the sum of target VOCs (cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene) from the 2018 sampling round.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ALTERNATIVE 3A
IN-SITU TREATMENT > 500 UG/L

FORMER MELROSE AVENUE DRY CLEANER
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

0 50 100
FEET

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FIGURE 9

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\FEASABILITY STUDY\FIGURE 9 - ALTERNATIVE 3A.MXD - USER: HROSADO - DATE: 1/30/2020

LEGEND

- Monitoring Well
- Site Boundary
- Approximate GW flow direction
- Proposed Injection Locations
- Proposed ISCO Wells
- 7.5-ft Radius of Influence

Groundwater VOC Isoconcentrations 2018

- 50 ug/l
- 500 ug/l

Notes:

All results given in ug/l.

Results are the sum of target VOCs (cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene) from the 2018 sampling round.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ALTERNATIVE 3B
IN-SITU TREATMENT > 500 UG/L AND FORMER SOURCE-AREA

FORMER MELROSE AVENUE DRY CLEANER
753 MELROSE AVENUE, BRONX, NY
SITE NO 203009

0 50 100
FEET

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

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FIGURE 10

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0070209\CON0095033\0000000000247044\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MXD\FEASABILITY STUDY\FIGURE 10 - ALTERNATIVE 3B.MXD - USER: HROSADO - DATE: 1/30/2020

Appendix A

Cost Estimate Summary

A.1 Cost Estimate for Alternative 1

A.2 Cost Estimate for Alternative 2

A.3 Cost Estimate for Alternative 3a

A.4 Cost Estimate for Alternative 3b

Appendix A - Summary of Total Cost of Remedial Alternatives for the Former Melrose Dry Cleaners

Site:	Former Melrose Avenue Dry Cleaner Site	**Base Year:**	2020
Location:	Bronx, New York	**Date:**	January 31, 2020
Phase:	Feasibility Study (-30% - +50%)		

	Alternative 1	Alternative 2	Alternative 3a	Alternative 3b
Description	**No Action**	**MNA; SVI Monitoring and Mitigation**	**In-Situ Treatment for Total VOCs > 500ug/l; SVI Monitoring and Mitigation**	**In-Situ Treatment for Total VOCs > 500ug/l and Former Source-Area; SVI Monitoring and Mitigation**
Estimated Active Project Duration (Years)	-	2	5	5
Estimated Long Term Monitoring (Years)	-	30	30	30
Capital Cost	$ -	$ 766,980	$ 1,421,009	$ 1,778,976
Annual O&M Cost	$ -	$ 71,180	$ 71,180	$ 71,180
Periodic Cost	$ -	$ 228,532	$ 353,151	$ 356,186
Total Present Worth of Alternatives	**$ -**	**$ 2,109,481**	**$ 2,906,878**	**$ 3,267,880**

Appendix A1 - Cost Estimate for Alternative 1

Alternative 1
In-Situ Treatment for Total VOCs >500 ug/l + Former

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 1 consists of no further action.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Capital Costs**					
1.1	No Capital Costs	0	LS	$ -	$ -	
	Sub-Total				**$ -**	
2	**Institutional Controls**					
2.1	No Institutional Controls	0	LS	$ -	$ -	
	Sub-Total				**$ -**	
	TOTAL CAPITAL COST				**$ -**	

ANNUAL O&M COST:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1	**Annual O&M Costs**					
1.1	No Annual O&M Costs	0	LS	$ -	$ -	
	Sub-Total				**$ -**	
2	**Maintenance**					Injection Cost - Assume 1 per day
2.1	No Maintenance Costs	0	LS	$ -	$ -	
	Sub-Total				**$ -**	
	Sub-Total				**$ -**	
	Contingency	15%			$ -	
	Sub-Total				**$ -**	
	Project Management				$ -	
	Technical Support				$ -	
	TOTAL ANNUAL O&M COST				**$ -**	

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**Periodic Costs**						
1.1	No Periodic Costs		0	LS	$ -	$ -	
	Sub-Total					**$ -**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		$ -	
2	**Annual O&M Cost**		0	$ -	
3	**Periodic Costs**		0	$ -	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ -**	

Appendix A2 - Cost Estimate for Alternative 2

Alternative 2
In-Situ Treatment for Total VOCs >500 ug/l + Former

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 2 consists of groundwater MNA for the area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Groundwater Performance Monitoring**					
1.1	Groundwater Sampling	160	EA	$ 750	$ 120,000	Sample 20 wells quarterly for 2 years to evaluate MNA; includes labor
1.2	Groundwater Sample Laboratory Analysis	192	EA	$ 600	$ 115,200	VOCs, Metals, and MNA parameters + 20% QC samples.
1.3	Fate and Transport Modeling and Calculations	1	LS	$ 20,000	$ 20,000	Performed after the 8th round of sampling.
1.4	Data Reduction, Evaluation and Reporting	8	LS	$ 20,000	$ 160,000	
	Sub-Total				**$ 415,200**	
2	**Soil Vapor Intrusion**					
2.1	Remedial Action Workplan/Permitting	1	LS	$ 20,000	$ 20,000	
2.2	Indoor Air/ Soil Gas Sampling	50	EA	$ 458	$ 22,917	Soil Gas/ Indoor Air TO-15 sampling; includes labor
2.3	Vapor Mitigation System - Residential Property	1	EA	$ 7,500	$ 7,500	Assume the installation of a mitigation system in a 1,000 SF basement of a 3-story residence. Estimate includes contractor costs.
2.4	Vapor Mitigation System - Commercial Property	1	EA	$ 10,000	$ 10,000	Assume the installation of a mitigation system in a 1,000 SF basement of a 4-story commercial/ residential property. Estimate includes contractor costs.
2.5	SVI Report	1	LS	$ 20,000	$ 20,000	
	Sub-Total				**$ 80,417**	
3	**Institutional Controls**					
3.1	Site Institutional Controls	1	LS	$ 20,000	$ 20,000	Injection Cost - Assume 1 per day
	Sub-Total				**$ 20,000**	
	Sub-Total				**$ 515,617**	Sub-Total All Construction Costs.
	Contingency	25%			$ 128,904	10% scope + 15% bid
	Sub-Total				**$ 644,521**	
	Project Management	5%			$ 32,226	
	Remedial Design	8%			$ 51,562	
	Construction Management	6%			$ 38,671	
	TOTAL CAPITAL COST				**$ 766,980**	

ANNUAL O&M COST

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**LTM and Institutional Controls - Year 2 to 30**	2 to 30					
1.1	Maintain Institutional Controls		1	LS	$ 5,000	$ 5,000	
1.2	Groundwater Sampling		20	EA	$ 750	$ 15,000	20 wells sampled annually; includes labor
1.3	Groundwater Sample Laboratory Analysis		24	EA	$ 550	$ 13,200	Total VOCs analysis + 20% QC samples.
1.4	Data Reduction, Evaluation and Reporting		1	EA	$ 20,000	$ 20,000	
	Sub-Total					**$ 53,200**	
	Contingency		15%			$ 7,980	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL ANNUAL O&M COSTS (Year 2 to 30)					**$ 71,180**	

Appendix A2 - Cost Estimate for Alternative 2

Alternative 2
In-Situ Treatment for Total VOCs >500 ug/l + Former

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 2 consists of groundwater MNA for the area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PERIODIC COSTS

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**SVI Monitoring**	5 to 30					
1.1	Soil Gas/ Indoor Air Sampling		25	EA	$ 458	$ 11,458	Every 5 years through year 30
1.2	SVI Mitigation System		1	EA	$ 10,000	$ 10,000	Assume 1 new installation plus inspection and repairs to existing systems.
1.3	SVI Reporting		1	LS	$ 20,000	$ 20,000	
	Sub-Total					**$ 41,458**	
	Contingency		15%			$ 6,219	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 5 to 30)					**$ 57,677**	
2	**Site Close Out**	30					At the end of Year 30
2.1	Monitoring Well Abandonment		36	EA	$ 1,500	$ 54,000	Drilling subcontractor and abandonment of monitoring
2.2	Final Closure Report		1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 104,000**	
	Contingency		15%			$ 15,600	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 30)					**$ 129,600**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Inflation Rate 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 766,980**	
2	**Annual O&M Cost**				
2.1	LTM/ICs - Years 2 to 30	2 to 30	71,180	$1,113,970	
	Sub-Total			**$ 1,113,970**	
3	**Periodic Costs**				
3.1	SVI Monitoring (5, 10, 15, 20, 25, and 30)	5 to 30	57,677	$187,207	
3.2	Site Closeout - Year 30	30	129,600	$41,325	
	Sub-Total			**$ 228,532**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 2,109,481**	

Appendix A3 - Cost Estimate for Alternative 3a

Alternative 3a
In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3a consists of in-situ treatment for total VOCs > 500ug/l and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:							
1	**Pre-Design Investigation**						
	1.1	Investigation Workplan	1	LS	$ 25,000	$ 25,000	Sampling Plan, QAPP, HASP
	1.2	Driller Mob/Demob	1	LS	$ 10,000	$ 10,000	Hollow-stem auger drilling mobilization
	1.3	Performance Monitoring Wells	3	EA	$ 5,000	$ 15,000	2" dia, 30 ft TD, PVC construction MWs to be used for monitoring ISCO performance. Soil samples collected during installation will be used to design ISCO injection plan. Flush-mount completion. Includes MW development.
	1.4	Performance Soil Sampling	15	EA	$ 250	$ 3,750	Assume 5 soil samples per MW. Collect samples for geochemical and physical properties to be used for the ISCO design.
	1.5	IDW	3	EA	$ 350	$ 1,050	Non-hazardous IDW disposal
	1.6	ISCO Bench Testing/ Design	1	LS	$ 20,000	$ 20,000	
	1.7	Survey	1	Day	$ 1,500	$ 1,500	Survey newly installed performance MWs.
	1.8	PDI Report	1	LS	$ 25,000	$ 25,000	
		Sub-Total				**$ 101,300**	
2	**In-Situ Treatment**						
	2.1	In-Situ Treatment Workplan	1	LS	$ 20,000	$ 20,000	In-Situ Treatment workplan
	2.2	Driller Mob/Demob	1	LS	$ 10,000	$ 10,000	Hollow-stem auger drilling mobilization
	2.3	Injection Well Installation	12	EA	$ 5,000	$ 60,000	Assume 2" dia PVC to a depth <30ft bgs - similar construction to performance MWs.
	2.4	Chemicals Cost	38	EA	$ 2,500.00	$ 95,000	Vendor quote - ISCO Chemical Cost. Assumes 14 injection wells and 3 rounds of injections.
	2.5	Injection Cost	38	Day	$ 2,500	$ 95,000	Injection Cost - Assume 1 per day
	2.6	Injection Support	38	Day	$ 1,000	$ 38,000	Daily injection support - Water, misc tools, equipment, etc.
	2.7	In-Situ Treatment Performance GW Monitoring	21	EA	$ 750	$ 15,750	Assumes 7 MWs (3 new + 4 existing). Samples collected 6 months after each injection event.
	2.8	Groundwater Sample Laboratory Analysis	25	EA	$ 250	$ 6,300	VOCs + 20% QC
	2.9	In-Situ Treatment Report	1	LS	$ 25,000	$ 25,000	
		Sub-Total				**$ 365,050**	
3	**Groundwater Performance Monitoring**						
	3.1	Groundwater Sampling	160	EA	$ 750	$ 120,000	Sample 20 wells quarterly for 2 years to evaluate MNA; includes labor
	3.2	Groundwater Sample Laboratory Analysis	192	EA	$ 600	$ 115,200	VOCs, Metals, and MNA parameters + 20% QC samples.
	3.3	MNA Modeling	1	LS	$ 20,000	$ 20,000	Performed after the 8th round of sampling.
	3.4	Data Reduction, Evaluation and Reporting	8	LS	$ 20,000	$ 160,000	
		Sub-Total				**$ 415,200**	
4	**Soil Vapor Intrusion**						
	4.1	Remedial Action Workplan/Permitting	1	LS	$ 25,000	$ 25,000	
	4.2	Indoor Air Sampling	50	EA	$ 225	$ 11,250	Soil Gas/ Indoor Air TO-15 sampling
	4.3	Vapor Mitigation System - Residential Property	1	EA	$ 7,500	$ 7,500	Assume the installation of a mitigation system in a 1,000 SF basement of a 3-story residence. Estimate includes contractor cost - T&M
	4.4	Vapor Mitigation System - Commercial Property	1	EA	$ 10,000	$ 10,000	Assume the installation of a mitigation system in a 1,000 SF basement of a 4-story commercial/ residential property. Estimate includes contractor cost - T&M
		Sub-Total				**$ 53,750**	

Appendix A3 - Cost Estimate for Alternative 3a

Alternative 3a
In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3a consists of in-situ treatment for total VOCs > 500ug/l and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
5	**Institutional Controls**						
	5.1	Site Institutional Controls	1	LS	$ 20,000	$ 20,000	ICs to restrict well drilling and GW use in areas impacted by the site.
		Sub-Total				**$ 20,000**	
	Sub-Total					**$ 955,300**	Sub-Total All Construction Costs.
		Contingency	25%			$ 238,825	10% scope + 15% bid
	Sub-Total					**$ 1,194,125**	
	Project Management		5%			$ 59,706	
	Remedial Design		8%			$ 95,530	
	Construction Management		6%			$ 71,648	
	TOTAL CAPITAL COST					**$ 1,421,009**	

ANNUAL O&M COST

Item No.		Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**LTM and Institutional Controls - Year 5 to 30**		5 to 30					
	1.1	Maintain Institutional Controls		1	LS	$ 5,000	$ 5,000	
	1.2	Groundwater Sampling		20	EA	$ 750	$ 15,000	20 wells sampled annually; includes labor
	1.3	Groundwater Sample Laboratory Analysis		24	EA	$ 550	$ 13,200	Total VOCs analysis + 20% QC samples.
	1.4	Data Reduction, Evaluation and Reporting		1	EA	$ 20,000	$ 20,000	
		Sub-Total					**$ 53,200**	
		Contingency		15%			$ 7,980	
	Project Management						$ 5,000	
	Technical Support						$ 5,000	
	TOTAL ANNUAL O&M COSTS (Year 2 to 30)						**$ 71,180**	

Appendix A3 - Cost Estimate for Alternative 3a

Alternative 3a
In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3a consists of in-situ treatment for total VOCs > 500ug/l and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PERIODIC COSTS

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**SVI Monitoring**	5 to 30					
1.1	Soil Gas/ Indoor Air Sampling		25	EA	$ 458	$ 11,458	Every 5 years through year 30
1.2	SVI Mitigation System		1	EA	$ 10,000	$ 10,000	Assume 1 new installation plus inspection and repairs to existing systems.
1.3	SVI Reporting		1	LS	$ 20,000	$ 20,000	
	Sub-Total					**$ 41,458**	
	Contingency		15%			$ 6,219	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 5 to 30)					**$ 57,677**	
2	**Site Close Out**	30					At the end of Year 30
2.1	Monitoring Well Abandonment		39	EA	$ 1,500	$ 58,500	Drilling subcontractor and abandonment of monitoring wells. Assumes 36 existing MWs + 3 performance MWs.
2.2	Final Closure Report		1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 108,500**	
	Contingency		15%			$ 16,275	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 30)					**$ 134,775**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Inflation Rate 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 1,421,009**	
2	**Annual O&M Cost**				
2.1	LTM/ICs - Years 5 to 30	5 to 30	71,180	$1,132,718	
	Sub-Total			**$ 1,132,718**	
3	**Periodic Costs**				
3.1	SVI Monitoring (5, 10, 15, 20, 25, and 30)	5 to 30	57,677	$234,583	
3.2	Site Closeout - Year 30	30	134,775	$118,569	
	Sub-Total			**$ 353,151**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 2,906,878**	

Appendix A4 - Cost Estimate for Alternative 3b

Alternative 3b

In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI Monitoring and Mitigation

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3b consists of in-situ treatment for total VOCs > 500ug/l and the former source-area, and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Pre-Design Investigation**					
1.1	Investigation Workplan	1	LS	$ 25,000	$ 25,000	Sampling Plan, QAPP, HASP
1.2	Driller Mob/Demob	1	LS	$ 10,000	$ 10,000	Hollow-stem auger drilling mobilization
1.3	Performance Monitoring Wells	5	EA	$ 5,000	$ 25,000	2" dia, 30 ft TD, PVC construction MWs to be used for monitoring ISCO performance. Soil samples collected during installation will be used to design ISCO injection plan. Flush-mount completion. Includes MW development.
1.4	Performance Soil Sampling	25	EA	$ 250	$ 6,250	Assume 5 soil samples per MW. Collect samples for geochemical and physical properties to be used for the ISCO design.
1.5	IDW	5	EA	$ 350	$ 1,750	Non-hazardous IDW disposal
1.6	ISCO Bench Testing/ Design	1	LS	$ 20,000	$ 20,000	
1.7	Survey	1	Day	$ 1,500	$ 1,500	Survey newly installed performance MWs.
1.8	PDI Report	1	LS	$ 25,000	$ 25,000	
	Sub-Total				**$ 114,500**	
2	**In-Situ Treatment**					
2.1	In-Situ Treatment Workplan	1	LS	$ 20,000	$ 20,000	In-Situ Treatment workplan
2.2	Driller Mob/Demob	1	LS	$ 10,000	$ 10,000	Hollow-stem auger drilling mobilization
2.3	Injection Well Installation	22	EA	$ 5,000	$ 110,000	Assume 2" dia PVC to a depth <30ft bgs - similar construction to performance MWs.
2.4	Chemicals Cost	66	EA	$ 2,500	$ 165,000	Vendor quote - ISCO Chemical Cost. Assumes 22 injection wells and 3 rounds of injections.
2.5	Injection Cost	66	Day	$ 2,500	$ 165,000	Injection Cost - Assume 1 per day
2.6	Injection Support	66	Day	$ 1,000	$ 66,000	Daily injection support - Water, misc. tools, equipment, etc.
2.7	In-Situ Treatment Performance GW Monitoring	30	EA	$ 750	$ 22,500	Assumes 10 MWs (5 new + 5 existing). Samples collected 6 months after each injection event.
2.8	Groundwater Sample Laboratory Analysis	36	EA	$ 250	$ 9,000	VOCs + 20% QC
2.9	In-Situ Treatment Report	1	LS	$ 25,000	$ 25,000	
	Sub-Total				**$ 592,500**	
3	**Groundwater Performance Monitoring**					
3.1	Groundwater Sampling	160	EA	$ 750	$ 120,000	Sample 20 wells quarterly for 2 years to evaluate MNA; includes labor
3.2	Groundwater Sample Laboratory Analysis	192	EA	$ 600	$ 115,200	VOCs, Metals, and MNA parameters + 20% QC samples.
3.3	MNA Modeling	1	LS	$ 20,000	$ 20,000	Performed after the 8th round of sampling.
3.4	Data Reduction, Evaluation and Reporting	8	LS	$ 20,000	$ 160,000	
	Sub-Total				**$ 415,200**	
4	**Soil Vapor Intrusion**					
4.1	Remedial Action Workplan/Permitting	1	LS	$ 25,000	$ 25,000	
4.2	Indoor Air Sampling	50	EA	$ 225	$ 11,250	Soil Gas/ Indoor Air TO-15 sampling
4.3	Vapor Mitigation System - Residential Property	1	EA	$ 7,500	$ 7,500	Assume the installation of a mitigation system in a 1,000 SF basement of a 3-story residence. Estimate includes contractor cost - T&M
4.4	Vapor Mitigation System - Commercial Property	1	EA	$ 10,000	$ 10,000	Assume the installation of a mitigation system in a 1,000 SF basement of a 4-story commercial/ residential property. Estimate includes contractor cost - T&M
	Sub-Total				**$ 53,750**	

Appendix A4 - Cost Estimate for Alternative 3b

Alternative 3b

In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI Monitoring and Mitigation

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3b consists of in-situ treatment for total VOCs > 500ug/l and the former source-area, and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
5	**Institutional Controls**					
5.1	Site Institutional Controls	1	LS	$ 20,000	$ 20,000	ICs to restrict well drilling and GW use in areas impacted by the site.
	Sub-Total				**$ 20,000**	
	Sub-Total				**$ 1,195,950**	Sub-Total All Construction Costs.
	Contingency	25%			$ 298,988	10% scope + 15% bid
	Sub-Total				**$ 1,494,938**	
	Project Management	5%			$ 74,747	
	Remedial Design	8%			$ 119,595	
	Construction Management	6%			$ 89,696	
	TOTAL CAPITAL COST				**$ 1,778,976**	

ANNUAL O&M COST

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**LTM and Institutional Controls - Year 5 to 30**	5 to 30					
1.1	Maintain Institutional Controls		1	LS	$ 5,000	$ 5,000	
1.2	Groundwater Sampling		20	EA	$ 750	$ 15,000	20 wells sampled annually; includes labor
1.3	Groundwater Sample Laboratory Analysis		24	EA	$ 550	$ 13,200	Total VOCs analysis + 20% QC samples.
1.4	Data Reduction, Evaluation and Reporting		1	EA	$ 20,000	$ 20,000	
	Sub-Total					**$ 53,200**	
	Contingency		15%			$ 7,980	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL ANNUAL O&M COSTS (Year 2 to 30)					**$ 71,180**	

Appendix A4 - Cost Estimate for Alternative 3b

Alternative 3b

In-Situ Treatment for Total VOCs >500 ug/l + Former Source-Area; SVI Monitoring and Mitigation

COST ESTIMATE SUMMARY

Site: Former Melrose Avenue Dry Cleaner Site
Location: Bronx, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2020
Date: January 31, 2020

Description: Alternative 3b consists of in-situ treatment for total VOCs > 500ug/l and the former source-area, and MNA for the remaining area exceeding the GWQS. SVI monitoring will be conducted at potentially impacted residential and commercial properties, and if needed, vapor mitigation systems will be installed. Institutional controls to restrict well drilling and groundwater use will be in place and maintained.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PERIODIC COSTS

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**SVI Monitoring**	5 to 30					
1.1	Soil Gas/ Indoor Air Sampling		25	EA	$ 458	$ 11,458	Every 5 years through year 30
1.2	SVI Mitigation System		1	EA	$ 10,000	$ 10,000	Assume 1 new installation plus inspection and repairs to existing systems.
1.3	SVI Reporting		1	LS	$ 20,000	$ 20,000	
	Sub-Total					**$ 41,458**	
	Contingency		15%			$ 6,219	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 5 to 30)					**$ 57,677**	
2	**Site Close Out**	30					At the end of Year 30
2.1	Monitoring Well Abandonment		41	EA	$ 1,500	$ 61,500	Drilling subcontractor and abandonment of monitoring wells. Assumes 36 existing MWs + 5 performance MWs.
2.2	Final Closure Report		1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 111,500**	
	Contingency		15%			$ 16,725	
	Project Management					$ 5,000	
	Technical Support					$ 5,000	
	TOTAL PERIODIC COSTS (Year 30)					**$ 138,225**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Inflation Rate 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0		**$ 1,778,976**	
2	**Annual O&M Cost**				
2.1	LTM/ICs - Years 5 to 30	5 to 30	71,180	$1,132,718	
	Sub-Total			**$ 1,132,718**	
3	**Periodic Costs**				
3.1	SVI Monitoring (5, 10, 15, 20, 25, and 30)	5 to 30	57,677	$234,583	
3.2	Site Closeout - Year 30	30	138,225	$121,604	
	Sub-Total			**$ 356,186**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 3,267,880**	