REMEDIAL INVESTIGATION REPORT

for

561 GREENWICH STREET

551 and 561 Greenwich Street
Block 598, Lots 42 and 48
New York, New York

Prepared For:

The Rector, Church-Wardens, and Vestrymen of Trinity Church, in the city of New-York
561 HH LLC
New Remainderman 561 Greenwich LLC
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LANGAN

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LIST OF ACRONYMS

Acronym	Definition
1,2,4-TMB	1,2,4-trimethylbenzene
1,3,5-TMB	1,3,5-trimethylbenzene
ACM	Asbestos Containing Material
AOC	Areas of Concern
ASP	Analytical Services Protocol
BCP	Brownfield Cleanup Program
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
bgs	Below Grade Surface
CAMP	Community Air Monitoring Program
CHASP	Construction Health and Safety Plan
CSM	Conceptual Site Model
CU	Commercial Use
CVOC	Chlorinated Volatile Organic Compound
DER	Division of Environmental Remediation
DO	Dissolved Oxygen
DUSR	Data Usability Summary Report
EIMS	Environmental Information Management System
el	Elevation
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
ESA	Environmental Site Assessment
eV	Electron volt
FWRIA	Fish and Wildlife Resources Impact Analysis
GPR	Ground Penetrating Radar
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
ICP	Inductively Coupled Plasma
IDW	Investigation Derived Waste
LBP	Lead Based Paint
mg/kg	Milligram per Kilogram
NTU	Nephelometric Turbidity Units
NYC	New York City
NYCRR	New York Codes, Rules, and Regulations
NYSDOH	New York State Department of Health

Acronym	Definition
NYSDEC	New York State Department of Environmental Conservation
ORP	Oxidation-Reduction Potential
PBS	Petroleum Bulk Storage
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Parts per Million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAWP	Remedial Action Work Plan
REC	Recognized Environmental Condition
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
RL	Reporting Limit
SCO	Soil Cleanup Objective
SGV	Standards and Guidance Value
SMMP	Soil/Materials Management Plan
SMP	Site Management Plan
TAL	Target Analyte List
TCL	Target Compound List
SVOC	Semivolatile Organic Compound
TOGS	Technical and Operational Guidance Series
µg/L	Microgram per Liter
$\mu g/m^3$	Microgram per Cubic Meter
UN/DOT	United Nations/Department of Transportation
UST	Underground Storage Tank
UU	Unrestricted Use

CERTIFICATION

I, Michael Burke, certify that I am currently a Qualified Environmental Professional as defined in Title 6 New York Codes, Rules and Regulations (NYCRR) Part 375 and that this Remedial Investigation Report was prepared in accordance with applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10).

Michael D. Burke

Michael Burke, P.G., CHMM

1.0 INTRODUCTION

This Remedial Investigation Report (RIR) was prepared on behalf of The Rector, Church-Wardens, and Vestrymen of Trinity Church, in the city of New-York, 561 HH LLC, and New Remainderman 561 Greenwich LLC (the Participants) for the property at 561 Greenwich Street in the Hudson Square neighborhood of Manhattan, New York (the site). The site was assigned an E-Designation (E-288) for hazardous materials (Hazmat), air quality, and noise by the New York City Department of City Planning (NYCDCP) following the March 20, 2013 Hudson Square Rezoning (City Environmental Quality Review [CEQR] No. 12DCP045M). The E-Designation requires environmental assessments of soil, groundwater, and soil vapor and coordination with the New York City Mayor's Office of Environmental Remediation (OER). Toward that end, Langan prepared and submitted a draft Remedial Investigation Report (RIR) to OER in August 2018. This RIR is being submitted in conjunction with the Participants' application for the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) to remediate the site.

The site is identified as Block 598, Lots 42 and 48 on the New York City (NYC) Manhattan Borough Tax Map and is improved with a one-story building built circa 1932 (Lot 42) and an open-air parking lot (Lot 48) surrounded by a chain-link fence. An application for Mergers or Apportionments was submitted to the NYC Department of Finance on November 30, 2018 to merge Lots 42 and 48 into a single lot.

This RIR presents environmental data and findings from an RI that was completed between 23 April and 2 May 2018. The objectives of the RI are listed below.

- Define the nature and extent of contamination in all media at the site
- Evaluate the potential for contamination in all media to emanate from the site
- Generate sufficient data to evaluate remedial action alternatives
- Generate sufficient data to evaluate actual and potential threats to human health and the environment

The remainder of this RIR is organized as follows:

- Section 2.0 describes the site setting and the physical characteristics of the site.
- Section 3.0 describes the site background including results of previous reports and identified areas of concern (AOC).
- Section 4.0 presents the RI field sampling procedures.
- Section 5.0 describes the RI field observations and analytical results.
- Section 6.0 presents an assessment of the exposure risks of site contaminants to human, fish, and wildlife receptors.
- Section 7.0 presents the nature and extent of contamination in all sampled media as determined through the field investigation and analysis of environmental samples.

- Section 8.0 summarizes the results of the investigation and presents conclusions based on field observations and analytical results.
- Section 9.0 presents the references used in preparation of this report.

2.0 SITE PHYSICAL CHARACTERISTICS

2.1 Site Description

The site is identified as Block 598, Lots 42 and 48 on the NYC Manhattan Borough Tax Map and is improved with a one-story building built circa 1932 (Lot 42) and an open-air parking lot (Lot 48) surrounded by a chain-link fence. The one-story building contains a partial cellar (about 130 square feet) in the northwestern portion of the lot. An application for Mergers or Apportionments was submitted to the NYC Department of Finance on November 30, 2018 to merge Lots 42 and 48 into a single lot, pending approval. A copy of the merger application is provided in Appendix A.

The 20,045-square-foot site is bound by King Street to the north, a 17-story commercial office building to the east, Charlton Street to the south, and Greenwich Street to the west. The site has about 100 feet of frontage along King Street and Charlton Street to the north and south, respectively, and about 200 feet of frontage along Greenwich Street to the west. A site location map is provided as Figure 1, and a site plan is provided as Figure 2.

2.1.1 Description of Surrounding Properties

The site is located in an urban setting characterized by multi-story residential, mixed-use, industrial, commercial, and institutional buildings. Because of the urban nature of the area, major infrastructure (e.g., storm drains, sewers, and underground utility lines) exist in the vicinity of the site. The following table includes a summary of surrounding properties and uses:

<table>
<tr><th rowspan="2">Direction</th><th colspan="3">Adjoining Properties</th><th>Surrounding Properties</th></tr>
<tr><th>Block No.</th><th>Lot No.</th><th>Description</th><th></th></tr>
<tr><td>North</td><td>599</td><td>64</td><td>18-story commercial office building</td><td rowspan="5">Multi-story residential, mixed-use, industrial, commercial, and institutional buildings</td></tr>
<tr><td>East</td><td>598</td><td>58</td><td>17-story commercial office building</td></tr>
<tr><td rowspan="2">South</td><td rowspan="2">597</td><td>45</td><td>6-story residential building</td></tr>
<tr><td>39 (former lot 46)</td><td>Active construction site for a multi-story residential building</td></tr>
<tr><td>West</td><td>596</td><td>92</td><td>3-story warehouse building</td></tr>
</table>

The nearest ecological receptor is the Hudson River, which is located about 800 feet west of the site. Sensitive receptors, as defined in the DER Technical Guidance for Site Investigation and Remediation (DER-10), located within a half mile of the site are listed in the following table:

Number	Name (Approximate Distance from Site)	Address
1	East Village ICF (about 200 feet east)	345 Hudson Street New York, NY 10014
2	City As School (about 700 feet northeast)	16 Clarkson Street New York, NY 10014
3	Parks After School at Tony Dapolito (about 950 feet north)	1 Clarkson Street New York, NY 10014
4	LREI High School (about 1,000 feet southeast)	40 Charlton Street New York, NY 10014
5	Village Nursing Home (about 1,130 feet northeast)	214 West Houston Street New York, NY 10014
6	The Downing Street Playgroup, Inc. (about 1,700 feet northeast)	32 Carmine Street New York, NY 10014
7	PS3 The John Melser Charrette School (about 1,800 feet north)	490 Hudson Street New York, NY 10014
8	Montessori Schools (about 1,800 feet southeast)	75 Sullivan Street New York, NY 10012
9	Cooke Center Academy (about 1,850 feet east)	60 Macdougal Street New York, NY 10012
10	LREI Lower and Middle School (about 1,850 feet east)	272 Sixth Avenue New York, NY 10014
11	Our Lady of Pompeii School (about 1,850 feet northeast)	240 Bleecker Street New York, NY 10014
12	St Luke's School (about 1,900 feet north)	487 Hudson Street New York, NY 10014
13	Broome Academy Charter High School (about 2,100 feet southeast)	121 Sixth Avenue New York, NY 10013
14	Chelsea High School (about 2,100 feet southeast)	131 Sixth Avenue New York, NY 10013
15	Village Community School (about 2,100 feet north)	272 West 10th Street New York, NY 10014
16	Senior Home Service (about 2,285 feet southeast)	115 Wooster Street New York, NY 10012
17	Village Center-Care Home Health (about 2,500 feet north)	112 Charles Street New York, NY 10014
18	Bright Horizons Childrens Center, Inc. (about 2,500 feet south)	129 Hudson Street New York, NY 10013
19	TriBeCa Community School (about 2,600 feet south)	22 Ericsson Place New York, NY 10013
20	University Plaza Nursery School (about 2,600 feet east)	110 Bleecker Street New York, NY 10012

Surrounding land use and sensitive receptors within 1,000 feet of the site are shown on Figure 3.

2.1.2 Topography

According to the May 24, 2018 American Land Title Association (ALTA)/National Society of Professional Surveyors (NSPS) Land Title Survey, prepared by Langan, the site elevation (el) ranges from el 10.77 in the southern portion of the site to el 13.88 in the northeastern portion of the site. Elevations presented in the survey are measured in feet and referenced to the North American Vertical Datum of 1988 (NAVD88). The surrounding area slopes down toward the Hudson River, which is about 800 feet west of the site.

2.2 Geology and Hydrogeology

2.2.1 Regional Geology

A review of the historical "Sanitary & Topographical Map of the City and Island of New York" (Viele, 1865) shows the site was on a meadow within the original shoreline of Manhattan. The USGS "Bedrock and Engineering Geologic Maps of New York County and Parts of Kings and Queens Counties, New York, and parts of Bergen and Hudson counties, New Jersey" (Baskerville 1994) indicate that bedrock underlying the site consists of Manhattan Schist. More specifically this formation is described as gray sillimanite-muscovite-tourmaline schist.

2.2.2 Regional Hydrogeology

Groundwater flow is typically topographically influenced, as shallow groundwater tends to originate in areas of topographic highs and flows toward areas of topographic lows, such as rivers, stream valleys, ponds, and wetlands. A broader, interconnected hydrogeologic network often governs groundwater flow at depth or in the bedrock aquifer. Groundwater depth and flow direction are also subject to hydrogeologic and anthropogenic variables such as precipitation, evaporation, extent of vegetation cover, and coverage by impervious surfaces. Other factors influencing groundwater include depth to bedrock, the presence of anthropogenic fill, and variability in local geology and groundwater sources or sinks. Regional groundwater is inferred to flow west toward the Hudson River, following the influence of local topography.

2.2.3 Wetlands

Wetlands on the site were evaluated by reviewing the National Wetlands Inventory and NYSDEC regulated wetlands map. There are no wetlands located on the site.

3.0 SITE BACKGROUND

This section describes historical site use, the proposed redevelopment, and the findings from previous environmental investigations. Based on a review of the previous reports, AOCs were identified and are also summarized in Section 3.4.

3.1 Historical Site Use

According to the January 2009 Phase I Environmental Site Assessment (ESA) Report prepared by AKRF, Inc. (AKRF), historical site use included various commercial, manufacturing and industrial buildings from as early as 1894. Multi-story buildings occupied the north portion of the site from the 1890s until 1968, when they were demolished, and the site was occupied by an open-air parking lot (Lot 42). A one-story parking garage was constructed circa 1932 (Lot 48). Historical uses of the site include a preserves factory, a packing canned goods company, confectioners' supplies, and an express depot. Two 550-gallon gasoline underground storage tanks (UST) were located beneath the parking garage, as indicated on the 1951, 1968, 1980 and 1994 Sanborn Fire Insurance Maps. UST documentation was not available in the NYSDEC Petroleum Bulk Storage (PBS) database. The surrounding area was developed prior to 1894 and included a paper box factory, coal yard, and an iron storage space across King Street to the north. A map displaying historical site and surrounding property usage is shown on Figure 4.

3.2 Proposed Redevelopment Plan

The proposed development project is in the early planning stages, but currently is anticipated to include a 10-story commercial office building spanning both tax lots (about 20,045-square-feet), with ground-floor retail and one or two full cellar levels at about 15 or 30 feet bgs, respectively. Cellar uses have not been determined but are expected to include utility and mechanical rooms, storage rooms, and offices. Proposed redevelopment plans are included in Appendix B.

3.3 Previous Environmental Reports and Investigations

A previous environmental report is summarized below, and is included in Appendix C:

<u>January 2009 Phase I Environmental Site Assessment (ESA) prepared by AKRF, Inc.</u>

The Phase I ESA identified the following recognized environmental conditions (REC):

- The site was historically used for industrial and commercial uses, including a preserves factory, packing canned goods company, confectioner supplies, and express depot. According to Sanborn Fire Insurance Maps, the current structure was built between 1922 and 1951.
- A potential fill port was observed along the Greenwich Street sidewalk. Additionally, two 550-gallon gasoline USTs were located beneath the parking garage, as indicated on

the 1951, 1980, and 1994 Sanborn Fire Insurance Maps. UST documentation was not available in the NYSDEC PBS database.

- The existing building on Lot 42 was constructed prior to 1978 and may contain polychlorinated biphenyl (PCB)-containing and/or mercury-containing lighting fixtures, asbestos-containing materials (ACM), and/or lead based paint (LBP). Hydraulic lifts used for car storage in the active parking lot in the northern portion of the site may have used PCB-containing hydraulic fluids.
- Historical uses of the surrounding properties include residential, commercial, industrial, and automotive uses. Over 200 spills were reported within a ½-mile radius of the site. The off-site release of petroleum, chemicals, and/or hazardous substances may have adversely impacted groundwater and/or soil vapor on the site.

3.4 Potential Areas of Concern

Potential AOCs investigated during the RI include the following. An AOC map is provided as Figure 5:

AOC-1: Historic Fill

Following demolition of on-site buildings, the site was backfilled with fill of unknown origin. Historic fill in Manhattan typically contains contaminants, particularly metals and semivolatile organic compounds (SVOC), at concentrations exceeding applicable state and/or federal standards.

AOC-2: On-Site Petroleum Bulk Storage

The site contained two gasoline USTs from approximately 1951 to 1994. During the 2009 Phase I ESA site visit, a potential fill port was observed in the Greenwich Street sidewalk adjacent to the site.

AOC-3: Historic Site Use

Historical manufacturing/industrial site use included a preserves factory (1894-1905), packing canned fruits, jellies, and company (1905-1922), express depot (1951-1968), garage (1951-present), and a parking lot (1968-present).

4.0 REMEDIAL INVESTIGATION

The RI was implemented by Langan between 23 April and 2 May 2018 to investigate and characterize the nature and extent of the contamination at the site. The RI included the following and was conducted in accordance with the OER-approved 6 June 2017 Remedial Investigation Work Plan (RIWP), prepared by Langan, 6 NYCRR NYSDEC Part 375, the NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation (May 2010), the NYSDEC Draft Brownfield Cleanup Program Guide (May 2004), and the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006) (hereinafter referred to as NYSDOH Guidance):

<u>Geophysical Survey</u>

- Geophysical survey conducted to identify anomalies indicative of USTs and associated piping and clear boring locations from physical and/or subsurface utilities and structures.

<u>Soil Borings and Sampling</u>

- Completed 10 soil borings
- Field screened soil borings for environmental impacts using visual and olfactory methods and with a photoionization detector (PID) equipped with a 10.6 eV bulb
- Collected up to three soil samples per boring (total of 25 soil samples, including duplicate) for laboratory analysis

<u>Monitoring Well Installation and Sampling</u>

- Installed four permanent monitoring wells at select soil boring locations
- Collected one groundwater sample from each monitoring well (total of 5 groundwater samples, including duplicate) for laboratory analysis
- Surveyed and gauged monitoring wells to evaluate groundwater elevations and flow direction

<u>Soil Vapor and Ambient Air Sampling</u>

- Installed seven soil vapor points
- Collected one vapor sample from each vapor point (total of 7 soil vapor samples) for laboratory analysis
- Collected one outdoor ambient air sample for laboratory analysis

Sample locations from the RI are shown on Figure 6 and summarized in Table 1. A soil boring, monitoring well and soil vapor point construction summary is provided as Table 2.

4.1 Geophysical Survey and Utility Location

On April 20, 2018, prior to intrusive field activities, Nova Geophysical Engineering (Nova) conducted a geophysical survey using ground-penetrating radar (GPR) and electromagnetic detection equipment to document potential subsurface utilities, USTs, and subsurface anomalies at proposed investigation locations. Boring locations were screened for obstructions and utilities prior to drilling activities. Access for the geophysical survey was limited by hydraulic parking lifts along the perimeter of both tax lots. A copy of the geophysical survey report presenting these findings is included in Appendix D.

4.2 Soil Investigation

Ten soil borings (designated EB-01 through EB-10) were installed by AARCO Environmental Services Corp. (AARCO) between 23 April and 2 May 2018 to investigate AOCs. Boring locations are shown on Figure 6. Soil borings without monitoring wells were advanced to at least 16 feet bgs. Soil borings with collocated monitoring wells were advanced to 20 to 28 feet bgs. Boring termination depths and rationale are summarized as follows:

Soil Boring ID	Termination Depth (feet bgs)	Termination Depth Rationale
EB-02	28	Converted to monitoring well
EB-03 and EB-06	24	Converted to monitoring well
EB-05	24	Delineate petroleum impacts
EB-01 and EB-04	20	Development depth
EB-07, EB-08, EB-09, EB-10	16	Development depth

4.2.1 Investigation Methodology

Soil borings were advanced continuously using a Geoprobe 7822DT direct-push drill rig from the surface to the boring termination depth. The direct-push drill rig was equipped with either an open-point or closed-point MacroCore^{TM} sampler with 4-foot-long acetate liners. A Langan field engineer or scientist documented the work, screened soil borings for environmental impacts, and collected soil samples for laboratory analyses. Soil was screened continuously to the boring termination depth for organic vapors with a PID equipped with a 10.6 electron volt (eV) lamp and for visual and olfactory evidence of environmental impacts (e.g., staining and odor). Soil was visually classified for color, grain size, texture, and moisture content, and was recorded in a field log. Soil boring logs documenting these observations are included in Appendix E.

Following sample collection, borings were backfilled with sand and soil cuttings that did not exhibit evidence of impacts or converted to groundwater monitoring wells. Excess soil was containerized in labeled United Nations/Department of Transportation (UN/DOT)-approved 55-gallon steel drums with sealed lids in preparation for off-site disposal.

Work complied with the safety guidelines outlined in Langan's April 2018 Health and Safety Plan (HASP).

4.2.2 Sampling Methodology and Rationale

Twenty-five soil samples, including one duplicate sample, were collected and submitted for laboratory analysis during the RI. Two discrete (grab) soil samples were collected from borings EB-01 through EB-09: one sample was collected from the shallow subsurface (0 to 4 feet bgs), and a second sample was collected from the groundwater interface. Boring EB-10 was added to investigate the area east of the suspected gasoline USTs, and one sample was collected at the groundwater interface. To vertically delineate petroleum impacts, additional samples were collected at the termination depths of borings EB-02 (26 to 28 feet bgs), EB-03 (23 to 24 feet bgs), EB-05 (22 to 24 feet bgs), and EB-06 (22 to 24 feet bgs).

Soil samples were collected in laboratory-supplied containers and were sealed, labeled, placed in an ice-chilled cooler (to maintain a temperature of about 4ºC), and transported via courier service to Alpha Analytical, Inc. (Alpha) for analytical analysis. Alpha is an NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory located in Westborough, Massachusetts (ELAP No. 11148). Samples submitted for VOC analysis were collected directly from the acetate liner by Terra Core® samplers. Soil samples were analyzed using the latest United States Environmental Protection Agency (EPA) methods as follows for NYSDEC Part 375 list and EPA Target Compound List (TCL)/Target Analyte List (TAL):

- VOCs by EPA Method 8260C
- SVOCs by EPA Method 8270D
- PCBs by EPA Method 8082A
- Metals by EPA Method 6010C/7470A
- Pesticides by EPA Method 8081B

A sample summary is provided in Table 1.

4.3 Groundwater Investigation

Four groundwater monitoring wells were installed by AARCO between 23 and 25 April 2018. Monitoring well locations are shown on Figure 6.

4.3.1 Monitoring Well Installation and Development Methodology

Soil borings EB-02, EB-03, EB-04, and EB-06 were converted to permanent groundwater monitoring wells. The monitoring wells were constructed with 2-inch diameter pre-pack well screens, which consist of an outer layer of stainless steel mesh screen and silica over 0.01-inch slotted schedule-40 polyvinyl chloride (PVC) screens. Monitoring wells were installed with 10-foot screens straddling the groundwater interface and schedule-40 PVC risers to the surface. The annulus of the borehole was backfilled to about 2 feet above the screened interval using

FilPro No. 2 filter sand, followed by a one foot hydrated bentonite seal, and No. 2 sand to surface grade. The wells were finished with an expanding well plug and flush-mount steel manhole cover. After installation, the wells were developed using a submersible pump to remove sediments and prevent the well screen from being blocked with fines. A minimum of three well volumes were purged using a submersible pump. Monitoring well construction and development logs are included in Appendix F.

A synoptic groundwater gauging event was conducted on 2 May 2018 and a monitoring well survey was conducted on 25 May 2018. A groundwater elevation summary, based off of monitoring well survey data, is included in Table 3.

4.3.2 Groundwater Sampling

Groundwater monitoring wells were sampled at least one week after development. Before sampling, the headspace of each monitoring well was screened with a PID. Monitoring wells were sampled in general accordance with the EPA's low-flow groundwater sampling procedure to allow for collection of a representative sample ("Low Stress [low flow] Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells", EQASOP-GW 001, January 19, 2010). Prior to sample collection, groundwater was purged from each well until groundwater parameters (pH, conductivity, turbidity, dissolved oxygen [DO], temperature, and oxidation-reduction potential [ORP]) stabilized. The turbidity did not reach the target of <5 Nephelometric Turbidity Units (NTU) during sampling of the monitoring wells. Monitoring wells were purged and groundwater samples were collected using a peristaltic pump connected to high-density polyethylene (HDPE) tubing. Groundwater sampling logs are included in Appendix G. Purged groundwater was containerized in labeled 55-gallon steel drums in preparation for off-site disposal.

A total of five groundwater samples, including one field duplicate sample, were collected for laboratory analysis. The samples were collected in laboratory-supplied containers and were sealed, labeled, placed in an ice-chilled cooler (to maintain a temperature of about 4ºC), and transported via courier service to Alpha for analytical analysis. Samples submitted for dissolved metal analysis were filtered in the field using a 0.45-micron filter. Groundwater samples were analyzed using the latest EPA methods as follows for NYSDEC Part 375 list and EPA TCL/TAL:

- VOCs by EPA Method 8260C
- SVOCs by EPA Method 8270D
- PCBs by EPA Method 8082A
- Dissolved metals by EPA Method 6010C/7470A/7196A
- Pesticides by EPA Method 8081B

A sample collection summary is provided in Table 1.

4.4 Soil Vapor and Outdoor Ambient Air Investigation

Seven soil vapor and one outdoor ambient air sample were collected from 25 April to 2 May 2018. Soil vapor and outdoor ambient air sampling locations are shown on Figure 6.

4.4.1 Soil Vapor Point Installation and Methodology

Seven soil vapor points, SV01 through SV07, were installed to a depth of about 12 feet bgs using a Geoprobe 7822DT drill rig. Due to water intrusion into vapor sampling tubes, SV01, SV03, and SV05 were removed and re-installed to a depth of 6 feet bgs. The soil vapor investigation was conducted in general accordance with the 2006 New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York. Each soil vapor sample location included a 2-inch-long, polyethylene vapor implant installed at the base of the borehole. The implants were fitted with polyethylene tubing extending to the surface. A sand filter pack was installed around the implant to a depth of about 1 to 2 feet bgs. The remainder of the annulus was filled to grade surface with a hydrated bentonite seal to prevent ambient air infiltration.

4.4.2 Soil Vapor and Outdoor Ambient Air Sampling

Before collecting vapor samples, a minimum of three implant volumes (i.e., the volume of the sample probe and tubing) were purged from each sample port at a rate of 0.2 liters per minute using a RAE Systems MultiRAE® Plus meter. The purged soil vapor was monitored for VOCs with the MultiRAE® Plus meter during purging.

A helium tracer gas was used in accordance with the NYSDOH protocols to serve as a quality assurance/quality control (QA/QC) technique to document the integrity of each sampling point seal before and after sampling. The tracer gas was introduced into an overturned container, sealed at the ground surface with bentonite, which acted as a shroud for the vapor point and seal. Helium was measured from the sampling tube and inside the container with a MGD-2002 Helium Leak detector. If the sample tubing contained more than 10% of the tracer gas concentration that was introduced into the container, then the seal was considered compromised and was enhanced or reconstructed to reduce non-sub-surface air infiltration.

After confirming the seal integrity, soil vapor samples were collected into laboratory-supplied, batch-certified clean, 2.7-liter (AA-01, SV-01, and SV-04) or 6-liter (SV-02, SV-03, SV-05, SV-06, and SV-07) Summa® canisters with flow controllers calibrated for a 2-hour sample interval. One outdoor ambient air sample was collected on 25 April 2018.

The samples were collected, labeled, and transported via courier service to Alpha for analytical analysis. The samples were analyzed for VOCs by EPA Method TO-15. A sample summary table is included in Table 1. Soil vapor point construction and sampling logs are provided in Appendix H.

4.5 Quality Assurance and Quality Control Sampling

During the course of the investigation, QA/QC samples were collected for laboratory analysis. One QA/QC sample set, containing one field duplicate, one field blank, and one trip blank, was collected for the soil and groundwater matrices. One outdoor ambient air sample was collected during soil vapor sampling. Collected QA/QC samples are detailed below and in Table 1.

<u>Soil samples</u>

- One field duplicate sample
- One field blank sample
- One trip blank sample

<u>Groundwater samples</u>

- One field duplicate sample
- One field blank sample
- One trip blank sample

<u>Soil Vapor Samples</u>

- One outdoor ambient air sample

Field duplicates were collected to assess the precision of the analytical methods relative to the sample matrix. Duplicates were collected from the same material as the primary sample by splitting the volume of homogenized sample collected in the field into two sample containers.

Field blanks were collected to determine the cleanliness of unused tubing, neoprene gloves and acetate liners used to collect groundwater and/or soil samples. Field blank samples consisted of deionized, distilled water provided by the laboratory that has passed through the sampling apparatus. Field blank samples were analyzed for the same list of analytes as the corresponding sampling event and sample matrix.

Trip blank samples were collected to assess the potential for contamination of the sample containers and samples during the trip from the laboratory, to the field, and back to the laboratory for analysis. Trip blanks contained about 40 milliliters of acidic water (doped with hydrochloric acid) that were sealed by the laboratory when the empty sample containers were shipped to the field, and unsealed and analyzed by the laboratory when the sample shipment was received from the field. The trip blank samples were analyzed for VOCs.

The outdoor ambient air sample was collected to assess ambient air conditions and determine whether ambient air conditions during soil vapor sampling could have potentially interfered with sampling results. The ambient air sample was analyzed for the same parameter list as the soil vapor samples.

4.6 Data Validation

Laboratory analyses of soil, groundwater, and soil vapor samples were conducted by a NYSDOH ELAP-certified laboratory in accordance with EPA SW-846 methods and analytical data was reported consistent with the NYSDEC Analytical Services Protocol (ASP) Category B deliverable format. Environmental data was reported electronically using the database software application Environmental Quality Information Systems (EQuIS) as part of NYSDEC's Environmental Information Management System (EIMS).

QA/QC procedures required by the NYSDEC ASP and SW-846 methods, including initial and continuing instrument calibrations, surrogate compound spikes, and analysis of other samples (blanks and laboratory control samples) were followed.

The laboratory provided sample bottles, which were pre-cleaned and preserved in accordance with the SW-846 methods. Where there were differences in the SW-846 and NYSDEC ASP requirements, the NYSDEC ASP took precedence.

Data validation was performed in accordance with the EPA validation guidelines for organic and inorganic data review. Validation included the following:

- Verification of QC sample results (both qualitative and quantitative)
- Verification of sample results (both positive hits and non-detects)
- Recalculation of 10 percent of all investigative sample results
- Preparation of Data Usability Summary Reports (DUSR)

Laboratory analytical results from the April and May 2018 RI were reported in NYSDEC ASP Category B deliverable format and validated by Ms. Emily Strake of Langan, a qualified data validator.

4.6.1 Data Usability Summary Reports

A DUSR was prepared for each sampling matrix. The DUSRs present the results of the data validation, including a summary assessment of laboratory data packages, sample preservation and chain of custody procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method. For the soil and groundwater samples, the following items were assessed:

- Holding times
- Sample preservation
- Sample extraction and digestion
- Laboratory blanks
- Laboratory control samples
- System monitoring compounds
- MS/MSD recoveries
- Initial and continuing calibrations

- Target compound identification and quantification
- Instrument tune
- Internal standard area counts
- Dual column imprecision
- Contract-required detection limit standards
- Inductively Coupled Plasma (ICP) serial dilutions
- Field duplicate, trip blanks, and field blanks sample results
- Overall method performance

For the air samples, the following items were assessed:

- Holding times
- Clean canister certification
- Initial and final canister pressurization
- Laboratory blanks
- Laboratory control samples
- System monitoring compounds
- Initial and continuing calibrations
- Internal standard area counts
- Target compound identification and quantification

Based on the results of data validation, the following qualifiers were assigned to the data in accordance with EPA's guidelines and best professional judgment:

- "U" – The analyte was analyzed for, but was not detected at a level greater than or equal to the reporting limit (RL), or the sample concentration results were impacted by blank contamination.
- "UJ" – The analyte was not detected at a level greater than or equal to the RL; however, the reported RL is approximate and may be inaccurate or imprecise.
- "J" – The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- "R" – The sample results are not useable due to quality of the data generated because certain criteria were not met. The analyte may or may not be present in the sample.
- "NJ" – The analysis indicates the presence of an analyte that has been "tentatively identified", and the associated numerical value represents its approximate concentration.

- No Flag – The results are accepted without qualification

4.7 Field Equipment Decontamination

Handheld sampling equipment including the groundwater interface probe was decontaminated by hand using an Alconox®-based solution and triple rinsed with distilled water. Direct contact of sampling equipment with the ground was avoided. Decontamination liquid was temporarily containerized in 5-gallon buckets and then it was drummed pending off-site disposal.

4.8 Investigation-Derived Waste Management

Investigation-derived waste (IDW) generated during the RI was properly handled and containerized. Soil cuttings from boring advancement, groundwater from monitoring well development and purging, and decontamination water were placed into UN/DOT-approved 55-gallon steel drums with sealed tops. The drums were staged in a secured area on site pending transport by a licensed waste hauler for disposal at an approved facility.

5.0 FIELD OBSERVATIONS AND ANALYTICAL RESULTS

This section summarizes the field observations and laboratory analytical results from the RI conducted between 23 April and 2 May 2018. Soil sample analytical results are compared to the NYSDEC Title 6 of the NYCRR Part 375 Unrestricted Use (UU) and Commercial Use (CU) Soil Cleanup Objectives (SCO). Groundwater sample analytical results are compared to the NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values (SGV) for Class GA Water. Soil vapor sample results are compared to outdoor ambient air samples and were evaluated using the NYSDOH Decision Matrices. The nature and extent of contamination are discussed separately in Section 7.0.

A complete list of the samples (soil, groundwater, soil vapor, ambient air, QA/QC) collected during the RI is provided in Table 1. A photographic log of the RI is included as Appendix I.

5.1 Geophysical Investigation Findings

The geophysical survey identified electrical, water, sewer and gas utilities entering the site from Greenwich Street. An about 450-square-foot anomaly indicative of a UST, an associated fill port, and vent pipes were identified in the western portion of Lot 42 adjacent to the Greenwich Street sidewalk. Evidence of former gasoline dispenser islands was observed to the north and south of the anomaly. A second vent pipe was identified in the southwestern portion of Lot 48 and is demarcated as a potential UST in the geophysical survey report. Due to the presence of hydraulic lifts associated with parking, access necessary to survey near the vent pipe was limited. The results of the geophysical survey report are provided in Appendix D.

5.2 Site Geology and Hydrogeology

A description of the geologic and hydrogeologic observations made during the RI is provided in this section. Soil boring logs from the RI are provided in Appendix E.

<u>5.2.1 Historic Fill</u>

Historic fill was observed immediately below the existing surface to depths ranging from about 7.5 to 13 feet bgs. The fill layer was shallowest in the southern portion of the site and deepest in the northern portion of the site. Fill material generally consisted of light to dark brown and grey, medium sand with trace fine sand, fine gravel, silt, and varying amounts of coal, brick and concrete fragments. Slag and/or fly ash were observed within the fill layer in borings EB-04, EB-06, and EB-08 located in the northwestern portion of the site.

<u>5.2.2 Native Soil Layers</u>

A native sand layer consisting of brown fine sand with trace medium sand, clay and silt was observed below the fill layer throughout the site. Peat and organic clay layers were observed in the eastern and southeastern portions of the site in borings EB-01 (11.5 to 12 feet bgs) and EB-03 (13.5 to 14.5 feet bgs).

5.2.3 Bedrock

Bedrock was not encountered during the RI. However, during Langan's May 2018 geotechnical investigation, bedrock was encountered between about 105 and 118 feet bgs, corresponding to el -93 to -106, respectively.

5.2.4 Hydrogeology

Groundwater flow is typically topographically influenced, as shallow groundwater tends to originate in areas of topographic highs and flows toward areas of topographic lows, such as rivers, stream valleys, ponds and wetlands. A broader, interconnected hydrogeologic network often governs groundwater flow at depth or in the bedrock aquifer. Groundwater depth and flow direction are also subject to hydrogeologic and anthropogenic variables such as precipitation, evaporation, extent of vegetative cover, subsurface structures (e.g., subways), and coverage by impervious surfaces. Other factors influencing groundwater include depth to bedrock, the presence of historical fill and variability in local geology and groundwater sources or sinks.

During groundwater sampling on May 2, 2018, groundwater depth ranged from about 14.97 to 17.36 feet bgs, corresponding to el -4.4 to -4.88. Regional groundwater is inferred to flow west toward the Hudson River, following the influence of local topography. Based on groundwater measurements collected during the RI, local groundwater flows to the northwest. Groundwater elevations measured during sampling and gauging events are recorded in Table 3, and a groundwater elevation contour map is included in Figure 7.

5.3 Soil Findings

5.3.1 Field Observations

Chemical and/or petroleum impacts, evidenced by odors, staining and/or elevated PID readings above background levels were observed at 5 of 10 soil boring locations. The following table presents the observed fill interval, depth of impacted interval, the highest recorded PID readings (with depth), and the associated field observations at the five locations where petroleum-like impacts were observed:

Soil Boring ID	Observed Fill Interval (feet bgs)	Impacted Interval (feet bgs)	Max PID Reading and Depth (parts per million)	Field Observations
EB-02	0 – 10	9 – 26	3,600 ppm (16.5 feet bgs)	Staining and petroleum-like odor
EB-03	0 – 11	15 – 17	21.3 ppm (16.5 feet bgs)	Petroleum-like odor
EB-05	0 – 10	9.5 – 22	590 ppm (11 feet bgs)	Staining and petroleum-like odor
EB-06	0 – 8	11 – 22	1,550 ppm (14.5 feet bgs)	Petroleum-like odor
EB-10	0 – 7.5	6.5 – 16	3,500 ppm (12 feet bgs)	Petroleum-like odor

The depth of impacts was delineated vertically at the boring locations by field observations and/or analytical results. Subsurface profiles of select borings, including those referenced in the above table, are shown in Figure 8.

5.3.2 Analytical Results

Soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Soil sample analytical results are provided in Table 4 with comparisons to the NYSDEC Part 375 UU and CU SCOs. Soil sample results that exceed the UU or CU SCOs for soil samples are shown in Figure 9. The following contaminants were detected at concentrations exceeding UU and/or CU SCOs (concentrations exceeding CU SCOs are **bolded** below):

VOCs

Concentrations of nine VOCs exceeded the UU SCOs and CU SCOs in one or more samples. The list below provides concentration ranges of the VOCs detected at concentrations above their respective SCOs (applicable SCOs for each compound shown in parentheses):

- 1,2,4-trimethylbenzene (1,2,4-TMB): 49 milligrams per kilogram (mg/kg) in EB-06_13-15 to **290** mg/kg in EB-02_14-16 (UU SCO of 3.6 mg/kg; CU SCO of 190 mg/kg)
- 1,3,5-trimethylbenzene (1,3,5-TMB): 17 mg/kg in EB-06_13-15 to 100 mg/kg in EB-02_14-16 (UU SCO of 8.4 mg/kg; CU SCO of 190 mg/kg)
- acetone: 0.072 mg/kg in EB-07_1-2 (UU SCO of 0.05 mg/kg; CU SCO of 500 mg/kg)
- benzene: 0.68 mg/kg in EB-05_13-15 to **49** mg/kg in EB-02_14-16 (UU SCO of 0.06 mg/kg; CU SCO of 44 mg/kg)
- ethylbenzene: 15 mg/kg in EB-06_13-15 to 95 mg/kg in EB-02_14-16 (UU SCO of 1 mg/kg; CU SCO of 390 mg/kg)
- naphthalene: 16 mg/kg in the duplicate sample collected from EB-06_13-15 to 66 mg/kg in EB-02_14-16 (UU SCO of 12 mg/kg; CU SCO of 500 mg/kg)

- n-propylbenzene: 5.6 mg/kg in EB-06_13-15 to 33 mg/kg in EB-02_14-16 (UU SCO of 3.9 mg/kg; CU SCO of 500 mg/kg)
- toluene: 19 mg/kg in EB-06_13-15 to 220 mg/kg in EB-02_14-16 (UU SCO of 0.7 mg/kg; CU SCO of 500 mg/kg)
- total xylenes: 0.37 mg/kg in EB-05_13-15 to **700** mg/kg in EB-02_14-16 (UU SCO of 0.26 mg/kg; CU SCO of 500 mg/kg)

Acetone, detected in one soil sample at a concentration above the UU SCO, is a common laboratory contaminant. The detection of acetone in soil samples is not necessarily representative of soil quality at the site.

SVOCs

Concentrations of ten SVOCs exceeded the UU or CU SCOs in one or more samples. The list below provides concentration ranges of the SVOCs detected at concentrations above their respective SCOs (applicable SCOs for each compound shown in parentheses):

- 3-methylphenol/4-methylphenol: 0.52 mg/kg in EB-09_3-4 (UU SCO of 0.33 mg/kg; CU SCO of 500 mg/kg)
- benzo(a)anthracene: 2.3 mg/kg in EB-04_0-1 to **35** mg/kg in EB-09_3-4 (UU SCO of 1 mg/kg; CU SCO of 5.6 mg/kg)
- benzo(a)pyrene: **2** mg/kg in EB-04_0-1 to **32** mg/kg in EB-09_3-4 (UU SCO of 1 mg/kg; CU SCO of 1 mg/kg)
- benzo(b)fluoranthene: 2.4 mg/kg in EB-04_0-1 to **38** mg/kg in EB-09_3-4 (UU SCO of 1 mg/kg; CU SCO of 5.6 mg/kg)
- benzo(k)fluoranthene: 0.84 mg/kg in EB-04_0-1 to 11 mg/kg in EB-09_3-4 (UU SCO of 0.8 mg/kg; CU SCO of 56 mg/kg)
- chrysene: 2 mg/kg in EB-04_0-1 to 28 mg/kg in EB-09_3-4 (UU SCO of 1 mg/kg; CU SCO of 56 mg/kg)
- dibenz(a,h)anthracene: 0.53 mg/kg in EB-01_0-2 and **4.2** mg/kg in EB-09_3-4 (UU SCO of 0.33 mg/kg; CU SCO of 0.56 mg/kg)
- dibenzofuran: 7.8 mg/kg in EB-09_3-4 (UU SCO 7 mg/kg; CU SCO 350 mg/kg)
- indeno(1,2,3-cd)pyrene: 1.4 mg/kg in EB-04_0-1 to **19** mg/kg in EB-09_3-4 (UU SCO of 0.5 mg/kg; CU SCO of 5.6 mg/kg)
- naphthalene: 15 mg/kg in EB-02_14-16 (UU SCO of 12 mg/kg; CU SCO of 500 mg/kg)

Pesticides

Concentrations of two pesticides exceeded the UU SCOs in one or more samples. The list below provides concentration ranges of the pesticides detected at concentrations above their respective SCOs (applicable SCOs for each compound shown in parentheses):

- 4,4'-DDE: 0.00898 mg/kg in EB-09_3-4 (UU SCO of 0.0033 mg/kg)
- 4,4'-DDT: 0.00448 mg/kg in EB-07_1-2 to 0.0154 mg/kg in EB-09_3-4 (UU SCO of 0.0033 mg/kg)

Pesticides were detected in soil samples at concentrations below their respective CU SCOs.

PCBs

PCBs were not detected at concentrations above the UU or CU SCOs.

Metals

Concentrations of five metals exceeded the UU and/or CU SCOs in one or more samples. The list below provides concentration ranges of the metals detected at concentrations above their respective SCOs (applicable SCOs for each compound shown in parentheses):

- barium: **450** mg/kg in EB-01_0-2 to **1,040** mg/kg in EB-08_0-2 (UU SCO 350 mg/kg; CU SCO of 400 mg/kg)
- lead: 200 mg/kg in EB-03_1-2 to **4,680** mg/kg in EB-08_0-2 (UU SCO of 63 mg/kg; CU SCO of 1,000 mg/kg)
- mercury: 0.344 in EB-01_0-2 to 1.39 mg/kg in EB-08_0-2 (UU SCO of 0.18 mg/kg; CU SCO of 2.8 mg/kg)
- nickel: 57.7 mg/kg in EB-07_1-2 (UU SCO of 30 mg/kg; CU SCO of 310 mg/kg)
- zinc: 118 mg/kg in EB-06_0-2 to 672 mg/kg in EB-08_0-2 (UU SCO of 109 mg/kg; CU SCO of 10,000 mg/kg)

5.4 Groundwater Findings

5.4.1 Field Observations

Monitoring wells were gauged for free product with an oil-water interface probe. Free product was not detected in any of the monitoring wells. Prior to sampling, well headspaces were screened with a PID, and readings ranged from 2.1 ppm to 250 ppm (highest readings in MW02 and MW06). Monitoring wells MW02 and MW06 exhibited petroleum-like odor during purging and sampling. Monitoring well constructions logs are included in Appendix F. Groundwater sampling logs are included in Appendix G.

5.4.2 Analytical Data

Groundwater samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and dissolved metals. Groundwater sample analytical results are provided in Table 5 with comparisons to Class GA SGVs. Groundwater sample results that exceed Class GA SGVs for groundwater samples are shown in Figure 10. The following contaminants were detected at concentrations exceeding Class GA SGVs:

VOCs

Detected concentrations of VOCs exceeded Class GA SGVs in groundwater samples collected from monitoring wells MW02 and MW06. The list below provides concentration ranges of the VOCs detected at concentrations above their respective Class GA SGVs (applicable Class GA SGVs for each compound shown in parentheses).

- 1,2,4,5-tetramethylbenzene: 54 micrograms per liter (µg/L) in MW06 (5 µg/L)
- 1,2,4-TMB: 740 µg/L in MW06 and 1,200 µg/L in MW02 and its duplicate sample (5 µg/L)
- 1,3,5-TMB: 210 µg/L in MW06 to 390 µg/L in the duplicate sample from MW02 (5 µg/L)
- benzene: 4,400 µg/L in MW06 to 13,000 µg/L in the duplicate sample from MW02 (1 µg/L)
- ethylbenzene: 480 µg/L in MW06 and 1,400 µg/L in MW02 and its duplicate sample (5 µg/L)
- naphthalene: 380 µg/L in MW06 to 550 µg/L in the duplicate sample from MW02 (10 µg/L)
- n-propylbenzene: 60 µg/L in MW06 and 120 µg/L in MW02 (5 µg/L)
- o-xylene: 550 µg/L in MW06 to 3,600 µg/L in the duplicate sample from MW02 (5 µg/L)
- p/m-xylene: 1,300 µg/L in MW06 to 7,100 µg/L in the duplicate sample from MW02 (5 µg/L)
- toluene: 850 µg/L in MW06 to 16,000 µg/L in the duplicate sample from MW02 (5 µg/L)

SVOCs

Detected concentrations of SVOCs exceeded Class GA SGVs in groundwater samples collected from monitoring wells MW02, MW04, and MW06. The list below provides concentration ranges of the SVOCs detected above their respective Class GA SGVs (applicable Class GA SGVs for each compound are shown in parentheses).

- 2,4-dimethylphenol: 4.6 µg/L in MW06 to 8.5 µg/L in MW02 (1 µg/L)
- benzo(a)anthracene: 0.11 µg/L in MW04 (0.002 µg/L)

- benzo(a)pyrene: 0.09 µg/L in MW04 (Non-detect)
- benzo(b)fluoranthene: 0.14 µg/L in MW04 (0.002 µg/L)
- benzo(k)fluoranthene: 0.06 µg/L in MW04 (0.002 µg/L)
- chrysene: 0.11 µg/L in MW04 (0.002 µg/L)
- naphthalene: 140 µg/L in MW06 to 310 µg/L in MW02 (10 µg/L)
- phenol: 16 µg/L in the duplicate sample from MW02 to 58 µg/L in MW06 (1 µg/L)

Pesticides

Detected concentrations of pesticides exceeded Class GA SGVs in groundwater samples collected from monitoring well MW02 (applicable Class GA SGVs for each compound are shown in parentheses).

- aldrin: 0.005 µg/L in the duplicate sample from MW02 and 0.008 µg/L in MW02 (Non-detect)
- dieldrin: 0.01 µg/L to 0.013 µg/L in the duplicate sample from MW02 and MW02, respectively (0.004 µg/L)

PCBs

Detected concentrations of PCBs exceeded Class GA SGVs in groundwater samples collected from monitoring well MW02 (applicable Class GA SGVs for each compound are shown in parentheses).

- Total PCBs: 0.139 µg/L in MW02 to 0.21 µg/L in the duplicate sample from MW02 (0.09 µg/L)

Dissolved Metals

Detected concentrations of dissolved metals exceeded Class GA SGVs in all groundwater samples collected. The list below provides concentration ranges of the dissolved metals detected at concentrations above their respective Class GA SGVs (applicable Class GA SGVs for each compound are shown in parentheses).

- iron: 586 µg/L in MW03 to 11,200 µg/L in MW06 (300 µg/L)
- magnesium: 56,400 µg/L in MW04 to 124,000 µg/L in the duplicate sample from MW02 (35,000 µg/L)
- manganese: 440.1 µg/L in MW04 to 3,616 µg/L in the duplicate sample from MW02 (300 µg/L)
- sodium: 158,000 µg/L in MW04 to 308,000 µg/L in the duplicate sample from MW02 (20,000 µg/L)

5.5 Soil Vapor and Ambient Air Findings

Soil vapor and outdoor ambient air samples were collected and analyzed for VOCs. A summary of laboratory detections in soil vapor samples is provided in Table 6 with comparisons to outdoor ambient air samples. Soil vapor sample results are shown in Figure 11. Soil vapor point construction and sampling logs are included as Appendix H.

Petroleum-related VOCs were detected in soil vapor samples at concentrations above ambient air sample concentrations. The total detected VOC concentration in the outdoor ambient air sample was 32.471 micrograms per cubic meter (µg/m^3) (AA01_042518). The total detected VOC concentration in the soil vapor samples ranged from 290.01 µg/m^3 (SV07_042518) to 56,650 µg/m^3 (SV06_042518). Total benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in soil vapor samples ranged from 84.05 µg/m^3 in sample SV01 to 7,748 µg/m^3 in sample SV06.

In addition, soil vapor results were applied to the lowest concentration for which monitoring or mitigation is recommended in Matrices A, B, and C of the NYSDOH Guidance for Evaluating Soil Vapor in the State of New York Document. Tetrachloroethene (PCE) was detected across the site at concentrations above the ambient air sample, but below the lowest concentration for which monitoring or mitigation is recommended in Matrices A, B and C.

5.6 Quality Assurance and Quality Control Results

QA/QC sample results were evaluated during data validation, and the analytical results for filed blanks and trip blanks are summarized in Table 7.

5.7 Data Usability

Category B laboratory reports for the soil, groundwater and soil vapor samples were provided by Alpha and were forwarded to Langan's data validator. Copies of the laboratory data reports are included as Appendix J. Copies of the DUSRs are provided in Appendix K. The results of the data validation review are summarized below.

The data were determined to be acceptable, however minor deficiencies were identified and are summarized in the DUSRs. Completeness, defined as the percentage of analytical results that are judged to be valid, is 100%. The data is considered usable, as qualified.

5.8 Evaluation of Potential Areas of Concern

This section discusses the results of the RI with respect to the AOCs identified prior to the start of the RI (described in Section 3.4). AOC locations are shown on Figure 5.

5.8.1 AOC-1: Historic Fill

Historic fill was encountered in all borings from the ground surface to depths ranging from about 7.5 to 13 feet bgs. Contaminants typically associated with historic fill include SVOCs and metals. Other contaminants of concern that are occasionally found in historic fill depending on the source and nature of the fill material include VOCs, pesticides, herbicides and PCBs. SVOCs and metals, as well as pesticides, herbicides and PCBs, are not readily soluble in groundwater and are generally not detected unless turbid groundwater is sampled. VOCs are readily soluble in groundwater and can volatilize to impact soil vapor.

AOC-1 Findings Summary

AOC-1 Soil

Historic fill material generally consists of light to dark brown and grey medium sand with trace fine sand, fine gravel, silt, and varying amounts of coal, brick and concrete. Results of the 9 soil samples collected from historic fill material are summarized as follows (detections above the CU SCOs are **bolded**):

- One VOC, acetone, was detected at a concentration exceeding the UU SCO in one of nine soil samples collected from the historic fill interval. Acetone is a common laboratory contaminant and is likely not representative of on-site conditions.
- Nine SVOCs were detected at concentrations exceeding the UU SCOs and five SVOCs were detected at concentrations exceeding the CU SCOs (3-methylphenol/4-methylphenol, **benzo(a)anthracene**, **benzo(a)pyrene**, **benzo(b)fluoranthene**, benzo(k)fluoranthene, chrysene, **dibenz(a,h)anthracene**, dibenzofuran, and **indeno(1,2,3-cd)pyrene**) in three of nine soil samples collected from the historic fill interval.
    - The highest SVOC concentrations were identified in boring EB-09 from 3 to 4 feet bgs.
- Pesticides were detected at concentrations exceeding the UU SCOs (4,4’-DDE and 4,4’-DDT) in three of nine soil samples collected from the historic fill interval.
- Metals were detected at concentrations exceeding the UU and, in some cases, CU SCOs (**barium**, **lead**, mercury, nickel, and zinc) in eight of nine soil samples collected from the historic fill interval.

AOC-1 Groundwater

Ten VOCs (1,2,4,5-tetramethylbenzene, 1,2,4-TMB, 1,3,5-TMB, benzene, ethylbenzene, naphthalene, n-propylbenzene, o-xylene, p/m-xylene, and toluene), eight SVOCs (2,4-dimethylphenol, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, naphthalene and phenol), two pesticides (aldrin and dieldrin), total PCBs, and four dissolved metals (iron, magnesium, manganese, and sodium) were detected at concentrations exceeding Class GA SGVs.

The SVOCs detected in the sample collected from monitoring well MW04 (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene) were also detected in three soil samples collected from historic fill (EB-01_0-2, EB-04_0-1, and EB-09_3-4) at concentrations above the UU and/or CU SCOs. The source of these SVOCs in groundwater is historic fill material.

Pesticides and total PCBs were only detected in the samples collected from monitoring well MW02. One of the pesticides, aldrin, was not detected in any soil samples, and the other pesticide, dieldrin, was detected in shallow soil sample EB-07_1-2 at a concentration below its UU SCO. The source of pesticides in groundwater is historic fill material. Total PCBs were detected in four shallow soil samples collected from historic fill (EB-03_1-2, EB-04_0-1, EB-05_0-2, and EB-07_1-2) at concentrations below the UU SCOs. The PCBs in groundwater are attributed to historic fill.

Four metals, including iron, magnesium, manganese, and sodium, were detected in groundwater samples at dissolved concentrations above the Class GA SGVs. These metals are representative of regional groundwater quality.

Ten VOCs (1,2,4,5-tetramethylbenzene, 1,2,4-TMB, 1,3,5-TMB, benzene, ethylbenzene, naphthalene, n-propylbenzene, o-xylene, p/m-xylene, and toluene) and three SVOCs (2,4-dimethylphenol, naphthalene, and phenol) were detected above Class GA SGVs in samples collected from monitoring wells MW02 and MW06, and are addressed in the AOC-2 discussion.

AOC-1 Soil Vapor

VOC impacts associated with AOC-1were not detected.

AOC-1 Conclusions

Historic fill was identified from surface grade to depths of up to 13 feet bgs across the site. SVOCs and metals were detected at concentrations above CU SCOs in historic fill samples, and VOCs and pesticides were detected at concentrations above the UU SCOs in historic fill samples. SVOCs detected in historic fill samples at concentrations above UU and CU SCOs were detected in one groundwater sample at concentrations exceeding Class GA SGVs. The source of SVOCs, PCBs, and pesticides in groundwater is historic fill material. The metals detected in groundwater are representative of regional groundwater quality and not historic fill. Impacts to soil vapor are not attributed to the presence of historic fill at the site.

5.8.2 AOC-2: On-Site Petroleum Bulk Storage

The site contained two gasoline USTs from approximately 1951 to 1994. A potential fill port and vent pipes were observed in the Greenwich Street sidewalk adjacent to the site.

AOC-2 Findings Summary

Petroleum-like impacts were observed in soil borings, groundwater monitoring wells, and soil vapor points through analytical data and/or field observations.

A summary of findings associated with AOC-2 is presented below:

AOC-2 Soil

Petroleum impacts, evidenced by odors, staining and/or elevated PID readings above background levels were observed at 5 of 10 soil boring locations (EB-02, EB-03, EB-05, EB-06, and EB-10). Sample results relating to petroleum-like impacts in soil are summarized as follows (compounds detected above the CU SCOs are **bolded**):

- Eight petroleum-related VOCs (**1,2,4-TMB**, 1,3,5-TMB, **benzene**, ethylbenzene, naphthalene, n-propylbenzene, toluene, and **total xylenes**) were detected at concentrations exceeding the UU SCOs and three VOCs exceeded the CU SCOs in one or more of five samples (EB-02_14-16, EB-06_13-15 and its duplicate DUP01_042418, EB-05_13-15, and EB-10_14-16).
- One petroleum-related SVOC, naphthalene, was detected at a concentration exceeding the UU SCO in one sample (EB-02_14-16).

AOC-2 Groundwater

Petroleum-like impacts, as evidenced by odors and elevated PID readings during purging and sampling, were observed in MW02 and MW06. Sample results relating to petroleum-like impacts in groundwater are summarized as follows:

- Ten petroleum-related VOCs (1,2,4,5-tetramethylbenzene, 1,2,4-TMB, 1,3,5-TMB, benzene, ethylbenzene, naphthalene, n-propylbenzene, o-xylene, p/m-xylene, and toluene) were detected above the Class GA SGVs in the samples collected from monitoring wells MW02 and MW06.
- Two petroleum-related SVOCs (naphthalene and phenol) were detected above the Class GA SGVs in samples collected from monitoring wells MW02 and MW06.

AOC-2 Soil Vapor

Petroleum-related VOCs, including BTEX, were detected in all soil vapor samples. BTEX concentrations in soil vapor samples ranged from 84.05 $\mu g/m^3$ in sample SV01 to 7,748 $\mu g/m^3$ in sample SV06. Benzene, toluene, and xylenes were also detected in outdoor ambient air sample AA01_042518, but at a concentrations more than an order of magnitude less than those detected in soil vapor samples.

AOC-2 Conclusions

Petroleum impacts observed in soil, groundwater, and soil vapor are associated with historical releases from on-site USTs. According to Sanborn Fire Insurance Maps, the site contained two gasoline USTs from approximately 1951 to 1994. The geophysical survey identified an approximately 450-square-foot anomaly indicative of a UST, an associated fill port, and vent pipes in the western portion of Lot 42 adjacent to the Greenwich Street sidewalk. Evidence of former gasoline dispenser islands was observed to the north and south of the anomaly. In response to the observed subsurface conditions, the NYSDEC was contacted on May 1, 2018 and Spill Number 1801068 was assigned.

Petroleum impacts to soil were identified in the western portion of the site in samples collected from about 13- to 16- feet bgs. Petroleum impacts were horizontally delineated to the north (EB-09_14-15, EB-04_15-16, EB-07_14-15), east (EB-03_16-17, EB-05_13-15, and south (EB-01_14-16, and EB-08_13-15). Petroleum impacts were vertically delineated by samples EB-06_22-24, EB-02_26-28, and EB-05_22-24.

Petroleum impacts to groundwater were identified in the western portion of the site in samples collected from monitoring wells MW02 and MW06. Petroleum impacts to groundwater were horizontally delineated to the north and east by groundwater samples collected from monitoring wells MW03 and MW04.

5.8.3 AOC-3: Historic Site Use

Historical manufacturing/industrial site use included a preserves factory (1894-1905), packing canned fruits, jellies, and company (1905-1922), express depot (1951-1968), garage (1951-present), and parking lot (1968-present).

AOC-3 Findings Summary

Impacts associated with historic site use were not identified in soil, groundwater, or soil vapor. Hydraulic lifts associated with current and historic use of the site as a garage and parking lot were observed during the RI. PCBs were not detected at concentrations above the UU SCOs in soil samples, which indicates that the potential historic use of PCB-containing hydraulic fluids has not impacted the subsurface.

6.0 QUALITATIVE HUMAN AND FISH/WILDLIFE EXPOSURE ASSESSMENT

Human health exposure risk was evaluated for both current and future site and off-site conditions in accordance with the May 2010 NYSDEC Final DER-10 Technical Guidance for Site Investigation and Remediation. The assessment included an evaluation of potential sources and migration pathways of site contamination, potential receptors, exposure media, and receptor intake routes and exposure pathways.

In addition to the human health exposure assessment, NYSDEC DER-10 requires an on-site and off-site Fish and Wildlife Resources Impact Analysis (FWRIA) if certain criteria are met. Based on the requirements stipulated in Section 3.10 and Appendix 3C of DER-10, there was no need to prepare an FWRIA for the site. A completed form of DER-10 Appendix 3C is enclosed in Appendix L.

6.1 Current Conditions

The about 20,045-square-foot site is bound by King Street to the north, a 17-story commercial office building to the east, Charlton Street to the south, and Greenwich Street to the west. The site is identified as Block 598, Lots 42 and 48 on the NYC Manhattan Borough Tax Map and is improved with a one-story building built circa 1932 (Lot 42) and an open-air parking lot (Lot 48) surrounded by a chain-link fence. The one-story building contains a partial cellar (about 130 square feet) in the northwestern portion of the lot. The nearest ecological receptor is the Hudson River, which is located about 800 feet west of the site. Several sensitive receptors were identified within 1/2 mile of the site and are listed in the table in Section 2.1.1.

6.2 Proposed Conditions

The purpose of the project is to develop an underutilized, contaminated parcel of land into commercial space while implementing remedial measures that are protective of human health and the environment. The proposed development project is in the early planning stages, but it is anticipated to include a 10-story commercial office building spanning both tax lots (20,045-square-feet), with ground-floor retail and one or two full cellar levels at a depth of about 15 or 30 feet bgs, respectively. Cellar uses have not been determined but are expected to include utility and mechanical rooms, storage rooms, and offices. Proposed redevelopment plans are included in Appendix B.

6.3 Summary of Environmental Conditions

Soil contaminants of concern (COC) include VOCs, SVOCs, pesticides, and metals. Analysis of soil samples revealed VOCs, SVOCs, pesticides and metals at concentrations that exceeded UU SCOs, and multiple VOCs, SVOCs, and metals at concentrations that also exceed the CU SCOs.

Historic fill was encountered in all borings from the ground surface to depths ranging from about 7.5 to 13 feet bgs. Historic fill impacts include SVOCs, metals, and pesticides at concentrations above UU SCOs, and SVOCs and metals at concentrations above CU SCOs.

Petroleum-like staining, odors, elevated PID readings above background, and petroleum-related VOCs and SVOCs were identified in soil samples near the groundwater interface and in groundwater samples, and petroleum-like VOCs were identified in soil vapor. Petroleum impacts are associated with historical releases from suspected gasoline USTs at the site.

6.4 Conceptual Site Model

A conceptual site model (CSM) was developed based on the findings of the RI. The purpose of the CSM is to develop a simplified framework for understanding the distribution of impacted materials, potential migration pathways, and potentially complete exposure pathways, as discussed below.

6.4.1 Potential Sources of Contamination

Potential sources of contamination have been identified and include historic fill and potential USTs. The site-wide presence of historic fill has been established as a source of SVOCs, pesticides, PCBs, and metals. Historical USTs have been established as a source of petroleum impacts.

6.4.2 Exposure Media

The impacted media include soil, groundwater, and soil vapor. Analytical data indicates that the historic fill material contains SVOCs, pesticides, and metals. Pesticides and PCBs were also identified in site groundwater. Petroleum-related VOCs and SVOCs were detected in soil and groundwater. Petroleum-related VOCs were detected in soil vapor.

6.4.3 Receptor Populations

The site is occupied by a one-story ventilated parking structure and an open-air parking lot. Site access is limited to employees and customers of the active business, authorized guests, and consultants involved with the proposed development. During site development, human receptors will be limited to construction and remediation workers, authorized guests and the public adjacent to the site. Under future conditions, receptors will include the new building tenants, workers, and visitors to the commercial spaces.

6.5 Potential Exposure Pathways – On-Site

6.5.1 Current Conditions

The site is occupied by a one-story ventilated parking structure and an open-air parking lot. The site is covered with a concrete and asphalt surface; therefore, exposure to contaminated soil is only possible during a subsurface investigation.

Because groundwater in this area of NYC is not used as a potable water source, no complete exposure pathway to contaminated groundwater through ingestion or direct contact exists under current site conditions.

The potential exists for soil vapor to accumulate below the building slab and within the building and for exposure to receptor populations to occur in occupied buildings. The current building is used as a parking garage and access is limited to site employees and authorized guests, so human exposure to contaminated vapors is only possible during a subsurface investigation. Minimal surficial cracks were observed in the parking garage; however, punctures of the concrete slab were not observed in either the cellar or the main floor slab of the parking garage. The concrete slab thickness ranges from 6 to 16 inches in the parking garage. The parking garage is ventilated through open garage doors during business hours and is used only for parking. In localized areas where human exposure to contaminated soil, groundwater and soil vapor is possible during soil, soil vapor and groundwater sampling, the potential exposure pathways for dermal absorption, inhalation and ingestion are controlled through implementation of a HASP.

6.5.2 Construction/Remediation Condition

Potential exposure pathways exist for dermal absorption, ingestion, and/or inhalation during construction/remediation. Construction and remedial activities will include demolition, excavation and off-site site disposal of historic fill material and soil, dewatering of contaminated groundwater, installation of injection wells for in-situ soil and groundwater treatment, and construction of foundation components. Complete exposure pathways will be possible during these activities, but would be avoided through the implementation of a construction health and safety plan (CHASP), Community Air Monitoring Plan (CAMP), and use of vapor and dust suppression techniques.

6.5.3 Proposed Future Conditions

The proposed redevelopment project is in the early planning stages, but currently is anticipated to include a 10-story commercial office building spanning both tax lots (20,045-square-feet), with ground-floor retail and one or two full cellar levels at a depth of about 15 or 30 feet bgs, respectively. Cellar uses have not been determined but are expected to include utility and mechanical rooms, storage rooms, and offices. The site will be capped with a concrete building slab underlain by a waterproofing and vapor barrier membrane. The development plan calls for excavation of contaminated material; backfill with clean material, where necessary; and capping with building foundations. This barrier will prevent direct exposure to impacted soil and groundwater that may be left in place; therefore the pathway will not be complete.

There is no pathway for ingesting petroleum-impacted groundwater, since the site and surrounding areas obtain their drinking water supply from surface water reservoirs including the

Delaware, Catskills and Croton watersheds and not from groundwater; therefore, the groundwater will not be intended for consumption.

In the absence of remediation, engineering and/or institutional controls, the presence of VOCs in the soil, groundwater, and soil vapor creates potential for VOC vapors to volatilize and potentially accumulate in the proposed building and impact future users. Points of exposure include potential cracks in the foundation or lower-level slab of the proposed development. Routes of exposure may include inhalation of vapors entering the building. This exposure pathway will be mitigated through the construction of the building foundation slab and the installation of a waterproofing and vapor barrier membrane.

6.6 Potential Exposure Pathways – Off-Site

In the absence of CAMP and a CHASP, soil has the potential to be transported off-site by wind in the form of dust or on the tires of vehicles or equipment leaving the site during development and can create an exposure risk to the public adjacent to the site. Groundwater is anticipated to flow northwest towards the Hudson River. Groundwater will be treated during or prior to construction. Dewatering of groundwater may be required to accommodate excavation; dewatering fluids may be pre-treated and discharged to the NYC sewer system, in accordance with NYC Department of Environmental Protection permit requirements, or containerized in a temporary storage tank pending disposal at a permitted off-site facility. Therefore, the potential for public exposure to groundwater on adjacent sites will be eliminated. During construction, soil vapor will primarily migrate vertically through the subsurface and will dissipate and dilute with ambient air.

The potential off-site migration of site contaminants is not expected to result in a complete exposure pathway for current, construction and remediation, or future conditions for the following reasons:

- The site is located in an urban area and predominantly covered with continuous relatively impervious surface covering (i.e. building foundations and concrete and asphalt paving)
- During site redevelopment, remediation and construction, the following protective measures will be implemented:
  - Community air monitoring will be conducted for particulates (i.e., dust) and VOCs during intrusive activities as part of a CAMP. Dust and/or vapor suppression techniques will be employed to limit potential for off-site migration of soil and vapors.
  - Vehicle tires and undercarriages will be washed as necessary prior to leaving the site to prevent tracking material off-site.

  - A soil erosion/sediment control plan will be implemented during construction to control off-site migration of soil.

- The planned redevelopment will include a waterproofing/vapor barrier membrane to be installed beneath the slab and along foundation walls to grade surface. The site will also be covered by impervious surfaces.
- Groundwater in NYC is not used as a potable water source and the nearest ecological receptor, the Hudson River, is located about 800 feet to the west of the site.

6.7 Evaluation of Human Health Exposure

Based on the CSM and the review of environmental data, complete on-site and off-site exposure pathways appear to be present, in the absence of institutional and engineering controls, under current, construction and remediation, and future conditions. The complete exposure pathways indicate there is a risk of exposure to humans from site contaminants via exposure to soil, groundwater, and soil vapor if mitigation and controls are not implemented.

Complete exposure pathways have the following five elements: 1) a contaminant source; 2) a contaminant release and transport mechanism; 3) a point of exposure; 4) a route of exposure; and 5) a receptor population. A discussion of the five elements comprising a complete pathway as they pertain to the site is provided below.

6.7.1 Current Conditions

Contaminant sources include the historic fill with varying levels of SVOCs, pesticides, and metals and petroleum-impacted soil, groundwater and soil vapor.

Contaminant release and transport mechanisms include potential release and transport during penetration of the site cover for soil, groundwater and soil vapor sampling. Under current conditions, the likelihood of exposure to humans is limited by the following: site use is limited to a ventilated parking garage and an open-air parking lot that are covered by continuous concrete foundations and asphalt, respectively; groundwater is not a potable water source; access is restricted to employees, authorized guests, and customers; and sampling is completed in accordance with a HASP and CAMP that is designed to monitor and prevent exposure to soil, groundwater, and soil vapor contaminants. The parking garage is a well-ventilated space, thereby minimizing the potential for exposure to soil vapor.

6.7.2 Construction/Remediation Activities

During redevelopment and remediation, points of exposure include disturbed and exposed soil during excavation, dust and organic vapors generated during excavation, and contaminated groundwater that will be encountered during excavation and/or localized dewatering operations. Routes of exposure include ingestion and dermal absorption of contaminated soil and groundwater, inhalation of organic vapors arising from contaminated soil and groundwater, and inhalation of dust arising from contaminated soil. The receptor populations include construction and remediation workers and, to a lesser extent, the public adjacent to the site.

The potential for completed exposure pathways is present since all five elements exist; however, the risk can be avoided or minimized by applying appropriate health and safety measures during construction and remediation, such as monitoring the air for organic vapors and dust, using vapor and dust suppression measures, cleaning truck undercarriages before they leave the site to prevent off-site soil tracking, maintaining site security, and wearing the appropriate personal protective equipment (PPE).

In accordance with the Remedial Action Work Plan (RAWP), which will include a CHASP, a Soil/Materials Management Plan (SMMP), and a CAMP, measures such as conducting an air-monitoring program, donning PPE, covering soil stockpiles, altering work sequencing, maintaining a secure construction entrance, proper housekeeping, and applying vapor and dust suppression measures to prevent off-site migration of contaminants during construction will be implemented. Such measures will prevent completion of these potential migration pathways.

6.7.3 Proposed Future Conditions

Under the proposed future condition, residual contaminants may remain on-site, depending on the remedy, and would, to a lesser extent, include those listed under current conditions. Contaminant release and transport mechanisms include volatilization of contaminants from the groundwater matrix to the soil vapor phase and intrusion of soil vapor. If residual impacts exist and institutional and/or engineering controls are not implemented, points of exposure include potential cracks in the foundation or slab of the proposed development and exposure during any future soil-disturbing activities. Routes of exposure include inhalation of vapors entering the building. The receptor population includes the building occupants and employees, visitors, and maintenance workers. The possible routes of exposure can be avoided or mitigated by removal of historic fill and petroleum-impacted material, construction and maintenance of a site capping system (i.e., concrete or at least 2 feet of clean soil), installation of a waterproofing and vapor barrier membrane, and implementation of a Site Management Plan (SMP), if necessary.

6.7.4 Human Health Exposure Assessment Conclusions

1. Under current conditions, there is a marginal risk for exposure. The primary exposure pathways are for dermal contact, ingestion and inhalation of soil, soil vapor, or groundwater by employees and customers of the on-site businesses and site investigation workers. The exposure risks can be avoided or minimized by following the appropriate health and safety and vapor and dust suppression measures outlined in the site-specific HASP and implementing the CAMP during investigation activities.
2. In the absence of mitigation and controls, there is a risk of exposure during the construction and remediation activities. The primary exposure pathways are:

a. Dermal contact, ingestion and inhalation of contaminated soil, groundwater or soil vapor by construction workers.

b. Dermal contact, ingestion and inhalation of soil (dust) and inhalation of soil vapor by the community in the vicinity of the site.

These can be avoided or minimized by performing community air monitoring and by following the appropriate health and safety, vapor and dust suppression and site security measures.

3. The existence of a complete exposure pathway for site contaminants to human receptors during proposed future conditions is unlikely, as all or a majority of historic fill and petroleum-impacted soil will be excavated and transported to an off-site disposal facility and any residual soil that remains would be capped with an impermeable cover. Regional groundwater is not used as a potable water source in NYC and the site cover will limit access to the subsurface so exposure to regional groundwater contaminants is unlikely. The potential pathway for soil vapor intrusion into the building would be addressed by installation of a waterproofing and vapor barrier membrane.

4. It is possible that a complete exposure pathway exists for the migration of site contaminants to off-site human receptors for current, construction phase, or future conditions. Monitoring and control measures have been and will continue to be used during investigation and construction to prevent completion of this pathway. Under future conditions, the site will be remediated and engineering and institutional controls will be implemented, if necessary, to prevent completion of this pathway.

7.0 NATURE AND EXTENT OF CONTAMINATION

This section evaluates the nature and extent of soil, groundwater, and soil vapor contamination. The nature and extent of the contamination is derived from a combination of field observations and analytical data that were discussed in Section 5.0.

7.1 Soil Contamination

Soil contamination, characterized by field observations and soil sample analytical results exceeding UU and/or CU SCOs, is attributed to the presence of historic fill material and releases of petroleum products.

7.1.1 Historic Fill Material

Contaminants related to historic fill included SVOCs, pesticides, and metals. Historic fill exists across the site from surface grade to depths ranging from about 7.5 to 13 feet bgs and predominantly consists of light to dark brown and grey, medium sand with trace fine sand, fine gravel, silt, and varying amounts of coal, brick and concrete fragments. Of the nine soil samples collected from the historic fill interval, eight samples exhibited concentrations of SVOCs, pesticides, and/or metals that are consistent with typical historic fill in NYC at concentrations exceeding the UU SCOs, and in some cases the CU SCOs.

Pesticides and metals were not detected at concentrations above UU SCOs in the 16 soil samples collected from the native material below the historic fill layer. One petroleum-related SVOC, naphthalene, was detected in one of the 16 samples collected from the native material below the historic fill layer, but is associated with the existing petroleum spill condition.

7.1.2 Petroleum-Impacted Material

Petroleum impacts to soil, including PID readings above background, odors, and staining, were observed in five borings at depths ranging from 6.5 to 26 feet bgs. The maximum PID reading of 3,600 ppm was recorded in EB-02 at about 16.5 feet bgs. Contaminants related to petroleum releases include VOCs and SVOCs. Analytical results for soil samples collected from EB-02, EB-05, EB-06, and EB-10 exhibited concentrations of petroleum-related VOCs, including 1,2,4-TMB, 1,3,5-TMB, benzene, ethylbenzene, naphthalene, n-propylbenzene, toluene, and total xylenes exceeding the UU and/or CU SCOs at the groundwater interface. One petroleum-related SVOC, naphthalene, was detected in a sample collected from EB-02 at the groundwater interface. Petroleum-impacts observed in soil are consistent with releases of petroleum products at the groundwater interface within the western part of the site. Petroleum impacts to soil were horizontally delineated to the north, east, and south and vertically delineated to depths from 22 to 26 feet bgs in the spill area.

7.2 Groundwater Contamination

Groundwater contamination, characterized by field observations and groundwater sample analytical results exceeding Class GA SGVs, is attributed to the presence of historic fill and releases of petroleum products. Groundwater sampling identified ten VOCs (1,2,4,5-tetramethylbenzene, 1,2,4-TMB, 1,3,5-TMB, benzene, ethylbenzene, naphthalene, n-propylbenzene, o-xylene, p/m-xylene, and toluene), 8 SVOCs (2,4-dimethylphenol, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, naphthalene, and phenol), two pesticides (aldrin and dieldrin), total PCBs, and four metals (iron, magnesium, manganese, and sodium) at concentrations above the SGVs. The ubiquitous presence of iron, magnesium, manganese and sodium in the samples is typical of regional groundwater conditions. The pesticides, PCBs, and SVOCs in groundwater are attributed to historic fill material. The petroleum-related VOCs and SVOCs in groundwater are indicative of an on-site petroleum release. The petroleum-related compounds were identified in the down-gradient western portion of the site, and petroleum impacts to groundwater were horizontally delineated to the north and east by the samples collected from monitoring wells MW03 and MW04.

7.3 Soil Vapor Contamination

Petroleum-related VOCs (including BTEX and other constituents) were detected at concentrations exceeding outdoor ambient air samples in all soil vapor samples, with the highest concentrations at SV06 in the western portion of the site. In addition, soil vapor results were applied to the lowest concentration for which monitoring or mitigation is recommended in Matrices A, B, and C of the NYSDOH Guidance for Evaluating Soil Vapor in the State of New York Document. PCE was detected across the site at concentrations above the ambient air sample, but below the lowest concentration for which monitoring or mitigation is recommended in Matrices A, B and C. Petroleum impacts to soil vapor are attributed to releases of petroleum products related to historic on-site USTs.

8.0 CONCLUSIONS

The RI was implemented between 23 April and 2 May 2018 to characterize the nature and extent of contamination and provides sufficient information for establishment of remedial action objectives and selection of a remedy that is protective of human health and the environment consistent with the proposed use of the site. The findings summarized herein are based on both qualitative data (field observations and instrumental readings) and quantitative data (laboratory analytical results). The analytical data generated by the RI was determined to be 100% acceptable by validation. Findings and conclusions are as follows:

1. Topography: Current site elevations range from about el 10.77 in the southern portion of the site to el 13.88 in the northeastern portion of the site.
2. Geophysical Findings: The geophysical survey identified electrical, water, sewer and gas utilities entering the site from Greenwich Street. An anomaly indicative of a UST, an associated fill port, and vent pipes were identified in the western portion of Lot 42 adjacent to the Greenwich Street sidewalk. Evidence of former gasoline dispenser islands was observed to the north and south of the anomaly. A second vent pipe was identified in the southwestern portion of Lot 48. Due to the presence of hydraulic lifts associated with parking in the potential UST area demarcated in the geophysical survey, access near the vicinity of the vent pipe was limited.
3. Stratigraphy: The subsurface consisted of fill material underlying the surficial concrete and asphalt cover to depths of about 7.5 to 13 feet bgs. A native sand layer consisting of brown fine sand with trace medium sand, clay and silt was observed below the fill layer. Peat and organic clay layers were observed in the eastern and southeastern portion of the site in borings EB-01 (11.5 to 12 feet bgs) and EB-03 (13.5 to 14.5 feet bgs). Gasoline-like odors and PID readings up to 3,600 ppm were measured from 6.5 to 26 feet bgs in borings located in the central and western portions of the site.
5. Hydrogeology: Groundwater was encountered from 14.97 to 17.36 feet bgs, corresponding to -4.40 to el -4.88. Regional groundwater flow is estimated to the west, toward the Hudson River. Based on groundwater measurements collected during the RI, local groundwater generally flows to the northwest.
6. Historic Fill: Contaminants related to historic fill included SVOCs, two pesticides, and metals. Historic fill exists across the site from surface grade to depths ranging from about 7.5 to 13 feet bgs. Of the nine soil samples collected from the historic fill interval, eight samples exhibited concentrations of SVOCs, pesticides, and/or metals that are consistent with typical historic fill in NYC at concentrations exceeding the UU SCOs, and in some cases the CU SCOs. SVOC, pesticide, and PCB exceedances in groundwater are attributed to historic fill. The metals detected in the groundwater are representative of regional groundwater quality.

7. Native Soil: A native soil layer was identified beneath the fill layer. Outside of the petroleum spill area, native soil samples did not exceed the UU SCOs.

8. Petroleum Contamination in Soil, Groundwater, and Soil Vapor: Petroleum impacts to soil, including PID readings above background (max. of 3,600 ppm at EB-02), odors, and staining were observed from 6.5 to 26 feet bgs in the western and central portions of the site. Analytical results for soil samples exhibited concentrations of eight petroleum-related VOCs and one petroleum-related SVOC exceeding the UU and/or CU SCO at the groundwater interface. Petroleum impacts to groundwater were observed during sampling of groundwater monitoring wells MW02 and MW06, as evidenced by odors, sheen, and elevated PID readings. Headspace PID readings above background and gasoline-like odors were apparent in MW02 (250 ppm), MW03 (21.9 ppm) and MW06 (250 ppm). No sheen was observed on groundwater during groundwater sampling. Ten petroleum-related VOCs and three petroleum-related SVOCs were detected at concentrations above the Class GA SGVs in monitoring wells MW02 and MW06. Analytical results for soil vapor samples across the site exhibited petroleum-related VOC concentrations above outdoor ambient air concentrations. In response to the observed subsurface conditions, the NYSDEC was contacted on May 1, 2018 and Spill Number 1801068 was assigned. Petroleum impacts to soil were horizontally delineated to the north, east, and south and vertically delineated to depths from 22 to 26 feet bgs in the spill area. Petroleum impacts to groundwater were horizontally delineated to the north and east by the samples collected from monitoring wells MW03 and MW04.

9. Remedial Action Work Plan: Sufficient analytical data was gathered during the RI to establish soil cleanup levels and to develop a remedy for the site. However, supplemental sampling will be required to horizontally delineate the extent of petroleum-impacts and characterize site material for off-site disposal. The remedy will be described and evaluated in the forthcoming RAWP to be prepared in accordance with NYS BCP guidelines. The remedy will need to address petroleum- and historic fill-impacted media across the site, provide measures for the removal and closure of possible USTs on the site and closure of NYSDEC Spill No. 0801068. It is anticipated that the remedy will include source, historic fill and petroleum-impacted material removal, groundwater treatment (via in-situ chemical oxidation, or similar) and vapor mitigation.

9.0 REFERENCES

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7. New York State Department of Environmental Conservation, Division of Environmental Remediation, Draft Brownfield Cleanup Program Guide, dated May 2004.
8. New York State Department of Health, Final Guidance for the Evaluation of Soil Vapor Intrusion in the State of New York, dated October 2006.
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