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Remedial Investigation Report

East 11th Street Works Site
NYSDEC Site No. V00534

November 13, 2007

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Remedial Investigation Report

East 11th Street Works Site

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Our Ref.:
B0043013.0000

Date:
November 13, 2007

Table of Contents

Tables

Figures

APPENDICES

1. Introduction

1.1 Overview

This Remedial Investigation Report (Report) presents the results and findings of the Remedial Investigation (RI) that was conducted on behalf of Consolidated Edison Company of New York, Inc. (Con Edison) during 2006 and 2007 for the East 11th Street Works Site (Site No. V00534), the former grounds of a manufactured gas plant (MGP) that was operated by Con Edison's predecessor companies in the lower East Side of Manhattan, New York. The RI was conducted pursuant Voluntary Cleanup Agreement Index No. D2-0003-02-08 (VCA) by and between the New York State Department of Environmental Conservation (NYSDEC) and Con Edison, and was carried out in conformance with the NYSDEC-approved October 2005 Remedial Investigation Work Plan (RIWP) prepared by TRC Environmental Corporation (TRC).

As specified in Appendix A of the VCA, the East 11th Street Works Site (the Site) is compromised of the following properties:

Street Address	Tax Map Block/Lot Number
Jacob Riis Houses 152 Avenue D, New York, NY	Block 367 Lot 1
Jacob Riis Houses 184 Avenue D, New York, NY	Block 367 Lot 25
Haven Plaza 3 188 Avenue C, New York, NY	Block 382 Lot 1
St. Emeric R.C. Church and School 181 Avenue D, New York, NY	Block 382 Lot 22

Because the results of earlier NYSDEC-approved Site Characterization Study that Con Edison for the Site under the VCA indicated a potential for off-Site migration of MGP-related contamination the RI study area was enlarged to include the sidewalk area along East 13th Street between Avenue D and Szold Place and the portion of the East River Park between East 11th and 13th Street. The East River Park is owned by the City of New York and operated by the New York City Department of Parks and Recreation. The portions of the park included in the RI are designated as Block 316 Lot 114 and Block 316 Lot 200 on the New York City Tax Map for the Borough of Manhattan. The RI study area is shown on Figure 1.

The purpose of RI is to ensure that the nature and extent of the MGP contamination on and around the Site is adequately characterized and delineated so that an effective and reliable remediation strategy can be developed for addressing the contamination. Where appropriate, this Report also incorporates the results and findings of the following environmental investigations completed prior to the RI:

- Site History Report for, East 11th Street Works (Langan Engineering, 2002)

- Indoor Air Quality Study and Soil Gas Survey, completed during 2002 and 2003 for the Saint Emeric School building and the Jacob Riis Houses apartment buildings located on the Site

- Site Characterization Study Report for the Former East 11th Street Works Site, Manhattan, New York - VCA Site # V00534 (TRC, 2005)

1.2 Report Organization

This Report is organized as follows:

- Section 1: Introduction – Discusses the Site setting and history

- Section 2: Summary of Previous Investigations – Summarizes the results and findings of the Site Characterization Study (SC), indoor air quality study, and soil gas survey that were completed for the Site

- Section 3: Investigation Activities – Describes the investigation activities, sampling locations, and sampling and analytical methods of the RI

- Section 4: Field Observations and Findings – Discusses the Site hydrogeology and the distribution of observed Site contamination and environmental impacts

- Section 5: Analytical Results – Presents and interprets the results of the surface soil, subsurface soil, groundwater, indoor air, and soil vapor testing conducted as part of the RI (and earlier SC) and the observed distribution of non-aqueous phase liquid (NAPL) encountered during the RI and earlier SC

- Section 6. Qualitative Human Health Exposure Assessment- Identifies the Compounds of Potential Concern (COPCs) encountered during the RI and earlier SC, potential receptors on and around the Site, and complete exposure pathways

- Section 7. Conceptual Site Model – Discusses the nature and extent of DNAPL in subsurface soil and groundwater across the Site and adjacent areas

- Section 8. Conclusions and Recommendations – Presents a summary of the findings and conclusions drawn, and identifies potential data gaps and recommendations to address potential data gaps

- Section 9. References – Lists the references used for the development of the RI Report

This Report also includes a significant number of attached tables, figures, boring logs and appendices. The compact disk (in pdf format) included with this Report contains additional documentation, including previous investigation reports, laboratory data reports, and data usability reports. A complete list of these items can be found in the Table of contents.

1.3 Gas Works Description

The former East 11th Street Works (Works) was located on the Lower East Side of the Borough of Manhattan, New York City, New York (see Figure 2). Based on a review of historic documents it appears that the footprint of the Works at its most developed stage extended beyond the boundaries of specific properties listed in Appendix A of the VCA. As such for the purpose of the RI, the term “Site” refers to the specific properties listed in the Appendix A of the VCA while the term “Works” refers to the area that encompasses the footprint of the former East 11th Street Works (as that area is defined below).

According to historic documents, the most developed stage of the Works was during the 1920’s, when the grounds of the Works encompassed approximately seven acres. At that time, the northern extent of the Works was bounded by East 13th Street (Figure 3). North of East 12th Street the Works extended approximately 450 feet west of Avenue D. North of East 11th Street the Works extended from Avenue D to the East River. Note that East 11th Street between Avenue D and the East River no longer exists. The former location of East 11th Street corresponds approximately to the northern boundary of Jacob Riis Houses Building Nos. 1, 7, and 8.

1.4 Current Land Use

The Site is zoned as a residential district (R7-2) by the New York City Planning Commission and includes land uses designated as multi-level elevator residential buildings, transportation and utility use, and public facilities and institutions. The properties that once composed the grounds of the East 11th Street Works along with the address, current owner, property name, and land use are listed in Table 1.

1.4.1 Block 367 Lot 1 – Jacob Riis Houses

The Jacob Riis Houses apartment complex was completed in 1949 and is owned by the New York City Housing Authority (NYCHA). The Jacob Riis complex consists of 19 multi-story buildings extending from East 6th Street to East 13th Street between Avenue D and the FDR Drive. The portion of the Jacob Riis complex that is located on the former grounds of the Works includes five multi-story brick apartment buildings known as Building Nos. 2, 3, 4, 5, and 6 (Figure 3). In addition to the apartment buildings, the Jacob Riis Houses complex includes landscaped areas and a play area with a basketball court, playground equipment, and several park benches in the center of the complex.

The following buildings in the Works portion of Jacob Riis Houses have basements:

- Building No. 2 located at 170 Avenue D
- Building No. 4 located at 12-23 FDR Drive
- Building No. 6 located at 11-15 FDR Drive

1.4.2 Block 367 Lot 25 – Manhattan Pump Station

The Manhattan Pump Station (also known as the East 13th Street Pump Station) is owned and operated by the New York City Department of Environmental Protection (NYCDEP). The pump station was constructed during the 1960’s and consists of a one-story brick building with a parking area on the north side of the building and a vertical surge tank on the east side of the building. The pump station is being upgraded and is currently under construction

1.4.3 Block 382 Lot 22 – Church of St. Emeric

The Church of St Emeric (St. Emeric's), located at 740 East 13th Street, was constructed in 1950. In addition to the Church, the St. Emeric's property includes a multiple-story school building with a basement, a playground area along Avenue D, a corrugated metal Quonset hut-like structure, a small shed, a paved parking lot area, and a landscaped garden area located at 185 Avenue D. The school is currently used as parish offices, along the western boundary of the property.

The school building was built in 1953 as the St. Emeric School – a parochial elementary school. Portions of the foundation of the gas holder that was formerly located on the property are visible in the building's basement. This building is now occupied by the Escuela Hispana Montessori School and used as parish offices, daycare, and Head Start facility with a maximum enrollment of 99 students. To the north and west of the school there is an asphalt parking lot. The recently constructed play area is located along Avenue D between the school building and East 13th Street. The property is surrounded by a chain-link fence.

1.4.4 Block 382 Lot 1 – Haven Plaza

Block 382 Lot 1 consists of six buildings, three of which are located on the former grounds of the Works.

- Three Haven Plaza is a 16-story residential apartment building located at 726 East 13th Street and constructed in 1967.
- A one-story brick garage attached to Three Haven Plaza. The 1976 Sanborn Map depicts a basement beneath the garage.
- A two-story brick building located at 700-722 East 13th Street with approximately 22 apartments is located north of the garage.

1.4.5 Block 316 Lots 114 and 200 – East River Park

The portion of East River Park that was part of the Works extends from approximately 200 feet north of East 10th Street (the former location of East 11th Street) to the northern boundary of present day Block 316 Lot 114. Note historic maps indicate that no MGP-related structures were present on this portion of the grounds of the Works.

1.5 Site History

Based on historical information, the East 11th Street Works began operations sometime between 1859 and 1868 and was shut down in approximately 1933. The history of the Works summarized from the MGP Research report, Site Characterization Study report, and other historical documents is presented in Table 2. An overlay of historic structures developed primarily from the Sanborn maps is presented in Figure 3.

Over its operational period, the Works consisted of 17 gas holders ranging in capacity from approximately 50,000 cubic feet to 5,000,000 cubic feet. Several of the gas holders were converted from gas storage to liquid storage of naphtha, tar or gas oil. The original gas holders built in the late 1800's were most likely constructed with below grade bottoms. Many of these were replaced by large gas holders built on grade with storage capacities greater than 1,000,000 cubic feet of gas. Other production and storage facilities that were present during the operational life of the Works included:

- Retorts
- Fuel/gas oil tanks
- Tar separators
- Purifying houses
- Condensers
- Scrubbers

The initial gas manufacturing process and construction details of the early gasholders could not be determined with certainty from available historical information. It is assumed that the coal carbonization process was used from start up of the Works until at least 1875, because this was the process used exclusively in the gas industry from 1816 to 1875. The Lowe Carburetted Water Gas process, invented in 1873, came into use in the gas industry after 1875, but cannot be determined to have been used at the Works with any certainty until 1903. Based on information from the New York Public Service Commission (PSC) Report for 1907, gas manufacturing using the Lowe process began at the Works in December 1903 and was used exclusively until at least December 31, 1905, and possibly as late as 1915. The historical information reviewed does not indicate the gas manufacturing process used after this time until the Works were retired in 1933. By 1907, the process consumed approximately 40,000 tons of coal for the making of steam, 10,000,000 gallons of gas oil and 22,000 bushels of oxide for gas purification (PSC, 1907 Annual Report). In 1915, the MGP produced 2.08 billion cubic feet of gas.

2. Summary of Previous Investigations

2.1 Overview

This section summarizes the scope and general findings of the previous Site environmental investigations that preceded the RI and were conducted as part of the VCA.

2.2 Site Characterization Study Report

TRC reported the findings of an SC, conducted on behalf of Con Edison for the East 11th Street Works Site, in March 2005. The following subsections summarize the TRC investigations.

2.2.1 Objectives

The objectives of the field investigations, as stated in the June 2002 NYSDEC-approved Work Plan, were to:

- Confirm the presence or absence of remnant historic MGP structures.
- Determine the presence or absence of any residual MGP waste materials/impacts.
- Identify the presence of contaminant impacts resulting from non-MGP sources.

The June 2002 Site Characterization Work Plan was prepared by Langan Engineering and Environmental Services, P.C. (Langan) and was approved by the NYSDEC by letter dated November 20, 2002. For the purpose of data presentation, the Site was divided into two distinct areas:

- Jacob Riis area – includes Block 367 Lot 1
- Saint Emeric's area – includes Block 382 Lot 22

Access to Block 382 Lot 1 (Haven Plaza) was not obtained before the site characterization was completed therefore it was included in the remedial investigation. Block 316 Lots 114 and 200 (East River Park) were not part of the SC.

2.2.2 Findings

Residuals from the operation of the MGP were identified on both of these areas of the Site. A summary of the primary SC findings for each area is provided below:

2.2.2.1 Jacob Riis Area

Petroleum and/or MGP-related odors were evident in samples from 19 of the 28 soil boring locations. In addition, 16 of the 28 samples contained an oil-like material (OLM) and/or tar-like material (TLM). The northeast portion of the Jacob Riis area (former MGP oil tank and gas holder areas) had the highest number of such observations (11 out of 16), with the remaining five locations with observed OLM and/or TLM in the southeastern portion of the property. Two of the locations had OLM and/or TLM in both the unsaturated and saturated zones; all other observations were in the saturated zone only. The following list summarizes the results of soil and groundwater analyses, and includes a comparison to the Recommended Soil Cleanup Objectives (RSCOs) specified in NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4046:

- Total volatile organic compounds (VOCs) – exceeded the TAGM RSCO in 12 of the 28 soil boring locations, and in one test trench location
- Total semi-volatile organic compounds (SVOCs) – exceeded the TAGM RSCO in 7 of the 28 soil boring locations, and in two test trench locations
- A total of 7 VOCs, 19 SVOCs and 4 metals were detected in test pits and soil borings at concentrations exceeding their respective TAGM RSCO criteria
- There were no TAGM RSCO exceedances for polychlorinated biphenyls (PCBs) in either the soil borings or the test trench locations
- None of the 64 surface soil samples exhibited an exceedance of the TAGM RSCO for total VOCs, Total SVOCs or individual VOCs (note: only the first 20 samples were analyzed for VOCs)
- Ten SVOCs and five metals were detected in surface soil samples at concentrations exceeding the TAGM RSCO
- Cyanide was not detected in the surface soil samples

- A total of 6 VOCs, 11 SVOCs and lead were detected in groundwater at levels exceeding the NYSDEC Technical and Operational Guidance Series (TOGS) Class GA criteria for groundwater

- One sample of non-aqueous phase liquid (NAPL) was collected from monitoring well MW-3 and submitted for laboratory fingerprint analysis; the sample contained a number of monocyclic aromatic hydrocarbons and naphthalene, characteristic of the water soluble fraction of tar

2.2.2.2 Saint Emeric's Area

MGP-related odors were noted in three of the nine soil boring locations, and petroleum-like odors (gasoline) were noted in two of the nine soil borings. OLM was observed in the saturated zone at one location, while TLM was not observed in any of the soil borings. The following list summarizes the results of soil and groundwater analyses, and includes a comparison to the RSCOs specified in NYSDEC TAGM 4046:

- All soil samples were in compliance with the TAGM RSCO criteria for total SVOCs and PCBs

- Total VOCs exceeded the TAGM RSCO in two soil borings (both are located approximately 15 to 25 feet west of the school building)

- Individual TAGM RSCO exceedances were observed for several VOCs, SVOCs and Resource Conservation and Recovery Act (RCRA) metals

- None of the five surface soil samples had exceedances of the TAGM RSCO for individual VOCs, total SVOCs or PCB's; however, each of the samples had exceedances of individual SVOCs

- There were no TAGM RSCO exceedances for PCBs in either the soil borings or the test trenches

- Metals were detected in several soil borings and test trenches at concentrations which exceeded the TAGM RSCO criteria

- A groundwater sample from monitoring well MW-1 contained lead and several VOCs at concentrations in exceedance of the TOGS Class GA criteria; no measurable NAPL was detected in either of the two wells installed in this area.

2.3 Indoor Air Quality and Soil Gas Study

Prior to the SCS, the RETEC Group (RETEC) conducted two air sampling events (August 2002 and December 2002) for Con Edison at the the Escuela Hispana Montessori School, located on the Saint Emeric property. The results of these sampling events indicated that the quality of the air sampled within the buildings was generally within the range expected for indoor air. Indoor air quality in the school or church buildings did not appear to be impacted by subsurface intrusion of MGP-related vapors (RETEC, May 2003).

RETEC also conducted an indoor air quality and soil gas sampling event in October 2003 for Con Edison at the Jacob Riis property. The results of those studies indicated that the indoor air quality within the apartment buildings located on the former MGP section of the Jacob Riis Houses complex did not appear to be impacted by subsurface intrusion of MGP-related vapors. The results of these studies were presented in a separate report (RETEC, April 2004) prepared for Con Edison and previously submitted to the NYSDEC.

3. Remedial Investigation Activities

The goals and objectives of the RI program as stated in the NYSDEC approved Remedial Investigation Work Plan for the Former East 11th Street Works Manhattan, New York VCA Site # V00534, dated October 2005 were to:

- Delineate the horizontal and vertical extent of residual MGP waste materials/impacts in soil and groundwater identified during the SCS
- Determine the extent and continuity of OLM and TLM in the eastern portion of the Jacob Riis property identified during the SCS
- Delineate the presence and locations of contaminant levels that pose potential risks to human health and/or the environment
- Collect sufficient data in order to develop a proposed site remediation strategy, if necessary.

ARCADIS BBL conducted the majority of the remedial investigation activities between June 2006 and March 2007. Specific activities completed as part of the RI to meet the objectives listed above included:

- Underground utility clearance
- Subsurface soil investigation
- Groundwater investigation
- Field survey
- Indoor air sampling
- Soil vapor sampling
- Chemical analysis of collected soil, groundwater, and vapor samples

Each of these activities is discussed below.

A number of subcontractors were utilized during this remedial investigation as outlined in the table below.

Table 3 Subcontractors Used During Remedial Investigation Activities

Subcontractor	**Office Location**	**Service Provided**
All State Power Vac	Brooklyn, NY	Utility clearance
Aquifer Drilling and Testing	New Hyde Park, NY	Utility clearance
Naeva Geophysics	Congers, NY	Utility Clearance
Universal Testing and Inspection	West Babylon, NY	Hollow-stem auger drilling
Boart Longyear Corp.	Windsor, NJ	Rotary sonic drilling
Severn Trent Laboratories	Shelton, CT	Analytical services
CompuChem	Cary, NC	Analytical service
Munoz Engineering, P.C.	New York, NY	Surveying
Triumvariate Environmental	Astoria, NY	Waste transport and disposal
CleanEarth of North Jersey	South Kearny, NY	Waste transport and disposal

All work conducted during the remedial investigation was completed in general conformance with the following documents:

- Draft DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC, 2002)
- Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH, 2006)
- Remedial Investigation Work Plan For the Former East 11th Street Works Manhattan, New York VCA Site # V00534 (TRC, 2005)
- Field Sampling Plan for the Remedial Investigation of the Former East 11th Street Works (TRC, 2005)
- Health and Safety Plan Former East 11th Street Works Manhattan, New York VCA Site #00534 (BBL, 2005)
- Quality Assurance/Quality Control Project Plan for the Remedial Investigation of the Former East 11th Street Works Manhattan, New York (TRC, 2005)

- Utility Clearance Process for Intrusive Activities Revision 1 (Con Edison 2003)
- Technical Specification No. REM-MGP-2005-01 For Environmental Consulting Services In Support of the Former Manufactured Gas Plant Sites Program (Con Edison, 2005)

3.1 Underground Utility Clearance

Prior to initiation of intrusive investigation activities, sample locations were cleared in accordance with Con Edison's utility clearance procedures. The New York City "One Call" organization was contacted to request utility mark-outs in accordance with Code 753, a minimum of three working days prior to that start of fieldwork. All mark outs by Code 753 participating companies were completed in the specified timeframes in advance of all field-intrusive activities. Renewal calls were made in accordance with the timeframes allowed in the regulations.

As an added precaution for worker safety and to minimize the potential for damage to subsurface utilities, proposed boring locations were cleared by non-mechanical means (e.g. hand digging and vacuum extraction). Soil was excavated, typically to a maximum depth of 5 feet bgs, by non-mechanical means to physically confirm the presence/absence of subsurface utilities at each of the proposed boring locations. If proposed sample locations were determined to be too close to subsurface utilities to safely conduct the field investigations, the boring was relocated to achieve the same investigative objective

3.2 Subsurface Soil Investigation

Subsurface soil investigation activities conducted at the Site included installation of soil borings and subsurface soil sampling. A total of 41 soil borings were completed between June 2006 and February 2007 using a combination of rotary sonic (rotosonic) or hollow-stem auger (HSA) drilling methods. Specific drilling methods for each of the soil borings are described in the soil boring logs provided in Appendix A. Figure 3 presents the locations of soil borings installed during the RI. Note that the soil borings completed during the SCS are also shown on Figure 3.

During rotosonic drilling soil samples were collected continuously to the bottom of the borings using 5 foot long, 4-inch diameter core barrels lined with a plastic sleeve. During HSA drilling a combination of 2-inch and 3-inch outside diameter split-spoons were used to collect soil core continuously to the base of the borings.

Regardless of drilling method used, the completion of the soil borings followed a consistent methodology, as follows:

- Soil samples were retrieved continuously from grade to the total boring depth using either split-spoons (HSA drilling) or plastic lined core barrels (rotosonic drilling).
- Recovered soil samples were reviewed and screened for VOCs using an organic vapor meter equipped with a photoionization detector (PID).
- Selected samples were submitted for laboratory analyses, as described in Section 4.2.1.3.
- Upon completion, borings not to be completed as monitoring wells were tremie-grouted from the bottom of the boring to grade.

Boring locations were later surveyed for position and ground surface elevation.

Table 4 lists the soil boring identification, drilling method, boring depth, general location and purpose as presented in the RIWP for each boring completed during the RI.

Up to five soil samples were collected from each soil boring and submitted under chain of custody protocols to Severn-Trent Laboratories (STL) of Shelton, CT or CompuChem of Cary, NC, for analysis of the following parameters:

- VOCs by United States Environmental Protection Agency (USEPA) Method 8260B
- SVOCs by USEPA Method 8270C
- Priority Pollutant List (PPL) Metals by USEPA Method 6000/7000
- Total cyanide by USEPA Method 9013A

Analytical reports from the respective laboratories are provided on the accompanying CD. The selection rationale of soil samples for analysis followed the procedures presented in the Remedial Investigation Work Plan (TRC, 2006) and is summarized below.

- Within the vadose zone where, based on PID readings and visual and olfactory observation, the strongest evidence of impacts were identified

- At the soil/water table interface

- Within the saturated zone where, based on PID readings and visual and olfactory observation, the strongest evidence of impacts were identified

- Above the top of the first low permeability unit encountered (if any) in the soil boring

- In borings where impacts were apparent based upon field observations, from the interval of apparently clean material below impacted soil (to provide data for vertical delineation)

The specific soil samples collected during the RI along with the sample date, sample depth and analysis performed are listed in Table 5. Analytical methods, sample-handling procedures and laboratory protocols are outlined in the RIWP. Sample analyses followed the NYSDEC ASP-2000 analytical protocol and included quality assurance/quality control (QA/QC) samples as required by the Quality Assurance/Quality Control Project Plan (QAPP) included with the RIWP.

3.3 Groundwater Investigation

3.3.1 Monitoring Well Installation

Groundwater monitoring wells were installed during the RI to better characterize the groundwater quality and flow at the site as well as to determine the presence or absence of NAPL. Specifically, 20 monitoring wells were installed of which four were installed at St. Emeric's, 11 were installed at Jacob Riis, and five were installed at East River Park. SCS and RI monitoring well locations are shown on Figure 3.

Each monitoring well was installed and constructed in conformance with the following specifications:

- Wells were constructed with 2-inch-inside-diameter (ID), threaded, flush-joint, schedule 40 PVC casing and screen

- Screens were 10 feet long with either 10-slot (0.01-inch) or 20-slot (0.02-inch) openings

- A 2-foot-long PVC well casing blank was added below the screen as a sump if DNAPL was observed during soil sampling

- The annulus around the screens was backfilled with appropriately sized clean silica sand (e.g., Morie No. 1) to a minimum height of 2 feet above the top of the screen

- A bentonite pellet seal with a minimum thickness of 2 feet was placed above the sand pack. The bentonite seal (pellets) was allowed to hydrate before placement of grout above the seal

- The remainder of the annular space was filled with a cement-bentonite grout to near the ground surface. The grout was pumped from the bottom up, and was allowed to set for a minimum of 24 hours before well development

- Each monitoring well had a sealed cap (J-plug) and was contained in a flush-mounted vault. The J-plug keeps surface water from infiltrating into the well during rain events, high water conditions, etc.

- The concrete seal or pad was sloped slightly to channel water away from the well, and was deep enough to remain stable during freezing and thawing of the ground. The vaults and concrete pads were completed so that they would not pose a trip hazard

Table 6 summarizes the monitoring well construction details for each well installed at the site. Appendix A includes the monitoring well construction logs.

Monitoring wells were developed a minimum of 24 hours after installation using pump and surge methods. Prior to development, fluid levels and the total depth for each well were measured to the nearest 0.01 foot using a clean electronic oil/water interface probe. No LNAPL or DNAPL was observed in any of the wells to be developed. Dedicated polyethylene tubing with a foot valve and surge block attached was then lowered to the bottom of each well to begin development. Using a Waterra® inertial pump, the surge block was repeatedly lifted and dropped (surged) across a short section of the well screen, then lifted to surge sequentially higher sections of the screen until the entire length of the well screen had been developed. Development continued until a minimum of three well volumes had been evacuated and/or for a maximum of 2 hours. Periodic water field parameters were measured during the well purging. These parameters included pH, temperature, conductivity and turbidity. As shown on the well development logs, field parameters did not stabilize within the allotted timeframe. Purge water was contained within 55-gallon drums staged at the site.

3.3.2 Groundwater Sample Collection

From August 28 through August 31, 2006 groundwater samples were collected from 17 monitoring wells on the Jabob Riis and St. Emeric's properties (Table 5). On March 5, 2007, groundwater samples were collected from the six monitoring wells located across FDR Drive on the East River Park property (Table 5). Groundwater samples were submitted under chain of custody protocols to Severn-Trent Laboratories (STL) of Shelton, Connecticut or CompuChem for analysis of the following parameters:

- VOCs by USEPA Method 8260B
- SVOCs by USEPA Method 8270C
- PPL Metals by USEPA Method 6000/7000
- Total cyanide by USEPA Method 9013A

Prior to sample collection, each monitoring well was gauged to measure and record the static groundwater level and to determine the presence or absence of NAPL. Measurements were recorded in the field notebook. Water level and NAPL measurements are presented on Table 7.

Low-flow purge and sampling was conducted using peristaltic pumps. Groundwater field parameters measured during purging include conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), pH and temperature. Field parameters were monitored until stabilized following the criteria set forth in the USEPA's SOP #GW0001 for Low Stress/Flow Groundwater Sampling.

Analytical reports from the respective laboratories are provided on the accompanying CD as appendix B.

3.4 Vapor Sampling

Vapor sampling included the collection of indoor air, ambient air, sub-slab vapor samples (where concrete or other impervious surfaces exist within the basement of the sampled structures) or soil gas samples (where earthen floors exist in these structures). The sampling event was conducted in accessible portions of the basements at the Jacob Riis Housing Development, Escuela Hispania Montessori Head Start School (formerly St. Emeric's Roman Catholic School), the Church of St. Emeric's, and the Haven Plaza North Co-Op Apartments. The Vapor Intrusion Air Sampling Work Plan (BBL, October 30, 2006) was developed based on the New York State Department of Health (NYSDOH) *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (October 2006; NYSDOH final guidance document).

A total of 26 indoor air, 4 ambient air and 14 soil gas and/or sub-slab gaseous samples were collected, as listed in Table 5. The sampling locations were consistent with locations from previous vapor sampling work at the site and are illustrated on Figure 4. One outdoor ambient air sample (i.e., background sample located upwind) was collected each day and concurrent with of the indoor air sampling. The sample was collected at a height above the ground to represent breathing zones (approximately 3 to 5 feet above ground surface) and away from wind obstructions (e.g., trees or bushes).

3.4.1 Sampling Methodology

The sub-slab vapor, indoor air and ambient air samples were collected in general accordance with the NYSDOH final guidance document. Each sample was collected using a six-liter SUMMA® canister equipped with an attached pre-set flow regulator. Batch-certified clean canisters with an initial vacuum of approximately 26 inches of mercury were provided by the laboratory for sample collection. Flow regulators were pre-set by the laboratory to provide uniform sample collection over a 24-hour sampling period except where site conditions or constraints necessitated a shorter sampling period. The flow controller/regulator on the SUMMA® canister, as well as with the vacuum in the canister, was used to collect the air samples directly from the subsurface sampling points. The valve on the SUMMA® canister was closed when a minimum of two inches of mercury vacuum remained in the canister, leaving a vacuum in the canister as a means for the laboratory to verify the canister did not leak while in transit.

Based on inspection of the basement areas, one of two different sampling strategies was followed:

- For basements with concrete floors, a ½- to 1-inch diameter hole was drilled through the slab and a sample of the soil gas from beneath the slab was collected using a ¼-inch outside diameter stainless steel probe. The hole was sealed around the probe during sample collection using modeling clay. The probe was then installed into the sub-slab aggregate material (i.e., approximately 2 to 6 inches below the bottom of the slab, depending on conditions encountered). Teflon™-lined tubing was used to connect the sample point to the SUMMA® canister. After installation of the probes, one to three volumes of vapor (i.e., the volume of the sample probe and tube) was purged using the PID prior to collecting the samples. The flow rates for both purging and sample collection did not exceed 0.2 liters per minute. The temporary sample probes were installed and removed the same day that the samples were collected. The sample probes were decontaminated between sampling locations using a low-suds detergent wash and distilled water rinse, followed by drawing of ambient air through the tube via a Gilian pump for a minimum of five minutes.

- A helium tracer gas was used as a QA/QC tool to assess the integrity of the soil vapor probe seal and to confirm that infiltration of air from above the slab did not occur. An inverted plastic bucket was used as an enclosure to keep the tracer gas in contact with the probe during integrity testing, as described in the NYSDOH final guidance document. A portable helium monitoring device was used to analyze a sample of soil vapor prior to and after sample collection. At the completion of sampling, the floor was repaired using a similar material (e.g., Portland cement concrete patch).

- Where the basement inspection indicated that no concrete slab exists (e.g., dirt floor), the tip of the sampling equipment was installed at a depth of 2 to 3 feet below floor elevation within a hand-excavated opening in the floor. The opening was backfilled with the hand-excavated materials and sealed prior to commencing sampling. At dirt floor sampling locations, short circuiting was prevented through the use of a bentonite seal near the ground level. As with the subslab samples, an enclosure with the helium tracer gas was used to assess the integrity of the surface seal, as defined in the NYSDOH final guidance document.

Detailed information was gathered at the time of sampling to document conditions during sampling and to aid in interpreting the test results. The following information was documented in the field book:

- Weather conditions (precipitation, temperature and wind direction) prior to and during the sampling activities

- Date and time (start and end time) each sample was colleted

- Sample identification
- Identification of laboratory samplers/regulators/devices
- Purge volumes
- Volume of air/vapor extracted
- Vacuum pressure of canister (before and after sample was collected)
- Chain of custody identification
- Inventory of potential sources of VOCs in the area of the sampling

3.4.2 Laboratory Analyses

The SUMMA® canisters were shipped in batches to the laboratory within three days of sample collection. Samples were submitted for laboratory analysis in accordance with the USEPA Compendium Method TO-15, entitled *Determination of VOCs in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*. In addition to the TO-15 Target Analyte List, the samples were analyzed for naphthalene, 2-methylpentane, isopentane, 2,3-dimethylpentane, isooctane, indene, indane and thiopene as defined in the Vapor Intrusion Sampling Work Plan.

3.5 Data Usability Assessment

All analytical data were validated by ARCADIS BBL. According to following USEPA guidance documents:

- SOP Number HW-24, Revision 1, June 1999, Validating Volatile Organic Compounds by SW-846 Method 8260B
- SOP Number HW-22, Revision 2, June 2001, Validating Semi-Volatile Organic Compounds by SW-846 Method 8270
- SOP Number HW-2, Revision 11, January 1992, Evaluation of Metals Data for the CLP Program

In accordance with the QAPP, QA/QC samples were collected periodically throughout the RI. Analytical results for the blind duplicate samples and the corresponding sample are presented in the data summary tables. Data usability summary reports (DUSRs) for all laboratory sample delivery groups are presented in Appendix C.

3.6 Investigation-Derived Waste Management

Investigation-derived waste (IDW) generated during the RI included:

- Drill cuttings
- Development and purge water
- Personal protective equipment
- Sampling equipment

All IDW was placed in Department of Transportation (DOT)-approved 55-gallon closed-topped drums. The drums were labeled as investigation-derived waste and temporarily stored in a secured area designated by Con Edison. The drums were stored on wooden pallets in a plastic-lined containment area until waste characterization results were received from the analytical laboratory (CompuChem or STL). Once the waste characterization results were received the IDW was transported offsite and disposal at a Con Edison-approved disposal facility.

3.7 Survey

Munoz Engineering, P.C. completed a detailed survey of all investigation locations, including position, surface elevation, and, in the case of monitoring wells, measuring-point elevations. The elevations shown in this report are in Borough President of Manhattan Vertical Datum, which is 2.75 feet above mean sea level at the National Oceanic and Atmospheric Administration (NOAA) station No. 8531680 located in Sandy Hook, New Jersey. All surface coordinates are shown in NAD 83 New York State Plane Coordinate System.

4. Field Observations and Findings

This section summarizes field observations including geology, hydrogeology, and MGP-related impacts. This summary is based on information obtained from published sources and from the 40 RI soil borings, 40 SCS borings, 15 SCS test trenches, and 27 groundwater monitoring wells.

4.1 Regional Geological Setting

Bedrock beneath the site is gneiss of the Ravenswood Unit (Baskerville, 1994), located at least 90 feet below ground surface (bgs). None of the soil borings completed during the SCS or RI encountered bedrock.

Overburden materials at the site include - from the surface downward - fill, alluvium and glacial deposits. The fill material consists of typical urban debris including reworked gravel, sand and clay as well as various types of anthropogenic material such as concrete, brick, ash, cinder, glass etc. The alluvium and glacial deposits consist of interbedded well-sorted gravel, sand, silt and clay.

Most of the fill materials were placed during filling of the river to extend usable land surface eastward during the 19th and early 20th centuries by constructing timber cribbing and filling in it with cinders, ash, and spoils from construction sites. The historic Manhattan shoreline had been located along the south side of East 13th Street and the west side of Avenue D Areas north of East 13th Street and east of Avenue D were under water prior to being filled (Baskerville, 1994). This was confirmed by historic Perris & Browne maps and Sanborn Fire Insurance maps reviewed by ARCADIS BBL. The bulkhead in the 1850's ran along the west side of Avenue D, inland from the original shoreline. By 1879 the shoreline had been extended east of the current location of FDR Drive. The bulkhead in 1920 extended even farther into the East River in some locations, while in the northern portion of the site the 1920 bulkhead was inland when compared to the 1879 shoreline. Historic shoreline locations are shown on Figure 3 and are indicated in the cross sections where applicable.

Groundwater is typically first encountered in the fill or alluvial deposits. Groundwater flow is generally toward the East River with minor deviations due to underground structures or conduits.

4.2 Site Geology

Three stratigraphic units were encountered during the SCS and RI; Fill Unit, Sand-Silt Unit and Silty-Clay Unit. The Fill Unit was the uppermost unit encountered of which the top represents the present-day surface of the site. The Fill Unit is underlain by the Sand-Silt Unit which is underlain by the Silty-Clay Unit. These units are depicted on six generalized cross-sections (Figures 5 through 10). Cross sections A-A', B-B' and E-E' trend east to west, while cross sections C-C', D-D', and F-F' trend generally north-south. Cross section locations and the associated boring locations included in each cross-section are shown on Figure 3. The inferred shallow water table surface, location of former MGP structures, and visual observations of impacts are also depicted in each of the cross-sections. Note that the inferred bottom elevation of the East River depicted on the cross-sections is based on soundings in the East River as shown on the National Oceanic and Atmospheric (NOAA) Nautical Chart No. 12335 dated April 2000.

Each of the stratigraphic units encountered at the property are described in further detail below.

4.2.1 Fill Unit

The Fill Unit comprises materials typically found in urban environments such as Manhattan (urban fill). The Fill Unit consists of construction debris (brick, cinders, ash, and wood) intermingled with undifferentiated brown to black sand, cobbles, gravel and silt.

The thickness of the Fill Unit ranges from 7 to 30 feet. The thickness of this unit generally increases from west to east, consistent with the progressive extension of the East River shoreline during the 19th and early 20th centuries (Figures 5, 6 and 9). The maximum thickness of 30 feet was observed in the northeastern portion of the site (Figure 8).

4.2.2 Sand-Silt Unit

The Sand-Silt Unit underlies the Fill Unit and consists of fine to medium sand with silt and clay lenses and trace gravel lenses.. Organic material and shell fragments were also observed in the Sand-Silt Unit, pointing to the inferred alluvial origin of this unt. The Sand-Silt Unit is laterally continuous beneath the site and varies in thickness from 10 feet to 35 feet (Figures 5 through 10). In general the Sand-Silt Unit thickens from east to west with the greatest thickness encountered in borings SB-133, SB-133, and SB-134 located on St. Emeric's and Haven Plaza properties (Figures 5 and 9).

4.2.3 Silt-Clay Unit

The Silt-Clay Unit underlies the Sand-Silt Unit and consists of variably colored silt and clay with trace fine sand. The Silty-Clay Unit was encountered in most soil borings completed during the RI that were located on the Jacob Riis and East River Park properties (Figures 5 through 10), with the exception of borings MW-107B, SB-108, and SB-109, located on the northern edge of the Jacob Riis property. The Silt-Clay Unit was not encountered in soil borings completed on the western portion of St. Emerics and Haven Plaza properties (Figures 5 and 9). As per the RIWP each of the borings located on St. Emeric's and Haven Plaza was advanced to a maximum depth of 50 feet bgs. Since the Silt-Clay Unit was not encountered it is unknown if this unit is absent or present below 50 feet bgs. The thickness of the Silty-Clay Unit beneath the site is unknown.

The inferred elevation of the top of the Silty-Clay Unit is illustrated in Figure 11. The elevation contours in Figure 10 were generated using all soil borings that were advanced to the Silt-Clay Unit during the SCS and RI. From Figure 11, the Silt-Clay Unit is shallowest in the area beneath Jacob Riis buildings No. 2 and 3. (also see Figures 5 and 7). In this area the depth to the Silt-Clay Unit is approximately 25 feet bgs. As illustrated in Figure 11 the depth to the Silt-Clay Unit increases to the north and toward the East River.

4.3 Site Hydrogeology

Based on lithologic properties the Fill and Sand-Silt Units appear to be permeable units whereas the Silt-Clay Unit appears to be semi-confining. In most soil borings completed during the SCS and RI saturated soil conditions were first encountered in the Fill Unit and as such the Fill Unit along with the Sand-Silt Unit represents a shallow unconfined aquifer (or water table aquifer).

Groundwater elevations in the water table aquifer are illustrated on Figure 12. Groundwater contours were developed using depth to groundwater measurements collected on March 5, 2007 in each of the shallow wells installed during the RI. Note as previously discussed shallow monitoring wells were screened across the water table surface (see Table 6 for monitoring well construction details). From Figure 12, shallow groundwater appears to flow in a radial pattern from a groundwater mound centered in the vicinity of MW-115A and MW-121A.

From Figure 12, horizontal hydraulic gradients in the water table range from 0.01 feet/feet near MS-130A to 0.004 feet/feet north of MW-115A. A comparison of water levels in adjacent wells screened across the water table as well as deeper in the Sand-Silt Unit (i.e. paired wells) indicates that both downward and upward vertical hydraulic gradients exist at the site. Downward hydraulic gradients are present in the paired wells MW-107, MW-111, MW-121, MW-122, and MW-125. The greatest downward vertical gradient was measured between MW-121A and MW-121B which suggests an area of recharge. Upward hydraulic gradients are present in the paired wells MW-127, MW-128, and MW-130 which are each located adjacent to the East River. Upward hydraulic gradients in these wells indicate that shallow groundwater discharges to the East River. Note that surface water elevations in the East River in the area of the site are influenced by tides. According to NOAA, the mean tidal range at the Williamsburg Bridge (NOAA station no. 8518687), located about 0.6 miles south of the site, is 4.2 feet. Water elevations based on NAVD typically range from 2.0 feet to -2.0 feet.

4.4 Field Observations of MGP-related Impacts

This subsection presents the field observations of potential MGP-related impacts and remnants of former MGP structures, as well as an assessment of the distribution of MGP-related impacts and NAPL relative to potential source areas.

4.4.1 Potential Sources of Impacts

Former MGP structures located on the East 11th Street Works included gas holders, above and below ground fuel oil tanks, a retort house, a scrubber house, an oil separating house, a superheating house, purifying and condenser houses, and a coal shed.

By 1868 there were four gas holders in St Emeric’s and at least nine gas holders of different sizes in the Jacob Riis portion of the site. By 1920 most of these gas holders had been replaced by larger structures. A 4,225,000 cubic feet gas holder and 5,000,000 cubic feet gas holder were located on the western portion of Jacob Riis. Gas holder No. 9 (5,000,000 cubic feet in size) occupied the eastern portion of St Emeric’s. Some of the smaller holders used as gas holders in 1868 on the northeastern portion of Jacob Riis were later used as tar tanks or gas oil tanks in the 1900’s. The former location of MGP structures is shown on Figure 3.

In addition to the potential MGP sources at the site, other non-MGP related sources of hydrocarbons were identified during the SCS within a ½-mile radius of the site, including 24 leaking storage tank incidents. Given the historic commercial use of the vicinity of the site, unidentified potential sources have likely impacted the subsurface quality at the site.

4.4.2 Field Observations of Potential Impacts

Both petroleum and MGP-related impacts were observed during the SCS and the RI. Evidence of impacts included odors, staining, sheens, oil-like material (OLM) and tar-like material (TLM). RI field observations in conjunction with those made during the SCS are summarized in Table 9 and presented graphically in Figures 13 through 17. As noted above field observations of sheen, OLM, and TLM are also depicted on the cross-sections in Figures 5 through 10.

From Table 9, petroleum, gasoline, solvent-like, and MGP odors were identified during the SCS and RI.

For the purposes of this report, OLM is used to denote visible contamination that may be of petroleum or MGP origin that has an apparent viscosity similar to oil, while TLM are used to denote black, highly viscous material (including material that appears to be solid) likely of MGP origin.

In general, sheens, OLM and TLM were only observed in the Fill and Sand-Silt Units, with the majority of the impacts occurring in the Fill Unit. Sheens, OLM and TLM were not observed in the Silty-Clay Unit indicating the Silty-Clay Unit acts as a confining layer to the downward migration of OLM and TLM. For example as illustrated in Figure 5 (cross-section A-A') in SCS boring B-32 TLM, OLM and sheens were observed through the Fill and Sand-Silt Units but not in the underlying Silty-Clay Unit.

Figures 13 through 17 illustrate the distribution of OLM, TLM, and sheens in subsurface soil at 10-foot intervals. For example the distribution of OLM, TLM, and sheens from 0 to 10 feet bgs is shown on Figure 13. Only borings which extended to the depth interval illustrated on the figure are shown on the figure.

The distribution of sheens, OLM and TLM within the 0 to10 foot subsurface interval are illustrated in Figure 13. For the most part this depth interval consists of the Fill Unit (Figures 5 and 8). From Figure 13, OLM and TLM are limited to the eastern half of the Jacob Riis property north of building nos. 1, 7, and 8. As shown on Figure 3, this area corresponds to the primary location of MGP operations. The majority of the OLM and TLM observed within this interval were present between seven and 10 feet bgs (see Table 9). Exceptions included soil boring B-5 in which OLM was observed from three to five feet bgs and test trench TT-16 in which a seam of TLM was observed between two and four feet bgs. No OLM or TLM was observed within this interval at the East River Park, St. Emeric's and Haven Plaza properties.

The distribution of sheens, OLM and TLM within the 10 to 20 foot subsurface interval are illustrated in Figure 14. This depth interval consists mostly of the Fill Unit in the eastern half of the site and the Fill and Silty-Sand Units in the western half of the site. From Figure 14, the distribution of OLM and TLM is more widespread in the 10 to 20 foot interval than the 0 to 10 foot interval. In addition to the Jacob Riis property, TLM and OLM were observed in the 10 to 20 foot interval at the East River Park and St. Emeric's properties.

The distribution of sheens, OLM and TLM within the 20 to 30 foot subsurface interval are illustrated in Figure 15. For the most part this depth interval consists of the Sand-Silt Unit (Figures 5 and 8). The distribution of OLM and TLM within the 20-30 foot interval is similar to the distribution of TLM and OLM in the 10 to 20 foot interval.

The distribution of sheens, OLM and TLM within the 30 to 40 foot subsurface interval are illustrated in Figure 16. For the most part this depth interval consists of the Silt-Clay Unit (Figure 11). From Figure 16, the only observation of TLM and OLM in this interval occurs in the northeast portion of the Jacob Riis property where the Sand-Silt Unit is present at this depth interval (Figure 5 and 8).

The distribution of sheens, OLM and TLM within the 40 to 50 foot subsurface interval are illustrated in Figure 17. From Figure 17, no OLM or TLM was observed within the 40 to 50 foot subsurface interval. A sheen was observed in SB-127 located on the East River Park property.

As noted above two rounds of water level and NAPL measurement were completed during the RI. Results of the NAPL measurement are provided in Table 7. Measurable DNAPL was identified in three monitoring wells (MW-3, MW-5, and MW-111B) in August 2006. Measured DNAPL ranged from 0.3 to 1.6 feet. Each of these wells are screened in the Sand-Silt Unit and located in or adjacent to potential source areas along the eastern edge of the Jacob Riis property. Measurable DNAPL was not identified in any of the wells during the March 2007 groundwater sampling event. However, DNAPL was detected on the monitoring probe used to measure DNAPL in

MW-1, MW-5, and MW-111B. MW-1 is located on St. Emeric's property within the footprint of a former gas holder.

5. Analytical Results

This section presents the environmental conditions present in surface soil, subsurface soil, groundwater, soil vapor and indoor air. The discussion is based on environmental samples and field observations collected during the SCS and RI field investigative phases of the remedial investigation. Analytical results are provided in tabular form for each environmental media. Where appropriate applicable analytical data for each medium are compared to cleanup objectives and/or screening criteria to identify *constituents of potential concern* (COPCs). COPCs are defined as any constituent that is detected at a concentration greater than a cleanup objective or screening value. Note that analytical results which exceed the SCO/groundwater standards or guidance values are bolded and shaded gray in the summary tables. The environmental conditions in each sample media are also illustrated in figures as an aid to evaluate the vertical and horizontal distribution of target compounds at the Site.

Based on the data validation as discussed in the DUSRs, it is concluded that the data quality is usable for the purposes of satisfying the project objectives.

5.1 Screening Criteria

Surface and subsurface soil data were compared to 6 NYCRR Part 375 Unrestricted Use Soil Cleanup Objectives (SCOs) (NYSDEC, 2006). These SCOs represent the most conservative values of the human health, groundwater, and ecological SCOs. Specifically, the human-health based SCOs were developed to represent exposure of a child resident and an adult resident to soils via ingestion, inhalation, dermal contact, and through consumption of homegrown vegetable and animal products. The groundwater SCOs are protective of groundwater via the soil to groundwater migration pathway (i.e., soil leaching and groundwater transport). The ecological SCOs are protective of ecological resources (i.e., wildlife). The final unrestricted use SCOs also incorporate the rural soil background concentrations determined by the NYSDEC/NYSDOH rural soil survey (NYSDEC, 2006). For purposes of this analysis, if the final unrestricted use SCO was the ecological SCO, the lower of the human health and groundwater SCO was used instead.

For groundwater, standards and/or guidance values from the NYSDEC (1998) Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations were used to identify COPCs. Specifically, Class GA standards and guidance values were used to screen groundwater data. These standards and guidance values are considered protective of drinking water sources.

Air samples were collected as part of the SC and RI to determine if there is a complete transport pathway of MGP-related VOCs from soil gas and/or subslab vapor to indoor air. Note that benzene, toluene, ethylbenzene, xylene(s) (BTEX) and naphthalene are the most likely MGP-related VOCs that may be present in air or soil vapor. If a complete transport pathway for MGP-related VOCs exists in indoor air then both of the following environmental conditions must be present:

- The same compound must be present in indoor air and ambient air or soil vapor
- The concentration in ambient air or soil vapor must be greater than the concentration in indoor air

Note the second condition assumes there is no indoor source of BTEX or naphthalene present.

Indoor air sample results were compared to ambient air, soil gas and subslab vapor results as well as the 75th percentile, 90th percentile and upper fence (Upper F) criteria of the NYSDOH 2003 Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes (NYSDOH, 2006). Even though the indoor air samples were collected in buildings that are not heated by fuel oil, the 2006 NYSDOH guidance states “the Upper Fence values from the NYSDOH Fuel Oil Study data may be used as initial benchmarks when evaluating residential indoor air”. Note that the state of New York does not have any standards, criteria or guidance values for concentrations of volatile chemicals in subsurface vapors including soil vapor and subslab vapor (NYSDOH, 2006).

5.2 Surface Soil

The evaluation of the environmental conditions in surface soil is based on 59 surface soil samples collected at the Jacob Riis property and five surface soil samples collected at the St. Emeric’s. All surface soil samples were collected during the site characterization. Surface soil samples were collected from the 0 to 0.2 ft bgs interval. Validated analytical results for VOCs, SVOCs, and inorganics including cyanide surface soil samples are provided in Tables 10, 11, and 12 respectively. PCB analytical results are also provided in Table 11. In addition to individual compound results the total VOC and total SVOC content for each surface soil sample is provided in Table 10 and 11 respectively. The NYSDOH benzo(a)pyrene total equivalency factor is also provided in Table 12. Summary statistics including the minimum and maximum detected concentration, total number of samples, number and percent of each compound detected and number and frequency of samples detected above the SCO is provided in Table 13.

5.2.1 VOCs

From Table 10, VOCs were detected in two surface soil samples. Toluene was detected in sample SS-2 located in the northeast portion of the Jacob Riis houses and cyclohexane (a possible laboratory contaminant) was detected in sample SS-14 located in the southwest portion of the Jacob Riis houses (Figure 18). Note the detected concentration of toluene in SS-2 (2.4 ug/kg) is less than the unrestricted use SCO of 700 ug/kg.

5.2.2 SVOCs

From Table 11, SVOCs detected in surface soil included polycyclic aromatic hydrocarbon (PAH) compounds as well as other SVOCs including bis(2-ethylhexyl)phthalate, carbazole, 2-Methylnaphthalene, dibenzofuran, di-n-butylphthalate, butylbenzylphthalate, 1,1-Biphenyl, 4-Nitrophenol, and di-n-octyl phthalate

Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in each surface soil (Table 13). Except for dibenz(a,h)anthracene the other PAH compounds were detected in at least 50 percent of the surface soil samples.

Total SVOC concentrations which for the most part are based on the PAH compound concentrations ranged from 1,900 ug/kg to 469,000 ug/kg in SS-3, located in the northeast portion of the Jacob Riis area. Total SVOC concentrations in the St. Emeric's property ranged from 13,800 ug/kg to 28,500 ug/kg. Total SVOC concentrations in surface soil at Jacob Riis varied over three orders of magnitude with the majority of the total SVOC concentrations between 10,000 ug/kg and 100,000 ug/kg. Total SVOC concentrations greater than 100,000 ug/kg were detected in surface soil samples SS-4 (148,000 ug/kg), SS-17A (176.000 ug/kg), SS-17 (203,000 ug/kg), SS-16A (224, 000 ug/kg) and SS-3 (469,000 ug/kg). SS-16, SS-17 and SS-17A were located in the southeast portion of Jacob Riis and SS-3 and SS-4 were located in the northeast portion of Jacob Riis (Figure 18).

Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and dibenz(a,h)anthracene were detected above the unrestricted use SCO at the Jacob Riis and St. Emeric's properties.

5.2.3 Inorganics, Cyanide and PCBs

Each of the priority pollutant inorganics were detected in surface soil (Table 12). Arsenic, barium, chromium, lead and mercury were detected in each surface soil sample. Cyanide was detected in two surface soil samples (SS-22 and SS-23) located on St. Emeric's property. PCB's were detected in six surface soil samples at concentrations below the unrestricted use soil cleanup objective of 0.1 ppm. The maximum arsenic concentration was observed in sample SS-13. Maximum concentrations of chromium and lead were found in samples SS-2 and SS-3, respectively, which are located in the northeast section of Jacob Riis. Sample SS-17, which is located in the southeast section of Jacob Riis, had the highest mercury concentration.

From Table 13, the surface soil concentration of chromium, lead and mercury exceeded the unrestricted use SCO in each surface soil sample. Other inorganics which are present at concentrations above their respective unrestricted use SCO include arsenic and silver.

5.3 Subsurface Soil

The evaluation of the environmental conditions in subsurface soil is based on 24 test trench soil samples and 87 soil boring subsurface soil samples collected during the site characterization and 129 subsurface soil samples collected during the RI. Validated analytical results for VOCs, SVOCs, inorganics including cyanide, and PCBs in subsurface soil samples are provided in Tables 14 through 19 as follows.

Table	Description
14	Summary of VOCs in Test Pit Trenches – Site Characterization Samples
15	Summary of SVOCs in Test Pit Trenches – Site Characterization Samples
16	Summary of Inorganics, Cyanide and PCBs in Test Pit Trenches
17a	Summary of VOCs in Subsurface Soil – Site Characterization Samples
17b	Summary of VOCs in Subsurface Soil – Remedial Investigation Samples
18a	Summary of SVOCs in Subsurface Soil – Site Characterization Samples
18b	Summary of SVOCs in Subsurface Soil – Remedial Investigation Samples

Table	Description
19a	Summary of Inorganics, Cyanide and PCBs in Subsurface Soil – Site Characterization Samples
19b	Summary of Inorganics and Cyanide in Subsurface Soil – Remedial Investigation Samples

Summary statistics including the minimum and maximum detected concentration, total number of samples, number and percent of each compound detected and number and frequency of samples detected above the SCO is provided in Table 20. Note for this discussion SCS and RI subsurface soil samples collected from test pit trenches and soil borings are discussed together.

5.3.1 VOCs

Validated analytical results for VOCs are provided in Tables 14, 17a and 17b. From Table 20, the benzene, toluene, ethylbenzene, and xylene (BTEX) compounds as well as isopropylbenzene, 1,3,5-trimethylbenzene and carbon disulfide were detected in more than 10 percent of the subsurface soil samples. m/p-xylene was the most prevalent VOC detected in subsurface soil. Total VOC concentrations ranged from 0.84 ug/kg to 4,720,000 ug/kg

The distribution of VOCs in subsurface soil at the St. Emeric's and Haven Plaza properties that are present above their respective unrestricted use SCO is illustrated in Figure 19. Total VOCs in subsurface at the St. Emeric's and Haven Plaza properties range from non-detect to 31,900 ug/kg in sample B-TT1 at depth of 12 feet bgs.

Individual VOCs present at St. Emeric's and Haven Plaza with concentrations greater than their unrestricted use SCO include acetone (a common laboratory contaminant), benzene, ethylbenzene, toluene, xylene, and methylene choride (another common laboratory contaminant).

The distribution of VOCs, including total VOCs, in subsurface soil at Jacob Riis and the East River Park that are present above their respective unrestricted use SCO is illustrated in Figure 20. Total VOC concentrations greater than 10,000 ug/kg (10 mg/kg) were detected throughout the Jacob Riis and East River Park properties at depths ranging from 5 feet to 32 feet bgs. Note that one sample (SB-126 46-47 feet) collected at the East River Park property contained at total VOC concentration of 2,160,000 ug/kg. Total VOC concentrations greater than 1,000,000 ug/kg were limited to the northeastern portion of the Jacob Riis property and the northern portion of the East River Park at depths ranging from 17 feet to 47 feet bgs (SB-126). Total VOC concentrations greater than 100,000 ug/kg were generally found in the northern half of the Jacob Riis and East River Park properties Total VOC concentrations below 32 feet bgs (except for SB-126 noted above) were less than 10,000 ug/kg.

5.3.2 SVOCs

Validated analytical results for SVOCs in subsurface soil are provided in Tables 15, 18a and 18b. From Table 20 each of the PAHs as well as 2-methylnaphthalene 1,1-biphenyl, dibenzofuran, bis(2-ethylhexyl)phthalate, and carbazole were detected in at least 10 percent of the subsurface soil samples:

Except for dibenz(a,h)anthracene each of the PAHs were detected in ay least 50 percent of the subsurface soil samples. The concentration of individual PAH compounds ranged seven orders of magnitude from less than 100 ug/kg to more than 10,000,000 ug/kg. Each of the PAH compounds as well as dibenzofuran, phenol and p-cresol were detected at concentrations above their respective unrestricted use SCO.

The distribution of SVOCs in subsurface soil at St. Emeric's and Haven Plaza for those compounds that exceed their respective SCO is illustrated in Figure 21. From Figure 21, total SVOC concentrations greater than 500,000 ug/kg (500 mg/kg) were detected at SB-131 (7-8 feet bgs) and SB-104 (20-21 feet bgs). The distribution of individual PAHs at concentrations greater than their SCO appear limited to the upper 37 feet of the subsurface soil.

The distribution of SVOCs in subsurface soil at the Jacob Riis and East River Park properties for those compounds that exceed their respective SCO is illustrated in Figure 22. Similar to the distribution of the VOCs in subsurface soil, total SVOCs greater than 500,000 ug/kg typically occur throughout the Jacob Riis and East River Park properties in the 15 foot to 35 foot subsurface soil horizon. Subsurface soil samples collected below 35 feet bgs typically contained individual PAH concentrations less than their respective SCO and total SVOC concentrations less than 10,000 ug/kg. However, two subsurface soil samples collected below 35 feet contained total SVOC concentrations greater than 500,000 ug/kg (SB-126 collected at 46-47 feet bgs and SB-128 collected at 43-44 feet bgs). Both of these samples were collected at East River Park.

5.3.3 Inorganics, Cyanide and PCBs

Validated analytical results for inorganics, cyanide and PCBs are provided in Tables 16, 19a and 19b. From Table 20 each of the 14 priority pollutant analytes as well as barium were detected in more than 10 percent of the subsurface soil samples. Each of the priority pollutant analytes were detected above their respective SCO in at least one sample. PCB's were detected in four subsurface soil samples at concentrations below the unrestricted use soil cleanup objective of 0.1 ppm..

The distribution of inorganics in subsurface soil at St. Emeric's and Haven Plaza is illustrated in Figure 23. In general, from Figure 23 inorganics are present throughout the St. Emeric's and Haven Plaza properties at concentrations above their respective SCO. Similarly the distribution of inorganics in subsurface soil at the Jacob Riis and ERPP properties as illustrated in Figure 24 indicates that inorganic concentrations above their respective SCO are present throughout the subsurface.

The distribution of total VOCs and total SVOCs at each of the four Works properties is illustrated in Figure 25. In Figure 25, a circle divided into halves is used to represent the total VOC and total SVOC concentration to 10,000 ug/kg and 500,000 ug/kg respectively. The left half of the circle represents the total VOC concentration in which green and red are used to denote concentrations less than or greater than 10,000 ug/kg respectively. The right half of the circle represents the total SVOC in which green and red are used to denote concentrations less than and greater than 500,000 ug/kg respectively. Note that the highest concentration detected at each soil boring/monitoring well location was used to develop Figure 25.

From Figure 25, total VOC concentrations greater than 10,000 ug/kg in subsurface soil are present at the St. Emeric's, Haven Plaza, Jacob Riis, and the East River Park properties. The majority of the locations where total VOC concentrations are greater than 10,000 ug/kg occur at Jacob Riis where most of the Works operations were located. Total SVOC concentrations greater than 500,000 ug/kg in subsurface soil occur at the St Emeric's (one location), Jacob Riis, East River Park properties. As with the total VOC concentration, the majority of the locations where the total SVOC concentration was greater than 500,000 ug/kg occurs at the Jacob Riis property. Note that the total SVOC concentration at each of the East Rive Park sample locations was greater than 500,000 ug/kg.

5.4 Groundwater

The evaluation of the environmental conditions in groundwater is based on three rounds of groundwater sampling completed in October 2004, August 2006 and March 2007. Validated groundwater analytical results for each round of groundwater sampling are provided in Tables 21 through 23. Since additional well were installed during the RI this section will focus on the groundwater analytical results from August 2006 and March 2007. Note that in March 2007 only the wells located on the East River Park property were sampled. Summary statistics including the minimum and maximum detected concentration, total number of samples, number and percent of each compound detected, and number and frequency of samples detected above the Class GA groundwater standard is provided in Table 24.

5.4.1 VOCs

Validated VOC analytical results for groundwater samples collected during the SCS are provided in Table 21a. Groundwater results from the two rounds of groundwater sampling completed during the RI are provided in Table 21b. From Table 21b the BTEX compounds as well as 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2-butanone, carbon disulfide, chloroform, cyclohexane, isopropylbenzene, methyl acetate, methylcyclohexane, methyl tertiary-butyl ether (MTBE), and styrene were detected in at least one groundwater sample.

From Table 21b, 21 of the 23 groundwater samples contained at least one VOC. Benzene was the most prevalent VOC, detected in 18 out of 23 groundwater samples. Other VOCs detected in at least 50 percent of the groundwater samples included toluene, ethylbenzene, xylenes, 1,2-4-trimethylbenzene, and isopropylbenzene. Total detected VOC concentrations in groundwater ranged five orders of magnitude from 0.16 MW-121B to 24,600 ug/L in MW-127B. Note from Table 6 MW-127B is located on the ERPP property and is screened from 40-50 feet bgs in the sand-silt layer. Other groundwater samples in which the total VOC content was greater than 1,000 ug/L included MW-2 (1,030 ug/L) and MW-128B (1,350 ug/L).

1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, chloroform, ethylbenzene, isopropylbenzene, toluene, and xylenes were detected in groundwater at concentrations above their Class GA groundwater standard.

The distribution of these compounds at St Emeric's and Haven Plaza is illustrated in Figure 26. The highest total VOC concentration (665 ug/L) in groundwater at St

Emeric's occurred in MW-104B in which TLM was observed in subsurface soil. MW-1 and MW-103A which are located hydraulically downgradient of MW-104B (see Figure 12) also contained elevated concentrations of VOCs.

The distribution of the VOCs detected in groundwater above their Class GA standard at the Jacob Riis and East River Park properties is illustrated in Figure 27. In general the VOC concentrations in the deeper screened "B" designated monitoring wells is greater than the VOC concentration in the shallow "A" designated monitoring wells. This is consistent with findings of the soil boring program in which the greatest impacts in the subsurface were identified in the zones where the "B" wells are screened. In addition the distribution of VOCs in groundwater appear to be more related to the presence of isolated residual impacts (TLM/OLM) than to a well-defined groundwater plume that has developed as a result of groundwater transport.

5.4.2 SVOCs

Validated SVOC analytical results for groundwater samples collected during the SCS are provided in Table 22a. Groundwater results from the two rounds of groundwater sampling completed during the RI are provided in Table 22b. From Table 22b acenaphthene, acenaphthylene, anthracene,benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene, were detected in at least on groundwater sample:

Other SVOCs detected in at least one sample included 1,1-biphenyl, 2-4-dimethylphenol, 2-methylnaphthalene. 2-methylphenol, acetophenone, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, di-n-butylphthalate, p-cresol, and phenol,

From Table 24, acenaphthene, naphthalene, and fluorene where detected in more than 50 percent of the groundwater samples. Detected PAH concentrations varied over four orders of magnitude from less than 1 ug/L to 4,700 ug/L (naphthalene). Total SVOC concentrations ranged from non-detect in two samples to 5,880 ug/L in MW-127B. As noted above NW-127B is located adjacent to the East River in the East River Park property.

1,1-biphenyl, 2-4-dimethylphenol, 2-methylphenol, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, p-cresol, phenanthrene, and phenol, were detected above their respective Class GA 2 standard.

The distribution of SVOCs in groundwater at the St. Emeric's and Haven Plaza properties is illustrated in Figure 26. As with the distribution of VOCs in groundwater discussed above, the highest total SVOC concentration (1,660 ug/L) in groundwater at St Emeric's occurred in MW-104B in which TLM was observed. MW-1 and MW-103A which are located hydraulically downgradient of MW-104B (see Figure 12) also contained elevated concentrations of SVOCs.

The distribution of SVOCs at the Jabob Riis and East River Park properties is illustrated in Figure 27. For the most part the distribution of SVOCs in groundwater mimics the distribution of VOCs in groundwater discussed above.

The distribution of benzene in groundwater at each of the four Works properties is illustrated in Figure 28. A green circle denotes location where the benzene concentration was less than Class GA standard of 1 ug/kg. A red circle denotes locations where the benzene concentration was greater than 1 ug/kg. From Figure 28, 18 of the 25 groundwater samples collected during the RI contained a benzene concentration greater than 1 ug/kg. This includes five of the six groundwater samples collected at the St Emeric's property and each of the six samples collected at East River Park. Benzene concentrations in groundwater less than 1 ug/kg where detected in monitoring wells located along the northern and southern boundary of the Works area.

5.4.3 Inorganics and Cyanide

Validated inorganic analytical results for groundwater samples collected during the SCS are provided in Table 23a. Groundwater results from the two rounds of groundwater sampling completed during the RI are provided in Table 23b. Nickel, arsenic, cyanide, copper, cadmium, zinc, chromium, lead, mercury, and silver were detected in at least one groundwater sample collected during the RI.

Of the inorganic analytes detected, nickel, arsenic, cyanide, copper, and cadmium where detected in at least 50 percent of the groundwater samples collected during the RI (Table 24). Copper, lead and mercury were the only inorganic analytes detected above their respective Class GA standard.

5.5 Air Sampling Results

Analytical results for indoor air, soil vapor and soil gas, and ambient air samples are presented in Tables 25, 26, and 27 respectively. Air sample locations are provided in Figure 4.

5.5.1 Jacob Riis

A total of 18 indoor air samples were collected at the Jacob Riis complex. Samples were collected in five buildings, with three or four samples collected at the lowest floor level of each building. From Table 25 BTEX and naphthalene were detected in indoor air samples. The maximum concentration of benzene, toluene, o-xylene, and m-p-xylene was below the 75th percentile of the NYSDOH indoor air background data (NYSDOH, 2006). The ethylbenzene concentration of one sample was greater than the 75th percentile but less than Upper Fence value and 90th percentile. The concentration of ethylbenzene in all other samples was less than the 75th percentile background concentration.

Several non-MGP related compounds including 1,4-Dichlorobenzene, 1,2 Dichloro-1,1,2,2-tetrafluoroethane, chloroform, methylene chloride, n-Undecane, tetrachloroethene, and vinyl chloride were detected in indoor air samples at the Jacob Riis complex at concentrations above the NYSDOH background Upper Fence Criterion.

From Table 26, BTEX and naphthalene were detected in sub-slab and soil vapor samples collected at the Jacob Riis property. In general, BTEX and naphthalene concentrations detected in sub-slab and soil vapor samples were on average about one order of magnitude higher than concentrations detected in indoor air samples.

5.5.2 Saint Emeric's

Eight indoor air samples were collected from the Escuela Hispana Montessori School and the Church of Saint Emeric's (Figure 4). From Table 25, each the BTEX compounds were detected in indoor air samples collected at St. Emerics property. Naphthalene was not detected in any of the samples collected at St. Emeric's property. The maximum concentration of benzene, ethylbenzene, o-xylene, and toluene was below the 75th percentile of the NYSDOH indoor air background data. The m,p-xylene concentration of one sample was greater than the 75th percentile but less than Upper Fence value and 90th percentile. The concentration of m,p-xylene in all other samples was less than the 75th percentile background concentration.

1,1,1-Trichloroethane and chloroform, both of which are non-MGP related compounds, were detected in indoor air samples at the St. Emeric's property at concentrations above the NYSDOH Upper Fence criterion

From Table 26, BTEX and naphthalene were detected in sub-slab and soil vapor samples collected at the St. Emeric's property. In general, BTEX and naphthalene concentrations detected in sub-slab and soil vapor samples were on average about one order of magnitude higher than concentrations detected in indoor air samples.

6. Qualitative Human Health Evaluation

This section of the RI presents a qualitative human health exposure assessment (HHEA) that evaluates the potential for human exposure to MGP residuals at the Site. This HHEA is conducted consistent with the NYSDOH guidance as presented in *Draft DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDOH, 2002) and uses information regarding current and foreseeable land uses and available site data to evaluate the potential for exposure of human receptors. The HHEA includes an identification of the site-specific COPCs, an evaluation of contaminant fate and transport for the primary COPCs and the identification and characterization of complete exposure pathways. The results of this qualitative HHEA will be used, in part, to help evaluate proposed remedial actions for the site.

6.1 Site-Specific COPCs

The site-specific COPCs for surface soil, subsurface soil, groundwater, indoor air and soil vapor are presented n Table 28. From Table 28, SVOCs including the PAH compounds and inorganics are considered COPCs in surface soil, subsurface soil and groundwater. VOCs including the BTEX compounds are considered COPCs in subsurface soil and groundwater.

6.2 Contaminant Fate and Transport

The following discussions of environmental fate and transport for primary COPCs are taken from the toxicological profiles provided by the Agency for Toxic Substances and Disease Registry (ATSDR).

6.2.1 Benzene

The environmental fate and transport of benzene is primarily attributed to its high volatility (ATSDR, 1997). In soil, benzene partitions to the atmosphere through volatilization, to surface water through runoff, and to groundwater through leaching. Bioaccumulation of benzene in the aquatic food chain generally does not occur, and there is no scientific evidence of biomagnification. Aerobic biodegradation is the primary mechanism for degradation of BTEX in soils, surface water, and groundwater.

6.2.2 Toluene

The majority of toluene released to the environment partitions to air, although rates of volatilization from soils depends on temperature, humidity, and soil type (ATSDR, 2000a). Transport of toluene from soil to groundwater depends on the degree of adsorption to soil, which is mediated by the presence of organic matter. Toluene will be readily leached from soils with low organic content. The metabolism of toluene limits its biomagnification in the food chain. Degradation of toluene in surface water, soil, and sediment occurs primarily by microbial action.

6.2.3 Ethylbenzene

Ethylbenzene has a high vapor pressure and will partition into the atmosphere from surface soils and surface water; subsurface soil infiltration will also occur (ATSDR, 1999a). This chemical has a relatively high mobility in soils because sorption is not significant enough to prevent migration. Ethylbenzene will leach into groundwater, particularly in soils with low organic carbon content. Significant bioaccumulation does not occur in aquatic food chains. In surface water, ethylbenzene can be transformed via photooxidation and biodegradation. In soils, aerobic soil microbes are responsible for biodegradation.

6.2.4 Xylenes

In soils, xylenes tend to adsorb to organic matter, and will leach into groundwater from subsurface soils with low organic carbon content (ATSDR, 1995a). Volatilization and photooxidation are the primary removal mechanisms in surface soil and surface water. Biodegradation is the primary removal mechanism in subsurface soils.

6.2.5 PAHs

In soils, PAHs can volatilize, undergo abiotic degradation, biodegrade, or bioaccumulate in plants (ATSDR, 1995b). Some PAHs may leach into groundwater from subsurface soils. The transport and partitioning of PAHs in the environment are dependent on several chemical factors, such as water solubility, vapor pressure, Henry's law constant, octanol-water partition coefficient, and organic carbon partition coefficient. Due to their low solubility and high affinity for organic carbon, PAHs in aquatic systems are generally sorbed to bottom sediments or particulate matter suspended in the water column.

6.2.6 Arsenic

Arsenic in soil may be transported by wind and runoff, and may leach into subsurface soil (ATSDR, 2000b). Transport and partitioning of arsenic in water depends upon its chemical form (i.e., oxidation state) and other materials present (ATSDR, 2000b). Arsenic may be present in soluble form in the water column, or adsorbed onto sediments or soils. Groundwater arsenic concentrations are generally controlled by adsorption rather than mineral precipitation (ATSDR, 2000b).

6.2.7 Lead

The amount of lead that remains in solution in surface water depends on the pH of the water and the dissolved salt content (ASTDR, 1999b). In most surface waters and groundwater, the concentration of dissolved lead is low because lead forms compounds with anions in the water such as hydroxides, carbonates, sulfates, and phosphates and precipitates out of the water column. The environmental fate of lead in soil is affected by the specific or exchange adsorption at mineral interfaces, the precipitation of sparingly soluble solid forms of the compound, and the formation of relatively stable organic-metal complexes or chelates with soil organic matter (ATSDR, 1999b). These processes are dependent on factors such as soil pH, soil type, particle size, organic matter content of the soil, the presence of inorganic colloids and iron oxides, cation exchange capacity, and the amount of lead in the soil (ATSDR, 1999b). The accumulation of lead in most soils is primarily a function of the rate of deposition from the atmosphere (ASTDR, 1999b). Lead may bioconcentrate in plants and animals, although biomagnification is not expected (ATSDR, 1999b).

6.3 Potential Exposure Points, Receptors and Route of Exposure

An initial step in evaluating potential human exposure is the identification of potentially complete exposure pathways. For an exposure pathway to be complete, the following five elements must exist: 1) a contaminant source; 2) contaminant release and transport mechanisms; 3) a point of exposure; 4) a route of exposure; and 5) a receptor population. If all five elements exist, then that exposure pathway is considered to be complete (NYSDOH, 2002).

In general, the same COPCs were identified for similar media at the Jacob Riis, Saint Emeric, Haven Plaza, and East River Park areas. As previously described, PAHs, arsenic, chromium, lead, and mercury were identified as COPCs in surface soil.

Subsurface soil COPCs were BTEX, PAHs, and metals. Groundwater COPCs included VOCs, SVOCs, copper, lead, and mercury.

The potential receptors on the Jacob Riis property are residents living in the apartment buildings, visitors, recreational users of the playground, onsite personnel including maintenance/commercial workers and construction workers that may work on the property, and workers at the sewage pumping station.

The potential receptors on the Saint Emeric property are school-aged children who attend the Montessori Head Start School, parishioners of the Roman Catholic Church of Saint Emeric, visitors and onsite personnel including maintenance/commercial workers and construction workers that may work on the property.

The potential receptors on the Haven Plaza property are residents living in the apartment buildings, visitors and onsite personnel including maintenance/commercial workers and construction workers that may work on the property.

The potential receptors on the East River Park are recreational users and onsite personnel including maintenance/commercial workers and construction workers that may work on the property.

The magnitude of exposure to COPCs depends on the type of worker or resident activity, the specific areas of the site used in daily activities, and the frequency and length of time spent at each area. Potentially complete human exposure pathways for the site are qualitatively evaluated below.

Potential direct contact with soils – The Jacob Riis area of the site includes several brick apartment buildings, landscaped areas and a play area with a basketball court, playground equipment and several park benches in the center of the property. The pumping station on the Jacob Riis property consists of a one-story brick building with a parking area on the north side of the building and a vertical surge tank on the east side of the building. The St. Emeric area of the site includes a church, asphalt parking lot, and a school with a play area (enclosed by a fence). Haven Plaza includes residential apartment buildings, walkways and landscaped areas. East River Park includes a basketball court, paved areas and green space.

The surface soil samples from both the Jacob Riis property and the St. Emeric property were collected from unpaved areas. Therefore, potential exposure of human receptors to COPCs in onsite surface soils could occur via incidental ingestion and dermal contact. However, the majority of these soils are vegetated, which likely mitigates any potential exposures. The highest potential for exposure would be for children playing in exposed soil areas. Exposure of most receptors to subsurface soils is unlikely because these receptors are not expected to be involved in intrusive activities. However, construction workers may be exposed to subsurface soils during future construction/excavation activities. Note that surface soils were not collected at the Haven Plaza and the East River Park properties.

Potential inhalation of vapors and/or particulates from surface soils – Surface soil COPCs are primarily non-volatile constituents (i.e., PAHs, metals). Human receptors may be exposed to COPCs in surface soils via inhalation of particulates from areas of exposed soil; however, the majority of the onsite soils are vegetated, which most likely mitigates the potential for soil particulates to become airborne. Further, because there are no ongoing activities at the site, there is likely little potential for dust generation. Because VOCs (i.e., BTEX) were detected in subsurface soils at the site, there is potential for exposure of construction workers to COPCs via inhalation of vapors during construction/excavation activities. Potential exposures could be mitigated by use of personal protective equipment.

Direct contact with groundwater – The groundwater Table beneath the site ranges from approximately 5 to 9 feet below grade. Groundwater is not used as a potable source at the site, and depth to groundwater precludes potential direct exposures of human receptors to this medium. Construction workers may be exposed to site groundwater during intrusive activities, but potential exposures could be mitigated by use of personal protective equipment. Based on the lack of an exposure point, groundwater is not considered to be a complete exposure pathway.

6.3.1 Inhalation of indoor air

MGP-related compounds including BTEX and naphthalene were detected in indoor air samples. All BTEX concentrations were below the NYSDOH Upper Fence criteria. In addition, all but one ethylbenzene concentration and one m,p-xylene concentration was below the respective 75th percentile concentration.

6.4 Summary

Analytical data indicate for the Jacob Riis and St. Emeric's properties, PAHs and metals are present in site surface soils concentrations exceeding NYSDEC SCOs. These surface soil samples were collected from unpaved areas of the site. Therefore, surface soils represent a potentially complete exposure pathway for the general population (e.g., residents, recreational users, students, workers). However, the presence of vegetation (e.g., grass) most likely mitigates the potential for exposure of these receptors to COPCs in surface soil. Construction workers may also be exposed to surface soils during intrusive activities, but potential exposures could be mitigated through the use of personal protective equipment.

Analytical data indicate that VOCs (BTEX), SVOCs (primarily PAHs), and several metals are present in site subsurface soils at concentrations exceeding NYSDEC SCOs. The potential for exposure to COPCs in subsurface soils is most likely limited to construction workers engaged in intrusive activities, although potential exposures could be mitigated through the use of personal protective equipment. Potential exposures of other human receptors to constituents in subsurface soils are unlikely because these receptors would not be involved in intrusive activities.

Groundwater beneath the site is not used as a potable source, and therefore exposure via ingestion of groundwater is unlikely. Likewise, there is relatively little potential for direct contact to groundwater for residents, recreational users, and workers given the depth to groundwater and because these receptors would not be involved in intrusive activities. Construction workers may be exposed to groundwater during future intrusive activities, although these exposures could be mitigated with the use of personal protective equipment.

7. Conceptual Site Model

This section of the RI presents the conceptual site model (CSM) that pertains to the nature, extent, and transport of DNAPL in subsurface soil and groundwater.

7.1 DNAPL Sources and Movement

Based on information obtained during the SCS and RI there are two primary sources of DNAPL at the former East 11th Street Works:

- Former MGP operations and storage facilities located on the Jacob Riis property
- Former gas holders located on the St. Emeric's property

Former MGP operations and storage facilities located on the Jacob Riis property include retorts, 11 gas holders, tar, fuel oil, and gas oil tanks, tar/oil separators, condensers, and scrubbers.

Construction details for these structures are limited. However based on the age of some of the structures, especially the gas holders constructed in the late 1800's, it is assumed that some structures were constructed with below ground bottoms.

DNAPL, once it enters the subsurface it will migrate downward primarily due to gravity (density) through the pore spaces of permeable stratigraphic units until an impermeable layer is encountered. In addition the volume released, viscosity, interfacial tension, and wettability of DNAPL may effect downward migration. It should be noted that for most MGP sites the nature of these physical characteristics of DNAPL are unknown.

Once an impermeable layer is encountered, the DNAPL will, depending on the surface configuration of the impermeable layer, either pool or continue to migrate downward along the surface of the impermeable layer. Over time some of the DNAPL may enter the top few feet of the impermeable layer if root zones, clay partings or microfractures are present

7.2 DNAPL Delineation

Cross-sections A-A' through E-E' on Figures 5 through 9 and the summary of visual MGP impacts illustrated on Figures 12 through 15 depict the vertical and lateral extent of DNAPL in subsurface soil. Based on soil borings completed during the SCS and RI, DNAPL in the form of OLM and TLM is limited to the Fill and Sand-Silt Units. No OLM or TLM was observed in the Silt-Clay Unit. The majority of DNAPL is located below seven feet bgs and within the footprint of the former MGP production area located on the Jacob Riis property. In this area DNAPL was observed to depths up to 30 feet within the Fill and Sand-Silt Units. On St. Emerics property, DNAPL associated with the former gas holders was present from 10 to 30 feet bgs within the Fill and Sand-Silt Units. Below 30 feet DNAPL was observed in soil borings completed on the East River Park property and on the northeast portion of the Jacob Riis property. Since MGP operations were not located in these areas it is assumed the DNAPL has migrated laterally within the Sand-Silt Unit away from the main source area. It appears DNAPL has not migrated laterally within the Sand-Silt-Unit at St. Emeric's property.

Based on soil borings completed at the East River Park property, DNAPL is present from 10 to 40 feet bgs adjacent to the East River. Soundings in the East River performed by NOAA in 2000 indicate the bottom of the East River near the site is between 16 and 30 feet deep. As such it is possible DNAPL may be migrating into or under the East River.

Measurable DNAPL was identified in three monitoring wells (MW-3, MW-5, and MW-111B) in August 2006. Measured DNAPL ranged from 0.3 to 1.6 feet. Each of these wells are screened in the Sand-Silt Unit and located in or adjacent to potential source areas along the eastern edge of the Jacob Riis property. Measurable DNAPL was not identified in any of the wells during the March 2007 groundwater sampling event. However, DNAPL was detected on the monitoring probe used to measure DNAPL in MW-1, MW-5, and MW-111B. MW-1 is located on St. Emeric's property within the footprint of a former gas holder. Since DNAPL has accumulated in some of the wells implies DNAPL has the potential to migrate within the Sand-Silt Unit. None of the monitoring wells installed along at the East River Park property contained measurable DNAPL during the March 2007 monitoring. However, these wells were only installed one month prior to the March 2007 sampling event. Since DNAPL was observed in the soil borings during the installation of these wells, additional DNAPL monitoring should be performed.

8. Summary and Conclusions

A RI was conducted at the East 11th Street Works Site (NYSDEC Site No. V00534) in compliance with VCA No. D2-003-02-8 between Con Edison and the NYSDEC. The objectives of the RI were to:

- Delineate the horizontal and vertical extent of residual MGP waste materials/impacts in soil and groundwater identified during the SCS
- Determine the extent and continuity of OLM and TLM in the eastern portion of the Jacob Riis property identified during the site characterization study
- Delineate the presence and locations of contaminant levels that pose potential risks to human health and/or the environment
- Collect sufficient data in order to develop a proposed site remediation strategy, if necessary

As a result of the field sampling efforts and the evaluation and analysis of environmental data collected during the field sampling efforts the objectives of the RI have been satisfied.

8.1 Site Setting

The East 11th Street Works was located on the Lower East Side section of the Borough of Manhattan in New York City, New York. The East 11th Street Works operated from between 1859 and 1868 through 1933. The gas works occupied approximately 7 acres at the height of its gas production in the 1920's. Current site use includes residential, religious, education, and recreation facilities.

8.2 Hydrogeology

Three stratigraphic units were encountered during the SCS and RI; Fill Unit, Sand-Silt Unit and Silty-Clay Unit. The Fill Unit consists of construction debris (brick, cinders, ash, and wood) intermingled with undifferentiated brown to black sand, cobbles, gravel and silt. The thickness of the Fill Unit ranges 7 to 30 feet increases from west to east.

The Sand-Silt Unit underlies the Fill Unit and consists of fine to medium sand with silt and clay lenses and trace gravel lenses. The Sand-Silt Unit is laterally continuous beneath the site and varies in thickness from 10 feet to 35 feet. In general the Sand-Silt Unit thickens from east to west with the greatest thickness encountered in borings located on St. Emeric's and Haven Plaza properties.

The Silt-Clay Unit underlies the Sand-Silt Unit and consists of variably colored silt and clay with trace fine sand. The Silty-Clay Unit was encountered in all soil borings completed during the RI that were located on the Jacob Riis and East River Park. The Silt-Clay Unit was not encountered in soil boring completed on the western portion of St. Emerics and Haven Plaza properties. The thickness of the Silty-Clay Unit beneath the site is unknown. The Silt-Clay Unit is shallowest in the area beneath Jacob Riis buildings No. 2 and 3.. In this area the depth to the Silt-Clay Unit is approximately 25 feet bgs. As illustrated in Figure 10 the depth to the Silt-Clay Unit increases to the north and toward the East River.

Shallow groundwater appears to flow in a radial pattern from a groundwater mound centered in the vicinity of MW-115A and MW-121A. The groundwater flow pattern in the water table aquifer mimics the top of the Silt-Clay Unit elevations. Horizontal hydraulic gradients in the water table range from 0.01 feet/feet to 0.004 feet/feet north of MW-115A. A comparison of water levels in the nested wells indicates that both downward and upward vertical hydraulic gradients exist at the site. The greatest downward vertical gradient was measured between MW-121A and MW-121B which indicates an area of recharge. Upward hydraulic gradients are observed adjacent to the East River indicating that shallow groundwater discharges to the East River.

8.3 NAPL Evaluation

Results of the SCS and RI indicate that the majority of the OLM and TLM occur in three areas of the site: the eastern half of the Jacob Riis property, the southern portion of the St. Emeric's property, and the East River Park property. NAPL at each of these properties is mostly confined to the the Fill and Sand-Silt Units and present at depths greater than seven feet bgs. The greatest measured NAPL thickness (1.6 feet) was observed in well MW-5, located in the southeastern portion of the Jacob Riis complex. Other wells, in which measurable NAPL was observed, included MW-3 (0.6 feet) and MW-111B (0.3 feet). OLM or TLM was not observed in the Silt-Clay Unit.

8.4 Soil Evaluation

- At least half of the VOCs detected in soil samples at concentrations above their SCO (predominantly BTEX) were found in the 10 foot 30 foot bgs interval, below the water table. VOCs were typically not detected in surface soil samples.

- SVOCs (most of them PAHs) were detected in all soil samples. The vertical distribution of individual SVOCs that exceeded their SCO appear limited to the upper 37 feet of the site. Exceedances do not appear limited to samples where visual MGP-impacts were observed. The highest total SVOC concentrations in surface soil samples were detected in the northeast and southeast portions of the Jacob Riis complex.

- Inorganics were detected in all soil samples above their respective SCO and are generally attributed to the presence of historic fill material at the site

8.5 Groundwater Evaluation

- In groundwater, most VOCs that exceeded their Class GA groundwater standard were BTEX compounds. In general VOC concentrations were greater in the deeper screened “B” monitoring wells than those in shallow “A” monitoring wells. This is consistent with findings of the soil boring program in which the greatest impacts in the subsurface were identified in the zones where the “B” wells are screened. Distribution of VOCs in groundwater appears to be more related to the presence of isolated residual impacts (TLM/OLM) than to a well-defined groundwater plume that has developed as a result of groundwater transport.

- SVOCs detected above their respective Class GA groundwater standard included several PAH, phenol, and phthalate compounds. For the most part the distribution of SVOCs in groundwater mimics the distribution of VOCs in groundwater discussed above.

- Copper, lead and mercury were the only inorganic analytes detected above their respective Class GA standard. These metals all occur naturally in the environment and are also produced by a variety of man-made sources.

8.6 Indoor Air/Soil Vapor Evaluation

- MGP-related compounds including BTEX and naphthalene were detected in indoor air as well as soil vapor and sub slab samples.

- Indoor air sample concentrations were compared to the NYSDOH background data for indoor air provided in NYSDOH 2006.

- All BTEX concentrations were below the NYSDOH Upper Fence background criteria. In addition, all but one ethylbenzene concentration and one m,p-xylene concentration was below the respective 75th percentile background concentration.

8.7 Human Health Exposure Assessment

- PAHs and several metals are present in site surface soils at concentrations exceeding NYSDEC SCOs. As such surface soils represent a potentially complete exposure pathway for the general population, including construction workers. However, the presence of vegetation (e.g., grass) most likely mitigates the potential for exposure of these receptors to COPCs in surface soil.

- VOCs (BTEX), SVOCs (primarily PAHs), and several metals are present in site subsurface soils at concentrations exceeding NYSDEC SCOs. The potential for exposure to COPCs in subsurface soils is most likely limited to construction workers engaged in intrusive activities. Potential exposures of other human receptors to constituents in subsurface soils are unlikely because these receptors would not be involved in intrusive activities.

- Groundwater beneath the site is not used as a potable source, and therefore exposure via ingestion of groundwater is unlikely. Likewise, there is relatively little potential for direct contact to groundwater for residents, recreational users, and workers given the depth to groundwater and because these receptors would not be involved in intrusive activities. Construction workers may be exposed to groundwater during future intrusive activities.

8.8 Conclusions and Recommendations

The RI objectives were achieved except for delineation of MGP impacts north of the Jacob Riis property and to the east of East River Park. Since there is little additional land east of the sample locations in East River Park Con Ed will propose that sediment investigation be conducted in the East River. North of the Jacob Riis property is the Con Ed East River Generating Station property. This property is presently under investigation for MGP impacts under Appendix B of the NYSDEC Order on Consent R2-1023-88-06 et seq (Consent Order) and Con Ed recommends that further investigation for MGP impacts north of Jacob Riis be conducted under that Consent Order.

Based on the findings outlined above it is recommended that an Alternatives Analysis for the land side of the E. 11th Street Works site (i.e. Jacob Riis, St. Emeric's, Haven Plaza and East River Park) be conducted to evaluate potential remedies for the MGP impacts at the site.

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