Site Characterization Study Report

for the

Former West 18th Street Gas Works

Manhattan, New York

VCA Site # V00530-2

Prepared For:
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EXECUTIVE SUMMARY

The former West 18th Street Gas Works Site (Site), which is located in the Chelsea section of Manhattan, New York, was investigated by the Consolidated Edison Company of New York, Inc. (Con Edison) to determine if structures of the former gas plant or residual byproducts from the gas production process are present at the Site. The former Site, which operated from approximately 1833 to approximately 1914 when the last of the gas holders were demolished, occupied a four-block area bounded by West 16th and West 20th Streets between 10th Avenue and the bulkhead along the Hudson River. In addition, a small parcel located along the south side of West 18th Street, west of 10th Avenue, contained two gas holders. The plant included the gas works, which was located on the block between West 17th and West 18th Streets, a total of eleven above-ground gas holders previously located on various parcels, and coal storage areas. The former plant site currently contains commercial and industrial businesses that include storage warehouses, office buildings, art galleries, commercial studios and public parking lots.

Site characterization study (SCS) activities were performed in accordance with a Voluntary Cleanup Agreement (VCA) (Index #D2-0003-02-08), between Con Edison and the New York State Department of Environmental Conservation (NYSDEC), and in accordance with the NYSDEC-approved SCS Work Plan. Due to the number of property owners involved and access conditions, the SCS was conducted in a discontinuous manner from April 2004 to November 2005.

For ease of discussion, the Site has been segmented in to six areas, as designated below.

FORMER WEST 18th STREET GAS WORKS

HISTORICAL MGP STRUCTURES

DESIGNATED AREAS	HISTORICAL STRUCTURES
Area 1	Two former gas holders (Designated Gas Holder No. 1 and Gas Holder No. 2), located on the south side of West 18th Street between 9th and 10th Avenues.
Area 2	Two former gas holders (Designated Gas Holder No. 3 and Gas Holder No. 4), and the former Gas Light Company pipe and store yards. Located between West 19th and 18th Streets and between 10th Avenue and the bulkhead along the Hudson River.

FORMER WEST 18th STREET GAS WORKS HISTORICAL MGP STRUCTURES	
DESIGNATED AREAS	HISTORICAL STRUCTURES
Area 3	Former structures include a retort house, purifying house, workshops, and laboratory. Located between West 17th and 18th Streets and between 10th Avenue and the bulkhead of the Hudson River.
Area 4	The former Gas Light Company coal yards. Located between West 16th and 17th Streets and between Route 9A and 10th Avenue.
Area 5	Three former gas holders (Designated Gas Holder No. 5, Gas Holder No. 6, and Gas Holder No. 7), located between West 19th and 20th Streets and between the bulkhead along the Hudson River and 10th Avenue.
Area 6	Four former gas holders (Designated Gas Holders No. 8 through No. 11), centrally located along current Route 9A, between Area #4 and the bulkhead along the Hudson River.

The following table summarizes the types and numbers of investigation activities that were conducted in each of the six Areas of the Site.

Although the SCS entailed a significant number of sampling locations within the Site, additional investigation is required to characterize and fully delineate the subsurface soil and groundwater contamination present there. A proposed remedial investigation strategy is presented as an appendix to this SCS Report.

SCS Activity Description	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Exploratory Test Pits	2	1	2	0	1	0
Soil Boring Locations	7	13	15	2	12	3
Soil Samples (Including Duplicates)	33	58	61	11	39	10
Monitoring Wells	2	3	2	1	3	0
Groundwater Samples (Including Duplicates)	2	4	1	1	3	0
Collection of NAPL Samples	2	1	0	0	0	0

The key findings from the Site Characterization Study are summarized below.

- Soils encountered beneath the Site consist of four primary stratigraphies, overlying bedrock and consisted of urban fill, an upper sand unit, a low-permeability silty-clay unit, and a lower sand unit. Auger refusal, believed to be due to bedrock, occurred at depths ranging from approximately 45 feet below ground surface (ft bgs) in SB-07 to 86 ft bgs in SB-30 and SB-24. Based upon depths to auger refusal, bedrock appears to dip from the northeast to the west/southwest. Bedrock core samples were not collected as part of this SCS. The silty-clay unit is absent or discontinuous to the east (upgradient) of the majority of the former MGP site (i.e., east of 10th Avenue). Depth to top of the silty-clay ranged from approximately 20 ft bgs in the east to approximately 41 ft bgs in the western portions of the Site.

- Groundwater occurs in the shallow water table aquifer and deeper aquifer. The water table generally resides in the fill unit and the deeper aquifer occurs in the lower sand unit. The deep aquifer is effectively isolated from the water table aquifer beneath the former MGP by the low permeability silt/clay unit.

- The shallow water table occurs at depths between approximately 5 and 11 ft bgs and groundwater in this aquifer generally flows from east to west towards the Hudson River.

- Impacted subsurface soil, where detected, was almost exclusively present in the urban fill and upper sand units above the silty-clay unit. With one exception, no impacts were detected in the deeper aquifer.

- The presence of former MGP related structures were identified in the subsurface in Areas 1, 2, 3 and 5. Gas holder foundations were encountered in Areas 1, 2 and 5. Retort House, Laboratory and Scrubber foundations were encountered in Area 3.

- Physical evidence of both petroleum and MGP-related contamination was detected in subsurface soil in Areas 1, 2, 3, 4 and 5. Evidence of contamination included odors, staining, sheen, oil-like material (OLM), tar-like material (TLM), light non-aqueous phase liquid (LNAPL) and or dense non-aqueous phase liquid (DNAPL). Where detected, MGP impacts were typically encountered in discrete bands within the 10-foot interval above the top of the silty-clay unit.

- All petroleum impacts detected are not attributed to operations of the former MGP, but rather are due to operations of on-site underground storage tanks (USTs) used to store petroleum or to documented petroleum spills in adjacent and upgradient off-site areas.

- Approximately five feet of coal tar DNAPL was measured in groundwater monitoring well MW-24B (screened in the deep aquifer) prior to groundwater sampling. During drilling and

soil sampling at this well location, no evidence of contamination was detected. The source and mechanism for the occurrence of the DNAPL in this well is not known.

- The concentrations of volatile organic compounds (VOCs), Total VOCs, semi-volatile organic compounds (SVOCs), Total SVOCs and several metals detected in subsurface soil exceeded their NYSDEC recommended soil cleanup objectives (RSCOs) in all Areas of the Site. It is noted that some of the elevated VOCs and SVOCs and the majority, if not all, of the elevated metals concentrations are attributed to the ambient quality of soil that constitutes the urban fill, and are not related to the former MGP.

- The concentrations of VOCs, SVOCs, several metals, and total cyanide detected in shallow groundwater exceeded their NYSDEC ambient water quality standards and guidance values (AWQSGVs) in Area 1. In Areas 3 and 5 only VOCs and SVOCs were detected at elevated concentrations. Only one metal and one VOC were detected at elevated concentrations in Area 2. In area 4 only one metal was detected in groundwater at an elevated concentration. In Area 1 the elevated VOCs and SVOCs concentrations are attributed almost exclusively to documented petroleum releases from existing and former USTs that were operated in this Area and are generally not due to operations of the former gas holders here.

- With the exception of coal tar in monitoring well MW-24B (discussed above), no MGP-related impacts were detected in the deep groundwater.

- The results of the qualitative exposure assessment showed that there are no potential risks of exposure to subsurface soil and groundwater under the current site conditions. Under the current site configuration, all surfaces at the former MGP Site are covered by concrete or asphalt pavement or concrete building foundations. However maintenance, construction and or utility workers may be exposed through direct contact and or inhalation of vapors and or airborne dust containing contaminants of interest.

Recommendations and Conclusions

Residuals from the operations of the former MGP have been identified at the former West 18th Street Gas Works Site. Elevated concentrations of VOCs, SVOCs and metals were detected in subsurface soil and groundwater. Based on these subsurface conditions a Remedial Investigation (RI) will be conducted at the Site to delineate impacts identified during the SCS. A RI Work Plan is provided in Appendix E of this SCS Report.

1 INTRODUCTION

This report (Report) presents the results of the Site Characterization Study (SCS) that was conducted by TRC Environmental Corporation (TRC) on behalf of the Consolidated Edison Company of New York, Inc. (Con Edison) for the former West 18th Street Gas Works Site, located on the lower west side of Manhattan (Chelsea section). The site is a former manufactured gas plant (MGP) that was operated by one of Con Edison's predecessor companies through the early 1900's. Figure 1 shows the Site location. The SCS for the properties that once comprised the grounds of the former West 18th Street Gas Works (the "Site") was conducted pursuant to the terms of Voluntary Cleanup Agreement (VCA) Index # D2-0003-02-08 (the VCA) between Con Edison and the New York State Department of Environmental Conservation (NYSDEC). The SCS field investigation activities for the Site were carried out and completed in accordance with a NYSDEC-approved Site Characterization Work Plan (SCSWP) that was prepared for Con Edison by TRC.

1.1 Project Background

In 2002, Con Edison entered a VCA with the NYSDEC. Under the agreement, Con Edison agreed to investigate and, if necessary, remediate former MGP sites that were operated by its predecessor companies. The West 18th Street former MGP was identified as one of these former sites. Therefore, in compliance with the VCA, Con Edison implemented a SCS at this Site. The details of the SCS are presented herein.

1.2 Project Objectives

The objectives of the SCS were to:

- Determine the presence or absence of residues related to operations of the former MGP;
- Determine if remnant structures of the former MGP are present in the subsurface at the Site; and
- Determine the need for additional site investigation, if any.

As a initial step in satisfying these objectives TRC, on behalf of Con Edison prepared the *Site Characterization Study Work Plan for the Former West 18th Street MGP Site, Manhattan, New York* [SCSWP] (TRC, 2003). The workplan was developed based on the *West 18th Street Manufactured Gas Plant Site History Report* [SHR] (Parsons, 2002), the draft NYSDEC Guidelines for Site Characterization and Remedial Investigation (Draft NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, 2002) and observations made during

a site reconnaissance conducted by Con Edison and TRC in August, 2003. The SCS Work Plan was approved by NYSDEC in February 2004.

1.3 SCS Report Outline

The remainder of this Report is organized as follows:

Section 2.0 outlines the Site Background, including a description of the Site and adjoining properties, current land use and zoning, Site history and ownership, regional geologic and hydrogeologic conditions, findings of previous Site investigations, and the findings of the environmental records search performed by Parsons on behalf of Con Edison.

Section 3.0 provides descriptions of the key aspects of the Site Characterization Study. For the purposes of this Report, the Site has been divided into six Areas as defined below. Note that, with the exception with the adjunct parcel (designated Area 1), all areas are bound on the east and by 10th Avenue and on the west by 11th Avenue (as it existed when the plant was operating – See Figure 2).

Area Number	Current Boundaries	Tax Block and Lot	Key MGP Features
1	Along West 18th Street between 9th and 10th Avenues	Block 715, Lot 59	Gas Holders No. 1 and No. 2
2	Between West 18th and West 19th Streets, from 10th Avenue westward to the bulkhead of the Hudson River	Block 690, Lots 12, 20, 29, 40, 42 and 54; a portion of Block 622	Gas Holders No. 3 and No. 4, Pipe and Storage Yards
3	Between West 17th and West 18th Streets, from 10th Avenue westward to the bulkhead of the Hudson River	Block 689, Lot 17; a portion of Block 622	Retort House, Purifying House, Scrubbers, Laboratory, Workshops, New and Foul Lime Storage
4	Between West 16th and West 17th Streets, from 10th Avenue westward to Route 9A	Block 688, Lots 1001 and 1002	Coal Yard

Area Number	Current Boundaries	Tax Block and Lot	Key MGP Features
5	The western portion of the block between West 19th and West 20th Streets, westward to the bulkhead along the Hudson River	Block 691, Lots 1 and 11; a portion of Block 622	Gas Holders No. 5, No. 6, and No. 7
6	A portion of Route 9A westward to the bulkhead along the Hudson River, from West 16th Street to West 17th Street	A portion of Block 662	Gas Holders No. 8, No. 9, No. 10, and No. 11

Section 4.0 presents site-specific geologic and hydrogeologic information, and discusses the field observations and analytical data in comparison to the applicable NYSDEC regulatory standards.

Section 5.0 presents the qualitative exposure assessment, which consists of characterizing the exposure setting (including the physical environment and potentially exposed human populations), identifying exposure pathways, and evaluating contaminant fate and transport.

Sections 6.0 presents the conclusions and recommendations developed in consideration of the findings and observations discussed in Section 4.0.

Section 7.0 presents the references used in preparation of this SCS Report.

2 SITE BACKGROUND

A detailed summary of the Site Background was developed by Parsons for Con Edison, and is presented in the August 2002 MGP Site History Report (SHR). That report was prepared based on Parson's review of available data and records for the Site with respect to both historical operations and current Site conditions. A summary description of the information presented in the SHR, and supplemented by additional information, is provided below. The Site background presented in the SHR was supplemented present-day conditions observed by Con Edison and TRC during a site walk on August 5, 2003.

2.1 Site Description

The former West 18th Street Gas Works is located in the Borough of Manhattan, New York City and New York County, New York (Figure 1). As is recorded in the SHR and the VCA, thirteen present-day Blocks/Lots comprise the former MGP Site, which covers portions of five modern city blocks, parts of Route 9A, and parts of the Chelsea Piers (Figure 3) along the Hudson River bulkhead. Specifically, the former MGP includes:

- Block 688, tax Lots 1001 and 1002 (entire block bounded by West 16th Street, West 17th Street, 10th Avenue and Route 9A);
- Block 689, tax Lot 17 (entire block bounded by West 17th Street, West 18th Street, 10th Avenue and Route 9A);
- Block 690, tax Lots 12, 20, 29, 40, 42, and 54 (entire block [except tax Lot 46] bounded by West 18th Street, West 19th Street, 10th Avenue and Route 9A);
- Block 691, tax Lots 1 and 11 (western end of block bounded by West 19th Street, West 20th Street, 10th Avenue and Route 9A);
- Block 715, tax Lot 59 (northwestern area of block bounded by West 17th Street, West 18th Street, 9th Avenue and 10th Avenue);
- The line of Route 9A between West 16th Street and West 20th Street (formerly parts of Blocks 688, 689, 690 and 691); and
- Portions of the Chelsea Piers (Piers 59, 60, 61 and 62) designated Block 662, (formerly part of Blocks 666, 688, and 689) along the Hudson River bulkhead.

The western ends of Blocks 688, 689, 690, and 691 were truncated for the inland extension of the Hudson River piers (now designated Block 662, City 3, 7, 11, 16, 19, and 62) and the reconfiguration of 11th Avenue and Marginal Street in the early twentieth century, and the later construction of the Route 9A during the 1920s and 1930s. A major reconstruction project for segments of Route 9A took place in the vicinity of the Site from 1996 to 2001. Block 666, a wedge-shaped area of the gas plant formerly located west of present-day Blocks 688, 689, and 690 along the then bank of the Hudson River, was condemned when the piers were extended inland. It should be noted that the existing tax Lots are an amalgam of smaller real estate lots, which were historically sold to the Manhattan Gas Light Company (one of Con Edison's

predecessor companies) by individual owners. Figure 3 shows the current street configuration with an overlay of the former MGP structures (based on historical maps and drawings (e.g., Sanborn Fire Insurance maps, Viele maps, Beers maps, etc.) and aerial photographs.

2.2 Current Land Use and Zoning

Within the general geographic area of the Site, property usage is light commercial, light industrial, local service district, and residential. All of the tax Lots contained on the Blocks (688, 689, 690, 691, and 715) that comprise the former MGP Site are zoned as M1-5 and are defined as Light Manufacturing District - High Performance. The Site usage includes storefront retail facilities to the east and west and a sports/entertainment complex located to the west and adjacent to the Site. A mixture of commercial office/warehouse facilities, art galleries and residential properties are located to the north and adjacent to the Site. An office facility and high-rise apartment building are located to the south. Details of current land use are described in the following paragraphs.

No aboveground remnants of MGP-related structures or by-products were observed during the site walk.

2.3 Site History, Process Operations and Uses

A summary of the Site history, ownership and use based on the SHR, is presented below chronologically as pre-, active, and post-MGP periods. In addition to the title search results, Sanborn Insurance Maps from 1895 to 1996 and other historical maps and atlases were used to develop the chain of ownership and evolution of site operations. A complete and tabular description of the real estate property transfers for each block/lot, as of Summer 2002, is included in the SHR (Parsons, August 2002).

2.3.1 Pre-MGP Ownership and Site Operations

The West 18th Street Gas Works property housed various structures prior to its use as a MGP, as described below by location and or present-day Tax Block number. Note that 11th Avenue was later replaced by Route 9A, and 13th Avenue was destroyed when the Hudson River shoreline/bulkhead was re-aligned.

Block 688 (bounded by West 16th and West 17th Streets, 10th and 11th Avenues)

As described above, Block 688 was completely under water until the 1830s, when landfilling began west of 10th Avenue. By the late 1830s and early 1840s the eastern half of the block, now reclaimed from the river, supported two houses along 10th Avenue (Assessed Valuation of Real Estate 1836 through 1842). By 1857, there were fifteen houses along 10th Avenue; six houses, a

stone yard, and two sheds on the south side of West 17th Street; and two houses east of 11th Avenue (Assessed Valuation of Real Estate 1857). These structures are depicted on the 1852 Dripps map. On the eastern end of the block, various residences, shops, a "Whiting Factory," a wagon factory, and a wood yard appeared on the 1859 Perris and Company map and the 1869 Perris and Browne map.

Block 689 (bounded by West 17th and West 18th Streets, 10th and 11th Avenues)

Housed little or no development prior to its use as an MGP. Once the eastern end of the block had been filled, the Manhattan Gas Light Company purchased the lots along West 18th Street and part of 10th Avenue in 1833 from various owners. Concurrently, individuals bought lots and constructed five houses at the southeast end of the block, adjacent to the MGP Works. These houses endured until the late 1850s, when the gas company bought these lots and razed the houses to make room for additional MGP structures.

Block 690 (bounded by West 18th and West 19th Streets, 10th and 11th Avenues)

The earliest development on Block 690 was a steam mill, constructed by William Hockman on the south side of the block along the newly filled shoreline by the late 1830s or early 1840s. Block 690 also contained a lumberyard, a coal yard, several houses, various sheds and shanties, a "Distillery and Manufactory of Compressed Yeast" complex, a paint factory, a cooperage (repair and making of barrels and tubs), and the "Manhattan Pottery" complex.

Block 691 (bounded by West 19th and West 20th Streets, 10th and 11th Avenues)

Housed primarily residences from the 1830s, when its eastern end was reclaimed from the Hudson River, through 1866, when the gas company purchased its first lots on the block. In the late 1830s and early 1840s, the block supported a stable and 8 houses. By 1857, the block had 19 houses, 8 lots with sheds, and a lumberyard.

Block 715 (bounded by West 17th and West 18th Streets, 9th and 10th Avenues)

Supported a number of houses and shops, although tax Lot 59, the property later owned by the gas company, was vacant during these years. In 1845 and 1846, individuals sold what would become tax Lot 59 to the Manhattan Gas Light Company for construction of a building to house two gasholders.

Block 662 - Former Block 666 (bounded by West 16th and West 19th Streets, former 11th and 13th Avenues)

Was under water through the 1830s and early 1840s, but had been filled by the early 1850s. The gas company purchased the central part of Block 666 in 1846 and 1849 and the southern part in 1858.

2.3.2 Active MGP History

MGP operations began at the West 18th Street Gas Works in 1834. During 1834, the Manhattan Gas Light Company purchased its initial property on the eastern end of Area 3 (Block 689) and began construction of the gas plant. The Manhattan Gas Light Company had formed in 1830, and by 1834, was providing gas to all of Manhattan north of Grand and Canal streets. The West 18th Street Gas Works was to be the second gas plant in the city, and the first erected by the Manhattan Gas Light Company. Construction of the West 18th Street Gas Works began in the fall of 1833, and continued for the next year. By November 1834, the plant was manufacturing and distributing coal gas to customers (Collins, 1934). During the nineteenth century, the West 18th Street Gas Works grew in size as the Manhattan Gas Light Company continued to purchase land and construct additional facility structures.

The first property bought by the Gas Works was on the south side of West 18th Street, at the eastern end of Area 3 (Block 689). A Retort House, Condensers, Scrubbers, and Purifying House, likely contained in one or two structures were constructed on this parcel.

In 1845 and 1846, the company purchased lots on Block 715 (Area 1) and built its first gas holders, enclosed in a brick warehouse-type structure along the south side of West 18th Street. Also purchased at this time was the center section of former Block 662, which allowed direct access to the river and a company pier. It used this area as a coal yard as well.

The purchase of more property at the eastern end of Area 3 in 1848 and 1849 allowed the MGP to expand its operations by constructing a new, detached Purifying House at the northeastern corner of the block. The company also bought land at the eastern end of Area 2 (Block 690), directly to the north, and constructed the initial pair of large, open gasholders.

In 1858, the Manhattan Gas Light Company purchased the western two-thirds of Block 688 (western portion of Area 4), and the southern section of former Block 666 (Area 6). The company erected four additional gas holders (250,000 cubic feet) in the middle of Area 6 and used the western end of Block 688 as a coal yard (now the Hudson River). The western-most portion of the then newly purchased part of former Block 666 was used for a lime yard. Also during this period, the Retort House (Area 3) had been expanded to include six groups of 160 retorts each, for a total of 960 retorts. To the west of the Retort House was a large coal house,

where coal was stored after being unloaded from the adjacent waterfront pier. To the east of the Retort House was a Laboratory along West 18th Street, and south of that, a building containing Condensers, Scrubbers and Washers.

In the late 1860s, the company purchased additional properties on Area 2 and Area 4, as well as lots on Area 5 (Block 691). The MGP works were expanded to include several large coal yards in Areas 2, 4 and 5, a pipe yard in Area 2, and another pair of large gas holders in Area 5. The West 18th Street Gas Works continued to operate through the final decades of the nineteenth century, although it did not acquire any additional property or change its configuration markedly during that period. The West 18th Street Gas Works appears to have operated only one or two years into the twentieth century.

In 1909, the two smaller gas holders in Area 5 were demolished, and in 1914, the remaining gas holders in Areas 1 and 2 were razed. During the 1910s, the gas company began to sell its property on the West 18th Street Gas Works blocks to other owners, marking the end of the MGP history.

2.3.3 Post-MGP Ownership and Use

The Site covered approximately four contiguous city blocks bound by West 20th Street to the north, West 16th Street to the south, 10th Avenue to the east, and the present Hudson River bulkhead to the west; as well one property located along 18th Street between 9th and 10th Avenues. Con Edison no longer owns any of the parcels that comprise the site of the former MGP. Figure 3 presents the current tax block/lot numbers referenced below.

Area 1 (Block 715, bounded by West 17th and West 18th Streets, 9th and 10th Avenues) housing tax Lot 59 contains the former gas holder house, now used as a garage. Although the gas holders have been removed and the building has been retrofitted, the exterior shell of the building has changed little.

Area 2 (Block 690, bounded by West 18th and West 19th Streets, 10th Avenue and the Hudson River bulkhead) had its western end condemned for pier and roadway reconfigurations, nearly all of the remaining property on the block belonged to the Consolidated Gas Company through the early 1900s. Specifically, the former MGP occupied modern tax Lots 12, part of 20, 29, part of 40, 42, and 54, as well as a portion of Block 662 (Chelsea Piers). ?After that time, tax Lot 12 was used as a wagon yard until 1922, when a large garage (with buried gasoline tanks), was built over nearly the entire lot. This structure, with some modifications, still stands in its original location.

- On tax Lot 12, the owners (West 19th Street Development, LLC) entered into an independent VCA with the NYSDEC, which required it to conduct a site investigation

and remediate impacts identified in the subsurface. Subsequently, West 19th Street Development, LLC, conducted two extensive site investigations to assess soil and groundwater quality beneath the site, as part of its property redevelopment. The results of the investigations showed that soil and groundwater beneath this parcel were impacted by MGP residuals as well as various petroleum products. Due to the thorough site investigations and NYSDEC-approved remediation that has taken place, residual contamination is being let in place;

- On tax Lot 20, a large garage was erected over the portion fronting West 18th Street in 1919, and is still standing in its original location. The smaller portion of tax Lot 20 along West 19th Street contained two row houses, built in the 1890s. They were razed for construction of a private garage, erected in 1947, which remains;

- Tax Lot 29 was used as a wagon yard after the gas holders were razed; it later became an truck parking lot, and last, a public automobile parking lot. Two structures located on the southeast corner of the lot were built in the mid-1920s. The lot contains underground gasoline tanks;

- Tax Lot 40 originally contained two halves: the Consolidated Gas Company owned one part, and used it as a pipe yard, while the second part was owned by other individuals, and contained a shop, which later became an automobile repair facility. In 1923, the Huntoon Ice Company purchased both halves of the lot, and in 1929, constructed a warehouse for ice storage over the entire lot. In 1969, Eli Studios purchased the building and lot; the former warehouse has been used as a movie studio since that time;

- Tax Lot 42 was sold to the Huntoon Ice Company in 1922, which erected a two-story warehouse the following year. A spring water company occupied the building later, which is still standing in its original location;

- Tax Lot 54 located at the corner of West 19th Street and Route 9A contained a two-story hotel, which later burned. The lot has been vacant since the 1960s; and

- The portion of Block 662, along the Hudson River bulkhead, where the Chelsea Piers Sports and Entertainment Complex, constructed in 1995, is now present.

Area 3 (Block 689, bounded by West 17th and West 18th Streets, 10th Avenue and the Hudson River bulkhead) also was owned entirely by the gas company, and is now designated principally as tax Lot 17. A portion of this area also extends to the Hudson River bulkhead, abutting Chelsea Piers (Block 662). In 1917, the Consolidated Gas Company sold the whole block (West 17th to West 18th Streets) to the New York State Realty and Terminal Company. From 1932-

1960, the property was owned by the New York Central Railroad Company. Since 1960, the block has been owned by a series of realty companies and corporations. After the gas company sold the property, some of the former MGP buildings on the block were used for other purposes. The remainders of the old MGP buildings were razed after the railroad acquired the property (1932), and a railroad yard (with tracks) was built in their place. Later, the tracks were covered and the block was used as surface parking for cars. In the mid-1950s, an automobile service station and garage were also built along West 17th Street, near present-day Route 9A. The buildings were demolished in the 1980s.

Currently, the block is used exclusively as a parking lot. The remainder of this area encompasses the portion of Route 9A along the west side of the block and a portion of the Chelsea Piers Sports and Entertainment Complex (Block 662).

Area 4 (Block 688, bounded by West 16th and West 17th Streets, 10th Avenue and Route 9A) was owned entirely by the gas company, and was designated as tax Lots 1001 and 1002 (now 7501). In 1916, the Consolidated Gas Company sold the whole block to the Merchants Refrigerating Company, and the following year the new owner constructed a ten-story warehouse with basement, covering the entire block. The property purchased by the Able Empire Group in 1982, and by the Tenth Avenue Mini Storage Associates in 1984. This building, although somewhat modified since its initial construction, still stands on the lot in its original location. Today it is occupied by condominiums and a mini storage facility.

Area 5 (Block 691, bounded by West 19th and West 20th Streets, 10th Avenue and the Hudson River Bulkhead) is comprised of modern tax Lots 1 and 11. After the gas holders were demolished, tax Lot 1 contained a small office building at its northwest corner while the rest of the property was vacant and used as a "house wrecker's yard." The eastern portion of tax Lot 11 was used for the Department of Street Cleaning's wagon yard. The American Red Cross had a structure along the 11th Avenue side of the block during the 1920s, covering parts of tax Lots 1 and 11. In 1929, the YMCA of New York purchased tax Lot 1, and the following year constructed an eight-story building (with basement) for use of its members (after the American Red Cross building was razed). This building, with minor alterations, remains on the lot in its original location today. Tax Lot 11 has been vacant since the American Red Cross building was demolished, and currently is used as a parking lot.

Area 6 (portion of Block 662, opposite of West 16th Street and west of Route 9A) is part of a paved pedestrian and bike path along the Hudson River bulkhead and Chelsea Piers Sports and Entertainment Complex. The original western ends of Blocks 662, 688, 689, 690, and 691 are now under the current alignment of Route 9A or were removed during waterfront modifications, which were laid out in the first decades of the twentieth century. By the 1930s, this roadway also supported the elevated Miller Highway, which was demolished in the early 1970s.

2.4 Site Operations

The processes and practices described in the following section are drawn from Harper's New Monthly Magazine (1862), historic maps, Con Edison records, Collins (1934), Hartgen (n.d.), Public Service Commission (PSC) Records, Brown's Directories, Eng (1985), Hornby (1911), Alrich (1934), Downing (1934), Stewart (1958), and EEI (1984), as described in the Parsons SHR.

The West 18th Street Gas Works manufactured coal gas from 1834 to the early 1900s (Collins, 1934 and Department of Docks and Ferries 1903 through 1905). Anthracite coal was delivered by barge or lighter to the Hudson River waterfront piers, and then by cart to the plant itself, located in Area 3. The coal was stored in a "coal house" at the western end of the block. Condensers and Scrubbers were located at the eastern end of the Retort House. Raw gas was piped to and went through the Purifying House, located at the far eastern end of the block. From the Purifying House the gas went to the holders at various locations in Areas 1, 2, and 5, for storage before being distributed to customers. At its peak, the West 18th Street Gas Works had 11 gas holders, with a combined capacity of approximately 3,500,000 cubic feet (PSC, 1908).

The Retort House was constructed of brick, and consisted of a furnace supporting a series of clay retorts on brick benches. Each bench contained 15 retorts, and there were 64 benches, for a total of 960 retorts (Perris and Company, 1859 and Harper's, 1862). The retorts were heated by lighting fires below them, which in turn heated the coal inside the retorts in the absence of ambient air. The retort gas was passed through a series of processes to recover byproducts and impurities. Once the raw gas was driven from the coal, it was drawn from the retort and through a hydraulic main located on the roof of the Retort House. The hydraulic main was sealed and contained water, which permitted steam, tar vapors, and some ammonia compounds to settle out before continuing to the condensers. From the hydraulic main, the gas traveled to the air condenser, located immediately east of the Retort House. The air condenser cooled the gas by indirect contact cooling water to remove heavy tars and water vapor. Tar byproducts were siphoned off at this stage, for reuse or sale. The gas was then fed through a second, water-cooled condenser, located just east of the air condenser, to remove additional impurities. Next, the gas flowed through an exhauster, situated south of the Condensers, which blew the gas through the Scrubber or Washer (located east of the Condensers) to remove ammonia and some sulfur. The Scrubber was a cylindrical structure filled with coke; materials in the Scrubber were sprayed with water, and these water soluble impurities settled to the bottom of the chamber, where they were collected (Harper's, 1862 and Hartgen, n.d.).

The final stage in the removal of impurities was the removal of sulfur. Sulfur was removed from the gas stream by the formation of calcium sulfate as the coal gas was passed through lime purifiers. The purifiers consisted of square tanks (eastern side of Area 3, see Figure 2) in which

stacked trays containing damp, powdered lime, were situated. The gas was forced up from beneath the trays, in the process removing sulfurous compounds like hydrogen sulfide through reaction with the calcium in the lime. At the West 18th Street Gas Works, a fresh lime house was attached to one side of the purifying house, while a foul lime house was located at the other end. The spent lime could then be sold for fertilizer (Harper's 1862, and Hartgen, n.d.).

From the Purifiers, the gas was metered and then passed into a storage holder, ready for distribution to the customers. The West 18th Street Gas Works began with only two gas holders (in Area 1), but by the turn of the twentieth century, there were eleven holders on four contiguous blocks.

A complete record of by-product quantities, reuse, sale, and disposal is not available. PSC reports began publication in 1908, after the West 18th Street Gas Works had essentially stopped producing gas. During the period that the West 18th Street Gas Works operated, there were no known published reports detailing byproduct output and sales. Typical residuals and byproducts produced at an MGP may include coal tar, ammonia, purifier wastes (calcium sulfate and/or spent ferric oxide impregnated wood chips), sulfur, coal ash and cinders. The disposal history of purifier residuals is unknown. The coal tar was sold as a byproduct, as was the sulfur. The coal tars could be distilled to produce ammonia liquors, light oils, creosote oils, anthracene oils, and pitch. The light oils could be further rectified yielding benzol, solvent naphtha, carbolic acid, and anthracene (Collins, 1934).

2.5 Previous/Other Investigations

Prior to and independent of the SCS, site investigations were performed at several of the present-day properties within the former MGP. The results of these investigations are summarized below by property location and or owner.

2.5.1 Site Investigation of Block 689, Lot 17

MTA performed a Phase I and Limited Phase II environmental site investigation in 1998 on Block 689, Lot 17 (MTA, 1998b and MTA, 1998c), AKRF prepared a summary document, *Soil Sample Summary and Result for Soil Safe Criteria* in April 1999 (AKRF, 1999), and Blasland, Bouck and Lee, Inc (BB&L) prepared a *Remediation Work Plan* in November, 1999 (BB&L, 1999). This investigation was conducted to characterize the subsurface soil quality and determine acceptance of the soil by a facility in New Jersey (Soil Safe) where soil excavated during planned future site development would be disposed. Towards this goal, paired soil borings were excavated at each of 18 locations to depths of approximately 20 feet below ground surface (ft bgs). During the investigation, subsurface soil samples were collected from two depth intervals (0 to 8 ft bgs and 8 to 20 ft bgs) from each boring. As ground water generally occurred

at 8 to 11 ft bgs, this sampling scheme was developed to evaluate soil quality above the water table and that below the water table. The soil recovered from each interval for each soil boring pair was composited and analyzed for metals using the Toxicity Characteristics Leaching Procedure (TCLP), polychlorinated biphenyls (PCBs), pesticides, VOCs, and total petroleum hydrocarbon (TPH). The sample interval was specific for the analysis being performed. The soil analytical results were compared to the appropriate New Jersey waste acceptance thresholds, Resource Recovery and Conservation Act (RCRA) toxicity criteria for waste acceptance purposes. The analytical results were also compared to NYSDEC RSCOs.

The findings of the investigation are summarized below:

- Total VOCs were detected at concentrations above the disposal facility acceptance criteria of 500 milligrams per kilogram (mg/kg) total in 8 of 66 composite samples;
- TPH concentrations exceeded New Jersey 30,000 parts per million (ppm) threshold for TPH in only 1 of 139 composite samples;
- No hazardous waste for TCLP Metals;
- PCBs and pesticides were not detected at above the disposal facility acceptance criteria;.
- A UST was identified at one soil boring location in the central portion of Block 689;
- VOCs and polycyclic aromatic hydrocarbons (PAHs) were detected in soils across the property;
- VOCs from 0 to 8 ft bgs did not exceed NYSDEC RSCOs for individual compounds detected;
- One PAH sample from 0 to 8 ft bgs exceeded the NYSDEC RSCO for Total SVOCs of 500 mg/kg. This sample was collected from a soil boring pair located on the western end of Block 689;
- Total VOC concentrations exceeded the NYSDEC RSCO for Total VOCs of 10 mg/kg in samples collected from 8 to 20 ft bgs in seven soil boring pairs. The borings were primarily located in the central and western portions of Block 689;
- Total PAHs were detected at concentrations exceeding the NYSDEC RSCO for Total SVOCs of 500 mg/kg in three composite samples collected from between 8 and 20 ft bgs in three soil boring pairs located in the central and western portions of Block 689;
- Worldwide Geosciences, Inc. performed an interpretive characterization of TPH results from 71 samples collected on the eastern portion of Block 689 to fingerprint the source materials contained in the soil samples. The conclusion was that 56 of the 58 interpretable chromatograms were indicative of coal tar or MGP residues; and

- BTEX and PAHs were detected in all three groundwater samples collected on Block 689. The highest BTEX and PAH concentrations exceeded NYSDEC AWQSGVs for Class GA water in one groundwater monitoring well located near the northwest corner of Block 689. Benzene and naphthalene exceeded the standards in one monitoring well located at the eastern end of the site, and only benzene exceeded the standards in one well located near the southwest corner of the Block.

2.5.2 Geotechnical Investigation Block 689, Lot 17

In July 1998, Melick-Tully and Associates, P.C. (MTA) conducted a geotechnical investigation and limited Phase II environmental investigation at the property. The geotechnical engineering investigation was performed in support of design of a distribution center, which was planned for construction at the property at Block 689, Lot 17 (i.e., that portion of Area 3, the entire block bounded by West 17th and West 18th Streets and 10th and Route 9A).

The Phase II investigation was performed to assess soil quality to evaluate disposal options for soil that would ultimately be excavated as part of the site redevelopment. Two soil samples were collected from each of the intervals 0 to 5 ft bgs, 8 to 12 ft bgs, and 15 to 20 ft bgs. The samples were analyzed for the full suite RCRA constituents using the TCLP. The results of these investigations are summarized below.

Geotechnical Investigation Findings:

As presented in the report, the subsurface conditions encountered at the site consisted of the strata described listed below, presented in order of increasing depth:

Surface Materials: Surface materials at the site generally consisted of a thin (less than six inches) asphalt/stone base course layer. The asphalt thickness is generally on the order of two to three inches in thickness. The "stone" base course is variable, consisting of varying mixtures of clean stone, cinders, and silty sand.

Fill: Underlying the surface materials is a layer of a heterogeneous mixture of native and non-indigenous anthropogenic material ranging in thickness from roughly 20 feet in the eastern portions of the site to roughly 40 feet in the western portions. The fill consists of a heterogeneous mixture of silt, sand, gravel, and cinders, with frequent obstructions, particularly in the upper five to ten feet. Based on fragments collected in the split spoons or captured on the auger flights, the obstructions appeared to consist primarily of concrete and brick rubble. Frequent intermixing of organic silt was also encountered in the lower portions of the fill.

The fill is highly variable in consistency, ranging from very loose to very dense, although the higher Standard Penetrations Test results (i.e., N-values) appeared to be mostly due to the presence of obstructions.

Corrosivity testing results of two fill samples indicated moderately corrosive resistivity levels and moderately corrosive levels of sulfates. Sulfides, redox potential, and pH indicate low corrosivity potential.

Organic Silt: A layer of very soft to stiff clayey organic silt is present below the fill across most of the site, although several of the borings in the eastern portion of the site did not encounter any organic silt. One Atterberg Limits test was conducted on a sample of the organic silt indicated that this lithology was of low to moderate plasticity with a plastic limit of 19 percent and a liquid limit of 37 percent.

The organic silt is generally five to ten feet thick, ranging occasionally as thick as 15 to 20 feet. The bottom of the organic silt generally ranges in depth from approximately 20 to 25 feet below the ground surface in the eastern portion of the site to approximately 50 feet below the ground surface in the western portion.

Silty Sand: Silty sand typically underlies the organic silt (or the fill where organic silt is not present) and extends to the top of bedrock. The sand is generally loose to medium dense in consistency and is stratified with varying amounts of silt and generally low percentages of gravel. Occasional zones were encountered where the percentage of gravel in this stratum exceed the percentage of sand.

Based on the behavior of the drill rig while conducting the explorations, cobbles and/or boulders were believed to be present throughout this stratum, particularly below a depth of approximately 70 to 80 feet. High N-values reported at these depths are believed to be a result of cobbles/and or boulders.

Interbedded Clayey Silt: Discontinuous layers of medium to stiff clayey silt with varying amounts of fine sand were encountered at varying depths in many of the test borings within and above the silty sand stratum. The encountered thickness of these interbedded layers generally ranged from 5 to 15 feet.

Schist Bedrock: - Schist bedrock underlies the silty sand stratum at depths ranging from approximately 60 to 100 feet below the ground surface. The top of rock is generally shallowest in the eastern portion of the site (at depths ranging from 60 to 70 feet below the ground surface) and deepest in the central portion of the site (at depths ranging from 90 to 100 feet below the ground surface).

The upper one to five feet of the schist bedrock is generally highly to completely weathered and was occasionally penetrated several feet with hollow stem auger drilling equipment. Generally, below this depth, the schist is slightly to moderately weathered with a relatively high Rock Quality Designation, RQD (generally above 70 to 80 percent). At one location, however, in the center of the site (Boring B-13), the boring was advanced approximately 20 feet into the rock using hollow stem augers without obtaining refusal.

Phase II Findings:

- Groundwater was typically encountered at depths ranging from approximately 8 to 11 ft bgs. Due to the close proximity of the Site to the Hudson River, MTA concluded that tidal fluctuations in groundwater depths should be anticipated, particularly in the western portion of the Site;
- Groundwater table is relatively flat and flows to the west-southwest;
- The permeability of the soil that comprise the water table aquifer were estimated to range from 0.1 to 1.3 ft per day;
- No analytes were detected at concentrations that exceeded their respective RCRA Toxicity Criteria (TC);
- VOC and or SVOCs were detected in groundwater at concentrations that exceeded their respective NYSDEC AWQSGVs in monitoring wells MW-2, located in the central western-most portion of Block 689; and
- Naphthalene was detected in groundwater at a concentration that exceeded its NYSDEC AWQSGVs in monitoring wells MW-3, located in the central eastern-most portion of Block 689.

2.5.3 Site Investigation Tax Block 690, Lot 12

On October 16 and 17, 2002, Blasland, Bouck, and Lee, Inc. (BB&L, 2002) conducted a preliminary site investigation at Block 690, Lot 12. The subject of the investigation was the property that comprises the western-most portion of the block, which is located between West 18th and 19th Streets and between 10th Avenue and Route 9A.

The investigation entailed advancing eight soil borings and four temporary well points. Material indicative of urban fill was encountered to a depth of 4 ft bgs. Native materials included gravelly sands, sandy silts, and clayey sands and were described intermittently between 4 feet and 16 ft bgs. Groundwater was encountered at 7 feet to 8 ft bgs. Slight to strong odors were detected at all locations between 2 and 12 ft bgs. NAPLs were not observed in any borings.

BB&L concluded that the types of VOCs detected during the investigation (soil and groundwater) were indicative of gasoline/kerosene products, and MGP by-product tars. The highest benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations were detected adjacent to and down gradient of a series of former underground storage tanks (USTs) used to store petroleum products, including gasoline and fuel oils and north of the MGP Retort House located on Block 689, due south of the property investigated.

BB&L also concluded that the semi-volatile organic compounds detected in both soil and groundwater (including phenolic compounds and PAHs) was indicative of MGP-related tars. The highest PAH concentrations were detected in the same soil and groundwater samples, as were the BTEX compounds.

BB&L recommended supplemental investigation activities, including the installation of borings to delineate the horizontal and vertical extent of BTEX and PAH impacted soil, to determine the presence of the clay layer, and to confirm that NAPLs are not present at the property. BB&L also recommended the installation of additional monitoring wells to delineate the horizontal and vertical extent of BTEX, phenolic and PAH compounds, to evaluate groundwater flow direction, and to evaluate hydrogeologic properties.

2.5.4 Site Investigation Tax Block 715, Lot 59

The building that occupies this property has been utilized as a parking garage since its construction in 1915. Prior to that, the property contained two 85-foot diameter gas holders, which were used to store gas produced by the West 18th Street Gas Works that operated along the west side of 10th Avenue. In 1993, six USTs that were used as part of the garage operations were removed from this property. The USTs included five 550-gallon tanks used to store gasoline located under the northeast corner of the garage building and one 4,000-gallon tank used to store diesel fuel was located along the west side of the building. No evidence of soil contamination was reportedly observed during the tank removals.

In early 2000, Langan Engineering (Langan) conducted a Phase I Environmental Site Assessment (ESA). Based on the findings from this assessment, Langan identified several areas of concern, which included the locations of the former USTs and a hydraulic lift system.

In June 2001, during building renovation activities being performed by Verizon, the then and current building tenant, petroleum contaminated subsurface soil was encountered below the concrete building foundation slab. The soil was screened for total VOCs using an organic vapor meter equipped with a photoionization detector (PID). Total VOCs measured with the PID ranged in concentration from 16 ppm to 634 ppm. In addition, samples were submitted to

Worldwide Geosciences, Inc of Houston, Texas for product fingerprint analysis. The result of the fingerprint determined the source of the contamination to be gasoline.

In response to this finding, Verizon notified the NYSDEC, which assigned Spill No. 01-03363 to the property. The petroleum-contaminated soil was excavated at that time.

Based on the PID screening results, EnviroTrac sampled the contaminated soil, on behalf of the property owner. The analytical results for these samples showed that the concentrations of several VOCs and SVOCs exceeded their respective NYSDEC RSCOs.

In August 2001, EnviroTrac performed a Subsurface Investigation at the property. During the investigation 12 soil borings were advanced using GeoProbe drilling methods. One soil and one groundwater sample was collected from each boring. The samples were analyzed for VOCs and SVOCs.

The result of this investigation showed that VOCs and SVOCs were detected at concentrations above their respective NYSDEC RSCOs in 9 of the 12 borings. The VOCs detected at elevated concentrations included benzene, toluene, ethylbenzene, and xylenes (collectively referred to as BTEX), isopropylbenzene, naphthalene, n-propylbenzene, methyl tert-butyl ether (MTBE) and 1,2,4- and 1,3,5-trimethylbenezenes. Two samples contained total VOCs at concentrations above the NYSDEC RSCO for total VOCs of 10 ppm. One or more of six SVOCs, all PAHs, were detected at elevated concentrations in eight of the 12 soil samples. Total SVOCs concentrations exceeded the NYSDEC RSCO for total SVOCs of 500 ppm in soil from two soil borings.

All groundwater samples contained VOCs at concentrations that exceeded their respective NYSDEC AWQSGVs. The VOCs detected at elevated concentrations at least once, were BTEX; isopropylbenzene; 1,2,4- and 1,3,5-trimethylbenezenes; n-propylbenzene and naphthalene. Benzene was detected at elevated concentrations in all groundwater samples.

Based on the findings of the investigation discussed above, an additional 60 cubic yards of contaminated soil were excavated from the property and disposed off-site.

Subsequently, eight permanent groundwater monitoring wells were installed at the property. Sampling of the wells was performed by EnviroTrac periodically between 2002 and May 2005. Analytical results of these sampling events, were similar to those previously detected.

2.5.5 Route 9A Reconstruction Project

The western end of the West 18th Street Gas Works was sampled by AKRF, Inc. as part of the Route 9A reconstruction project (AKRF et al, 1994). Six test borings were drilled between the

former MGP and the Hudson River and piers, three during Phase 1A and three during Phase 1B of the reconstruction. One monitoring well was installed two blocks south of the former MGP and one well was installed approximately two blocks north of the former MGP during Phase 1A. Analytical results for samples collected from these locations, which were all in the vicinity of the former MGP, indicated the following:

Soil

Heavy metals and PAHs were detected in most soil samples at concentrations below Extraction Procedure (EP) toxicity criteria. Total lead was detected in Site soils below the EP toxicity criteria and below NYSDEC RSCOs. VOCs, Cyanide, and TPH were detected sporadically at low concentrations in limited areas of the Site.

Groundwater

A groundwater sample from a monitoring well located mid-block along West 16th Street contained BTEX and PAHs concentrations of 1.0 mg/L and 0.063 mg/L, respectively. An additional groundwater sample collected from a monitoring well located two blocks south of the Site contained BTEX and PAHs concentrations of 132 mg/L and 63 mg/L respectively. This sample also exhibited the presence of many heavy metals.

2.6 Environmental Records Search

Files at Con Edison and the Department of City Planning were searched for records of additional site history and information on documented contaminant release sites. A freedom-of-information request was filed with the NYSDEC for information on potential waste sites (e.g., petroleum spill sites, hazardous waste sites, etc.) within and in the vicinity of the investigation area.

Summary Documented Spills in the Vicinity of the Site

Twenty-three petroleum spills were within approximately one-quarter mile of the Site, and an additional thirty petroleum spills were within approximately one-quarter to one-half mile of the Site, as reported in the Leaking Storage Tank Incident Reports (LTANKS) section of the environmental database search. The location of and distance/direction from the Site the LTANKS are as follows:

Equal/Higher Elevation	Address	Distance (mile)/Direction from the Site
528 West 19th Street/Manhattan	528 West 19th Street	0-1/8 ESE
555 West 17th Street/Manhattan	555 West 17th Street	0-1/8 SSE
501-513 West 19th Street	513 West 19th Street	0-1/8 ESE
Mendon Leasing Corporation	515 West 18th Street	0-1/8 SE
GETTY 58542	152 Tenth Avenue	0-1/8 E
152-156 Tenth Avenue/Manhattan	152-156 Tenth Avenue	0-1/8 E
535 East 21st Street	535 East 21st Street	1/8-1/4 NE
507 West 21st Street	507 West 21st Street	1/8-1/4 ENE
Pier 57- 11th Avenue	Pier 57/11th Avenue	1/8–1/4 S
NYC Transit Authority/Manhattan	West 15th Street/ 11th Avenue	1/8–1/4 S
193 10th Avenue	193 10th Avenue	1/8–1/4 ENE
Pier 57- Westside Highway	Pier 57/17th Street	1/8–1/4 S
Auto Care West	458-460 West 18th Street	1/8–1/4 SE
19 11th Avenue/NYCTA-Hudson	19 11th Ave	1/8–1/4 S
11 Eleventh Avenue	11 Eleventh Avenue	1/8–1/4 S
Freedman Cutouts	444 West 17th Street	1/8–1/4 SE
562 West 23rd Street/Manhattan	562 West 23rd Street	1/8–1/4 NNE
Edison Parking Garage	527 West 23rd Street	1/8–1/4 NE
Mendon Leasing Corporation	527 West 23rd Street	1/8–1/4 NE
Tank failed Mendon Leasing	527 West 23rd Street	1/8–1/4 NE
Menden Leasing	523 West 23rd Street	1/8–1/4 NE
505 West 14th Street	505West 14th Street/ 10th Ave	1/8–1/4 S
501 West 14th Street/ SUNOCO	501 West 14th Street	1/8–1/4 S

Additional information on spills and releases is presented in the Site History Report. It is noted that all LTANKS sites are located to the north, south, or east of the former MGP site. As the predominant groundwater flow direction in the fill unit was determined to be towards the west/southwest, many of these spills are upgradient of the Site.

2.7 Regional Geology/Hydrogeology

A U.S.G.S Quadrangle Map indicating the location of the Site is included as Figure 1. The geology beneath the site is based on data collected from two borings drilled as part of the Route 9A Reconstruction Project (AKRF, 1994).

According to the subsurface conditions encountered in the above-referenced borings, fill material is ubiquitous and consists of dredged river sediment, coal plant refuse, and construction debris in thickness of approximately 3 to 25 feet. Pockets of silt, sand and clay are found between the fill and bedrock (AKRF, 1994). Typical subsurface soils (fill) consisted of brown fine to coarse sand, with traces of silt and fine to medium gravel, brick, and ash fill to a depth of 13 ft bgs. Water was encountered at approximately 5 to 6 ft bgs. Fill materials encountered consisted of black slag-like material with brick-like material and glass from near the surface to approximately 3 ft bgs. Below the fill was light brown sand with silt and some gravel. Black-brown coarse to fine sand with abundant rock fragments and slight odor was encountered at approximately 9 ft bgs. Water was encountered at approximately 6 ft bgs. AKRF reports that in general, the overburden materials in the area consist of up to 35 feet of construction debris that may include brick, weathered schist, sand, silt, clay, stone, and wood above a 10 to 40 foot thick layer of organic silt above a layer of up to 50 feet of glacial till (AKRF, 1994).

The Hudson River forms the western boundary of the Site as it exists today. The Hudson River is a Class I surface water body adjacent to the West 18th Street Site (NYSDEC, 2001). Manhattan's drinking water is obtained from reservoirs located greater than 25 miles north of the city. No drinking water supply wells were identified in the vicinity of the Site (EDR, 2002 and NYSDOH, 1982). Old stream channels and buried utilities may act as preferential pathways and exert some influence on the occurrence and movement of shallow groundwater in the region. Depths to groundwater at the western end of the former West 18th Street Gas Works are approximately 5 to 6 ft bgs (AKRF, 1994), and depths to groundwater on Block 689 are approximately 8 to 11 ft bgs (MTA, 1998a). It is noted that differences in groundwater depths between those measured by AKRF and MTA likely reflect seasonal and daily changes in ground water elevations in response to seasonal and daily tidal fluctuations in water elevations in the Hudson River.

3 SITE CHARACTERIZATION SCOPE OF WORK

This section provides a description of the methodologies used during the field investigation of the West 18th Street former MGP Site. The location and number of samples taken, along with the corresponding analytical parameters, are presented in the following sections. Descriptions of all field activities conducted during the SCS are presented by field task and/or environmental media. The locations of the SCS samples are shown on Figure 4. Specific tasks performed during the SCS consisted of the following:

- Underground utility clearance and geophysical survey;
- Community air monitoring;
- Subsurface soil sampling;
- Test pit excavation;
- Soil boring installation;
- Monitoring well installation and development;
- Groundwater sampling;
- Soil and groundwater analysis;
- Quality assurance/quality control sampling (QA/QC);
- Investigation residuals management; and
- Site survey.

Due to delays posed by the owners of various properties, associated access restrictions, subcontractor availability and permit constraints, the field work was executed in a non-contiguous manner, beginning in April 2004 and extending until December 2005.

Ambient air, indoor air, and subsurface gas sampling was conducted at two properties during the SCS. The first was within Area 2, at Block 690, Lot 46. The second was conducted within Area 5, at Block 691, Lot 1. Separate reports were prepared and submitted independently for each investigation, and these activities are not discussed further in this SCS Report.

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. Due to the highly developed nature of the Site and a review of available utility plates, subsurface utilities including natural gas, electric, and steam lines, telephone lines as well as fiber optic cables, water lines, and sewers, were located. 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 start of the fieldwork. All mark outs by Code 753 participating companies were complete in the specified timeframes in advance of all field intrusive activities. Renewal calls were made in accordance with the timeframes allowed in the regulations.

A geophysical survey was also conducted using ground penetrating radar, electromagnetic conductivity, a magnetometer, and a pipe locator within an approximate 10-foot radius of each of the proposed sample locations (whenever possible). Manholes and other utility boxes (e.g., gas valve box) were opened and inspected in order to confirm or ascertain the depth to and orientation of the subsurface utilities. This non-intrusive investigation provided an added level of assurance with respect to confirming utilities marked out by the New York City One Call group, to trace utilities onto the private properties, and/or to identify anomalous areas where private utilities or other unknowns may be present.

As an additional precaution to ensure worker safety and to prevent damage to potential 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 of five feet below grade, 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 location was moved to another area to achieve the same investigative objective. Alternatively, special precautions were taken (e.g., coordinating with Con Edison's Gas Operations Group and exposing the utility) when working in close proximity to a high pressure gas main. Concrete and asphalt materials were saw cut prior to excavation. Soil excavated from the pilot holes was stored on plastic poly sheeting adjacent to the area and then used as backfill. Temporary repairs using asphalt cold patch, concrete, and/or steel road plates were made as a means to secure the openings until in-kind, final repairs to the surface could be made.

3.2 Community Air Monitoring

The site-specific Health and Safety Plan for the SCS field investigation includes a Community Air Monitoring Program (CAMP) that was implemented during all ground intrusive activities. Community air monitoring was conducted using real-time, hand-held monitoring instruments (Mini-RAE organic vapor meter equipped with PID for volatile organic compounds and a MIE DataRam for airborne particulates). Two sets of air monitoring equipment were calibrated daily and set up at upwind and downwind stations near each invasive activity. If concurrent invasive activities were in close proximity, the two stations were sufficient to monitor the ambient air. If the invasive activities were distant, two sets of equipment were utilized for each activity.

3.3 Subsurface Soil Sampling

3.3.1 Exploratory Test Pits

In general, exploratory test pits were used to locate and investigate remnant MGP structures. The primary objectives of the exploratory test pits were to visually inspect and determine the

presence or absence of historic MGP features, such as ring wall structures of former gas holders or the foundations of supporting operational buildings, to identify the presence of MGP-related impacts (such as the presence of non-aqueous phase liquids), and to evaluate subsurface conditions in the vicinity of these structures.

The exploratory test pits were excavated using a backhoe with a qualified OSHA-certified operator. Asphalt surfaces were saw-cut prior to the excavations. Using a bucket attachment on the backhoe, soils were removed in lifts of one to two feet at a time to accurately correlate the soils brought to the surface with the depth from which they were obtained. The exploratory test pit was left open only for the amount of time needed to log and photo-document conditions within the test pit (i.e., sidewalls, presence of ring wall, foundation construction etc.), to physically inspect the excavated materials, screen with a PID, and to collect samples for laboratory analysis. All excavated materials were returned to the test pit and compacted with the backhoe bucket. Temporary patching was installed where necessary to minimize contact with the soil until such time that the final restoration to the surface could be made. In certain instances, the use of steel road plates was required.

3.3.2 Soil Borings

Prior to excavating soil borings, utility clearance was performed at each location in accordance with Con Edison's subsurface utility clearance procedure. Typically, locations were saw cut and shallow soil samples were obtained using a decontaminated steel spoon or a hand auger.

After confirming the absence of subsurface utilities, drilling at each soil boring location was performed using either hollow stem auger (HSA) or direct-push "DP" (e.g., GeoProbe™) drilling methods. Using these methods soil was continuously sampled from approximately 5 ft bgs (i.e., below the interval excavated by hand during utility clearance) to the final depth. Using HSA methods, soil samples were obtained with a standard 2-inch diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) Method (ASTM D-1586). The SPT method entails recording the number of blows required to advance the split-spoon sampler the last 12 inches of the split-spoon using a 140 pound weight falling freely for 30 inches. A four-foot long by 2-inch diameter stainless steel macro core sampler containing a clean polyethylene liner was used to collect soil with the DP drilling method.

The retrieved soil was characterized by the field geologist for physical properties including lithology, grain size, and moisture content, and for physical evidence of contamination, including staining, sheen, light non-aqueous phase liquid (LNAPL), dense non-aqueous phase liquid (DNAPL), and/or odors, etc. Each sample was field screened with a PID for Total VOCs immediately upon opening the sampler. Soil was classified in accordance with the Unified Soil

Classification System (USCS). All field observations and measurement were recorded in a bound field notebook.

Based on field screening of the soil cores, soil samples were collected for chemical analysis from each boring, in general accordance with the following sampling strategy:

(1) From the six-inch interval within the vadose zone that exhibited the strongest evidence of contamination (if any), such as staining, sheen, odors, elevated VOCs based on PID readings, etc.;
(2) At the soil/water table interface;
(3) From the 6-inch interval within the saturated zone that exhibited the strongest evidence of contamination (if any), such as staining, sheen, odors, elevated VOCs based on PID readings, etc.;
(4) From the 6-inch interval above the top of the first low permeability unit encountered (if any) in the soil boring; and/or
(5) In borings where contamination was apparent based upon field observations, from a 6-inch interval of apparently clean material below contaminated soil (to provide data for vertical delineation).

If there was insufficient sample volume to fill the sample jars for chemical analyses from the 6-inch interval, additional soil was collected from the split-spoon sampler within the same 2-foot interval. Samples for VOCs were collected first.

Samples were transferred from either the split-spoon sampler or macro-core samplers directly to laboratory-supplied sample jars. The jars were sealed, labeled and placed in a cooler containing ice for shipment to Chemtech Laboratories, located in Mountainside, New Jersey for analysis. The coolers were shipped under chain of custody protocols. The samples were analyzed as described in Section 3.6 of this report.

Retrieved drill cuttings were returned to the borehole if not grossly contaminated. Soil cuttings containing free product or staining were containerized in 55-gallon steel drums and managed as described in Section 3.8 of this report. Drums were labeled on a daily basis.

During setup of the drill rig at each location, a polyethylene plastic liner was placed under the working platform of the drill rig to contain any potential spills and drips resulting from equipment failure or leaks of motor oil, hydraulic fluid, and/or diesel fuel. Soil cuttings generated during drilling and soil samples that are not submitted for analysis were placed in DOT-approved 55-gallon drums and handled as described in Section 3.8 of this Report. Once sampling was complete, the borehole was then backfilled and sealed with cement-bentonite grout.

3.4 Monitoring Well Installation and Development

To accommodate each overburden aquifer monitoring well (designated with "A") installation, a soil boring was first completed using a HSA drill rig with 4.25-inch inside diameter (ID) augers. After advancing a soil boring to the desired depth, a well was installed in the boring. All wells were constructed using 2-inch diameter polyvinyl chloride (PVC) casing and 10-feet long 20-slot screen. The screen was installed such that it straddled the water table. In addition, a two-foot long sump for the collection of DNAPL, if any was encountered during drilling of the boring, was installed at the bottom of the well screen.

Semi-confined or confined monitoring wells (designated with a "B") were installed below the low permeability silty/clay unit. In order to prevent vertical migration of contamination from the vadose zone to deeper intervals via the soil boring/monitoring well, a 6-inch diameter steel casing was installed in the borehole to a depth of at least over two feet into the clay. The annulus between the steel casing and borehole was filled with grout from the base to grade using a tremie pipe. The grout was allowed to cure for a minimum of 24 hours prior to resuming drilling to final well depth inside the steel casing. The monitoring well construction was similar to that used for the overburden monitoring wells, with the exception that the top of the screen was set within one foot of the bottom of the low permeability unit.

Following well installation and prior to sampling, new wells were developed using surging and pumping. The wells were pumped at low flow rates to minimize the volume of development water generated, while also ensuring that they are sufficiently developed to achieve the target water quality. Development was not initiated sooner than 24 hours after well installation. Prior to development, the wells were checked for presence of LNAPL and/or DNAPL using an electronic oil/water interface probe. Wells that contained LNAPL and/or DNAPL greater than 1/16 inch were not developed.

Groundwater generated during well development was performed until a minimum of three well volumes was evacuated from each well and the discharge water was reasonably free of visible sediment, the field parameters have stabilized. Development was continued up to a maximum of two hours in efforts to achieve turbidity measurements below the NYSDEC goal of 50 Nephelometric Turbidity Units (NTUs). The well development observations and field measurements were recorded in a bound field logbook and well development log form.

All monitoring wells were developed in September 2005. The wells were pumped with a submersible pump and dedicated polyethylene tubing at low flows to minimize the volume of development water generated, while also ensuring sufficient development to achieve the target water quality. Properly decontaminated and/or dedicated equipment was used during development. Prior to development, the wells were checked for LNAPL and/or DNAPL.

Field parameters monitored during well development included temperature, pH, conductivity, and turbidity. Parameters were considered stabilized upon successive readings for temperature within 0.1ºC, pH levels within 0.1 standard unit (S.U.), conductivity levels within 5 percent, and turbidity levels within 10 percent (for values greater than 1 NTU).

3.5 Groundwater Sampling

Prior to groundwater sampling an electronic oil/water interface probe was used at each well to measure static water levels, depth to water, and depth to the well bottom (to check for possible siltation). The oil/water interface probe was also used to confirm the absence of measurable separate-phase product. In accordance with the SCS Work Plan, groundwater samples were not collected from any wells containing of LNAPL and/or DNAPL of greater than 1/16 inch.

The well diameter and the length of water column in each well were used to calculate the volume of water in the well. A peristaltic pump and dedicated polyethylene tubing were used during sampling to minimize turbidity and purge water volumes. Using this method, water was drawn through the well screen from the formation at a flow rate that was equal to or less than the natural well recharge rate. A minimum of one well volume was required to be removed with the low flow method, assuming stabilization of field parameters was achieved, as the standing water column in the well above the screen zone was not drawn into the screen and removed, therefore, need not be purged from the well. Field parameters consisted of pH, temperature, conductivity, and turbidity. Additional parameters that were recorded in the field at selected wells included oxidation-reduction potential (ORP) and dissolved oxygen (DO). Parameter stabilization is described in the USEPA Standard Operating Procedure (SOP) #GW 0001.

Purge water and other IDW were containerized in DOT-approved 55-gallon drums and disposed off-site at a permitted waste disposal facility, as described Section 3.8 of this report.

After purging was complete, groundwater samples were collected directly from the polyethylene tubing discharge into laboratory-supplied sampled bottles containing appropriate preserving agents. Collected samples were stored in iced coolers and shipped under chain-of-custody procedures to the laboratory for analysis.

3.6 Soil and Groundwater Analyses

The soil and groundwater samples collected during the SCS were analyzed for:

- VOCs by USEPA SW-846 Method 8260B;
- SVOCs by USEPA SW-846 Method 8260C;
- Metals (Priority Pollutant List – PPL) by USEPA SW-846 Method 6010B and 7471A;
- Total and Amenable Cyanide by USEPA SW-846 Method 9012A;

- Herbicides by USEPA SW-846 Method 8151;
- Pesticides by USEPA SW-846 Method 8081A; and
- PCBs by USEPA Method 8082.

All soil, groundwater, and waste classification samples were analyzed by Chemtech Laboratories of Mountainside, New Jersey in accordance with the NYSDOH's Analytical Services Protocol (ASP). Selected soil samples were also subject to pesticides, polychlorinated biphenyls (PCBs) and forensics analysis. Pesticides and PCBs were analyzed fusing USEPA Methods 9010 and 9012A , respectively. Forensics analysis was performed by Meta Environmental, located in Watertown, MA. The forensics analysis entailed solvent extraction of the samples, followed by analysis of the extractant fluid by gas chromatography with a flame ionization detector (GC/FID). The resulting chromatogram was then interpreted by comparisons to a library of chromatograms of known source materials.

3.7 Quality Assurance / Quality Control

Data quality objectives are qualitative and quantitative criteria, which specify the quality of data required to the objectives outlined in Section 1.2 of this report. All analytical data were validated independently by TRC. The review criteria used for the SC investigation data are from following United States Environmental Protection Agency, Region 2 documents:

- Standard Operating Procedure (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 23B, Revision 1.0, May 2002, Validating PCB Compounds by SW-846 Method 8082; and
- SOP Number HW-2, Revision 11, January 1992, Evaluation of Metals Data for the CLP Program.

Data usability summary reports were prepared and are included in Appendix B of this Report.

3.8 IDW Management

The IDW generated during this SCS was managed and properly classified, transported, and disposed of at a pre-approved, licensed off-site facility. IDW was contained in DOT-approved 55-gallon drums. Drums containing IDW were labeled at the end of each day with the date, contents, contact information, job name/number, location origin, and drum count number.

Four types of IDW were generated as listed below.

- Concrete and asphalt;
- Soil cuttings;
- Aqueous wastes (decontamination fluids, well development and purge groundwater); and
- Plastic/personal protective equipment/bottleware/miscellaneous waste.

Concrete and asphalt was placed in 55-gallon drums and disposed of as a non-DOT regulated non-hazardous waste. PPE, used bottle-ware, and miscellaneous waste (such as plastic used for the staging of soil from test pits) were disposed of in 55-gallon steel drums as non-DOT regulated non-hazardous waste. Soil cuttings and aqueous wastes were managed separately in 55-gallon drums, sampled, and chemically analyzed for Toxicity Characteristic Leaching Procedure (TCLP) volatile organic compounds, TCLP semi-volatile organic compounds, TCLP metals, RCRA Characteristics, and PCBs.

The drums were transported by Clean Earth of New Jersey, Inc., a licensed, Con Edison-approved waste hauler. The drums were disposed at properly licensed, permitted and Con Edison-approved disposal facility.

3.9 Surveying

The locations of all soil borings, test pits and groundwater monitoring wells were surveyed by a NYS-licensed surveyor. Other Site and proximal features, such as building corners, streets, etc., were also surveyed for purposes of establishing a base map for the SCS field investigation project. Horizontal locations were measured to an accuracy of 0.1-foot. Elevations were measured to an accuracy of 0.01-foot, and included the top of well casing and ground surface elevations. All horizontal coordinates were surveyed using the New York State Coordinate System (East), North American Datum (NAD) 83, as derived from the global positioning system (GPS). All vertical datum are based upon the North American Vertical Datum (NAVD) 88, as derived from GPS.

3.10 Site Restoration

All Areas of the Site properties that were disturbed by the SCS field investigation activities were restored to the satisfaction of the property owners.

3.11 Summary of Changes from the Approved SCS Work Plan

One test pit (TP-1) was planned in Area 1 across the ring walls of the two former gas holders in this portion of the Site. Due to the volume of vehicular traffic and parking in this area, a less intrusive approach was taken. Two smaller test pits (TP-1 and TP-1B) were completed manually based upon scaled drawings and field observations made during the utility clearance procedure

implementation. Brick structures consistent with remnants of ring walls were encountered in both test pits.

For all of the borings installed to a depth below a low permeability unit in order to achieve a target depth of 100 ft bgs or top of bedrock, whichever came first, the sampling strategy in the original work plan was modified to collect an additional sample directly below the bottom of the low permeability unit and at the bottom of each boring. Additional samples were collected at Con Edison's discretion to provide additional data in determining the horizontal and vertical extent of impacts.

Due to the presence of a multiple utility vaults and subsurface utilities, exploratory test pit TP-5 was deleted from the program.

The confined aquifer monitoring well MW-40B was deleted from the program based on the field observations that the confining unit was continuous/semi-continuous down to bedrock, and that there was no observed confined aquifer at the soil boring location.

Additional soil borings (SB-53, SB-54 and SB-55) were added to the field activities when Con Edison gained access to the building on West 19th Street (Block 690, Lot 42). The boring locations were advanced using direct push drilling techniques due to limited overhead clearance. As such, blow counts and SPT could not be recorded for the soil boring locations in this Area.

Due to overhead clearance constraints, all soil borings in Area 1 were completed using direct push techniques. As such, blow counts and SPT could not be recorded.

The boring locations SB-35 and SB-37 were deleted from the program due to restricted access at the original location and subsurface utilities and obstructions surrounding the location.

The boring locations SB-41 and SB-42 (western sidewalk along Route 9A) were deleted from the program due to subsurface utilities and electrical vaults on this block. One monitoring well (MW-41A) was planned for installation in Area 6 of the Site. However, this location could not be completed due to the presence of electrical vaults beneath the sidewalk.

At several soil boring locations where visible oil-like and/or tar-like material was encountered, a representative sample from the 6-inch interval of apparently clean material below the contaminated soil interval could not be collected. In these borings, there was too much potential carry down of the oil-like and/or tar-like material product into the clean interval for a representative clean sample to be collected.

At select boring locations, a temporary steel casing was installed into the low permeability unit to allow drilling to continue while minimizing the potential for carry down of contamination and/or NAPL.

4 RESULTS

This section discusses the field observations and analytical results for the samples collected during the SCS at the Site. The analytical results of the subsurface soil samples that were collected as part of the SCS are summarized and compared to the NYSDEC RSCOs specified in TAGM 4042. The analytical results of the groundwater samples are compared to NYSDEC AWQSGVs specified in the Technical and Operational Guidance Series 1.1.1 (TOGS), Class GA criteria.

Tables 4-7 through 4-35 organize the field observations and laboratory results into the six geographic areas of the Site (i.e., Areas 1 thought 6), as defined in Section 1.3 of this report. In general, all references to intervals in the tables and narrative are relative to feet below grade.

4.1 Data Usability Summary Reports and QA/QC Samples

In accordance with the Quality Assurance Project Plan (QAPP), QA/QC samples were collected periodically throughout the SCS investigation. The 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 B. The complete laboratory reports (NYSDEC ASP Category B deliverable format) are provided in Adobe Acrobat format on compact discs in Appendix C.

In brief, 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 as summarized in Section 1.2 of this report.

4.2 Site-Specific Geology

Geology and hydrogeology was determined based on observations in the soil borings and test pits excavated across the Site. The stratigraphy and groundwater encountered at the Site is summarized below.

Stratigraphy:

Geology beneath the Site is consistent with that described by others (see Section 2.5.2) and consists of four primary stratigraphies, which are underlain by bedrock. The stratigraphic units, in order from shallowest to deepest, are: fill, upper sand, silty/clay and lower sand.

Fill Unit: The fill material consists of construction debris (brick, concrete, glass, wood timbers, ash, slag, rebar, etc.) co-mingled with brown to black, fine to coarse sand, gravel, cobbles and silt. The thickness of the fill is variable and was encountered from the near surface to depths

ranging from of 7 ft bgs to greater than 35 ft bgs. The apparent thickness is consistent with those reported during previous investigations.

Upper Sand Unit: In some areas of the Site, the fill is underlain by a layer of poorly sorted to well sorted sands. Where present, this unit ranges up to 29-feet thick. The sand is characterized by brown to gray, fine to coarse sand, trace silt, and trace gravel. This unit is generally absent from the eastern portion of the Site where the silty/clay unit was closer to or at the surface, prior to backfilling out from the shoreline.

Silty Clay Unit: The low-permeable silty clay is gray to black in color with intermittent peat lenses. The silty clay is likely a Holocene salt march deposit. Salt marshes were once prevalent along the Manhattan shoreline and, since the 1800s, have been filled and built over. This unit contains small marine shells, such as those from clams, mussels, and snails, etc, and organic material, such as decayed fibrous and non-fibrous plant materials. The upper surface of the clay-silt layer is irregular, but generally slopes down towards the Hudson River. Poorly sorted to well sorted sand, silty sand and gravel lenses were found within the silty clay unit, which are likely remnants of ancient stream channels or estuarine environments. In general, this unit pinches out to the east and is absent or discontinuous in the eastern portions of the Site and thickens to the west towards the Hudson River.

Lower Sand Unit: Underlying the silty clay is poorly sorted coarse to medium sand. In some areas of the Site, the lower sand unit is interbedded by silty sand, up to 13 feet thick.

A geologic cross section of the stratigraphic units extending across Areas 1 and 3 of the Site is presented as Figure 4A.

Groundwater

Groundwater occurs in the fill unit and occurs at depths ranging from 1.80 ft mean sea level (MSL) (MW-34A) to approximately -1.19 ft MSL (MW-12A). On October 11, 2005 a synoptic round of groundwater depth measurements was performed in all wells. Using the surveyed elevation of the measuring point on each well, the measured depths to groundwater were converted to elevations. The groundwater depth measurements and corresponding elevations are summarized in Table 4-36. The groundwater elevations were plotted on Figure 14 and contoured. Based on the plotted groundwater elevations shown on Figure 14, groundwater predominantly flows to the west/southwest in the fill unit towards the Hudson River. Based on variations in the depth to groundwater observed and or measured in various borings and monitoring wells during the course of the SCS, and in consideration of previous investigations conducted by others, it appears that groundwater levels are influenced by seasonal and daily tidal

fluctuations. In addition, there may be some localized groundwater mounding in the vicinity of MW-34A/Areas 2 and 5.

4.3 Area 1 – Summary of Findings

Area 1 has been designated as that portion of the Site where former Gas Holders No. 1 and No. 2 were located, along 18th Street between 9th and 10th Avenues (see Figures 2 and 4). At the time of the SCS activities, Verizon was using the property for vehicle parking and offices. This portion of the Site has been the subject of ongoing investigations of multiple leaking underground storage tanks, which are being conducted by the property owner. The results of these investigations to date are summarized in Section 2.5.4 of this report. The USTs were used to store gasoline, fuel oil and hydraulic oil.

A total of two test pits (TP-1 and TP-1B), seven soil boring locations (SB-1, SB-2, SB-3, SB-4, SB-5A, SB-5B, and SB-6) and two groundwater-monitoring wells (MW-5A and MW-5B) were completed in Area 1. These sample locations are shown on Figure 4. Table 4-7 presents a summary of the field work and observations. The following sections present a discussion of the field observations and analytical results for subsurface soil samples.

4.3.1 Summary of Field Observations

During excavation of the exploratory test pits, brick walls, which appeared to correlate with the approximate locations of the ring wall foundations for the two former gas holders were encountered at TP-01 (Gas Holder No. 2) and TP-01B (Gas Holder No. 1). While hand excavating for utility clearance at soil boring SB-6, a brick wall, which corresponded to the location of northwest portion of the ring wall for the former Gas Holder No. 2, was encountered. The apparent ring wall of former Gas Holder No. 1 was encountered in test pit TP-01B.

Note that all depths referenced on boring logs, tables, and subsequent text is relative to surface elevations (top of concrete slab) at each location. It is noted however, that the top of the concrete slab in the parking area of the building that occupies Area 1 is approximately 2.5 feet higher than street level at this location. It is believed that this elevated parking area is due to the placement of fill around the gas holder foundations during initial construction of the building. The source of this non-indigenous fill material (above street level elevation) does not represent soil conditions during operations of the former gas holders on this property.

No odors or staining were detected in subsurface soil encountered in exploratory test pit TP-01. In exploratory test pit TP-01B, gasoline-like odors were detected from 0 to 3 ft bgs. Wood timbers containing black staining were also observed in this test pit from 2 to 3 ft bgs.

Petroleum, fuel oil, gasoline, and/or MGP-related odors were observed in six of the seven soil borings (SB-2, SB-3, SB-4, SB-5A, SB-5B, and SB-6) completed in Area 1. It is noted that soil boring SB-1 in the southeastern portion of the property could not be advanced to the water table and, therefore, it is not known if the evidence of petroleum impacts also occur at this boring location. The most predominant odor detected was petroleum in five locations (SB-2, SB-4, SB-5A, SB-5B, and SB-6). The petroleum odors were detected consistently through the following depth intervals: 13 to 15 ft bgs in SB-2, 11 to 15 ft in SB-4, 10 to 22 ft bgs in SB-5A, 10 to 19 ft bgs in SB-5B, and 10 to 19 ft bgs in SB-6. These intervals all start at the approximate depth of the water table encountered at this parcel. This is indicative of a plume of petroleum contamination in groundwater across most of this parcel. A petroleum sheen was observed on the groundwater associated with soil samples from borings SB-4, SB-5A, SB-5B, and SB-6, and trace LNAPL was observed in SB-6. Gasoline odors were detected in subsurface soil at a depth interval of 0.8 to 2 ft bgs in soil boring SB-2, at a depth interval of 13 to 15 ft bgs in soil boring SB-3, and at a depth interval of 6.5 to 11 ft bgs in soil boring SB-4, which suggests a smear zone. Observations of gasoline odors are not consistent throughout the borings and do not indicate a consistent source. As noted previously, there is an ongoing groundwater investigation study at the Verizon building involving a gasoline release(s) from several former USTs.

MGP-related odors were only detected in SB-2 and SB-4 ranging from 15 to 20.5 ft bgs and 15 to 21 ft bgs, respectively. Both of these borings were excavated inside the footprints of former Gas Holders No. 1 and No. 2, respectively. It is noted that refusal at both of these locations was at approximately 21 ft bgs, which suggests that the holder bottoms are present at this depth. Soil borings MW-5B and SB-6 were excavated outside the former holders (e.g., in) were advanced to depths 42 ft bgs and 72 ft bgs, well below the 21 foot depth achieved at borings inside the holders. In addition, subsurface soil encountered in the upper 20 feet in these borings (i.e., outside the holder) was different than that inside the holder.

There were no observations of TLM in any of the seven soil borings completed in Area 1. OLM was only observed in soil boring SB-4 between 19 and 21 ft bgs, directly above the point of drilling refusal (i.e., the apparent holder bottom of Gas Holder No. 2). The affected soil in this interval also exhibited a very strong MGP-like odor, heavy black staining and an elevated PID reading of 3,124 ppm.

Depths to groundwater ranged from approximately 8 ft bgs in soil borings SB-4, 5 and 6 to approximately 13 ft bgs in soil borings SB-2 and SB-3. Groundwater elevations were 0.63 ft MSL and 0.84 ft MSL for MW-5A and MW-5B, respectively.

4.3.2 Analytical Results for Subsurface Soil

A total of thirty-three soil samples (from 30 discrete intervals plus 3 duplicates) and two groundwater samples were collected. The monitoring wells MW-5A and MW-5B were installed in soil boring locations SB-5B and SB-5A, respectively. Analytical results for VOCs, SVOCs and inorganics (metals and cyanide) for subsurface soil samples collected in Area 1 are summarized in Tables 4-8 through 4-10, respectively. Figure 5 presents a summary of constituents detected and a comparison with the NYSDEC RSCOs. Concentrations that exceeded their respective individual NYSDEC RSCOs have been bolded, italicized, and or colored in the summary tables and figures to for easy identification.

4.3.2.1 Volatile Organic Compounds

A total of 17 VOCs were detected in subsurface soil samples collected from Area 1. Six of these VOCs, namely benzene, toluene, ethylbenzene, m/p-xylenes, o-xylene, and isopropylbenzene were detected at concentrations that exceeded their respective individual NYSDEC RSCOs. M/p-xylenes, ethylbenzene, and isopropylbenzene had the highest frequency of exceedances (approximately 12% of the number of samples analyzed), and m/p-xylenes and o-xylene were detected at the highest concentrations (320,000 ug/kg and 120,000 ug/kg, respectively) reported at location SB-6 in the 13 to 15 ft bgs interval. Strong petroleum-like odor, black staining, and trace LNAPL were also detected in this interval. The maximum PID reading in soil boring SB-6 was 3,520 ppm. None of the concentrations of the VOCs detected in the shallow subsurface soil samples collected from either of the test pits exceeded their respective NYSDEC RSCOs.

The concentrations of Total VOCs in soil samples SB-2 (19 to 20.5 ft bgs), SB-4 (19 to 21 ft bgs), SB-5B (11 to 12 ft bgs), and SB-6 (13 to 15 ft bgs) exceeded the NYSDEC RSCO of 10,000 ug/kg. As discussed above, soil borings SB-2 and SB-4 were excavated inside the former gas holder foundations. There was no evidence of Total VOC impacts to deeper soils in soil borings SB-5B or SB-6.

4.3.2.2 Semi-Volatile Organic Compounds

Twenty-three SVOCs were detected in subsurface soil samples. Eleven of the 23 SVOCs detected exceeded their respective NYSDEC RSCOs. Benzo(a)pyrene exhibited the highest frequency of exceedances (approximately 18%), followed by benzo(a) anthracene and chrysene (approximately 6%). Naphthalene had the highest detected concentration (220,000 ug/kg) in the soil sample SB-4 (19 to 21 ft bgs). This is consistent with the observation of OLM between 19 to 21 ft bgs in soil boring SB-4, which is located inside Gas Holder No. 2. None of the concentrations of the SVOCs detected in subsurface soil samples collected from the test pit exceeded their respective NYSDEC RSCOs.

The concentration of Total SVOCs in soil sample SB-4 (19 to 21 ft bgs) exceeded the NYSDEC RSCO of 500,000 ug/kg.

4.3.2.3 Inorganics

Twelve metals were detected in the subsurface soil samples. The concentrations of five metals, namely copper, lead, mercury, nickel, and zinc exceeded their respective NYSDEC RSCOs in one or more samples. The maximum concentration of lead of 2,240 mg/kg was detected in soil sample SB-2 (19 to 20.5 ft bgs). Mercury was detected at the highest frequency of exceedances (approximately 36%), although the maximum detected concentration was within one order of magnitude of its NYSDEC RSCO. Cyanide was sporadically detected and ranged in concentration from 0.66 mg/kg in soil sample SB-5B (21 to 22 ft bgs) to 190 mg/kg in SB-2 (19 to 20.5 ft bgs). There are no NYSDEC RSCOs established for total or amenable cyanide.

4.3.2.4 Fingerprint Results

Two soil samples (SB-4 [19 to 21 feet] and SB-6 [13 to 15 feet]) were submitted for fingerprint analysis from this Area. The soil sample from SB-4 contained monocyclic aromatic hydrocarbons (MAHs) and polycyclic aromatic hydrocarbons (PAHs) in a pyrogenic pattern. Pyrogenic substances are complex mixtures of primarily hydrocarbons produced from organic matter subjected to high temperatures, but with insufficient oxygen for complete combustion. Pyrogenic materials are produced by fires, internal combustion engines, and furnaces. They are also formed when coke or gas are produced from coal or oil. Coal-tar based products, such as roofing, pavement sealers, waterproofing, pesticides, and some shampoos contain pyrogenic materials. The fluoranthene/pyrene ratio (1.10) and the dibenzofuran/fluorine ratio (0.55) suggested that the pyrogenic material was coal tar. The predominance of naphthalene and the high relative concentrations of MAHs indicated that the coal tar had been subjected to little or no weathering.

The soil sample from SB-6 contained a petrogenic substance. Petrogenic substances include crude oil and crude oil derivatives such as gasoline, heating oil, and asphalt. The petrogenic material in this sample was characterized by aromatic and aliphatic hydrocarbons eluting about from about hexane (3 minutes on the GC/FID fingerprint) to about tetradecane (22 minutes). The sample contained primarily alkylated benzenes. Some common petroleum products with these characteristics include gasoline and some jet fuels. The reduced relative concentrations of benzene and toluene suggested that the material had been subjected to mild to moderate weathering.

4.3.3 Analytical Results for Groundwater

A total of 2 groundwater samples (2 locations) were collected from the 2 monitoring wells (MW-5A and MW-5B) that were completed in Area 1. Table 4-7 presents a summary of the field work and observations. Analytical results of the groundwater samples are presented in Tables 4-33 to 4-35. Well construction details and groundwater elevations are presented in Table 4-36. The concentrations of VOCs, SVOCs, and inorganics that exceeded the NYSDEC AWQSGVs concentrations are posted on Figure 11. Concentrations that exceeded their respective individual NYSDEC RSCOs are bolded and or italicized in the tables and figure to ease in their identification.

4.3.1.1 Volatile Organic Compounds

A total of eight VOCs were detected in shallow groundwater collected from monitoring well MW-5A, which is the only water table well installed in this area during the SCS. Six of these VOCs, acetone, benzene, m/p-xylenes, and o-xylene were detected at concentrations above their respective NYSDEC AWQSGVs. Acetone was detected at the highest concentration of 1,100 ug/l.

Only methyl tert-butyl ether (MTBE) was detected in the one deep well installed on this property during the SCS, MW-5B. MTBE is a gasoline additive and is not related to operations of the former gas holders.

4.3.1.2 Semi-Volatile Organic Compounds

Five SVOCs were detected in MW-5A. The concentrations of two of these (2,4-dimethylphenol and naphthalene) exceeding their NYSDEC AWQSGVs. The highest concentration was reported for 2,4-diemthylphenol (500 ug/l). No SVOCs were detected in groundwater sample MW-5B.

4.3.1.3 Inorganics

Six metals were detected in MW-5A, with concentrations of arsenic and lead exceeding their NYSDEC AWQSGVs. In MW-5B, antimony was the only metal out of the three detected that exceeded its' NYSDEC AWQSGVs. Both total and amenable cyanide were detected in MW-5A. The concentration of total cyanide of 1.4 mg/l exceeded the NYSDEC AWQSGV of 0.2 mg/l). There is no NYSDEC AWQSGV for amenable cyanide.

4.4 Area 2 – Summary of Findings

Area 2 has been designated as that portion of the Site bounded by West 18th and West 19th Streets, from 10th Avenue westward to the bulkhead along the Hudson River. Features of the

former gas works that were present in this area included (west to east) the former MGP storage and pipe yards, and Gas Holders Nos. 3 and 4 (see Figure 2). At the time of the SCS activities, demolition and remediation activities were being conducted on the western-most quarter of the block (abutting Route 9A) by the West 19th Street Development, LLC. The parcels that comprise the remainder of Area 2 are occupied by art galleries, a night club, a vacant building, a public parking lot, the adjacent portions of Route 9A, and Chelsea Piers Sports and Entertainment Complex.

One exploratory test pit (TP-2), 13 soil borings (SB-7, SB-8, SB-9, SB-10, SB-11, SB-12, SB-13, SB-14/SB-14A, SB-15, SB-18, SB-53, SB-54 and SB-55) and a total of three groundwater monitoring wells [two overburden (MW-7A and MW-12A) and one deep confined (MW-12B)] were completed in Area 2. The locations of all sampling points are shown on Figure 4.

One subsurface soil sample was collected from the test pit, a total of 58 subsurface soil samples (56 discrete intervals plus 2 duplicates) were collected from the 14 soil borings. A total of 4 groundwater samples were collected from the wells in Area 2; one groundwater sample was collected from each well, along with the collection of one blind duplicate sample. Table 4-2 presents a summary of the sample locations, the rationale for sample location selection, sample interval(s), list of the chemical analyses, and a summary of comparisons of the each analytical group to NYSDEC RSCOs. Table 4-11 presents a summary of the field work and observations. The following sections present a discussion of the field observations and analytical results.

4.4.1 Summary of Field Observations

Table 4-11 summarizes the field observations and other information (e.g., rationale for end of boring depth). The test pit was a series of excavations that targeted the ring walls of the two former gas holders located on the east end of Area 2.

Based on the soil encountered in the borings, stratigraphy encountered in Area 2 was consistent with that described in Sections 2.5.2 and 4.2.

Depths to groundwater ranged from approximately 7 ft bgs in soil borings SB-7, SB-13, SB-15 and SB-18 to approximately 11 ft bgs in soil boring SB-14A. Groundwater elevations measured in monitoring wells MW-7A and MW-12A were 0.97 ft MSL and -1.19 ft MSL, respectively, suggesting that the water table slopes down towards the west. The groundwater elevation in MW-12B was measured at -0.03 ft MSL, suggesting an upward hydraulic pressure (when compared to MW-12A) in this area of the Site.

Note that all depths referenced on boring logs, tables, and subsequent text is relative to surface elevations (e.g., sidewalk, top of concrete slab) at each location. Soil borings SB-53, SB-54 and SB-55 were drilled in the foundation slab inside the building at Block 660, Lot 42, which is level

with the top of the loading docks. The top of the loading docks, as well as the top of the foundation slab inside the building, are approximately 4 feet above the grade of the sidewalk in front of the building. Accordingly, the upper four feet of soil beneath the raised building foundation slab inside the building was imported from an unknown source during construction and does not represent ambient soil conditions/quality at this lot prior to construction of the building.

During the exploratory test pit activities, apparent remnants of former MGP structures were encountered. Photographs of these structures are presented in Appendix D. An intact brick wall, which correlates with the approximate location of the ring wall foundation for the former Gas Holder No. 3, was encountered at test pit TP-2. A slight petroleum odor was detected throughout the test pit to the final depth of 11 ft bgs. There was no evidence of staining or residual MGP products within the test pit.

Evidence of contamination, which included odors, NAPL, staining and or sheen, was detected in 11 of the 13 soil borings completed at Area 2. No evidence of contamination (odors, staining, sheen, visible product, etc.) was detected at soil borings SB-12, MW-12A, and MW-12B.

Petroleum, fuel oil, gasoline, and/or MGP-related odors were observed in eleven of the thirteen soil borings (soil borings SB-7, SB-8, SB-9, SB-10, SB-11, SB-13, SB-14A, SB-15, SB-53, SB-54, and SB-55) completed in Area 2. The most predominant odor detected in this Area was petroleum. These odors were detected in seven soil borings (SB-8, SB-9, SB-10, SB-11, SB-13, SB-14A, and SB15). The petroleum odors were consistently detected in subsurface soil from one foot bgs to several feet into the water table (i.e., to approximately 15 feet bgs). Specific intervals where petroleum odors were detected are: 1 to 15 ft bgs in SB-8; 1 to 10 ft bgs in SB-9; 1 to 14 ft bgs in SB-10; 1 to 9 ft bgs in SB-11; 11 to 13 ft bgs in SB-13; 7 to 19 ft bgs in SB-14A; and 5 to 13 ft bgs in SB-15. LNAPL, along with petroleum odors, black staining, sheen and or elevated PID readings, was observed from 5 to 13 ft bgs in soil boring SB-15. Elevated total VOCs concentrations based on field screening using a PID ranged from 1,000 ppm [SB-10 (6 to 10 ft bgs)] to over 2,800 ppm in [SB-10 (4 to 6 ft bgs)].

MGP-related odors were observed in seven locations (SB-7 from 19 to 35 ft bgs; SB-9 from 22 to 26 ft bgs; SB-11 from 21 to 33 ft bgs; SB-15 from 13 to 21 ft bgs; SB-53 from 1 to 4.5 ft bgs and 9 to 11 ft bgs; SB-54 from 0.8 to 1 ft bgs and 2 to 4 ft bgs; and SB-55 from 0.8 to 2 ft bgs. Several of these soil borings (SB-7, SB-9, and SB-11) were located within or near the footprints of former gas holders, while some are located within the former storage yard (SB-15, SB-53, SB-54, and SB-55). Some of these intervals correlate with physical evidence of MGP-related residue.

OLM was observed in two locations (SB-11 from 23 to 29 ft bgs, and SB-15 from 13 to 21 ft bgs). TLM was observed in three locations (SB-11 from 25 to 29 ft bgs, SB-15 from 13 to 21 ft bgs, and SB-54 from 2 to 4 ft bgs).

Based on the field observations contamination was identified in three potential portions of Area 2. The contamination in both of these areas is characterized by visible OLM, TLM, sheen, black staining, and MGP-related odors. One of these areas includes soil borings SB-7, SB-9, SB-11, which are located in the area immediately surrounding the former gas holders on the eastern-most end of Area 2. The observed contamination occurs at depths ranging from approximately 19 to 35 ft bgs. The second area includes SB-15 and the surrounding area and occurs at depths of approximately 13 to 21 ft bgs. Soil boring SB-15 is located approximately 15 feet due east of a parcel known to contain MGP-contamination and which has recently been remediated (see Section 2.5.3) The third area includes soil borings SB-53, SB-54, SB-55, and the surrounding area and is located approximately 0.8 to 5 ft bgs. However, based upon the physical difference in elevation between the street and the top of the concrete slab (upon which the soil sample intervals are referenced) for the borings in the third area, the contamination is limited to the fill materials brought in to construct the present building. The source of the fill material is unknown, and is not known to be related to former MGP operations.

The SHR indicated that there were 53 reported leaking storage tank incidents within 0.5-mile of the Site. There were at least 3 reported spills that involved leaded or unleaded gasoline that abut Area 2. In addition, numerous underground tanks were used throughout Area 2 to store various petroleum products. These underground storage tanks (USTs) are either still active, have been abandoned or their status is not known. Since petroleum was not known to have been used during operations of the former MGP, the relatively shallow petroleum contamination is due to spills or leaks of petroleum from on-site USTs and or off-site USTs. There does not appear to be any direct correlation between the other odors observed in this area and former Site operations.

4.4.2 Analytical Results for Subsurface Soil

Fifty-eight subsurface soil samples were collected from 13 soil borings and one test pit in Area 2 and analyzed for VOCs, SVOCs, and inorganics (metals and cyanide). Soil samples from several sample locations along 10th Avenue were also analyzed for pesticides, herbicides, and PCBs.

Analytical results for VOCs, SVOCs, and inorganics (metals and cyanide) and pesticide/PCBs in the subsurface soil samples are presented in Tables 4-12 to 4-15, respectively. Figure 6 presents a summary of constituents detected and a comparison with the NYSDEC RSCOs. Concentrations of analytes that exceeded NYSDEC RSCOs have been bolded, italicized, and or colored in that figure and respective tables to facilitate ease of identification.

4.4.2.1 Volatile Organic Compounds

As shown in Table 4-12, a total of 15 VOCs were detected in subsurface soil samples collected from Area 2. Eight of these VOCs, namely acetone, methyl-tert butyl ether (MTBE), benzene, toluene, ethylbenzene, m/p-xylenes, o-xylene, and isopropylbenzene and were detected at concentrations that exceeded their respective individual NYSDEC RSCOs. Benzene had the highest frequency of exceedances (approximately 16% of the number of samples analyzed), and m/p-xylenes and o-xylene, which both had at the highest concentrations (250,000 ug/kg and 100,000 ug/kg, respectively) at sample SB-10 (6 to 8 ft bgs). A strong gasoline/fuel oil odor was detected in this interval, with the maximum concentration of total VOCs reading of 1,200 ppm measured in the headspace using a PID. Visible brown product was observed from 8.4 to 8.8 ft bgs, with a maximum concentration for total VOCs of 1,100 ppm measured in the sample headspace using a PID. Significant reductions in the PID measurements of total VOCs (maximum 3 ppm) were recorded in the 10 to 12 ft bgs interval, and only a slight petroleum odor was present. Significant reductions in soil VOC concentrations were observed at this location in the 20 to 22 ft bgs interval, where the only benzene was detected at an elevated concentration (64 ug/kg). In soil boring SB-10 the water table was encountered at a depth of approximately 9 ft bgs. None of the concentrations of the VOCs detected in subsurface soil samples collected from the test pit exceeded their respective NYSDEC RSCOs.

The concentrations of Total VOCs in seven soil samples (SB-9 [20 to 22 ft bgs], SB-10 [5 to 6 ft bgs, 6 to 8 ft bgs, 8 to 10 ft bgs], SB-11 [27 to 29 ft bgs], and SB-15 [5 to 6 ft bgs, 17 to 19 ft bgs] exceeded the NYSDEC RSCO for Total VOCs of 10,000 ug/kg. None of the concentrations for Total VOCs exceeded the NYSDEC RSCOs for Total VOCs in deeper soil samples from these borings.

4.4.2.2 Semi-Volatile Organic Compounds

Twenty-seven SVOCs were detected in subsurface soil samples. None of the concentrations of the SVOCs detected in subsurface soil samples collected from the test pit exceeded their respective NYSDEC RSCOs. Twenty-one of the 27 SVOCs detected exceeded their respective NYSDEC RSCOs. Benzo(a)pyrene exhibited the highest frequency of exceedances (approximately 36%), followed by benzo(a) anthracene and chrysene (approximately 29% and 26%, respectively). Of the SVOCs detected, naphthalene had the highest concentration (4,700,000 ug/kg) in soil sample SB-15 (17 to 19 ft bgs). This is consistent with the observation of OLM and TLM observed in this boring immediately above the low permeability silty/clay unit, with the unit commencing at 19 ft bgs.

Based upon a review of historical maps, there were no former MGP structures or features at or in the vicinity of soil boring SB-15. It is noted however, that soil boring SB-15 was located adjacent to a parcel where petroleum and MGP-impacted soil was recently remediated.

The concentrations of total SVOCs in three of the soil samples from Area 2 (SB-11 [27 to 29 ft bgs], SB-15 [17 to 19 ft bgs], and the duplicate sample for SB-55 [2 to 3 ft bgs]) exceeded the NYSDEC RSCO for total SVOCs of 500,000 ug/kg. The total SVOC concentrations in sample SB-55 2 to 3 ft bgs and its duplicate were 184,780 ug/kg and 542,100 ug/kg, respectively. This variability is consistent with the heterogeneity typical of urban fill such as that which comprises the shallow soils across the Site.

4.4.2.3 Inorganics

Thirteen metals were detected in the subsurface soil samples. The concentrations of eight metals, namely arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc exceeded their respective NYSDEC RSCOs in one or more samples. Lead was reported at a maximum concentration of 1,740 mg/kg in the subsurface soil sample SB-11 (27 to 29 ft bgs). The concentration of lead in the next interval sampled (35 to 37 ft bgs) at this location was below the NYSDEC RSCO for lead. Of the metals detected, zinc was detected at elevated concentrations most frequently (approximately 31%). The maximum concentration of zinc was within one order of magnitude of its NYSDEC RSCO. Cyanide was detected in 15 samples and ranged in concentration from 0.57 mg/kg in soil sample SB-14 (17 to 19 ft bgs) to 160 mg/kg in SB-53 (6 to 7 ft bgs). There are no NYSDEC RSCOs established for total or amenable cyanide.

4.4.2.4 Pesticides, Herbicides, and PCBs

Twenty-two subsurface soil samples were collected from 7 soil borings in Area 2. No pesticides were detected in any sample. Three herbicides were detected, at low concentrations. One PCB (Aroclor 1260) was detected in samples SB-9 and SB-10 at concentrations of 16 ug/kg and 21 ug/kg, respectively, which are below the NYSDEC RSCO for subsurface PCBs of 10,000 ug/kg.

4.4.2.5 Fingerprint Results

The fingerprint analytical results for soil sample SB-14A (3 to 4 ft bgs) indicated the presence of a petrogenic substance. Petrogenic substances include crude oil and crude oil derivatives such as gasoline, heating oil, and asphalt. The petrogenic material in this sample is characterized by an unresolved complex mixture (UCM), which is typically reflected as a "hump" on the gas chromatograms during the analysis, from approximately octane (C8 - 8 minutes) to tetradecane (C14 - 22 minutes) with a maximum at undecane (C11 - 16 minutes). Common petroleum products with these characteristics include kerosene and some jet fuels. The lack of a dominant normal alkane pattern in the chromatogram indicates that this material has been subject to mild to moderate weathering. The sample also contains a low level, late eluting UCM in the lube oil range. In addition to the petrogenic materials, the sample contains a series of low concentration heavy PAHs in a pyrogenic pattern. Pyrogenic substances are complex mixtures of primarily hydrocarbons produced from organic matter subjected to high temperatures but with insufficient

oxygen for complete combustion. Pyrogenic materials are produced by fires, internal combustion engines, and furnaces. They also are formed when coke or gas are produced from coal or oil. Coal-tar based products, such as roofing, pavement sealers, waterproofing, pesticides, and some shampoos contain pyrogenic materials. The specific source of these compounds could not be determined.

4.4.3 Groundwater Analytical Results and Field Measurements

A total of four groundwater samples (three locations plus one duplicate) were collected from the three monitoring wells (MW-7A, MW-12A, and MW-12B) that were completed in Area 2. Table 4-11 presents a summary of the field work and observations. Analytical results of the groundwater samples are presented in Tables 4-33 to 4-35. The concentrations of VOCs, SVOCs, and inorganics that exceeded the NYSDEC AWQSGVs concentrations are posted on Figure 11. Concentrations that exceeded their respective individual NYSDEC RSCOs are bolded and or italicized in the tables and figure to ease in their identification. Well construction details and groundwater elevations are presented in Table 4-36.

4.4.3.1 Volatile Organic Compounds

Six VOCs were detected in the three monitoring wells from this area of the Site, with only benzene exceeding the NYSDEC AWQSGVs. The highest concentration was for benzene which was detected at 65 ug/l in monitoring well MW-12B. Exceedances of the benzene NYSDEC AWQSGV were detected in groundwater sample MW-7A (20 ug/l) and MW-12A (1.2 ug/l, estimated). No VOCs detected in the blind duplicate sample of MW-12A (i.e., MW-22A) exceeded their NYSDEC AWQSGVs.

4.4.3.2 Semi-Volatile Organic Compounds

SVOCs were detected in groundwater samples from Area 2. No SVOCs concentrations exceeded their NYSDEC AWQSGVs for SVOCs. Di-n-butylphthalate was detected in all four samples as estimated and in the laboratory blank. Accordingly, the presence of this compound is attributed to a laboratory source and not associated with the Site.

4.4.3.3 Inorganics

Nine metals were detected in the four groundwater samples collected from this area of the Site. Only thallium (5.2 ug/l) exceeded its NYSDEC AWQSGVs in the blind duplicate sample of MW-12A. All other metals were in compliance with the NYSDEC criteria. This metal is not related to MGP residues.

Total cyanide was detected in three of the four samples, ranging from 0.01 mg/l to 0.013 mg/l. These concentrations are well below the NYSDEC AWQSGV of 0.2 mg/l for total cyanide. No amenable cyanide was detected in the groundwater samples collected from this area.

4.5 Area 3

Area 3 is bounded by West 17th and West 18th Streets, from 10th Avenue westward to the bulkhead along the Hudson River. At the time of the SCS activities, the property was being used as a private parking lot. Area 3 of the Site housed many of the former gas plant operational structures, including the Retort House, Scrubbers, the Purifying House, the Laboratory, and the Workshop. In its' original configuration, a Coal House was located on the western most portion of the block, however, the footprint of that former structure would now be in the Hudson River.

A total of two exploratory test pits (TP-3 and TP-6), 15 soil borings (SB-19, SB-20, SB-21, SB-22, SB-23, SB-24, SB-25, SB-26, SB-27, SB-47, SB-48, SB-49, SB-50, SB-51 and SB-52) and two monitoring wells MW-24A and MW-24B were completed in Area 3. The location of each of these is depicted on Figure 3. A total 61 soil samples (59 discrete intervals plus 2 duplicates) were collected for chemical analysis. Sample locations are shown on Figure 4. Table 4-3 presents a summary of the sample locations, the rationale behind the selection of the sample location, the sample interval(s), a listing of the chemical analyses conducted, and a comparison to the NYSDEC RSCOs for soil. Table 4-16 presents a summary of the field work and observations. The following sections provide summaries of the field observations and analytical results for subsurface soil samples.

4.5.1 Summary of Field Observations

Test pit excavations TP-3 and TP-6 were completed in Area 3 in efforts to determine the presence or absence of remnant foundation structures of the former Scrubbers and Laboratory Building, respectively. In test pit TP-3, a brick wall was encountered from 2.3 to 3.8 ft bgs. A tar-like residue was observed on the east wall of the test pit from 1.9 to 3.75 ft bgs. No other evidence of contamination was observed in test pit TP-3. In test pit TP-6, two ashlar (block-type) walls and two brick walls were encountered between 2 and 5 ft bgs. These walls are consistent with the approximate location of a former Laboratory building (See Figures 2 and 4). No physical evidence of contamination was detected in test pit TP-6.

Depths to groundwater ranged from approximately 5 ft bgs in soil boring SB-24 to approximately 12 ft bgs in soil boring SB-49. Groundwater elevations measured in monitoring wells MW-24A and MW-12A (in Areas 2) in the water table aquifer were 0.97 ft MSL and -1.19 ft MSL. The difference between these water elevations suggests that the water table is relatively flat and may have a slight slope toward the west.

Field observations of contamination in Area 3 included odors (MGP-related, unidentified, non-MGP-related, petroleum, solvent, and ammonia), black staining, sheen, OLM, and TLM/coal tar. Only one boring, SB-21, showed no evidence of contamination.

Petroleum odors were detected in soil boring SB-23 from 9 to 17 ft bgs.

MGP-related odors were detected in five of the 14 soil borings, which were SB-19 [9 to 15 ft bgs], in SB-24 [23 to 33.8 ft bgs], in SB-26 [15 to 33 ft bgs], in SB-48 [9 to 16 ft bgs], and in SB-52 [7 to 9 ft bgs, 15 to 17 ft bgs, and 25 to 31 ft bgs]. In three of these borings (SB-26, SB-48, and SB-52) MGP-related residue was also observed.

In SB-26, OLM occurred from 29 to 33 feet. The top of the silty clay layer was encountered at 32 ft bgs. Black staining was observed in this soil boring from 15 to 17 ft bgs and 19 to 33 ft bgs and sheen was present between 21 and 33 ft bgs. In soil boring SB-48, OLM and TLM occurred from 13 to 16 ft bgs. No staining was observed, but a sheen was present at the same depth as the OLM and TLM. At SB-52, visible OLM/coal tar was observed from 27 to 31 ft bgs. Black staining was present from 13 to 15 ft bgs and 23 to 31 ft bgs and sheen was observed from 25 to 27 ft bgs. These three borings are located within the footprint of either the former retort house (SB-26 and SB-52) or the former workshops (SB-48). In all other borings (except SB-21) in Area 3, either black staining and/or sheen were observed at various depths, both above and below the water table.

A strong ammonia-like odor was detected in SB-19 (17 to 21 ft bgs), which may be attributable to residues from the Scrubbers, which functioned to remove hydrogen sulfide and ammonia. A solvent-like odor was detected in soil boring SB-52 from 23 to 25 ft bgs. Sewage-like odors were detected in soil boring SB-26 from 11 to 13 ft bgs. Non-distinguishable odors were also detected in SB-49 (8 to 20 ft bgs), SB-50 (13 to 17 ft bgs, and 21 to 27 ft bgs), SB-51 (13 to 15 ft bgs and 17 to 27 ft bgs)

4.5.2 Analytical Results for Subsurface Soil

Analytical data for subsurface soil from soil borings and test pits are summarized in Tables 4-17 to 4-20. Figure 7 presents a summary of the constituents detected and a comparison of the sample results with NYSDEC RSCOs. Concentrations that exceed of the NYSDEC RSCOs are bolded, italicized, and or colored in the figure to facilitate identification.

4.5.2.1 Volatile Organic Compounds

A total of 18 VOCs were detected in subsurface soil samples collected from Area 3. Seven of these VOCs, namely acetone, benzene, toluene, ethylbenzene, m/p-xylenes, o-xylene, and isopropylbenzene and were detected at concentrations that exceeded their respective individual

NYSDEC RSCOs. Benzene had the highest frequency of exceedances (approximately 48% of the number of samples analyzed). Of the VOCs detected, m/p-xylenes and toluene had the highest concentrations in soil sample SB-51 (21 to 22 ft bgs) at respective concentrations of 950,000 ug/kg and 640,000 ug/kg, respectively. This soil boring was located within the footprint of the former Retort House. A strong odor, elevated total VOCs of (140 ppm, based on PID measurement) and black staining were detected in this sample interval, which was immediately above the top of clay. Significant reductions in VOC concentrations were observed at this location in the 32 to 33 ft bgs interval where only benzene, with a concentration of 270 ug/kg, exceeded its NYSDEC RSCO. None of the concentrations of the VOCs detected in subsurface soil samples collected from the test pits exceeded their respective NYSDEC RSCOs.

Twelve samples exceeded the Total VOC NYSDEC RSCO of 10,000 ug/kg, with the maximum reported concentration of 2,851,248 ug/kg at the in soil sample SB-51 (21 to 22 ft bgs).

4.5.2.2 Semi-Volatile Organic Compounds

Thirty-three SVOCs were detected in subsurface soil samples. The concentrations of 20 of these 33 SVOCs exceeded their respective NYSDEC RSCOs. Benzo(a)pyrene exhibited the highest frequency of exceedances (approximately 72%), followed by benzo(a) anthracene and chrysene (approximately 61% and 54%, respectively). Of the SVOCs, naphthalene had the highest concentration (820,000 ug/kg) in soil sample SB-51 (21 to 22 ft bgs). This is consistent with the detection of the highest VOC concentrations reported in Area 3. The concentration of benzo(a)pyrene in soil sample TP-3 (7.5 ft bgs) of 150 ug/kg exceeded its NYSDEC RSCO (of 61 ug/kg.

Total SVOCs concentrations in soil samples SB-49 (17 to 18 ft bgs) SB-51 (14 to 15 ft bgs and 21 to 22 ft bgs), and SB-52 (27 to 29 ft bgs and 33 to 35 ft bgs) exceeded the NYSDEC RSCO for Total SVOCs of 500,000 ug/kg.

4.5.2.3 Inorganics

Thirteen metals were detected in the subsurface soil samples. The concentrations of seven metals, namely arsenic, cadmium, copper, lead, mercury, nickel, and zinc exceeded their respective NYSDEC RSCOs in one or more samples. Lead was detected at a maximum concentration of 677 mg/kg in subsurface soil sample TP-6 (9.5 ft bgs). Zinc was detected at elevated concentrations most frequently (approximately 41%). Total cyanide was detected in nine samples and ranged in concentration from 0.985 mg/kg in soil sample SB-20 (19 to 20 ft bgs) to 13.62 mg/kg in SB-19 (17 to 19 ft bgs). Amenable cyanide was detected in three soil samples, with the maximum concentration of 5.8 mg/kg in sample SB-21 (11 to 13 ft bgs). There are no NYSDEC RSCOs established for total or amenable cyanide.

4.5.2.4 Pesticides, Herbicides, and PCBs

Seven subsurface soil samples were collected from 2 soil borings in this Area. No pesticides, herbicides, or PCBs were detected in any sample.

4.5.3 Groundwater Analytical Results and Field Measurements

One groundwater sample was collected from the monitoring well MW-24A, which was installed in Area 3. Table 4-16 presents a summary of the field work and observations. Analytical results of the groundwater samples are presented in Tables 4-33 to 4-35. Well construction logs are provided in Appendix A. The concentrations of VOCs, SVOCs, and inorganics that exceeded the NYSDEC AWQSGVs concentrations are posted on Figure 11. Concentrations that exceeded their respective individual NYSDEC RSCOs are bolded and or italicized in the tables and figure to ease in their identification. Well construction details and groundwater elevations are summarized in Table 4-36.

DNAPL was observed in monitoring well MW-24B during well development. Accordingly, no ground water sample was collected. Initial measurements of the DNAPL thickness with two different types of oil/water interface probes (Solinst and GeoTech) did not detect any product. However, upon retrieval, the probes and cables were sporadically coated with DNAPL. TRC conducted an inspection of the monitoring well with a downhole camera, and observed oil-like globules suspended in the water column. At approximately 49 ft bgs, heavy black staining/DNAPL was observed entering the well screen. All threaded joints in the monitoring well were in good condition. The DNAPL entrance point approximately 4 feet below the bottom of the silty/clay layer, which occurs at approximately 45 ft bgs.

4.5.3.1 Volatile Organic Compounds

Six VOCs were detected in the groundwater sample collected from MW-24A, with two of them (benzene and ethyl benzene) exceeding the NYSDEC AWQSGVs. The benzene concentration was the higher of the two, reported at 19 ug/l.

4.5.3.2 Semi-Volatile Organic Compounds

Eleven SVOCs were detected in the groundwater sample collected from MW-24A, with three exceedances of the NYSDEC AWQSGVs (naphthalene, acenaphthene, and fluorene. Of these SVOCs exceedances, fluorene had the highest concentration of 54 ug/l. TLM observed in soil above the clay in this area of the Site, may be locally influencing groundwater quality.

4.5.3.3 Inorganics

Two metals were detected in the groundwater sample collected from MW-24A, with no exceedances of the NYSDEC AWQSGVs. Total cyanide was reported at 0.048 mg/l, below the NYSDEC AWQSGV.

4.6 Area 4

Area 4 has been designated as that portion of the Site where one of the former coal yards was located, from 16th Street to 17th Street, between 10th Avenue and the bulkhead along the Hudson River (see Figure 2). At the time of the SCS fieldwork, the property was used for below-ground vehicle parking and offices at this multi-story building. Sample locations were limited to sidewalk and roadways along the perimeter of the building. In addition, the basement of the building is vaulted and extends beneath the sidewalk on the south, east and west sides of this block. Presence of the structures further restricted the available spaces available for drilling of soil borings and installation of monitoring wells.

No exploratory test pits were planned or conducted in Area 4. Two soil borings (SB-29 and SB-30) and one groundwater monitoring well (MW-29A) were completed in Area 4 at the locations shown in Figure 4. Soil borings were proposed in additional locations, but could not be completed due to subsurface obstructions and utilities, safety considerations and restricted access. A total 11 soil samples (inclusive of two duplicate samples) were collected for chemical analysis.

Table 4-21 presents a summary of the field work and observations. The following sections present a discussion of the field observations and analytical results for subsurface soil samples. Figure 8 presents a summary of the detected constituents at each location, and comparison to the NYSDEC RSCOs.

4.6.1 Summary of Field Observations

Soil boring SB-29 was completed in the southeast corner of the Area 4 near the intersection of West 16th Street and 10th Avenue, and SB-30 was completed along the south side of West 17th Street. No evidence of contamination was observed in soil boring SB-29.

Depth to groundwater was approximately 11 ft bgs in soil borings SB-29 and SB-30. The groundwater elevation was measured in monitoring well MW-29A at -0.62 ft MSL.

Petroleum odors were detected from 12 to 16 ft bgs in SB-30.

MGP-like odors, and visible OLM and TLM blebs were detected in the 20 to 24 ft bgs interval in soil boring SB-30. Based on measurement with a PID, the maximum concentration of total

VOCS in this boring was 1,585 ppm, in the 22 to 24 ft bgs interval. MGP-related odors and a slight sheen on the water in the split spoon samplers were detected in soil boring SB-30 from 16 to 24 ft bgs. Within this interval, black staining was observed from 22 to 24 ft bgs and OLM and TLM blebs were observed from 20 to 24 ft bgs. The occurrence of the TLM and OLM may be related to operations of the gas works on the block directly north of soil boring SB-30.

The top of the silty clay layer was encountered at 24 ft bgs in soil boring SB-30. During drilling into and through this layer, a temporary steel casing was installed several feet into the clay to minimizing the potential for carry-down of the OLM and TLM observed from 20 to 24 ft bgs, above the top of the clay.

4.6.2 Analytical Results for Subsurface Soil

A total of 11 subsurface soil samples (9 discrete intervals plus 2 duplicates) were collected from the two borings that were completed in Area 4. Table 4-4 presents a summary of the sample locations, the rationale behind the selection of the sample location, the sample interval(s), a listing of the chemical analyses conducted, and a comparison to the NYSDEC RSCOs.

Analytical results for VOCs, SVOCs and inorganics (metals and cyanide) for subsurface soil samples collected in Area 4 are summarized in Tables 4-22 through 4-24, respectively. Figure 8 presents a summary of constituents detected and a comparison with NYSDEC RSCOs. Concentrations that exceeded their respective individual NYSDEC RSCOs have been bolded, italicized, and or colored in the summary tables and figures to for easy identification.

4.6.2.1 Volatile Organic Compounds

A total of 13 VOCs were detected in subsurface soil samples collected from Area 4. Eight of these VOCs, namely acetone, methylene chloride, benzene, toluene, ethylbenzene, m/p-xylenes, o-xylene, and isopropylbenzene were detected at concentrations that exceeded their respective individual NYSDEC RSCOs. Of the VOCs detected, benzene concentrations exceeded its NYSDEC RSCO most frequently (approximately 27% of the number of samples analyzed), and m/p-xylenes and toluene were detected at the highest concentrations (150,000 ug/kg and 81,000 ug/kg, respectively) reported at location SB-30 in the 22 to 24 ft bgs interval. With the exception of benzene, which was detected at a concentration of 86 ug/kg, none of the other VOCs detected in soil sample SB-30 (28 to 30 ft bgs) exceeded their NYSDEC RSCOs. No VOCs were detected in soil sample SB-30 (84 to 86 ft bgs). Soil boring SB-30 was located approximately 100-300 feet to the east/northeast of the gas holders to the west end of Area 4. The main MGP operational facility was located approximately 100 to 250 feet north of the SB-30 location (i.e., in Area 3). Therefore, the source of the apparent impacts in soil boring SB-30 may be the OLM and TLM detected at former gas works in Area 3 or MGP residues that may be related to operations of the former gas holders in this Area 6.

Two samples exceeded the NYSDEC RSCO for Total VOCs of 10,000 ug/kg, with the maximum reported concentration of 390,900 ug/kg in soil sample SB-30 (22 to 24 ft bgs).

4.6.2.2 Semi-Volatile Organic Compounds

Twenty-three SVOC constituents were detected in subsurface soil samples. Six of the 23 SVOCs detected (benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene) exceeded their respective NYSDEC RSCOs. Benzo(a) anthracene and benzo(a)pyrene exhibited the highest frequency of exceedances (approximately 18% each.) The highest concentrations of naphthalene and phenanthrene (6,600 ug/kg and 5,800 ug/kg, respectively) were detected in the soil samples SB-30 (22 to 24 ft bgs) for naphthalene, and SB-30 (10 to 12 ft bgs) for phenanthrene. The elevated concentrations for these SVOCs are consistent with the presence of OLM and TLM blebs between 20 to 24 ft bgs.

None of the samples exceeded the NYSDEC RSCO for Total SVOCs of 500,000 ug/kg.

4.6.2.3 Inorganics

Thirteen metals were detected in the subsurface soil samples. Of the metals detected, mercury and zinc concentrations exceeded their respective NYSDEC RSCOs in sample SB-30 (10 to 12 ft bgs). The concentrations for these two metals were only slightly elevated. Mercury was detected at 0.113 mg/kg as compared to it s NYSDEC RSCO of 0.1 mg/kg. Zinc was detected at a concentration of 57.4 mg/kg as compared to its NYSDEC RSCO of 50 mg/kg. The concentrations of these and other metals detected are typical for urban fill. Based upon the data validation performed by TRC, the mercury result was rejected. Further details are presented in the DUSR in Appendix B.

Cyanide (total and amenable) was not detected in any of the soil samples from this Area.

4.6.3 Groundwater Analytical Results and Field Measurements

One groundwater sample was collected from Area 4 monitoring well MW-29A. Table 4-21 presents a summary of the field work and observations. Analytical results of the groundwater sample are presented in Tables 4-33 to 4-35. Well construction details and groundwater elevations are presented in Table 4-36. The concentrations of VOCs, SVOCs, and inorganics that exceeded the NYSDEC AWQSGVs concentrations are posted on Figure 11. Concentrations that exceeded their respective individual NYSDEC RSCOs are bolded and or italicized in the tables and figure to ease in their identification.

4.6.3.1 Volatile Organic Compounds

There were no exceedances of the NYSDEC AWQSGVs for VOCs in this area of the Site. Only one compound, cis-1,2-dichloroethene, was detected.

4.6.3.2 Semi-Volatile Organic Compounds

Two compounds were detected in the groundwater sample collected from MW-29A (di-n-butylphthalate and bis(2-ethylhexyl phthalate)), both of which were in compliance with the NYSDEC AWQSGVs. Di-n-butylphthalate was also detected in the laboratory blank.

4.6.3.3 Inorganics

Four metals were detected in the groundwater sample collected from MW-29A, with thallium exceeding its NYSDEC AWQSGV. There were no detections for total or amenable cyanide in this sample.

4.7 Area 5

Area 5 covers the northern-most block of the former MGP. The western portion of this area formerly contained three former Gas Holders (Nos. 5, 6, and 7). Spatially, this Area covers a portion of Route 9A, an area along the Hudson River bulkhead adjacent to Chelsea Piers, and the western portion of the block between West 19th and West 20th Streets. The Correctional Facility and a public parking lot occupy the Area (see Figure 3). During the SCS, the property was used as a New York State-run medium security women's penitentiary, vehicle parking, and a public roadway.

One exploratory test pit (TP-4), 12 soil borings (SB-31, SB-32, SB-33, SB-34, SB-36, SB-38, SB-39, SB-40A, SB-40B, SB-90, SB-91 and SB-92) and three overburden aquifer monitoring wells (MW-31A, MW-34A and MW-40A) were completed in Area 5. Test pit TP-4 was relocated from the southeast to the northwest corner of the parking lot in part due to the presence of a 1.5 foot thick reinforced concrete slab at the original location. The test pit location is depicted in Figure 4. All of these locations are depicted in Figure 4.

A total of 39 subsurface soil samples (38 discrete samples plus 1 duplicate) were collected for chemical analysis from the twelve borings and one test pit that were completed in Area 5. Table 4-5 presents a summary of the sample locations, the rationale behind the selection of the sample location, the sample interval(s), a listing of the chemical analyses conducted, and a comparison to the NYSDEC RSCOs. Table 4-25 presents a summary of the field work and observations. The following sections present a discussion of the field observations and analytical results for subsurface soil samples.

4.7.1 Summary of Field Observations

During the excavation of test pit TP-4 a concrete structure and a 2-inch diameter metal pipe were encountered at 2 ft bgs. In addition, a brick wall trending from northeast to southwest was encountered in this test pit at a depth of 3 ft bgs, along the western edge of the excavation. This structure correlates with the approximate location of the ring wall foundation of former Gas Holder No. 6. No evidence of contamination was detected in the soil in this test pit.

Depths to groundwater ranged from approximately 4.5 ft bgs in soil borings SB-32, SB-36, and SB-38 to approximately 8 ft bgs in soil borings SB-39. Groundwater elevations measured in MW-31A, MW-34A, and MW-40A in the water table aquifer were -3.01 ft MSL, 1.80 ft MSL, and 1.73 ft MSL, respectively. Based on these elevations, it appears that groundwater is flowing towards the west.

Evidence of contamination, which were detected in soil borings in Area 5 included odors (petroleum, MGP-related, sewage, burned wood, sulfur, natural gas-like, sweet wood, or unspecified), black staining, sheen, and visible OLM.

Petroleum odors were detected in four of the five soil borings typically in the vicinity of the soil water interface. Specifically, the petroleum odors were detected in soil borings SB-32 (5 to 7 ft bgs), SB-32 (9 to 13 ft bgs), SB-33 (5 to 7 ft bgs), SB-34 (2 to 3 ft bgs), and SB-36 (5 to 9 ft bgs). There are several USTs present at the parcel where the borings were excavated. Additionally, these borings are all located in the area due north of (i.e., across the street from) a site where significant releases from operations of former underground storage tanks has been documented. MGP-related odors were only detected in SB-33 (23 to 25 ft bgs) and SB-33 (27 to 37 ft bgs). Visible OLM was only detected in soil boring SB-34 in fill material from 19 to 21 ft bgs. Sheen was observed in five borings (SB-32, SB-33, SB-34, SB-36, and SB-38) at various depths at or below the soil/water table interface between 5 and 27 ft bgs. In soil borings SB-32 and SB-33 sheen was detected in both shallow intervals between 5 and 13 ft bgs and deep intervals from 19 to 25 ft bgs. The shallow intervals show evidence of impacts by petroleum residues and the deeper intervals are associated with MGP residues. In soil borings SB-36 and SB-38 sheen was only observed in the shallow intervals and in SB-34 was only detected in the deep interval.

A strong natural gas-like or decaying odor was detected in soil boring SB-36 in the interval 23 to 27 ft bgs, with a maximum PID reading of 219 ppm recorded in the 25 to 27 ft bgs interval. A continuous clay layer of at least a 6-foot thickness was observed at this location from 28 to 34.7 ft bgs.

Soil boring SB-36, located in the parking lot along West 19th Street, is approximately 14 feet to the west/southwest of former Gas Holder No. 6; and 68 feet south/southeast of former Gas Holder No. 7. At nearby sample location SB-33 (inside of former Gas Holder No. 6), drilling proceeded through wood from approximately 27 to 35 ft bgs (no recovery in 3 split-spoons).

There were no PID readings greater than 75 ppm, and no observances of OLM or TLM. At soil boring location SB-38, located approximately 57 feet to the north of SB-36, the clay was encountered at a shallower depth (17.5 feet to 23.3 ft bgs), and there were no indications of organic contamination being present.

4.7.2 Analytical Results for Subsurface Soil

Analytical results of the subsurface soil samples are presented in Tables 4-26 to 4-28. Figure 9 presents a summary of the detected constituents at each location, and comparison to NYSDEC RSCOs. Samples that exceeded their respective individual NYSDEC RSCOs are highlighted (bolded and italicized) in the tables. The analytical results for soil samples from Area 5 are discussed below.

4.7.2.1 Volatile Organic Compounds

A total of 18 VOCs were detected in subsurface soil samples collected from Area 5. Six of these VOCs, namely acetone, benzene, toluene, ethylbenzene, m/p-xylenes, and o-xylene were detected at concentrations that exceeded their respective individual NYSDEC RSCOs. Acetone exceedances may be associated with laboratory activities. Benzene was detected at elevated concentrations most frequently (approximately 13% of the number of samples analyzed). Of the VOCs detected, m/p-xylenes and benzene had the highest concentrations of 45,000 ug/kg and 43,000 ug/kg, respectively). These elevated concentrations were both detected in soil sample SB-36 (25 to 27 ft bgs). With the exception of benzene (2,000 ug/kg), the concentrations of all VOCs detected in soil sample SB-36 (33 to 35 ft bgs), which is the deepest sample collected from this boring, were below their respective NYSDEC RSCOs. However, because no field evidence of contamination was detected in the clay layer in this sample interval, it is possible that the elevated benzene concentrations may be due to smearing of benzene-impacted soil from the upper interval near the top of the silt/clay layer. VOCs concentrations in the upper sampling intervals of SB-36 (3 to 4 ft bgs), (5 to 7 ft bgs), and (17 to 19 ft bgs [and its' duplicate]) were all in below their NYSDEC RSCOs for VOCs.

The concentration of Total VOCs in soil sample SB-36 (25 to 27 ft bgs) of 157,000 ug/kg exceeded the NYSDEC RSCO for Total VOCs of 10,000 ug/kg. The Total VOCs in this sample are primarily comprised of the BTEX compounds.

4.7.2.2 Semi-Volatile Organic Compounds

Twenty-seven SVOC constituents were detected in subsurface soil samples. Twelve of the 27 SVOCs detected (naphthalene, dibenzofuran, phenanthrene, di-n-butylphthalate, fluoranthene, butylbenzylphthalate, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene) exceeded their respective NYSDEC RSCOs. Benzo(a)pyrene and benzo(a)anthracene exhibited the highest frequency of exceedances (approximately 77% and 51%, respectively.) Butylbenzylphthalate and phenanthrene had the highest detected concentrations (170,000 ug/kg and 77,000 ug/kg, respectively) in the soil samples SB-36 (5 to 7 ft bgs for butylbenzylphthalate, and 25 to 27 ft bgs for phenanthrene).

None of total SVOCS concentrations exceeded the NYSDEC RSCO for Total SVOCs.

4.7.2.3 Inorganics

Thirteen metals were detected in the subsurface soil samples. The concentrations of seven metals, including arsenic, cadmium, copper, lead, mercury, nickel, and zinc, exceeded their respective NYSDEC RSCOs. The highest metal concentration detected in Area 5 was for lead (2,000 mg/kg) in the soil sample TP-4 (5 to 6 ft bgs). Zinc and mercury were detected at the highest frequency of exceedances (approximately 92% and 79%, respectively). The maximum concentrations of zinc and mercury were 311 mg/kg and 2.3 mg/kg, respectively.

Total cyanide was detected in five samples, with a maximum concentration of 3.26 mg/kg. Amenable cyanide was not detected in any soil samples from this Area. There are no NYSDEC RSCOs established for total or amenable cyanide.

4.7.3 Groundwater Analytical Results and Field Measurements

A total of three groundwater samples were collected; one from each of the monitoring wells MW-31A, MW-34A, and MW-40A, which were installed in Area 5. Table 4-25 presents a summary of the field work and observations. Analytical results of the groundwater samples are presented in Tables 4-33 to 4-35. Well construction details and groundwater elevations are presented in Table 4-36. The concentrations of VOCs, SVOCs, and inorganics that exceeded the NYSDEC AWQSGVs concentrations are posted on Figure 11. Concentrations that exceeded their respective individual NYSDEC AWQSGVs are bolded and or italicized in the tables and figure to ease in their identification.

4.7.3.1 Volatile Organic Compounds

Only one compound (acetone) was detected in any of the groundwater samples. The concentration of acetone was 76 ug/l, which exceeded its NYSDEC AWQSGV. Acetone is not related to MGP residues.

4.7.3.2 Semi-Volatile Organic Compounds

A total of five compounds were detected in the groundwater samples, with only one of them (naphthalene) exceeding the NYSDEC AWQSGV. The reported concentration was 11 ug/l, slightly above the NYSDEC AWQSGV of 10 ug/l for this compound. No SVOC compounds were detected in groundwater sample MW-40A.

4.7.3.3 Inorganics

Eight metals and total cyanide were detected in the groundwater samples collected from this area, however none of them exceeded their NYSDEC AWQSGVs. Amenable cyanide was not detected.

4.8 Area 6

Area 6 is situated in the southwestern portion of the Site, due west and adjacent to Area 4 and includes the southernmost end of the Chelsea Piers Sports and Entertainment Complex. Four of the former Gas Holders (Nos. 8, 9, 10, and 11) were located in this Area, partially under what is now Route 9A. Spatially, this Area covers a portion of Route 9A, from West 16th Street to West 17th Street and is bounded by the Hudson River to the west (see Figures 2 and 4). At the time of the SCS activities, the property was used by the public (e.g., for jogging, skating, biking, etc.), and as a public roadway.

A total of 10 subsurface soil samples were collected from the three boring locations that were completed in Area 6. Table 4-6 presents a summary of the sample locations, the rationale behind the selection of the sample location, the sample interval(s), a listing of the chemical analyses conducted, and a comparison to the NYSDEC RSCOs. The following sections present a discussion of the field observations and analytical results for subsurface soil samples.

The following sections present a discussion of the analytical results for each type of sample group.

4.8.1 Summary of Field Observations

Three soil borings, SB-43, SB-44B, and SB-45, were completed in Area 6. Observations during the field activities are summarized in Table 4-29 and discussed below.

One exploratory test pit (TP-5), two soil borings (SB-41 and SB-42) and one monitoring well (MW-41A) were planned for this area. However, these activities could not be performed at these locations due to restricted access, the presence of subsurface obstructions, structures related to the adjacent building, and or utilities and related safety considerations.

Similarly, despite several attempts to complete soil borings SB-43 and SB-44, refusal due to buried wood prevented their advancement to the target depth (i.e., 50 feet or top of clay). The maximum depth achieved for these borings (i.e., refusal depth) was 24 ft bgs in soil boring SB-43, and 9 ft bgs in soil boring SB-44. It is suspected that the refusal encountered in these borings was due to a wooden platform and/or wooden pilings, which are part of the bulkhead infrastructure in this area. Based on available information the relieving platform for the bulkhead in this Area extends westward approximately 25 to 30 feet from the bulkhead along the Chelsea Piers area. The wooden platform is set at approximately 8 ft bgs, with numerous wooden pilings, rip rap, and fill material beneath it. The original soil boring designated SB-46 was subsequently renumbered to SB-44, as noted in Table 4-31.

MGP-related odors were detected in soil boring SB-44B, from 6 to 9 ft bgs. An elevated concentration for Total VOCs of over 1,500 ppm was measured in soil sample SB-44 (8 to 9 ft bgs) using a PID. No physical evidence of contamination was detected in soil borings SB-43 and SB-45.

Groundwater was encountered from approximately 5.8 ft bgs in soil boring SB-44 to approximately 7.5 ft bgs in soil boring SB-45. Due to site conditions, the monitoring well planned for this area could not be installed, and no direct measurements of groundwater elevation were conducted.

4.8.2 Analytical Results for Subsurface Soil

Ten subsurface soil samples were collected from soil borings in Area 6 and were analyzed for VOCs, SVOCs and inorganics (metals and cyanide [total and amenable]). Analytical results of the subsurface soil samples are presented in Tables 4-30 to 4-32. Figure 10 presents a summary of the detected constituents at each location, and comparison to NYSDEC RSCOs. Samples that exceeded their respective individual NYSDEC RSCOs are highlighted (bolded and italicized) in the tables.

4.8.2.1 Volatile Organic Compounds

A total of 14 VOCs were detected in subsurface soil samples collected from Area 6. Four of these VOCs, namely acetone, benzene, m/p-xylenes, and o-xylene were detected at concentrations that exceeded their respective individual NYSDEC RSCOs. Acetone exceedances may be associated with laboratory activities. O-xylene and acetone had the highest

frequency of exceedances (approximately 20% of the number of samples analyzed), and m/p-xylenes and o-xylene were detected at the highest concentrations (5,900 ug/kg and 5,100 ug/kg, respectively). These elevated concentrations were both detected in soil sample SB-44 (8 to 10 ft bgs).

Concentrations of one or more VOCs were detected in excess of their NYSDEC RSCOs in two of the 10 subsurface soil samples [SB-44 (8 to 10 ft bgs) and SB-45 (31.5 to 32 ft bgs)]. The concentrations of VOCs detected in the shallow samples collected from both of these borings were below their NYSDEC RSCOs. Benzene, o-xylene and acetone were detected at concentrations that exceeded their respective NYSDEC RSCOs in soil sample SB-45 (31.5 to 32 ft bgs).

The concentration of Total VOCs in soil sample SB-44 (8 to 10 ft bgs) of 20,080 ug/kg exceeded the NYSDEC RSCO for Total VOCs of 10,000 ug/kg. The VOCs that contribute to the total concentrations were primarily comprised of o- and m/p-xylenes, acetone and methylcyclohexane.

4.8.2.2 Semi-Volatile Organic Compounds

Twenty-three SVOCs were detected in subsurface soil samples. Concentrations of six of the 23 SVOCs detected (4-nitrophenol, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) exceeded their respective NYSDEC RSCOs. Benzo(a)pyrene and benzo(a)anthracene exhibited the highest frequency of exceedances (approximately 70% and 60%, respectively). Pyrene and fluoranthene are PAHs that exhibited the highest detected concentrations (13,000 ug/kg and 7,000 ug/kg, respectively) in the soil samples SB-43 (8 to 10 ft bgs). The SVOCs concentrations detected in the deeper sample in soil boring SB-43 (23 to 23.5 ft bgs) were below their respective NYSDEC RSCOs except benzo(a)anthracene (270 ug/kg versus 224 ug/kg) and benzo(a)pyrene (230 ug/kg versus 61 ug/kg).

No Total SVOC concentrations exceeded the NYSDEC RSCO for Total SVOCs.

4.8.2.3 Inorganics

Thirteen metals were detected in the subsurface soil samples. Of these, the concentrations of arsenic, cadmium, copper, lead, mercury, nickel and zinc exceeded their respective NYSDEC RSCOs. The maximum reported metal concentration in Area 6 was that for lead of 956 mg/kg, which was detected in subsurface soil sample SB-43 (8 to 10 ft bgs). Of the metals detected, the concentrations of zinc and mercury exceeded their respective NYSDEC RSCOs most frequently (approximately 90% and 80%, respectively). The maximum concentrations of zinc and mercury were 485 mg/kg and 9.3 mg/kg, respectively.

Total cyanide was detected in two samples, with a maximum concentration of 0.72 mg/kg, Similarly, amenable cyanide was detected in two soil samples from this Area, with a maximum concentration of 0.72 mg/kg. There are no NYSDEC RSCOs established for total or amenable cyanide.

4.8.3 Groundwater Analytical Results and Field Measurements

There were no monitoring wells installed in this area of the Site, nor were any groundwater samples collected from this area as part of the SCS.

4.9 Site-Wide Summary of Organic Compounds Detected in Subsurface Soil

Figures 12 and 13 present a graphical interpretation of the ranges of concentrations reported in soil samples for Total VOCs and Total SVOCs, respectively. Concentrations below the NYSDEC RSCO for Total VOCs (10 mg/kg) and Total SVOCs (500 mg/kg) are presented in green. Other colors, as presented in the figures, represent different ranges of concentrations for each chemical class.

4.9.1 Total VOCs

The concentrations of Total VOCs exceeded the NYSDEC RSCO for Total VOCs in soil from 18 boring locations and 27 sample intervals across the six designated Areas of the Site. The majority of the exceedances were located in Area 3 (which was the location of the Retort House, Scrubbers, Purifying House, Laboratory and Workshops), with the central portion of this area in the vicinity of soil boring SB-51, which had the highest concentration of Total SVOCs of approximately 2,850 mg/kg. The occurrence and concentrations for Total VOCs above the NYSDEC RSCO are summarized by area in the table below.

Area	Sample Location	Sample Interval (ft bgs)	Concentration (mg/kg)
1	SB-2	19 to 20.5	103.10
	SB-4	19 to 21	182.23
	SB-5B	11 to 12	110.80
	SB-6	13 to 15	596.70

Area	Sample Location	Sample Interval (ft bgs)	Concentration (mg/kg)
2	SB-9	20 to 22	13.81
	SB-10	5 to 6 6 to 8 8 to 10	68.96 535.60 234.80
	SB-11	27 to 29	72.37
	SB-15	5 to 6 17 to 19	28.00 360.48
3	SB-19	17 to 19	12.75
	SB-24	25 to 27	863.02
	SB-25	20 to 22 33 to 34	26.84 40.49
	SB-48	15 to 16 19 to 21	35.38 12.44
	SB-49	10 to 12 14 to 15 17 to 18	243.86 34.61 300.02
	SB-51	14 to 15 21 to 22	447.52 2,851.25
	SB-52	27 to 29	196.90
4	SB-30	22 to 24 24 to 26	390.90 30.44
5	SB-36	25 to 27	157.50
6	SB-44	8 to 10	20.08

4.9.2 Total SVOCs

The concentrations of Total SVOCs exceeded the NYSDEC RSCO for Total SVOCs in soil from seven boring locations and nine sample intervals. Spatially, the highest density of exceedances was again in Area 3 of the Site (similar to the Total VOCs trend), with the maximum Total SVOC concentration reported in SB-15 (Area 2, 13,749 mg/kg). SB-15 was located on the

sidewalk, outside of the building at Block 690, Lot 46. The occurrence and concentrations for Total SVOCs above the NYSDEC RSCO are summarized by area in the table below.

Area	Sample Location	Sample Interval (ft bgs)	Concentration (mg/kg)
1	SB-4	19 to 21	728.28
2	SB-11	27 to 29	1,645.70
	SB-15	17 to 19	13,749.00
	SB-56 (Dup.)	2 to 3	542.10
3	SB-49	17 to 18	1,003.05
	SB-51	14 to 15 21 to 22	561.09 2,112.75
	SB-52	27 to 29 33 to 35	797.11 1,391.60

4.10 Groundwater Flow

Based upon the synoptic water level measurements recorded on October 11, 2005, and field survey information, groundwater elevations were calculated in each of the eleven monitoring wells installed within the areas of the Site. Information related to monitoring well construction details, groundwater elevations, and other information is summarized in Table 4-36. The groundwater elevations were then plotted and a groundwater contour map developed, as presented in Figure 14.

Based upon the topography and regional hydrogeologic information, the expected groundwater flow is to the west, towards the Hudson River. It is anticipated that groundwater levels are likely influence by seasonal and tidal fluctuations of water levels in the river. Based upon the water table elevations, the groundwater flow direction within the fill unit on the majority of the Site is towards the west/southwest. There appears to be a hydraulic anomaly located near Area 2, where the water table appears to be mounded. There may be influences from the steel sheet pile that was installed on the Block 690, Lots 12 and 54 properties.

4.11 Community Air Monitoring Results

During the Site characterization study implementation, there was no work stoppage due to elevated PID or particulate readings in excess of the CAMP criteria. There were no complaints from tenants, owners, or operators of commercial establishments of nuisance odors or dust during the Con Edison/TRC investigative efforts. Periodically, an instantaneous reading above the action level on the PID and/or dust monitor was recorded. However, these anomalies were attributed to weather-related conditions (e.g., humidity) by the field personnel.

4.12 Summary of Findings

The key field observations and analytical results for each of the six designated areas are summarized below.

Summary of Findings – Area 1

- The silty/clay unit that forms an intermediate low permeability boundary elsewhere on the Site between the water table and the lower aquifer units is discontinuous or absent in Area 1.

- Evidence of petroleum-related impacts, which included odors and LNAPL, was prevalent in the water table aquifer. The petroleum is related releases from one or more of the 6 USTs that were operated at this property. The spill is actively being managed by the regional NYSDEC office and related actions are ongoing.

- The foundations of the two former gas holders are present in the subsurface of this Area. The bottoms of the holders appear to be intact. The soil fill inside the holders appears to be different than the soil encountered in soil borings outside the holders.

- Evidence of MGP-residues (e.g., OLM, odors, black staining, etc.) was only detected in two soil borings (SB-2 and SB-4) at a depth immediately above of the bottom of both of the former gas holders. These soil borings were advanced inside the holders.

- VOCs, Total VOCs, SVOCs, Total SVOCs and metals were detected at elevated concentrations in subsurface soil.

- Concentrations of VOCs, SVOCs, two metals, and total cyanide were detected at concentrations exceeding the NYSDEC AWQSGVs in shallow groundwater (MW-5A). The majority of the VOCs and SVOCs detected are related to the petroleum contamination at the property from garage operations conducted by others.

- No VOCs or SVOCs were detected at elevated concentrations in deep groundwater (MW-5B). One metal, arsenic, exceeded the NYSDEC AWQSGVs in this well.

Summary of Findings – Area 2

- The silty/clay unit that forms an intermediate low permeability boundary between the water table and the lower aquifer appears to be continuous across Area 2. The depth to the top of the silty/clay unit varies.

- Evidence of petroleum-related impacts, which included odors and LNAPL, was prevalent in the water table aquifer and was typically detected from 1 ft bgs to depths ranging to 15 ft bgs. The petroleum is likely related operations of one or more USTs that were operated in this Area or the numerous petroleum spills that have been identified and documented in the vicinity of the Site.

- Structures associated with the two former gas holders are present in the subsurface in the eastern-most portion of Area 2. The southern portion of the ring wall of former Gas Holder No. 3 was visually confirmed in test pit TP-2, although the ring wall of former Gas Holder No. 4 could not be located. At SB-10, located inside former Gas Holder No. 4, the gas holder bottom was encountered.

- Where detected, evidence of MGP-residues (e.g., OLM, TLM, naphthalene odors, black staining, etc.) was detected as discrete narrow bands in 6 soil borings within the interval of 19 to 35 ft bgs in the eastern-most portion of this Area and adjacent to the area being remediated (Georgetown property) on the western end of Area 2 along Route 9A.

- VOCS, Total VOCs, SVOCs, Total SVOCs and metals were detected in subsurface soil at concentrations exceeding NYSDEC RSCOs. No pesticides, herbicides or PCBs were detected at concentrations in subsurface soil in excess of the NYSDEC RSCOs.

- Concentrations of one VOC, benzene, in shallow groundwater exceeded the NYSDEC AWQSGV. SVOCs were not detected in excess of the NYSDEC AWQSGVs. One metal, thallium, was detected in excess of the NYSDEC AWQSGV in the duplicate sample of MW-12B.

Summary of Findings – Area 3

- The silty/clay unit that forms an intermediate low permeability boundary between the water table and the lower aquifer appears to be continuous across Area 3. The top of this unit ranged in depth from 15 ft bgs on the eastern portion of this Area to 33 ft bgs on the western portion.

- The remnant of the foundation for several former structures were are present in subsurface in the subsurface of this Area. Based upon historical maps, the structures encountered included portions of the retort house, laboratory and scrubbers.

- With the exception of soil boring SB-21, soil encountered in all borings in Area 3 exhibited some evidence of MGP-related impacts, which included OLM, TLM, naphthalene and ammonia odors, black staining, etc. The strongest evidence of MGP impacts (e.g., OLM, TLM and heavy black staining) was detected in four borings (SB-24/MW-24 cluster, SB-26, SB-48 and SB-52). Where present, OLM, TLM, and black staining were encountered in the interval 13 to 33 ft bgs. Ammonia odors were detected in the vicinity of the Scrubbers in the eastern side of this Area.

- VOCs, Total VOCs and SVOCs, Total SVOCs and metals were detected at elevated concentrations in subsurface soil in Area 3.

- Concentrations of 2 VOCs and 3 SVOCs in the groundwater sample collected from MW-24A exceeded the NYSDEC AWQSGVs. There were no other exceedances of the NYSDEC AWQSGVs in this Area.

- During monitoring well development and groundwater sampling, several feet of coal tar DNAPL was measured in the deep monitoring well MW-24 B located in the western portion of Area 3. It is noted that no evidence of contamination was detected during installation of this well. The source and mechanism for its migration in to the well has not been determined.

Summary of Findings – Area 4

- The silty/clay unit that forms an intermediate low permeability boundary between the water table and the lower aquifer may be continuous across Area 4, but becomes notably thin on the east side of the block.

- Of the two borings completed in Area 4, only subsurface soil in soil boring SB-30 exhibited evidence of contamination, which included petroleum odors, MGP-related odors, sheen, black staining, OLM and TLM. The OLM and TLM were detected in soil from 20 to 24 ft bgs.

- VOCs, Total VOCs, SVOCs, Total SVOCs and metals were detected at elevated concentrations in subsurface soil in Area 4.

- One VOC (1,2-dichloroethene) and one metal (thallium) were detected in groundwater at concentrations above their NYSDEC AWQSGVs. Neither parameter is associated with MGP residues.

Summary of Findings – Area 5

- The silty/clay unit that forms an intermediate low permeability boundary between the water table and the lower aquifer appears to be continuous across the western portion of Area 5. The depth to the top of the silty/clay unit varies.

- A brick-wall foundation, which appeared to correlate with Gas Holder No. 6 is present in the subsurface in the southwestern portion of this Area. No evidence of MGP-related impacts associated with this structure was observed.

- Evidence of petroleum-related impacts, which included odors and sheen, was detected in several borings completed in this area. The impacts were typically in the shallow overburden or in the immediate the vicinity of the water table, which occurred between 4 to 7 ft bgs. The petroleum may have several sources, which likely include the in-place USTs on-site and documented releases from historic or current USTs on adjacent properties.

- Evidence of MGP-residues (e.g., OLM, odors, black staining, sheen etc.) was detected in five borings. MGP-related odors were detected intermittently in soil boring SB-33 in the interval from 21 to 37 ft bgs. OLM was only detected in soil boring SB-34 in the interval of 19 to 21 ft bgs. Sheen was observed in soil borings SB-32, SB-33, SB-34, SB-36 and SB-38 at various depths in the interval 5 to 27 ft bgs.

- VOCs, Total VOCs, SVOCs, Total SVOCs and metals were detected at elevated concentrations in subsurface soil.

- Only acetone (VOC) and naphthalene (SVOC) were detected at elevated concentrations in groundwater in Area 5. Acetone is not associated with MGP residues.

Summary of Findings – Area 6

- The extent of the silty-clay unit that forms an intermediate low permeability boundary between the water table and the lower aquifer could not be determined in this Area due to the inability to advance soil borings to the target depth. Boring refusal is believed to have been due to the presence of subsurface structures related to the nearby bulkhead and relieving platform.

- Of the four soil borings completed in Area 6, only one boring contained MGP-related odors and an elevated PID reading. These observations are consistent with MGP-related waste that would occur near former gas holders, such as the four that were present in Area 6.

- VOCs, Total VOCs, SVOCs, and metals were detected at elevated concentrations in subsurface soil in Area 6.

- There were no monitoring wells installed in this area of the Site, nor were any groundwater samples collected from this area as part of the SCS.

5 QUALITATIVE EXPOSURE ASSESSMENT

A qualitative exposure assessment was conducted in accordance with NYSDEC, Division of Environmental Remediation, Draft DER-10, Technical Guidance for Site Investigation and Remediation (NYSDEC, 2002). The purpose of this qualitative exposure assessment is to determine whether Site conditions pose an unacceptable hazard to potentially exposed receptor populations. In order to pose an unacceptable hazard to receptor populations, the receptor must be exposed to contaminants at the Site. This assessment evaluates whether complete exposure pathways exist at the Site and identifies chemicals of concern (COCs) for those receptors and media of concern where a complete exposure pathway exists (NYSDEC, 2002).

The former West 18th Street Gas Works was located between West 16th Street and West 20th Street, and 10th Avenue and the Hudson River bulkhead (with one additional parcel on the block bounded by West 17th Street, West 18th Street, 9th Avenue and 10th Avenue) in western downtown Manhattan, New York. As discussed in Section 2.2, the Site is located in a mixed usage area with commercial properties including storefront retail facilities to the east and west and a sports/entertainment complex located to the west and adjacent to the Site. A mixture of commercial office/warehouse facilities, art galleries and residential properties are located to the north and adjacent to the Site. An office facility and high-rise apartment building are located to the south. The areas at and around the Site are anticipated to remain the same as the current use for the foreseeable future. Buildings and structures within the former Site boundaries are presently being demolished, with new construction planned. It is anticipated that additional properties within this area will also undergo future redevelopment in a similar manner.

This Qualitative Exposure Assessment addresses all six of the designated areas as one Site. These areas are in a heavily developed urban setting, and are characterized by numerous tightly spaced buildings, concrete, and asphalt covered areas. The analysis is broad in nature, capable of being applied to current and future activities. If a specific pathway exists in one of the designated areas, it was given further attention and analyzed in the context of the elements below.

5.1 Exposure Pathway Assessment

A complete exposure pathway consists of five elements (NYSDEC, 2002):

- A contaminant source;
- Contaminant release and transport mechanisms;
- A point of exposure;
- A receptor population; and
- A route of exposure.

The evaluation of these exposure pathway elements as they apply to the Site is presented below.

5.2 Contaminant Source

The Site is the location of the former West 18th Street Gas Works. MGP operations began at in 1834, with numerous production and storage-related expansions occurring throughout the history of the facility. The West 18th Street Gas Works appears to have operated only one or two years into the twentieth century. By 1914, all of the gas holders were razed. The available historical information on the West 18th Street Gas Works indicates that this Site was both a gas manufacturing and a gas storage facility. There were no known waste storage areas. Typical MGP residues, such as tars, purifier wastes (wood or other solids), clinkers (consolidated ash-like material), condensates (liquids), and oils, were generally observed at various locations within the Site. No historical records are available that describe waste management practices during the operation of the former gas works. However, based upon visual and olfactory field observations, tars (DNAPL), clinkers, and oils (petroleum-based LNAPL) were determined to be present intermittently across the Site.

5.3 Contaminant Release and Transport Mechanisms

Contaminant release and transport mechanisms carry contaminants from the source to points where people may be exposed. Potential contaminant release mechanisms include historic direct release of MGP-associated contaminants to soils, and the potential release from existing or historic utilities. Transport mechanisms include the leaching, percolation or infiltration of contaminants from contaminated soils to groundwater; volatilization of contaminants from soils or groundwater to air and the potential transport of contaminants in groundwater to surface water.

5.4 Points of Exposure

An exposure point is a location where actual or potential human contact with a contaminated medium may occur. With respect to the former West 18th Street Gas Works, possible exposure points include contaminants in soil, groundwater and soil gas/indoor air intrusion. Off-site potential exposures include particulates in ambient air generated during construction activities, as well as potential exposure to contaminated soil, groundwater and vapors.

5.5 Receptor Populations

Based on current and potential future land uses at the Site, potential receptor populations that may come in contact with Site-related contaminants are commercial tenants, building residents, off-site residents, indoor maintenance workers, outdoor workers (i.e., landscapers/ groundskeepers) and construction/utility workers.

5.6 Routes of Exposure

A route of exposure is the way in which a receptor may be exposed to Site-related contaminants. Potential routes of exposure considered for this assessment include ingestion and dermal contact with soils, ingestion and dermal contact with groundwater, inhalation of indoor and ambient air that contains volatilized constituents present in Site soil and/or groundwater, and inhalation of soil particulates that enter the air column as fugitive dust emissions. The potential exposure routes for which a complete exposure pathway exists for a specific receptor are discussed below.

Commercial Tenants and Residential Receptors: A tenant in one or more of the buildings, or an adult or child residential receptor could, in general, be exposed to surface soil through incidental ingestion, inhalation, and/or dermal contact. For this Site, however, the prevalence of buildings, paving and concrete that cover almost the entire Site reduce the potential exposure routes, rendering these pathways as not being of potential significance. An adult or child resident or tenant may be exposed to surface and subsurface soil through the inhalation of particulates in ambient air associated with fugitive dust emissions during construction activities. Residential and commercial tenant receptors will not be exposed to groundwater at the Site through ingestion or dermal contact. Groundwater is not used as a drinking water supply in Manhattan. New York City residents receive their water supply from upstate reservoirs. Due to the Site's proximity to the Hudson River, groundwater beneath the Site is likely to be brackish or saline, and unsuitable for human consumption and therefore is not a media of concern for direct ingestion. Due to the presence of VOCs in groundwater which may volatilize into the residential buildings on-site, inhalation of volatiles in indoor air is a potential route of exposure for residents and commercial tenants at this Site.

Off-Site Residents: An adult or child off-site resident may be exposed to surface and subsurface soil through the inhalation of particulates in ambient air associated with fugitive dust emissions during construction activities.

Indoor Maintenance Worker: An indoor maintenance worker is assumed to work only indoors. Therefore, no routes of exposure to soils and groundwater exist for this Site. Due to the presence of VOCs in groundwater which may volatilize into the residential and commercial buildings on-site, inhalation of volatiles in indoor air is a potential route of exposure for indoor maintenance workers at this Site.

Construction Worker: A construction worker may be exposed to surface and subsurface soil and groundwater during construction activities that may occur in the future. The routes of exposure are incidental ingestion and dermal contact with soils and groundwater, inhalation of particulates in ambient air, and inhalation of volatiles in ambient air that have volatilized from soil and groundwater.

5.7 Identification of Chemicals of Concern

The evaluation of whether there are chemicals of concern at this Site considers the concentrations of Site-related chemicals and whether the concentrations pose a health hazard to the identified receptors through the complete routes of exposure identified in Section 5.6 above. Chemicals of concern that require further evaluation are those that exceed protective cleanup objectives in soil and groundwater cleanup standards (i.e., NYSDEC RSCOs and NYSDEC AWQSGVs) or applicable screening criteria. This evaluation was conducted for each medium of concern.

5.8 Surface Soil

There were no surface soil samples collected in association with this project, as paving, concrete or buildings dominate the urban landscape at the Site.

5.9 Subsurface Soils

A total of 9 VOCs, 25 SVOCs and 8 metals were detected across the six Areas of the Site in test pits and soil borings at concentrations exceeding their respective NYSDEC RSCOs. Therefore, subsurface soil is a medium of concern and could contribute to a potentially complete exposure pathway. The only receptors who may be exposed to subsurface soils is the construction worker, and possibly on-Site tenants/residents and off-site tenants (particulate inhalation during construction activities). For the construction worker, exposure may occur through incidental ingestion of surface/subsurface soil, dermal contact with surface/subsurface soil and/or groundwater, and inhalation of particulates in ambient air. Therefore, these VOCS, SVOCs and metals are COCs in subsurface soil for the construction worker.

5.10 Groundwater

A total of 5 VOCs, 5 SVOCs, 4 metals, and total cyanide were detected in groundwater at the Site in excess of the NYSDEC AWQSGVs. Therefore, groundwater is a medium of concern and could contribute to a potentially complete exposure pathway. The only receptors who may be exposed to groundwater is the construction worker, as there are no known pumping wells in vicinity of the Site. For the construction worker, exposure may occur through incidental dermal contact with groundwater. Therefore, these VOCS, SVOCs, metals, and total cyanide are COCs in groundwater for the construction worker.

5.11 Sub-Slab Vapors

A Site-wide investigation of sub-slab vapor conditions has not been conducted by Con Edison. Within Areas 2 and 5, however, Con Edison conducted limited studies (baseline sub-slab and

indoor air quality sampling program at Block 690, Lot 46 (Area 2) and at Block 691, Lot 1 (Area 5).

For the Area 2 study, a total of 12 compounds exceeded the 75th percentile NYSDOH criteria, indicating that there is a potential for vapor intrusion into indoor spaces at this location. The majority of the detected compounds can be attributed to tenant operations/storage and/or previous UST releases. As was demonstrated, certain types of construction activities by others on the adjacent parcel exacerbated the conditions, resulting in cracks in the buildings' concrete slab and walls. Tenants and residents complained of odors collecting inside the building during construction-related activities. Intrusion of sub-slab vapors was considered to be an exposure pathway for tenants and residents that would warrant further evaluation due to the limited amount of data available.

Subsequent to the Con Edison investigation, the cracks in the floor slab and walls were sealed, and construction techniques were changed. Additional soil vapor studies conducted by others indicated that there was no vapor intrusion. Since the performance of both of these studies, subsurface construction activities have been completed, the adjacent property is sealed below grade with a liner, and a new structure is being built atop it. In addition, the tenant on the first floor is reportedly moving out of this location.

The air and sub-slab soil gas sampling program conducted in Area 5 confirmed the presence of a total of 12 compounds above the 75th percentile NYSDOH criteria, five of which were in excess of the NYSDOH 90th percentile NYSDOH criteria. Two of these may be related to MGP sources and three of these compounds are not associated with former MGP operations. The data suggests that the presence of these compounds in sub-slab soil gas have the potential to impact indoor air quality. However, the analytical data, in conjunction with the observed presence of numerous VOC-containing products stored and used at the facility during routine operations and maintenance and the air flow in the basement, suggest that these potential sources are likely having a greater influence on the overall indoor air quality than intrusion of VOCs in the soil gas into the basement. Finally, comparison of the various VOCs detected in indoor air to the NYSDOH published background concentrations, it is concluded that their concentrations are generally typical for in indoor air. Although several VOCs were detected above background for residential indoor air, regardless of the source(s), the concentrations are well below published levels considered to pose an exposure risk.

In summary, subsurface soil and groundwater are mediums of concern that could contribute to potentially complete exposure pathways. The only receptors who may be directly exposed to subsurface soils is the construction worker. It is noted that on-Site tenants/residents and off-site tenants may be indirectly exposed to subsurface soil containing COCs if this media becomes

airborne as dust (e.g., particulate inhalation during construction activities). The only receptor who may be exposed to groundwater is the construction worker. The potential for a complete exposure pathway in association with sub-slab vapors exists across the Site due to the presence of elevated VOCs in subsurface soil and groundwater. However, the majority of the VOCs detected in the shallow subsurface soil and groundwater are not attributed to MGP residues but rather are most directly to the numerous documented and suspected petroleum spills throughout and in the vicinity of the Site.

6 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the SCS, soil and or groundwater quality in each of the six designated Areas of the West 18th Street Gas Works Site have been influenced by historical operations of the former MGP. In response to these findings and in accordance with the VCA, Con Edison will conduct a Remedial Investigation (RI) at the Site to delineate impacts in the affected areas. Towards this goal, a RI Work Plan was prepared and is presented in Appendix E of this report.

7 REFERENCES

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