REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 1, WEST 45TH STREET GAS WORKS SITE

Site Number V00532-2

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SECTION 1

INTRODUCTION

This Remedial Investigation Report (RIR) presents the results of the Site Characterization and Remedial Investigation activities conducted at Operable Unit 1 (OU-1) of the West 45th Street Gas Works Site (VCA Site No. V00532-2) – the former location of a manufactured gas plant (MGP). The West 45th Street Gas Works Site (the Site) is located in the Borough of Manhattan in New York City, New York and New York County, New York (Figure 1). The investigation activities were performed in accordance with the New York State Department of Environmental Conservation (NYSDEC) approved *Site Characterization Work Plan for the Former West 45th Street Works Site* (Parsons, 2005) and the *Remedial Investigation Work Plan* (Parsons, 2006). For characterization purposes, the site has been divided into two distinct areas, designated as OU-1 and OU-2 as shown in Figure 2. This RIR focuses on OU-1.

1.1 SITE OVERVIEW

The former West 45th Street Gas Works Site occupies portions of city tax blocks 1092, 1093 and 1107 from 44th to 46th Street, between 11th Avenue and the Hudson River in Manhattan, New York. As mentioned previously, the Site has been divided into two distinct units: OU-1 and OU-2. OU-1, which is the subject of this RIR, is located between West 44th Street and West 45th Street on tax blocks 1092 and 1107 (Figure 2).

The portion of block 1092 not truncated by roadway reconfiguration includes Tax Lots 7, 16, and 49 (Figure 2). Multiple-story (with basement) concrete buildings used primarily as warehouses or storage currently occupy Tax Lots 7 and 49. Based on a review of New York City building records, the building on Lot 49 has a basement which is used on a limited basis as a boiler room and book vault. The United Postal Service (UPS) currently owns Tax Lot 16, which is covered with asphalt and used for truck parking and fueling. UPS currently maintains gasoline and diesel fuel pumps and underground storage tanks (USTs) on the lot.

1.2 ADJOINING PROPERTY DESCRIPTION

Various multiple-story buildings occupy the eastern end of Tax Block 1092, along 11th Avenue, which is outside the former MGP footprint. A variety of single level and multiple-story buildings, parking lots, and a parking garage are located within Tax Block 1093, situated across West 45th Street from OU-1. OU-2 comprises the west half of Tax Block 1093. State Highway Route 9A (12th Avenue), the Hudson River, and City Pier 21 and 30 are located directly west of the Site. UPS currently owns and operates the building located one block south of Tax Block 1092 which is located between West 43rd and 44th Streets. This building includes an underground parking garage in the eastern portion of the building.

Within a one-quarter mile radius of the West 45th Street Site the neighboring properties consist of residential buildings, restaurants, commercial storage facilities, commercial and

private parking lots, retail stores, tourist attractions, and automotive repair and dry-cleaning facilities. Commercial structures including storage and moving facilities, automotive repair and cleaning companies are present to the northwest and southwest of the Site along 12th Avenue. The Intrepid Sea, Air, and Space Museum is located to the west of the Site along the Hudson River. Other attractions such as restaurants and recreational activity centers are also located along the piers within the general vicinity of the Site. Residential properties including multi-story apartment buildings, commercial retail facilities as well as public parking lots are present east of the Site. The areas to the north and south of the Site mainly consist of light industrial and commercial facilities. The area buildings are generally well maintained and the roads are in good condition. The roads receive a heavy volume of traffic. The area has a high density of people working in the businesses and living in the multifamily and high-rise housing.

1.3 SITE HISTORY

The West 45th Street Gas Works (MGP) plant operated from 1877 to 1913. Gas was manufactured using the coal gas process from 1877 to the mid–1890s prior to switching to a carbureted gas process. A complete history of the former MGP site is presented in a report entitled *West 45th Street Gas Works Site History Report* (Parsons, 2002). A general overview of the site history is provided herein.

Former MGP structures located on OU-1 included a retort house, generator house, purifying house, and five gasholders and associated structures. Four of the gasholders each had a capacity of 375,000 cubic feet and one holder with a capacity of approximately 184,000 cubic feet. Most of the buildings and structures associated with the former MGP facility were removed in 1913. However, subsurface remnants of the gasholders are still present. Following demolition of the MGP structures, portions of the property were sold to other owners. The approximate locations of the former MGP structures are shown on Figure 2.

The entire expanse of Tax Lots 7 and 49 have, since 1923, consisted of multiple-story concrete buildings (with basements) used primarily as warehouses or storage. Tax Lot 7 overlies the area of the MGP formerly containing portions of the generator house, condenser, and engine house, as well as parts of the purifying house, office and meter house, and fire pump (Sanborn, 1911). Tax Lot 49 overlies the area of the MGP formerly containing portions of the retort house and the purifying house (Sanborn, 1911). Since both existing buildings have basements, it is likely that the majority of the former MGP structures and the original ground surfaces have been removed.

Portions of Tax Lot 16 contained bus repair shops and storage structures (including pits under a concrete floor and a laundry) from the 1940s through the 1960s. The remainder of the tax lot has been used for bus or truck parking. Gasoline pumps and underground storage tanks have existed on portions of the property at various points after demolition of the MGP. UPS currently maintains both pumps and USTs on the lot. Lot 16 overlies the former location of the five former gasholder structures. One portion of the lot was excavated to the brick foundation of the holders (at about 10 feet below grade) for new construction, while footings for the same structure were excavated to solid ground, noted to range from 15 to 30 feet below grade

(Parsons, 2002). Portions of the gasholders still exist beneath the parking lot, in areas where later structures or USTs were not constructed.

The western end of original Block 1092 currently is under 12th Avenue. This section of the block once contained portions of the generator house, retort house, coal shed, and various scrubber and coal tar tanks. It is likely that parts of these structures were removed during the significant reconstruction and utility work that has occurred along 12th Avenue.

1.4 PREVIOUS INVESTIGATIONS

Previous investigations of OU-1 include a historical research to evaluate ownership, occupancy, use, and operations over time (including pre-gas works use, use during gas works operation, and post-gas works use). A site reconnaissance was conducted in April 2002 to ascertain current conditions and neighboring property use and a review of federal, state, and local databases was conducted to assess other sites in the vicinity that may be impacting the former gas works site and the neighboring properties. Research undertaken included review of in-house documents and photographs provided by Con Edison, as well as materials gathered at the Municipal Archives of the City of New York, Municipal Reference and Research Center of the City of New York, New York City Recorder of Deeds office, New York City Department of Buildings, New York Public Library, Library of Congress, NYSDEC, Environmental Protection Agency, and various web sites that post historical maps and journal articles. Environmental Data Resources, Inc. (EDR) compiled the radius search data for the Site (EDR, 2002). Results of these efforts are documented in a report entitled *West 45th Street Gas Works Site History Report* (Parsons, 2002).

A Site Characterization was conducted at OU-2 in 2003 and documented in the *Site Characterization Report for the Former West 45th Street Gas Works Site (OU-2)* (Parsons, 2003). Results indicated subsurface soil at OU-2 has been impacted primarily by benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), and non-aqueous phase liquid (NAPL). The majority of impacted soils at OU-2 were encountered outside and along the perimeter of the former gasholders in the vicinity of the former tar tank/skimmer pump structures. Groundwater throughout OU-2 also appears to be impacted primarily with BTEX and PAHs; the highest levels encountered immediately outside the larger gasholder walls. Dense non-aqueous phase liquid (DNAPL) was also encountered in three of the groundwater monitoring wells.

SECTION 2

REMEDIAL INVESTIGATION ACTIVITIES

This section describes the field investigation activities conducted at the West 45th Street Works Site as part of the Site Characterization and Remedial Investigation (RI). Field activities were conducted by Parsons in accordance with the NYSDEC and NYSDOH-approved *Site Characterization Work Plan for the Former West 45th Street Works Site* (Parsons, 2005) and the *Remedial Investigation Work Plan* (Parsons, 2006). The scope of field investigation activities included test pit excavation, soil boring and groundwater monitoring well installation, and a tidal study. In addition, soil, soil gas, groundwater, and free product samples were collected for laboratory analysis. All sampling locations are shown on Figure 3. Table 1 provides a summary of each of the samples submitted for laboratory analysis during the field investigation activities.

2.1 INVESTIGATION TEST PIT EXCAVATION

During the Site Characterization, test pits were excavated at three locations on the UPS parking lot (TP-1 through TP-3) to determine whether MGP structure remnants and/or impacted subsurface materials were present. Test pit locations are depicted on Figure 3. The test pits were excavated using a rubber-tired backhoe to depths ranging from 4 to 10 feet below ground surface (bgs). During excavation activities, test pit walls and floors were inspected for evidence of MGP-related impacts (e.g., odors, staining, sheens, NAPL, PID readings above background levels) and the remnants of MGP structures. The soil characteristics, PID, and visual/odor inspection results are summarized in the test pit logs provided in Appendix A.

In general, samples were collected from the bottom of the test pit and from the sidewalls of the test pit to confirm that the soil had not been impacted by MGP operations. The samples were submitted for laboratory analysis for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, and cyanide. A summary of subsurface samples collected and analyzed can be found in Table 1.

2.2 UTILITY CLEARANCE TEST PIT EXCAVATION

To clear each drilling location for subsurface utilities, test pits were excavated at each proposed soil boring and monitoring well location. Test pit excavation entailed cutting and removing any surface paving materials and hand excavating the underlying materials. The typical utility clearance test pit excavation consisted of saw-cutting and jack-hammering the surface pavement (if necessary), and hand excavating via vacuum or hand auger to a minimum depth of five feet bgs. During these excavation activities, soils were screened for VOCs using a PID, their physical characteristics (e.g., soil type, grain size, color, etc.) were described, and notes of any evidence of physical impacts observed (staining, odor, sheen, free product, etc.) were recorded. When a test pit could not be completed to a depth of five feet bgs due to the presence of underground utilities or subsurface obstructions, the location was moved

approximately five to 10 feet away from the original location and re-excavated. Following completion of the utility clearance test pits, each test pit was backfilled prior to drilling.

2.3 SOIL BORING INSTALLATION

During the Site Characterization, a total of twenty soil borings (SB-26 through SB-33, SB-36A, SB-37 through SB-45, SB-47 and SB-48) were installed at the locations shown on Figure 3. Three soil borings proposed in the NYSDEC-approved Site Characterization Work Plan (Parsons, 2005) were not installed. Two of the proposed soil borings (SB-25 and SB-34) could not be installed due to the presence of scaffolding along the sidewalk. The third soil boring, SB-35, could not be advanced due to subsurface obstructions and safety concerns. Site Characterization soil borings were advanced to refusal depths ranging from 5.5 to 34 feet bgs.

During the RI, a total of seventeen soil borings (MW-12 through MW-15, MW-17, MW-18, SB-25, SB-34, SB-49 through SB-54, and SB-56 through SB-58) were installed at locations shown on Figure 3. Two of these borings, SB-25 and SB-34, were proposed during the Site Characterization scope of work as discussed above and were installed during the RI phase since the scaffolding had been removed. Although the RI Work Plan (Parsons, 2006) had proposed that monitoring wells be installed in six of these borings (MW-12 through MW-15, MW-17, MW-18), groundwater was not encountered at these locations and accordingly, monitoring wells were not installed. In addition, MW-12 was relocated to the north sidewalk of West 45th Street due to space/access restrictions on the south sidewalk. RI soil borings were advanced to refusal depths ranging from two to 18.5 feet bgs.

All borings were advanced using a truck or track-mounted drill rig, direct-push drill rig, or vacuum excavation and hand digging. Soil samples were collected on a continuous basis and visually characterized for color, texture, moisture content, evidence of impacts, and screening for organic vapors using a PID. Soil boring logs are provided in Appendix B.

In general, two soil samples were selected from each location and submitted to the laboratory for chemical analysis.

- One sample was collected from the zone with the highest PID readings and/or visibly stained soils from either the utility clearance test pit or boring. If no visual impacts or PID readings above background levels were noted, a sample was collected from directly above the water table.
- One sample was collected below the impacted zone or near the base of the boring to define the vertical extent of impacts at that location.

The soil samples were submitted for laboratory analysis of TCL VOCs and SVOCs, cyanide, and TAL metals. Due to poor recovery and insufficient sample volume, a number of samples could not for be submitted for all analyses. A summary of the soil samples collected and analyses performed is provided in Table 1.

2.4 MONITORING WELL INSTALLATION AND DEVELOPMENT

Four monitoring wells (MW-7 through MW-10) were installed during the Site Characterization and five additional monitoring wells (MW-11, MW-16, MW-19, MW-20, and MW-55) were installed during the RI. Two of these monitoring wells were originally proposed as soil borings (MW-10 and MW-55). These locations were completed as monitoring wells to provide additional information regarding groundwater conditions at the Site. Monitoring well logs provided in Appendix B include the construction details for each monitoring well.

Monitoring well borings were advanced with 4.25-inch ID hollow stem augers. The depth of the wells ranged from 11.5 to 31.5 feet bgs. Soil samples were collected on a continuous basis using a two-foot long, two-inch diameter, split-spoon sampler. Each sample was split lengthwise and logged by field personnel. Logging consisted of: describing the soil (e.g., color, texture, moisture content); describing any evidence of impacts (e.g., oil-like or tar-like NAPL, staining, sheens, odors); and screening for organic vapors using a PID.

Similar to the soil borings, two soil samples were generally selected from each monitoring well boring location and submitted to the laboratory for chemical analysis.

- One sample was collected from the zone with the highest PID readings or visual impacts from either the utility clearance test pit or boring. If no visual impacts or PID readings above background levels were noted, a sample was collected from directly above the water table.
- One sample was collected below the impacted zone or near the base of the boring to define the vertical extent of impacts at that location.

Additional samples were collected for laboratory analysis where appropriate based on subsurface conditions observed. The soil samples were analyzed for TCL VOCs and SVOCs, cyanide, and TAL metals. A summary of the soil samples collected and analyses performed is provided in Table 1.

The monitoring wells were constructed with two-inch ID, threaded, flush-joint, PVC casing and approximately ten feet of 0.02-inch slot screens. A two-foot sump was placed below the screens to monitor for potential dense non-aqueous phase liquid (DNAPL) if NAPL was observed during installation of the monitoring well boring. The screened interval for each well varies depending on the subsurface conditions encountered during installation, but generally the screens were placed across the water table interface to allow for the monitoring of light non-aqueous phase liquid (LNAPL), if present. The wells were completed in flush-mounted vaults to maintain accessibility to the area after completion.

After a minimum of 24 hours, the monitoring wells were developed by purging until the well was reasonably free of sediment (50 NTU or less where possible) or until the pH, temperature and conductivity stabilized.

2.5 GROUNDWATER SAMPLING

Two groundwater sampling events were conducted at the Site. The first was conducted following installation of monitoring wells MW-7 through MW-10 during the Site Characterization field investigation in March 2006. All four wells were sampled during this sampling event. The second groundwater sampling event was conducted during the RI in May 2007. Groundwater samples were collected from six of the existing monitoring wells and the monitoring wells installed during the RI, which included (MW-11, MW-16, MW-19, MW-20 and MW-55).

Sampling procedures were the same during both sampling events. Prior to collecting the samples, the depth to groundwater was measured in the wells using an electronic oil/water interface probe attached to a measuring tape accurate to 0.01 foot.

Prior to sampling, a minimum of three times the volume of standing water in each well was purged using a peristaltic pump to allow for collection of a representative sample. Water quality parameters, including temperature, conductivity, pH, dissolved oxygen, oxidation reduction potential (ORP), and turbidity, were measured approximately every five minutes during the purging process and were measured immediately before sample collection. Groundwater samples were collected using a low-flow peristaltic pump with dedicated tubing. Water quality parameter measurements and observations recorded during sampling are documented on the groundwater sampling records provided in Appendix C.

Each well was sampled using low-flow purging and sampling techniques. Groundwater samples were collected directly into laboratory supplied sample bottles using dedicated Teflon-lined sample tubing. The samples were submitted for the following analysis: TCL VOCs, TCL SVOCs, TAL metals, total cyanide, and available cyanide. A summary of the groundwater samples collected and analyses performed is provided in Table 1. All non-dedicated sampling equipment (e.g., oil/water interface probe and sampling pump) was decontaminated between sampling locations. All decontamination water was placed in 55-gallon drums and handled as described in Section 2.11.

2.6 SOIL GAS INVESTIGATION ACTIVITIES

As part of the Site Characterization, soil gas samples were collected from two locations along the southern sidewalk of West 45th Street adjacent to the Time Moving and Storage Warehouse (SG-3 and SG-4), and three locations within the UPS parking lot (SG-2, MW-9, and SB-27). The soil gas sampling locations are shown on Figure 3. Soil gas samples were collected in accordance with the New York State Department of Health (NYSDOH) Draft Guidance for Evaluating Soil Vapor Intrusion (NYSDOH, 2005). Two soil gas samples were collected from each location with the exception of SG-4. Refusal was encountered during three separate attempts to install the deeper location at SG-4. Therefore, the deep soil gas sample was eliminated at SG-4. Sub-slab soil gas samples were also proposed at indoor soil boring locations SB-52 and SB-53. However due to shallow groundwater table elevations, sub-slab soil gas samples could not be obtained. Groundwater was noted immediately below the concrete slab during utility clearance test pit excavations.

Prior to soil gas sampling, groundwater levels were obtained from all accessible monitoring wells at the Site to determine the approximate depth to groundwater at each soil gas sampling location. Groundwater appeared to be between eight and 11 feet bgs in the vicinity of SG-2, MW-9 and SB-27. Therefore, soil gas samples were collected from depths of approximately one foot and six feet bgs at these locations. Groundwater appeared to be at a depth of approximately five feet bgs in the vicinity of SG-3. Therefore, soil gas samples were collected from one foot and four feet bgs at this location in accordance with the work plan.

Soil gas samples were collected using a probe/sampling assembly comprised of stainless steel tubing fitted with an expendable steel probe point. Prior to soil gas sampling, the sampling probe was driven via a direct push method to the desired sampling depth. The expendable point was released into the soil and the sampler was withdrawn approximately 0.5 feet to create a void space. The space between the probing rod and the surrounding soil column was filled with granular bentonite, which was then hydrated to form an airtight seal to prevent aboveground ambient air from influencing the quality of a subsurface soil gas sample. A minimum of one implant volume (the volume of the sample probe and tube) was purged prior to sample collection.

A tracer gas (helium) was utilized in the field to verify the integrity of the soil vapor probe seal prior to sample collection at select locations. An enclosure (plastic pail) was placed over the location where the probe intersected the ground and the atmosphere within the enclosure was enriched with helium gas. After the atmosphere within the enclosure had been enriched, a vapor sample from the probe was screened to ensure the presence of the tracer gas was less than 20%.

Six-liter Summa canisters with flow regulators were used to collect soil gas. A vacuum gauge was used to check both the initial and final vacuum in the canisters. Flow rates for both purging and sample collection did not exceed 0.2 liters per minute. All soil gas samples were submitted for laboratory analysis of VOCs using modified EPA Method TO-15. A summary of the soil gas samples collected and analyses performed is provided in Table 1.

2.7 SURVEYING

At the completion of field investigation activities, a licensed New York State land surveyor identified the horizontal and vertical locations of each soil boring and monitoring well. The survey elevations were measured to an accuracy of 0.01 feet above the North American Vertical Datum of 1988 (NAVD 88).

2.8 GROUNDWATER LEVEL MEASUREMENTS

Two rounds of groundwater level measurements have been obtained at the Site. The first was conducted between March 17 and 31, 2006 as part of the Site Characterization tidal study. The second round of groundwater level measurements was conducted as part of the RI field activities on May 22, 2007.

2.9 TIDAL STUDY

As part of the Site Characterization field activities, a tidal study was conducted to evaluate the effects that tidal fluctuations in the Hudson River have on groundwater elevations and flow directions at the Site. Mini-Trolls™, a combination transducer and data logger, were installed in monitoring wells MW-7, MW-8, and MW-9 at OU-1 and monitoring wells MW-2, MW-3 and MW-5 at OU-2 (Figure 3). The following monitoring wells were not included in the tidal study; MW-1, MW-4, MW-6 and MW-10. Monitoring well MW-1 was damaged and could not be utilized. NAPL was observed in monitoring wells MW-4 and MW-6 and monitoring well MW-10 was not included because this was a step-out location added at the end of the investigation program and was not installed at the time of the tidal study. Continuous groundwater levels were obtained from the six monitoring wells at 10-minute intervals over an approximately 72-hour period during the tidal study.

2.10 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW), which included decontamination wash and rinse water, soil cuttings, purge water, disposable PPE, etc., was containerized in clean New York State Department of Transportation (NYSDOT)-approved 55-gallon drums. The drums were stored in a secured location on each respective property or transported off-site for treatment/disposal on a daily basis. The drums were sealed at the end of each work day and labeled with the date, the well or boring number(s), and the type of waste (i.e., drill cuttings, purge water, etc.). Representative samples of the IDW were collected from the drums for waste characterization analysis. All IDW was disposed of at an off-site Con Edison-approved location in accordance with applicable local, state, and federal regulations.

2.11 DATA VALIDATION AND REPORTING

Data validation was performed in accordance with USEPA Region II standard operating procedures (SOPs) for organic and inorganic data review. These validation guidelines are regional modifications to the National Functional Guidelines for organic and inorganic data review (USEPA 1999 and 2004). Validation included the following:

- Verification of 100% of all quality control (QC) sample results (both qualitative and quantitative);
- Verification of the identification of 100% of all sample results (both positive hits and non-detects);
- Recalculation of 10% of all investigative sample results; and
- Preparation of a Data Usability Summary Report (DUSR).

The quality of the data has been assessed and is documented in the DUSR(s) provided in Appendix D.

SECTION 3

REMEDIAL INVESTIGATION RESULTS

3.1 SITE GEOLOGY

The geology encountered during subsurface activities conducted at the Site is described in the test pit and boring logs provided in Appendices A and B. The logs show that the upper three to 12 feet contained fill materials (generally sand, gravel and silt with cobbles, cement and brick fragments). Deposits of fine to medium-grained sand, silt and some gravel underlie the fill. A peat layer was encountered in the vicinity of the UPS building located between W 43rd and West 44th Streets ranging from one to four feet in thickness. Soil boring and monitoring well logs from the field investigations were used to develop three representative cross sections. A north-south cross-section of the Site is shown on Figure 4 (cross section A-A') and two east-west cross sections are shown on Figures 5 and 6 (cross sections B-B' and C-C', respectively).

Figure 7 summarizes the suspected bedrock elevations encountered at the Site during the investigation activities based on observations and refusal during drilling activities. Suspected bedrock was encountered at depths between 25 and 34 feet within the UPS parking lot, which is elevated in relation to the surrounding areas. Bedrock was generally shallower (between two and 23.5 feet bgs) along the 43rd Street, 44th Street, 45th Street, 46th Street, 11th Ave and Route 9A sidewalks. Suspected bedrock elevation contours provided on Figure 7 infer that bedrock elevations underlying the Manhattan Mini Storage and Time Moving & Storage Warehouse buildings are significantly shallower than bedrock elevations where the former gasholders were located. A bedrock trough appears to be present in the vicinity of MW-20 and SB-48. The bedrock trough appears to start in the general vicinity of the former gasholders and terminate under the UPS building prior to West 43rd Street. Sharp variations in bedrock depths may be due to the extreme folding in the natural bedrock that is known to underlie Manhattan. These variations may also be attributed to manmade alterations to bedrock during construction (e.g., streets/utility corridors, subsurface structures, and building foundations).

3.2 SITE HYDROGEOLOGY

Two sets of groundwater levels were used to assess groundwater flow conditions at the Site. The first set of data was collected between March 13 and 18, 2006 as part of the tidal study; a second round of water levels was obtained on May 22, 2007. Results from both data sets are described below.

Tidal Study Results – March 2006

In March 2006, pressure transducers were installed in six monitoring wells (MW-2, MW-3, MW-5, MW-7, MW-8 and MW-9) for a four day period. The transducers recorded water levels every 10 seconds during the study. The logger data obtained from the tidal study conducted at OU-1 and OU-2 are summarized in Table 2. The water level changes in the monitoring wells

were plotted and compared with high and low tide readings obtained from a gauge located at the Battery and with barometric readings from La Guardia Airport. The Hudson River is tidal with two high tides and two low tides every day that range over five feet during this period. The hydrograph of the Hudson River water levels and the water level elevations from the six monitoring wells indicate the wells MW-2, MW-3, MW-5, MW-7 and MW-8 do not show tidal fluctuations. During the study period, water levels in these wells showed a decreasing trend with no apparent tidal influence on the shallow aquifer. There appears to be some tidal effects measured in well MW-9. The water levels in monitor well MW-9 shows some oscillations roughly at the same frequency of the tidal peaks from the Hudson River. However, the oscillations are minor (i.e., 0.1 to 0.2 feet). The tidal study data is provided in Appendix F.

Groundwater Gauging Event - May 2007

Groundwater was encountered beneath the Site at elevations ranging from -2.54 to 9.42 feet above mean sea level (AMSL), approximately 1.64 to 10.8 feet bgs. Groundwater levels in monitoring wells MW-4, MW-5 and MW-8 appear to be significantly higher than the general groundwater table surface. This may be due to differential recharge. MW-19 also appears to be high. This well is adjacent to a planter which may be allowing higher rates of infiltration in this area. Wells MW-20 and MW-10 are adjacent to the street and appear to be low. This may be due to utility corridors beneath the street. Utilities can act as drains due to the gravel pack, and/or improperly maintained piping (i.e., broken storm drains). The groundwater levels and corresponding elevations are summarized in Table 2 and on the groundwater contour map (Figure 8). The groundwater contours based on the May 2007 event are generally consistent with the groundwater conditions noted during the March 2006 Tidal Study.

3.3 SOIL INVESTIGATION RESULTS

Former MGP Structures

The test pitting and soil boring activities conducted during the Site Characterization confirmed that below-grade remnants of the five former gasholders are present at OU-1. As depicted in photos provided in Appendix A, remains of the walls of the former gasholders were encountered during the test pit activities. The larger gasholders appear to be sharing a common north/south wall as shown in Figure 2. In addition, the smaller gasholder appears to be sharing its western wall with one of the larger gasholders. Boring refusals within the larger gasholders indicate potential steel-lined bottoms of the gasholders are present at depths between 13 and 17.5 feet bgs. Refusal on rock was encountered in the former smaller gasholder at a depth of 28 feet bgs. No other former MGP structures were confirmed during the site investigation activities.

Solidified Coal Tar/NAPL

A dense, solid, black solidified coal tar material was encountered at soil borings SB-43 and SB-44 at depths between 3 and 5 feet bgs. Non-Aqueous Phase Liquid (NAPL) or globules were observed at MW-9, MW-20, SB-39, SB-40, SB-45, and SB-48 at depths ranging from 12 to 33 feet bgs. Additionally, a non-measurable amount (less than 0.01 feet) of NAPL was

encountered prior to the development of monitoring well MW-9 and during the sampling of this well on March 17, 2006. Figure 7 summarizes the locations of solidified coal tar material and NAPL observed during the investigation activities. The distinction between solidified coal tar material and NAPL was made based on their physical state observed in the field (coal tar was observed as a solid material and NAPL was observed as a liquid material).

Samples of the coal tar material encountered at SB-43 and of the NAPL impacted soils from MW-9 and SB-39 were collected and submitted to META Environmental, Inc. (META) for forensic hydrocarbon fingerprint analysis by modified Method 8100. The laboratory reports for these fingerprint analyses are provided in Appendix E. The reports indicate that these samples contained pyrogenic material and were similar in nature to carbureted water gas tar, suggesting that they originated from former MGP operations. In addition, these materials were found in close proximity to the former gasholders.

Soil Analytical Results

A total of 90 soil samples (including duplicates) were collected from the soil borings and test pits completed as part of the field investigations. In general, soil samples were analyzed for TCL VOCs, SVOCs, TAL metals, and cyanide as described in Section 2.3. The analytical results of the soil samples are summarized in Table 3. Table 3 contains soil sample results from the Site Characterization field activities and the Remedial Investigation activities. The soil sample results have been compared to the Unrestricted Soil Cleanup Objectives (USCOs) provided by NYSDEC in 6 NYCRR Part 375 (NYSDEC, 2006).

PID Readings/Visual Observations

Table 4 provides a summary of photoionization detector (PID) readings recorded at each of the monitoring well and soil boring locations. PID readings of soil samples collected during soil boring/monitoring well installation ranged from 0.0 to 3,558 ppm above background. The highest PID reading was detected in soil boring SB-39 at 31 to 33 feet bgs, where NAPL was also observed.

VOCs

A summary of VOC results for soil samples collected during the field investigation activities is shown on Figure 9 and presented in Table 3. A total of 31 VOCs were detected at least once in the subsurface soil samples collected during the field investigations. As summarized in Table 3, 10 VOCs were detected at concentrations exceeding their respective USCOs. Total VOC concentrations in all subsurface soil samples ranged from non-detect to 5,771 ppm. The highest total VOC concentrations were detected in a sample collected from soil boring location SB-30, which is located in close proximity to former gasholders, at 32 to 32.5 feet bgs.

SVOCs

A summary of SVOC results for soil samples collected during the field investigation activities is shown on Figure 10 and presented in Table 3. A total of 28 SVOCs were detected at

least once in the subsurface soil samples collected during the field investigations. As summarized in Table 3, 14 SVOCs were detected at concentrations exceeding their respective USCOs. Of the SVOCs analyzed, only PAHs were detected at concentrations that exceeded their respective USCOs with one exception, phenol at SB-33. Total SVOC concentrations in all subsurface soil samples ranged from non-detect to 2,867 ppm. The highest total SVOC concentration was detected in a sample collected from 20 to 21 feet bgs at soil boring location SB-48. Soil boring SB-48 is located in close proximity to former gasholders and NAPL was observed in this boring from 20-23 feet bgs.

Metals and Cyanide

Table 3 summarizes the laboratory analytical results for metals and cyanide detected in subsurface soil. Analytical results for metals in soil indicated the presence of 20 metals at concentrations that exceeded the USCOs in at least one of the boring locations. The exceedances were present throughout the Site with no discernable pattern. Metals are a primary component of naturally occurring soil and are typically detected in soil used for fill in urban areas, such as New York City. Cyanide was also analyzed in soil samples and ranged in concentrations from not detected to 576 ppm. Cyanide exceeded its USCO of 27 ppm in three samples (SB-30, 32-32.5 ft; SB-37, 32-34 ft; and SB-39, 31-33 ft).

3.4 GROUNDWATER INVESTIGATION RESULTS

Laboratory analytical results for constituents detected in the groundwater samples are summarized in Tables 5 and 5.1 and on Figure 11. For evaluation purposes, analytical results were compared with Class GA groundwater quality standards (GWQS) and guidance values contained in NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 (NYSDEC, 1998).

Field Measurements

During groundwater sampling activities, each monitoring well was monitored for the presence of NAPL. A rainbow sheen, as well as a non measurable amount of Dense Non-Aqueous Phase Liquid (DNAPL) were observed in MW-9. No sheens, Light Non-Aqueous Phase Liquid (LNAPL), or DNAPL were observed in any of the other wells at OU-1. Water quality parameters as well as visual descriptions and observations made during the groundwater sampling activities are presented on the groundwater sampling records provided in Appendix C.

VOCs

Table 5 summarizes the laboratory analytical results for VOCs detected in groundwater samples during the March 2006 sampling event. Seventeen VOCs were detected in the groundwater samples collected during this event. BTEX compounds and isopropylbenzene were detected at concentrations exceeding their applicable standards or guidance values in three of the four wells (MW-7, MW-8 and MW-9) that were sampled during this sampling event. Styrene was also detected at concentrations above GWQS in MW-8 and MW-9 while acetone and 2-butanone were detected above guidance values in MW-7. Two chlorinated VOCs, 1,2-dichloroethane and cis-1,2-dichloroethene, were also detected above GWQS in MW-10. The

highest total VOC concentrations were detected in monitoring well MW-9 during this sampling event. As previously noted, a sheen and DNAPL were also observed in this well during the sampling event.

Table 5.1 summarizes the laboratory analytical results for VOCs detected in groundwater samples during the May 2007 sampling event. Thirteen VOCs were detected in the groundwater samples collected during this sampling event. Each of the BTEX compounds and isopropylbenzene were detected at concentrations exceeding their applicable standards or guidance values in six of the 11 monitoring wells (MW-5, MW-7, MW-8, MW-9, MW-19 and MW-20) sampled during the May 2007 sampling event. Six compounds, benzene, ethyl benzene, m/p-xylene, o-xylene, and isopropylbenzene were detected at concentrations above GWQS in MW-10. Benzene was also detected at concentrations above GWQS in MW-11 and MW-16 while styrene was detected at concentrations above GWQS in MW-19. Methyl tert-butyl ether was detected in monitoring wells MW-5, MW-9 and MW-10. VOCs were not detected in MW-2 or MW-55 during the May 2007 sampling event. The highest total VOC concentrations were detected in monitoring well MW-19 during this sampling event. Monitoring well MW-19 is located in close proximity to the former gasholder at OU-2.

SVOCs

Table 5 summarizes the laboratory analytical results for SVOCs detected in groundwater samples during the March 2006 sampling event. A total of 25 SVOCs were detected in the groundwater samples collected during this event. Sixteen of the 25 SVOCs detected were polycyclic aromatic hydrocarbons (PAHs). The detected concentrations of 13 SVOCs, nine of which were PAHs, exceeded their respective GWQS. Concentrations exceeding the GWQS were detected in each of the four monitoring wells (MW-7, MW-8, MW-9 and MW-10) sampled during this event. Similar to VOCs, the highest total SVOC concentrations were detected in monitoring well MW-9 during this sampling event.

Table 5.1 summarizes the laboratory analytical results for SVOCs detected in groundwater samples during the May 2007 sampling event. A total of 20 SVOCs were detected in the groundwater samples collected during this event. Nine of the 20 SVOCs detected were PAHs. The detected concentrations of nine SVOCs, four of which are PAHs, exceeded their respective GWQS. Concentrations exceeding the GWQS were detected in eight of the 11 monitoring wells sampled during this event. No SVOCs were detected above GWQS or guidance values in monitoring wells MW-11, MW-16 and MW-55 during the May 2007 sampling event. As with the March 2006 sampling event, the highest total SVOC concentrations were detected in monitoring well MW-9 during this sampling event.

Metals and Cyanide

A total of 24 metals were detected in at least one of the groundwater samples collected during the March 2006 sampling event as summarized on Table 5. Eight of these metals (antimony, barium, iron, lead, magnesium, manganese, selenium and sodium) were detected at concentrations exceeding the GWQS. Results for the analysis of cyanide indicated all detected concentrations were below the GWQS. Available cyanide was detected in monitoring well

MW-10 at a concentration of 5.9 ug/L. No GWQS for available cyanide is provided in the NYSDEC TOGS 1.1.1.

A total of 21 metals were detected in at least one of the groundwater samples collected during the May 2007 sampling event as summarized on Table 5.1. Five of these metals (antimony, iron, magnesium, manganese and sodium) were detected at concentrations exceeding the GWQS. Results for the analysis of cyanide indicated all detected concentrations were below the GWQS and available cyanide was not detected in any of the groundwater samples collected during this sampling event.

3.5 SOIL GAS INVESTIGATION RESULTS

Table 6 presents the soil gas analytical results. Thirty-seven compounds were detected in the soil gas samples at concentrations ranging from 0.33 ug/m^3 to 610 ug/m^3. Ten of these compounds (freon 12, ethanol, acetone, benzene, toluene, tetrachloroethene, xylene (m,p), xylene (o), 1,2,4-trimethylbenzene, and 2,2,4-trimethylpentane) were detected in each of the soil gas samples collected. The number of VOCs detected in each sample ranged from 15 compounds in the six-foot depth sample collected from sample location SB-27 to 25 compounds in the four-foot depth sample collected from the OU-1 SG-3 sample location. The highest total concentration of VOCs was detected in the sample collected from one-foot bgs at location MW-9. Monitoring well MW-9 is located in the vicinity of the UPS fueling area and as previously noted, NAPL was observed at MW-9 during installation of the monitoring well soil boring.

SECTION 4

NATURE AND EXTENT OF IMPACTS

The nature and extent of impacts at OU-1 based on both the Site Characterization and Remedial Investigation results are summarized below.

Former MGP Structures/NAPL

Three test pits were excavated on the perimeter of the five former gasholders at OU-1. Below grade remains of brick walls were observed to be present at all five former gasholders. Soil borings installed within the former gasholders identified potential steel-lined bottoms in the larger gasholders. However, based on field observations at soil boring SB-33, a holder bottom may not be present in the small gasholder. NAPL was observed in close proximity to the former small gasholder. As shown on Figure 7, NAPL was encountered outside of the gasholders immediately north of West 44th Street and appears to extend south beneath West 44th Street, generally consistent with the apparent bedrock trough in this area. However, NAPL was not observed further to the south beneath the UPS building located between West 44th and 43rd Streets. NAPL was also observed in MW-9 the source of which is unclear. Solidified coal tar material was noted in soil borings SB-43 and SB-44 which are located along West 44th Street and adjacent to two of the larger gasholders (Figure 7). Forensic hydrocarbon fingerprinting of both the solidified coal tar and NAPL materials observed at soil borings SB-39, SB-43 and MW-9 were similar in nature to carbureted water gas tar, suggesting that they originated from former MGP operations. Other than the gasholders, no other remnants of former MGP structures were encountered during the field investigation.

Soil

The highest total VOC and SVOC concentrations were typically detected in soil samples collected in the vicinity of the former gasholders and apparent bedrock trough that extends to the south of the Site across West 44th Street. The three highest total VOC concentrations and three of the four highest total SVOC concentrations were detected at soil boring locations SB-30, SB-39 and SB-48. These locations are in close proximity to the former gasholders or are located within the apparent bedrock trough. Soil samples collected from within the former large gasholders generally did not exceed the USCOs for VOCs or SVOCs. However, several USCOs for VOCs and SVOCs were exceeded in a soil sample collected from the former small gasholder. Outside of the soil samples that are located within close proximity to the former gasholders at OU-1 and the bedrock trough, two other locations contained more than one VOC concentration above the USCOs, MW-19 and MW-7. Monitoring well MW-19 is situated immediately adjacent to the former gasholder at OU-2. Monitoring well MW-7 is situated in the vicinity of the former retort house, generator house, and condenser based on information from the Site History Report (Parsons, 2002). Metals were detected throughout the Site in soil at concentrations exceeding the NYSDEC USCO. The exceedances were present throughout the Site with no discernable pattern and are consistent with urban fill materials.

Groundwater

VOCs were detected at concentrations exceeding GWQS in nine of the eleven monitoring wells that were sampled. BTEX compounds constituted a majority of the VOCs detected in these wells. At least one BTEX compound exceeded GWQS in each of the nine wells. SVOCs were detected at concentrations exceeding GWQS in eight of the eleven monitoring wells. Monitoring wells MW-7, MW-8, MW-9 and MW-10 were sampled twice during the field investigations summarized in this RIR. In general, detected total VOC and SVOC concentrations decreased in each of these monitoring wells between the two sampling events with the exception of MW-10. VOC concentrations in MW-10 increased between the two monitoring events conducted on 3/31/06 and 5/10/07. In general, groundwater impacts are primarily limited to the east of 12th Avenue and the highest VOC and SVOC concentrations are being detected in monitoring wells MW-9 and MW-19 (Figure 11). Monitoring well MW-9 is located in the vicinity of the UPS refueling area and former gasholders at the Site while MW-10 is located in close proximity to the large gasholder at OU-2. MTBE was detected in monitoring wells MW-5, MW-9 and MW-10 during the 5/10/07 monitoring event. Two of these monitoring wells, MW-9 and MW-10, are downgradient of the UPS refueling area based on groundwater contours generated during the 5/22/07 gauging event (Figure 8).

Soil Gas

VOCs including non-MGP related compounds (Freon, chlorinated compounds or methyl tert-butyl ether) were detected in each of the soil gas samples collected. In general, VOC concentrations were higher in the shallow sample (one foot bgs) at soil gas locations SB-27 and SG-2 while higher VOC concentrations were detected in the deeper sample at SG-3 and MW-9. The highest total concentration of VOCs was detected in the sample collected from 1-foot bgs at location MW-9. In addition, this is the only soil gas sample in which methyl tert-butyl ether was detected. As previously noted, monitoring well MW-9 is located in the vicinity of the UPS fueling area. Also, NAPL was observed at MW-9 during installation of the monitoring well soil boring.

SECTION 5

EXPOSURE ASSESSMENT

The information collected during both the Site Characterization and Remedial Investigation has been used to qualitatively assess potential exposure pathways for the various detected compounds at OU-1.

The Former West 45th Street Gas Works Site is located in a highly urbanized area, which is primarily commercial. Accordingly, the current surface at the Site is covered by concrete, asphalt and buildings. Therefore, surface soils are not a potential exposure pathway.

Results from several subsurface soil samples indicate the presence of solidified coal tar and NAPL-impacted soils, as well as VOC and SVOC concentrations exceeding the USCOs. The solidified coal tar impacted soils are located beneath the northern West 44th Street Sidewalk (SB-43 and SB-44) at depths ranging from three to five feet. Therefore, it is unlikely that these materials would be encountered during routine use of this area but they may be exposed during maintenance activities (e.g., utility work). The NAPL-impacted subsurface soils were noted at depths ranging from 12 to 33 feet bgs and are covered by the UPS parking lot, West 44th Street and its associated sidewalks. Soils containing the highest total VOC and SVOC concentrations were detected at depths ranging from nine to 33 feet bgs and were generally located within the same areas as the NAPL impacted soils, in addition to the southern sidewalk of West 46th Street and eastern sidewalk of 12th Avenue. Due to their depths, it is unlikely the NAPL-impacted subsurface soils, or soils containing the highest total VOC or SVOC concentrations, would be encountered during routine use of the area or during maintenance activities. Exposure to impacted subsurface soils may occur during potential future construction. However, there are no known plans for future construction activities at the Site.

Groundwater results identified VOC and SVOC concentrations exceeding GWQS at the Site. These GWQS and guidance values are protective of groundwater quality assuming that groundwater is used as a drinking water source. However, groundwater is currently not used at the Site or this area of Manhattan for a potable water source and there are not plans for future use of potable or commercial/industrial groundwater at the Site. Accordingly, the use of Class GA standards and guidance values for comparison to site groundwater data is conservative. Given the depth of groundwater at OU-1, between six and 11 feet bgs, potential exposure to groundwater may occur during future construction activities or maintenance of deep underground utilities such as sewers.

The Hudson River is located west of the Site. VOC and SVOC concentrations in soil samples collected from soil borings and monitoring wells installed along the bikepath, adjacent to the Hudson River and downgradient of the former MGP structures, were all below the USCOs with one exception, acetone. Acetone was detected at concentrations slightly above its USCO in soil samples collected from MW-16 and SB-54. However, acetone is a common lab contaminant and was not detected in groundwater samples collected from monitoring wells MW-16 or

MW-55. No VOCs or SVOCs were detected in groundwater at MW-55 and only one VOC and one SVOC were detected in groundwater at MW-16. The VOC detection in MW-16 was slightly above the GWQS and the SVOC detection was below the GWQS. Both of these monitoring wells are located adjacent to the Hudson River.

Soil gas may be a potential pathway for exposure at OU-1. Soil gas sampling results indicate the presence of VOCs, including non-MGP related compounds (Freon, chlorinated compounds, methyl tert-butyl ether), in soil gas samples collected adjacent to buildings located on Block 1092 including the Time Moving & Storage Warehouse, Manhattan Mini-storage, and the two buildings located on the eastern portion of the block adjacent to 11th Avenue.

SECTION 6

CONCLUSIONS

Based on the results of the Site Characterization and Remedial Investigation activities documented in this report, the following conclusions are noted for OU-1 of the Former West 45th Street Gas Works Site.

- Subsurface soil at OU-1 appears to be impacted by former MGP operations. Site soils have been impacted primarily with BTEX and PAHs. The greatest impacts to soil were found in areas where visible NAPL was encountered in the subsurface.

- Remnants of former gasholder structures are present within the UPS parking lot. The majority of impacted soils at OU-1 were encountered outside and along the perimeter of the former gasholders, especially the small gasholder, and within an isolated area extending south of the small gasholder.

- Impacted soils encountered at OU-1 appear to be limited to depths greater than nine feet bgs, with the exception of solidified coal tar observed in an isolated area along the northern sidewalk of West 44th Street. Solidified coal tar was observed in this area at depths of between three and five feet bgs.

- Groundwater at OU-1 appears to be impacted primarily with BTEX and PAHs with the highest concentrations encountered near the former gasholders.

- There is no current pathway for human exposure to impacted soils or groundwater at OU-1 during day-to-day operations. However, exposure to impacted soils or groundwater may be possible during intrusive activities (e.g., repair of underground utilities or structures, potential future construction).

- Further investigation of potential soil vapor intrusion within the UPS building is not warranted since 1) MGP source materials (NAPL) was not encountered in soil borings conducted within the building basement, 2) the area of the building located nearest to NAPL-impacted soils associated with OU-1 is operated primarily as a parking garage and does not contain offices, and 3) results indicate that the western portion of the UPS building where offices are present has not been impacted by former MGP operations at OU-1.

SECTION 7

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