SITE CHARACTERIZATION

PHASE IV DATA SUMMARY REPORT

WORK ASSIGNMENT D004433-22

MEEKER AVENUE PLUME TRACKDOWN
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA

SITE NO. 2-24-121
KINGS (C), NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Alexander B. Grannis, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B

URS Corporation
77 Goodell Street
Buffalo, New York 14203

Final
May 2009

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DATA SUMMARY REPORT

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SITE ID NO. 2-24-121

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BROOKLYN, NEW YORK

PREPARED FOR:

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77 GOODELL STREET

BUFFALO, NEW YORK 14203

FINAL

MAY 2009

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APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ADT	Aquifer Drilling and Testing, Inc.
aka	also known as
amsl	above mean sea level
ASP	Analytical Services Protocol
bgs	below ground surface
BP	British Petroleum
BQE	Brooklyn-Queens Expressway
C&D	construction and demolition
CD	compact disc
CO	carbon monoxide
COC	chain-of-custody
Con-Test	Con-Test Analytical Laboratory
DCA	dichloroethane
DCE	dichloroethene, aka dichloroethylene
DEP	Department of Environmental Protection
DNAPL	dense non-aqueous phase liquid
DOB	Department of Buildings
DOT	Department of Transportation
DSNY	City of New York Department of Sanitation
DUSR	Data Usability Summary Report
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Approval Program
EM	electromagnetic
EPM	Environmental Planning and Management, Inc.
FAP	Field Activities Plan
FDNY	New York City Fire Department
FID	flame ionization detector
FOIL	Freedom of Information Law
Frank's	Frank's Vacuum Truck Service, Inc.
FSP	Field Sampling Plan
GeoLogic-NY	GeoLogic NY, Inc.
GPR	ground penetrating radar
HASP	Health and Safety Plan
HC-V	Hampton-Clarke, Inc.- Veritech Laboratory
HDPE	high-density polyethylene
HSA	hollow stem auger
ID	inside diameter
IDW	investigation derived wastes
L	liter
LEL	lower explosive limit
mg/kg	milligrams per kilogram (parts per million)
MIP	membrane interface probe
mL	milliliter

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

MW	monitoring well
MTBE	Methyl tert-butyl ether
NAVD	North American Vertical Datum
NYC	New York City
NYCRR	New York Codes, Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
OD	outside diameter
PCB	polychlorinated biphenyl
PCE	perchloroethene, aka tetrachloroethene or tetrachloroethylene or perchloroethylene
PID	photoionization detector
PMWP	Project Management Work Plan
ppbv	parts per billion by volume
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RQD	rock quality designation
RSI	Radar Solutions International
SAP	Sampling and Analysis Plan
TAGM	Technical and Administrative Guidance Memorandums
TCE	trichloroethene, aka trichloroethylene
TCL	target compound list
TIC	tentatively identified compound
TOGS	Technical and Operational Guidance Series
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
$\mu g/m^3$	micrograms per cubic meter
UHP	ultra high purity
URS	URS Corporation
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WA	Work Assignment
Zebra	Zebra Environmental Corporation

1.0 INTRODUCTION

This Site Characterization Phase IV Data Summary Report has been prepared to summarize the field activities and analytical results for the Meeker Avenue Plume Trackdown Site in the Greenpoint/East Williamsburg Industrial Area section of Brooklyn, New York. The work for this site was issued to URS Corporation (URS) as Work Assignment (WA) No. D004433-22A. This report presents data and information gathered prior to and during the Phase IV field investigation, which was conducted from November 3 through December 8, 2008.

1.1 Site Background

The Meeker Avenue Plume Trackdown Site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, New York (Figure 1). Geographical, site use and background information is provided in the following sections.

1.1.1 Site Location and Description

The Meeker Avenue Plume Trackdown site investigation area (Figure 2) is located in a region of historic petroleum refining and storage operations that occupied a significant portion of the Greenpoint area. By 1870 over 50 refineries were located along the banks of Newtown Creek. Currently, bulk oil storage terminals exist north of the site, including the British Petroleum (BP) Terminal, and the ExxonMobil Brooklyn Terminal (ExxonMobil). The former Paragon Oil facility was located along the northeast portion of the site along Newtown Creek, north of Bridgewater Street, between Meeker Avenue and Apollo Street. Peerless Importers, Inc., is currently located on a portion of the former Paragon Oil facility along Newtown Creek.

In September 1978, the United States Coast Guard (USCG) noted the signs of an oil spill entering Newtown Creek from the northeastern end of Meeker Avenue. A subsequent investigation concluded that the area of the spill under the Greenpoint/East Williamsburg Industrial Area was in excess of 52 acres and the total spill volume, as estimated in 1979, was approximately 17 million gallons of

petroleum products (Roux, October 14, 2005). The current BP property was determined to be the source of the petroleum free product plume. Investigation and remediation activities were conducted by Roux Associates Inc. (Roux Associates) on behalf of ExxonMobil from 1990 to the present and have further defined the extent of the Off-Site Plume. The Off-Site Plume area consists of the area underlain by the petroleum-free product plume that is not on the BP Terminal or the Peerless Importers, Inc., properties. Currently, the extent of the Off-Site Plume area is less than what it was in 1990 due to the operation of the Off-Site Free Product Recovery System (Off-Site System). The Off-Site System has recovered approximately 4,220,967 gallons since it became operational in 1995 (Roux, October 31, 2008). The current Off-Site Plume area boundary measured by Roux Associates on August 21, 2008 (Roux, October 31, 2008) is shown on Figure 2.

The original Meeker Avenue Plume Trackdown site investigation area was bounded by the former ExxonMobil Brooklyn Refinery/current BP Terminal to the north (Norman Avenue/Bridgewater Street), Newtown Creek to the east, Lombardy Street to the south, and Kingsland Avenue to the west (Figure 2). During the first phase of fieldwork (May 7 through July 10, 2007), the southern boundary of the site investigation area along Lombardy Street between Porter and Morgan Avenues was extended three blocks south to Richardson Street. During the second phase of fieldwork (November 5 through December 27, 2007), the southern boundary of the site investigation area along Richardson Street between Vandervoort and Morgan Avenues was extended one block south to Frost Street. During the third phase of fieldwork (May 5 through July 24, 2008), the southern boundary was additionally extended one block south to Withers Street between Vandervoort and Morgan Avenues. In addition, the boundary in the northwest corner of the site investigation area was extended west from Kingsland Avenue between Norman and Nassau Avenues to Monitor Street. A review of historical data during the fourth phase of fieldwork (November 3 through December 8, 2008) indicated that several additional potential sources of contamination may exist north of Norman Avenue, between Kingsland Avenue and Monitor Street. Therefore, the boundary in the northwest corner of the site investigation area was extended north for approximately 1 block from Norman Avenue, between Kingsland Avenue and Monitor Street.

The areas located north of Nassau Avenue, east of Van Dam Street, and south of Meeker Avenue are primarily used for commercial/industrial purposes. Residential areas are located in both the northwestern portion of the site (extending from Van Dam Street between Nassau and Meeker Avenues, to the western site boundary) and within the southern portion of the site (along Beadel Street from Morgan to Porter Avenues, and along Vandervoort Avenue from Lombardy Street to Division Place).

Based on the results of several investigations conducted in the area (see Section 1.1.2 for more details), chlorinated solvents such as tetrachloroethene (PCE) and trichloroethene (TCE) were found in soil vapor, soil, and groundwater in areas outside the historic petroleum spill. As these chemicals are not related to petroleum, the NYSDEC initiated this investigation in order to determine the source(s) of this contamination.

1.1.2 Previous Investigations

Impact Environmental Consulting, Inc. - March 1998

In March 1998, Impact Environmental Consulting, Inc. (Impact Environmental), conducted a Phase I Environmental Site Assessment (ESA) at 46-60 Anthony Street/ 95 Lombardy Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, March 30, 1998a). A copy of the Phase I ESA may be found in PDF format on a compact disc which is included in Appendix A. The property historically had been utilized for iron working, metal shearing and finishing operations. At the time of the ESA, operations at the property included office space and operational space. The operational space was utilized for the machining, finishing, and storage of materials and products used in the manufacture of doors and knock down frames. The ESA identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were unknown. It was suspected that some drains may have discharged directly to on-site soils. Several underground storage tanks (USTs) and aboveground storage tanks (ASTs) were identified and had been used for fuel oil storage or storage of degreasing products. It was noted that

at the time of the ESA the facility was using a phosphate wash and rinse as a degreaser. During a personal interview, it was revealed that any regulated waste (i.e., waste paint, waste oil, waste degreaser and waster water precipitate) generated at the property was stored in the yard at 72 Anthony Street prior to disposal.

Impact Environmental Consulting, Inc. - March 1998

In March 1998, Impact Environmental conducted a Phase I ESA at 72 Anthony Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, March 30, 1998b). A copy of the Phase I ESA may be found in PDF format on a compact disc which is included in Appendix A. The property historically had been utilized as a brass foundry and civilian observation patrol. Operations on the property at the time of the ESA included office space and operational space. The operational space was utilized for the grinding, sanding and finishing of steel doors. The investigation identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were unknown. It is suspected that some drains may have discharged directly to on-site soils. One UST and one AST dip tank exist and have been used for fuel oil storage or storage of degreasing products, respectively. It was noted that at the time of the ESA, the facility was using a phosphate wash and rinse as a degreaser. It was also noted that the floor of the room containing the AST dip tank was impacted by the release of degreasers from the dip tank. In addition, significant storage of portable chemical containers was observed in the building. A paint room was identified in the center of the building, as was an associated paint storage room. The floor of the paint room was significantly stained by painting operations. Floor drains were observed in the paint storage room. Outside the building, a chemical storage area existed to the east of the building and a bermed, concrete storage pad was also observed. Numerous chemical containers were noted outside the building and consisted of 55-gallon drums and smaller containers of primers, cutting oils, hydraulic oils, waste water, xylene, waste paints, adhesives, waste degreasers, steam cleaners and waste oil contaminated absorbents. However, most of the drums were located outside the bermed, concrete storage pad and were uncovered or missing screw caps. Two dry wells were identified along the south side of the building. In addition, during a personal interview it was revealed that the

property previously maintained two dip tanks for degreasing. A Phase I ESA was previously performed on the property in June 1995 by Conestoga-Rovers & Associates which revealed that 1,1,1-trichloroethane (1,1,1-TCA) was formerly utilized in the dip tanks and that a floor drain was observed under one of the dip tanks.

Impact Environmental Consulting, Inc. - June 1998

In June 1998 Impact Environmental conducted a Phase II ESA at 46-60 Anthony Street/ 95 Lombardy Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, July 8, 1998). A copy of the Phase II ESA may be found in PDF format on a compact disc which is included in Appendix A. The scope of the Phase II ESA was based on the recommendations of the Phase I ESA (Impact Environmental, March 30, 1998a) and included a remote survey [ground penetrating radar (GRP)]of a floor drain located in the northeast portion of the building and the collection of a sample from 0-2 feet below ground surface (bgs) below the floor drain. The remote survey conducted confirmed that the floor drain directly discharged to the subsurface soils. A soil sample collected from the 0-2 foot interval below the floor drain contained the VOCs, PCE and TCE, at 1,190 and 99.2 µg/kg respectively. In addition, the semi-volatile organic compounds (SVOCs) di-n-butylphthalate, pyrene and bis(2-Ethylhexyl) phthalate were detected at 4,460, 539 and 1,690 µg/kg respectively. The metals arsenic (4.93 µg/kg), barium (114 µg/kg), cadmium (6.53 µg/kg), chromium (123 µg/kg), lead (906 µg/kg) and mercury (0.045 µg/kg) were detected. Cadmium, chromium and lead exceeded their respective criteria found in the Technical and Administrative Guidance Memorandum (TAGM) #4046, *Determination of Soil Cleanup Objectives and Cleanup Levels* (NYSDEC, January 24, 1994). The Phase II ESA concluded that on-site operations had impacted the environmental quality beneath the property and recommended that corrective actions were required to mitigate the contaminated soil associated with the floor drain.

Environmental Planning and Management, Inc. – September 2005

In September 2005, Environmental Planning and Management, Inc., (EPM) completed an investigation for the New York State (NYS) Department of Transportation (DOT) in connection with the Kosciuszko Bridge Project (EPM, January 2006). The investigation included the collection and analysis of soil and groundwater samples. PCE was detected at 7,760 µg/kg in the 0-4 foot sample from boring SB-29 (southeastern corner at the intersection of Gardner Avenue and Thomas Street). PCE was also detected at 89.9, 569, and 1, 060 micrograms per liter (µg/L) in ExxonMobil wells MW-018 (eastern side of Vandervoort Avenue between Anthony and Cherry Streets), MW-023 (southwestern corner at the intersection of Gardner Avenue and Thomas Street), and MW-030 (eastern side of Varick Avenue between Anthony and Cherry Streets), respectively.

Roux Associates – September 2005

In September 2005, Roux Associates ,on behalf of ExxonMobil, sampled soil vapor at 23 temporary locations in and around the perimeter of the Off-Site Plume area (Roux, October 14, 2005). The soil vapor samples collected in September 2005 indicated the presence of PCE at 10,200 micrograms per cubic meter (µg/m^3) at the monitoring point located on the southwestern corner of the Vandervoort Avenue and Anthony Street intersection, and 7,050 µg/m^3 at the monitoring point on the western side of Morgan Avenue between Nassau and Norman Avenues. Much lower concentrations of PCE were detected throughout the remainder of and around the perimeter of the Off-Site Plume area. In addition, TCE was detected at 4,500 µg/m^3 at the monitoring point located on the western side of Apollo Street between Nassau Avenue and Meeker Avenue, and 151,000 µg/m^3 at the monitoring point on the western side of Morgan Avenue between Nassau Avenue and Norman Avenue. Much lower concentrations of TCE were detected throughout the remainder of and around the perimeter of the Off-Site Plume area. It was determined that the chlorinated solvents detected (i.e., PCE and TCE) were from a different source than the petroleum-free product plume.

Roux Associates – September 2006

Between June and September 2006, Roux Associates performed an additional soil vapor investigation in and around the perimeter of the Off-Site Plume area (Roux, November 10, 2006). A total of 50 permanent soil vapor monitoring points were installed. This included 20 nested monitoring points (one shallow and one deep) in the commercial/industrial area and 10 deep monitoring points in the residential area. Elevated concentrations of PCE were detected at 1,300 $\mu g/m^3$ at the monitoring point located at the northwestern corner of the intersection of Morgan and Nassau Avenues, and 930 $\mu g/m^3$ at the monitoring point on the western side of Van Dam Street between Nassau and Meeker Avenues. Elevated concentrations of TCE were detected at 8,200 $\mu g/m^3$ at the monitoring point on the eastern side of Apollo Street between Bridgewater Street and Nassau Avenue and 700 $\mu g/m^3$ at the monitoring point on the northwestern corner of the intersection of Morgan and Nassau Avenues.

1.2 Findings of Previous Phases of Site Investigation Fieldwork

To date, URS has conducted four phases of site investigation fieldwork at the Meeker Avenue Plume Trackdown site. The following sections discuss the findings from the Phase I, Phase II, and Phase III site investigations.

1.2.1 Summary of Phase I Findings

The Phase I field investigation was conducted from May 7 through July 10, 2007. The field activities of Phase I were primarily focused on locations that were identified as potential historic users of PCE and/or TCE during the historical information review. Field activities associated with the Phase I field investigation included: obtaining historical information reports (e.g., Sanborn maps) from Environmental Data Resources, Inc.; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 23 permanent soil-gas conduits; installation of 20 groundwater monitoring wells; collection of 27 soil-gas samples from 21 newly installed and 6 existing soil-gas conduits; collection of 26 soil samples from 20 monitoring

well borings; collection of 28 groundwater samples from 20 newly installed and 8 existing monitoring wells; daily pick-up of investigation-derived waste for disposal and a site survey. A complete description of the field investigation and results may be found in the Phase I Data Summary Report (URS, October 2007).

Based upon the results of the Phase I field investigation, the following conclusions were made:

- Soil-gas samples from both north and south of Meeker Avenue indicated that PCE and TCE have impacted soil-gas quality, as shown on Figures 3 and 4. Elevated soil-gas concentrations appear to be associated near locations that potentially have used PCE and TCE (i.e., a former metal working facility, a research lab, two former dry cleaners, and a dye works).
- A soil sample from the 5-6 feet bgs interval from monitoring well location DEC-016 that is located adjacent to a former brass foundry was the only sample that exceeded TAGM 4046 criteria, with 220 milligrams per kilogram (mg/kg) of PCE.
- Groundwater samples from both north and south of Meeker Avenue indicated that groundwater has been impacted above Class GA groundwater standards for both PCE and TCE, as shown on Figures 5 and 6. Elevated groundwater concentrations appear to be associated near locations that potentially have used PCE and TCE (i.e., two former dry cleaners, a former dry cleaners/dye works, a drum recycling facility, a research lab, a former brass foundry, two metal working facilities, and a former soap manufacturer).
- Phase I recommendations for Phase II fieldwork included the installation of additional soil-gas conduits to further delineate impacted soil-gas both north and south of Meeker Avenue. Direct-push soil borings were recommended in the vicinity of DEC-16 to delineate the horizontal and vertical extent of PCE impacted subsurface soil. Direct-push groundwater sampling was recommended south of Meeker Avenue and east of Porter Avenue to aid in the delineation of PCE and TCE impacted groundwater in this area. Based on the impacts to groundwater quality by PCE and TCE, additional monitoring wells were recommended to delineate the horizontal extent of the PCE and TCE impacts and to help distinguish potential point sources.

1.2.2 Summary of Phase II Findings

The Phase II field investigation was conducted from November 5 through December 27, 2007. The field activities of Phase II were primarily focused on investigating and delineating the extent of impacted soil-gas, soils and/or groundwater at locations where elevated concentrations of PCE and/or TCE were encountered during the Phase I field investigation. Field activities associated with the Phase II field investigation included: a review of historical information reports (e.g., Sanborn maps) from Environmental Data Resources, Inc.; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 28 permanent soil-gas conduits; advanced 11 direct-push borings; advanced 15 direct-push groundwater sample locations; installation of 14 groundwater monitoring wells; collection of 55 soil-gas samples from 28 newly installed and 27 existing soil-gas conduits; collection of 30 soil samples from 11 direct-push borings and 14 monitoring well borings; collection of 14 groundwater samples from 15 direct-push groundwater sample locations; collection of 44 groundwater samples from 14 newly installed and 30 existing monitoring wells; daily pick-up of investigation derived waste for disposal and a site survey. A complete description of the field investigation and results may be found in the Phase II Data Summary Report (URS, April 2008).

Based upon the results of the Phase II field investigation, the following conclusions were made:

- There appears to be five areas of elevated soil-gas concentrations within the site boundary, as shown on Figures 7 and 8. The horizontal extent of impacted soil-gas was not fully determined at three of the five areas. The impacted soil-gas plumes in the area south of Meeker Avenue appear to have coalesced. However, the individual areas are apparent.

- Analytical results from soil samples indicated that a shallow source of impacted soil exists in the vicinity of the northeastern corner of the building located at 72 Anthony Street. Soil samples from boring SB-08 confirmed the presence of PCE in shallow soils at a concentration that exceeded TAGM 4046 criteria. Soil boring SB-08 is located within 20

feet of monitoring well DEC-016. The results of the sample form SB-08 confirm the results of soil samples taken from DEC-016 during the Phase I field investigation.

- There appears to be five potential source areas within the site boundary where dissolved phase chlorinated solvents have adversely impacted the shallow groundwater, as shown on Figures 9 and 10. The horizontal extent of impacted shallow groundwater was not fully determined at four of the five potential source areas. The potential impact of dissolved phase chlorinated solvents to deeper groundwater was not investigated at the five potential sources during Phase II fieldwork.

- Phase II recommendations for Phase III fieldwork included the installation of additional soil-gas conduits to fill existing data gaps and further delineate the horizontal extent of impacted soil-gas that has not been determined at three of the five potential sources. Direct-push soil borings were recommended in the vicinity of DEC-031 to locate and delineate the horizontal and vertical extent of PCE impacted subsurface soils near the former dry cleaner. Direct-push groundwater sampling was recommended to the north and east of DEC-018 to aid in the delineation of PCE and TCE impacted shallow groundwater. Additional water table (shallow) monitoring wells were recommended to fill existing data gaps and further delineate the horizontal extent of impacted groundwater that has not been determined at four of the five potential sources. In addition, deep monitoring wells were recommended at each of the five potential source areas to assess the impact of dissolved phase chlorinated solvents to deeper groundwater.

1.2.3 Summary of Phase III Findings

The Phase III field investigation was conducted from May 5 through July 24, 2008. The purpose of the Phase III fieldwork was to fill any data gaps identified in the Phase II Final Data Summary Report (URS, April 2008) concerning the horizontal extent of impacted soil-gas at three of the five areas identified; determine if impacted soils existed at one potential source area; the horizontal extent of impacted shallow groundwater at four of the five potential sources; and to assess the vertical extent of impacted groundwater at each of the five potential sources. In addition, the NYSDEC directed URS

to assess and delineate any chlorinated solvent impacts to soil and groundwater in the vicinity of the EPM soil boring located at the southeastern intersection of Gardner Avenue and Thomas Street (see Section 1.1.2). Field activities associated with the Phase III field investigation included: submitted Freedom of Information Law (FOIL) requests to the New York City (NYC) Fire Department (FDNY), NYC Department of Buildings (DOB) and, NYC Department of Environmental Protection (DEP) for records on potential sources; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 14 permanent soil-gas conduits; advanced 24 direct-push borings; advanced 20 direct-push groundwater sample locations; installation of 16 shallow and 8 deep groundwater monitoring wells; collection of soil-gas samples from 14 newly installed soil-gas conduits; collection of 38 soil samples from 24 direct-push borings and 24 monitoring well borings; collection of 20 ground water samples from 20 direct-push groundwater sample locations; collection of 59 groundwater samples from 24 newly installed and 35 existing monitoring wells; collection of one dense non-aqueous phase liquid (DNAPL) sample for analysis; daily pick-up of investigation derived waste for disposal; and a site survey. A complete description of the field investigation and results may be found in the Phase III Data Summary Report (URS, October 2008).

Based upon the results of the three phases of the field investigation, the following conclusions were made:

- The five areas of elevated soil-gas concentrations identified within the site boundary during Phase II field investigation were further delineated during Phase III, as shown on Figures 11 and 12. The horizontal extent of impacted soil-gas was not fully delineated at two of the five areas.

- Soil borings performed in the vicinity of the EPM soil boring located at the southeastern intersection of Gardner Avenue and Thomas Street did not indicate the presence of chlorinated solvent impacted soils in this area.

- A Dense Non-Aqueous Phase Liquid (DNAPL) containing 700,000 mg/kg (i.e., 70%) PCE was identified in monitoring well DEC-024D.

- The results of groundwater samples collected during Phase III has allowed URS and the NYSDEC to identify four sources of dissolved phase chlorinated solvents in the shallow groundwater, as shown on Figures 13 and 14. In addition, there are potentially two other sources, but insufficient information was gathered to positively identify these locations as sources without additional investigation. The horizontal extent of impacted shallow groundwater was not fully determined at the two potential source areas. The potential impact of dissolved phase chlorinated solvents to deeper groundwater was investigated at all four source areas and two potential source areas. Data indicates that deeper groundwater was impacted at all four source areas and both potential source areas. The vertical extent of impacted groundwater was not fully determined at the four source areas and the two potential source areas.

Phase III Source Characterization

Using data obtained during the three Phases of the investigation [i.e., historical information (e.g., Sanborn maps, EDR reports, and business directories) soil-gas data, soil data, and groundwater data], four sources and two potential sources of PCE and/or TCE contamination were identified within the study area. The description and location of the four sources and two potential sources are discussed below.

Sources

- The former Spic and Span Cleaners and Dyers, Inc. [aka Eastern District Dye Works (1916 Sanborn) and Norman Cleaners and Dyers Inc. (1942 Sanborn)], located at 315 Kingsland Avenue (Brooklyn Tax District, Block 02657, Lot 0009) was identified as a source of groundwater contamination. Based on Sanborn map data, this facility was located at the above address from the early 1900s until the mid 1960s. DNAPL containing 70% PCE was identified in monitoring well DEC-024D. DEC-024D is located on Kingsland Avenue adjacent to the southeastern corner of the former facility.

- The former and current metal works located at 95 Lombardy (Brooklyn Tax District, Block 02819, Lot 0008) was identified as a source of groundwater contamination. Based on Sanborn map data, the facility has been utilized from the 1930s to the present as a metal fabricator and painting facility. ACME Steel is listed in the EDR report as a generator of F001 waste (spent halogenated solvents used in degreasing) for this facility. Monitoring wells DEC-005 and DEC-005D are located on the western side of the building on Vandervoort Avenue. Groundwater samples from these wells indicate significant TCE contamination and the potential presence of DNAPL given the increasing TCE concentrations with depth.

- A former brass foundry located at 72 Anthony Street (Brooklyn Tax District, Block 02820, Lot 0005) was identified as a source of soil and groundwater contamination. Based on Sanborn map data, the facility was utilized as a brass foundry from the mid 1960s to approximately 1993. ACME Steel is listed in the EDR report as a generator of F001 waste (spent halogenated solvents used in degreasing) for this facility. Soil samples from DEC-016 and SB-08, located at the northeastern corner of the facility along Anthony Street, indicate shallow PCE contaminated soils are located adjacent to this facility. Monitoring wells DEC-016 and DEC-016D are located on the Anthony Street (north) side of the facility. Groundwater samples from these wells indicate significant PCE and TCE contamination.

- The former Klink Cosmo Cleaners, located at 364 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001) was identified as a source of groundwater contamination. The facility is shown on Sanborn Maps to be a clothing warehouse from the mid 1950s until some time after 1995. Klink Cosmo Cleaners is listed in the EDR report as a generator of F002 waste (spent halogenated solvents) for this facility. Monitoring wells DEC-031 and DEC-031D are located on the southwestern corner of Vandervoort Avenue and Richardson Street (northeast building corner). Soil-gas and groundwater samples indicate significant PCE and TCE contamination at the northeast corner of the building.

Potential Sources

- The facility that contained a former soap manufacturer and lacquer storage, located at 171 Lombardy Street (Brooklyn Tax District, Block 02821, Lot 0001), is a potential source of groundwater contamination. Based on Sanborn map data, the facility was utilized during the 1930s for lacquer storage and as a manufacturer of powdered soap from the early 1950s to 1989. Monitoring wells DEC-018 and DEC-018D are located on the Varick Avenue or western side of the building, near Lombardy Street. Groundwater samples from these wells indicate significant PCE and TCE contamination. The PCE and TCE contamination in the shallow groundwater zone is centered on DEC-018, suggesting the contamination is near its source.
- The former Curtis Electro N.Y. Inc. facility located at 126 Cherry Street (Brooklyn Tax District, Block 02814, Lot 0010) is a potential source of groundwater contamination. Based on Sanborn map data, the facility was utilized as a light fixture manufacturer from the mid 1960s until some time after 1995. Monitoring wells DEC-049 and DEC-049D are located adjacent to the facility on the corner of Stewart Avenue and Cherry Street. Groundwater samples these wells indicate significant PCE and TCE contamination that increase with depth.

Phase III recommendations included the installation of shallow groundwater wells to assist in determining the horizontal extent of the dissolved phase plume originating from near DEC-018/018D and if the impacted groundwater found at well pair DEC-049/049D is associated with the dissolved phase plume originating from near DEC-018/018D. In addition, deep monitoring wells were recommended in areas to assess the impact of dissolved phase chlorinated solvents to deeper groundwater and to determine the horizontal extent of impacted deep groundwater. Four Membrane Interface Probe (MIP) borings were recommended on private property to assist in determining both the horizontal and vertical extent of impacted groundwater. The MIP borings were recommended because it was likely that the property owners would be more inclined to allow temporary operations on their property that would be performed relatively quickly (i.e., one to two days) instead of permanent monitoring points (i.e., monitoring wells).

1.3 Phase IV Investigation Project Objectives and Scope

The purpose of the Phase IV fieldwork was to assist in determining: the horizontal extent of the dissolved phase plume originating from near DEC-018/018D; if the impacted groundwater found at well pair DEC-049/049D is associated with the dissolved phase plume originating from near DEC-018/018D; the impact of dissolved phase chlorinated solvents to deeper groundwater; and the horizontal extent of impacted deep groundwater. The investigation area for Phase IV (Figure 15) was limited to the area located east of, but not including DEC-016/016D and DEC-040 (between Porter and Varick Avenues) to the eastern boundary of the site investigation area (i.e., Newtown Creek). In addition, the NYSDEC directed URS to obtain and review additional Sanborn maps for the area bound by Meserole Avenue to the north, Sutton Avenue to the east, Nassau Avenue to the south and Humboldt Street to the west (Figure 16). The purpose of the review of the additional Sanborn maps was to confirm the report of a dry cleaner north of Norman Avenue and west of Kingsland Avenue.

In accordance with the NYSDEC Scope of Work (NYSDEC, February 1, 2007) URS prepared a Project Management Work Plan (PMWP) and budget estimate (Final, April 2007), a Field Activities Plan (URS, April 2007) which includes the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), and a Health and Safety Plan (HASP, April 2007).

The work assignment provided by the NYSDEC indicates that the fieldwork associated with the Meeker Avenue Site Characterization will proceed in four phases (or time periods) in order to help identify the PCE and TCE source areas.

Tasks performed during the Phase IV field investigation included:

- Reviewed additional Sanborn maps to confirm the report of a dry cleaner located north of Norman Avenue and west of Kingsland Avenue;
- Reviewed additional responses to FOIL requests by the FDNY, NYC DOB and NYC DEP on suspected sources;

- Utility locating was conducted by Radar Solutions International of Waltham, MA;
- 4 membrane interface probe (MIP) borings were advanced by Zebra Environmental Corporation of Lynbrook, NY (Zebra Environmental);
- Manual and/or Vac-Tron® utility clearance for monitoring well installation was performed by Aquifer Drilling and Testing, Inc., of New Hyde Park, NY (ADT);
- Installation of 3 shallow and 5 deep groundwater monitoring wells was performed by ADT;
- Collection of 5 soil samples from 8 monitoring well borings for analysis by Hampton-Clarke, Inc – Veritech Laboratory, of Fairfield, NJ (HC-V);
- Collection of 21 groundwater samples from 8 newly installed and 13 existing monitoring wells for analysis by HC-V;
- Daily pick-up of investigation derived waste for disposal was performed through Frank's Vacuum Truck Service of Niagara Falls, NY (Frank's); and
- Site survey was conducted by NAIK Consulting Group, P.C., of Edison, NJ.

1.4 Data Presentation

This Data Summary Report has six sections. Section 2.0 includes a description of field activities that occurred during the Phase IV fieldwork. Section 3.0 includes a description of the subsurface conditions that have been found at the site. Section 4.0 includes a description and summary of the analytical results for the groundwater samples from monitoring wells collected during the Phase IV fieldwork. Section 5.0 consists of the conclusions and recommendations derived from the Phase IV field effort. Section 6.0 contains a list of references cited. Tables, Figures, and Appendices immediately follow the text.

2.0 FIELD ACTIVITIES

Field activities performed during Phase IV of the site characterization from November 3 through December 8, 2008 are discussed below.

2.1 Historical Record Review Results

Additional Sanborn map coverage was purchased from Environmental Data Resources, Inc. (EDR) for the area shown on Figure 16. The Sanborn maps submitted by EDR are provided on a compact disc in Appendix B. The Sanborn maps were reviewed for the presence of dry cleaners and other businesses that may have used dry cleaner-related fluids (i.e., PCE and/or TCE) such as metal working facilities, laboratories and painting operations. The following facilities were identified:

- From 1942 to present, laundry facilities, dry cleaners and foundries have been identified to exist in the building complex on the northern side of Norman Avenue between Monitor Street and Kingsland Avenue (Figure 3). The addresses include 253 through 269 Norman Avenue, 242 through 260 Monitor Street and 327 through 353 Kingsland Avenue. In the northeastern part of the complex between 347 and 353 Kingsland Avenue, 6 underground storage tanks (USTs) are identified as containing benzene on the 1942 and 1951 maps and solvent on all subsequent years to the present.

- The Rose & Company Dye Works occupied 337-353 Kingsland Avenue from 1942 through 1986. The above mentioned solvent USTs were part of this facility. Foundries were located at 343-345 Kingsland Avenue and 252 to 268 Monitor Street from 1916-1951.

- A laundry was located at 253-257 Norman Avenue/242-250 Monitor Street (building on the northeastern corner of the intersection of Norman Avenue and Monitor Street) until 1951. A laundry is also located on 252-258 Monitor Street into the center of the building complex

from 1951 to the present. Other notable uses include an experimental chemical laboratory at 263 Norman Avenue on the 1942 and 1951 maps.

- Colonial Paint Works was located at 223-227 Norman Avenue and 200-210 Russell Street (building on the northeastern corner at the intersection of Norman Avenue and Russell Street) from 1942-1951. A shellac manufacturer replaced the Colonial Paint Works at this location on the 1965-1991 maps.

2.2 Freedom of Information Law Request

In July 2008, URS submitted FOIL requests to the FDNY, NYC DOB and, NYC DEP for records on suspected sources. A separate FOIL request was submitted for each suspected source address to each of these agencies. The following addresses were subject to FOIL requests:

- 72 Anthony Street
- 315 Kingsland Avenue
- 95 Lombardy Street
- 171 Lombardy Street
- 420 Morgan Avenue
- 364 Richardson Street
- 478 Vandervoort Avenue

The following information was requested from each of the agencies:

FDNY

- Violations

NYC DOB

- Certificates of Occupancy; and

- Environmental Control Board Violations, Complaints and Actions.

NYC DEP

- Hazardous materials emergency response (BEC);
- Right to Know (BEC);
- Environmental Review/SEQRA (BEPA);
- Industrial Pretreatment/Sewer Discharge Violations (BTW); and
- Watershed Area Incident Reports (DEP PD).

URS has reviewed the responses to the information requests from all of the agencies listed above. All FOIL request submittals and responses received to date by URS are provided in Appendix C. Additionally, the Certificates of Occupancy available for each lot associated with the above addresses were obtained from the NYC DOB web site and included in Appendix C.

Additional FOIL request were made to NYC DEP for the following properties that were identified in Section 2.1:

- 327-353 Kingsland Avenue
- 242-260 Monitor Street
- 223-227 Norman Avenue
- 253-269 Norman Avenue
- 200-210 Russell Street

At the time of this Final report preparation, URS has not received responses from the NYC DEP for this recent FOIL request. Any information that is received will be submitted to the NYSDEC as a separate report addendum. Additionally, the NYC DOB web site was searched for each property of interest. Certificates of Occupancy available for each lot associated with the above addresses are

included in Appendix C. No incidents of fire were identified in the DOB on-line records, therefore FOIL requests were not submitted to the FDNY.

2.3 Utility Clearance

Prior to site work, each subcontractor arranged for all appropriate utility clearances. This included (but was not limited to) contacting the NYC Departments of Environmental Protection and Transportation, the Transit Authority, Consolidated Edison, Keyspan, and Verizon, in addition to using the Dig-Safely number for New York City – 811 or (800) 272-4480.

2.4 Geophysical Survey for Utility Markouts

On November 5, 2008, Radar Solutions International (RSI) mobilized a crew with ground penetrating radar (GPR) and electromagnetic (EM) induction equipment to the site. The purpose of the geophysical survey was to screening for and identifying the presence/location of underground utilities in areas where MIP borings were to be advanced and where drilling for monitoring well installations were proposed.

A 10-foot square reference grid was established around each monitoring well and direct-push boring location prior to collecting the geophysical data. A GSSI SIR-2000 digital radar system was used to perform the GPR survey. GPR data were acquired along lines spaced 1.0 to 2.5 feet apart. The EM induction equipment used to determine the location of buried utilities was a Ditch Witch 950 RT locating system, which consists of a locator and a transmitter.

RSI marked utilities and anomalies by spray-painting the outline on the pavement as soon as they were located. A URS geologist supervised and assisted RSI. RSI's report is provided in Appendix D. A photograph of a completed RSI utility mark out can be found in Appendix E.

2.5 Membrane Interface Probe Borings

On November 13-14, 2008, Zebra Environmental mobilized a 6620 DT direct push track unit and an Electrical Conductivity (EC)/Membrane Interface Probe (MIP) system mounted on a 4X4 John Deere Gator (data acquisition vehicle) to the site to advance four MIP borings at the locations shown on Figure 17. The purpose of the four MIP borings was to assess if there was: 1: VOC impacted shallow groundwater under the subject property; 2: VOC impacted deep groundwater beneath the subject property; and 3: the vertical extent of any VOC impacted groundwater up to a depth of 100 feet bgs, a confining layer, or refusal. The property upon which the MIP borings were advanced is owned by the City of New York Department of Sanitation (DSNY) and is used as a staging area for road salt used for de-icing operations.

The electrical conductivity (EC) probe measures the relative electrical conductivity of soil and groundwater that comes in contact with the probe. The EC probe provides a means to estimate the grain size distribution of soil particles. Intervals with higher electrical conductivity may be interpreted as indicative of the presence of more colloidal sized particles compared to soils exhibiting lower conductivities. Soils with lower electrical conductivity may be interpreted as indicative of the presence of less colloidal sized particles and the presence of more silt and sand sized particles.

The MIP, developed by Geoprobe Systems, Inc., provides real-time detection of volatile organic chemicals (VOCs) or NAPLs in the vadose and saturated zones. The MIP fits onto conventional direct push technology (DPT) equipment and is inserted into the target investigation zone in a manner similar to a standard DPT sampling device. The MIP tool contains a membrane in the tip that is permeable to VOCs and a built-in heating element that heats the soils and groundwater adjacent to the probe to 120 degrees Celsius. The heating element causes VOCs near the MIP to volatilize and the vapors diffuse across the membrane, where an inert carrier gas transports the VOCs through sealed tubing to the data acquisition vehicle containing a Photoionization Detector (PID), a Flame Ionization Detector (FID), and an Electron Capture Detector (ECD). The detectors do not provide a quantitative concentration of VOCs in the groundwater or soil, nor do they differentiate between compounds (e.g., identify PCE or TCE). However, the response level from the detector corresponds to the amount of VOCs present in the carrier gas, which is proportional to the amount of VOCs in the

soil or groundwater at the MIP location. A greater response from the detector indicates greater VOC concentrations in the subsurface. Because MIP analytical detection systems do not provide fully quantitative results, accuracy is assessed qualitatively by measuring the agreement between detect and non-detect determinations made by the MIP and by corresponding confirmatory laboratory samples.

The MIP was advanced at 4 locations (MIP-01, MIP-02, MIP-03 and MIP-04), with final depths ranging from 48 feet bgs to 82 feet bgs. Prior to advancing the borings, the locations were also cleared for underground utilities by ADT as described in Section 2.6.1. Each boring was advanced in 1 foot intervals from approximately 5 feet bgs to the bottom of the boring. For each 1-foot interval the probe was advanced, the probe was held stationary for 1.5 minutes to allow for the carrier gas to return the volatilized VOCs to the PID, FID, and ECD detectors. The final depth of the borings was variable and was based upon refusal encountered by the MIP probe. At location MIP-02, five attempts were made to advance the boring, with 4 shallow refusals ranging from 5.0 to 19.0 feet bgs. The fifth attempt at location MIP-02 was successful to 60.3 feet bgs.

After the completion of each boring, the borehole was backfilled with bentonite chips and the surface was repaired with asphalt. A URS geologist supervised and assisted Zebra. Site photographs are provided in Appendix E. Zebra Environmental's summary report is provided in Appendix F.

2.6 Groundwater Monitoring Well Installation

The following sections describe the monitoring well installation program for the Phase IV fieldwork.

2.6.1 Pre-Boring Clearing

Prior to any intrusive activities, the subcontractor obtained all necessary permits (i.e., NYC DOT street opening permits) for conducting intrusive activities. On November 3, 2008, ADT mobilized a Vac-Tron® unit to perform location specific utility clearance at each of the proposed monitoring well locations. A total of 8 monitoring well locations and 4 MIP boring locations were cleared between

November 3 and 5, 2008. At each location, a two-foot by two-foot square area of the sidewalk was cut. An approximately one-foot diameter by five-foot deep hole was excavated using post-hole diggers, pry bars, and an air knife along with the Vac-Tron® unit. After the location was cleared for drilling, the hole was backfilled flush with the sidewalk using the excavated spoils (rocks and debris removed) and if necessary, temporarily patched with blacktop patch or concrete.

2.6.2 Soil Borings

During the period of November 5 through November 12, 2008, ADT utilized a Central Mine Equipment Company (CME) 55LC track-mounted drill rig for the installation of 4 monitoring wells (DEC-050, DEC-050D, DEC-052 and MW-097D) at the locations shown on Figure 18. This drill rig is a dual-purpose hollow-stem augers (HSA)/mud rotary rig designed to work in areas requiring low clearance. In addition, a CME-75 truck-mounted drill rig was mobilized to the site on November 12, 2008 and operated until November 25, 2008, for the installation of the remaining four monitoring wells (DEC-021D, DEC-051, DEC-051D and MW-023D) in areas where a low clearance rig was not required. The CME-75 was also a dual-purpose HSA/mud rotary rig.

Of the 8 monitoring wells installed during Phase IV, 3 were water table (shallow wells) and the remaining 5 were deep wells. The deep wells were installed to assess the potential impacts of the dissolved phase chlorinated solvents to deep groundwater near potential source areas (i.e., DEC-018/DEC-018D and DEC-049/DEC-049D).

The soil borings were advanced using 4-inch ID drive and wash with mud rotary drilling methods. Split spoon samples were collected continuously using standard penetration techniques (ASTM D1586-84) unless an obstruction was encountered that required the advancement of the augers to drill past the obstruction. The final boring depths ranged from 42 to 80 feet bgs. At deep well locations, the 4-inch spin casing used during drive and wash drilling were advanced past the bottom of the corresponding shallow well before split spoons were collected. During the advancement of the 4-inch spin casing, the casing was driven to refusal or the desired interval (during split spoon sampling) and then washed out to the bottom of the casing before continued driving of the casing. All IDW

generated from the monitoring well installation was containerized in DOT approved 55-gallon drums and picked up by Frank's Vacuum Truck Service on a daily basis for off-site disposal at a permitted facility.

Each split spoon sample was screened with a PID. Up to two soil samples were collected from each boring; one soil sample was collected from the interval just above water table, the second sample was collected from the interval exhibiting odors, staining, or the highest PID reading. If no odors, staining, or elevated PID reading were encountered, then only one sample from the interval just above water table was collected. Site photographs are provided in Appendix E, copies of the daily field notes are provided in Appendix G and soil boring logs are provided in Appendix H.

A chain-of custody (COC) form was maintained and accompanied the sample containers to HC-V. The samples were analyzed for TCL VOCs as listed in Table 1, plus TICs following USEPA SW846 Method 8260B.

2.6.3 Well Construction

The monitoring wells were constructed with 10 to 15 feet of 2-inch ID, Schedule 40 polyvinyl chloride (PVC) 0.010-inch slot screen and riser. In shallow wells, the screen was nominally set between 5 feet above and 10 feet below the water table at most locations. At deep well locations, a 10-foot screen was set approximately 25 to 35 feet below the adjacent shallow well screen. A 10 to 20 mesh size sand pack was installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry was then installed around the riser to an elevation of 1-foot below grade via tremie pipe. Each monitoring well was finished with a locking well cap, a 2-foot square concrete apron, and a flush-mounted curb box. Security bolts were installed in the well covers to minimize the potential for unauthorized well access. The concrete apron for each well pad was approximately 6 inches thick. Site photographs are provided in Appendix E, monitoring well construction logs are provided in Appendix I.

2.7 Monitoring Well Development

At least 24 hours after the monitoring wells were installed, the wells were developed by URS personnel with the pump and surge development method using a Wattera Inertial Hydrolift pump with dedicated/disposable HDPE tubing and dedicated/disposable HDPE check valves. Prior to well development, a 100-foot long Solinst oil/water interface probe was used to check for the presence/ thickness of any free product. During well development, water quality parameters (pH, specific conductivity, temperature and turbidity) were measured using a Hanna 991301 Multiparameter Meter and a Lamotte 2020 turbidimeter and recorded. A monitoring well was considered developed when a minimum of 5 well volumes was removed, and water quality parameters had stabilized. Well development logs may be found in Appendix J. Well development water was collected into DOT approved 55-gallon drums and picked up daily by Frank's Vacuum Truck Service for off-site disposal at a permitted facility.

2.8 Groundwater Sampling

From December 2 through December 8, 2008, URS collected groundwater samples from 21 monitoring wells (8 newly installed DEC wells, 9 existing DEC wells and 4 existing ExxonMobil) using low-flow sampling procedures plus QA/QC samples. Roux Associates acting on behalf of ExxonMobil, provided URS with split-samples from the four ExxonMobil locations (MW-004, MW-023, MW-030, and MW-097).

Prior to sample collection, standing water was purged from each well with a QED SamplePro Micropurge bladder pump using dedicated/disposable bladders and HDPE tubing. Wells were purged at a rate of 1-liter per minute or less and the purge rate was adjusted to minimize draw down. During the purging of the well, water quality parameters (pH, specific conductivity, temperature, dissolved oxygen, turbidity) were measured using a Horiba U-22 Multi-parameter Instrument with a flow-through cell and documented on a purge log. Samples were collected after the water quality parameters stabilized. Purge logs are provided in Appendix K. Purge water was collected into DOT

approved 55-gallon drums, and was picked up daily by Frank's Vacuum Truck Service for proper disposal.

All samples were transported under COC via laboratory courier to HC-V. The samples were analyzed for TCL VOCs as listed in Table 1, plus TICs following USEPA SW846 Method 8260B.

2.9 Monitoring Well Maintenance

During Phase IV fieldwork, well maintenance was performed on all DEC wells where groundwater samples were collected. Every well cover was removed and all the bolt holes were tapped out and lubricated with an anti-seize paste. All flush-mount protective casings on DEC wells were equipped with tamper proof bolts. At DEC wells with stick-up protective casings, the well locks were inspected and found to be in good shape and working order. During a site visit on March 17, 2009, URS personnel noticed that the well pad and protective cover at MW-023D had been damaged. On March 20, 2009 URS personnel removed and replaced the damaged well pad and protective casing.

2.10 Investigation Derived Waste Disposal

Frank's Vacuum Truck Service was contracted for the daily pick-up and disposal of all drummed IDW at a permitted disposal facility. Copies of the non-hazardous bills of lading and hazardous waste manifests are provided in Appendix L.

2.11 Site Survey

NAIK Consulting Group surveyed the area, including all new monitoring well and MIP boring locations for location and elevation. The survey provides 100-scale mapping and does not include elevated roadways and expressways (i.e., BQE). All surveying was performed under the supervision of a New York State licensed land surveyor. All vertical control points were referenced to the North American Vertical Datum 1988 (NAVD 1988). Horizontal datum was referenced to the North

American Datum of 1983 (NAD83), New York State Plane Coordinate System, Long Island Zone. Copies of survey field notes and site sketches are provided in Appendix M. A site survey drawing is provided in Appendix N.

3.0 SUBSURFACE CONDITIONS

3.1 Regional Geology

The site investigation area is located within the Atlantic Coastal Plain physiographic province of New York State (Broughton, et al. 1966). The Atlantic Coastal Plain is characterized by low relief with elevations ranging from sea level to almost 400 feet above mean sea level (amsl). The lithology of Brooklyn and Queens consists of Cretaceous and Pliestocene age unconsolidated deposits underlain by Precambrian crystalline bedrock. The unconsolidated deposits pinch out in northwestern Queens where bedrock outcrops, but reach a thickness of more than 1,000 feet in southeastern Queens. The unconsolidated deposits form six distinct hydrogeologic units consisting of four aquifers and two confining layers that generally dip to the south-southeast (Figure 19). The units in ascending order are the Lloyd aquifer (0-300 feet thick), the Raritan confining unit (0-200 feet thick), the Magothy aquifer (0-500 feet thick), the Jameco aquifer (0-200 feet thick), the Gardiners clay (0-150 feet thick), and the upper glacial aquifer (0-300 feet thick)(USGS. 1999a). The units pinch out to the north-northeast and may not all be found at any one location.

Based on borings performed near the site for unrelated work, the site is underlain from the surface down by upper glacial aquifer, the Raritan confining unit, and crystalline bedrock (Figure 20). The upper glacial aquifer is of Wisconsin age and consists of a terminal moraine, a ground moraine, and glacial outwash deposits whose area is characterized as an unsorted and unstratified mixture of clay, sand, gravel and boulders. The Raritan confining unit consists of deltaic clay and silty clay beds and some interbedded sands. The Raritan confining unit has been encountered in three borings performed near the site: one boring near Morgan Avenue and Meeker Avenue (-47 feet amsl); one boring under the BQE near the west bank of Newtown Creek (-48 feet amsl); and one boring near Meeker Avenue between Stewart Avenue and Gardner Avenue (-71 feet amsl). The boring near Morgan Avenue and Meeker Avenue penetrated the Raritan confining unit into the underlying crystalline bedrock at a depth of -163 feet amsl.

3.2 Site Geology

The topography of the site investigation area varies from approximately 6 feet above mean sea level (amsl) at the bulkhead along Newtown Creek to approximately 56 feet amsl in the central part of the site area. Based upon subsurface data obtained during this and previous investigations, only the upper glacial aquifer has been penetrated. The following textural units have been found in the upper glacial aquifer in most areas of the site from the surface downward: a fill unit, a sand unit, a discontinuous glacial till unit and, a discontinuous clay/silt unit.

The fill unit varies from approximately 0 to 9 feet thick and consists of a heterogeneous mixture of sand, silt, clay and varying amounts of construction and demolition debris (i.e., bricks, concrete, coal, slag, etc.) and has been found at most boring locations. The sand unit has been found underlying the fill unit at most boring locations and is represented by stratified sands of varying textures containing some to no fines. The entire thickness of the sand unit has not been penetrated, however it was found to be approximately 100 feet thick at location DEC-016 (Anthony Street between Porter and Varick Avenues). The discontinuous glacial till unit was noted in borings in the western and southwestern portion of the site (i.e., west of Morgan Avenue north of Meeker Avenue and west of Porter Avenue south of Meeker Avenue) and consists of a heterogeneous mixture of sand, silt, and clay and varying amounts of gravel, cobbles and boulders. The discontinuous clay/silt unit has been observed as an inclusive unit within the sand unit and has been observed in most of the borings at the site. The thickness of the clay/silt unit, where present, varies from 0.5 to over 10 feet thick. The presence of the less permeable clay/silt unit at well location DEC-024D has resulted in the accumulation DNAPL at the interface between the sand unit and the inclusive clay/silt unit (approximately 50 feet bgs).

Figure 21 depicts the locations of cross-sections A-A', B-B', C-C', D-D', and E-E' which are shown on Figure 22 through Figure 26.

3.3 Investigation Area Hydrogeology

The primary hydrogeologic unit identified beneath the investigation area is the upper glacial aquifer. Perched groundwater has been found in some site borings (DEC-004, DEC-006, DEC-007, DEC-015, DEC-017, DEC-22, DEC-30, SB-008, and SB-011) where less permeable units are present above the sand unit (i.e., glacial till and or clay/silt unit). The water table surface may be found between approximately 11 and 54 feet bgs depending on the well location. The water table on the northern and northeastern portions of the site has been influenced by the operation of the Off-Site System operated by ExxonMobil since approximately 1995. The operation of the Off-Site System has produced localized cones of depression resulting in an inward hydraulic gradient around the perimeter of the Off-Site Plume area, which has prevented the expansion of the Off-Site Plume.

On December 1, 2008, a round of synoptic groundwater level measurements was obtained from 21 monitoring wells (17 DEC wells and 4 ExxonMobil wells) within the Phase IV investigation area. The water level measurements are provided in Table 2. A potentiometric surface map based on the water level measurements from the shallow wells, using a 0.5-foot contour interval, is provided in Figure 27. A potentiometric surface map based on the water level measurements from the deep wells, using a 0.5-foot contour interval, is provided in Figure 28. Historic water level measurements are also included in Table 2.

The groundwater flow in the Phase IV investigation area is north to northwest towards the Off-Site System. The horizontal hydraulic gradient in the Phase IV investigation area ranges from 0.001 to 0.017 foot per foot (ft/ft) with the steepest gradients being between DEC-018 and surrounding wells.

The vertical hydraulic gradients in well pairs varied in direction across the Phase IV investigation area. A flat vertical gradient was found in well pair DEC-051/051D. Vertical hydraulic gradients in well pairs DEC-049/049D and MW-024/024D are very slightly positive or upwards based upon the water level information shown in Table 2. Vertical hydraulic gradients in well pairs DEC-018/018D, DEC-021/021D, and MW-023/023D are slightly negative to negative or downwards based upon the water level information shown in Table 2.

4.0 ANALYTICAL RESULTS

The following sections discuss the results of the MIP borings, soil sample, and groundwater sample analyses for the Phase IV fieldwork at the Meeker Avenue Plume Trackdown site.

4.1 Membrane Interface Probe Results

The EC/MIP probe was advanced at 4 locations (MIP-01 through MIP-04) on the DSNY property located at the southeastern corner of the intersection of Varick Avenue and Cherry Street. Portions of Zebra Environmental's Summary Report may be found in Appendix F, with the entire report on a compact disc. The groundwater beneath the DSNY property was estimated to be approximately 46 feet bgs based on the depth to water at nearby monitoring well MW-030 (46.12 feet bgs or 0.95 feet amsl), which is approximately 65 feet east of location MIP-03.

Location MIP-01 was logged from 0 to 47.5 feet below ground surface, with the exception of conductivity measurements, which were started at 0.75 feet bgs. Increases in ECD response were noted in the 13.0 to 14.8 feet bgs interval, 24.2 to 25.7 feet bgs interval, and from 43 feet bgs to the bottom of the borehole, with the highest response at 45.3 feet bgs. Slight PID responses corresponded with the larger ECD responses. It cannot be confirmed that MIP-01 reached groundwater, but the highest ECD and PID responses correspond with just above where the water table was expected (approximately 46 feet bgs) indicating potentially impacted groundwater.

Location MIP-02 was logged from 0 to 67 feet below ground surface, with the exception of conductivity measurements, which were started at 0.75 feet bgs. An increase in ECD response was noted in the 52.6 feet bgs to the bottom of the borehole, with the highest response between 60.3 to 67.0 feet bgs. As with MIP-01, PID responses corresponded with the larger ECD responses. The first large ECD and PID response at 52.6 feet bgs is just below where groundwater was expected. The ECD and PID responses increase with intensity and frequency with depth to the bottom of the

boring. This indicates that impacted groundwater exists at this location with concentrations increasing with depth.

Location MIP-3 was logged from 0 to 80.6 feet below ground surface, with the exception of conductivity measurements, which were started at 0.75 feet bgs. Increases in ECD response were noted in the 10.0 to 10.6 feet bgs interval, 20.4 to 21.7 feet bgs interval, 45.3 to 47.0 feet bgs interval and from 50.8 feet bgs to the bottom of the borehole, with the highest response from 61.5 to 80.6 feet bgs. As with the previous borings, PID responses corresponded with the larger ECD responses. The first large ECD and PID response at 45.3 feet bgs is approximately where groundwater was expected. The ECD and PID responses increase with intensity and frequency with depth to the bottom of the boring. This indicates that impacted groundwater exists at this location with concentrations increasing with depth.

Location MIP-04 was logged from 0 to 69.9 feet below ground surface, with the exception of conductivity measurements, which were started at 0.75 feet bgs. Increases in ECD response were noted in the 3.8 to 4.9 feet bgs interval, 8.8 to 10.8 feet bgs interval, 12.6 to 15.1 feet bgs interval, 39.8 to 40.9 feet bgs interval and from 55.2 feet bgs to the bottom of the borehole, with the highest response at 55.2 to 69.8 feet bgs. As with MIP-01, PID responses corresponded with the larger ECD responses. The large ECD and PID response at 39.8 to 40.9 feet bgs is just above where the water table was expected and the ECD and PID responses increase with intensity and frequency with depth to the bottom of the boring. This indicates that impacted groundwater exists at this location with concentrations increasing with depth.

In summary, the ECD and PID responses significantly increase in each of the borings just above or near the water table, which is estimated to be approximately 46 feet bgs at MIP-01, MIP-03 and MIP-04 which, indicates that shallow groundwater beneath the property has been impacted by VOCs. The highest ECD and PID responses are below the water table, suggesting that the concentrations of contaminants increase with depth indicating that deep groundwater beneath the property has been impacted by VOCs. The results of the MIP borings indicate that dissolved phase chlorinated solvents have impacted shallow and deep groundwater that is moving beneath the property. Based on this

data, it has been determined that the concentrations of PCE and TCE that were detected in DEC-049 and DEC-049D during Phase III groundwater sampling are related to the impacted groundwater originating near DEC-018/DEC-018D.

4.2 Soil Analytical Results

The soil sample results were compared to TAGM 4046 criteria. A summary of the detected TCL VOCs in the Phase IV soil samples is presented in Table 3. Results exceeding TAGM 4046 criteria are indicated with a circle. Table 4 provides a historical summary of the detected parameters for all soil samples collected by URS since Phase I in the Phase IV investigation area. Table 5 provides a statistical summary of the detected parameters for all samples collected by URS since Phase I in the Phase IV investigation area as follows: the number of detections; the minimum, maximum and average values; and the location and depth of the maximum value. The complete validated analytical results from the Phase IV soil samples are presented in the Data Usability Summary Report (DUSR) in Appendix O, on a compact disc. The Form Is and data summary tables provided in the DUSR include the reporting limit for each non-detected compound.

Five soil samples were collected during the Phase IV fieldwork from the monitoring well borings. No sample had detections exceeding TAGM 4046 criteria (Figure 29). PCE was only detected in the soil sample from MW-097D. The soil data collected during Phase IV fieldwork is similar to that found in the Phase IV study area during previous phases of fieldwork.

4.3 Groundwater Analytical Results

A summary of the detected TCL VOCs in the Phase IV groundwater samples collected from monitoring wells is presented in Table 6. Results exceeding TOGS No. 1.1.1 Class GA groundwater criteria are indicated with a circle. The locations of detected VOCs that have exceeded their respective criteria are shown on Figure 30. Isoconcentration contours of PCE and TCE in the Phase IV groundwater samples are shown on Figures 31 through 34. Table 7 provides a statistical summary

of the detected parameters for the Phase IV groundwater samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. Table 8 provides a historical summary of the detected parameters for all groundwater samples collected by URS since Phase I in the Phase IV investigation area. Table 9 provides a statistical summary of the detected parameters for all samples collected by URS since Phase I in the Phase IV investigation area as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. The complete validated analytical results from the Phase IV groundwater samples are presented in the DUSR in Appendix O. The Form Is and data summary tables are provided in the DUSR including the reporting limit for each non-detected compound.

4.3.1 Groundwater PCE Detections

PCE was detected in 16 of the 21 Phase IV groundwater samples collected, at concentrations exceeding groundwater criteria. Concentrations ranged from 8.5 µg/L to 7,200 µg/L (Figure 30). The highest concentrations of PCE were detected at MW-097D (7,200 µg/L), DEC-041 (4,100 µg/L) DEC-018 (3,500 µg/L), DEC-050 (2,400 µg/L), DEC-049D (2,000 µg/L), DEC-017 (1,200 µg/L), and DEC-021D (1,000 µg/L).

Figure 31 depicts isoconcentration contours for PCE in the shallow groundwater and includes the locations of potential sources. The concentration of PCE in the shallow wells is similar to the concentrations found during Phase III groundwater sampling. As noted from the previous phases of groundwater sampling, the area around DEC-018 appears to be a potential source of PCE in the shallow groundwater. The horizontal extent of PCE impacted shallow groundwater appears to be delineated to the east, north and west, with concentrations decreased by up to four orders of magnitude in downgradient and sidegradient wells from DEC-018. The dissolved phase plume associated with DEC-018 is moving to the northeast with shallow groundwater flow.

Figure 32 depicts isoconcentration contours for PCE in the deep groundwater and includes the locations of potential sources. PCE concentrations in the deep wells are similar to the concentrations encountered during Phase III groundwater sampling. The highest concentrations of PCE are centered

near MW-097D. PCE concentrations decrease one to two orders of magnitude to the south and east of the well. The horizontal extent of PCE in deep groundwater has not been delineated and occupies a larger area compared to PCE in shallow groundwater. The vertical extent of PCE impacted groundwater has not been determined.

Groundwater samples collected during Phase IV have confirmed the potential of a shallow source of PCE in the vicinity of DEC-018/DEC-018D. The Phase IV samples have found no indication of a potential source of shallow PCE in the vicinity of DEC-049/DEC-049D as previously suspected. Groundwater samples from MW-097D indicate that the well appears to be near the center of PCE impacted deep groundwater. The PCE detected in DEC-049 during the Phase III groundwater sampling appears to be associated with the PCE impacted deep groundwater centered on MW-097D. In addition, the full vertical extent of PCE impacted groundwater is anticipated to extend at a minimum, up to the shallowest confining unit (i.e., Raritan Formation – approximately 100 feet bgs).

4.3.2 Groundwater TCE Detections

TCE was detected in 16 of the 21 Phase IV groundwater samples collected, at concentrations exceeding groundwater criteria, ranging from 6.6 µg/L to 2,700 µg/L (Figure 30). The highest concentrations of TCE were found at MW-097D (2700 µg/L) and DEC-018 (1,200 µg/L).

Figure 33 depicts isoconcentration contours for TCE in the shallow groundwater and includes the locations of potential sources. As noted from the previous phases of groundwater sampling, the area around DEC-018 has the highest concentration of TCE in the shallow groundwater. The horizontal extent of TCE impacted shallow groundwater appears to be delineated to the east, north and west, with concentrations decreasing by up to four orders of magnitude in downgradient and sidegradient wells. The dissolved phase plume associated with DEC-018 is moving to the northeast with shallow groundwater flow.

Figure 34 depicts isoconcentration contours for TCE in the deep groundwater and includes the locations of potential sources. The highest concentration of TCE in the deep groundwater wells is centered on MW-097D with concentrations decreasing one to two orders of magnitude to the south and east of the well. The horizontal extent of TCE impacted deep groundwater has not been delineated and occupies a smaller area compared to that of the PCE impacted deep groundwater. The vertical extent of TCE impacted groundwater has not been determined.

Groundwater samples collected during Phase IV have confirmed the potential of a shallow source of TCE in the vicinity of DEC-018/DEC-018D. The groundwater sample from MW-097D indicates that the well appears to be at the center of TCE impacted deep groundwater. In addition, the full vertical extent of TCE impacted groundwater is anticipated to extend at a minimum, up to the shallowest confining unit (i.e., Raritan Formation – approximately 100 feet bgs).

4.3.3 PCE and TCE Degradation Product Detections

The presence of PCE and TCE degradation products has also been detected in the Phase IV groundwater samples at concentrations exceeding groundwater criteria Figure 30. The concentration of PCE and TCE degradation products is similar to the concentrations found during Phase III groundwater sampling.

Cis-1,2-DCE was detected in 14 of the 21 Phase IV groundwater samples. The range of cis-1,2-DCE varied from 10 µg/L to 1,200 µg/L, with the highest concentration detected at MW-097. Vinyl Chloride was detected in 6 of the 21 Phase IV groundwater samples. Vinyl chloride ranged from 2.4 µg/L to 190 µg/L, with the highest concentration detected at MW-097. Trans-1,2-DCE was detected in 3 samples (DEC-050D - 5.2 µg/L, DEC-049 - 60 µg/L, and MW-097 - 510 µg/L) and 1,2-DCA was detected in 3 samples (DEC-020 - 1 µg/L, MW-023 1.9 µg/L and MW-097D - 240 µg/L. 1,1-DCA was detected in 2 samples (DEC-017 - 11 µg/L and DEC-050D - 9.5 µg/L) and 1,1-DCE was detected in 1 sample (DEC-050D - 8 µg/L).

PCE and TCE degradation products have typically been found at the highest concentrations in wells located closest to the Off-Site Plume area boundary (i.e., DEC-021, DEC-021D, DEC-049, DEC-049D, DEC-050, DEC-050D, MW-023, MW-023D, MW-097, and MW-097D). This is most likely caused by the degradation of the non-chlorinated hydrocarbons associated with the Off-Site Plume which has produced an oxygen-deficient environment. Such anaerobic conditions are more favorable to the degradation of chlorinated VOCs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based upon the results of the four Phases of the investigation, the following conclusions are provided concerning the Phase IV investigation area:

Soils

No soil sample collected in the Phase IV investigation area exceeds TAGM 4046 criteria. The soil data collected during Phase IV fieldwork is similar to that found in the Phase IV study area that was collected during previous phases of fieldwork.

Groundwater

Based on the data gathered during the four Phases of the investigation, the groundwater in the Phase IV investigation area has adversely been impacted by dissolved phase chlorinated solvents. The investigation to date has allowed URS and the NYSDEC to identify the area in the immediate vicinity of DEC-018 as a potential source of PCE and TCE in the shallow groundwater. The horizontal extent of PCE and TCE in the shallow groundwater has been delineated to the west, north, and east. PCE and TCE concentrations decrease by up to four orders of magnitude in wells downgradient and sidegradient from DEC-018. PCE and TCE degradation products have typically been found at the highest concentrations in shallow groundwater wells located closest to the Off-Site Plume area boundary. This is most likely caused by the degradation of the non-chlorinated hydrocarbons associated with the Off-Site Plume, which has produced an oxygen-deficient environment.

Based on MIP data and Phase IV groundwater data, it has been determined that dissolved phase chlorinated solvents have impacted shallow and deep groundwater moving beneath the DSNY property located at the southeastern corner of the intersection of Varick Avenue and Cherry Street.

Based on this data, it has been determined the concentrations of PCE and TCE that was detected in DEC-049 and DEC-049D during Phase III groundwater sampling are more likely related to the impacted groundwater originating from near DEC-018/DEC-018D. No separate source of PCE and/or TCE exists near DEC-049 and DEC-049D as previously hypothesized.

It has been found that deep groundwater, centered on MW-097/MW-097D, has been significantly impacted by both PCE and TCE. Concentrations decrease by one to two orders of magnitude moving to the east and south away from the well. The horizontal extent of PCE and TCE in deep groundwater has not fully been determined. Data gaps exist to the north and west of MW-097/MW-097D. The horizontal extent of the PCE impacted deep groundwater occupies a larger footprint than the horizontal extent of PCE in the shallow groundwater. This suggests that multiple shallow sources are contributing to the PCE and TCE, which have been found in the deep groundwater zone. The full vertical extent of impacted groundwater has not been determined.

5.2 Source Characterization

Using data obtained during the four Phases of the investigation performed by URS, it has been determined that there are four sources and seven potential sources of PCE and TCE contamination within the study area. Additional information gathered from the FOIL requests, a review of certificates of occupancy, and a review of additional reports has been incorporated in the descriptions of each source and potential source.

Sources

A total of four source areas have been identified within the study area (Figure 35). The four source areas were listed as NYSDEC Class 2 Inactive Hazardous Waste Disposal Sites in January 2009. A brief description of each site follows.

- An identified source of groundwater contamination is the building housing the former Spic and Span Cleaners and Dyers, Inc. [a.k.a. Eastern District Dye Works (1916 Sanborn) and Norman Cleaners and Dyers Inc. (1942 Sanborn)], located at 260 Norman Avenue/315-325 Kingsland Avenue (Tax District of Brooklyn, Block 02657, Lot 0009) and 307-313 Kingsland Avenue (Tax District of Brooklyn, Block 02657, Lot 0015). The site is listed as NYSDEC Site Number 2-24-129. The facility was located at the above address from the early 1900's until the mid 1960's based on Sanborn Maps. DNAPL containing 70% PCE was identified in monitoring well DEC-024D which is located on Kingsland Avenue adjacent to the former facility. During a review of NYC DOB certificates of occupancy (see Appendix C), it was determined that the former Spic and Span Cleaners and Dyers, Inc. occupied both Lots 0009 and 0015, as opposed to just Lot 0009 as previously indicated in the Phase III report.

- A source of groundwater contamination is the former Klink Cosmo Cleaners, which was located at 368 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). The site is listed as NYSDEC Site Number 2-24-130. The facility is shown on Sanborn Maps to be a clothing warehouse from the mid 1950's until some time after 1995. The facility is listed as a generator of F002 waste (spent halogenated solvents) for Klink Cosmo Cleaners. Groundwater containing PCE up to 33,000 µg/L was detected in monitoring well DEC-031, which is located on Richardson Street adjacent to the facility.

- A source of groundwater contamination is a former and current metal works, which is located at 95 Lombardy Street (Tax District of Brooklyn, Block 02819, Lot 0008) and 46-60 Anthony Street (Tax District of Brooklyn, Block 02819, Lot 0011). The site is listed as NYSDEC Site Number 2-24-131. The facility has been utilized from the 1930's to the present as a metal fabricator and painting facility based on Sanborn Maps. During a review of additional documents (see Appendices A and C) it was determined that the former and current metal works occupied both Lots 0008 and 0011 as opposed to just Lot 0008 as previously indicated in the Phase III report. The facility is also listed as a generator of F001 waste (spent halogenated solvents used in degreasing) for ACME

Steel. Phase I and II ESAs performed at the facility in March 1998 and June 1998 respectively (Appendix A), have indicated that on-site operations had impacted the environmental quality beneath the property and recommended that corrective actions were required to mitigate the contaminated soil associated with the floor drain. Groundwater containing TCE up to 70,000 µg/L was detected in monitoring well DEC-005D, which is located on Vandervoort Avenue adjacent to the facility.

- A source of soil and groundwater contamination is a former brass foundry and a stainless steel door finishing facility operated by ACME Architectural Products, Inc., located at 72 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0005) and 90 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0001). The site is listed as NYSDEC Site Number 2-24-132. The facility had been utilized as a brass foundry from the mid 1960's to approximately 1993 based on Sanborn Maps. Subsequently, ACME Architectural Products, Inc. utilized the facility to grind, sand, and finish stainless steel doors. During a review of a Phase I ESA performed at the property (Appendix A), it was determined that the facilities at one time occupied both Lot 0001 and 0005 as opposed to just Lot 0005 as previously indicated in the Phase III report. A waste accumulation area is located on Lot 0001, to the east of the building while the building occupies Lot 0005. ACME Architectural Products, Inc. is listed as a generator of F001 waste (spent halogenated solvents used in degreasing). The Phase I ESA performed at the property identified a number of potential contamination sources that existed on the property due to current and/or past site activities. The sources of potential contamination included a waste accumulation area outside the building, two dry wells and a degreasing dip tank. Soils containing PCE up to 200 mg/kg were detected in the boring for DEC-016, which is located on Anthony Street adjacent to the facility. Groundwater containing PCE up to 6,100 µg/L and TCE up to 12,000 µg/L were detected in DEC-016 and DEC-016D respectively.

Potential Sources

A total of seven additional potential source areas have been identified within the study area (Figure 36). The seven potential source areas have been identified as areas where additional information needs to be gathered to determine if any of these areas are responsible for or a contributor to the presence of PCE and/or TCE in the environment. A brief description of each potential source is given below. The recently acquired Sanborn maps used to identify the new potential sources located near the Spic and Span Cleaners and Dyers, Inc. may be found in Appendix B. FOIL material and Certificates of Occupancy available for each lot were obtained from the NYC DOB web site and included in Appendix C.

- The facility that was and is currently occupied by a laundry, a dyer, and dry cleaners, located at 355 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0078), 347-353 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0079), 262-268 Monitor Street (Brooklyn Tax District, Block 02608, Lot 0082), and 252 Monitor Street (Brooklyn Tax District, Block 02608, Lot 0099) may be a potential source of PCE and/or TCE. The facility was utilized as a laundry, dyers and dry cleaners from approximately 1965 to present based on Sanborn Map data.
- The facility that was occupied by a laundry located at 242 Monitor Street/253A-257 Norman Avenue (Brooklyn Tax District, Block 02608, Lot 0095) may be a potential source of PCE and/or TCE. The facility was utilized as a laundry from approximately 1933 to 1951 based on Sanborn Map data and a review of certificates of occupancy.
- The facility that was occupied by the former Rose & Co. Dye Works, located at 355 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0078), 347-353 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0079), 341 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0084), and 337-339 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0084) may be a potential source of PCE and/or TCE. The facility was utilized as a laundry and dry cleaners from approximately 1944 to 1986 based on Sanborn Map data and a review of certificates of occupancy. The Sanborn maps identified six underground tanks, listed for use as benzene tanks from

1942-1965 and then as solvent tanks from 1965-present, exist on Block 02608 Lots 0084 and 0085.

- The facility that is occupied by a current metal works, located at 96-102 Anthony Street/157-163 Lombardy Street (Brooklyn Tax District, Block 02820, Lot 0028) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility started metal working in 1977 based on a review of certificates of occupancy.

- The facility that is occupied by a current metal works, located at 104-110 Anthony Street/169 Lombardy Street/503-519 Varick Avenue (Brooklyn Tax District, Block 02820, Lot 0021) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility is adjoining 157 Lombardy Street to the east.

- The facility that was occupied by a former soap manufacturer and lacquer storage, located at 171-179 Lombardy Street/496-508 Varick Avenue (Brooklyn Tax District, Block 02821, Lot 0001) appears to be a potential source of groundwater contamination. Based on Sanborn Map data, the facility was utilized during the 1930s for lacquer storage, and as a manufacturer of powdered soap from the early 1950s to 1989. Monitoring wells DEC-018 and DEC-018D are located on the Varick Avenue or west side of the building, near Lombardy Street. Groundwater samples from these wells indicate significant PCE and TCE contamination in shallow groundwater.

- The facility that was occupied by a former metal works, located at 122-132 Anthony Street/181-193 Lombardy Street (Brooklyn Tax District, Block 02821, Lot 0011) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility started metal working in 1953 based on a review of certificates of occupancy.

It should be noted the former Curtis Electro N.Y. Inc. facility, which was located at 126-140 Cherry Street (Tax District of Brooklyn, Block 02814, Lot 0010), is no longer considered a potential source of groundwater contamination. Based upon data obtained during the Phase IV investigation, it has

been determined the concentrations of PCE and TCE that were detected previously in DEC-049 and DEC-049D, which are adjacent to the former Curtis Electro N.Y. Inc. facility, are likely related to the impacted groundwater originating from near DEC-018/DEC-018D (i.e., further upgradient). No separate source of PCE and/or TCE exists near DEC-049 and DEC-049D as previously hypothesized.

5.3 Recommendations

The following recommendations are offered for consideration by the NYSDEC for the area north of Meeker Avenue, in the vicinity of the former Span Cleaners and Dyers, Inc.

- Five shallow monitoring wells should be installed at the locations shown on Figure 37. These wells will assist in determining if the there are additional potential sources of PCE and TCE impacting shallow groundwater to the north of the former Span Cleaners and Dyers, Inc. The shallow wells should be constructed with a 15-foot long PVC screen and PVC riser. The rationale for the shallow well locations for the area north of Meeker Avenue may be found in Table 10.
- Four deep monitoring wells should be installed at the locations shown on Figure 37. These wells will assist in determining impacts of PCE and TCE to deep groundwater in the area north and west of the former Span Cleaners and Dyers, Inc. In addition, the deep wells may assist in determining if the there are additional potential or contributing sources of PCE and TCE impacting deep groundwater. Finally, the deep wells will assist in determining the potential presence of DANPL if a less permeable unit is encountered, as found in well DEC-024D. The deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings 35 feet or to the top of a less permeable unit. The deep wells should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump and stainless steel riser. Stainless steel has been recommended due to the incompatibility between PCE and/or TCE and PVC materials. The rationale for the deep well locations for the area north of Meeker Avenue may be found in Table 10.

- Soil samples will be collected as per the Field Activities Plan (URS, April 2007). All soil samples will be analyzed for TCL VOCs plus TICs by 8260B.
- If DNAPL is encountered in any new monitoring well(s), a DNAPL sample will be collected for laboratory analyses. The DNAPL sample(s) will be analyzed for TCL VOCs plus TICs by 8260B and TCL SVOCs plus TICs by 8270C.
- A complete round of groundwater samples should be collected from all new and existing DEC wells and Exxon/Mobil wells that are highlighted on Figure 37 (for a total of 21 wells). The groundwater samples will be analyzed for TCL VOCs plus TICs by 8260B. A synoptic round of water levels will be collected from the wells to be sampled prior to the start of groundwater sampling.
- A DNAPL gauging event should be performed at DEC-024D to determine if DNAPL is still present in the well. If DNAPL is encountered, an attempt will be made to measure the amount (thickness) in the well.
- If DNAPL is present in DEC-024D, then the well will be decommissioned and a replacement well, DEC-024DR will be installed adjacent to DEC-024D. The replacement well should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump and stainless steel riser.

The following recommendations are offered for consideration by the NYSDEC for the area south of Meeker Avenue, in the vicinity of the Phase IV investigation area:

- Four shallow monitoring wells should be installed at the locations shown on Figure 38. These wells will assist in determining if the there are additional potential sources contributing to the PCE and TCE impacted shallow groundwater found in the vicinity of DEC-018/018D. The wells should be constructed with a 15-foot long PVC screen and PVC riser. The rationale for the shallow well locations for the area south of Meeker Avenue may be found in Table 11.
- Six deep monitoring wells should be installed at the locations shown on Figure 38. These wells will assist in the delineation of the deeper groundwater to south and

southwest of well pair DEC-018/018D. The new deep wells will also assist in determining if PCE and TCE impacted groundwater is associated with an upgradient source and/or if there are any additional potential sources contributing to the impacted deep groundwater. The deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings 35 feet or to the top of a less permeable unit. The wells should be constructed with a 10-foot long PVC screen and PVC riser. The rationale for the deep well locations for the area north of Meeker Avenue may be found in Table 11.

- Three top of clay wells should be installed at the locations shown on Figure 38 to determine the vertical extent of PCE and TCE impacted groundwater. The top of clay wells should be advanced to the top of the Raritan Formation, which is anticipated to be approximately -47 and -71 feet amsl. Split spoon samples should be collected continuously from the bottom of the existing borings to the top of the Raritan Formation. The wells should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump, 10 feet of stainless steel riser above the screen and PVC riser the remainder of the well string. A stainless steel has been recommended due to the incompatibility between PCE and/or TCE and PVC materials. The recommendation for the stainless steel was based on the increasing concentrations of PCE and TCE with depth and the possibility of DNAPL being encountered at the top of clay locations.
- Soil samples will be collected as per the Field Activities Plan (URS, April 2007). All soil samples will be analyzed for TCL VOCs plus TICs by 8260B.
- If DNAPL is encountered in any new monitoring well(s), a DNAPL sample will be collected for laboratory analyses. The DNAPL sample(s) will be analyzed for TCL VOCs plus TICs by 8260B and TCL SVOCs plus TICs by 8270C.
- A complete round of groundwater samples should be collected from all new and existing DEC wells and Exxon/Mobil wells that are highlighted on Figure 38 (for a total of 42 wells). The groundwater samples will be analyzed for TCL VOCs plus TICs by 8260B.

A synoptic round of water levels will be collected in the wells to be sampled prior to the start of groundwater sampling.

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