nationalgrid

Construction Completion Report

50 Kent Avenue Property Holder Area
Portion of NYSDEC Site Number 224055
and
Brooklyn North 1 Garage
NYSDEC Site Number 224028
Brooklyn, Kings County, New York

Prepared for:

National Grid
One MetroTech Center
Brooklyn, New York 11201

Prepared by:

AECOM
257 West Genesee Street, Suite 400
Buffalo, NY 14202

March 2018

G4669M

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BROOKLYN, KINGS COUNTY, NEW YORK

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CERTIFICATIONS

I, Mark Lang, am currently a registered professional engineer licensed by the State of New York, I had responsibility for implementation of the remedial program activities, and I certify that the Interim Remedial Design was implemented and that the construction activities were completed in substantial conformance with the Department-approved Interim Remedial Design which includes NYSDEC-approved revisions made during construction.

I certify that the documents generated in support of this report have been submitted in accordance with the DER's electronic submission protocols and have been accepted by the Department.

I certify that the data generated in support of this report have been submitted in accordance with the Department's electronic data deliverable and have been accepted by the Department.

I certify that technical information and statements associated with design and construction in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, Mark Lang, of AECOM, am certifying as Owner's Designated Site Representative for the site.

074013	JAN 12 2018	
NYS Professional Engineer #	Date	Signature

STATE OF NEW YORK
MARK E. LANG
074013
LICENSED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS

Acronym	Definition
amsl	Above Mean Sea Level
AST	Above Ground Storage Tank
BCP	Brownfield Cleanup Program
Bgs	Below Ground Surface
BSM	Bucket Soil Mixing
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BUG	Brooklyn Union Gas
CAMP	Community Air Monitoring Plan
CB	Cement Bentonite
CBS	Chemical Bulk Storage
CCR	Construction Completion Report
C&D	Construction & Demolition
CERP	Community and Environmental Response Plan
CFR	Code of Federal Regulations
CQCP	Construction Quality Control Plan
CSM	Conceptual Site Model
CTC	Cost to Cure
CVOCs	Chlorinated Volatile Organic Compounds
CY	Cubic Yards
DUSR	Data Usability Summary Report
dBA	A-weighted decibels
DNAPL	Dense Non-Aqueous Phase Liquid
EB	Excavation and Backfill
EBC	Environmental Business Consultants
EEA	Energy and Environmental Analysts, Inc.
EFR	Enhanced Fluid Recovery
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
ESI	Ecosystem Strategies, Inc.
GAC	Granular Activated Carbon
GGBFS	Ground Granular Blast Furnace Slag
gpm	Gallons per Minute
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
IDIP	IRM Design and Implementation Plan
IRM	Interim Remedial Measure
ISEE	International Society of Explosive Engineers
ISS	In-Situ Solidification

ISRP	Investigative Summary and Remedial Plan
M. cu. Ft.	Million cubic feet
MDL	Method Detection Limit
mg/kg	Milligrams per Kilogram
MGP	Manufactured Gas Plant
MOSF	Major Oil Storage Facility
MTBE	Methyl tert-Butyl Ether
NAPL	Non-Aqueous Phase Liquid
NAVD	North American Vertical Datum
NYCDDC	New York City Department of Design and Construction
NYCDEP	New York City Department of Environmental Protection
NYCDGS	New York City Department of General Services
NYCDOB	New York City Department of Building
NYCDOS	New York City Department of Sanitation
NYCDOT	New York City Department of Transportation
NYCDPR	New York City Department of Parks and Recreation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORC	Oxygen Release Compound
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PDI	Predesign Investigation
PID	Photoionization Detector
PM_{10}	Inhalable Particulate Matter
PPE	Personal Protective Equipment
ppm	Parts per Million
PRPs	Potentially Responsible Parties
PSA	Preliminary Site Assessment
psi	Pounds per Square inch
PTI	Post-Tensioning Institute
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RIWP	Remedial Investigation Work Plan
SCO	Soil Cleanup Objective
SCOPGQ	Soil Cleanup Objective to Protect Groundwater Quality
sf	Square Feet
SI	Site Investigation
SMMP	Soil/Materials Management Plan
SMP	Site Management Plan

SOCONY	Standard Oil Company of New York
SOE	Support of Excavation
SOPs	Site Operations Plan
SPDES	State Pollutant Discharge Elimination System
STARS	Spill Technology and Remediation Series
SVOCs	Semi-Volatile Organic Compounds
SWPPP	Storm Water Pollution Prevention Plan
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TFS	Temporary Fabric Structure
TOGS	Technical and Operational Guidance Series
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TVOCs	Total Volatile Organic Compounds
UCS	Unconfined Compressive Strength
UST	Underground Storage Tank
$\mu g/m^3$	Microgram per Cubic Meter
VMS	Vapor Management System
VOCs	Volatile Organic Compounds
WWTP	Wastewater Treatment Plant

Executive Summary

The Brooklyn Union Gas Company, now doing business as National Grid NY (National Grid) entered, as a co-respondent, into an Order on Consent and Administrative Settlement, Index # A2-0-552-0606 (the Order), with the New York State Department of Environmental Conservation (NYSDEC) in March 2007 to develop and implement remedial programs for former manufactured gas plant (MGP) and gas holder locations in Kings, Queens, Nassau, and Suffolk counties, New York. The location of the former Williamsburg Gas Light Company at North 12th Street and Kent Avenue, Williamsburg, Brooklyn, Kings County, New York, identified as the Williamsburg Works MGP site (site No. 224055), was added to the Order via a modification dated August 2007. National Grid has completed an Interim Remedial Measure (IRM) at a portion of the Williamsburg Works MGP site identified as the 50 Kent Ave Holder Area. The IRM was conducted from November 2015 through June 2017.

In November 2017 NYSDEC and National Grid entered into a Stipulation and Order of Settlement and Discontinuance (the Stipulation) upon which the Order was terminated with respect to the Williamsburg Works MGP site. This IRM Construction Completion Report (CCR) satisfies a condition of the Stipulation for a final engineering construction completion report to be submitted to NYSDEC by National Grid no later than January 15, 2018. As this report is an IRM CCR, only, a Site Management Plan is not included.

The 50 Kent Avenue Holder Area, which comprises a portion of the Williamsburg Works MGP site, is coterminous with the Brooklyn North 1 Garage site (Site no. 224028), located at 50 Kent Avenue, Brooklyn, NY. Both the 50 Kent Avenue Holder Area and the Brooklyn North 1 Garage are located in the County of Kings, New York, on a parcel of land identified on the New York City Tax Map as Block 2287, Lot 1 (the Site). The Site is bounded by N. 12th Street to the north, N. 11th Street to the south, Kent Avenue to the east, and Block 2278, Lot 16 to the west. The Site is located within approximately 600 feet of the East River and within approximately 400 feet of Bushwick Inlet.

Block 2287 Lot 1 and the Brooklyn North 1 Garage were previously leased and operated by the New York City Department of Sanitation (NYCDOS). There have been at least three spill numbers (9401167, 9600011, and 9607376) and a petroleum bulk storage site number (2-456098) associated with the Brooklyn North 1 Garage. The NYSDEC Environmental Site Remediation Database Site Record for the Brooklyn North 1 Garage states, under the Site Description heading, "The site is being addressed under site no. 224055 (Williamsburg Works MGP)."

The Site and adjacent and nearby properties have been part of a highly industrialized area of Brooklyn dating back to at least the mid-1800s that included dozens of historic, industrial, and manufacturing uses and reported spills, all of which constitute sources of soil and groundwater contamination surrounding the Site. Historic property uses in the vicinity of the Site included petroleum refining, fuel storage, smelting, steel and iron works, machine shops, paint and varnish manufacturing, chemical works, textiles, and other manufacturing facilities. Facilities that used or generated petroleum and tar-like substances include the former Pratt Manufacturing Company, Eagle Oil Works, and former iron foundries. During World War I the United States government, acting through the Ordnance Department of the War Department, constructed a toluol manufacturing plant within and adjacent to the contemporary boundaries of the Williamsburg Works MGP. Portions of the toluol manufacturing plant were located within the Site.

Several investigations and sampling events were conducted at the Site, by various parties, from at least 1995 through 2015. Three 2,000 gallon underground storage tanks (USTs) for gasoline and fuel oil and an oil/water separator were known to have been located at the Site prior to the IRM. Multiple reports for the investigations conducted at the Site concluded that both petroleum-related and other non-MGP-related and MGP-related impacts were commingled in the subsurface of the Site. Forensic analysis of selected samples confirmed the commingled nature of the impacts act the Site.

In January 2017, National Grid filed a complaint, Civil Action No.: 1:17-cv-00045-MKB-ST, amended in April 2017, in the United States District Court for the

Eastern District of New York ("the Amended Complaint"). The Amended Complaint identifies 15 defendants, including Exxon Mobil Corporation (ExxonMobil or Exxon), Bayside Fuel Oil Depot Co. (Bayside); Texaco, Inc. (Texaco); Motiva Enterprises LLC (Motiva); Sunoco, Inc. (Sunoco), Chevron, U.S.A. Inc. (Chevron); The United States of America; and The City of New York, and "is a civil action for cost recovery arising out of the disposal, release, and/or threatened release of hazardous substances into the environment at current and historical facilities owned and/or operated by Defendants… adjacent to the Bushwick Inlet and the East River in Brooklyn, New York (the 'Bushwick Site'…)….[National Grid's] historical Williamsburg Works Manufactured Gas Plant was operated and controlled by Defendant ExxonMobil and/or its corporate predecessors and sat on the Bushwick Site, adjacent to the facilities owned and/or operated by Defendants." In a letter dated November 27, 2017, NYSDEC stated that it had identified ExxonMobil, Bayside, Texaco, Motiva, Sunoco, and Chevron, "(collectively, 'the Parties')" and The City of New York as potential responsible parties (PRPs) for the Bushwick Site.

The Site was formerly the location of three gas holders (identified as Relief Holder, Holder No. 1, and Holder No. 2), their tanks, associated foundations, a still house and piping that were part the toluol manufacturing plant, and piping related to the former MGP operations. A few other subsurface brick structures were also encountered during the IRM that might be associated with the former MGP operations at the Site. According to available maps and information, there was no MGP-related petroleum storage on the property. In addition to the known structures, other subsurface concrete structures, piping, as well as underground storage tanks were encountered during the IRM. Due to placement of these structures above or through, or across MGP-related structures, it is apparent that they were constructed after operation of the MGP ceased and that they were associated with other post-MGP operations at the Site. Concrete footings were encountered at various locations at the Site during shallow excavation and are believed to be associated with the buildings and structures associated with usage of the Site both during the MGP and toluol manufacturing plant operation and post-MGP operation. A large, reinforced, concrete monolith was encountered within the footprint of the deep excavation area while underground storage tanks were encountered within various excavation areas. Since these structures were placed fully or partially within the former MGP holder tank footprints, it is believed that they were placed during the post-MGP operations at the Site. A few small and large diameter pipes were encountered in subsurface of the Site at various places. A portion of a pipe encountered in the western shallow excavation exhibited odors similar to that of fuel oil and not of MGP-related material.

The scope of the IRM was defined in the IRM Design and Implementation Plan (IDIP) prepared by AECOM in 2013. The New York State Department of Environmental Conservation (NYSDEC) approved the IDIP in April 2013 and the design as presented in the IRM 100% Design Report, prepared by AECOM, in June 2015. This plan defined the objective of the IRM to excavate soil over the entirety of the Site. In the vicinity of the former holder tanks, excavation would be to approximately 30 ft bgs, below the holder foundations. Elsewhere on the Site excavation would be to shallower depths. Subsequent to the approval of the IDIP, NYSDEC approved substitution of in-situ solidification of the contents of the Holder No. 2 tank adjacent to the intersection of Kent Ave. and North 11th Street in order to protect the adjacent infrastructure. National Grid retained the following parties for the IRM: Sevenson Environmental Services, Inc. (the Contractor); de maximis, Inc. (the Construction Manager), and AECOM (the Engineer). GEI Consultants, Inc. P.C. performed community air monitoring, and noise, vibration, settlement, and movement monitoring during the IRM.

Mobilization for the IRM began in October, 2015. The Contractor performed the in-situ solidification of the contents of the Holder No. 2 tank using bucket soil mixing in February through March 2016. Prior to solidification, approximately 223 tons of material from within the Holder No. 2 tank was disposed at Clean Earth of North Jersey as a characteristic hazardous waste with elevated levels of lead. During solidification, all samples collected by the Engineer met the performance goals of greater than 50 pounds per square inch (psi) unconfined compressive strength and less than 10^{-6} cm/sec hydraulic conductivity. Additionally, NYSDEC required performance of a boring program to provide visual confirmation of effective mixing and to demonstrate the absence of free non-aqueous phase liquids (NAPL). Two borings were advanced in March 2016 and demonstrated successful solidification. The solidification was performed under a temporary fabric structure (TFS) with negative pressure provided by a vapor management system (VMS) to minimize odors to the surrounding community.

The Contractor installed a support of excavation (SOE) wall surrounding the Relief Holder and Holder No. 1 to allow excavation to depths below the holder foundations. The Contractor pre-drilled the SOE alignment to clear potential obstructions from March to July 2016, and excavated a cement-bentonite (CB) slurry trench to an average? depth of 48 feet below ground surface (bgs) to facilitate placement of steel sheet piles for the SOE wall. The trenching and sheet pile placement was performed from May through July 2016. Sheet piles were installed to an average depth of 55 feet bgs. A TFS with a VMS was erected above the deep excavation area upon completion of sheet pile installation for odor control. Following initial excavation of the Relief Holder and Holder No. 1 (the deep excavation area) to approximately 8.5 feet bgs, the Contractor installed tiebacks to support the SOE wall and allow excavation to depths of up to 30 feet bgs.

Portions of the deep excavation area were found to contain lead that was leachable (as measured by the Toxicity Characteristic Leaching Procedure) so as to be defined as a characteristic hazardous waste. The Contractor treated these soil and fill materials using a proprietary stabilization agent (Maectite®) to remove the hazardous characteristic of toxicity and to allow these materials to be disposed of as nonhazardous.

Excavation in the deep excavation area was completed in February 2016. Most of the deep excavation area was excavated to a depth of approximately 30 feet bgs. However, the southwest portion of this area was visually determined to be unimpacted by NAPL, and with approval from NYSDEC, was excavated to an approximate depth of only 22 feet bgs. 47,049 tons of soil and fill were removed from the deep excavation, including the CB slurry trench, and sent off-site for treatment and disposal. Three previously-abandoned, 2,000 gallon USTs were excavated from this area and disposed. Based on past investigation results and forensic analysis of selected sample analyses, the top approximately five feet of the subsurface was predominantly contaminated by petrogenic material with some pyrogenic material present, from approximately five feet bgs to approximately 17 feet bgs there was a mix of pyrogenic and petrogenic material, and below 17 feet bgs impacts were primarily pyrogenic.

The Contractor performed dewatering during the deep excavation to maintain the groundwater elevation at least 2 feet below the excavation surface. Both a well point extraction system and pumping from sumps was used for dewatering. The Contractor treated the water on-site using filtration, oil/water separation, and carbon treatment prior to discharging the water to a permitted New York City Department of Environmental Protection (NYSDEP) combined sewer under Kent Avenue.

Before, during, and after the in-situ solidification and deep excavation activities described above, the Contractor excavated the east shallow excavation area, the west shallow excavation area, and the former “no excavation” area to a minimum of 5 feet below the final grade established during restoration. During this shallow excavation, the Engineer inspected the soil and fill for visual and olfactory evidence of contamination. Shallow soils deemed free of such contamination (in accordance with the NYSDEC-approved acceptance plan) were stockpiled as Reuse Material for backfilling of the deep excavation. Of the soil and fill excavated from the shallow excavation areas, 17,480 tons were determined to be unacceptable for reuse and were sent off site for treatment and disposal. Three previously unknown USTs, apparently associated with post-MGP petroleum storage, and a small, riveted UST within the area of the former toluol manufacturing plant were excavated from the east shallow excavation area and disposed. Based on past investigation results and forensic analysis of selected sample analyses, the top five feet of the subsurface of the Site was predominantly contaminated by petrogenic material with some pyrogenic material present.

Soil and fill material from the deep excavation and those shallow soil and fill materials not acceptable for reuse were sent to Bayshore Soil Management in New Jersey for thermal desorption treatment.

The Contractor performed backfilling simultaneously with excavation. Reuse Material from the shallow excavations was placed in the deep excavation area at depths greater than 13 feet bgs. Elsewhere, the Contractor placed clean imported backfill meeting the New York Code of Rules and Regulations (NYCRR) Part 375 restricted residential use criteria (Table 375-6.8 (b)). The Contractor re-installed a fence around the entire perimeter of the Site. Sidewalks adjacent to the Site were also replaced. The Contractor placed topsoil as the top 6 inches of the backfill and, to complete site restoration, seeded the entire surface of the Site with grass.

CONSTRUCTION COMPLETION REPORT

1.0 BACKGROUND AND SITE DESCRIPTION

The Brooklyn Union Gas Company, now doing business as National Grid NY (National Grid) entered, as a co-respondent, into an Order on Consent and Administrative Settlement, Index # A2-0-552-0606 (the Order), with the New York State Department of Environmental Conservation (NYSDEC) in March 2007 to develop and implement remedial programs for former manufactured gas plant (MGP) and gas holder locations in Kings, Queens, Nassau, and Suffolk counties, New York. The location of the former Williamsburg Gas Light Company at North 12th Street and Kent Avenue, Williamsburg, Brooklyn, Kings County, New York (see Figure 1), identified as the Williamsburg Works MGP site (site No. 224055), was added to the Order via a modification dated August 2007. With its addition to the Order, a Remedial Investigation was required for the Williamsburg Works MGP site.

On behalf of National Grid, GEI Consultants Inc. P.C. (GEI), conducted the Remedial Investigation (RI) field work for the Williamsburg Works MGP site from June 2009 through December 2012. The initial RI field work was conducted in accordance with the NYSDEC-approved RI Work Plan, (GEI, 2008) and NYSDEC-approved RI Work Plan (RIWP) Addendums dated November 19, 2008, February 12, 2009, and December 17, 2009. At their request, an interim data deliverable was submitted to NYSDEC in August 2010, and in September 2010 NYSDEC responded with a letter requesting that an excavation/stabilization-based Interim Remedial Measure (IRM) be performed at "the 50 Kent Ave. parcel (bounded by Citi Storage [Block 2278, Lot 16], N. 12th St., Kent Ave., and N. 11th St.)."

On August 2, 2011, NYSDEC approved, with modification, a GEI-prepared IRM Design Work Plan dated July 2011 and subsequently revised in August 2011. The IRM Design Work Plan was implemented by URS (URS has since become part of AECOM) between January 2012 and June 2015. URS submitted an IRM 100% Design Report (Design Report) to NYSDEC in June 2015. The Design Report was approved by NYSDEC on August 17, 2015. The Design Report provided for a Construction Completion Report documenting the activities performed during the IRM be submitted to NYSDEC, for approval after completion of construction activities. The IRM was conducted from November 2015 through June 2017.

During design of the IRM, GEI continued to implement RI field work in accordance with a NYSDEC-approved Supplemental RIWP dated August 25, 2010. A RI Report, prepared by GEI, was submitted to NYSDEC on January 31, 2015 (the RI Report). NYSDEC neither approved nor disapproved the RI Report.

In a letter to NYSDEC dated November 7, 2016, National Grid announced that it was exercising its unilateral right to withdraw the Williamsburg Works MGP site from the Order. In November 2017 NYSDEC and National Grid entered into a Stipulation and Order of Settlement and Discontinuance (the Stipulation) upon which the Order was terminated with respect to the Williamsburg Works MGP site. This IRM Construction Completion Report (CCR) satisfies a condition of the Stipulation for a final engineering construction completion report to be submitted to NYSDEC by National Grid no later than January 15, 2018. As this report is an IRM CCR, only, a Site Management Plan is not included.

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1.1 BACKGROUND

The RI Report describes six parcels on or around which the Remedial Investigation was performed. The Parcel IDs, addresses, and tax map information for these properties are presented in the table below.

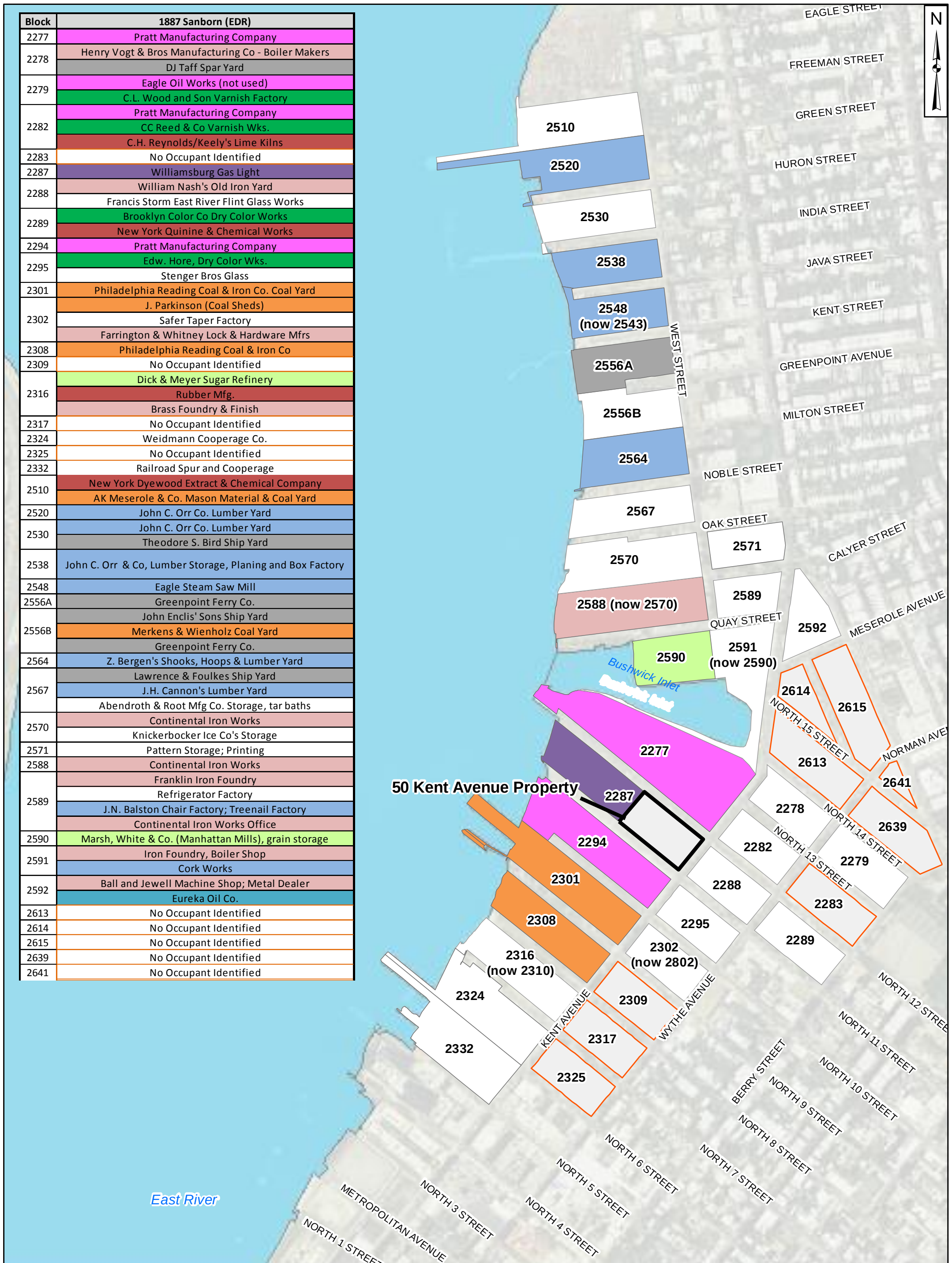
Parcel ID	Address	Block	Lot
Parcel 1	35 Kent Avenue Brooklyn, NY	2288	1
Parcel 2 (the Site)	21 North 12th Street (50 Kent Avenue) Brooklyn, NY	2287	1
Parcel 3	20 North 12th Street Brooklyn, NY	2287	16
Parcel 4	2 North 11th Street Brooklyn, NY	2287	30
Parcel 5	16 North 11th Street Brooklyn, NY	2294	1
	33 North 10th Street Brooklyn, NY	2294	5
Parcel 6	1-26 North 12th Street Brooklyn, NY	2277	1

The locations of the Parcels 1 through 6 are shown on Figure 3. Figure 3 also shows the location of 25 Kent Avenue, which was not labeled as parcel in the RI Report.

The western end of 25 Kent Avenue was the location of a portion of the Pratt Works Refinery.

The Site (Parcel 2) is an approximately 1.84 acre parcel located within a dense urban area of mixed commercial, industrial, and residential land use. The Site and adjacent and nearby properties have been part of a highly industrialized area of Brooklyn dating back to at least the mid-1800s, that included dozens of historic, industrial, and manufacturing uses and reported spills, all of which constitute sources of soil and groundwater contamination surrounding the Site. Historic property uses in the vicinity of the Site included petroleum refining, fuel storage, smelting, steel and iron works, machine shops, paint and varnish manufacturing, chemical works, textiles, and other manufacturing facilities. Facilities that used or generated petroleum and tar-like substances include the former Pratt Manufacturing Company, Eagle Oil Works, and former iron foundries. Some surrounding historical land uses that could contribute environmental contamination are shown in the following Figures 4A, 4B, 4C and 4D.

Block	1887 Sanborn (EDR)
2277	Pratt Manufacturing Company
2278	Henry Vogt & Bros Manufacturing Co - Boiler Makers
	DJ Taff Spar Yard
2279	Eagle Oil Works (not used)
	C.L. Wood and Son Varnish Factory
2282	Pratt Manufacturing Company
	CC Reed & Co Varnish Wks.
	C.H. Reynolds/Keely's Lime Kilns
2283	No Occupant Identified
2287	Williamsburg Gas Light
2288	William Nash's Old Iron Yard
	Francis Storm East River Flint Glass Works
2289	Brooklyn Color Co Dry Color Works
	New York Quinine & Chemical Works
2294	Pratt Manufacturing Company
2295	Edw. Hore, Dry Color Wks.
	Stenger Bros Glass
2301	Philadelphia Reading Coal & Iron Co. Coal Yard
2302	J. Parkinson (Coal Sheds)
	Safer Taper Factory
	Farrington & Whitney Lock & Hardware Mfrs
2308	Philadelphia Reading Coal & Iron Co
2309	No Occupant Identified
2316	Dick & Meyer Sugar Refinery
	Rubber Mfg.
	Brass Foundry & Finish
2317	No Occupant Identified
2324	Weidmann Cooperage Co.
2325	No Occupant Identified
2332	Railroad Spur and Cooperage
2510	New York Dyewood Extract & Chemical Company
	AK Meserole & Co. Mason Material & Coal Yard
2520	John C. Orr Co. Lumber Yard
2530	John C. Orr Co. Lumber Yard
	Theodore S. Bird Ship Yard
2538	John C. Orr & Co, Lumber Storage, Planing and Box Factory
2548	Eagle Steam Saw Mill
2556A	Greenpoint Ferry Co.
2556B	John Enclis' Sons Ship Yard
	Merkens & Wienholz Coal Yard
	Greenpoint Ferry Co.
2564	Z. Bergen's Shooks, Hoops & Lumber Yard
2567	Lawrence & Foulkes Ship Yard
	J.H. Cannon's Lumber Yard
	Abendroth & Root Mfg Co. Storage, tar baths
2570	Continental Iron Works
	Knickerbocker Ice Co's Storage
2571	Pattern Storage; Printing
2588	Continental Iron Works
2589	Franklin Iron Foundry
	Refrigerator Factory
	J.N. Balston Chair Factory; Treenail Factory
	Continental Iron Works Office
2590	Marsh, White & Co. (Manhattan Mills), grain storage
2591	Iron Foundry, Boiler Shop
	Cork Works
2592	Ball and Jewell Machine Shop; Metal Dealer
	Eureka Oil Co.
2613	No Occupant Identified
2614	No Occupant Identified
2615	No Occupant Identified
2639	No Occupant Identified
2641	No Occupant Identified



Legend

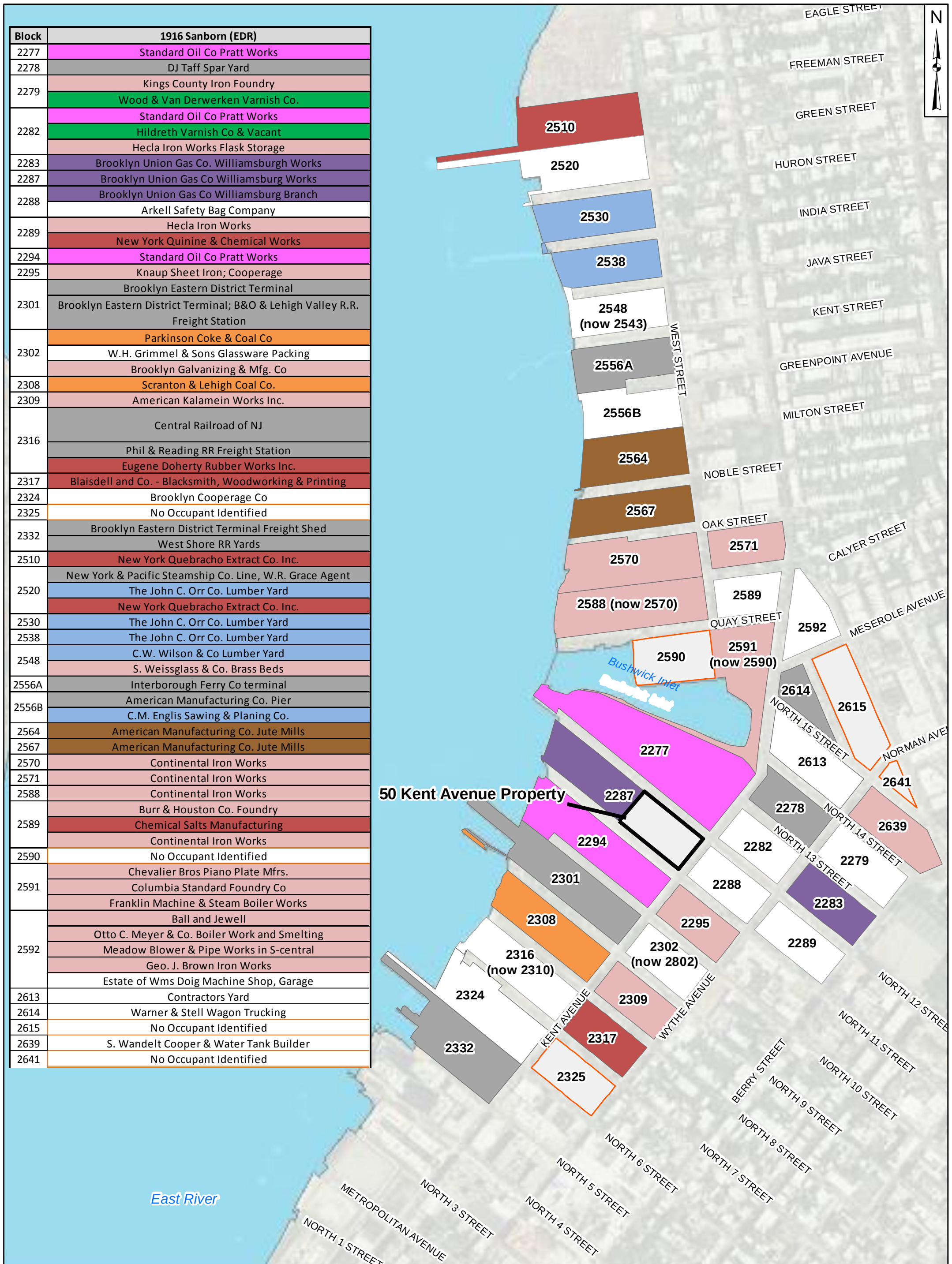
Coal	Transportation
Gas Works	Petroleum Storage and Distribution
Early Refinery	Cordage/Rope Manufacture
Foundary/Metals Works	Lumber Storage
Chemical	Misc. Storage, Manufacturing and Packaging, and Use Unknown
Paper and Boxes	Mixed Use
Paint and Vanish	No Occupant and/or No Entity Identified
Food Products	

Figure 4A

Historic Operations - 1887

Williamsburg
Brooklyn, New York

December 2017



Block	1916 Sanborn (EDR)
2277	Standard Oil Co Pratt Works
2278	DJ Taff Spar Yard
2279	Kings County Iron Foundry
	Wood & Van Derwerken Varnish Co.
2282	Standard Oil Co Pratt Works
	Hildreth Varnish Co & Vacant
	Hecla Iron Works Flask Storage
2283	Brooklyn Union Gas Co. Williamsburgh Works
2287	Brooklyn Union Gas Co Williamsburg Works
2288	Brooklyn Union Gas Co Williamsburg Branch
	Arkell Safety Bag Company
2289	Hecla Iron Works
	New York Quinine & Chemical Works
2294	Standard Oil Co Pratt Works
2295	Knaup Sheet Iron; Cooperage
2301	Brooklyn Eastern District Terminal
	Brooklyn Eastern District Terminal; B&O & Lehigh Valley R.R. Freight Station
2302	Parkinson Coke & Coal Co
	W.H. Grimmel & Sons Glassware Packing
	Brooklyn Galvanizing & Mfg. Co
2308	Scranton & Lehigh Coal Co.
2309	American Kalamein Works Inc.
2316	Central Railroad of NJ
	Phil & Reading RR Freight Station
	Eugene Doherty Rubber Works Inc.
2317	Blaisdell and Co. - Blacksmith, Woodworking & Printing
2324	Brooklyn Cooperage Co
2325	No Occupant Identified
2332	Brooklyn Eastern District Terminal Freight Shed
	West Shore RR Yards
2510	New York Quebracho Extract Co. Inc.
2520	New York & Pacific Steamship Co. Line, W.R. Grace Agent
	The John C. Orr Co. Lumber Yard
	New York Quebracho Extract Co. Inc.
2530	The John C. Orr Co. Lumber Yard
2538	The John C. Orr Co. Lumber Yard
2548	C.W. Wilson & Co Lumber Yard
	S. Weissglass & Co. Brass Beds
2556A	Interborough Ferry Co terminal
2556B	American Manufacturing Co. Pier
	C.M. Englis Sawing & Planing Co.
2564	American Manufacturing Co. Jute Mills
2567	American Manufacturing Co. Jute Mills
2570	Continental Iron Works
2571	Continental Iron Works
2588	Continental Iron Works
2589	Burr & Houston Co. Foundry
	Chemical Salts Manufacturing
	Continental Iron Works
2590	No Occupant Identified
2591	Chevalier Bros Piano Plate Mfrs.
	Columbia Standard Foundry Co
	Franklin Machine & Steam Boiler Works
2592	Ball and Jewell
	Otto C. Meyer & Co. Boiler Work and Smelting
	Meadow Blower & Pipe Works in S-central
	Geo. J. Brown Iron Works
	Estate of Wms Doig Machine Shop, Garage
2613	Contractors Yard
2614	Warner & Stell Wagon Trucking
2615	No Occupant Identified
2639	S. Wandelt Cooper & Water Tank Builder
2641	No Occupant Identified

Legend

- Coal
- Gas Works
- Early Refinery
- Foundary/Metals Works
- Chemical
- Paper and Boxes
- Paint and Vanish
- Food Products
- Transportation
- Petroleum Storage and Distribution
- Cordage/Rope Manufacture
- Lumber Storage
- Misc. Storage, Manufacturing and Packaging, and Use Unknown
- Mixed Use
- No Occupant and/or No Entity Identified

500 250 0 500 Feet

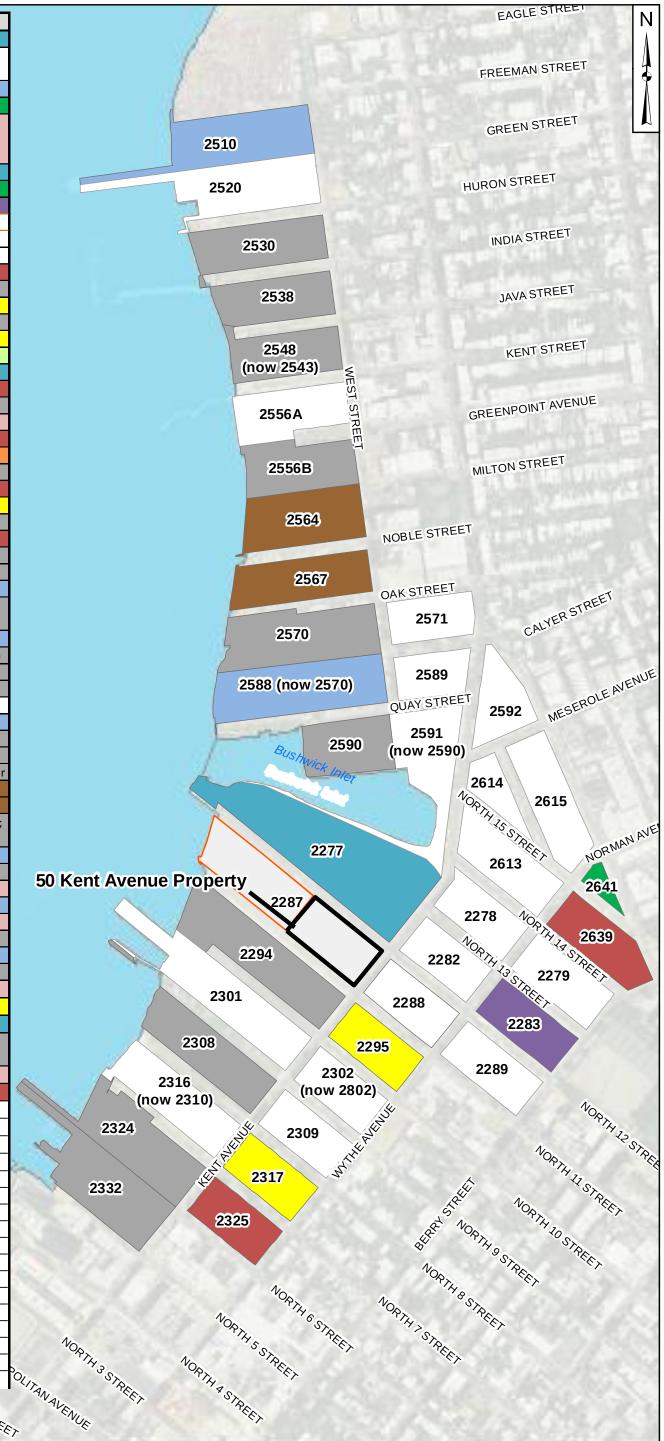
Figure 4B

Historic Operations - 1916

Williamsburg
Brooklyn, New York

December 2017

Block	1942 Sanborn (EDR)
2277	Standard Oil Co Pratt Works
2278	Scrap Metal, Iron Pipe and Hardware Storage, Pipe Cutting, Contractors Yard
	Lumber Storage
2279	Varnish Products Co
	Albert Pipe Supply Co, pipe storage; Metal Products and Bed Spring mfg. Enamel baking;
2282	Standard Oil Co Pratt Works
	Hildreth Varnish Co
2283	Gas Holders - Wythe Avenue Station
2287	No Occupant Identified
2288	Arkell Safety Bag Company
2289	Demuth Glass Works, Inc.
	New York Quinine & Chemical Works
2294	Brooklyn Eastern District Terminal
2295	Paper Storage
2301	Brooklyn Eastern District Terminal Stores
	Schrier Bros Inc. Paper Warehouse
2302	John Morrell & Co Meat Packers
	Oil Warehouse
	Asbestos Grinding
2308	Brooklyn Eastern District Terminal
2309	New York Standard Mfg Co (Ash Can Manufacturing)
	New York Quinine & Chemical Works Inc.
	Brooklyn Coal Co
2316	Brooklyn Eastern District Terminal - Flour Storage
	Eugene Doherty Rubber Works Inc.
2317	Whol. Paper & Twine Warehouse
2324	Railroad Spur/vacant
2325	Chemical Storage
2332	Brooklyn Eastern District Terminal Freight Shed
	West Shore RR Yards
2510	Lumber Storage
2520	Steamship Terminal Operating Corporation (Brooklyn Intercostal Terminal)
	Lumber Exchange Terminal Inc. Lumber Shed
2530	Steamship Terminal Operating Corporation (Lumber Storage)
2538	Steamship Terminal Operating Corporation
2548	Steamship Terminal Operating Corporation
2556A	W.N.Y.C. Radio Station & Transmittal Building
	E. Faber Pencil Co, Lumber Storage
	Private Garage
2556B	Greenpoint Terminal Corporation
	American Manufacturing Co. at Greenpoint Terminal Corp Pier
2564	American Manufacturing Co. Jute Mills
2567	American Manufacturing Co. Jute Mills
2570	American Manufacturing Co. Storage at Greenpoint Terminal; Iron Storage
2571	George Douglas Lumber Yard
	Garage & Storage
	Sheet Metal Worker
2588	Lumber Storage
2589	Burr & Houston Co. Foundry
	Auto House and Storage
	Woodworking
2590	Liberty Dry Dock Inc.
2591	Hollow Metal Door Mfg
	Paper Box Warehouse
	Filling Station
	D. Costagliola & Co. Inc. Ship Yard and Dock; Liberty Dry Dock Inc.; Auto and Wagon House
2592	Ball and Jewell Forge
	Wax Refining
	Meadow Blower & Pipe Works
	Greenpoint Brass & Bronze Foundry
	Edward Ehrbar Inc. Storage (construction equipment)
	Wms Doig Machine Shop and Garage
2613	Advance Pressure Castings
	Geo A Milton Can Co. Inc.
	Auto Wrecking, Service Station Oils
	Ferro-Co Corporation
2614	Welding
	Garages
	Warner Dog Food Co
	Plywood Storage
2615	C.E Halback & Co Iron Works
	Fish Smoking
	Garage & Storage
2639	Pilgrim Piece Dye Wks
2641	Paint and Varnish Mfg.



Legend

Coal	Transportation
Gas Works	Petroleum Storage and Distribution
Early Refinery	Cordage/Rope Manufacture
Foundary/Metals Works	Lumber Storage
Chemical	Misc. Storage, Manufacturing and Packaging, and Use Unknown
Paper and Boxes	Mixed Use
Paint and Vanish	No Occupant and/or No Entity Identified
Food Products	

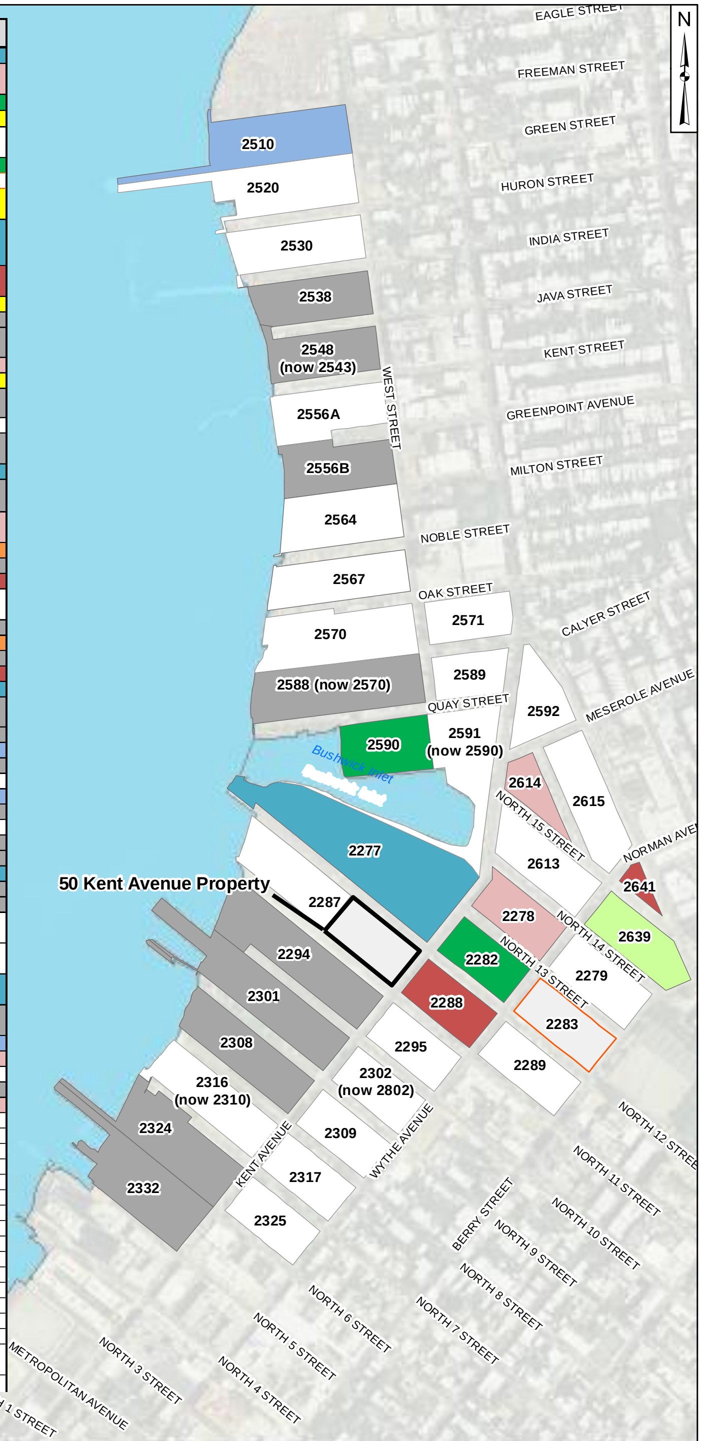
Figure 4C

Historic Operations - 1942

Williamsburg
Brooklyn, New York

December 2017

Block	1965 Sanborn (EDR)
2277	Paragon Oil Co Division of Texaco Inc.
2278	Williamsburg Steel Products Co. Iron Door Mfg.
2279	Dutch Masters Paint & Varnish Co
	Paper Products Storage
	Bed Spring Mfg; Ace Surplus Co, General and Machinery Storage
2282	Paint Manufacturing
2283	No Occupant Identified
2287	Commercial Corrugated Container Corporation
	Paragon Oil Co. (Division of Texaco) operations (per ACRIS): oil truck repair and parking/storage; scrap metal storage
2288	Laundry and Dry Cleaning Supplies Warehouse
2289	Paper and Cardboard Storage
	Private Parking, Truck Loading, Freight
2294	Brooklyn Eastern District Terminal
2295	Parker Steel Products, Inc.
	Waste Paper Storage
2301	Brooklyn Eastern District Terminal, storage tanks
2302	Storage and Scrap Metal
	Compound & Packing and Truck Loading, Flour Warehouse and Private Garage
	Oil Warehouse
2308	Brooklyn Eastern District Terminal; Locomotive Repair Shop
2309	New York Standard Mfg Co (Ash Can Manufacturing)
	Coal Yard
2316	Brooklyn Eastern District Terminal
	Chemical Supply Warehouse
2317	Warehouse, Washing Fluid Bottling, Painters Equipment Storage
	Truck Storage
	Coal Yard
2324	Railroad Spur, Auto Repair to NW
2325	Chemical W. Ho.
	Oil Truck Storage
2332	Brooklyn Eastern District Terminal
	West Shore RR Yards
2510	Lumber Storage, Saw Mill
2520	Sealand Dock & Terminal Corp.
	Cement Mfg. and Storage
2530	Lumber Storage
	Parking
	Pipe Shop, Misc Storage
2538	Sealand Dock & Terminal Corp.
2548	Sealand Dock & Terminal Corp.
2556A	Oil Drum Storage
	Machine Shop, Garage, Steel Stash Storage
2556B	Greenpoint Terminal Corporation
2564	Mill Framework and Structures (storage, construction)
2567	Mill Framework and Structures (storage, construction)
2570	Associated Transport Inc (parking) and Filling Station
	Greenpoint Terminal Warehouses - Jute Storage
2571	George Douglas Lumber Yard
	Welding Contractors, Sheet Metal Worker
	Garage and Storage
2588	Associated Transport Inc.
2589	Williamsburg Steel Products Co.
	Woodworking
2590	Iron Door Drying, Painting, and Storage
2591	Filling Station
	Storage and Warehouses
2592	Ball and Jewell
	Mueller Steam Specialty Co. Metals Wkg.
	Wax Refining and Wax and Resins Storage
	Manhattan Blower & Pipe Works
2613	Steel Drum Storage Yard and drum painting
	Service Station Oils
	Warehouse and Shipping
2614	Metal Finishing, Storage
2615	Williamsburg Steel Products Co.
	Fish Smoking
	Welding Supplies; Machine Shop
2639	Myer 1890 Dated Beverages, Inc.; Century Smoked Fish Co.
2641	Inflammable liquid canning



Legend

- Coal
- Gas Works
- Early Refinery
- Foundary/Metals Works
- Chemical
- Paper and Boxes
- Paint and Vanish
- Food Products
- Transportation
- Petroleum Storage and Distribution
- Cordage/Rope Manufacture
- Lumber Storage
- Misc. Storage, Manufacturing and Packaging, and Use Unknown
- Mixed Use
- No Occupant and/or No Entity Identified

Figure 4D

Historic Operations - 1965

Williamsburg
Brooklyn, New York

December 2017

In January 2017, National Grid filed a complaint, Civil Action No.: 1:17-cv-00045-MKB-ST, amended in April 2017, in the United States District Court for the Eastern District of New York ("the Amended Complaint"). The Amended Complaint identifies 15 defendants, including Exxon Mobil Corporation (ExxonMobil or Exxon), Bayside Fuel Oil Depot Co. (Bayside); Texaco, Inc. (Texaco); Motiva Enterprises LLC (Motiva); Sunoco, Inc. (Sunoco), Chevron, U.S.A. Inc. (Chevron); The United States of America; and The City of New York, and

> is a civil action for cost recovery arising out of the disposal, release, and/or threatened release of hazardous substances into the environment at current and historical facilities owned and/or operated by Defendants… adjacent to the Bushwick Inlet and the East River in Brooklyn, New York (the "Bushwick Site"…)….[National Grid's] historical Williamsburg Works Manufactured Gas Plant was operated and controlled by Defendant ExxonMobil and/or its corporate predecessors and sat on the Bushwick Site, adjacent to the facilities owned and/or operated by Defendants….Exxon's corporate predecessors Charles Pratt & Co., Astral Oil Company, and Standard Oil owned, managed, and/or operated the Pratt Works Refinery on the Bushwick Site. The site of the Pratt Works Refinery (the "Refinery" or the "Refinery Site") was owned by ExxonMobil and/or its corporate predecessors. The Refinery manufactured kerosene from coal and/or crude petroleum and produced naphtha and lubricant oils.

In a letter dated November 27, 2017, NYSDEC stated that it had identified ExxonMobil, Bayside, Texaco, Motiva, Sunoco, and Chevron, "(collectively, 'the Parties')" and The City of New York as potential responsible parties (PRPs) for the Bushwick Site. The letter goes on to state that the NYSDEC "will be providing notice to the identified PRPs, including National Grid, requesting that they agree to conduct an investigation of Block 2287…"

1.1.1 *History*

The history of the former Williamsburg Works MGP, the Pratt/Standard Oil refinery, and the surrounding area has been developed through the review of historical maps, photographs, drawings available Ordnance Department of the War Department files, available Sanborn Fire Insurance (Sanborn) maps, and periodicals; books; encyclopedias; and information presented in previous reports.

1.1.1.1 *Pre-Operational History*

A 1766 map depicts the former marsh and shorelines surrounding the Bushwick Site and Bushwick Creek. According to this map, the Creek extended to the east along North 14^{th} and North 15^{th} Street with the shoreline recessed to First Avenue (now Kent Avenue). An 1844 navigation map of the East River depicts a similar configuration of the historic shoreline and depth of water. Sometime between 1849 and 1855, approximately 20 feet of filling above the original ground surface, extended the land area westward into the East River. An 1868 insurance map shows Parcel 6 and Bushwick Creek filled and reshaped into what is now Bushwick Inlet. The basin at the end of North 12th Street was filled in between 1887 and 1898.

Based on the 1766 map, the present-day shoreline around Bushwick Inlet is further west than the historic shoreline. Historically, Parcel 1 comprised a portion of the shoreline and Parcel 2, Parcel 5, and 25 Kent Avenue were partially submerged, as were areas to the south of Parcel 5. South of North 7th Street the shoreline was similar to the current shoreline. Parcels 3, 4, and 6 were submerged, as were areas east of Parcel 6 to Berry Street. Other parcels east of Kent Avenue and south of 25 Kent Avenue were not submerged. To the north of Bushwick Creek, properties west of West Avenue were partially submerged.

1.1.1.2 *Consolidated Pratt Works Refinery-MGP Operational History (1860's – 1940's)*

By the late 1870s to early 1880s, the Standard Oil Company had seized control of approximately 80% to 90% of the refining capacity in the United States. In the late

1860's, William A. Rockefeller, Jr. had been sent by his older brother, John D. Rockefeller, from Cleveland, Ohio to New York City to head the export operations of what, in 1870, would become the Standard Oil Company. Henry Huttleston (H. H.) Rogers, an employee of Charles Pratt until the purchase of the Pratt Works refinery by The Standard Oil Company circa 1873/1874 and subsequently a trustee of the Standard Oil Trust and a Standard Oil vice president,[1] is credited with a patent, dated 1871, for distilling naphtha.[2] In the process, naphtha and its distillates were "entirely separated from the lubricating-oil and lamp-oil so that these heavier oils are entirely freed from light oils, which would make them dangerous to use."[3] The date of the patent approximately coincides with the development by Pratt's company of Astral Oil, a brand name for non-explosive kerosene, in response to a call for a safer illuminating product.

At the time, "in the ordinary method of distilling petroleum, the portion cut off as naphtha… [was] of little value"[4] and consequently there was little or no market for unrefined naphtha, which therefore was often discarded as an unusable by-product. With the purchase of Pratt's works by the Standard Oil Company, there would have been an emphasis on efficiency and reduction of waste, traits of John D. Rockefeller's management, and markets for the naphtha and its distillates would have been a focus for the company. In accomplishing its domination of the domestic refining capacity, Standard Oil's methods included "'predatory competition' that is, to sell at cost or less, until the rival is worn out. If the dealer still is obstinate, it [the Standard Oil Company] institutes an 'Oil War.'"[5]

With refining capacity under its control, the Standard Oil Company began to focus on controlling markets for petroleum products. The period from 1879 to 1889 was one of "great profits" for the Standard Oil Company; "competition practically out of the

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[1] "H. H. Rogers Dead, Leaving $50,000,000." *The New York Times*. 20 May, 1909.
[2] Rogers, Henry H. "Improvement in Distilling Naphtha and other Hydrocarbon Liquids." US Patent 120,539, issued October 31, 1871.
[3] Ibid, p. 3.
[4] Ibid, p. 3.
[5] Tarbell, Ida M. The History of the Standard Oil Company, Briefer Version. Ed. David M. Chalmers. Mineola: Dover, 1966. p. 123.

way, it set all its great energies to developing what it had secured.... In this period, too, the byproducts of oil were enormously increased."[6] "[John D. Rockefeller] undertook, late in the [eighteen] seventies, to organise the oil markets of the world, as he had already organised oil refining and oil transporting. Mr. Rockefeller was driven to this new task of organization….by that thing so abhorrent to his mind – competition. If, as he claimed, the oil business belonged to him, and if, as he had announced, he was prepared to refine all the oil that men would consume, it followed as a corollary that the markets of the world belonged to him…."[7]

In 1882, the Standard Oil Trust was formed and headquartered at 26 Broadway in New York, New York. That same year, the Standard Oil Trust formed the Standard Oil Company of New York (SOCONY and later Socony-Vacuum), and William A. Rockefeller, Jr. became its president.

1.1.1.2.1 Manufactured Gas Plant History

The earliest known gas holders at the Williamsburg Works MGP site were constructed circa 1863 and 1868.[8] The MGP is first shown on an 1868 Sanborn map. At that time, the gas production facilities were isolated to Parcels 2, 3, and 4 and consisted of coal carbonization gas production facilities including a retort house, an engine room, a meter house, and a condenser house.

During the 1870's, the city of Brooklyn was being served with gas by several companies. One of these companies, The Mutual Gas Light Company of Brooklyn, was incorporated on December 7, 1875.[9] James Jourdan was its president.[10] Construction of The Mutual Gas Light Company's works was begun during or after April 1877.[11] Circa 1879, "Jourdan secured the Long Island rights to the Tessie du Motay process of making

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[6] Ibid, pp. 185-186.
[7] Ibid, p. 110.
[8] New York City Department of Buildings, *Gas Holder Construction Information*, 1916, 1920, and 1921.
[9] Russell, Edwin F. The Brooklyn Union Gas Company Franchises and Municipal Consents. Cullen and Dykman, 1971, p. 69.
[10] "The Brooklyn Gas Monopolists." The New York Times. 27 July, 1879.
[11] "In Trouble." The Brooklyn Daily Eagle. 26 July 1879, p. 4.

water gas by combining steam with vaporized naphtha and other petroleum products…"[12]

Another gas company, The Fulton Municipal Gas Company of Brooklyn, was organized by James Jourdan and others and incorporated on March 5, 1879.[13,14] On April 9, 1879, The Fulton Municipal Gas Company of Brooklyn acquired The Mutual Gas Light Company of Brooklyn.[15] The sale price was allegedly $1, and the acquisition included The Mutual Gas Light Company's works, which were at that time under construction at the head of the Gowanus Canal.[16] With the transfer of assets to The Fulton Municipal Gas Company, construction on the works ceased. The plant was later completed, in 1880, as a carbureted water gas plant utilizing the Tessie du Motay process. Jourdan became vice-president of the Fulton Municipal Gas Company.[17,18]

Of the many Brooklyn gas companies, at this time The Fulton Municipal Gas Company alone manufactured carbureted water gas; the other companies manufactured gas by coal carbonization. The petroleum products used in The Fulton Municipal Gas Company's Tessie du Motay process "were controlled by the Standard Oil company], and the Standard Oil men with their unlimited capital thus became interested in the Fulton Municipal Gas company."[19] Accordingly, Standard Oil supplied The Fulton Municipal Gas Company with naphtha.[20]

In the early 1880's, The Fulton Municipal Gas Company of Brooklyn, having an "exceedingly comprehensive charter" but no territory of its own began a series of gas rate

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[12] "Financial Raids." The Brooklyn Daily Eagle. 13 May 1893, p. 2.
[13] Ibid, p. 2.
[14] Russell, Edwin F. The Brooklyn Union Gas Company Franchises and Municipal Consents. Cullen and Dykman, 1971, pp. 32 and 69.
[15] Russell, Edwin F. The Brooklyn Union Gas Company Franchises and Municipal Consents. Cullen and Dykman, 1971, p. 14.
[16] "The Brooklyn Gas Monopolists." The New York Times. 27 July, 1879.
[17] Stiles, Henry Reed. History of Kings County, Including Brooklyn, N.Y., 1683-1884, Volume 1. W. W. Munsell & Co. 1884. p. 676.
[18] Murphy, Robert E. Brooklyn Union: A Centennial History. The Brooklyn Union Gas Company. 1995, p. 9.
[19] Ibid.
[20] Stiles, Henry Reed. History of Kings County, Including Brooklyn, N.Y., 1683-1884, Volume 1. W. W. Munsell & Co. 1884. p. 675.

wars against other Brooklyn gas companies.[21] Consistent with "Oil Wars" conducted by the Standard Oil Company as it gained domination of oil refining capacity during the 1870's, the goal of the "gas wars" prosecuted by The Fulton Municipal Gas Company was to create and control a market for Standard Oil products.

Ultimately, a number of gas companies, including The Williamsburg Gas Light Company, agreed to settlement terms with The Fulton Municipal Gas Company. The settlement terms with the Fulton Municipal Gas Company varied among the defeated gas companies. The terms between The Fulton Municipal Gas Company and The Williamsburg Gas Light Company included that The Williamsburg Gas Light Company would lease The Fulton Municipal Gas Company's "Tesse de Motay [sic] system of making gas at a monthly rental of $3,000," though they never used it, and that "the Fulton-Municipal officials were presented with stock of the Williamsburgh [sic] company amounting, it is said, to one-third of the capital."[22] The monthly "tax" for the Tessie du Motay system varied over time, with the fluctuation of gas prices, to as low as $12,000 per year.[23] In the spring of 1883, H. H. Rogers and William [A.] Rockefeller[, Jr.] were on the boards of The Fulton Municipal Gas Company, The Metropolitan Gas Light Company, and the People's Gas Light Company.[24] Rogers and Rockefeller also served on the board of The Williamsburg Gas Light Company during the 1880s and 1890s.[25]

Standard Oil's control over The Williamsburg Gas Light Company and other Brooklyn gas companies, via The Fulton Municipal Gas Company, continued through the ten years following the settlement agreements of the early 1880's. In 1884, Joseph R. Thomas, formerly an engineer and director of the Williamsburg Gas Light Company testified that he "saw a check made by the Williamsburg Company to the Fulton Municipal Company. That check was indorsed [sic], 'Payable to William Rockafeller [sic];' and indorsed [sic] by William Rockafeller [sic], 'Payable to the Standard Oil

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[21] Progressive Age. Volume XI. 1893, p. 323.
[22] *Progressive Age*. Volume XI. 1893. pp. 323-324.
[23] *Progressive Age*. Volume XI. 1893. p. 324.
[24] Stiles, Henry Reed. History of Kings County, Including Brooklyn, N.Y., 1683-1884, Volume 1. W. W. Munsell & Co. 1884. p. 676.
[25] Progressive Age. Volume XI. 1893. p. 323.

Company.'"[26] In at least 1886 – 1887, SOCONY operated a Gas Stock Pool. In the pool, John D. Rockefeller owned 100 shares of The Fulton Municipal Gas Company and 175 shares of The Williamsburg Gas Light Company.[27] During this decade, two additional holders were built at the Williamsburg Works MGP site, one circa 1884 on Parcel 2 and the other circa 1888 on Parcel 1, to which the MGP had been expanded.[28, 29]

In the early 1890's, the settlement agreements of the early 1880s made with The Fulton Municipal Gas Company began to end. Though it had installed a Loomis (carbureted) gas process by at least September 1893, in April, The Williamsburg Gas Light Company had stopped buying naphtha from Standard Oil at above market prices.[30, 31] A second episode of gas wars was commenced by the Fulton Municipal Gas Company to return control of the gas market to Standard Oil. This episode included a notable conflict between The Fulton Municipal Gas Company and The Williamsburg Gas Light Company. The conflict began in August 1893 with The Fulton Municipal Gas Company securing the lease of a holder from The People's Gas Light Company and laying mains in Williamsburg. The Williamsburg Gas Light Company responded by laying mains into the territory of The People's Gas Light Company, knowing that loss of customers of The People's Gas Light Company would be loss of business to The Fulton Municipal Gas Company.[32] The second episode of gas wars ended in December 1894. As a result of the war, Standard Oil gained control of at least two-thirds of the stock of several Brooklyn gas companies, including The Williamsburg Gas Light Company, which amounts were needed to affect consolidation.[33]

The Brooklyn Union Gas Company (BUG) was incorporated on September 9,

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[26] Rand, Avery, and Company. Report of Hearing on Proposed Amendment of Statutes to Permit the Manufacture of Water Gas, Before Joint Standing Committee on Manufactures, Massachusetts Legislature, Massachusetts, General Court. Joint Standing Committee on Manufactures, 1884. pp 363 and 378.

[27] Letter from William Rockefeller, President of SOCONY, to John D. Rockefeller, October 25, 1887, Rockefeller Archive Center.

[28] New York City Department of Buildings, *Gas Holder Construction Information*, 1916, 1920, and 1921.

[29] The Sanborn Map Company, *Maps of Brooklyn*, 1887 and 1916.

[30] Progressive Age. Volume XI. 1893. p. 324.

[31] The American Gas Light Journal, 2 July, 1894, p. 12.

[32] Ibid, p. 324.

[33] Ibid, p. 324.

1895,[34] for the express purpose of acquiring seven Brooklyn gas companies.[35] A former "director of the Fulton Municipal company" identified Elverton R. Chapman, Henry H. Rogers, and William A. Rockefeller among others as the "promoters" of The Brooklyn Union Gas Company.[36] On November 4, 1895, BUG acquired by purchase the seven gas companies, including The Williamsburg Gas Light Company[37] and property on which would later be built its appurtenant Wythe Avenue Holder Station.[38] On December 10, 1896, The Williamsburg Gas Light Company was dissolved upon the ground of non-user in having failed to exercise its corporate powers for one year and having disposed of all its property and assets.

There was an interim board of directors for the first year of BUG's incorporation.[39,40] E. R. Chapman, "a recognized representative of the Standard Oil Company," was elected Treasurer.[41] At the November 1896 annual meeting, the elected directors included H. H. Rogers and William Rockefeller. H. H. Rogers was elected vice-president, later in the month, at a meeting of the board of directors.[42,43] Meetings of the BUG board of directors were held in Manhattan, at or near the offices of Standard Oil, rather than at the offices of BUG, in Brooklyn.[44] Board meetings continued to be held in Manhattan at least into 1914.[45]

With the filling of the basin on the western end of N. 12th Street, Standard Oil and Pratt Works Refinery infrastructure, in the form of oil pipes, was laid from Parcel 6, down N. 12th Street, and through Parcel 4 (Figure 5). The pipes connected Pratt Refinery Parcel 5 with Parcel 6 and Standard Oil refineries on Newtown Creek (See

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[34] Russell, Edwin F. The Brooklyn Union Gas Company Franchises and Municipal Consents. Cullen and Dykman, 1971, p. 2.
[35] Ibid, p. 4.
[36] "Sues to Recover Gas Stock." The Brooklyn Daily Eagle. 18 January 1896, p. 14.
[37] Ibid, pp. 2-3.
[38] *Minutes of the Board of Directors of the Brooklyn Union Gas Company*. 1895 - 1896.
[39] Murphy, pp. 22-27, 47.
[40] *Minutes of the Board of Directors of the Brooklyn Union Gas Company*. 1895 - 1896.
[41] Progressive Age, Volume XIII. 1895, p. 364.
[42] *Minutes of the Board of Directors of the Brooklyn Union Gas Company*. 1896.
[43] Murphy, pp. 21-27.
[44] *Minutes of the Board of Directors of the Brooklyn Union Gas Company*. 1895 - 1896.
[45] Murphy, pp. 39-40.

Section 1.1.1.2.2, below).[46,47]

In 1909, following settlement of a rate case with the New York Public Service Commission, Standard Oil gave BUG a rebate of $702,157.02.[48] The rebate was based on credits for Standard Oil delivering a lower grade of gas oil than required by contract in 1904 and for increasing the price of gas oil on two other occasions. At about this time, Standard Oil operatives maintained an ownership interest of approximately 10% in BUG.[49] Through at least 1919, Standard Oil remained the sole supplier of petroleum to BUG.[50] William A. Rockefeller, Jr. served as the Executive Committee Chairman of

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[46] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago),* Undated. Exxon Archives Box 2.207-F184.
[47] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.
[48] "Standard Oil Gave B'klyn Union Gas $700,000 Rebate." The Evening World 29 December 1915, p. 2.
[49] Murphy, p. 39.
[50] Ibid, p. 44.

BUG until his death in June 1922.[51,52] A Resolution, commemorative of his decease, adopted by the BUG board of directors states William Rockefeller was "one of the organizers of the Company and since its inception a member of the Board of Directors and Chairman of the Executive Committee. In his indefatigable service on the Board for a period of nearly twenty-seven years he was a potent influence on the upbuilding of the Company."[53]

During World War I the United States government, acting through the Ordnance Department of the War Department, constructed a toluol manufacturing plant within and adjacent to the contemporary boundaries of the Williamsburg Works MGP. Review of a title search performed on Parcel 2 indicated the United States of America owned a portion, or a sub-parcel, of this property from May 29, 1919 to October 31, 1921.[54] Prior to its ownership by the United States of America, the sub-parcel had been owned by Peter Doelger Brewing Company, Inc., and construction of a portion of the toluol plant on a sub-parcel of Parcel 2, caused this sub-parcel to become a portion of the Williamsburg Works MGP site. BUG took ownership of the sub-parcel on October 31, 1921.

The arrangements for construction and operation of the toluol plants were summarized in a September 17, 1917 memorandum from the War Department Office of the Chief of Ordnance. Five divisions of the War Department were involved in overall toluol program: the Design Section handled all general engineering, the Construction Section oversaw the construction and inspected the plants, the Production Section regulated the production of toluol and its transportation, the Purchase Section handled the acquisition of the toluol as well as the construction materials, and the Accounting Section tracked costs and payments.[55]

The contract between the United States of America and BUG for the operation of the Williamsburg plant contains several notable clauses including:

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[51] Ibid, p. 47.
[52] Resolution of the Board of Directors. Rockefeller Archive Center. William Rockefeller Collection, Record Group RG50, Series 1, Box 1, Folder 6.
[53] Ibid.
[54] Stewart Title Insurance Company. *Title No. ST-K-6299-SS*. 14 February, 2006.
[55] Memorandum to Major J.H. Burns, September 17, 1917.

Whereas, pursuant to the direction of the United States, the Contractor will maintain and operate said additional buildings, equipment, machinery, appliances, and other facilities now or hereafter to be provided by the United States…at the actual net cost of doing so, and the United States intends to reimburse the Contractor for such cost, so that the Contractor will not sustain any loss as the result of the performance of this contract on its part…[56]

The Contractor shall not acquire any property right, title, or interest of any kind in the Increased Facilities. The Increased Facilities shall be at all times considered personalty, which shall not be deemed or be affixed to or in any way part of the real estate to which said Increased Facilities are attached.[57]

In the event of removal by the United States of the Increased Facilities, the United States shall place the property affected by the construction of the Increased Facilities in as good condition as obtained prior to the construction of the Increased Facilities, subject only to reasonable wear and tear, all without expense to the Contractor. The United States shall reimburse the Contractor for any expense actually and necessarily caused by such removal[58]

The United States herby agrees, for and during the term of this agreement, to indemnify and hold the Contractor harmless from any and all costs, charges, and expenses (including liability for damages) imposed upon the Contractor by the municipal authorities in any permit for or consent to the construction, existence, use, maintenance, operation, or removal of any mains, pipes, conduits, poles, or any other sub or super structures in the streets which form part of the increased facilities.[59]

The United States shall pay the Contractor….The premiums such as bonds, fire, liability, and other insurance as the Contracting Officer may approve or require or

[56] Williamsburg Works Contract, July 2, 1918, p. 4.
[57] Williamsburg Works Contract, July 2, 1918, p. 4.
[58] Williamsburg Works Contract, July 2, 1918, p. 4.
[59] Williamsburg Works Contract, July 2, 1918, p. 8.

> as are required by the provisions of Articles X and XIX, including the premiums paid by the Contractor for insurance on the Gas Works against the extra hazard attributed to the maintenance and operation of the Increased Facilities in connection therewith.[60]

> The United States shall pay the Contractor….Such other items, credits, or allowances (including any unusual or extraordinary expenditures incurred in complying with the provisions of this agreement or in connection therewith) as should be in the opinion of the Contracting Officer be paid, allowed, or included….[61]

> In the event of the termination of this contract as aforesaid [in the event of failure of the Contractor to comply with the terms of this contract], the United States shall pay to the Contractor all costs to date, allowed and determined and not previously paid, and also all net outstanding obligations of the Contractor actually and necessarily incurred for the performance of this contract and from which the Contractor cannot otherwise be relieved, or the United States may, at its option, assume such obligations.[62]

The government provided material such as wash oil for use in the plants, paid direct materials and labor costs, as well as overhead and administrative and general expenses associated with the operation of the Toluol Plants.[63] The government also made decisions regarding the disposal of wastes, such as crude still residue, and various by-products. An example of this is found in a memorandum from the Ordnance Department's Procurement Section of the Explosives Division, in which the Ordnance Department noted that the light oil recovery plant contract states that "All other products obtained in the operation of the increased material shall, if so ordered in writing by the Contracting Officer, be and become the property of the United States or shall be used or disposed of by the Contractor as may be directed by the Contracting Officer."

[60] Williamsburg Works Contract, July 2, 1918, p. 13.
[61] Williamsburg Works Contract, July 2, 1918, p. 13.
[62] Williamsburg Works Contract, July 2, 1918, p. 16.
[63] See, for instance, Williamsburg Work Expenditures, May 1919.

Furthermore, "in order to keep the plants running it has already been necessary for this Division to authorize the operating companies to make disposition of crude still residue." The author of the memorandum added, "From time to time it will be necessary for us to authorize the disposal of crude benzol, solvent naphtha, crude naphthalene, and crude still residue." He recommended each plant dispose of the materials generated at its site, "but in order to keep a check on these companies, all specific offers that they receive, be submitted to us for approval."[64]

The Ordnance Department selected the Bartlett Hayward Company ("Bartlett") to construct the Two-Unit Scrubbing, Stripping and Fractionating Toluol Plant associated with the Williamsburg Works MGP. Procurement order GPWO 643-801G for the Williamsburg Toluol plant was issued December 21, 1917 and construction contract War-ord-G990-378E was dated January 31, 1918.[65] Construction of the toluol plant began on April 19, 1918.[66]

As a part of the construction of the Toluol Plants, it was necessary to lay pipes and other service lines through the city streets. In the Greater New York City area, the City of New York required that permits be obtained to lay the pipelines. Ultimately, the Ordnance Department agreed that the permits should be issued to the contractors acting as an agent for the Federal Government.[67] As described by the NYC Board of Estimate and Apportionment, the following pipes and service lines were installed by Bartlett during construction of the Williamsburg plant:[68]

- Six pipelines under and along the northerly sidewalk of North 11th Street, between the East River and Kent Avenue and under and along the westerly sidewalk of Kent Avenue and North 11th Street.

- Sixteen pipelines under and across Kent Avenue, about midway between North

[64] Memorandum to Major LeRoy Harkness, June 5, 1918.
[65] Department of Ordnance. *History of Light Oil Recovery Plants, Parts 1-3*.
[66] Department of Ordnance. *History of Light Oil Recovery Plants, Parts 1-3*.
[67] Ordnance Department. *History of Light Oil Recovery Plants, Part 1*, pp. 40-41.
[68] Board of Estimate Minutes, April 11, 1919

11th Street and North 12th Street. These pipelines were likely installed within Parcels 1 and 2.

The plant was "situated party upon premises of The Brooklyn Union Gas Company, under Contract G-1563-448-E, and partly upon adjoining premises purchased by the United States on or about July 12, 1919, from the Peter Dolger Brewing Company…"[69] A BUG drawing, dated July 27th 1921, suggested remnants of the equipment remained nearly three years after the operations ceased. The following features in the 1921 BUG drawing appear to be from the toluol plant:[70]

- Two scrubbers and a catch scrubber to the east of North 11th Street between the East River and Kent Avenue (Parcel 3). The drawing indicated these scrubbers were not in use. The number and type of scrubbers matches those used in the former toluol operation.

- A still house, with the note "Apparatus Dismantled", was located on the northeast corner of Parcel 2. The still house was located within the area of Parcel 2. This still house may have been used to house the wash oil and light-oil fractioning stills.

- Five tanks within two tank pits were located in the eastern and western corners of Parcel 1. The tank number and sizes are consistent with the 20,000-gallon vertical tanks described in the toluol operations. This tank configuration is also consistent with surveys review of other nearby toluol operations (Ordnance Department, unknown year).

- The pipelines and former toluol structures noted, suggest the former toluol operations extended to at least Parcels 1 through 3 and possibly onto Parcel 4.

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[69] Contract between the United States and McLoughlin, May 28, 1920, p. 4
[70] The Brooklyn Union Gas Co. Williamsburgh Works drawing 2-G-130 dated July 27, 1921.

In addition, a survey made for Chemical Equipment Corporation dated September 10th 1920 showed a tank on Parcel 2 near the corner of N.12th Street and Kent Avenue.[71]

The toluol plant began operations on October 8, 1918 and was discontinued 45 days thereafter, on November 21, 1918. Brooklyn Union Gas assumed operation under contract War-ord-G1563-448E on November 21, 1918. The toluol plant was rated to scrub 16,000 million cubic feet (M. cu. Ft.) of water gas per 24 hours and an average of 4.04 gals of gas oil were used per M. cu. ft. gas.[72] The performance of the plant is described below[73]:

- Gas
  - 14,509 M. cu. ft. gas scrubbed per day (average)
  - 90.6% of rated capacity
  - 17,629 maximum M. cu. ft. gas scrubbed per day
  - 10,220 minimum M. cu. ft. gas scrubbed per day
- Wash Oil
  - 8.1 gallons (average) circulated per M. cu. ft. gas
  - Loss of wash oil in of Light Oil recovered: 0.35%
- Recovery
  - 0.26 gallons Light Oil recovered per M. cu. ft. gas scrubbed (average)
  - 6.8% gas oil recovered as Light Oil (average)
- Candle Power
  - 18.8 candle power average inlet to scrubbers
  - 14.91 candle power average outlet to scrubbers
  - 3.89 candle power loss
- Fractionation, average recovery in percentages of Light Oil charged
  - Crude benzol: 35.7%
  - Solvent naphtha: 21.1%
  - Crude toluol: 19.8%
  - Still residue: 13.8%

The estimated annual pure toluol production was 407,000 gallons[74], however, given the short period of operation actual production was 39,829 gallons (see table below).

[71] Survey made for Chemical Equipment Corporation dated September 10, 1920.
[72] Department of Ordnance. *History of Light Oil Recovery Plants, Parts 1-3*.
[73] Department of Ordnance. *History of Light Oil Recovery Plants, Part 2*, p. 93-94.
[74] Department of Ordnance. *History of Light Oil Recovery Plants, Parts 1-3*.

In addition to toluol, other petroleum distillates were produced as reported by the Ordnance Department structures likely associated with the toluol plant[75]:

Month	Light Oil (Produced)	Crude Benzol (Produced)	Crude Toluol (Produced)	Solvent Naphtha (Produced)
October	94,881	17,806	8,706	2,875
November	106,625	54,127	31,121	39,658
Total	201,406	71,933	39,829	42,553

The toluol plant included the following equipment and operations[76]:

- A gas scrubbing system with two benzol vaporizers and one catch scrubber for gas enrichment.
- A wash oil stripping system with two wash-oil stills and two light-oil stills.
- A light-oil fractioning system with two crude still tanks, two rectifying columns, two dephlegamators, and two crude coolers.
- Storage capacity of four 40,000 gallon and five 20,000-gallon vertical steel tanks.
- One 560 HP Heine Boiler.

As mentioned above, the Toluol plant discontinued operations on November 21, 1918 after the signing of the Armistice. The Ordnance Department decided to sell the government-owned Toluol Plants as salvage in or about December 1919. The Ordnance Department entered into preliminary negotiations to sell the equipment to Brooklyn Union Gas, but evidently those negotiations failed.[77] On May 28, 1920, the United States entered into an agreement with McLoughlin Supply Company, Inc. for the sale of the government-owned equipment at the Williamsburg plant. The items identified at the Williamsburg Plant included the still building, pump house, laboratory and office building, fence tank pits, outside foundations, scrubbers, additional tanks together with manufacturing equipment, necessary overhead and underground piping connecting the various units, as well as “necessary sewer, drain, and other connections.” Furthermore,

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[75] Department of Ordnance. *History of Light Oil Recovery Plants, Part 2*, p. 93-94.
[76] Additional information on the facilities installed can be found in January 4, 1918, *List of Williamsburg Works, Light Oil Recovery Plant Costs*.
[77] Memo to Ordnance Salvage Board, December 9, 1919, pp. 1-2.

McLoughlin was to receive the proceeds from the sale of the 560 HP Heine Boiler, purchased by the Brooklyn Union Gas Co. from the US Government. [78] Forty-gallon Foamite engines, two units of pyrenes, a 4'6" Benzol feed tank, two W.O. coolers, 24 racks, two 40,000-gal tanks, and all straight pipe (formerly government owned property at the Williamsburg Plant) were exempt from the sale because they had already been sold to another party.[79] A list of the equipment at the Williamsburg Plant that was subject to the agreement can be found in Appendix B to the sale contract.[80]

By the mid-1920s, The American Light and Traction Company (American), a holding company organized for the purchase and reorganization of utilities and street railroads, had acquired an approximately 30% ownership interest in BUG. The United Light and Power Company (United), another holding company, had an ownership interest in American. In 1924, Koppers also made an investment in American.[81] By this time, "the Koppers interests had adopted the policy of acquiring coke producing properties at strategic points along the Atlantic Seaboard for the purpose of establishing a monopoly of that business in that area" and had formulated a plan for expanding its coke business. [82,83] In 1925 BUG acquired property in Greenpoint for the construction of combined carbureted water gas and by-product coke-oven plant. Construction of the combined plant, for which plans had been "kept in the drawer for many years," began in the winter of 1925-1926.[84]

In 1924, Henry B. Rust, president of Koppers, was elected to the board of directors of American.[85] In the fall of 1927, now chairman of the executive committee of American, Henry B. Rust began discussions with BUG to purchase the by-product coke

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[78] Contract between the United States and McLoughlin, May 28, 1920, p. 4-5.
[79] Schedule A, p. 1, attached to Contract between the United States and McLoughlin, May 28, 1920.
[80] The portion of the list pertaining to the Williamsburg Plant is located on pages 4-5 of Appendix B.
[81] Harry Helfman, et al. v. American Light and Traction Company, et al. 121 N.J. Eq. 1. (Court of Chancery, N.J. 1936).
[82] The United Light and Power Company v. Commissioner of Internal Revenue. 38 B.T.A 477 (1938).
[83] Harry Helfman, et al. v. American Light and Traction Company, et al. 121 N.J. Eq. 1. (Court of Chancery, N.J. 1936).
[84] Murphy. pp. 51-52.
[85] Harry Helfman, et al. v. American Light and Traction Company, et al. 121 N.J. Eq. 1. (Court of Chancery, N.J. 1936).

plant at Greenpoint.[86] The presidents of United and American, who were philosophically opposed to Koppers' business model, intervened and convinced BUG not to sell the coke-oven plant to Koppers.[87] To resolve the impasse, it was agreed that, in 1928, Koppers would obtain from American all of its holdings in BUG, allowing Koppers to negotiate with BUG, without interference from American, for the sale of the coke-oven plant, which began operation in November 1928.[88,89,90]

Koppers, by December 31, 1927, itself maintained an approximate 4% ownership interest in BUG, which combined with stocks acquired from American, in 1928, brought its total ownership interest in BUG to approximately 34%.[91,92,93] BUG agreed to sell the coke-oven plant to Koppers, who greatly expanded the plant and operated it until 1930, when the New York Public Service Commission blocked the sale.[94] Subsequently, BUG took over the plant and the Koppers staff which operated it.[95]

With the completion of the Greenpoint combined carbureted water gas and coke-oven plant, gas production at most of BUG's other gas plants was gradually decreased and the plants were taken out of service. During this period, from 1932 to 1937, Standard Oil refinery infrastructure, in the form of steam lines connecting Parcel 6 and Parcel 5, was installed over and across North 12th Street and North 11th Street and through the MGP (Figure 5).[96] Removal of the steam lines from North 11th and North 12th Streets, in 1937, approximately coincides with the cessation of operations and demolition of The Williamsburg Works MGP, after 1935. The 1941 Sanborn Map shows the Williamsburg

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[86] The United Light and Power Company v. Commissioner of Internal Revenue. 38 B.T.A 477 (1938).
[87] Ibid.
[88] Ibid.
[89] Murphy, p. 53.
[90] Koppers United Co. v. Securities Exchange Commission. Koppers Co. v. Same. Eastern Gas Fuel Associates v. Same. 138 F.2d 577 (D.C. Cir. 1943).
[91] "B'klyn Gas Deal Unverified." The Brooklyn Daily Eagle. 20 September 1928, p. 23.
[92] Koppers United Co. v. Securities Exchange Commission. Koppers Co. v. Same. Eastern Gas Fuel Associates v. Same. 138 F.2d 577 (D.C. Cir. 1943).
[93] In 1929, Koppers' approximate 34% ownership was reduced to 23.87% when debenture bonds that had been issued by The Brooklyn Union Gas Company in 1926 were converted to stocks. ("Brooklyn Union Gas Lists More Stock." The Brooklyn Daily Eagle 16 December 1928, p. 39.)
[94] Ibid.
[95] Ibid.
[96] Resolution of the Board of Estimate of the City of New York, February 3, 1938.

Works MGP site to be vacant lots.

During the period of Koppers interest, BUG bought all its coal from Koppers and sold all its surplus coke to Koppers. The directors of BUG "exerted only the most casual supervision over the prices involved in the inter-company sales." They gave "no serious consideration to the possibility of finding coke markets other than Koppers, although other concerns made unsolicited and unsuccessful attempts to buy Brooklyn's coke."[97] Going forward from at least 1934, Koppers received unlawful profits from BUG, in violation of the New York State Public Service Law.[98] Consequently, the New York State Supreme Court, ordered Koppers to pay $479,000 to BUG, minus income tax and lawyers' and accountants' fees for both the BUG directors and the plaintiffs.

Having petitioned the Securities and Exchange Commission to declare that BUG was not its subsidiary, the application having been denied, and all appeals having been lost, on March 29, 1944, Koppers sold its ownership interest in BUG. The next day, a Koppers vice-president, who had served on the BUG board since 1939, resigned.[99] As of this time, BUG "had issued no securities for nearly 20 years,"[100] an interval coincident with the period of Koppers ownership interest. The period encompassing control of BUG and its predecessor-in-interest, The Williamsburg Gas Light Company, by other entities overlaps with the operation and ownership of the Williamsburg Works MGP site from approximately 1883 through demolition of the MGP, and Koppers' sale of its ownership interest in BUG in 1944, respectively.

1.1.1.2.2 Refinery (Parcel 5, Parcel 6, and 25 Kent Avenue) History

The Pratt Works Refinery occupied approximately 8 acres with a quarter mile of water front and extended to over three parcels –Parcel 6, Parcel 5, and a portion of 25 Kent Avenue.[101] The majority of the distillation and refining operations occurred at

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[97] Ibid.
[98] Weis v. Coe. 180 Misc. 321 (N.Y. Misc. 1943).
[99] Murphy, pp. 63-64.
[100] Ibid, p. 63.
[101] Author Unknown, *The Model of the Refinery and Astral Oil Works – Chas. Pratt & Co, As Exhibited at the Centennial Exhibition, Philadelphia, 1876*, Undated. Exxon Archives Box 2.207-F184.

facilities on Parcel 6, located between Kent Ave, the East River, North 12th Street, and Bushwick Creek. These facilities on Parcel 6 were also known as Pratt's North 12th Street Refinery or the North 13th Street Plant. Parcel 5 historically appears to have been used primarily for filling, storage, and shipping – the 1887 and 1916 maps show oil storage in barrels (in 1887) and tanks (1916), as well as a cooperage, barrel printing operations, filling rooms and shipping rooms.[102] The western portion of 25 Kent Avenue was occupied by an agitator yard, bleaching pans, and R.O. storage tanks.

The construction of the plant began in the 1860s and the refinery, complete with crude stills and auxiliaries to manufacture light petroleum products, was erected by 1870 under the name Chas. Pratt & Co.[103,104] In 1873/1874 Pratt took his company into the growing Standard Oil Company and became a director of the larger organization; however because of his popularity and the popularity of "Astral Oil", both his name and that of his oil were retained in the Williamsburg operations. In 1874, Charles Pratt & Company was reorganized to encompass future functions as a holding company for Standard Oil. The firm of Charles Pratt & Company continued to grow over the following years with the backing of Standard Oil Company. In 1876, after his firm was taken into the Standard Oil Company and with their backing Charles Pratt purchased and began operating the refinery facilities, known as Pratt's Queens County Works, located on Newtown Creek.[105103] In 1877, Standard Oil gained control of the Sone and Fleming refinery, also located on Newtown Creek.

By the end of 1883, several changes had been made to the Refinery. The North 12th Street Refinery operations had been expanded through the acquisition of wharves and waterfront storage areas at the foot of North 10th and North 11th Streets (Parcel 5) and by the purchase of properties on the inland side of Kent Avenue between North 12th and North 13th Streets (portion of 25 Kent Avenue). According to Resolutions of the NY Board of Estimate, in 1882 Charles Pratt & Company received permission to build a

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[102] The Sanborn Map Company, *Maps of Brooklyn*, 1887 and 1916.
[103] Author Unknown, *Greenpoint History*, stamped 1954. Exxon Archives Box 2.207-F184.
[104] Asche, R. H. Pratt Works Brooklyn Superintendent, *Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.
[105] Author Unknown, Greenpoint History, stamped 1954. Exxon Archives Box 2.207-F184.

tunnel across Kent Ave (then First Street), between North 12th and North 13th Streets to connect the plant on Parcel 6 to facilities on 25 Kent Avenue. Subsequently, Parcel 6 and 25 Kent Avenue were connected "by way of a tunnel under Kent Avenue".[106] In 1883 the oil refining and marketing activities were transferred to a new company, Pratt Manufacturing Co. In December 1883 the Brooklyn Daily Eagle reported that an excavation was in progress between Bushwick Creek and Meserole Street related to "laying the last series of iron pipes connecting the Standard Oil Works on Newtown Creek with Pratt's Oil Works at North Thirteenth Street…Thus the Fourteenth Ward is placed in direct oleaginous connection with Pennsylvania."[107]

After 1883, Pennsylvania crude oil was delivered to the Pratt Works plant via pipeline.[108] The pipeline was built, starting in 1879, by the National Transit Company, a Standard Oil affiliate. It extended beneath the Hudson River through what is now Central Park in New York City, and under the East River and Blackwells Island (now Roosevelt Island), to Newtown Creek. The pipeline mainly supplied Standard Oil Refineries, along with some unaffiliated refineries, until approximately 1920, when barges began to be primarily employed.[109]

Beginning in 1890, the Pratt Works Refinery became known as the SOCONY Pratt Works[110] and in 1892, capitalization of the Standard Oil Company "permitted purchase of the properties of … Charles Pratt & Company" and others.[111] Sometime between 1887 and 1908 pipelines connecting Parcel 5 with Parcel 6 and with the Sone and Fleming refinery on Newtown Creek were installed in North 12th Street, underground across the MGP, and in North 11th Street (see Figure 5): "Tank steamers were loaded with refined oil for export at North 11th street…The oil being received there by pipe lines

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[106] Author Unknown, *Greenpoint History*, stamped 1954. Exxon Archives Box 2.207-F184.
[107] "A Big Job on Franklin Street, Oil to be Pumped from Pennsylvania to the Fourteenth Ward." *The Brooklyn Daily Eagle*. 6 December, 1883.
[108] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.
[109] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.
[110] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.
[111] Linton, W. L. *History of East River Works, January 24, 1950*. Exxon Archives Box 2.207-F184.

from North 12th Street, and from Sone & Fleming Works."[112,113]

Standard Oil operated two piers for the receipt of petroleum products and drums/barrels on the East River (north of 10th St and south of 11th St) and a bulkhead wharf on Bushwick Creek and East River associated with Pratt's 13th St plant operations (see below figure).[114] In the late 1800s product shipping occurred mainly via four-masted sailing vessels, various types of ships and barges, the largest of which could carry approximately 110,000 cases.[115] For transporting crude oil from railroad termini and shipping barrels and cases to different points in the harbor, two steamers and twelve lighters and canal boats were in constant use.[116] This manner of delivering gasoline in wooden barrels, and transporting in sailing ships continued until 1907 - when it was discontinued largely because of fires on shipboard, in many cases due to leakage of wooden barrels.[117,118] The law in early 1900s did not permit the movement of gasoline in bulk, so steel drums were filled at a yard at North 10th Street and then "as many as 10,000 bbls would be loaded aboard a single wooden lighter. The barge was then towed to one of various discharging stations along the New York."[119] Later on, starting around 1907, the delivery of gasoline in large quantity by tank steamers was begun. The two piers at North 10th St. and No. 11th St. furnished ample space for the vessels.[120,121]

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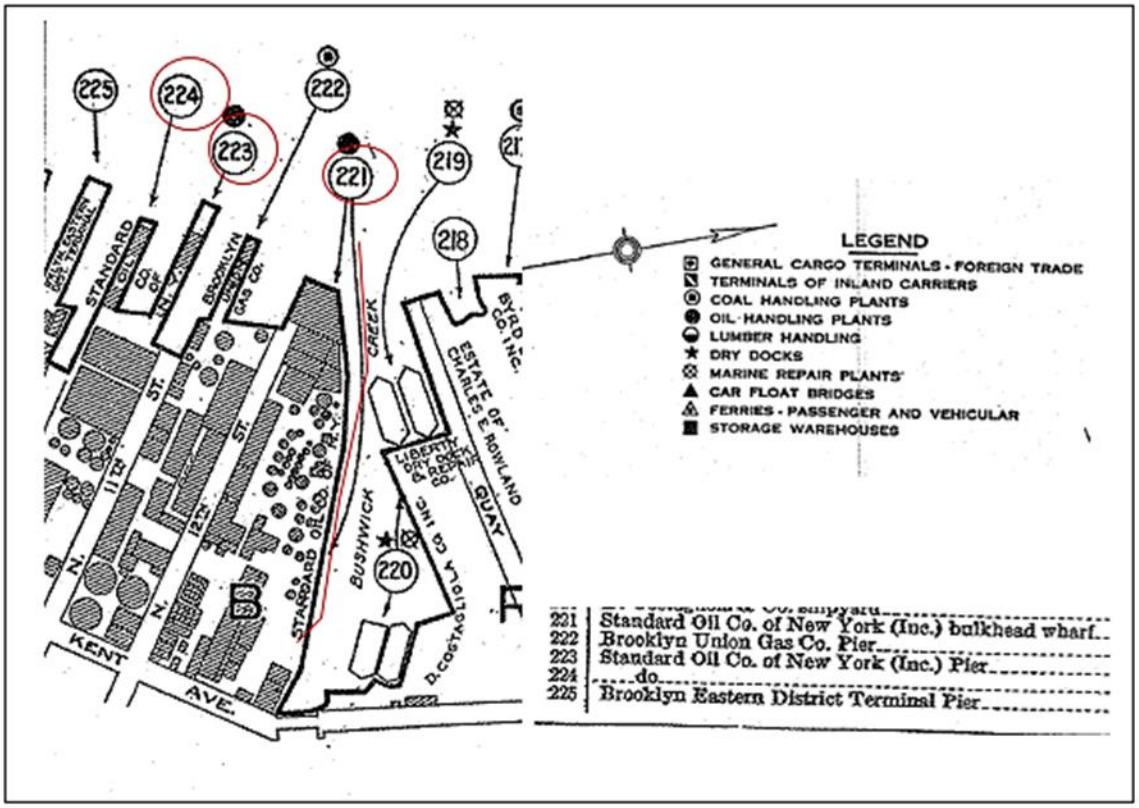
[112] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.
[113] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.
[114] Army Corps of Engineers, *The Port of New York Part 1: General Report*, 1932
[115] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.
[116] Author Unknown, *The Model of the Refinery and Astral Oil Works – Chas. Pratt & Co*, As Exhibited at the Centennial Exhibition, Philadelphia, 1876, Undated. Exxon Archives Box 2.207-F184.
[117] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.
[118] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.
[119] Mobil Mariner, *Three Former Deck Lighter Captains Now Retire Each Having 39 Years Employment with Socony*, 1956. Exxon Archives Box 2.207-F184.
[120] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.
[121] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.



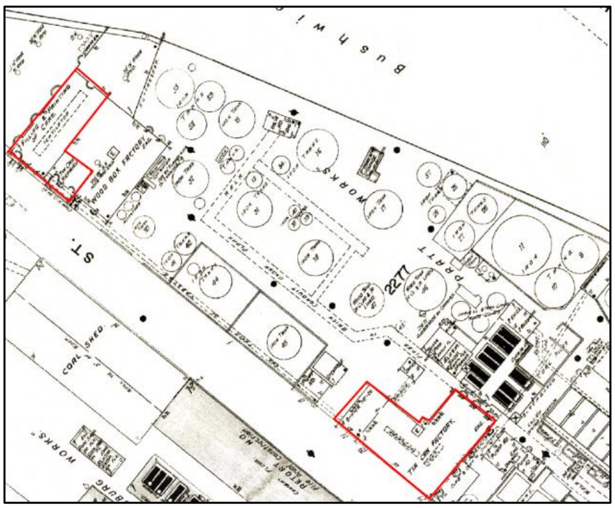
At the Pratt Works Refinery, "the greater part of the light gravity gasoline produced in the first distillation was used by the illuminating gas companies in and near New York," the filling of these grades was done at North 10th St.[122] A 1934 Socony-Vacuum *Flash* article further mentions that in 1886, "Captain Mackey…supervised the supplying of Gas Naphtha to the various gas plants in and around New York Harbor."[123] The Refinery also carried out "large business" in turpentine and an acid separating plant was also located on the plant property.[124]

Tin cans and cases were used for the storage and shipment of petroleum products, and all of the cans and cases used were manufactured at the Refinery.[125] Over 10,000 5-

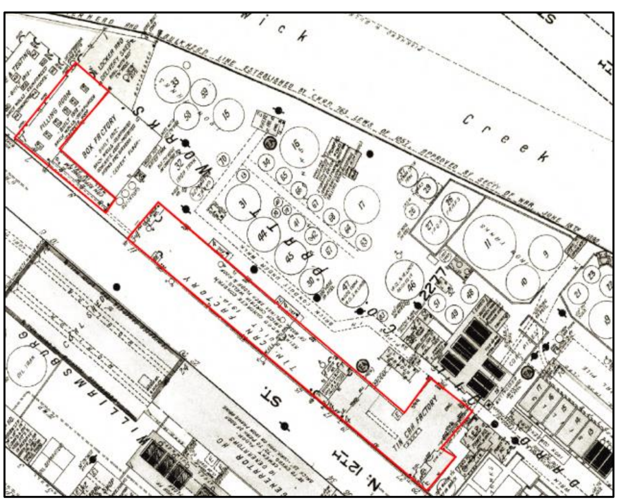
[122] Ibid.
[123] "A Visit to Pratt Works Forty-Eight Years Ago." Socony-Vacuum Flash. 20June, 1934. Exxon Archives Box 2.207-F184.
[124] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.
[125] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.

gallon tin cans were produced per day consuming 125,000 boxes of tin plate annually. Presses, trimmers, and various machinery for making the cans were located in a "can factory" near the East River and "all of the general tinsmith work was completed by hand"[126]. Tin, arsenic, and lead were used in the canning process. Canning operations expanded over time (see below figures – canning operations outlined in red).

1905



1916



[126] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.

As described in Section 1.1.1.2.1, above, between 1931 and 1937, steam lines across the Williamsburg Works MGP connected refinery operations on Parcel 6 and Parcel 5. By 1942, Standard Oil no longer operated the 10th Street and 11th Street piers, which were now part of the Brooklyn Eastern District Terminal. As more and more of the Refinery operations were transferred to other facilities in the Greenpoint-Newtown Creek area, the North 13th Street plant transitioned into a small packaging operation, employing only 50 people at the time it closed in the summer of 1949. A portion of the plant had been devoted to storage since 1923.[127]

Refinery Processes

In its early years the Pratt Works Refinery primarily manufactured, refined, canned, and exported high grade illuminating oils; then, around the early 1900s, the plant began to manufacture gasoline and naphthas.[128] Around 1876 nineteen stills handled over 120,000 gallons of Crude Oil on a daily basis[129],and eventually the plant was expanded to thirty-five stills (primarily for the production of naphtha)[130,]. At its peak, the Refinery "was regarded as one of the most complete in the United States,"[131] employed over 700 people[132] and handled over 50 million gallons of petroleum products per year including "Astral" oil (kerosene), crude petroleum, refined oils, naphtha, benzene, gasoline, lubricating oils, and turpentine. Around 1876 nineteen stills handled over 120,000 gallons of Crude Oil on a daily basis,[133] and eventually the plant was expanded to thirty-five stills (primarily for the production of naphtha).[134]

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[127] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.

[128] Asche, R. H. *Pratt Works Brooklyn Superintendent, Memo re: Plant History for Industrial Relations*, August 21, 1944. Exxon Archives Box 2.207-F184.

[129] Author Unknown, *The Model of the Refinery and Astral Oil Works – Chas. Pratt & Co*, As Exhibited at the Centennial Exhibition, Philadelphia, 1876, Undated. Exxon Archives Box 2.207-F184.

[130] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184..

[131] Ibid.

[132] Author Unknown, *Chas. Pratt & Co (1860) and Pratt Manufacturing Co. (1890) (of 60 years ago)*, Undated. Exxon Archives Box 2.207-F184.

[133] Author Unknown, *The Model of the Refinery and Astral Oil Works – Chas. Pratt & Co*, As Exhibited at the Centennial Exhibition, Philadelphia, 1876, Undated. Exxon Archives Box 2.207-F184.

[134] Linton, W. L. *History of East River Works*, January 24, 1950. Exxon Archives Box 2.207-F184.

After the crude oil was delivered to receiving tanks via pipeline or barge, water was separated from the crude and removed. From there, the refining process consisted of four primary steps: "1) "fractional distillation," where the petroleum was transferred into stills and heated, causing the constituent parts to separate out; 2) condensation of the kerosene distillate; 3) agitation with acid to bleach and deodorize the distillate; and 4) agitation with caustic soda or ammonia to neutralize any acids still in the kerosene."[135] During the fractional distillation step, "The crude oil…is run into horizontal cylindrical stills of wrought-iron, heated by anthracite fires…From these stills, pipes lead to large worms, cooled by running water and connected with a series of small tanks, so that the products from each still can be separately collected, and the successive portions that come from the still can be kept apart, according to their specific gravity."[136]

While kerosene was a primary product of the Pratt Works Refinery through the early 1900s, the distillation process could be manipulated to favor the production of other products. The temperature controls on the refining process result in variation in the composition, quality and quantity of the distillation products. At the Pratt Works Refinery, distillation temperatures started at 120°F and increased to 1000°F over approximately 48 hours, and the distillation products generally included gasoline (volatilizing at 225°F; specific gravity of 85° Baumé (B°)), naphtha (325°F; 74B°), benzine [sic] (350-400°F; 62B°), kerosene (400 increasing to 750°F; 50 to 48B°), and residuum or tar ; (20B°) remaining at the end.[137] At other Standard Oil Refineries in Brooklyn [Sone and Fleming], early refinery temperature controls were primitive: "For 40 of the plant's first 100 years, the people who operated it tried hard not to make gasoline, because there wasn't much market for it. The stillmen regulated the temperature of the stills by keeping track of the number of shovels of coal pitched onto the fire. If anybody lost count, the temperature went too high and the result was more gasoline and

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[135] J. Brown, D. Ment, *Factories, Foundries, and Refineries – A History of Five Brooklyn Industries,* 1980. Exxon Archives Box 2.207-F184

[136] "*Petroleum*." Popular Science. Vol 9. June 1876.

[137] Tarbell, Ida M. The History of the Standard Oil Company, 1963.

less kerosine [sic].”[138]

According to a SOCONY Lab Notebook re: Pratt’s Queens County Works on Newtown Creek[139] summarizing the fractional distillation process, the product streams were separated into a light worm (naphtha from 72 to 59B°, Water White from 59 to 39B°, 29B° distillate), intermediate worm (29B° distillate), and heavy worm (29B° distillate, wax pot, tar, cracking of 24.5B° and 12B°). Given the naphtha demands, the Water White cut could be omitted to produce more naphtha. After the still “has been turned into the wax pot and the stream flowing into this sort of open tank has become sufficiently sticky, the remainder in the still is dried out to form coke…Sometimes the still is not run down to coke “bottoms” but for tar naphtha or pitch. In that case the fires are hauled before the heavy stream reaches the wax pot stage and steam is turned into the still. If running for naphtha bottoms, full head of steam is turned into the still for from 3 ½ to 4 hours after the fires have been hauled and before pumping air out…Naphtha is further distilled from the product obtained from the crude by means of a steam still…Naphtha, Celsius and Petrolite, a similar oil, and Water White are treated and finished at the refinery. Tar, naphtha, pitch, and coke are finished products when the still run is over”. This summary appears to be consistent with operations, products, and process equipment at the Pratt Williamsburg facility.

Fires

Fires were reported at the Pratt Works in 1871, 1873, 1884, and 1909.[140,141,142,143,144,145] The 1871 fire was contained to one oil tank, but in 1873 it was reported that 6 stills full of crude were consumed and “burning oil ran along over the snow, and catching the wind created by the fire, formed large spiral columns of flame”

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[138] “Brooklyn.” *The Flying Red Horse*, Autumn. 1954. Exxon Archives Box 2.207-F184.
[139] *Queens County Works Lab Notebook*, 1913-1914. Exxon Archives Box 2.207-F186.
[140] “Fire in Williamsburg..” *The New York Times*. November 29, 1871.
[141] “Great Oil Fire.” *The New York Times*. January 27, 1873.
[142] *Watkins Express*, *Watkins, N.Y.*, December 25, 1884.
[143] “Oil Tanks in Flames.” *The New York Times*. December 22, 1884.
[144] “The Fire in the Oil Works.” *The New York Times*. December 23, 1884.
[145] “Oil Fire Rode in on the Tide.” *The New York Times*. October 13, 1909.

which threatened the Williamsburg Works MGP. It was further noted that "firemen, finding that the principal oil works could not be saved, turned their attention to the feed-tank, which contained over 500 barrels of oil…all the oil, amounting to between 5,000 and 6,000 barrels, that was in the works was all destroyed", however the fire was prevented from spreading to "the large stock which was lying in sheds near the river." The article states that "The large tanks in which the oil is kept are near the water side, at a safe distance from the refinery, and underground pipes connected with the stills, so that in the event of danger the oil can be run off," but according to the workmen this was not done during the 1873 incident.[146,147] During the 1884 fire "at one time five great tanks were filled with blazing oil, and eight tanks of crude oil, four tanks of naphtha, and one of tar were burned during the progress of the fire".[148] The fire extended to the wharf and almost engulfed the docked schooners loaded with oil. Articles report "boiling oil which overflowed the sinking tanks with each outburst, and ran in burning streams over the yard and toward the river and Bushwick Creek." A floating island of oil 50 yards in diameter was kept from spreading by fire-boats. Williamsburg Gas Works also suffered damage from the 1884 fire burning of coal houses and sheds.[149,150] In October 1909 it was reported that Bushwick Creek "was on fire for a while yesterday from burning oil" because "drainage from the Standard Oil Company works at the mouth of the creek was carried up the steam" and the oil on the surface of the water caught fire when a boat passenger tossed a lit cigar into the water.[151]

In 1891 and 1895 explosions were reported in stills and distilling tanks, the 1891 explosion occurring because the still was not "steamed out" after letting off the oil to remove the explosive gas inside.[152,153] According to the New York Times, the Health Board met in March 1872 to discuss whether "the Pratt Astral Oil-works, foot of North

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[146] "Fire in Williamsburg." *The New York Times*. November 29, 1871.
[147] "Great Oil Fire." *The New York Times*. January 27, 1873.
[148] *Watkins Express*, *Watkins, N.Y.*, December 25, 1884.
[149] "Oil Tanks in Flames." *The New York Times*. December 22, 1884.
[150] "The Fire in the Oil Works." *The New York Times*. December 23, 1884.
[151] "Oil Fire Rode in on the Tide." *The New York Times*. October 13, 1909.
[152] "An Oil Still Explodes." *The New York Times*. March 22, 1891.
[153] "Oil Explosion Killed Two Men." *The New York Times*. November 19, 1895.

Thirteenth-street, is a nuisance or not" and an 1882 Health Board report states that the vapors produced during the "blowing out" of stills are a nuisance and should be prevented.[154]

1.1.1.3 Post-Consolidated Refinery-Manufactured Gas Plant History

Subsequent to dismantlement of the MGP, the former Williamsburg Works MGP property was subdivided and redeveloped for commercial, industrial and manufacturing uses. A brief history of the post-MGP use has been developed from available BUG and Sanborn maps and is presented below by Site-specific Parcel IDs and tax lot/address.

BUG drawing 1G122 dated June 23, 1909 and retraced October 5, 1939 includes hand written notes indicating Block 2287 (Parcels 2 through 4) was leased by the United States Navy beginning on July 1, 1945, with permission to stay until June 30, 1946 or six months after the end of the war (World War II). The same lease was noted for Block 2288 (Parcel 1), with a cancelation of the lease in June of 1946.

Parcel 1

Parcel 1 was sold to Jerome Zirinsky in 1948. According to Sanborn maps, the property was developed as a beverage warehouse and garage in 1951 and had a gasoline storage tank. Subsequent Sanborn maps, 1965, 1978, and 1979 indicated the property use as a garage. Mr. Zirinsky was involved in property ownership until 1979 when the property was sold to NYC Industrial Development Agency. Colonial Mirror and Glass Corp. purchased the property on May 7, 1996. Colonial Mirror and Glass Corp. operated a garage at the property. January 7, 2002 Colonial Mirror and Glass Corp. sold the property to George and Abe Weiner, aka, Abraham individually and as trustees of the Colonial trust. On December 1, 2004, the property was purchased by Fourth Avenue Associates. More recently the property has become owned and/or operated by North 12th Associates LLC and 35 Kent Ave LLC. In August of 2013 Amazon opened a photography studio at the property.

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[154] "Brooklyn." *The New York Times*. March 3, 1872.

Parcel 2 (the Site)

The Brooklyn Union Gas Company sold the property to Kent Industrial Corp. on July 22, 1946. A warehouse/industrial building was constructed by 1951 and was occupied by the Ferro-Co. Corp. for sheet metal product manufacturing. (An underground storage tank, used as an oil/water separator for rainwater runoff from delivery trucks was identified beneath the floor of the building in a 1998 Phase I Environmental Site Assessment. See Section 1.2.1, below.) By 1965, the building was occupied by Commercial Corrugated Container Corp. On June 2, 1971 the property was owned by American Sandfill and Marine Corp. By 1980, the property was leased, and operated as a garage, by the New York City Department of Sanitation. New York City acquired block 2287, Lot 1 after June 2007, and ownership has since been transferred to New York City Department of Parks and Recreation (NYCDPR) for incorporation of the parcel into the nascent Bushwick Inlet Park. The NYCDOS garage occupied the property until prior to February 2009 when the garage building was demolished. Prior to the IRM, the parcel was vacant, fenced, and used by the NYCDPR as a parking lot and an outdoor concert space during warm weather months.

Parcel 3

Parcel 3 [Block 2287 Lot 16]: The property was sold by The Brooklyn Union Gas Company to Havemeyer and Elder Inc. on January 31, 1947, and Havemeyer and Elder, Inc. sold the property to Brooklyn Eastern District Terminal on August 31, 1948. Paragon Oil Co. Inc. purchased the property from the Brooklyn Eastern District Terminal on August 14, 1958. The 1965 Sanborn depicts two railroad spurs, a repair shop, office, scale, and scrap metal storage on the property. By 1978, the property and buildings were vacant except for the office. Texaco Inc. sold the property to Bridge Lumber Co. Inc. on May 24, 1982 which then sold the property to the New York City Industrial Development Agency on October 5, 1982. In 1983, the buildings were demolished and the property was used for parking. In March 26, 1987 the property was repurchased by the Bridge Lumber Co. Inc. which sold it to the R.A.R Realty Corp. on the same day. A warehouse building had been constructed on the property circa 1982, apparently coincidental with the purchase of the property by Bridge Lumber that year. The building was used for lumber storage until 1995, according to Sanborn maps. CitiPostal acquired the property from R.A.R Realty Corp. on June 29, 1995. 10th Street LLC acquired the parcel from CitiPostal on December 12, 2001, and New 10th Street LLC acquired the property on October 7, 2004. The building was used for by document storage business, CitiStorage, until January 31, 2015, when it was destroyed by a fire. The remnants of the building have been demolished and the parcel is currently vacant. In November 2016, New York City announced that it had reached a deal to acquire the property for its incorporation into Bushwick Inlet Park.

Parcel 4

Parcel 4 (Lot 30) appears to have been part of Lot 16 (current Parcel 3) until September 23, 1991. Prior and subsequent to that date, its ownership history is identical to that of Parcel 3. The 1965 Sanborn figure depicted three railroad spurs extending into the property from the west. Other Sanborn maps depict oil truck parking operations from approximately 1978 until 1982. As of 1984, the parcel appeared to be a paved parking lot, but it was later developed into multiple adjoining buildings, the westernmost of which was interconnected with the warehouse on Parcel 3. The buildings were used for offices and document storage until January 31, 2015 when they were destroyed by a fire. The remnants of the buildings have been demolished and the parcel is currently vacant. In November 2016, New York City announced that it had reached a deal to acquire the property for its incorporation into Bushwick Inlet Park.

Parcel 5

The 1941 Sanborn indicates the property was occupied by the Brooklyn Eastern District Terminal and that the oil storage tanks, coal pockets, and cooperage previously depicted on maps had been removed. At this time the Brooklyn Eastern District Terminal occupied multiple properties to the west along the East River. From 1942 to 1946, the property was used primarily for bulk flour storage, and rail lines. One chemical storage building was depicted to the southwest of the property, along North 10th Street.

In 1982, property operations remained very similar, according to the Sanborn map of that year. One exception was the additional railroad lines and spurs through the northern portion of the property into the footprint of the former Williamsburg Works MGP. Additional buildings were constructed to the north, adjacent to the railroad spurs, for lockers and general storage. A warehouse was constructed on the property in the 1990s and has been since used by CitiStorage for document storage. In November 2016, New York City announced that it had reached a deal to acquire the property for its incorporation into Bushwick Inlet Park.

Parcel 6

The 1951 Sanborn map depict similar property use as the 1941 Sanborn. However, the phrase, “not in use,” was noted above the SOCONY name. A 1954 aerial photograph confirmed the removal of the refining stills and equipment located in the southeastern portion of property. Since its operation by Standard Oil, the property has been owned and/or operated by many parties, including Paragon Oil Co. (a Division of Texaco, Inc.); Sunoco, Inc.; Motiva Enterprises LLC; Buckeye Partners, L. P; and Bayside Fuel Oil Depot Co (Bayside).

The 1965 Sanborn maps depicted a substantial change in property structures and ownership. The property was used by Paragon Oil Company Division of Texaco Inc. and all but one formerly existing building appears to have been removed as well as all the former tanks. Ten new tanks were shown:

- Four 500,000 gallon tanks for gasoline,
- One 212,000 gallon tank for kerosene,
- One 1,050,000 gallon tank for No. 2 fuel oil,
- One 840,000 gallon tank for No. 4 fuel oil,
- Two 212,000 gallon tanks for diesel oil, and
- One 1,206,000 gallon tank for No. 6 fuel oil.

A truck loading area is shown on the eastern portion of the property.

The 1978 Sanborn map notes the addition of a garage on the eastern portion of the property. Property conditions remain unchanged through the 1982 Sanborn map. Sometime after 1982, the property was converted for use by Bayside. The ten tanks and truck loading area are currently present and were in use through 2011, until Bayside Fuel began dismantlement. The NYSDEC Bulk Storage Database lists Bayside as Major Oil Storage Facility (MOSF) Site Number 2-1240. Bayside was also listed as Chemical Bulk Storage (CBS) with site number 2-000222, which expired on 02/08/2004. A building located south of the tanks, which remained through the property transformation, was used as office and warehouse storage space for Bayside with the upper floors rented out as studio space. New York City acquired the property in 2016 for its incorporation into Bushwick Inlet Park.

25 Kent Avenue

The 1941 Sanborn map indicates the property was used by SOCONY, Pratt Works, however the property is vacant except for a pump house and adjacent structure. The Refinery operated until 1949. The Hildreth Varnish Company operated on the property until at least 1942. Varnish works are shown, in the middle portion of the property, on historical maps dating back to 1868.

By the early 1950s, the Site was occupied by metal and lumber storage yards and a paint manufacturer. Between the mid-1960s and late-1970s, the paint manufacturing building was converted to a warehouse and several of the other structures at the central portion of the property were demolished. By the mid-1980s, the Site was occupied by an equipment rental facility and storage yard. The westernmost structure was demolished in 2012 and the Site was vacated sometime after April 2014. As of 2016, the property was owned by 19 Kent Acquisition LLC.

1.1.1.4 Successors to Owners and Operators

The Standard Oil Company, The American Light and Traction Company, The United Light and Power Company, Koppers, Paragon Oil Inc, Texaco Inc., and Motiva Enterprises LLC have been succeeded by other corporations, are doing business under other names, and/or are defunct. There are many successors to The Standard Oil Company; in the present instance, the relevant successor to The Standard Oil Company is ExxonMobil Corporation. Successors to The American Light and Traction Company include American Natural Resources Company, a wholly-owned subsidiary of TransCanada Corporation, and DTE Energy. The successor to Koppers is Beazer. The United Light and Power Company was liquidated and dissolved in 1950, with its liabilities ultimately passing to the Iowa-Illinois Gas & Electric Company, now MidAmerican Energy Company. The successor to Paragon Oil, Inc., Texaco, and Motiva Enterprises LLC is Chevron U.S.A. Inc. The successor to CitiStorage is Iron Mountain.

The United States of America; Sunoco, Inc.; Buckeye Partners, L. P.; Bayside Fuel Oil Depot Co.; 19 Kent Acquisition LLC; North 12th Associates LLC; 35 Kent Ave LLC; New 10th Street LLC; and City of New York are extant prior or current owners and operators of Parcels 1 through 6 and 25 Kent Avenue.

1.2 PRIOR INVESTIGATION AND REMEDIATION HISTORY

1.2.1 Investigations and Remediation Prior to the Remedial Investigation

Parcel 1

There are no known investigations that were conducted prior to the Remedial Investigation.

Parcels 2, 3, 4, and 5

Multiple investigations were completed at Parcel 2 [the Site] during NYCDOS operations. Volatile organic compounds (VOCs), heavy metals, and free phase diesel fuel were observed during these investigations as summarized below. During the investigations and/or subsequent removal actions, between 2000 and 2004, 6,402 gallons of contaminated fluids (including 131 gallons of free product) were removed from wells on the property. In 2004, an area around a well with free product was excavated. No NYCDOS reports are available for this property after January 2005.

Site Investigation (SI) and Cost to Cure Reports were prepared for the New York City Department of Design and Construction (NYCDDC) in 2006 and 2007, respectively, in preparation for developing the property as a park. These reports describe impacts by alleged responsible parties including: the former petroleum distillery operations, known and unknown off-site historic petroleum releases, the former Underground Storage Tanks (UST)s, including the one closed in place, the former MGP operations, and off-site industrial operations located along the East River. These reports also describe the conceptual plans for the park and provide potential remedial cost estimates.

1995-1996 - NYSDEC Correspondence and Internal Memoranda (Parcel 2, only)

A May 17, 1995 letter from the NYSDEC to the New York City Department of General Services (NYCDGS) indicates the presence of high concentrations of heavy metals discovered in a 1992 investigation.

In a letter dated June 7, 1995, the NYSDEC reports to the NYCDGS that the NYCDOS submitted a 1992 report prepared by Soil Mechanics Environmental Services. The report indicates there are areas of soil contaminated with heavy metals; including barium, lead, and mercury, on Parcel 2. The NYSDEC requested the collection of additional samples in the areas of heavy metals to confirm the presence of potential hazardous waste and to further delineate the areas of contamination.

The 1992 Soil Mechanics report was not available for review with the exception of Figures numbered 2, 3, 7, 10, and 11. The figures depict 12 soil borings (B-1 through B-12) and eight monitoring wells (MW-1 through MW-4 and MW-6 through MW-9) with summaries of contaminant concentrations. On the figures, lead, Total Petroleum Hydrocarbon (TPH), and total benzene, toluene, ethylbenzene and xylenes (BTEX) were reported within Parcel 2.

Two NYSDEC inner office memoranda (memos) (dated February 1 and March 27, 1996) discuss an Investigative Summary and Remedial Plan (ISRP) from the NYCDOS for Parcel 2. Previous property uses mention a long history of non-petroleum related industrial use including landfilling, coal gasification, and sheet metal operations.

The March 27 memo mentions extensive heavy metal and VOC soil and groundwater contamination across the entire property. The February 1 memo states:

> Lead concentrations range up to 1420 parts per million (ppm) in the soils and exceed class GA groundwater standards. Mercury was found in borings at concentrations up to 1.28 ppm. Boring logs also indicate the presence of elemental mercury. Trichloroethylene was found in one boring. Thousands of ppm of several chlorinated compounds were found in groundwater.

Most of the metals and VOC concentrations are above the then-applicable NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4046 guidelines, but none of the samples exhibited the hazardous characteristic of toxicity as determined by Toxicity Characteristic Leaching Procedure (TCLP) analysis. In the March 27 memo, the NYSDEC recommends the addition of Parcel 2 for “P” delineation as a potential hazardous waste site, and also recommends limited remediation for petroleum-related contaminants. The memo also states that further investigation and probably more extensive remediation will be required for the property.

A September 13, 1996 Raritan Enviro Sciences, Inc. (RES), inter-office memo RE: NYCDDC Contract PW348-04, Subject: Report of Free-Phase Petroleum Product at NYCDOS Brooklyn North 1 Site reports that on September 11, 1996 free phase petroleum product appearing to be diesel fuel was discovered for the first time in MW-2 located adjacent to the motor fuel tank system at the property. The product appeared to be a result of loss, which occurred earlier in 1996, from the active NYCDOS diesel tank system. Also noted in the memo is that during the attempt to develop MW-3, a dense non-aqueous phase liquid (DNAPL) was observed. It was recorded as “possible free-phase coal tar residuals and/or creosote.” RES recommended the skimming off of petroleum product in MW-2 with a passive recovery system. Further discussion between all the NYCDDC, NYC Law, NYCDOS, and NYSDEC was proposed regarding the product in MW-3.

An October 18, 1996 letter from the NYSDEC to the NYC Law Department provides comments on and conditional approval of the Phase Two Remedial Investigation Work Plan at the NYCDOS Brooklyn North 1 Site.

2004-2005 – LiRO Engineers, Inc. (Parcel 2 only)

As of at least 2001, an Interim Site Management Plan had been prepared for the NYDCOS facility.

First and fourth quarter 2004 Monitoring Reports by LiRo Engineers Inc. (LiRo) were submitted to NYSDEC describing current conditions, progress of remediation, and future recommendations for the NYCDOS Brooklyn North 1 facility located at Parcel 2 .

LiRo reports that in 2004 the NYCDOS facility consisted of a 44,000 square foot garage, used for vehicle storage and maintenance, bordered to the east by a 34,000 square foot parking lot. One 2,000 gallon gasoline and two 2,000 gallon fuel oil USTs, located in a common vault, are identified as closed in place. The LiRo report states that the USTs had reported leakage associated with piping failure and approximately 15 yards of visibly contaminated soil was removed from around the tank ports during closure. One petroleum spill was reported to NYSDEC for the property, the assigned spill number is 94-01167 in 1994.

The first quarter LiRo report references a letter dated February 7, 2002, where NYSDEC approved a plan to use a combination of oxygen release compound (ORC), bio-nutrient slurry, and vacuum enhanced fluid recovery (EFR) to address petroleum impacts associated with NYCDOS activities, as shown in Figure 2 and also discussed in the previous subsection.

Applications of bio-nutrient slurry began in January 2003 and continued once per week for six consecutive weeks. Each application consisted of bio-nutrient slurry being injected into each of 30 new bioremediation wells. On February 27, 2003 and August 27, 2003 ORC was applied to each of the 30 new wells.

During the work in 2003, a persistent plume of diesel fuel free product was identified around MW-2, and kerosene free product was intermittently observed in LW-1 and LW-2 located north across N 12th Street (i.e., adjacent to Parcel 6). LiRo states that the kerosene is not attributed to NYCDOS operations. From 2000 through April 2004, as part of the remediation of the NYCDOS property, LiRo removed 6,402 gallons of contaminated fluids, of which approximately 131 gallons was free product.

Both the April and January 2004 groundwater sampling results indicated that groundwater quality in the treatment area was generally stable or slightly higher than VOC concentrations previously measured and dissolved oxygen levels were continually high. NYSDEC requested that LiRo either install a product skimmer in MW-2 or excavate the area.

In December 2004, an area of approximately 10×10×7.5 feet deep was excavated around the MW-2 location where diesel fuel free product had been observed. No free product was observed within the excavation limits. Soil samples were collected from the four sidewalls and bottom of the excavated area before backfilling. Analytical results showed elevated semi-volatile organic compound (SVOC) concentrations in all five samples and elevated VOC concentrations in four of the five samples. MW-2 was replaced in January 2005. LiRo proposed adding two additional wells to the quarterly sampling plan and surveying the existing wells.

2006 – Metcalf and Eddy of New York, Inc. (Parcels 2, 3, 4, and 5)

For the proposed construction of the “Williamsburg Park” by NYC, Metcalf and Eddy of New York, Inc. (M&E) conducted a SI for the NYCDDC. The SI was completed at a property identified by the New York City Office of Environmental Coordination as, “west of Kent Avenue between and including North 10th and North 12th Streets”, an area which includes the former Williamsburg Works MGP and surrounding area. The purpose of the SI was to evaluate the lateral and vertical extent of potential contamination in subsurface soil, sediment, and groundwater that may relate to historic and current operations.

A subsurface investigation of the study area (Parcels 2, 3, 4, and 5) was conducted that included the following:

- Collection of 60 soil samples from 28 soil borings (BPB-1 through BPB-23, and LPB-1, LPB-6, LPB-11, LBB-12, LPB-15, and LPB-20). Soil borings were drilled to depths ranging from 27 to 68 feet below ground surface (bgs).
- Collection of 20 sediment samples from 9 sediment cores (ERS-1 through ERS-9). Sediment cores were drilled to depths ranging from 50 to 62 feet below the mud line of the East River.
- Collection of 13 groundwater samples taken from 9 newly installed wells (MW-1 through MW-9) and 2 previously installed wells (MW-7X and MW-8X).
- Soil and groundwater samples were analyzed for Target Compound List (TCL) VOCs, TCL SVOCs, polychlorinated biphenyls (PCB)s, and target analyte list (TAL) metals.
    - Analytical results from soil samples were compared to the then-applicable NYSDEC guidelines identified in TAGM No. 4046 (Recommended Soil Cleanup Objectives [RSCOs] and Soil Cleanup Objectives to Protect Groundwater Quality [SCOPGQ]); Spill Technology and Remediation Series (STARS) Memo No.1, TCLP Alternative Guidance Values; and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.
    - Analytical results from groundwater samples were compared to NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Memorandum (Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations); and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.

The SI report describes analytical results of M&E sampling as follows:

- TCL VOCs were detected in 30 of the 60 soil samples above either the NYSDEC TAGM RSCO, TAGM SCOPGQ criteria, and/or the STARS.

- TCL SVOCs were detected in 39 of the 60 soil samples above either the NYSDEC TAGM RSCO, TAGM SCOPGQ criteria, and/or the STARS Alternative Guidance Values.
- PCBs were detected in soil samples, but were below the NYSDEC TAGM criteria.
- TAL Metals were detected in all 60 soil samples, at levels above either the NYSDEC TAGM RSCO or the NYSDEC Eastern USA Background Criteria.
- Total Cyanide was detected in 10 of the 60 soil samples. There is no standard specified for total cyanide in either the NYSDEC RSCO or the NYSDEC Eastern USA Background Criteria.
- TCL VOCs were detected in 16 of the 18 groundwater samples above the NYSDEC TOGS Groundwater Criteria.
- TCL SVOCs were detected in 14 of the 18 groundwater samples above the NYSDEC TOGS Groundwater Criteria.
- PCB concentrations were not detected; however, the method detection limit of 1 microgram per kilogram exceeds the NYSDEC TOGS Groundwater Criteria.
- TAL Metals were detected in all 18 groundwater samples above the NYSDEC TOGS Groundwater Criteria.

The SI report describes the nature and extent of M&E's findings as follows:

- Visual petroleum impacts were described in 4 of the 13 soil borings at depths ranging from 5 to 19 feet bgs.
- Visual tar impacts were described in 11 of the 13 soil borings at depths ranging from 5 to 55 feet bgs.
- Visual petroleum impacts were described in two of the nine sediment borings at depths ranging from 14 to 30 feet bgs.
- Visual tar impacts were described in one of the nine sediment borings from 22-24 feet bgs.

The SI Report references and summarizes a number of previous investigations. Titles and summarized findings of these reports are listed below:

- A Phase I Environmental Site Assessment (ESA) was completed by Energy and Environmental Analysts, Inc. (EEA) in 1994 at 20 North 12th Street (Parcel 3). The report concluded that the historic use of the property and surrounding properties may have been a potential source of subsurface contamination at the study area.
- A Phase II Site Investigation was completed by EEA in August 1995 as a follow up to the 1994 Phase I. Six soil borings were installed. Analytical results indicated that polycyclic aromatic hydrocarbons (PAH)s were present at concentrations above the NYSDEC RSCOs, as well as exceeded values in one sample for Total SVOCs for the NYSDEC TAGM 4046 requirements. Metals were not detected significantly above the NYSDEC TAGM 4046 RSCOs. The report concluded that no action was needed to remediate the study area since the property was capped with a one-story warehouse building, asphalt, and concrete.
- A Phase I ESA was completed by EEA in April 1998 at 20 North 12th Street (NYCDOS yard). A UST was identified beneath the floor of the building. The tank was reportedly used as an oil/water separator for rainwater runoff from delivery trucks at the lumber company, which formerly occupied the property. This report also identifies 41 NYSDEC spill incidents within a half mile radius, but concludes that although soil and groundwater contamination has resulted from some of the spills, they are unlikely a significant source of contamination.
- A Preliminary Site Assessment (PSA) was completed by Montgomery Watson in November 1996 at the Kent Terminal Facility located west of Kent Avenue between North 5th and North 11th Streets (Parcel 5 is included as a portion of the larger study area). The Study area is adjacent to the southwest boundary of the former MGP. Six areas containing nine USTs (1 active) were identified as well as an underground No. 6 fuel oil pipeline located along Kent Avenue with four reported releases between North 5th and North 11th Streets between 1986 and 1996. Nine soil borings and four monitoring wells were installed immediately

southwest of the SI Study area between North 9th and North 10th street. Soil samples were tested for total recoverable petroleum hydrocarbons (TRPH), TCLP, VOCs, SVOCs, RCRA metals, and PCBs. Analytical results did not identify any constituents in the soil above regulatory limits. Groundwater samples were tested for TRPH, chloride, salinity, VOCs, SVOCs, PCBs, RCRA metals, and dissolved RCRA metals. VOCs were detected above NYSDEC standards in one of the four groundwater wells. This report was also summarized by M&E below in section 1.4.4.1.

- An Additional Site Investigation Report was completed by Montgomery Watson in May 1997 at the Kent Terminal Facility. Eight additional soil borings were installed between North 10th Street and North 11th Streets. Organic vapors, staining, petroleum-like odors, and oily sheen were reported in the boring logs. Laboratory analytical results showed VOCs and SVOCs above the applicable guidelines in both soil and groundwater samples.
- A Limited Subsurface Corridor Investigation Report was completed by EMTEQUE Corporation in January 2003. During the work one sample was collected from the Parcel 2 NYCDOS facility. The sample contained VOCs and SVOCs at levels greater than NYSDEC guidance values, as well as concentrations of mercury and zinc above the NYSDEC RSCOs.

Tar and petroleum plume maps were prepared by M&E based on the boring logs and observations made during the SI.

2007 - M&E (Parcel 2 Only)

On behalf of the NYCDDC, M&E prepared a Cost to Cure (CTC) report for the NYCDOS garage located at Parcel 2. The CTC was based on the findings of the 2006 SI report (summarized in subsection 1.5.1.6).

The findings of the 2006 SI report are summarized and state the following:

- The study area contains contaminated historic fill from depths of 9 to 42 feet bgs.

- A majority of petroleum hydrocarbons were spread over the entire study area from depths of 0 to 31 feet bgs.
- MGP contamination is mixed with petroleum contamination from depths of 5 to 31 feet bgs in the north and northeastern portions of the study area and along North 11th and North 12th Streets.
- The area had been impacted by the former refinery operations, known and unknown off-site historic petroleum releases, the former USTs closed in place at the NYCDOS yard (Parcel 2), the former MGP operations, and off-site industrial operations located along the East River.

NYC's conceptual site development for Parcel 2 proposed an 8,000-square foot paved walkway and a 72,000-square foot landscaped or vegetated, open space. Two remedial cost estimates were prepared based on whether or not the excavated soil would be disposed off-site or reused on-site. The cost estimate for off-site disposal was $1,522,000, while for reuse of the excavated contaminated soil on-site an estimated CTC was $600,000.

2013 – URS Corporation (Parcel 2 Only)

URS Corporation (URS) completed a predesign investigation (PDI) and a supplemental PDI of Parcel 2 to support the planned IRM of the Parcel. The PDI investigation included the following:

- Completion of 11 soil borings (WW-SB-100 through WW-SB-110).
- Excavation of 14 tests pits (WW-TP-100 through WW-TP-113).
- Installation of two intermediate monitoring wells (WW-MW-100I and WW-MW-102I screened from 46.5 to 56.5 feet bgs and 49 to 59 feet bgs, respectively)
- Installation of one deep monitoring well (WW-MW-102D screened from 92 to 102 feet bgs).
- Gauging of existing monitoring wells
- Hydraulic conductivity testing
- Utility and subsurface infrastructure investigation

- Baseline groundwater modeling
- Noise and vibration study
- Adjacent building foundation assessment

The following were described on the URS boring/test pit logs:

- Tar impacts were observed in all 11 of the soil borings at depths ranging from 5 to 81 feet bgs.
- Petroleum impacts were observed in 3 of the 11 soil borings at depths ranging from 5.5 to 19 feet bgs.
- Contamination impacts, including tar and petroleum, were observed in eight of the 14 test pits at depths ranging from 1 to 10 feet bgs.
- Eight inches of DNAPL were recorded at WW-MW-13.

The PDI report concludes the following:

- No simply-described pattern of contamination was observed, but the contaminant extent was consistent with the existing site conceptual model that describes tar contamination migrating vertically downward from the former holders until reaching lower permeability lenses whereupon the non-aqueous phase liquid (NAPL) would migrate horizontally down gradient.
- Slug testing indicated that the soil has moderate to low permeability.
- Soils are poorly sorted and are considered moderately to very dense based on blow counts. Cobble lenses were encountered. The basal clay layer was observed to be very stiff.
- The geotechnical properties of the soil are conducive to the installation of shoring to aid in excavation, with the fines content assisting to reduce permeability. The clay layer would provide a firm base for shoring installation and tie-in. However, the presence of cobbles and fill debris would make some technologies, such as sheet pile, difficult to install.
- Test pits revealed frequent obstacles such as walls, pipes, and former holder tank walls that would require removal during the implementation of the IRM.

The 2013 Supplemental PDI consisted of seven geotechnical borings (GR-1 through GR-7) along with geotechnical laboratory testing. The data collected generally confirmed previous findings but with a more precise delineation of geotechnical stratigraphy. Impacts observed in the Supplemental PDI borings were consistent with initial PDI boring logs showing tar impacts observed in all seven borings at depths ranging from 5 to 61 feet and petroleum impacts in one of the seven borings from 25.5 to 27 feet.

2014 and 2015 – URS Corporation (Parcel 2 Only)

URS designed and managed the construction of 13 NAPL recovery wells (NRW-1 through NRW-13) as part of IRM activities for Parcel 2. Recovery well locations are shown in Plates 1 and 2. Screen intervals range from 7 to 62 feet bgs, with some wells screened at multiple intervals based on soil sample inspection during installation. Measurable DNAPL was observed in NRW1 through NRW-4, NRW-7 through NRW-10, and NRW-12 at thickness ranging from 0.1 foot in NRW-1 to 17.2 feet in NRW-10. URS recovers NAPL on a weekly basis from wells where NAPL has collected in the sumps. A total of 873 gallons of NAPL have been removed to date.

URS collected NAPL samples on September 12, 2014 from NRW-2, NRS-7 through NRS-10, and a Verizon Manhole. A soil sample was also collected from the Verizon manhole and this sample was also analyzed for dielectric fluid forensics. All samples were analyzed for extended PAHs/Biomarkers and TPH. Results of the analysis were used by Exponent to perform forensics analysis. Exponent's forensics analysis report is provided in Appendix V.

During the period December 2014 through January 2015, URS performed boring and test pit investigations at the 50 Kent Avenue parcel. The objective of this field effort was to gather additional information about potential obstructions to installation of support of excavation walls. URS installed 12 borings to a depth of 55 feet, and excavated 9 test pits. During this investigation, three NAPL samples were collected and analyzed for extended PAHs/Biomarkers and TPH.

Parcel 6

In preparation for inclusion of Parcel 6 in the Bushwick Inlet Park development, a SI Report and Cost to Cure Report were prepared for NYCDDC in 2006 and 2007. These reports describe impacts by fill mixed with ash and cinders that was brought to the property, releases from petroleum storage operations, and off-site MGP impacts migrating onto the property. These reports underplay the historic operations by Pratt Works on this parcel and do not acknowledge this on-site source when discussing the results of the investigations. These reports also describe the conceptual plans for the Bushwick Inlet Park and provide potential remedial cost estimates.

2006 – M&E Site Investigation Report

M&E completed a SI at a property identified by the New York City Office of Environmental Coordination as the Bayside Fuel Oil Company located at 1-65 North 12th Street. The purpose of the SI was to evaluate the lateral and vertical extent of potential contamination in subsurface soil and groundwater that may exist from historic and current operations.

A subsurface investigation of the Parcel was conducted that included:

- Collection of 43 soil samples within 13 on-site and 6 off-site soil borings (B-7A, B-12A, B-13A, B-15A, B-16A, B-20A, B-24A, B-28/MW-28, B-29, B-30, B-31/MW-31, B-32, B-33/MW-33, B-34, BPB-4, BPB-5, BPB6/MW-2, BPB-9, and BPB-13/MW-4). Soil borings were drilled to depths ranging from 47.6 to 72 feet bgs.

- Collection of 23 groundwater samples, including 4 duplicates, from the 5 monitoring wells installed during the SI and 14 monitoring wells installed during a previous SI.

M&E submitted the *Site Investigation Report* to the NYSDEC in November 2006. The report describes the following nature and extent findings:

- Soil and groundwater samples were analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals.
    - Analytical soil samples were compared to the NYSDEC standards identified in TAGM No. 4046 (RSCO and SCOPGQ); STARS Memo No. 1, TCLP Alternative Guidance Values; and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.
    - Analytical groundwater samples were compared to NYSDEC TOGS 1.1.1 Memorandum (Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations); and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.
- Visual petroleum impacts were described in the boring log for 1 of the 19 soil borings, boring B-15A from 9 to 11 feet bgs.
- Visual tar impacts were described in the boring logs for 2 of the 19 soil borings, in borings B-20A from 19 to 21 feet and BPB-13/MW-4 from 50 to 52 feet.
- TCL VOCs were detected in 17 of the 43 soil samples, above either the NYSDEC TAGM RSCO, TAGM SCOPGQ criteria, and/or the STARS
- TCL SVOCs were detected in 18 of the 43 soil samples, above either the NYSDEC TAGM RSCO, TAGM SCOPGO criteria, and/or the STARS Alternative Guidance Values.
- PCBs were detected in soil samples, but detections were below the NYSDEC TAGM criteria.
- TAL Metals were detected in all 43 soil samples, at levels above either the NYSDEC TAGM RSCO or the NYSDEC Eastern USA Background Criteria.
- Total Cyanide was detected in 3 of the 43 soil samples. There is no standard specified for total cyanide in either the NYSDEC RSCO or the NYSDEC Eastern USA Background Criteria.

- TCL VOCs were detected in 18 of the 23 groundwater samples, at levels above the NYSDEC TOGS Groundwater Criteria.

- TCL SVOCs were detected in 5 of the 23 groundwater samples, at levels above the NYSDEC TOGS Groundwater Criteria.

- PCBs were not detected; however, method detection limits (MDL)s exceed the NYSDEC TOGS Groundwater Criteria.

- TAL Metals were detected in all 23 groundwater samples above the NYSDEC TOGS Groundwater Criteria.

The SI Report references and summarizes a previous Phase II Baseline ESA investigation performed at the property by TRC Environmental Corporation (TRC) in December 2002. The TRC report concludes the following:

- There is a significant amount of off-site MGP source material and tar DNAPL near the southeast and southwest corners of Parcel 6, which represents a continuing source of contamination to the property.

- On-site groundwater and soil has been impacted by the MGP source material. Groundwater impacts from the off-site sources extend across the property from the southeast corner to within approximately 60 feet of the Bushwick Creek Inlet.

- On-site soil is significantly impacted with petroleum from product storage and handling, and visibly impacted soil exists in many locations from near ground surface to 20 or more feet deep.

- Benzene was detected in groundwater at concentrations ranging from 6.5 micrograms per liter (ug/L) to 29,500 ug/L. The highest concentration occurred where tar appeared in the boring.

- Areas outside of Parcel 6 are contaminated with MGP material, petroleum, and materials inherent to urban fill. The Phase II Baseline ESA indicated that surrounding conditions (i.e., the former MGP) are comparable to or greater than the study area, which is significantly impacted by MGP, petroleum, and urban fill materials.

M&E's *Site Investigation Report* indicated that as of 2002, groundwater did not appear to be adversely impacting surface water beyond what would be considered background conditions.

According to Sanborn maps a Pratt Manufacturing Company tar tank was located at the southeastern corner of the property. The RI report states the off-site MGP source material and tar DNAPL described above is believed to be based upon visual observation and potentially analytical data. Given the complex property usage and that the Pratt Works kerosene process used coal as a starting material; forensic analysis would be required to substantiate the source of the petroleum and tar materials.

2007 – M&E Cost to Cure Report

On behalf of the NYCDDC, M&E prepared a CTC report for the Parcel 6 property. The CTC was based on the findings of the 2006 SI report.

NYC's conceptual site development for Parcel 6 proposed a 27,000-square foot paved walkway and 243,000 square foot park area. Two remedial cost estimates were prepared based on whether or not the excavated soil would be disposed off-site or reused on-site. The cost estimate for off-site disposal was $6,000,000, while for reuse of the excavated contaminated soil on-site an estimated CTC was $2,900,000.

2008 – NYSDEC Spill Report, Former Chevron Facility

The NYSDEC provided a letter stating no investigation or response was required for a spill identified as case no. 9804544. The letter was addressed as the former Chevron facility. The report indicated ARCADIS BB provided a November 2007 Site Progress report regarding the spill. The no further investigation or response did not extend to any off-site migration of petroleum contaminants that were not addressed by the evaluation.

25 Kent Avenue (BCP No. 224207)

Starting in 2009, there have been several investigations conducted at the 25 Kent Avenue property.

Spill Documents, 1999 to 2014

The Site is listed on the NYSPILLS database as Sylvan Equipment Company, 91 North 12th Street. The database lists two closed spill incidents. Spill No. 99-06462 occurred on July 15, 1999 and is related to the discovery of free product and impacted soils during a Phase II investigation. This spill was attributed to leaks from former on-Site USTs and adjacent fuel terminal and MGP facilities. Numerous investigations and remedial activities occurred between 2007 and 2012. Based upon groundwater monitoring results and soil endpoint sampling, the NYSDEC closed this spill on April 2, 2012. Spill No. 02-07277 occurred on October 14, 2002 and is related to the discovery of free product in a facility monitoring well. This spill was associated with the report of illegal dumping to storm drains adjacent to the Site. The NYSDEC investigated the Site, determined a spill impacted a storm drain and notified the New York City Department of Environmental Protection (NYCDEP). No additional information is provided in the database report; however, the NYSDEC closed this spill on November 19, 2003.

Environmental Business Consultants (EBC) reviewed and provided a list of previous Phase II ESAs, spill investigation reports and other documents prepared for the property as part of the Brownfield Cleanup Program (BCP) application. These reports document the various site investigation, sampling, remediation and monitoring activities conducted as required by the NYSDEC to satisfactorily close the four listed LTANKS and NYSPILLS incidents identified for the site, however, significant residual soil and groundwater impacts remain onsite.

Tank Closure Site Assessment and Site Remediation Report, Ecosystems Strategies, Inc., October 2009

In July of 2009 Ecosystems Strategies, Inc. **(**ESI) prepared an Investigative Summary Report which documented conditions of concern at the property warranting remedial response including free product in a monitoring well and elevated concentrations of VOCs in soil and groundwater. Based on these findings a Remedial Action Work Plan was prepared in July 2009. The remedy included excavation and off-site disposal of petroleum-contaminated soils from three locations and closure of one 3,000-gallon fuel oil UST. Confirmatory endpoint soil samples were collected and indicated the absence of petroleum contaminants above guidance levels. Any exceptions were attributed to urban fill. Post remedial groundwater monitoring documented the continued presence of VOC concentrations above guidance levels on the property. ESI recommended quarterly groundwater sampling for one year at select wells.

Supplementary Remediation Report, Ecosystems Strategies, Inc., October 2010, Revised November 2010

Following post-remedial groundwater sampling, NYSDEC requested additional remediation. Contaminated soil was excavated near a sediment trap southeast of the machine shop. Confirmatory endpoint soil samples indicate document the presence of petroleum contaminants at 15 feet below grade. No VOCs above guidance values were detected in side wall samples. Laboratory results from downgradient wells suggest that remaining contaminated soils beneath the former sediment trap are not significantly impacting downgradient groundwater. ESI recommended additional groundwater sampling in three months.

Supplementary Groundwater Investigation Report, Ecosystems Strategies, Inc,. February 2011

Following additional remedial activities, NYSDEC required that a previously destroyed monitoring well be replaced and soil samples collected during the installation of the new well and an additional round of sampling of downgradient monitoring wells be performed. Laboratory results from additional soil samples confirmed contaminated soil present at 15 feet below grade and is not accessible for excavation. Laboratory results from the replacement well confirm the continued presence elevated concentrations of VOCs in groundwater in the immediate vicinity of the sediment trap; however, sample results from downgradient wells show no evidence of substantial groundwater impacts. ESI recommended additional groundwater sampling in three months.

Phase I Environmental Site Assessment, Environmental Business Consultants, November 2014

EBC reported that the Site as well as the surrounding properties, were historically operated as a petroleum manufacturing and storage facility, a paint and varnish manufacturing facility, manufactured gas plants, manufactured gas storage facilities and various other manufacturing operations. As such, there is a potential for historic site operations and/or operations at adjacent sites to have impacted soil, groundwater and/or soil vapor quality beneath the Site. Residual soil and groundwater impacts associated with the closed NYSDEC spill incidents remain onsite and impacts related to petroleum and MGP were confirmed at adjacent properties.

EBC recommended a Soil/Materials Management Plan (SMMP) be prepared to address soil excavated as part of Site redevelopment. EBC did not recommend further investigation as the Site had been extensively investigated, with some soil removal and long-term groundwater monitoring activities related to the closed NYSDEC spill incidents. EBC also recommended removing four identified above-ground storage tanks (AST)s and various drums and other containers of waste oil and automotive fluids and conducting additional investigation and/or remediation if warranted.

Remedial Investigation Report, Environmental Business Consultants, December 2014

The BCP Remedial Investigation was conducted in November and December 2014 by EBC to determine local geologic and hydrogeologic conditions, source areas, potential for contaminants to migrate from the property, and to characterize site-related contamination. The RI included sampling soils from test pits and soil borings, groundwater sampling, and soil vapor and outdoor air sampling. Results and conclusions included the following:

- Historic fill material was identified to depths as great as 12 feet below grade. The historic fill material contains VOCs, SVOCs, and metals above unrestricted and restricted use soil cleanup objectives (SCO)s.

- Lead hazardous soil was documented within a test pit in the west central portion of the property. The vertical extent of the lead hazardous soil is limited to 3 feet below grade.
- A peat layer is present at some locations beneath the fill followed by fine brown silty-sands and clays to a depth of approximately 15 feet below grade.
- Groundwater at the property is present at a depth of approximately 5 to 12 feet below surface grade flows in an east to southeasterly direction.
- The historic use of the property as a petroleum works, equipment storage / maintenance yard facility has resulted in discharges of gasoline and diesel fuel / fuel oil contaminating most of the site with elevated levels of VOC and SVOCs. Releases have likely occurred from multiple sources including subsurface releases from USTs and piping, and from surface spills related to fueling operations, equipment maintenance, fuel transfer and damaged and leaking heavy equipment.
- Groundwater is impacted with petroleum VOCs in the western third of the property. SVOCs in groundwater were generally limited to naphthalene. There were other reported exceedances for SVOCs in groundwater however these were in the parts per trillion range and more a function of the precision of the laboratory than actual contamination.
- Soil gas sampling identified generally low levels of petroleum related VOCs (BTEX) though elevated levels of light-end petroleum compounds including heptane, hexane and cyclohexane were reported in several locations. Chlorinated VOCs (CVOCs) were reported in almost all of the soil gas samples and in some cases, were present at levels above that which monitoring and possibly mitigation would be required to prevent vapor intrusion. There is no evidence that the CVOCs are Site related and are unlikely to be related to off-gassing from impacted groundwater. They appeared to be migrating onto the property in vapor form from an off-site source.

Recommendations following the RI included excavation and disposal of petroleum contaminated soil within the source area along with proper handling and disposal of all soils excavated for structural elements of the new building under a Remedial Action Work Plan and re-evaluating the potential for soil vapor impacts at the completion of remedial activities.

The RI was used to support a BCP Application for the entirety of Block 2282 (incorrectly identified as Block 2312 on the cover of the application) under the name Former Sunbelt Equipment. In the application, on Table 5, under Section 3.6 – Previous Owners and Operators, contact information for SOCONY (now d/b/a ExxonMobil) was listed as "Unknown." Former Sunbelt Equipment was entered into the BCP as site No. 224207.

Supplemental Investigation Report, Environmental Business Consultants, June 2015

The Supplemental Investigation was conducted in May 2015 by EBC to investigate the utility tunnel, former iron works, former varnish works, and former petroleum works. The investigation included sampling soils from soil borings and installing a test pit to evaluate the utility tunnel. Results included the following:

- Petroleum impacts were not observed in the vicinity of the former iron works.
- Petroleum impacted soil was observed from approximately 9 to 20 feet bgs in the vicinity of the former varnish works.
- Petroleum impacted soil was observed from approximately the ground surface to 30 feet bgs in the vicinity of the former petroleum works. The completion depth of the borings was 30 feet so the extent of contamination was not determined.

A twenty by twenty-foot excavation to a depth of approximately 8-feet below grade was exposed approximately four feet to the east of the property line adjacent to Kent Avenue. The excavation of this area revealed a brick structure, historic fill material, and several 8 to 12-inch diameter metal pipes. Black-stained soil with a strong petroleum odor was encountered at approximately 4 feet bgs. No intact structures were observed; however, EBC assumed based upon field observations that the brick structure and metal pipes were what comprised the historic utility tunnel. The tunnel appeared to be approximately 15-feet wide and extend approximately 20-feet into the property. EBC recommended addressing and remediating this area during the early stages of development.

Final Engineering Report, Environmental Business Consultants, November 2017

The Site was remediated in accordance with the Remedial Action Work Plan prepared by AMC in December 2014, and revised in July 2015, and the Decision Document dated July 2015. The remedy was implemented from August 2016 to September 2017 and included the following:

- Excavation of soil/fill exceeding Track 1 Unrestricted Use SCOs to development depths which averaged 24 feet below grade, with deeper remedial excavation in certain areas where end point samples at development depth exceeded Unrestricted Use SCOs;
- Transportation and disposal of 3,117.42 tons of D008 Hazardous Lead Soil;
- Transportation and disposal of 134,530.02 tons of historic fill, petroleum contaminated soil, and clean native soil;
- Removal of one 550-gallon motor oil underground storage tank, one 2,000-gallon gasoline underground storage tank, one 550-gallon gasoline oil underground storage tank previously abandoned with water, four adjacent, 2,000-gallon gasoline underground storage tanks three of which were previously abandoned with sand, and one was abandoned with water, and one 250-gallon No. 2 fuel oil underground storage tank;
- Transportation and Disposal of 8,114 gallons of petroleum contaminated water and petroleum;
- Transportation and Disposal of 11 drums of tank sludge;

- Sealing the utility tunnel by installing timber lagging near the opening of the tunnel to construct a 2-foot wide void. The void was filled from the sidewalk with concrete, creating a plug in the tunnel;
- Dewatering and treatment of approximately 20,000,000 gallons of petroleum-impacted groundwater before discharging to the NYC sewer system under a NYCDEP sewer discharge permit between November 2016 and September 2017. The system continued to operate until December 2017;
- Import of clean stone and recycled concrete aggregate to be used for backfill below the building's concrete mat slab;
- In two areas in the southwestern corner of the Site, end point samples exceeded Track 1 SCOs, and samples obtained from test pits indicated that VOC impacts exceeding Track 1 SCOs extended to a depth below levels that could be safely excavated. Therefore, those two areas of the Site are designated as Track 2;
- Development and implementation of a Site Management Plan for long term management of remaining contamination below the Track 2 portions of the Site; and

An Environmental Easement recorded on the two Track 2 portions of the Site will ensure implementation of the Site Management Plan (SMP).

Other Investigations

2006 – M&E Site Investigation 9th Street Equities LLC Property

For the proposed construction of the Williamsburg Park by the NYC, M&E completed a SI for NYCDDC at a property identified by the NYC Office of Environmental Coordination as the 9th Street Equities LLC Property, also known as the Levine Property, located at 86 Kent Avenue, Block 2301, Lots 1, 50, 60, and 70. This study area is adjacent, to the south, of the former MGP footprint. The purpose of the M&E SI was to evaluate the lateral and vertical extent of potential contamination in subsurface soil and groundwater that may exist from historic and current on-site and off-site operations. This property is outside of the former Williamsburg Works MGP footprint; however, it overlaps with a portion of Parcel 5.

A subsurface investigation of the Parcel was conducted that included the following:

- Collection of 45 soil samples including one duplicate within 20 soil borings (LPB-1 through LPB-20). Soil borings were drilled to depths ranging from 25 to 51 feet bgs.

- Collection of 10 groundwater samples including one duplicate from 9 monitoring wells installed within soil borings advanced as part of the SI. Ten- to 20-foot well screens were installed to depths ranging from 15 to 24 feet.

M&E submitted the *Site Investigation Report* to the NYSDEC in August 2006. The report describes the following nature and extent findings:

- Soil and groundwater samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and TAL metals.

    - Analytical soil samples were compared to the NYSDEC standards identified in TAGM No. 4046 (RSCO and SCOPGQ); STARS Memo No. 1, TCLP Alternative Guidance Values; and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.

    - Analytical groundwater samples were compared to NYSDEC TOGS 1.1.1 Memorandum (Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations); and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.

- Visual impacts were not observed in any of the 20 soil borings.

- A VOC (acetone) was detected above the TAGM RSCO and/or TAGM SCOPGO criteria in 5 of the 45 soil samples. Exceedances are attributed to likely laboratory contamination. Benzene was detected in two soil samples above the STARS

TCLP Alternative Guidance Value. The samples were from borings LPB-6 from 7 to 9 feet bgs and LPB-12 from 5 to 7 feet bgs.

- SVOCs were detected in 30 of the 45 soil samples, at levels above either the NYSDEC TAGM RSCO, TAGM SCOPGO criteria, and/or the STARS Alternative Guidance Values.

- PCBs and pesticides were detected, but did not exceed the TAGM criteria values.

- TAL Metals were detected in all 45 soil samples above either the NYSDEC TAGM RSCO or the NYSDEC Eastern USA Background Criteria.

- VOCs were detected in 4 of the 10 groundwater samples (including the duplicate location) above the NYSDEC TOGS Groundwater Criteria from MW-1, MW-5 and MW-6

- SVOCs were detected in 3 of the 10 groundwater samples (including the duplicate location) above the NYSDEC TOGS Groundwater Criteria from MW-1 and MW-6.

- PCBs and pesticides were not detected above detection limits.

- TAL Metals were detected in all 10 groundwater samples above the NYSDEC TOGS Groundwater Criteria.

The SI Report references and summarizes a number of previous investigations performed at the site. Titles and reported findings of these reports are listed below:

- A PSA was completed by Montgomery Watson in 1996 at several properties along Kent Avenue between North 5^{th} and North 11^{th} Streets. This report was also summarized by M&E above in section 1.4.2.3. The PSA refers to previous environmental studies conducted in 1986 and 1994. Five soil borings and two monitoring wells were installed. One of the soil samples collected contained leachable concentrations of arsenic and selenium above the federal hazardous waste standards, though a confirmation sample collected from the same area did not confirm the initial results. The analysis and standards for these samples were specified in the report. The results of the groundwater samples detected several total metals above the applicable NYSDEC TOGS criteria. However, only dissolved concentrations of arsenic and selenium were detected slightly exceeding the applicable NYSDEC TOGS criteria.

- A Site Assessment Up-Date Report was completed by Fleming Lee Shue in 2002 as an update to the work conducted by Montgomery Watson in 1996. The report identified two additional investigations conducted by Montgomery Watson in 1996 and 1997. Significant levels of VOCs and SVOCs were not identified and the subject site was removed from the NYSDEC's list of potential inactive hazardous waste sites. The investigation conducted by Fleming Lee Shue consisted of the collection of 12 soil samples from 6 soil borings and 3 groundwater samples. Laboratory analysis of the samples showed:
  - SVOCs were detected in several of the surface and subsurface samples that contained coal ash.
  - Naphthalene was detected in one subsurface soil sample above NYSDEC TAGM criteria.
  - Elevated levels of arsenic and mercury were detected in the soil samples. Mercury was detected above the NYSDEC TAGM criteria in all of the surface samples and arsenic was detected above the criteria in one subsurface sample.

Based upon the results and a comparison to Montgomery Watson's results, the report concludes that the data is indicative of impacts due to the disposal of coal ash as fill, with minimal impacts from petroleum due to leaking motor vehicles.

A Phase I ESA was completed by Fleming Lee Shue in 2003. The report summarized the past and current environmental conditions of the area along Kent Avenue from North 9th Street to Quay Street. The report concluded that there is minimal contamination, but significant amounts of coal ash are present in on-site fill material.

2006 – M&E Site Investigation of Bushwick Creek Inlet Property

For the proposed construction of the Williamsburg Park by NYC, on behalf of the NYCDDC, M&E completed a SI at a property identified by the NYC Office of Environmental Coordination as the Bushwick Creek Inlet property, which is currently owned by Motiva Enterprises LLC. The study area is located along Kent Avenue between the south shoreline of the Bushwick Creek and Quay Street. This study area is adjacent, to the north, of Parcel 5. The purpose of the SI was to evaluate the lateral and vertical extent of potential contamination in subsurface soil and groundwater that may exist from historic and current operations.

A subsurface investigation of the Parcel was conducted that included the following:

- Collection of 18 soil samples within 8 soil borings (BC-1 through BC-8). Borings were drilled to depths ranging from 43.7 to 72 feet bgs.

- Collection of 22 sediment samples from 11 sediment cores (BCS-1 through BCS-11). Sediment cores were drilled to depths ranging from 35.8 to 54 feet below the mud line.

M&E submitted the *Site Investigation Report* to the NYSDEC in November 2006. The report describes the following nature and extent findings:

- Soil and sediment samples were analyzed for TCL VOCs, TCL SVOCs, PCBs, TAL metals, and cyanide.
    - Analytical soil and sediment samples were compared to the NYSDEC criteria identified in TAGM No. 4046 (RSCOs and SCOPGQ); STARS Memo No. 1, TCLP Alternative Guidance Values; and, Characteristics of Hazardous Waste published in RCRA and NYSDEC Part 371.

- Visual petroleum impacts were observed in one of the 8 soil borings from 25 to 27 feet bgs, and three of the 11 sediment borings at depths ranging from 6 to 18 feet bgs.

- Visual tar impacts were not observed in any of the soil or sediment borings.

- VOCs were detected above the STARS criteria in three of the 18 soil samples. Naphthalene was detected in one soil sample above the TAGM RSCO and TAGM SCOPGW Guidance Values.

- SVOCs were detected in 6 of the 18 soil samples above either the NYSDEC TAGM RSCO, TAGM SCOPGW criteria, and/or the STARS Alternative Guidance Values.

- PCBs were detected, but did not exceed the TAGM criteria values.

- TAL Metals were detected in 16 of the 18 soil samples, at levels above either the NYSDEC TAGM RSCO or the NYSDEC Eastern USA Background Criteria.

- VOCs were detected above the TAGM RSCO, TAGM SCOPGW, and/or STARS TCLP Alternative Guidance Values in eight of the 22 sediment samples.

- SVOCs were detected in 11 of the 22 sediment samples above either the NYSDEC TAGM RSCO, TAGM SCOPGW criteria, and/or the STARS Alternative Guidance Values.

- PCBs were detected, but did not exceed the TAGM criteria values.

- TAL Metals were detected in all 22 of the sediment samples above either the NYSDEC TAGM RSCO or the NYSDEC Eastern USA Background Criteria.

The Site Investigation Report references and summarizes a previous Phase I ESA completed by Fleming Lee Shue in 2003. The report concludes the following:

- Tax Block 2590, Lots 25 and 100 (between Bushwick Creek and Quay Street) located to the north of Parcel 6, are currently undeveloped, however, several structures historically existed on-site including a ship yard and dry dock facility. This facility appeared to occupy portions of Lot 100 from at least 1942 to sometime prior to 1966.

A limited subsurface investigation conducted along Franklin Street and Kent Avenue identified possible subsurface petroleum contamination. Prior use as a shipyard suggests that possible contamination from anti-fouling paints, petroleum, and solvents, which may have been used at the time.

1.2.2 Williamsburg Works MGP Site Remedial Investigation (GEI 2015)

RI activities and prior and contemporary investigations were completed on only two out of the four site parcels and the adjacent rights of way. As the following figure illustrates, and as summarized below, the parcels that have not yet been investigated represent data gaps for nature and extent of impacts and Conceptual Site Model (CSM) associated with the former MGP and impacts that are commingled from other historic sources as well as recent land uses that likely contributed to non-MGP impacts commingling with impacts related to the former MGP.

The following paragraphs are excerpted from the Summary and Conclusions Section of the RI Report.

> A review of available historical information reveals that the area of the former Williamsburg Works MGP was subject to considerable filling prior to the operation of the MGP. Following the decommissioning of the MGP, the United States Navy used the property before it was sold. After it was sold, the properties were used for parking, lumber storage, sheet metal manufacturing, and city sanitation operations, including bulk petroleum storage. Currently, the former Williamsburg Works Site is used for document storage by CitiStorage, a parking and concert venue by New York Parks and Recreation Department, and a photography studio by Amazon. The former MGP was surrounded to the north (Parcel 6), northeast (25 Kent Avenue), and the south (Parcel 5) by the former Pratt Works Williamsburg site (aka Astral Oil Works). The Pratt Works refinery was originally constructed circa 1867, and eventually merged with SOCONY, which became Exxon Mobil. The former Pratt Works was one of the earliest and largest refineries in New York and contained dozens of bulk petroleum and tar storage tanks. Parcel 6 fronting on North

12th Street has been operated as a MOSF until very recently. This property has been operated by Pratt Works, SOCONY, Exxon Mobil, Paragon Oil Co (a Division of Texaco, Inc.), Bayside Fuel Oil, TransGas Energy Systems, and Motiva. National Grid and NYSDEC are aware of substantial petroleum impacts located on the North 12th Street MOSF site (Parcel 6).

RI activities and prior and contemporary investigations have been completed on two of the four Site parcels and the adjacent rights of way. The parcels that have not yet been investigated represent data gaps for nature and extent of impacts and CSM associated with the former MGP and impacts that are commingled with other sources surrounding the former MGP and contemporaneous with or post-dating the operation of the MGP. Parcels 3, 4, and 5 have not been investigated because investigation was not possible at this time due to building use.

The field investigation revealed that the shallowest subsurface materials consist of fill underlain, in some cases, by alluvial deposits. Beneath these materials, glacial till, glacial outwash sands, glacial lake clay, and bedrock were encountered, although not all of these materials were observed in each boring.

Tar appears to have originated from gas production and tar handling areas of the MGP footprint, particularly around the gas holders. Tar, released from the MGP source area generally migrated downward through the permeable fill until it encountered less permeable till or silty lenses. Tar tanks on Parcel 6 are an additional potential source of tar. A portion of the tar then migrated laterally to the northwest along the top of the less permeable layers. The remainder of the tar migrated downward through coarse-grained deposits within the glacial till into coarse-grained glacial outwash until it encountered the glacial lake clay. The clay layer acts as a barrier to the downward migration of tar at the Site.

Based on the areas investigated to date, the bulk of tar–saturated soil was limited to Parcel 2 near the former gas holders. Tar impacted soil was encountered as shallow as 5 feet bgs (5.69 feet North American Vertical Datum [NAVD]) in WW-SB-100 installed by URS and as deep as 56.5 feet bgs (-46.127 feet NAVD) in WW-SB-45. Tar-saturated soil was generally encountered on Parcel 2 above the glacial lake clay, which acts as a barrier to the downward migration of tar.

The overall vertical extent of tar migration has been defined by this RI. Visual tar impacts were not observed below the clay layer within surrounding deep borings installed by GEI. The lateral extent of tar migration has been defined to the north, east, and south. The extent of tar impacts on-site remains a data gap because Parcels 3 and 4 have not been investigated.

The former gas works was sandwiched between the Pratt works/Standard Oil refinery operations, located on Parcel 5 and 6. Sanborn maps showed that Parcel 6 contained tar tanks and coal piles/bins, in addition to petroleum tanks and a tin can factory, among other activities. Historical fires and accidents that occurred on Parcel 6, across the street from the former MGP, resulted in burning of the tar and oil tanks. In one instance, the entire refinery operation was destroyed. Parcel 5, apparently connected to Parcel 6 by pipelines that ran across the former MGP, contained refined-oil storage tanks, railroads, and a chemical storage area. The overlapping of these industrial activities suggests commingling of contamination. (Exponent, …).

Tar impacts were commingled with petroleum-impacted soil and fill at depths from ground surface to greater than 40 feet. Products associated with the former gas works (Parcels 1–4) included coal tar and petroleum (e.g., gas oil) used as a feedstock in the carbureted water gas process. After the MGP operations ceased, several other operations occupied the site parcels, including sheet metal manufacturing, scrap metal shops, and tanks and oil/water separators, among other operations (Exponent, Appendix …). Petroleum impacts are likely associated with multiple sources including historic on-site fuel storage, oil use and storage during NYCDOS operations, long-term off-site fuel storage and operations at the adjacent former Pratt Works (Parcels 5 and 6), and historic urban filling. The presence of additional non-MGP related chemicals including metals, solvents, pesticides, and PCBs in soils on the Site and adjacent to the Site further confirm the presence and comingling of multiple sources of impacts that require further evaluation.

The western lateral extent of impacts in sediments was investigated and delineated to the satisfaction of NYSDEC. The source of the sediment impacts is not clear however and may relate to multiple releases associated with the MGP, the former Pratt Works operation (including a well-documented catastrophic fire that caused releases of petroleum to the East River), and releases associated with outfalls to the East River. Further forensic evaluation will be necessary to assess the contribution of sediment impacts associated with these potential sources.

Within samples collected from the top 5 feet of subsurface soil, BTEX values did not exceed the appropriate restricted SCO criteria, however, individual and total PAH values were detected in some areas above the appropriate restricted SCO criteria. Elevated metal concentrations (arsenic, barium, lead, and mercury) were also detected. However, due to the shallow depths, these COPCs are likely associated with historic fill material used in the development and post-MGP operation of the Site.

Samples collected from visually impacted subsurface soil deeper than 5 feet were associated with BTEX and total and individual PAH exceedances of the appropriate restricted SCOs, within all of the parcels but most frequently Parcel 2. Elevated concentrations of dibenzofuran and metals (arsenic, barium, cadmium, copper, lead, and mercury) were also present. However, dibenzofuran and the noted metals are not associated with MGP operation and are associated with historic fill material used in the development and post-MGP operation of the Site. The presence of non-MGP related chemicals confirm the presence and commingling of multiple impact sources.

With the exception of one soil boring (WW-SB-23), analytical concentrations within samples collected below observed impacts at the completion of the borings were all below the appropriate restricted SCO criteria, indicating the vertical extent of impacts has been determined.

Groundwater at the area investigated moves through soil that contains both impacts associated with the former MGP operations and non-MGP sources. Groundwater moving through the areas of tar-saturated soil, residual tar, and petroleum impacted soil will dissolve the BTEX components and low molecular weight PAHs (e.g., naphthalene). The resultant groundwater plume is migrating in the direction of groundwater flow. Shallow groundwater flows to the northwest toward the East River during both high and low tides.

Based on the distribution of impacted soil and the groundwater flow directions, dissolved phase BTEX and PAHs associated with both petroleum and tar impacted soil is being transported by groundwater flow toward the East River. Potential dissolved phase contaminants that enter the river will likely be mitigated by processes of biodegradation, volatilization, and dilution.

1.2.2.1 RI Tin Data Review

A review of tin concentrations analyzed, but not reported, in soil samples collected during the RI was performed by Geosyntec Consultants on behalf of National Grid. Tin is a greyish white- metal with an average concentration in the Earth’s crust of 2

-3 milligrams per kilogram (mg/kg).[155] Recent results from the United States Geological Survey Geochemical and Mineralogical Maps for Soils of the Conterminous United States provide a median concentration of 1.3 mg/kg of tin in surficial soils (0-5 cm)[156].

Releases of tin to the environment may result from transport of tin containing gases, dusts, and fumes from smelting and refining, industrial manufacturing, waste incineration, and fossil fuel burning. Tin is generally regarded as relatively insoluble and immobile in the environment as it partitions strongly to soil and sediment[157].

Per NYSDEC CP-51 Soil Clean-up Guidance, the Supplemental Soil Cleanup Objective for Tin (protection of ecological resources pathway) is 50 mg/kg. The average concentration of tin in surface sediments in Central Park Lake was reported at 32 mg/kg. The accumulation of tin in Central Park Lake sediments was attributed to the historical contribution from municipal solid waste incineration in New York City[158]. For comparison, the median concentration of tin in Gowanus Canal sediments[159] is approximately 50 mg/kg and the median concentration of tin in Newtown Creek sediments[160] is 30 mg/kg. While these are sediment tin concentrations and not soil fill concentrations, they are indicative of an anthropogenic signature of tin integrated from multiple historic industrial sources over time.

A review of the Williamsburg Works MGP RI data suggests the following:

The embedded figure below shows tin concentrations in soil boring locations in the top 7.5 ft of non-native material bgs (shallow fill, assumed fill, or unknown). Borings with tin concentrations greater than 50 mg/kg are primarily located within or adjacent to the former footprint of the tin operations.

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[155] http://www.atsdr.cdc.gov/toxprofiles/tp55-c6.pdf

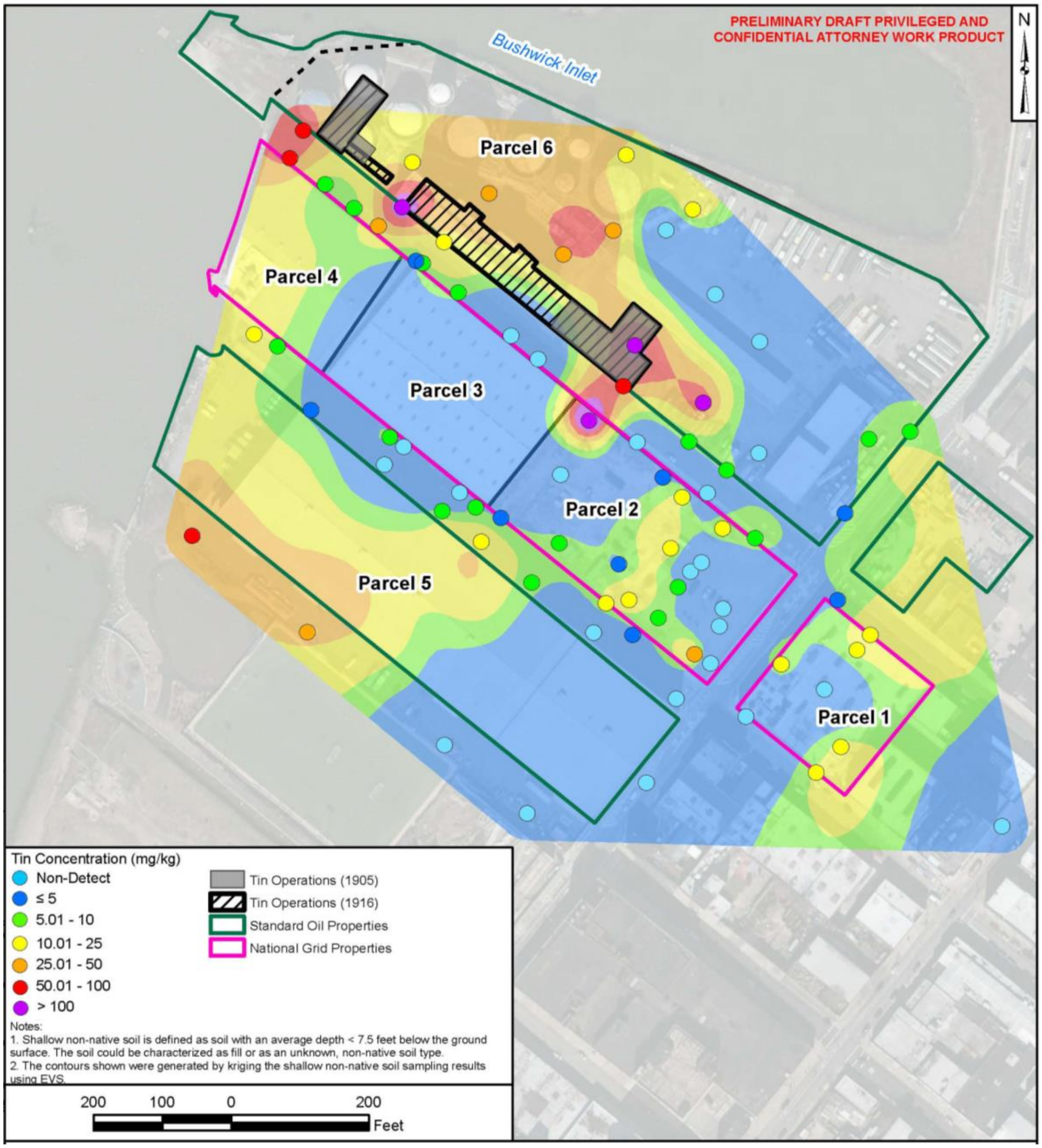
[156] Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, and Ellefsen, K.J., 2014,*Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report* 2014–1082, 386 p., *http://dx.doi.org/10.3133/ofr20141082*.

[157] http://www.atsdr.cdc.gov/ToxProfiles/tp55-c1-b.pdf

[158] WHO, 2005. Tin and Organotin Compounds

[159] Collected in Fall 2014 from depths ranging from the sediment surface down to a depth of 16.8 feet below the sediment surface.

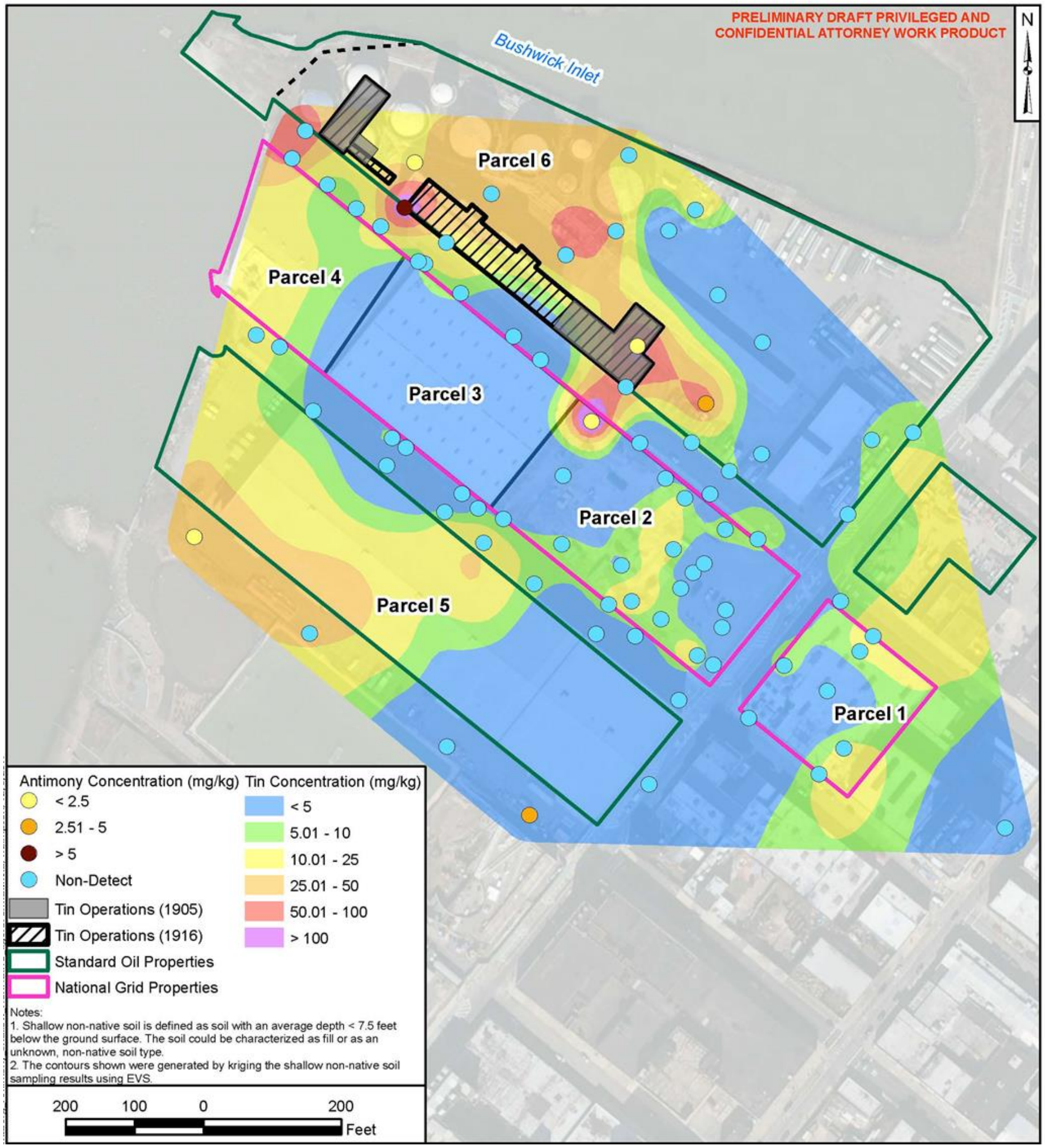
[160] Collected during multiple sampling events occurring from June 2010 to December 2014 from depths ranging from the sediment surface down to a depth of 37 feet below the sediment surface.



The embedded figure below shows antimony concentrations in soil boring locations in the top 7.5 ft of non-native material bgs (shallow fill, assumed fill, or unknown). These data are overlaid on the interpolated (kriged) tin surfaces to demonstrate that antimony detections coincide with some of the defined tin hot spots. Historically antimony was added as a strengthening agent in solders[161162]. It is unknown

[161] http://www.bomir.com/online/downloads/aim/Antimony_Study.pdf

if Standard Oil used antimony in their canning/soldering operations, but the antimony signature is spatially consistent with the tin.



Tin is not expected to be a key component of National Grids waste stream. While these investigation data are limited, the detections of tin at WW-MW-15 (66.1 mg/kg) and WW-SB-11 (587 mg/kg) within the Williamsburg Works MPG footprint suggests

[162] Domestic Engineering Vol. LIX No. 1 Pg. 18, 1912

that impacts from the tin operations at the Pratt Works Refinery migrated onto the MGP property. The mechanism of migration is unknown but could have resulted from dumping or windblown deposition from day to day operations or multiple fires that occurred on the Pratt property, some of which impacted the tin buildings163. Based on these preliminary findings, it is reasonable to presume that other contaminants from the Refinery were not contained within the bounds of Parcel 6

1.2.2.2 AECOM IRM In-Situ Waste Pre-characterization Sampling, 50 Kent Avenue IRM

AECOM collected soil/fill samples via test pitting and boring in March/April 2015, followed by supplemental sample collection in January, April, and October 2016. These samples were collected to provide precharacterization data to obtain approval from treatment and disposal facilities to accept the material. Results of this sampling are provided in Appendix U.

The March/April 2015 sampling event sampled the entire area to be excavated, specifically the east shallow excavation area to depths of 5 feet (outside the in situ solidification area) and 7 feet within the in situ solidification area where deeper excavation was planned to accommodate increases in volume during treatment), the deep excavation area to depths of 30 feet, and the west shallow excavation area, including the former "no excavation" area to depths of 5 feet. Each of these areas is depicted on Figure 10. The former "no excavation" area is a 55-foot wide portion of the Site originally planned to remain unexcavated as a buffer to minimize impacts to a building formerly present on Parcel 3. That building burned down and was demolished in early 2015.

The number of samples collected and the parameters tested were based on the required parameters and collection frequency required by the two disposal facilities that were considered to accept the excavated material – Bayshore Soil Management and Clean Earth. In accordance with the facilities' sampling requirements, both grab and composite samples were collected. Samples from the shallow excavation areas were collected

[163] *New York Times*, 23 December 1884.

through test pitting and samples from the deep excavation area were collected by a combination of tests pits and drilling. The approximate locations of the March/April 2015 sampling event, and tables describing which aliquots were used to comprise the composite samples, are included in Appendix U.

Because high levels of contamination were detected in samples taken from the deep excavation area, the disposal facilities were reluctant to preapprove acceptance for some of the material from this area. The preferred facility, Bayshore Soil Management, cited high VOC levels in certain composite samples which could provide too great a thermal load on their treatment facility. Additionally, some composite samples were determined to be characteristically hazardous (waste code D008) for lead. Therefore, AECOM performed a second waste precharacterization effort in January 2016 to collect additional data to allow Bayshore Soil Management to better evaluate the acceptability of the material, and to narrow down the location of soil exhibiting the characteristic of toxicity. The selection of sampling locations and depths was designed in consultation with Bayshore Soil Management to allow them to reach a conclusion on the acceptability of the material, specifically:

- Collection of samples from the interior of the relief holder tank where previously collected lead samples were above 100 mg/kg but did not have corresponding TCLP Lead analyses (not all samples required TCLP analysis during initial precharacterization to meet the facilities' minimum frequency).

- Better definition of the distribution of lead contamination (including TCLP lead) in the interior of the Holder No. 1 tank to better define the amount of material that needed to be handled as hazardous.

- Collection of additional VOC data outside the holder tanks where Bayshore had concerns about high VOCs. The samples were vertically composited at depths ranging from 17 to 26 feet bgs.

- Due to the high VOC concentrations observed elsewhere in the deep excavation area, collection of composite samples where the deep trench would be excavated for support of excavation (SOE) wall installation.

The approximate locations of the January 2016 sampling event are included in Appendix U. The results of this sampling provided enough additional information to allow Bayshore Soil Management to accept the high-VOC-concentration material. However, some composite lead sample analyses did not exceed the limits for the characteristic of toxicity for samples in zones where the initial sampling was found to be hazardous. Therefore, Bayshore Soil Management requested additional discrete sampling in the holder No. 1 tank area. These samples were collected in April 2016. The approximate locations of the April 2016 sampling event are included in Appendix U. The results of this sampling provided sufficient delineation of the zone of soil/fill exhibiting the hazardous characteristic of toxicity.

Also, two additional samples from the former "no excavation" area were collected in the area in October 2016.

1.2.2.3 Remedial, Pre-Design, and Design Investigations and In-Situ Waste Pre-Characterization Sampling Forensics Data Review

National Grid retained Exponent, Inc. (Exponent) to perform forensic evaluation of soil, sediment, and NAPL samples collected at and nearby the Williamsburg Works MGP site. Exponent has provided National Grid with two reports on their work, one in January 2015, which was discussed in and appended to the RI Report and one in January 2018 (revised March 2018). The 2015 and 2018 Exponent reports confirm the prior investigations' conclusions on the comingling of impacts. More specifically, Exponent reports indicate that petrogenic (*e.g.*, petroleum) and pyrogenic (*e.g.*, combustion or tar) materials, as well as post-MGP operation contaminants such as pesticides and PCBs, are commingled at the Site. Both reports are included in Appendix V.

The 2015 Exponent, Inc. report "Former Williamsburg Gas Works MGP Site, Brooklyn, New York – Analysis of Available Data to Track Sources of Contamination" report discusses chemistry data obtained from soil, sediment, and non-aqueous-phase liquid (NAPL) samples collected from the former Williamsburg Works MGP site and surrounding parcels and rights of way. Section 2 – Summary of Findings of the report includes the following statements.

> Within the former MGP Parcels 1 and 2, gas chromatograms showed the presence of various petroleum products (e.g., distilled petroleum products in the mid- to heavy boiling point ranges). In addition, methyl tert butyl ether (MTBE) was detected in Parcel 2 groundwater. Fingerprinting analysis conducted on two shallow soil samples from Parcel 2 showed the presence of various petroleum products. These findings are consistent with industrial operations that included storage of petroleum products after the MGP ceased operations.
>
> Several non-MGP compounds were found in soil samples across all sampled areas. Elevated polychlorinated biphenyls (PCBs, up to 1.8 mg/kg) were found in surface and shallow soils (down to 7.5 ft bgs). Sheet metal manufacturing, the corrugated containers and scrap metal operations among other activities that occupied the former MGP parcels are potential PCB sources. Pesticides (e.g., DDT, DDD, DDE, Endrin) were also detected at elevated concentrations compared to the unrestricted-use soil cleanup objective (SCO) at sampling locations in and around the former MGP site.
>
> Many solvents (e.g., PCE, and TCE) were found in soils across all sampled areas, at depths ranging from 0.5 ft to 64.5 ft bgs. Historical operations that may have been associated with these solvents include metal manufacturing, repair shops, and the tin can manufacturing that occurred in Parcels 2, 3, and Parcel 6.

The 2015 report's discussion on PAHs and gas chromatograms collected from Parcels 1 and 2 includes the following statements:

> In Parcel 2, the fill/shallow soil had gas chromatograms with different [with respect to Parcel 1] UCM profiles, indicating the presence of various petroleum products…
>
> Two shallow samples from the middle of Parcel 2 were analyzed for the full PAH list….In both samples, the PAHs originated from petrogenic sources based on the parent and alkylated PAH patterns. The gas chromatograms indicated a mix of petroleum products, with a dominant product in the heavy oil range…The PAHs were at different degrees of weathering in the two samples (GTP-7 was dominated by the lower molecular weight PAH compounds like naphthalene and alkylated naphthalenes, while sample GD-02 PAHs were dominated by the high molecular weight PAH compounds like benzo(a)pyrene. The presence of MTBE, various petroleum products, and petrogenic PAHs in the shallow soil are all consistent with petroleum storage operations that occurred in the area after MGP operations ceased.

Figure 5.4.1 of the 2015 Exponent report displays gas chromatograms for four other samples collected from within Parcel 2. The four other samples are WW-SB-04 (2-4), WW-SB-23 (1-4), WW-TP-03 (3.5-4), and WW-TP-04 (4.5-5). The caption of the figure states, "Gas chromatograms from the former MGP parcels indicate the presence of various petroleum products in the shallow soil/fill."

A sample of NAPL collected from a Verizon manhole located in the intersection of Kent Avenue and N. 12th Street was determined to be "a mix of diesel- and heavy fuel like products, inconsistent with products from the former MGP operations."

Exponent's January 2018 report (revised March 2018) reviews data from the March/April 2015 in-situ waste pre-characterization sampling. From the samples collected during this event, 26 samples were selected for forensic PAH analyses. The samples were analyzed for the full list of parent and alkylated PAH and petroleum biomarkers to determine the sources of PAHs to these soils. The chemistry data were evaluated to determine whether each sample contained PAHs from petrogenic sources (e.g., petroleum), pyrogenic sources (e.g., combustion or tar), or a mixture of multiple sources. This report summary states:

In the top 5 feet (ft) of soil, most PAH fingerprints were consistent with documented petroleum storage and use in above ground and underground storage tanks (ASTs and USTs, respectively), including an oil-water separator UST, leaks from equipment failures; and runoff from a service garage and parking lot. Pyrogenic PAHs were also present in the top 5 ft of soil, with profiles consistent with runoff from vehicle exhaust. One cannot exclude the presence of pyrogenic PAHs from the former MGP operations, and possibly from a series of large fires and explosions that occurred historically at the formerly adjacent refinery, located across North 12th Street. Between 5 and 17 feet below ground surface (ft bgs), the PAH fingerprints indicated pyrogenic sources consistent with the operations of a former manufactured gas plant (MGP). Petrogenic PAHs and petroleum hydrocarbons were also present in this depth range. Below 17 ft bgs, PAH contamination in the soil was predominantly from a pyrogenic origin, consistent with impacts from the former MGP. On samples collected within from the ground surface to 5 ft bgs, the report states

> Analysis of the grab samples GC-FID chromatograms showed the presence of Unidentified Complex Mixtures (UCMs), indicating the presence of petroleum impacts…. In some samples, alkanes associated with fresh petroleum were also present. The presence of alkanes is consistent with a relatively recent release of a petroleum product in these locations. Overall,…[the distribution of impacts] demonstrates that petroleum hydrocarbons were found throughout the sampled areas.
>
> The soil samples subjected to forensic analysis had PAH concentrations ranging from 4 to 799 mg/kg PAH_{16}. Analysis of the parent and alkylated PAH distributions in these samples demonstrated that the PAHs originated from a mix of petrogenic and pyrogenic sources…. The widespread petroleum-related contamination in the top 5 ft of soil is consistent with impacts from the post-MGP operations such as leaks, spills from the USTs

> and ASTs, spills associated with equipment failures, and the use of oil-water separators. The pyrogenic component in the PAH profiles vary from sample to sample, and are consistent with impacts from combustion-related sources such as those produced by vehicles exhaust and runoff …. Other pyrogenic input to the samples is consistent with the presence of former MGP operations at the 50 Kent Ave. property, and possibly related to the series of large fires and explosions that occurred historically at the former refinery across North 12th Street.

Regarding samples collected from between five and 17 ft bgs, the report states

> GCs from the grab soil samples showed the presence of a UCM in some samples indicating the presence of petroleum products. Other samples did not contain a visible UCM, thus indicating pyrogenic sources….
>
> The soil samples subjected to forensic analysis had PAH concentrations ranging from 21 to 448 mg/kg PAH_{16}. In these samples, PAH distributions and chromatogram profiles indicated pyrogenic PAHs with an input from petrogenic sources….

With respect to samples collected from deeper than 17 ft bgs, the report states

> Two soils collected from this deep excavation area were analyzed forensically and contained 5,461 and 3,248 mg/kg PAH_{16}. These two samples had very similar PAH profiles and chromatograms (Figure 10), both consistent with a tar-like source. Consistent with tar (pyrogenic) impacts, GCs from the samples collected from borings at that depth did not exhibit UCMs….

1.3 SITE DESCRIPTION

Prior to IRM activities, the Site was a vacant lot, paved with asphalt and/or concrete, owned and used by New York City Parks (see Figure 6). The asphalt and concrete had to be removed prior to intrusive activities during the IRM. Because North

11th Street and North 12th Street sloped slightly towards the East River whereas the site, due to the construction of building on the west half of the Site pots MGP operation, the surface of the western half of the Site increased to approximately one foot higher than the adjacent sidewalk. The surface in this area was the concrete slab of the former bus building, which most recently had been operated as a NYCDOS garage.

Three holder tanks and associated foundations and piping associated with the former MGP operations were present in the subsurface of the Site. A few other subsurface brick structures were also encountered during the IRM that might be associated with the former MGP operations at the Site. In addition to the known structures, other subsurface concrete structures, piping, as well as underground storage tanks were encountered during the IRM. Due to placement of these structures above or through, or across MGP-related structures, it is apparent that they were constructed after operation of the MGP ceased and that they were associated with post-MGP operations at the Site. Concrete footings were encountered at various locations at the Site during shallow excavation and are believed to be associated with the buildings and structures associated usage of the Site post-MGP. A large, reinforced, concrete monolith was encountered within the footprint of the deep excavation area while underground storage tanks were encountered within the footprint of the deep excavation and the east shallow excavation areas. Since these structures were placed fully or partially within the former MGP holder tank footprints, it is believed that they were placed during the post-MGP operations at the Site. A few small and large diameter pipes were encountered in subsurface of the Site at various places. A portion of a pipe encountered in the western shallow excavation exhibited odors similar to that of fuel oil and not of MGP-related material. According to available maps and information, there was no MGP-related petroleum storage on the property.

The Site is bordered by sidewalks on the north, south, and east, along N. 12th Street, N. 11th Street, and Kent Avenue, respectively. A two-way protected bicycle lane is located in Kent Avenue, adjacent to the sidewalk on the west side of the street.

1.4 CONSTRUCTION COMPLETION REPORT

The interim remedial measure was performed on the Site, in accordance with the NYSDEC-approved Interim Remedial Measure 100% Design Report dated August 2015. An electronic copy of this CCR with all supporting documentation is included as Appendix A.

2.0 SUMMARY OF INTERIM REMEDIAL MEASURE

2.1 REMEDIAL MEASURE OBJECTIVES

Based on the preliminary results of the Remedial Investigation as submitted to NYSDEC by National Grid on August 25, 2010, NYSDEC requested, on September 23, 2010, that National Grid implement an excavation/stabilization-based IRM for the 50 Kent Ave parcel such that remediation of the 50 Kent Ave parcel would allow NYC Parks to develop the parcel into an open space available for community use. The IRM Design Work Plan, prepared by GEI Consultants (August 2011) established the goal of the IRM to align and be consistent with the goals described in NYSDEC DER-10 for IRMs, specifically (in section 1.11 of DER-10), to "contain and/or stabilize, to the extent possible, sources of contamination in any media to reduce/eliminate receptor exposure to contaminants or to contain further movement of contaminants through any pathway."

National Grid's IRM Design and Implementation Plan (IDIP), prepared by AECOM, was submitted to NYSDEC as draft in March 2013. This plan established:

> The intent of the Interim Remedial Measure (IRM) is to implement a remedy at the Site where such remedy would be considered final and be considered interim only from the standpoint that it would be part of a larger remedy that would be implemented later. A "final" IRM would allow for the Site to be used by the property owner (the New York City (NYC) Parks Department) with few or no restrictions before the entire former Manufactured Gas Plant (MGP) footprint, which occupies properties beyond the Site, is remediated. The IRM is therefore a remedy that shall not require any re-work/removal in the future…

NYSDEC approved this IDIP on April 11, 2013, with the clarification that "The IRM will comprise excavation of the gas/holder foundations, contaminated soil immediately below them, and excavation of shallow soils elsewhere on the site". Thus the established objective of the IRM is to excavate soil over the entirety of the Site. In the vicinity of the former holder tanks, excavation would be to depths just below the holder foundations. Elsewhere on the site excavation would be to shallower depths.

Subsequent to the approval of the IDIP, NYSDEC approved substitution of solidification for the contents of the Holder No. 2 tank adjacent to the intersection of Kent Ave. and North 11th Street.

A separate, prior component of the IRM was installation of NAPL recovery wells. The installation of the NAPL recovery wells is addressed in a separate Construction Completion Report, approved by NYSDEC on September 8, 2015.

2.2 DESCRIPTION OF INTERIM REMEDIAL MEASURE

The Site was remediated in accordance with the Interim Remedial Measure (IRM) 100% Design Report, prepared by AECOM and dated June 2015, as approved by NYSDEC (the Design Report). The major components of the remediation were:

1. Excavation and off-site treatment and disposal of soil and fill material and subsurface structures up to a 30 ft depth (except as noted below and approved by NYSDEC) at and adjacent to the Relief Holder and Holder No. 1, depicted on Figure 6;
2. Excavation and off-site treatment and disposal of soil and fill material exceeding the criteria established in the NYSDEC-approved Shallow Soil Reuse Acceptance Plan dated February 2016 to a minimum depth of 5 ft or to water table if warranted by the visual impacts.
3. Excavation of the shallow soils across the Site and segregation, size reduction (as necessary), and reuse as backfill in the deep excavation of shallow soils that were suitable for reuse, in accordance with the NYSDEC-approved Shallow Soil Reuse Acceptance Plan dated February 2016.
4. Removal and disposal of former NYCDOS facility USTs.

5. In-situ solidification (ISS) of soils within Holder No. 2 using segmented Bucket Soil Mixing (BSM) to minimize the ability of contaminants to migrate and to prevent future direct contact exposures.
6. Construction of a minimum 5 ft soil cover system consisting of select fill material and top soil;
7. Abandonment of select monitoring and recovery wells within the footprint of the Site.

3.0 DESCRIPTION OF REMEDIAL MEASURES PERFORMED

Remedial measures completed at the Site were conducted in accordance with the Design Report. All deviations from the Design Report are noted in this section.

3.1 CONTRACTORS AND CONSULTANTS

AECOM (the Engineer) was contracted by National Grid as Project Engineer during the IRM. de maximis, Inc. (the Construction Manager) was contracted by National Grid to provide construction management services and act as the on-site representative during the IRM. AECOM provided construction observation to evaluate compliance with the plans and specifications. de maximis provided construction management of the remediation work to assure conformance with the construction contract and terms and conditions (Contract Documents). GEI Consultants, Inc. P.C. performed the noise and vibration monitoring and retained a subcontractor, Maser Consulting, to perform settlement and movement monitoring during the IRM. GEI also performed monitoring, recording, and reporting in accordance with the Community Air Monitoring Plan (CAMP) and the Noise, Vibration, & Settlement Monitoring Plan. The following companies completed the major tasks for this project:

- **Sevenson Environmental Services, Inc. of Niagara Falls, NY**. General contractor for the IRM (hereinafter, "the Contractor")
- **Underpinning Foundation Skanska, of Maspeth, NY**. Sheet pile and Tieback installation and testing subcontractor.
- **Glynn Geotechnical Engineering, of Kenilworth, NJ**. Structural engineering services subcontractor.
- **Griffin Dewatering New England LLC, of Lodi, NJ.** Dewatering Wells Installation subcontractor.
- **Simpson & Brown, Inc., of Cranford, NJ.** Drilling subcontractor and sheet pile installation contractor.

- **GEI Consultants, Inc. P.C.** CAMP and Noise, Vibration, & Settlement Monitoring Plan implementation and reporting.
- **Enviroprobe Service, Inc. of Mount Laurel, NJ.** Level A Utility survey subcontractor.
- **S&V Electrical, Inc. of Staten Island, NY.** Local electrician.
- **Allsite Structure Rentals of Las Vegas, NV.** Temporary Fabric Structure (TFS) rental and installation subcontractor.
- **Encotech, Inc., of Eighty Four, PA.** Vapor Management System subcontractor.
- **Bayshore Soil Management of Keasbey, NJ**. Non-hazardous soil and debris offsite thermal treatment and disposal facility.
- **Clean Earth, Inc. of North Jersey.** Hazardous MGP soil and debris disposal.
- **Alloco Recycling, Ltd. of Brooklyn, NY**. Construction and Demolition (C&D) debris disposal.
- **Corbett Aggregates Companies, LLC., of Quinton, NJ. Shamrock Materials Corp., of Staten Island, NY. Wantage Quarry, of Hamburg, NJ.** Source of common fill material.
- **A. Colarusso & Son, Inc., of Hudson, NY.** Source of select stone backfill material.
- **Kennon Surveying Services, Inc. , of Warren, NJ.** Final As-Built record drawing for the project.
- **Highway Safety Protection Company, of College Point, NY.** Trucking subcontractor.
- **Enviroscapes, Inc. of Monmouth Junction, NJ.** Seeding and landscaping subcontractor.

- **Consolidated Steel & Aluminum Fence Co., Inc. of Kenilworth, NJ**. Fencing subcontractor.
- **Aquifer Drilling and Testing, Inc**., **of Mineola, NY.** Recovery well drilling and development subcontractor.
- **Advance Testing Company, Inc**., **of Campbell Hall, NY.** Geotechnical testing subcontractor.
- **Akela Contracting LLC, of Scarsdale, NY**. Plumber for sewer tie-in and sidewalk repair and replacement subcontractor.
- **New York Paving, Inc., of Long Island City, NY**. Sidewalk construction contracted by National Grid.
- **Aqua Pro-Tech Labs, of Fairfield, NJ.** WWTP water sample testing.
- **JLT Laboratories, Inc, of Canonsburg, PA.** Grout testing subcontractor.
- **W. A. Wilson, of Buffalo, NY.** Grout testing subcontractor.
- **Bay Crane, of Long Island city, NY.** Crane services.
- **Evoqua Water Technologies LLC, of Pittsburgh, PA.** Carbon regeneration subcontractor.
- **FJC Security Services, Inc., of Melville, NY.** Security service provider.
- **McVac Environmental Services, of New Haven, CT.** Vacuum service provider.
- **Taylor Oil Co, Inc., of Somerset, NJ.** Fuel supplier.
- **Walter T. Gorman Engineering of Manhattan, NY.** Permit expeditor subcontractor.

3.2 GOVERNING DOCUMENTS

3.2.1 Site Specific Health & Safety Plan (HASP)

All remedial work performed under this IRM was performed in compliance with site and worker safety requirements mandated by the Federal Occupational Safety and Health Administration (OSHA). Worker health and safety was addressed by the site-specific Health and Safety Plan (HASP) developed by the Contractor. All work was performed in compliance with the industry standards for work at hazardous waste sites, presented in 29 Code of Federal Regulations (CFR) 1910.120, and with industry standards for the construction industry, presented in 29 CFR 1926.

Procedures outlined in the HASP included requirements for daily health and safety review meetings, the proper use of safety equipment, along with the proper use of mechanical equipment. The minimum Personal Protective Equipment (PPE) to be worn on Site included safety glasses, hard hat, reflective vest, and steel-toed shoes or boots. The subjects covered in the HASP included:

- Hazard Risk Analysis;
- Safety and Health Training;
- PPE;
- Medical Surveillance Program;
- Air Monitoring;
- Site Control Measures;
- Personal Hygiene and Decontamination;
- Emergency Contingency Plan;
- Inspection and Reporting;
- Job Safety Analysis;
- Health and Safety Forms;
- Confined Space Entry Program;

- Fall Protection Program;
- Control of Hazardous Energy;
- Chemical Information Sheets;
- Hazard Communication Program;
- Respiratory Protection Program; and
- National Grid Management of Change Procedure.

3.2.2 Quality Assurance Project Plan (QAPP)

The QAPP was developed by the Engineer in January 2016. The QAPP described the specific policies, objectives, organization, functional activities and quality assurance/quality control activities designed to achieve the project data quality objectives.

The QAPP managed performance of the IRM tasks through designed and documented Quality Assurance (QA)/Quality Control (QC) methodologies applied at the site during the IRM and in the lab. The QAPP provided a detailed description of the observation and testing activities that were used to monitor construction quality and confirm that remedial construction was performed in conformance with the remediation objectives and specifications.

The QAPP included the following:

- Definable Features of Work;
- Project Organization, Communication and Submittals Processes;
- QA Procedures Performed by AECOM;
- Sample Preparation, Documentation, and Quality Control; and
- Quality Assurance of Construction Quality Control Activities.

The following QA procedures and tests were implemented.

- Cement Bentonite Slurry Wall Testing – One sample set collected for every 250 cubic yards (CY) of trench excavation. The sample was tested for Unconfined Compressive Strength (UCS) in a laboratory.
- BSM Demonstration Test – One set of samples was collected each work day and tested for UCS and hydraulic conductivity in a laboratory.
- BSM Production Work – One set of samples was collected for every 250 CY for the first 1,000 CY treated and one set for every 500 CY treated thereafter. Samples were tested for UCS and hydraulic conductivity in a lab.

3.2.3 Bucket Soil Mixing Coring Quality Assurance/Quality Control Plan

A BSM Coring QA/QC Plan was developed by the Engineer to outline procedures to be followed to examine the BSM performance in accordance with revised NYSDEC In-Situ Solidification QA/QC guidance issued after the start of the IRM, The BSM Coring QA/QC Plan was approved by NYSDEC in February 2016.

3.2.4 Shallow Soil Reuse Acceptance Plan

A Shallow Soil Reuse Acceptance Plan was developed by the Engineer to describe the methodology used to distinguish between soil acceptable for reuse and soil requiring disposal offsite.

3.2.5 Construction Quality Control Plan (CQCP)

The Construction Quality Control Plan was developed by the Contractor in accordance with the design specifications. The CQCP was used to manage the performance of the IRM tasks through designed and documented QC methodologies applied in the field and in the laboratory. The CQCP provided a detailed description of the observation and testing activities that were used to monitor construction quality and confirm that the remedial construction was performed in conformance with the remediation objectives and specifications.

The CQCP included the following:

- Project Organization for the General Contractor – Key Personnel and their responsibilities;
- Implementation and Reporting procedures;
- Inspections and Procedures;
- Field Testing Procedures;
- Deficiency Tracking System;
- Submittals;
- Documentation; and
- Revision to Work.

3.2.6 Storm-Water Pollution Prevention Plan (SWPPP)

The erosion and sediment controls for all remedial construction were performed in conformance with requirements presented in the New York State Guidelines for Urban Erosion and Sediment Control and the site-specific Storm Water Pollution Prevention Plan (SWPPP) prepared by the Contractor, dated December 2015.

Projects that result in a disturbed area greater than one acre are typically required to comply with the requirements of the New York State Pollution Discharge Elimination System (SPDES) program (NYSDEC, 2010b). However; since the remedial construction was being performed under the subject Consent Order, in accordance with DER-10, a SPDES permit was not required.

Sevenson developed a site-specific SWPPP consistent with the requirements of SPDES General Permit GP-0-15-002 (NYSDEC, 2015) for Storm Water Discharges from Construction Activity. Because the project decreased the area of impervious surface at the site, no permanent post-construction storm water management features (detention or water quality ponds, etc.) were required in the design, and the SWPPP incorporated only the applicable practices and details of the New York State Standards and Specifications for Erosion and Sediment Control (NYSDEC, 2005). SWPPP inspections were conducted at least weekly and noted in weekly reports.

3.2.7 Community Air Monitoring Plan (CAMP)

The Engineer developed the site-specific Community Air Monitoring Plan (CAMP) dated September 2015. The purpose of the CAMP was to provide an early warning system to alert the Construction Manager that concentrations of total volatile organic compounds (TVOCs), particulates and odors in ambient air were approaching Alert Limits or Action Limits due to IRM activities. The early detection of emissions and associated contingency measures were intended to expedite any necessary mitigation measures and to reduce the potential for the community to be exposed to constituents at levels above regulatory limits and recommended guidelines.

The CAMP specified four fixed air monitoring stations, one located on each of the four sides of the Site, to conduct upwind and downwind air monitoring. The CAMP required that continuous monitoring be conducted 24 hours a day, 7 days a week during the IRM. During the first few weeks and last few weeks of the project, when dedicated power was not available for the fixed monitoring stations, a modified CAMP was implemented by monitoring upwind and downwind TVOCs and Particulate matter using a tripod-mounted monitoring system during working hours, only.

The table below presents the Alert Limit, the Response Limit and the action limit for the target constituents. The response limit was set at 5 ppm and Action Limit 25 ppm, based on a 15-minute, time-weighted average for TVOCs. The Action Limit for benzene was 1 ppm. The response limit was set at 100 $\mu g/m^3$ and Action Limit 150 $\mu g/m^3$ 15-minute, time-weighted average for TVOCs. The action limit for odor was an odor complaint or a 3 on the n-butanol scale. The Action Limit for naphthalene concentrations, was 440 $\mu g/m^3$.

				Site Condition			
Target – units	**Alert Limit**	**Response Limit**	**Action Limit**	**Operational Condition**	**Alert Condition (Above Background[1])**	**Response Condition (Above Background[1])**	**Action Condition (Above Background[1])**
TVOC (PID) – ppm	3.7	5.0	25.0	$[C_{avg}] \leq 3.7$	$3.7 < [C_{avg}] \leq 5.0$	$5.0 < [C_{avg}] \leq 25.0$	$[C_{avg}] > 25.0$
Benzene (GC) – ppm	N/A		1.0	$[C_{avg}] \leq 1.0$	NA	NA	$[C_{avg}] > 1.0$
PM_{10} – µg/m^3	NA	100	150	$[C_{avg}] \leq 100$	NA	$100 < [C_{avg}] \leq 150$	$[C_{avg}] > 150$
Odor[2] - n-butanol scale	NA	NA	3	OI ≤ 3 and No Odor Complaints	NA	NA	OI > 3 or Odor Complaints
Odor (naphthalene) – µg/m^3	NA	NA	440	$[C_{avg}] \leq 440$	NA	NA	$[C_{avg}] > 440$

Definitions:

TVOC = Total Volatile Organic Compounds
PID = Photoionization Detector
PM_{10} = Inhalable Particulate Matter
ppm = parts per million volume
µg/m^3 = micrograms per cubic meter
$[C_{avg}]$ = 15-minute average concentration of target
OI = Odor Intensity based on the n-butanol scale adapted from ASTM E544-99. Odor measurements made over a 15-minute interval.
NA = Not applicable, odor intensity will be either an Operational Level or Action limit; there is no Alert and/or Response Limit and there is no Alert Limit for PM_{10}.

Notes:

[1] Background is defined as the current upwind concentration. Background concentrations will be used to calculate the actual Property contributions to TVOC's and PM_{10} during the final evaluation of the Site conditions as part of the weekly data summaries.

[2] Odor intensity observations are based on the n-butanol scale.

3.2.8 Contractor's_Site Operations Plans (SOPs)

The Engineer reviewed all plans and submittals for this project. The Engineer confirmed that the plans and submittals were in compliance with the Design Report and Contract Documents. The key Contractor submittals were as follows:

- Excavation and Backfill Plan – The Excavation and Backfill (EB) Plan provides the Contractor's means and method to complete the IRM in accordance with the Contract Documents. The EB Plan provided details on:
  - Work Sequence;
  - Temporary Fabric Structure (TFS);
  - Vapor Management System (VMS);
  - Handling of Odor and Dust;
  - Construction Fencing;
  - Protection of Utilities;
  - Support of Excavation;
  - Excavation and Material Handling;
  - Shallow Excavation;
  - Deep Excavation;
  - Maectite® Lead Stabilization Plan;
  - Deep Excavation Sequencing;
  - Off-site Disposal;
  - Backfill and Compaction;
  - On-site Material Reuse; and
  - Site Restoration.

- Contractor’s Health and Safety Plan – The Contractor’s HASP was prepared in an effort to ensure that the construction work completed as part of the IRM complied with applicable Federal, State, and Local laws and regulations for Health and Safety.

- Storm Water Pollution Prevention Plan – The SWPPP was prepared so that necessary controls would be implemented and monitored pursuant to the SPDES general permit for storm water discharge from construction activities. The SWPPP was developed based on New York State Standards and Specifications Section for Erosion and Sediment Control and the Contract Documents.

- Traffic Control Plan – The Traffic Control Plan detailed the controls and measures implemented by the Contractor to ensure the safe transport of material and equipment into and out of the Site without injury or damage and in accordance with the Contract Documents and all applicable Federal, State, and Local laws and regulations.

- Cement Bentonite Design Mix, Handling and Construction Plan – This submittal was developed for construction of the cement bentonite (CB) Slurry Wall, which was installed at the perimeter of the deep excavation to facilitate placement of sheet piles with minimal obstruction and with reduced vibrations and noise. The plan included details of mix, installation, controls, monitoring, and testing implemented during the CB Slurry Wall construction.

- Bucket Soil Mixing Work Plan: The BSM work plan provided a description of the method used to remediate the soils within Holder No. 2 using BSM in a segmented approach. The BSM work plan included the grout mix; procedures for excavation and material handling, the segment survey, the dewatering technique, and spoil management; erosion and sediment control measures; estimated production rates; a list of equipment; and sampling and testing methods for BSM.

- Temporary Wastewater Treatment Plant Design – The temporary Wastewater Treatment Plant (WWTP) design included details of the treatment design; equipment; and operations, maintenance and monitoring plans for the construction water generated during the implementation of the IRM.
- Support of Excavation Design – The SOE consisted of trench excavation and installation of a CB slurry wall and sheet piles installed through it with walers and tie-backs for anchoring. The SOE design provided calculations and the implementation method for the SOE.
- Tieback Plan – The Tieback Plan provided detailed calculations and installation method for tiebacks and corner bracing. It also provided the method and the criteria for tieback testing.

3.2.9 Community and Environmental Response Plan

The Community and Environmental Response Plan (CERP) was developed by AECOM to identify and address environmental impacts to the community resulting from the implementation of the IRM. The CERP was presented as Appendix D of the Design Report and approved by the NYSDEC in 2015. The CERP required the following: restricted working hours, stabilized construction entrances to prevent tracking of dirt on the street, a CAMP, pre- and post-construction surveys of site surroundings, erosion and sediment control measures, waste management, and wastewater treatment and management measures.

In accordance with the CERP, an existing website, (www.williamsburgmgpsite.com) was updated weekly with a report on the week's activities, photographs of current work, a report and data presentation on the results of the community air monitoring and an outlook of upcoming IRM activities. A dedicated hotline was established and a response to all public comments/complaints was provided within 48 hours. There were no comments/complaints concerning the IRM received via the hotline. Regular updates on the IRM were also provided to the Community Board and to State Senator Daniel Squadron.

Document repositories were established at the following locations for the duration of the project and contain all applicable project documents and will, include this CCR after approval:

Williamsburg Branch Brooklyn Public Library 240 Division Avenue Brooklyn, NY 11211	Telephone: 718-302-3485
Brooklyn Community Board 1 435 Graham Avenue Brooklyn, NY 11211	Telephone: 718-389-0009 District Manager: Gerald A. Esposito
NYSDEC 625 Broadway, 11th Floor Albany, NY 12233-7014	Telephone: 800-402- 9564

3.2.10 Odor, Vapor, and Dust Control Plans

Odor and dust control as well as vapor management was required due to the proximity of residential and commercial buildings. A Vapor Management Control Plan and an Odor and Dust Control Plan were created by the Contractor. The plans described how vapor and dust were to be controlled. The control methods were 1) conducting deep excavation and associated soil handling inside a TFS and 2) operating a VMS that provided sufficient air exchanges and that discharged outgoing air through carbon beds to prevent public exposure to vapors, dust, and odors. The plans also described odor, dust and vapor control through application of water, BioSolve®, the use poly sheeting or odor suppressant foam during shallow soil excavations.

3.2.11 Vibration, Movement, and Noise Monitoring Plan

The Vibration, Movement, and Noise Monitoring Plan for IRM (Appendix E of the Design Report) described the procedure for monitoring possible noise, vibration, and settlement/movement impacts potentially resulting from the remedial construction activities. With respect to noise, the plan identified the receptors, the relevant criteria, the proposed monitoring locations, and the mitigation procedures for responding to observed exceedances of the noise criteria. For noise, the warning Action Limit was 80 A-weighted decibels [dB(A)] and stop work Action Limit was 90 dB(A). A pre-construction noise survey was conducted to establish background noise levels, which was used to compare noise levels during construction.

With respect to vibration and movement, the plan identified the vibration receptors and potential locations where movement might occur, the relevant damage criteria, monitoring equipment, the proposed monitoring locations, and the mitigation procedures for responding to observed exceedances of the vibration and movement thresholds. For vibration, the warning Action Limit was 0.5 in/sec and stop work Action Limit was 2.0 in/sec. For movement, the warning Action Limit was 0.125 inches and stop work Action Limit was 0.25 inches. Pre-construction vibration monitoring as well as groundwater monitoring was conducted to establish baselines vibrations and groundwater elevations adjacent to the Site. Pre-construction cracks were documented and three initial sets of movement readings were collected for the surrounding structures prior to excavation.

3.2.12 Haul Routes Plan

The Haul Routes Plan (Appendix C of the Design Report) described the procedures and the specific off-site transportation routes that were to be followed during the IRM to manage construction traffic in a manner that minimized disturbance to the community. The Haul Routes Plan was developed in accordance with the NYCDOT Truck Map.

3.3 REMEDIAL PROGRAM ELEMENTS

The IRM for the Site was completed from November 2015 through June 2016. Tasks associated with ensuring an acceptable vegetative cover will continue in 2018. The key milestones for the RA elements are summarized in the table below.

RA Element	Dates
Mobilization and Site Preparation	October 15, 2015 – January 19, 2016

TFS and VMS	January 6, 2016 – February 17, 2017
WWTP Setup	December 9, 2015 – February 11, 2016
Dewatering Structure & Sewer Connection	February 1, 2016 – February 8, 2016
Removal of Hardscape	February 2, 2016 – September 15, 2016
BSM Demonstration Test	February 5, 2016 – March 4, 2016
BSM Production Work	March 7, 2016 – April 5, 2016
Shallow Excavation	July 25, 2016 – October 10, 2016
Backfill Shallow Excavation Area	July 13, 2016 – October 5, 2016
Crushing plant Operation	March 17, 2016 – October 5, 2016
Management of Excavated Material Used for Backfill	March 17, 2016 – March 3, 2017
Pre-Drilling Along SOE Wall Alignment	March 28, 2016 – May 17, 2016
CB Slurry Wall and Sheet Pile Installation	May 11, 2016 – July 14, 2016
TFS Move	July 21, 2016 – July 22, 2016
SOE Installation and Bracing	September 12, 2016 – November 29, 2016
Deep Excavation	August 19, 2016 – February 6, 2017
Disposal of Excavated Material and Waste	February 11, 2016 – May 18, 2017
Backfill Deep Excavation Area	January 9, 2017 – May 1, 2017
Monitoring Well Abandonment	August 4, 2016 – May 12, 2017
Dismantle TFS and VMS	February 21, 2017 – March 14, 2017
Site restoration	March 14, 2017 – October 20, 2017
Demobilization	May/June 2017

3.3.1 Site Preparation

A pre-construction kick-off meeting was held at the New York City Parks Department office with representatives from National Grid, de maximis, AECOM, the Contractor, NYC Parks, and NYSDEC on November 30, 2015.

Documentation of agency approvals required by the IRM is included in Appendix B. Other non-agency permits relating to the remediation project are provided in Appendix C.

The Contractor mobilized to the Site on November 30, 2015 and initiated site management and site preparation activities. The installation of trailers and temporary facilities was also initiated. The preparation for IRM activities began immediately upon mobilization of equipment and personnel. Site mobilization activities were completed on January 19, 2016. IRM preparation included the following activities.

- Obtaining required permits, arranging for waste transportation, arranging for utility hook-ups (including temporary generator and permanent electrical service to the Site), staging necessary equipment and personnel;, and holding an on-site health and safety training sessions.
- Establishing parking areas, haul routes, and work zones for authorized personnel.
- Removing existing fencing and guard rails and installing temporary jersey barrier topped with wooden, sound-attenuation panels around the southern, northern and eastern perimeter of the Site, along the N. 11th St., N. 12th St., and Kent Avenue, respectively.
- Constructing the decontamination facility.
- Installing the erosion controls in accordance with local, state, and federal regulations and the SWPPP.
- Establishing temporary construction offices on N 12th St. between Kent Avenue and East River.
- Closing of N 12th St. and north sidewalk along N 11th St. west of Kent Ave.
- Clearing of asphalt within the portions of IRM areas.
- Surveying, by a New York State-licensed surveyor, for initial benchmarks and stakeout for the SOE wall and excavation limits.
- Installing the waste water treatment system and associated influent and discharge pipelines.

- Installing perimeter air monitoring stations and notification system and performing baseline air monitoring.
- Setting-up and performing noise and vibration baseline monitoring.
- Performing the Level A Utility survey and Protection.
- Constructing staging and containment areas and stabilized construction entrances.
- Partial Erection of the TFS and VMS.
- Establishing Traffic Control and Management, and,
- Establishing 24-hour security.

A project sign was erected at the corner of N. 12th Street and Kent Avenue and remained in place during all phases of the IRM.

3.3.2 Permitting

Permits relating to the IRM are provided in Appendix E and include the following:

- NYCDEP Dewatering Permit,
- NYCDEP Discharge Permit,
- NYCDEP Sewer Connection Permit,
- NYCDEP Noise Mitigation Plan,
- New York City Department of Building (NYCDOB) Construction Work (excavation, trenching, shoring, and soil removal) Permit,
- NYCDOB Construction Equipment Fence Permit,
- NYCDOB Temporary Structures Permit for two TFSs,
- NYCDOB Electric Work Permit,
- NYCDOB Compressed Gas Storage Permit,

- NYC Department of Transportation (NYCDOT) Building Operation Permit/Sidewalk /Street Occupancy Permit,
- NYCDOT Street Opening Permit,
- NYCDOT Fence Permit, and
- Fire Hydrant Permit.

3.3.3 General Site Controls

3.3.3.1 Site Security

Sevenson prepared a Site Security Plan for the project and provided a designated trailer for security operations. A security subcontractor retained by the Contractor maintained security at the Site twenty-four hours a day, seven days a week. All visitors, workers and subcontractors were required to sign a daily log maintained by the Contractor. The presence of any unauthorized personnel was immediately communicated to the Construction Manager and appropriate actions taken. The Site was secured at days' end and gates were locked during non-working hours.

Site security personnel were briefed on the site hazards. Security personnel were instructed to not enter any on-site exclusion zones. Security personnel were limited to patrolling the perimeter of the Site. All security personnel were routinely briefed on areas that were deemed inaccessible. Specific security controls were implemented during both working and non-working hours. In the event of forced entry, trespass and/or vandalism to the project site, the Contractor subcontracted security service was to notify the Contractor's emergency contact personnel and engage the local police and law enforcement.

3.3.3.2 Job Site Record Keeping

Job site records were managed by the Contractor, the Engineer, and the Construction Manager in both paper and electronic form, as applicable. The Contractor kept project submittal data for imported borrow material, exported waste material disposal, ISS, excavation elevation and backfill compactions, and provided submittals to the Construction Manager and the Engineer. The Construction Manager and Engineer shared on-site record keeping duties. Project photographs, daily reports, storm water pollution prevention plan reports, solidification reports, sheet pile logs, tieback testing logs, compaction reports, and lead stabilization reports are attached as appendices.

3.3.3.3 Erosion and sediment Controls

The storm water control measures were installed to minimize erosion, control transport of sediment, and control the amount of water entering active work areas.

Erosion was minimized by:

- Preserving existing vegetative/impervious cover where possible;
- Diverting run-on water away from disturbed areas; and
- Stabilizing disturbed areas soon after final grading.

Transport of sediment was controlled by:

- Preventing soil from leaving the Site through the use of waddles, hay bales, and/or stone (as necessary);
- Keeping run-off velocities low; and
- Reducing sedimentation by utilizing erosion control practices on site.

The amount of water entering active work areas was minimized by:

- Constructing berms, temporary swales, and trenches to direct surface water run-off / run-on away from open excavations areas.

Silt filters were placed at storm sewer inlets adjacent to the Site to minimize the transport of sediment into storm sewers. Soil berms were used to minimize the transport of sediment in storm water runoff and were installed down-slope of soil stockpile areas. Berms, temporary swales, and trenches were used to re-direct surface water run-off / run-on away from open excavation areas and completed site work. Silt fence was installed down-slope of re-vegetated areas where storm-water runoff was observed following hydroseeding until an adequate stand of vegetation was established. Waddles were used at the perimeter around the site to minimize any silt leaving the work area.

Any storm water that came in contact with impacted soils was diverted to the temporary water treatment system. The water treatment system was placed in a secondary containment made with liner and gravel with a sump to prevent any leaks from entering the ground or running off with storm water. All chemicals were stored in appropriate containers to prevent any unforeseen leakage from mixing with storm water. On-site decontamination pads were used to remove mud from truck tires and prevent tracking of mud and impacted soil onto the streets.

SWPPP inspections were conducted weekly and noted in weekly reports. The results of the SWPPP inspections were discussed weekly and any action items were immediately mitigated. Appendix F contains the weekly SWPPP inspection reports.

3.3.3.4 Equipment Decontamination and Residual Waste Management

Personnel and equipment decontamination stations were constructed in accordance with the Contractor's HASP. Two equipment decontamination pads and pressure washer areas were set up at the Site's northwestern and southern exits. The Contractor utilized a scaffolding configuration to facilitate tarping of waste disposal trucks prior to the decontamination pad. The decontamination of trucks and equipment was accomplished by washing wheels/tracks as well as trailer sides and backs using a pressure washer prior to trucks leaving the Site. The decontamination wastewater was pumped to the on-site WWTP. Solids were periodically removed and disposed off-site with other impacted soils. Regular housekeeping was employed to manage miscellaneous on-site construction debris and off-site residual dirt and dust.

3.3.3.5 Stockpile Management

Fill material was stockpiled on-site before being placed into the excavation. Fill material included imported clean fill and overburden materials, approved for reuse, from excavation areas (Reuse Material).

Imported clean fill did not require lining underneath the stockpiles. Clean material was always placed outside the TFS at temporary stockpile locations which were field-located depending on on-going activities. Reuse material, when stored on unexcavated soil, was stockpiled on liners.

Deep excavation and backfill activities occurred under the TFS. In the event that excavated impacted material could not be directly loaded for transportation and disposal, it was stockpiled, unlined, under the TFS on top of an impacted area scheduled for excavation. The stockpile was foamed as necessary to reduce odor.

The Engineer distinguished Reuse Material from impacted soils, as described by the NYSDEC-approved "Shallow Soil Reuse Acceptance Plan," through observations for staining and odor. Reuse Material was stockpiled for future use as backfill at pre-approved depths per the Contract Documents. Impacted soil was either directly loaded into the pre-lined trucks or placed over poly on the area that was not excavated. Excavated impacted soils were covered with polyethylene sheeting that was anchored with sand bags and/or were covered with long-duration, odor-suppressant foam to prevent migration of particles with wind and rain.

All stockpiles were periodically inspected for stability. Berms were created around stockpiles to prevent erosion by run-off water.

3.3.4 Nuisance controls

3.3.4.1 Trucking Controls

3.3.4.1.1 Truck Wash and Egress Housekeeping

The stabilized construction entrances consisted of smoothly graded areas large enough to accommodate equipment and truck traffic and were constructed to allow the cleaning of transport truck tires prior to exiting the Site. The base of each stabilized construction entrance was covered with non-woven geotextile and coarse aggregate, and maintained and redressed while in use. Trucks exiting the Site were cleaned as necessary using wet decontamination to minimize dust on adjacent roadways. Prior to exiting the

Site, they passed through an inspection area where they were inspected by the Contractor's personnel, and periodically by the Engineer and Construction Manager, to ensure tires and undercarriages were clean and that tarps were secured. Excessive mud and loose dirt observed on the trucks were manually removed with brooms and brushes as necessary. Non-asphalted truck routes on-site were wetted down using a water hose to reduce dust generation. Truck routes, on-site and off-site, were inspected during high truck traffic periods evaluate the effectiveness of the truck cleaning activities. Off-site streets were cleaned as needed.

3.3.4.1.2 Truck Routing

The Contractor was required to follow project-established truck routes, as summarized in the Haul Routes Plan. The implementation of the plan, as well as control of on-site traffic patterns, was carefully monitored by the Construction Manager. Prime considerations were safety to site personnel and pedestrians, minimizing traffic congestion, and cleanliness of roadways. A primary point of access to the Site and a procedure for use of site access points were developed prior to work.

3.3.4.2 Traffic Controls

The Contractor maintained and protected surrounding community traffic, vehicles and pedestrians during the IRM activities. Where work was performed on or adjacent to any roadway, right-of-way, or public place, the Contractor employed flaggers as well as furnished and erected barricades, fences, warning signs, and danger signals in accordance with the Manual of Uniform Traffic Control Devices (Federal Highway Administration, 2009). Traffic control complied with the applicable local codes, regulations and requirements. Construction operations were conducted to minimize traffic delays. Emergency vehicles were granted unlimited access to roadways and took priority over all other vehicles and/or work or other operations.

Fences and barricades were utilized to restrict access to areas where operations were on-going. Site ingress/egress points utilized during the project were inspected daily. Flaggers directed trucks in and out of the Site. Flaggers also directed trucks on Kent

Avenue due to heavy bicycle traffic on the designated bicycle lane and pedestrians on the Kent Ave sidewalk. Truck drivers were instructed of this potential safety consideration and other requirements during their initial orientation.

3.3.4.3 Dust Controls

Dust control measures were implemented to minimize the potential for dust generation during excavation, handling, and placement of soil and fill. The main dust control activity was application of water from lay-flat hoses connected to on-site hydrants. Proper cleaning of trucks exiting the Site aided in minimizing dusty conditions. Calcium chloride was used to reduce fugitive dust during winter months, when freezing conditions would cause applied water to become a slipping hazard. Dust control associated with all exposed stockpiles as well as all open-air excavation areas was maintained using water to wet all exposed surface areas without impeding the on-going work.

Perimeter and work-zone air monitoring was performed in accordance with the CAMP to evaluate the effectiveness of dust control measures. In general, real-time air monitoring equipment was utilized to monitor dust levels in the work zone and at the Site perimeter. If visible dust was generated or if work zone or perimeter air monitoring results indicated elevated dust levels, corrective measures were implemented. Corrective measures included increasing water coverage, ceasing select activities during high wind, reducing speed of equipment to reduce dust generation, and utilizing different sizes or types of equipment that would cause less dust generation. Stockpiles were also covered with poly or long duration foam to minimize dust generation. The TFS and the VMS served as the primary dust control measures during deep excavation work.

During winter months, pumps, hoses and any other water spraying systems were drained daily or when not in use for extended periods of time to prevent freeze up. A combination of poly, calcium chloride, water, and additional stone was used on haul roads to minimize dust from truck and equipment traffic. Ponding of water which had the potential for freezing was managed by providing positive drainage as practicable and by adding calcium chloride, if needed. Attention was paid to avoid excessive salting of surfaces as dust created from dried salt could become a nuisance.

3.3.4.4 Odor Controls

Odor was monitored during excavation and handling of impacted soils and BSM spoils. During shallow excavations outside the TFS, odor was controlled principally by the application of foam, BioSolve®, and/or placement of tarps to cover open excavations and/or stockpiles. The Contractor utilized a mobile odor-control foam-application unit to directly apply RUSMAR AC-645© or LM-900© foam (as appropriate) over excavation surface areas and stockpiles to provide immediate odor suppression as needed. Deep excavation, ISS, and impacted soil management activities were performed inside the TFS to minimize odors. RUSMAR AC-645© foam was also applied in the TFS as needed to maximize odor control and minimize VOCs.

3.3.5 Well Abandonment

Seventeen groundwater monitoring wells were identified for decommissioning, twelve by grouting and five via excavation, pursuant to the IRM Design report. These wells were depicted on Drawing 3 of the IRM Design. The five shallow wells located within the deep excavation area (WW-MW-07, MW-7, MW-9, WW-MW-05, and MW-4) were removed during excavation as planned. One additional well not in the design was found installed within the Holder No. 2 footprint and did not extend below the tank foundation. This well, which was not installed for MGP plant investigation, was removed by excavation during the BSM phase of the remediation. Five (MW-2, MW-3, WW-MW-04, WW-MW-100I, and WW-MW-102I) of the 17 were identified and decommissioned in accordance with NYSDEC guidance. Two (MW-8 and MW-6) of the 17 were excavated during the BSM and CB wall excavation, respectively. Two previous investigation monitoring wells, MW-5, and WW-MW-17, were observed during the shallow excavation activities. However, the Contractor revised the project sequence moving abandonment towards the end of the project. At that time they were not able to locate them again. In a letter dated April 17, 2017 (included in Appendix B) NYSDEC approved proposed efforts to find these two wells, plus MW-4 which was at the edge of the excavation, using efforts that did not disturb unexcavated and potentially impacted material remaining below the demarcation fabric in the locations of these three wells. However, these three wells were not located successfully and this was discussed with NYSDEC during a weekly progress summary. The remaining two monitoring wells (WW-MW-102D_and MW-1) could not be located.

It should be noted that six of the monitoring wells (MW-2, MW-3, MW-4, MW-5, MW-6, and MW-8) were originally installed by NYCDDC to investigate the DOS property and were not part of the National Grid investigations. Response costs were incurred by National Grid for the decommissioning of these NYC-installed wells

In addition to the monitoring wells identified for decommissioning in the Design Report, five NAPL recovery wells (NRWs), NRW-03, NRW-04, NRW-05, NRW-09, and NRW-11, installed during as part of the prior component of the IRM, were also abandoned with approval of the NYSDEC. Recovery wells NRW-03, NRW-04, and NRW-05 were located within the former “no excavation” area that was not to be excavated in the original design. After NYSDEC requested excavation of this area, NYSDEC approved abandonment of these three recovery wells in a letter dated October 24, 2016 (see Appendix B). NRW-09 and NRW-11 were damaged during tieback installation and were replaced with NRW-09R and NRW-11R as approved by the NYSDEC in the letter dated January 6, 2017 (see Appendix B). The damaged NRW-09 and NRW-11 were also decommissioned in accordance with the NYSDEC guidance (CP-43). Well abandonment records are included in Appendix G.

3.3.6 Bucket Soil Mixing within the Holder No. 2 Tank

Holder No. 2 was constructed circa 1884, during a period of time when The Williamsburg Gas Light Company was controlled by the Standard Oil Company. Based on available maps, the area of the Site in which Holder No. 2 was located was not used for gas storage prior to construction of Holder No. 2. The contaminated material within the former Holder No. 2 tank was addressed by solidification of the soil and fill located inside the tank through addition of cementitious grout to reduce permeability of the material and thus mobility of contaminants present there.

3.3.6.1 Mobilization for BSM

A TFS was erected over the Holder No. 2 tank footprint prior to intrusive activities, to contain VOCs, dust, and odors during the operation. A VMS was installed. The VMS units were filled with carbon and connected to the TFS via hoses. A grout batch plant was mobilized to the Site to mix cement, ground granulated blast furnace slag, and water into grout for the BSM, per the design specifications. Cement silos were also brought to the Site and were refilled with Type I/II Portland Cement as needed throughout the BSM activities.

3.3.6.2 Grout Mix

Due to unavailability of the contract-specified 75% ground granular blast furnace slag (GGBFS) /25% Portland Type I/II blend, the Engineer approved the use of a 70% GGBFS and 30% Portland cement reagent mixture. The reagent quantity per cubic yard of untreated soil/fill was increased to 180 lbs, from 176 lbs, to prevent normal metering tolerances from negatively impacting the quality of the grout being incorporated into BSM because of the quantity of bricks in the subsurface. The design volume of water per cubic yard of untreated soils was 35.2 gallons, which was adjusted in the field depending on groundwater conditions in the active segment of the BSM, to obtain an acceptable grout/soil/fill mix.

3.3.6.3 Batch Plant

Grout was produced using an on-site batch plant. Silos were equipped with a feeder to allow for measuring the precise amount of dry reagent required for each batch. Following water addition, the dry reagent was metered directly into the mixer by weight. The completed batches were then pumped to the holding tank where they remained under agitation while awaiting delivery to the BSM segments. The mixer had the capacity to deliver a continuous supply of grout to the BSM operation from the holding tank.

3.3.6.4 Area Preparation for BSM and Material Handling

Investigations conducted at the Site have shown that shallow soil/fill within the Holder No. 2 tank had been contaminated by non-MGP-related sources, such as pesticides, PCBs, metals, and petroleum. PCBs were detected in a soil sample collected from three to five feet bgs in soil boring WW-SB-03 and in the soil sample collected from five to ten feet bgs in WW-SB-04. Pesticides were detected in a soil sample collected from two to four feet bgs in soil boring WW-SB-04. The detected pesticides included 4,4'-DDT and dieldrin, both of which were detected at concentrations exceeding the Unrestricted Use Soil Clean-up Objective. Petroleum odors were noted in boring BPB-20/MW-8 at depths of 5 to 13 feet, and may have been present shallower but not logged due to preclearing activities. Gas chromatograms from soil samples WW-TP-03 (3.5-4) and WW-SB-04 (2-4) show a range of hydrocarbons indicative of petroleum contamination. Various metals exceeded the Unrestricted Use Soil Clean-up Objective. This area of the Site was not used for gas storage prior to the construction of Holder No. 2 during a period of time when The Williamsburg Gas Light Company was controlled by the Standard Oil Company.

The BSM area was covered with hardscape (asphalt and concrete surface) post-dating and unrelated to the MGP and associated with the most recent prior use of the Site as a DOS garage. Cut asphalt hardscape was removed by a tracked excavator and transported off-site for recycling at Bayshore Soil Management facility. Un-impacted concrete hardscape was sent to the crushing plant for sizing.

Following removal of hardscape, soils in the top 6 ft of the Holder No. 2 tank footprint were excavated and evaluated for reuse in accordance with the Soil Acceptance Plan. The shallow soils were segregated to either be disposed off-site or to be reused in the deep excavation after being crushed and sized in accordance with the Contract Documents. Approximately 223 tons of shallow soil/fill at the top of the Holder No. 2 tank were identified as unsuitable for reuse and transported off-site to Bayshore Soil Management for thermal treatment and disposal. The soils suitable for reuse were crushed and temporarily stored. Soil from 6 ft to 7 ft bgs inside the Holder No. 2 tank were identified as containing hazardous levels of lead during in-situ waste pre-characterization sampling. These soils were excavated separately and 223.4 tons were disposed of at the Clean Earth of North Jersey as lead impacted hazardous waste.

An UST encased in thick concrete was found within the fill inside the Holder No. 2 tank while excavating prior to performing BSM. This UST and concrete structure were removed, sized, and shipped off-site to Bayshore Soil Management for thermal treatment and disposal. Based on the location of the UST within the fill inside Holder No. 2, it was apparently sited in this location after operation and decommissioning of the MGP.

In addition to the initial excavation to 7 ft bgs in the BSM area, another 3 ft of soil/fill were excavated from each segment prior to the commencement of BSM to allow for expansion of the treated material due to grout addition. These soils were temporarily stockpiled within the TFS constructed over the Holder No. 2 footprint and foamed as needed. Material from this stockpile was introduced back into the segment during mixing as long as the final surface of the BSM area stayed below 5 ft from the final, designed grade. All such soil and debris was able to be worked back into each solidification segment and none of it was shipped off-site.

3.3.6.5 Field Demonstration Test

Prior to full-scale BSM production operations, a field demonstration test was performed in Segment 3B, depicted on the Figure 7, within the Holder No. 2 tank. The test was performed initially on February 10, 2016. Due to a significant brick percentage among the soil/fill components of the fill in the Holder No. 2 tank, porosity was greater than expected and the consequent, unanticipated volume of pore water present diluted the introduced grout and allowed the grout to migrate to adjacent segments. Therefore, the demonstration test was suspended and the procedures and grout mix volume were re-evaluated. The grout mix was changed for all BSM segments located adjacent to untreated segments. A 40 percent increase in total amount of dry reagent mix (246 lbs of mixed dry reagent per cubic yard of untreated soils) as well as reduction in water volume (to the minimum needed to provide a workable mix) was approved by the Engineer.

The demonstration test was repeated using the revised grout mix and completed in segment 3B on February 16, 2016. Approximately 200 CY of soil/fill was treated during the demonstration test by introducing approximately 49,200 lbs of dry reagent mix with 2,960 gallons of water. The fill within the segment was mixed with the grout using the excavator bucket to achieve a homogeneous mix throughout the segment. The three feet of soil/fill that was removed from the segment initially to account for volume expansion was also slowly added to the mix. After achieving a thorough consistency in the segment, samples of the soil/fill/grout mixture were collected in accordance with the BSM work plan by lowering the excavator bucket into the soil mix matrix in a vertical orientation (i.e. pointing down) to the interval to be sampled. The bucket was then curled 90 degrees and brought to the surface. Two locations were sampled in segment 3B. Each sample was collected at a depth of 10 feet below the top of the mixture. The mix was passed through a half-inch-opening sieve and six 3-inch × 6-inch sample cylinders (including three as backups) were prepared for UCS and six 3-inch × 6-inch sample cylinders (including three for backup) were prepared for permeability testing.

The sample molds were stored at the Site at controlled temperature and moisture until they were ready to be sent to a laboratory. The Contractor used W. A. Wilson, Inc. of Hamburg, NY for QC sample testing and the Engineer used Timely Engineering Soil Tests, LLC for QA sample testing. Laboratory UCS testing of the samples was conducted in accordance with ASTM D1633/D2166 at 7, 14 (instead of 10), and 28 days and at additional ages as necessary and as approved by the Engineer. Samples were also analyzed for hydraulic conductivity/permeability in the laboratory in accordance with ASTM D5084 at 7, 14 (instead of 10), and 28 days. The demonstration test samples surpassed the target UCS of 50 pounds per square inch (psi) and target permeability of less than 1×10^{-6} cm/sec within first 7 days. Results of the UCS and permeability test from the demonstration test and from the production are summarized in Table 1.

3.3.6.6 BSM Production Work

BSM production work commenced following the successful completion of the demonstration test and review of analytical data by the Engineer. The area inside the

Holder No. 2 tank perimeter was divided into 20 segments, including the segment for the demonstration test (see Figure 7). The BSM was performed in Holder No. 2 segment by segment. The sequence was determined to minimize disturbance to the recently stabilized segment and also to prevent unstable conditions that could cause an accident. The sequence of mixing by segments is depicted in the table on Figure 7. The walls of the tank acted as the excavation support structure during production mixing and remained in-place below 5 ft bgs upon the completion of IRM activities.

Boundaries for each segment were laid out by the Contractor's surveyors. Layout consisted of marking the building frame and pulling string lines for each segment, as needed, and painting the ground with the segment boundary. A segment map (Figure 7) shows a work layout based on approximately 210 CY segment volumes. This layout facilitated less remixing of partially mixed soils in adjacent segments. The BSM excavator operator relied on graduated markings established on the excavator stick and boom to estimate depths during the initial soil mixing process. Once BSM was complete in a segment, the operator communicated with the Contractor's Quality Control staff to obtain final depth verification by lowering the excavator stick through the soil mix until the bucket contacted the bottom of the excavation. The depth of each segment was estimated using graduated markings established on the excavator stick and boom. The Project Superintendent verified that the bottom of the holder was reached across the cell before samples were collected.

During BSM production, each segment was prepared and soil/fill was managed as discussed in section 3.3.6.4. Where possible, soils excavated from each segment to accommodate potential volume expansion were stockpiled immediately adjacent to the segment being mixed and at an appropriate distance from the segment boundary to maintain stability. After soil was excavated, grout was introduced into the segment and soils, fill, and grout were thoroughly blended. Where the sidewalls of the segment could not stay stable, grout was introduced prior to reaching the final depth and excavation continued until the holder bottom was reached. Excavation and mixing continued as the segment sidewalls were extended to the limits of the established segment dimension. This process continued until the sidewall soil was blended with the grout to the limits of the segment. Grout continued to be added as this step was completed. Mixing continued until the prescribed amount of grout was introduced into the segment and the soils and fill were thoroughly mixed with the grout. With the exception of the last two segments completed (segments 2A and 4A), the three feet of overburden removed from each segment prior to mixing, to accommodate potential volume increases, was blended into the segment using similar methods. Once the grout addition was complete and all soil within the designated segment limits had been disaggregated and blended with grout, the operator continued to make one more series of passes with the excavator bucket from top to bottom across the entire horizontal limits of the segment. Final blending continued until the segment was visually homogeneous as observed by the Contractor's Quality Control representative, the Site Superintendent, and the Engineer.

Variance from the above-described methods occurred in segments 2A, 3A, and 4A. Due to instability of segment sidewalls, segment 3A was completed in two sections. The northern two-thirds of the segment 3A were completed first and remaining one-third of segment 3A was solidified a few days later. Some soil/fill from the last two segments (2A and 4A) remained after those segments were solidified. This remaining soil and fill was mixed with grout and placed uniformly on top of the BSM surface. The final BSM surface was greater than 5 ft below the final designed grade.

3.3.6.7 BSM Sampling and Testing

The Engineer inspected the soil/grout mix for NAPL or sheen, thorough mixing, consistent color, and presence of any unmixed clumps exceeding three (3) inches in size (other than bricks present in the holder). The Engineer then screened the samples to remove particles greater than half-inch in size and molded samples into plastic cylinders. The molded cylinders were placed into a humid environment in the storage container and held at room temperature throughout the duration of on-site storage.

One sample set was collected per 250 CY of soil/fill for the first 1,000 CY treated and then one sample set per 500 CY soil/fill treated thereafter for both UCS and hydraulic conductivity testing. Sufficient cylinders were prepared for each sample set to ensure that a duplicate was available in case any laboratory sample set was lost, damaged, or required re-testing. For each test location, 12 molded specimens were made from the sample: six 3-inch × 6-inch cylinder for UCS testing and six 3-inch × 6-inch cylinders for permeability testing. These volume requirements were based on three each (7-day, 14-day, and 28-day) for both UCS and for permeability, including duplicate back-ups for both test types. UCS was measured on all samples at 7, 14, and 28 days. The hydraulic conductivity was measured on all samples at 28 days and on two of the samples and three of the of the samples at 7 and 14 days, respectively.

The list of samples as well as the USC and hydraulic conductivity results are included in Table 1. As depicted on the table, all samples achieved UCS of 50 psi or higher within 14 days (eight out of nine samples achieved UCS higher than 50 psi within 7 days), while seven out of nine samples achieved hydraulic conductivity lower than 1×10^{-6} cm/sec within 28 days. The backup specimens for the remaining two samples were sampled after longer curing durations and achieved permeability below 1×10^{-6} cm/sec within 50 days.

3.3.6.8 BSM Coring

Coring was performed in accordance with the BSM Coring QA/QC Plan. Pursuant to NYSDEC guidance, one coring was required per 5,000 square feet of BSM area. Since the total area of BSM treatment within the Holder No. 2 tank was approximately 6,400 square feet, two cores were performed within the BSM test segment. Locations of the coring are depicted on Figure 7. The core samples and related equipment were visually inspected for the following qualitative criteria:

- Presence of visible NAPL,
- Non-mechanical induced cracking within the core,
- Percent of core sample recovered,
- NAPL coating on drilling tools, and
- NAPL in drill wash tub.

Coring was performed using a 3-inch diameter wireline core barrel in presence of the NYSDEC on March 1 and 2, 2016. Cores were retrieved in five-foot intervals and continued until the core samples indicated that the bottom of the holder was encountered. Recovered cores were placed in a core box, labeled, and photographed. Once visual inspection of the recovered cores indicated that the bottom of the holder tank foundation had been reached, the coring locations were filled with grout. Core recovery was greater than 90%. No visible NAPL was observed on the cores and drilling tools or in drill wash tub. Pictures of the cores are included in Appendix D. Based on the coring results, in correspondence dated March 3, 2016, NYSDEC accepted that the BSM had successfully solidified the material within the Holder No. 2 tank .

3.3.7 Support of Excavation

A SOE system was required to facilitate deep excavation at the middle portion of the Site, comprised of Holder No. 1 and the Relief Holder. The SOE consisted of a steel sheet pile wall placed within a CB slurry trench. The entire SOE perimeter was pre-drilled to 48 ft bgs via soil and rock augering to facilitate the subsequent excavation of the trench.

NAPL was encountered during construction of the SOE, during CB slurry trenching and tieback installation. Forensic analysis of NAPL collected at 38 – 40 ft bgs from boring GD-03, located along the alignment of the support of excavation, at the perimeter of the deep excavation area, indicated the NAPL was from a carbureted water gas process (Appendix V). The carbureted water gas process was used during periods of control over MGP by the Standard Oil Company in order to create markets for their petroleum products.

3.3.7.1 Pre-trenching

The SOE alignment was covered with hardscape (asphalt and concrete surface) post-dating and unrelated to the MGP and associated with the most recent prior use of the Site as a DOS garage. The boring GD-02, installed along the trench alignment, contained

PAHs at a depth of 2 feet bgs that exhibited a species distribution that indicated a petrogenic origin.

The outline of the SOE trench was saw-cut to allow a smooth guide for the trenching operations. Cut asphalt hardscape was removed by a tracked excavator and transported off-site for recycling at Bayshore Soil Management facility. Un-impacted concrete hardscape was sent to the crushing plant for sizing. After removing hardscape, the SOE alignment was pre-trenched to a depth of approximately 10 feet to remove any shallow obstructions and to find and plug any unknown abandoned pipe infrastructure.

The Contractor removed soils, abandoned piping, and shallow obstructions, including a few boulders during pre-trenching operations. To minimize the potential of exposure of site workers and the public to VOCs, dust and odors, the excavated soils were covered with foam until they were placed back into the trench or transported offsite. BioSolve® was also used to prevent odors when needed. Some abandoned pipes found to be extending beyond the property boundary were plugged using sandbags to prevent CB slurry loss. Approximately 736 tons of impacted soil and fill were sent to Bayshore Soil Management for thermal treatment and disposal during pre-trenching and pre-drilling.

3.3.7.2 Pre-drilling

Sevenson and their subcontractor Simpson and Brown pre-drilled the deep excavation perimeter to remove obstructions. Upon completion of the shallow pre-trenching operations, an ABI Mobile ram with a rotary drill rig head and 24-inch rock auger was utilized to identify subsurface obstructions along the SOE wall. This was subsequently replaced by a Delmag RH12 drill rig with 24-inch rock auger and later a Bauer BG20H drill rig equipped with a 24-inch inch rock auger.

3.3.7.3 CB Slurry Trenching and Wall Construction

A trench was excavated to 48 feet bgs at the perimeter of the deep excavation prior to placement of sheet piles. A CB slurry was used to maintain the stability of the trench following excavation and prior to placement of the steel sheet piles.

3.3.7.3.1 CB Slurry

Based on the Contractor's bench scale test performed by JLT Laboratories, Inc., the CB slurry mix was 33 parts water, 1 part of 3 percent bentonite slurry, and 10 parts of Portland cement, which produced a CB slurry that was 30 percent by weight of water. Prior to mix preparation, 3 percent of bentonite by weight of water was prepared, mixed and hydrated for a minimum 24 hours. After 24 hours of curing, the CB slurry was tested and demonstrated viscosity of 34 seconds, pH of 9.1 and density of 63.4 lbs/cf. The UCS of fully cured CB slurry (28 days) in the lab was above 35 psi.

This mix was used to prepare the CB slurry using the on-site batch plant. Daily CB slurry quantity reports including weight and volume of ingredients as well as results of the on-site Marsh cone rating test and specific gravity measurement by mud balance are included in Appendix H.

3.3.7.3.2 CB Slurry Wall Construction

The CB slurry wall was constructed using the self-hardening CB slurry trenching construction method. As the trench was excavated, prepared CB slurry was added to the trench to support the trench opening and maintain a stable trench. The trenching was carried out using a Komatsu PC-600 with a heavy-duty long reach boom and stick assembly capable of reaching a depth of 55 ft bgs. The self-hardening CB slurry cured to become permanent backfill.

Spoils from the slurry-trench excavation were temporarily placed inside the TFS that had previously been erected over the Holder No. 2 tank. Because BSM work had been completed, and covered with Reuse Material, a pad for the spoils was created inside the TFS using an impervious heavy duty liner with some Reuse Material over it to prevent tearing of the liner. A berm was constructed around the area using Reuse Material . The slurry-trench spoils were loaded onto a site-dedicated dump truck and transported to the TFS where they were temporarily stored until drained. Once drained, the spoils were spread over the containment pad and moved around the TFS to expedite drying. The dewatered spoils were loaded onto trucks for off-site disposal at Bayshore

Soil Management. Approximately 5,933 tons of impacted spoils from the slurry trench excavation were sent to Bayshore Soil Management for thermal treatment and disposal.

The CB slurry trench was excavated with a minimum width of 2 feet, corresponding to the width of the long-reach boom. The CB slurry trench extended from a work platform at the surface of the Site, approximately 10 ft above mean sea level (amsl), to a depth of 48 ft bgs, an elevation of about -38 ft amsl. Due to a lost drill bit at depth along the western alignment of the trench, predrilling and CB slurry trenching were bumped out by approximately 7 feet along approximately 45 feet of the west wall. As a result of this bump out, the footprint of the deep excavation was larger than shown in the Design Report.

3.3.7.3.3 CB Slurry Testing

The Engineer collected one CB slurry sample from the trench per 250 CY of trench volume (based on a constant two-foot width and the design depth), in accordance with the QAPP. The Engineer formed at least 4 molded specimens from each sample: one 3" × 6" cylinder for penetrometer testing and three 3" × 6" cylinders for submission to the geotechnical laboratory for UCS testing. This number of cylinders ensured that a minimum of one set of archive samples would be available as backup in case any laboratory sample set was lost, damaged, or needed to be re-tested. Once cylinders were molded they were placed into a humid environment in a storage container at room temperature in a site trailer.

After two days, or when sufficient strength for shipment was achieved, the three UCS cylinders were shipped to the laboratory for testing by method ASTM D 1633. The samples were tested for UCS between 14 and 28 days. The results are presented in Table 2. Although the Contractor's proposed CB slurry mix, approved by the Engineer, met the minimum bentonite and cement percentages, and bench tests of the grout mix, as provided by the Contractor's submittals, met the specified 35 psi strength, many of the samples exhibited 14-day and 28-day UCS values less than 35 psi. This may have been due to the presence of NAPL mixing with the grout.

The Engineer did not require changes in the slurry mix as the 35 psi value included a factor of safety of 1.5, and the strength measurements were similar to the target strength without this factor applied. The main objective for the grout strength was that it be stronger than the adjacent soil, and the observed strengths were comparable to the expected values of the adjacent soils. The lack of significant sheet pile movement upon tieback tensioning confirmed this decision.

3.3.7.4 Sheet Pile Installation

As the CB slurry trench was constructed at the perimeter of the deep excavation, sheet piles were driven into the CB slurry after it hardened enough to support the driving equipment. The Contractor used an ABI Mobilram rig and a 45-ton hydraulic crane with vibratory hammer to drive the AZ-26 700 sheet piles within the CB wall to a top elevation of approximately 10 ft amsl and an average toe depth of elevation -45 ft amsl, for an average depth of about 55 ft bgs. A sheet-driving template was fabricated to ensure that the sheet piles were properly aligned with the CB wall. Noise and vibration levels were monitored closely during the sheet pile installation to minimize disruption within the community. Sheet pile installation started in the northeast corner and proceeded south along the east wall and proceeded clockwise along south, west and north walls. The sheet pile log included in Appendix I provides detailed sheet pile installation information, including date of installation, embedment depths of individual sheets, and notes with installation conditions. A total of 134 sheet-pile pairs were installed within the CB slurry wall and along the deep excavation perimeter. Due to deep obstructions and concern about noise and vibration, some sheet piles could not be fully installed. However, the average depth of all the sheets was slightly greater than 55 ft bgs. Figure 8 shows the depth of sheet pile installation as a function of distance around the perimeter of the SOE wall.

3.3.7.5 Tiebacks

Tiebacks were installed to provide support during deep (to 30 ft bgs) excavation. Prior to tieback installation, the TFS was moved from its original location over the Holder No. 2 tank to the southern portion of the deep excavation footprint and extended by adding more bays and fabric to cover the whole deep excavation footprint. Additional VMS units were installed to provide a minimum of six air exchanges per hour for the volume of the interior of the building plus the 30-ft depth of the deep excavation. Prior to tieback installation, the entire footprint of the deep excavation area was excavated to approximately 8 to 8.5 ft bgs to provide a stable surface for tieback installation at the design depth. Details of this excavation are provided in Section 3.2.9.2. The excavation area was covered with poly at 8.5 ft bgs to and a thin layer of Reuse Material to maintain the VOC ambient air levels below the PPE Level C requirements. The use of Level C PPE became necessary at times, locally, near the drill rig, when NAPL and impacted drill cuttings were generated.

The tiebacks were installed at a 30-degree angle from horizontal starting at elevation 3.5 ft amsl. The Contractor surveyed the locations of the tiebacks and cut square holes in sheet piles to allow tieback installation.

Tiebacks were 0.60-inch diameter, 7-wire, steel strands conforming to ASTM 416. The strands were outfitted with bond breaker sheath in the stressing length/free length. The tiebacks were 60 ft in length, out of which 40 feet was bond length. After tensioning, the tiebacks transferred their force to wales mounted along with seat bearing plate spacers, and anchor heads on the sheet piles. A total of 76 tiebacks were installed.

The tiebacks were grouted with 5,000 psi grout. The contractor prepared grout cubes and analyzed them at the lab. After the grout was adequately cured (defined as a minimum of 3,500 psi compressive strength being achieved), a tieback anchor test was performed for each tieback. Performance tests were performed on two anchors along each of the longer east and west walls, and on one anchor along each of the shorter north and south walls. Proof load tests were performed on all other anchors. The load was incrementally increased and the total anchor movement (creep) was recorded. If the creep exceeded 0.04 inches between 1 and 10 minutes, the test load was maintained for another 50 minutes and the movement was recorded. The creep within 60 minutes was less than 0.08-inches. The maximum test load was 133 percent of design load, per the Post-Tensioning Institute (PTI) recommendation. After a successful load test, the anchors were locked off at 75 percent of the design load. All anchors successfully passed the load tests. Tieback load test reports are included in Appendix J.

To demonstrate compliance for all inspections/tests required for the job, in accordance with the New York City Construction Codes, AECOM identified the inspections necessary prior to job approval. As a requirement of the project permit from the NYCDOB, the SOE installation was inspected by Robert Forstner, P.E., a licensed special inspector, for conformance with the approved design drawings and specifications.

Ten movement monitoring points (see Figure 9) were installed on the sheet piles after the tiebacks were tensioned. The movement monitoring points were surveyed weekly throughout the deep excavation and backfill activities for structural movement by GEI and their subcontractor Maser Consulting. When groundwater elevation monitoring outside the excavation area indicated drawdowns in excess of 2 feet from pre-construction elevations, movement monitoring was increased to twice per week. When visible movement was detected at the northwest corner sheet in late December 2016, additional surveying was conducted daily to prevent an accident and/or settlement of the street and to maintain stability of the structure while this corner was backfilled, to remove stress on the sheet pile.

3.3.8 Excavation

Following installation of the tiebacks, excavation to the target depth of 30 ft bgs was initiated within the area bounded by the SOE wall. The remainder of the site was excavated to a minimum of 5 ft bgs. The several distinct areas of excavation described in this section are shown on Figure 10. This figure also shows the depth of excavation in each section.

Several investigations at the Site have identified the presence of non-MGP-related petroleum impacts in the shallow subsurface at the Site. These investigations include ones conducted by Soil Mechanics, LiRo Engineering, Metcalf & Eddy, GEI, and URS/AECOM. In their review of RI and IRM design data (discussed in section 1.2.2.1), Exponent identified at least six shallow soil RI samples and five shallow precharacterization samples collected at the Site with gas chromatograms displaying hydrocarbon distributions indicative of petroleum-related impacts (Appendix V) Exponent's evaluation of the ratio of the total PAH concentrations to the TPH value was uniformly low for the shallow soils (labeld "surface soils" in the report) which suggests petrogenic origin.. Non-MGP-related contaminants, such as metals, PCBs, pesticides, MTBE, and chlorinated solvents, have also been detected in shallow soil samples and groundwater samples collected from Parcel 2. Some of the past investigations have also documented the presence of historic fill at the Site to depths from up to 20 to over 40 feet bgs.

3.3.8.1 Shallow Excavation

The shallow excavation area is defined as the entire area of the Site exclusive of the deep excavation area described in section 3.2.9.2. A Shallow Soil Reuse Acceptance Plan was implemented to identify and segregate shallow soils that would be suitable for reuse as backfill in the deep excavation zone. The acceptance plan was approved by the NYSDEC on March 1, 2016 (Appendix B). All soils excavated from the shallow excavation zone were inspected visually and olfactorily as they were excavated. Soils without strong or moderate odor as well as free of stains, sheens, and NAPL were designated for reuse in accordance with the approved acceptance plan. The accepted soils were segregated and stockpiled for later use as deep backfill.

The entire shallow excavation area was covered with hardscape (asphalt and concrete surface) post-dating and unrelated to the MGP and associated with the most recent prior use of the Site as a DOS garage. Cut asphalt hardscape was removed by a tracked excavator and transported off-site for recycling at Bayshore Soil Management facility. Un-impacted concrete hardscape was sent to the crushing plant for sizing.

Environmental investigations conducted at the Site have concluded that the shallow subsurface contains widespread petroleum-related contamination (Appendix V).

> Analysis of the grab samples GC-FID chromatograms showed the presence of Unidentified Complex Mixtures (UCMs), indicating the

> presence of petroleum impacts…. In some samples, alkanes associated with fresh petroleum were also present. The presence of alkanes is consistent with a relatively recent release of a petroleum product in these locations.
>
> ….Analysis of the parent and alkylated PAH distributions in [soil samples subject to forensic analysis] demonstrated that the PAHs originated from a mix of petrogenic and pyrogenic sources. The widespread petroleum-related contamination in the top 5 ft of soil is consistent with impacts from the post-MGP operations such as leaks, spills from the USTs and ASTs, spills associated with equipment failures, and the use of oil-water separators.….

3.3.8.1.1 East Shallow Excavation Area

The east shallow excavation area is approximately 200 ft long × 100 ft wide. Historically it was comprised of two distinct sub-areas related to the MGP site: the area in which Holder No. 2 was located and an area in which a portion of a toluol recovery plant was located. The southern approximately 100 ft × 100 ft portion of the east shallow excavation area was the location of Holder No. 2, which was constructed circa 1884, during a period of time when The Williamsburg Gas Light Company was controlled by the Standard Oil Company. Based on available maps, the area of the Site in which Holder No. 2 was located was not used for gas storage prior to construction of Holder No. 2. The northern approximately 100 ft × 100 ft portion of the east shallow excavation area was not part of the MGP until 1921. In 1918, the United States of America constructed portions of a toluol recovery plant, including a still house, in this sub-area of the east shallow excavation area, and it acquired the property 1919. Prior to 1918, according to available information, the area was being used as a brewery. Construction of the toluol plant was a causal factor in this sub-area becoming part of the MGP.

Investigations conducted at the Site have shown that shallow soil/fill within the east shallow excavation area had been contaminated by non-MGP-related sources, such as pesticides, and solvents. PCBs and pesticides 4,4' DDT and dieldrin were detected in a soil sample collected from five to ten feet bgs in soil boring WW-MW-04 4,4'-DDT was detected at concentrations exceeding the Unrestricted Use SCO. Various metals exceeded the Unrestricted Use Soil Clean-up Objective. Past investigations documented the presence of historic fill at the Site to depths from up to 20 to over 40 feet bgs.

The portion of east shallow excavation area over the Holder No. 2 footprint was excavated in preparation for the BSM work (see Section 3.3.6.4 for the discussion on the excavation of this sub-area of the east shallow excavation area). Following the TFS move from over the holder No. 2 footprint to over the deep excavation footprint, shallow soils from those portions of the east shallow excavation area that had not been excavated in preparation for the BSM were excavated. The Shallow Soil Reuse Acceptance Plan was again followed to segregate impacted soils from soils suitable for reuse. Excavation in this area extended to a minimum 5 ft below the proposed final grade. Excavation was extended slightly deeper in one area where the proposed bottom of the excavation exhibited NAPL or heavy staining. Shallow structures and soils from this area were removed using a track mounted excavator and a hoe ram. The Engineer deemed approximately 1,958 tons of the soil and fill removed from the shallow excavation in the east shallow excavation area to be unacceptable for reuse and were sent to Bayshore Soil Management. This area was excavated and backfilled prior to the adjacent deep excavation to prepare the area for VMS units placement and to have the Reuse Materials from this area available during the deep excavation area backfill. Backfill was placed in lifts and compacted in accordance with the design. Other than the bridge lift, backfill was placed and compacted in one foot lifts using a vibratory roller until 95 percent compaction was achieved. The backfill compaction was tested by Advanced Testing, using a nuclear densometer at a frequency of at least one test per 500 square feet (sf) per lift. Since the subcontractor didn't submit all test results, the Contractor re-excavated and re-compacted shallow soils in this area towards the end of the project to provide documentation confirming compliance with the design specifications. Compaction test results and reports are included in Appendix K.

Excavation of the east shallow excavation area included soils adjacent to borings BPB-19 and BPB-20, installed during the 2006 Metcalf & Eddy investigation discussed above in Section 1.2.1. Each of these two borings revealed the presence of petroleum odors at the depths of 5 to 13 feet bgs (these odors may also have been present at shallower depths since the borings were precleared to 5 feet prior to installation). Since excavation advanced to at least 5 feet near BPB-19, and to depths of 7 feet near BPB-20 (located within the footprint of the relief holder tank), the excavation likely removed petroleum contamination not associated with MGP operations.

Samples collected during the in-situ waste pre-characterization sampling (Appendix U) were evaluated by the environmental forensics firm Exponent, Inc. to distinguish petrogenic and pyrogenic PAH distributions. The result of this analysis (Appendix V) showed that samples taken to precharacterize the east shallow excavation area, including C2G3C, C1G2, and C2G2E were found to contain significant levels of unresolved complex hydrocarbon mixtures and alkanes.

Two fuel oil USTs (estimated to be approximately 2,000 gallon capacity each) were encountered in the east shallow excavation area, just north of the Holder No. 2. One of these tanks was partially in the footprint of the holder No. 2. The USTs, their content (which appeared to be fuel oil or similar hydrocarbons), and soils around these UST were sized and sent to Bayshore Soil Management of off-site thermal treatment and disposal.

A riveted tank was encountered and removed during the shallow excavation in the portion of the east shallow excavation area that was formerly occupied by the toluol facility.

3.3.8.1.2 West Shallow Excavation

<u>WWTP Area</u>

The west shallow excavation began using a track mounted excavator near the northwest portion of the Site in the WWTP footprint to prepare this area for the WWTP and secondary containment installation. Hardscape was removed from this area and soils were excavated to 5 ft below the final restoration elevation. Concrete footings were encountered and removed using a hoe ram during excavation. Soils and concrete acceptable as per the shallow soil reuse acceptance plan were segregated and stockpiled in the western portion of the Site for crushing and backfill in the future. Soils and concrete not meeting the reuse criteria were intermittently stockpiled within the excavation and covered with foam as needed before being loaded into trucks and shipped to Bayshore Soil Management for thermal treatment and disposal. The Engineer deemed approximately 654 tons of the soils and concrete from the WWTP area were unacceptable for reuse and were sent to Bayshore Soil Management. This quantity also includes some impacted soils removed during the deep excavation pre-trenching as described in Section 3.3.7.3 above.

Following partial backfill with imported select fill, secondary containment for the WWTP was installed in this area by placing a thick, impervious high density polyethylene (HDPE) liner approximately 2 ft bgs in this area. The sides of the liner were raised, creating a containment area. The liner was sloped towards the center where a sump was created and a pump was placed to pump out any accumulated liquids (including rainwater). Gravel was placed over the liner to prepare a stable pad for the WWTP equipment. This area of the Site was later re-excavated to at least 5 ft below the planned restoration grade instead of 5 ft below the pre-existing grade or to groundwater.

The area was backfilled in lifts with approved imported backfill and compacted in accordance with the design documents. Compaction of the backfill was tested on-site using a nuclear densometer at a frequency of at least one compaction sample per 500 sf per lift. If the area tested was less than 500 sf, then at least two tests were performed per area per lift. Soils were re-compacted using a vibratory roller until the compaction of 95 percent was achieved. Compaction results are summarized in Appendix K.

Remainder of West Shallow Excavation Area

Shallow soil/fill in the west shallow excavation area outside of the previously excavated WWTP area was excavated as schedule permitted during the deep excavation, primarily during tieback installation. Soil in this area was also excavated to a minimum 5 ft below final grade. The excavation extended deeper wherever the proposed bottom of excavation exhibited NAPL or heavy staining. Soil, fill, and shallow structures from this area were removed using a track mounted excavator and hoe ram.

The Shallow Soil Reuse Acceptance Plan was again followed in this area to segregate soils suitable for reuse from impacted soils. Approximately 8,319 tons of soil/fill was transported off-site to Bayshore Soil management for thermal treatment and disposal. The rest of the soil was stockpiled on-site and was sized as necessary to 4” or less by crushing prior to being used as deep backfill.

Excavation of the west shallow excavation area included excavation of soils adjacent to borings BPB-10, BPB-11, BPB-12, and BPB-15, installed during the 2006 Metcalf & Eddy investigation discussed above in Section 1.2.1. Each of these four borings revealed the presence of petroleum odors at the depths of 5 to 6 feet bgs (these odors may also have been present at shallower depths, however the borings were precleared to 5 feet prior to installation, but not logged). Since excavation advanced to depths of 5 to 6 feet near each of these borings, the excavation likely removed petroleum contamination not associated with MGP operations. For example, previous investigations have reported the presence of a former oil/water separator (since removed) in the western shallow excavation area. Metals, PCBs, and the pesticide 4,4’ DDT at concentrations exceeding the Unrestricted Use SCO were detected in soil samples collected borings in the western shallow excavation area. PAHs in test pit GTP-07 were found in a pattern to suggest a petrogenic origin. Past investigations documented the presence of historic fill at the Site to depths from up to 20 to over 40 feet bgs.

Samples collected during the in-situ waste pre-characterization sampling (Appendix U) were evaluated by the environmental forensics firm Exponent, Inc. to distinguish petrogenic and pyrogenic PAH distributions. The result of this analysis (Appendix V) showed that samples taken to precharacterize the east shallow excavation area, including AG2A, AG2D, AG5A, and AG6C showed PAH concentration histograms that clearly show the presence of PAHs primarily from petrogenic sources. Additionally, sample AG3E was found to contain significant levels of unresolved complex hydrocarbon mixtures and alkanes, also indicating the presence primarily of petrogenic hydrocarbons.

Imported select fill backfill was placed in lifts and compacted in accordance with the design. Other than the bridge lift, defined as an approximately 2 ft lift of imported fill placed where the bottom of excavation was wet, backfill was placed and compacted in one foot lifts using a vibratory roller until 95 percent compaction was achieved. The backfill compaction was tested by Advanced Testing, using a nuclear densometer at a frequency of at least one test per 500 sf per lift. Since the subcontractor didn't submit all test results, shallow soils in this area were re-excavated and re-compacted towards the end of the project to conform with the design specifications. Compaction test results and reports are included in Appendix K.

3.3.8.1.3 Former "No Excavation" Area

Although not part of the original design or scope of work, NYSDEC requested in a letter dated October 21, 2016 that shallow soil excavation to remediate the 55 ft wide "no excavation" area in the western portion of the site. This area was initially designated as buffer zone to prevent any adverse effect from the IRM on the warehouse located west of the site. However, following the design and prior to IRM activities, the building burned down and the site was cleared by the property owner removing the need for a no excavation area to act as buffer against building damage.

Shallow soil/fill in the 55 ft zone was excavated as schedule permitted during the deep excavation, primarily during tieback installation. Soil in this area was also excavated to a minimum of 5 ft below final grade. The excavation extended deeper wherever the proposed bottom of excavation exhibited NAPL or heavy staining. Soil, fill, and shallow structures from this area were removed using a track mounted excavator and a hoe ram.

The Soil Reuse Acceptance Plan was again followed in this area to segregate soils suitable for reuse from impacted soils. The Engineer deemed approximately 4,298 tons of soil/fill excavated from the former "no excavation" area were unacceptable for reuse and were transported off-site to Bayshore Soil Management for thermal treatment and disposal. The rest of the soil was stockpiled on site and sized to 4" or less by crushing operation prior to being placed into the deep excavation more than 5 ft below the final grade.

Excavation of the former “no excavation” area included excavation of soils adjacent to boring WW-SB-110, installed by the URS predesign investigation discussed above in Section 1.2.1, and NAPL recovery well NRW-03. WW-SB-110 revealed the presence of petroleum odors at the depths of 3 to 5 feet bgs and petroleum product coating at depths from 5 feet to below the bottom of excavation in this area. During the installation of NRW-03, petroleum odors were observed at depths of 5 to 11 feet bgs. Therefore, the excavation in these areas likely removed petroleum contamination not associated with MGP operations.

Imported select fill backfill was placed in lifts and compacted in accordance with the design. Other than the bridge lift, backfill was placed and compacted in one foot lifts using vibratory roller until 95 percent compaction was achieved. The backfill compaction was tested by Advanced Testing, using a nuclear densometer at a frequency of at least one test per 500 sf per lift. Since the subcontractor didn’t submit all test results, shallow soils in this area was re-excavated and re-compacted towards the end of the project to conform with the design specifications. Compaction test results and reports are included in Appendix K.

3.3.8.2 Deep Excavation

After completing the construction of the SOE Wall, deep excavation of impacted material was initiated. The area within the SOE wall was excavated to the target depth of 30 ft bgs (except as noted below) and all soil, fill, and structures were removed and disposed off-site. Excavation was conducted underneath the TFS discussed above in Section 3.3.7.5 The Contractor performed work zone air monitoring within the TFS to determine the level of PPE workers had to wear and to maintain a safe work environment. Dewatering was conducted during deep excavation using well points and sumps to maintain dry excavation.

3.3.8.2.1 Initial 8.5 ft of the Deep Excavation

Investigations conducted at the Site have shown that shallow soil/fill within the

Deep Excavation Area had been contaminated by non-MGP-related sources, such as metals, PCBs, pesticides, and solvents, and petroleum. Past investigations also documented the presence of historic fill at the Site to depths from up to 20 to over 40 feet bgs outside of the holder tanks. TCE and DCE were detected in the soil sample collected from 3 to 5 ft bgs in soil boring WW-SB-05. PCBs were detected in the soil samples collected from 2 to 2.5 ft bgs in test pits WW-TP-01 and WW-TP-02. Pesticides were detected in shallow soil samples collected from soil borings WW-SB-05, WW-SB-23, and WW-MW-05, and test pit WW-TP-01. 4,4'-DDT and dieldrin were detected at concentrations exceeding the Unrestricted Use SCO in the soil sample collected from WW-MW-05. The PAHs from a depth of 2 to 4 ft bgs in RI boring WW-SB-24 and precharacterization test pit B3G9 were found in a pattern to suggest a petrogenic origin. Metals were detected above Unrestricted Use SCOs in all RI samples. Gas chromatograms for soil samples collected from soil borings WW-SB-23 (1-4 ft bgs) and GD-02 (2 ft bgs) and test pits WW-TP-04 (4.5-5 ft bgs) and B2G5 (0–2 ft bgs) show hydrocarbon distributions indicative of petroleum contamination. Borings BPB-17 (installed during the 2006 Metcalf & Eddy investigation discussed above in Section 1.2.1), WW-MW-05, WW-SB-07, WW-SB-08, (installed during the RI), and GR-2 (installed by URS during the supplementing predesign investigation) revealed the presence of petroleum odors at the depths of 5 to 6 feet bgs, 8 feet bgs, 3 to 5 feet bgs, 3 to 5 feet bgs, and 1 to 4 feet bgs respectively. Since excavation advanced to depths to 8.5 feet bgs near each of these borings, the excavation likely removed petroleum contamination not associated with MGP operations.

Excavation of the soils within the deep excavation footprint in the TFS proceeded to a depth of approximately 8.5 ft bgs to prepare a flat surface for a drill rig to install tiebacks. Odor suppressant foam, BioSolve®, and plastic sheeting were used as required to contain the odors and reduce VOC levels. Concrete and brick structures were broken using a hoe ram and excavator as they were encountered. All soil/fill was excavated and loaded directly into trucks and transported to Bayshore Soil Management for thermal treatment and disposal. Due to the amount of fill encountered within the former holders in the deep excavation area, some loads were sized by crushing at the Bayshore Soil Management treatment facility before thermal treatment. Approximately 12,240 tons of soil/fill was excavated and disposed off-site at Bayshore Soil Management during the initial 8.5 ft of deep excavation. This tonnage includes disposal of soils from a section within the Holder No. 1 tank footprint from 5 to 9 ft bgs that was treated to remove the characteristic of toxicity, due to elevated lead concentration, using the MAECTITE® process, as discussed in the following section.

One gasoline and two fuel oil USTs, previously abandoned, were encountered inside the Relief Holder. These tanks were approximately 2,000 gallon capacity. They were used by the New York City Department of Sanitation (a former operator of the property) and were identified on the design drawings. These tanks, their associated piping, and the surrounding soils were sized and disposed off-site at the Bayshore Soil Management for thermal treatment and disposal.

A concrete monolith (approximately 40 ft by 50 ft by 7 ft deep) reinforced with rebar was encountered within a foot or so of the former ground surface in the footprint of the deep excavation. The monolith was located partially within the Holder No. 1 tank and Relief Holder tank footprints. After significant effort, this monolith was also removed and sized for off-site disposal at the Bayshore Soil Management for thermal treatment and disposal. Since this monolith was present across the footprints of two different holder tanks, it would have to have been installed after the former MGP facility ceased operation.

3.3.8.2.2 Maectite® Treatment for Hazardous Soils within Deep Excavation

Some of the fill in the Holder No. 1 tank was found to contain lead that leached at levels above the criterion for the hazardous characteristic of toxicity (5.0 mg/L) and was thus a D008 hazardous waste. This material, initially identified by the in-situ waste pre-characterization sampling performed in April 2015 and then further delineated by sampling performed in January 2016 and April 2016, was determined to be present in certain areas in the 5-9 ft bgs horizon, the 12-19 ft bgs horizon, and the 18-21 ft bgs horizon. Prior to transporting the material to Bayshore Soil Management, it was treated on-site using the MAECTITE® chemical treatment process to reduce the leachability of the lead. The MAECTITE® reagent is a liquid reagent that reacts with the lead in the soil/fill to incorporate the lead into a crystalline matrix that was resistant to leaching. The MAECTITE® application was approved by NYSDEC in the letter dated August 22, 2017 (Appendix B). The MAECTITE® liquid reagent was applied to the identified area in each depth horizon (525 gallons to the 5-9 ft bgs horizon, 630 gallons to the 12-19 ft bgs horizon, and 238 gallons to the 18-21 ft bgs horizon).

At each depth, the treatment area was surveyed in accordance with the precharacterization sampling locations. The reagent was applied directly to the center of the surveyed area via a two-inch-diameter chemical hose. The liquid reagent was evenly distributed by mixing soils using an excavator bucket. Mixing consisted of a back-and-forth folding motion, which created a homogeneous mixture. The MAECTITE® process had a predicted cure time of 3 - 5 hours. After curing, the Contractor collected composite samples at a frequency sufficient to meet the Bayshore Soil Management laboratory analysis guidelines of one sample per 500 CY of material treated. The TCLP analytical results for all treated samples were below 5.0 mg/L lead and the material was accepted by Bayshore Soil Management for thermal desorption and disposal. A MAECTITE® application summary and analytical results for the treated samples are included in Appendix L.

3.3.8.2.3 Remaining Deep Excavation

Following tieback installation, excavation of the soil/fill within the deep excavation footprint continued in the TFS proceeding to a depth of approximately 30 ft bgs except as noted below. Holder tank walls, floors, and associated piping were removed along with other unknown concrete and brick structures encountered during the excavation. An area in the southwest corner of the deep excavation footprint was identified as native unimpacted soil. NYSDEC had approved leaving soils below the holder foundation depth and above 30 ft bgs if no visual impacts were observed. NYSDEC approved, in letter dated March 31, 2017 (in Appendix B), leaving some soil deeper than 22 ft bgs in the southwest corner of the deep excavation area as shown on Figure 10. Approximately 28,876 tons of impacted soils were excavated and transported to Bayshore Soil Management during excavation after tieback installation. Level C PPE was required for the most part during deep excavation due to elevated levels of VOCs. Excavation of the remaining deep excavation area included excavation of soils adjacent to boring GR-1, installed by the URS supplemental predesign investigation. GR-1 revealed the presence of petroleum odors at the depths of 23 to 35 feet bgs. Therefore, the excavation in this area, which extended to 30 feet bgs, likely removed petroleum contamination not associated with MGP operations. The forensic evaluation of PAH concentrations from samples taken at depths of up to 17 feet bgs (see Appendix V) indicate the presence of both petrogenic and pyrogenic sources.

Due to the muddy bottom of excavation, a bridge lift of number 3 gravel was used as the initial backfill lift in the deep excavation. The stockpiled Reuse Material from the shallow excavation areas was then spread over the bridge lift in one foot lifts and compacted with a vibratory roller. The Engineer approved the lifts by checking the number of vibratory roller passes by checking for the presence of water and by walking over the compacted backfill surface to identify any soft spots before the next lift was placed. The Reuse Material was not tested for compaction as it was sufficiently heterogeneous to preclude the ability to generate a modified proctor that could be used for all Reuse Material placement. After Reuse Material was placed as backfill, imported select fill was placed to further backfill the excavation. Orange demarcation fabric was placed prior to placement of select fill material following the placement of the Reuse Material. The select fill material was also placed in one foot lifts and compacted using a vibratory roller. Compaction testing was conducted by Advanced Testing at a minimum frequency of at least one test per 500 sf per lift. The deep excavation area was divided into grids to keep track of compaction testing. The compaction test results were reviewed by the Engineer. Compaction continued until compaction of 95% or higher was achieved in each grid.

Before backfilling was completed, the TFS was dismantled and sheet piles were cut to at least 5 ft below final grade. After cutting the sheet piles down, notches, 2 ft deep by 2 ft wide, were cut into sheet piles at 30 spacing to allow for groundwater movement and enhance local drainage. The deep excavation footprint was then backfilled to within

0.5 ft of the final designed ground surface using select fill material placed it in one foot lifts.

3.3.8.3 Dewatering

To ensure a dry excavation, groundwater infiltration was controlled by installation of dewatering wells at the perimeter of the deep excavation as well as by localized dewatering sumps capable of drawing the water table down to below the excavation limits. A well point system was designed to dewater the excavation areas. Griffin, the dewatering subcontractor, had difficulty installing all of the well points to the required depths due to subsurface obstructions. Griffon installed six 12-inch-diameter schedule 40 polyvinyl chloride (PVC) dewatering wells to various depths as follows: 48, 37, 40, 52, 15, and 45 feet bgs.

Additionally due to slow infiltration into the well points, multiple localized sumps were installed around and within the excavation areas as needed throughout the excavation activities to achieve adequate dewatering. The sumps consisted of slotted 12-inch diameter corrugated steel pipe wrapped in geotextile fabric with 2-inch clean stone placed around the pipe and fabric. The wells and sumps were plumbed to the on-site WWTP. The sumps were removed and reinstalled as excavation progressed. Extra sump pumps were used as necessary to maintain water level two feet below the excavation depth. Excavation and backfill activities were conducted once the well points and/or sump pumps had operated for a sufficient time to achieve the necessary drawdown. .

3.3.8.4 Wastewater Treatment Plant

Water generated from construction activities was treated at the WWTP staged over the WWTP pad. A total of 2,171,000 gallons of water was treated by the WWTP and discharged into the combined sewer located in Kent Avenue under a discharge permit issued by the NYCDEP. A copy of the permit is included in Appendix C. The treatment system had a peak flow capacity of 200 gallons per minute (gpm) with average daily flow of 100 gpm. The system was operated as needed until the IRM was complete. Collected water was stored in tanks until a sufficient quantity was accumulated to initiate treatment.

The treatment system was designed to meet the limitations for effluent discharge to the NYCDEP combined sewer system. Carbon was changed out once during the project. The following major subsystems comprised the collection and treatment system:

- construction dewatering pumps/pit sump pump/vacuum pump;
- influent equalization tanks;
- influent feed pumps;
- Weir tanks with oil skimmers;
- filter feed pumps;
- 5 µm bag filters;
- Granular activated carbon (GAC) reactors;
- secondary bag filters;
- effluent/backwash storage tanks;
- effluent/backwash pump; and
- effluent flow meter and totalizer.

3.3.8.5 Restoration

Six inches of topsoil was placed over the entire property in late May 2017 and was hydroseeded on June 12, 2017. Partial sidewalk replacement took place between late May and early June 2017 by the Contractor and the remaining sidewalk restoration was completed by New York Paving, a contractor to National Grid, during the period of June 15-22, 2017. New fence and gates were installed by the Contractor in May 2017, simultaneously with site grading and top soil placement. Due to insufficient seed germination following the initial seeding (due in part to loss of seed during a large rain event shortly after sowing), a second seeding event was performed in September 2017 to conform with design specifications.

A survey was performed to document that the final ground surface met the elevation and slope specified in the design documents and drawings. The final site contours and the area seeded are shown on Figure 11.

3.3.8.6 Demobilization

Demobilization activities were completed from April 24 to May 12, 2017 and included:

- Decontamination and removal of heavy equipment used for excavation and backfill activities;
- Plugging of the subsurface WWTP discharge pipe beneath Kent Ave.;
- Removal of the WWTP;
- Removal of jersey barriers and temporary fencing;
- Demobilization of remaining miscellaneous equipment and material; and
- Removal of temporary utilities and facilities.

3.3.9 <u>CAMP Results</u>

In accordance with the CAMP dated September 2015 and as part of remedial operations, GEI conducted continuous, real-time, air monitoring for TVOCs and particulates at the perimeter of the work area during ground intrusive remedial operations and during the demolition of potentially contaminated structures. Copies of all field data sheets relating to the CAMP are provided in electronic format in Appendix M.

3.3.9.1 Continuous Monitoring

Continuous real-time air monitoring for TVOCs and particulates was conducted at four continuous real-time air monitoring stations located along the perimeter of the Site. Air monitoring station locations are shown in Figure 9 and in the Community Air Monitoring Report (Appendix M).

3.3.9.2 Supplemental Periodic Monitoring

Supplemental, chemical-specific, air monitoring for BTEX compounds was conducted at the four continuous, real-time, air-monitoring stations, if continuous monitoring detected VOCs at concentrations exceeding the Alert Limit and/or Action Limit.

Supplemental, periodic, air monitoring for TVOCs, particulates, and odors was conducted at the perimeter of the work area on an as-needed basis (for example, before and after power was available at the Site or during primary equipment malfunctions) using hand-held monitoring equipment.

3.3.9.3 Time-Weighted Average VOC Analysis

Supplemental, twenty-four hour, time-weighted average VOC samples were collected at the perimeter of the Site at one location upwind and one location downwind, on a weekly basis, to demonstrate that the real-time air monitoring stations were effective in measuring concentrations of the target VOCs. The samples were collected in 6-liter SUMMA vacuum canisters and submitted for laboratory analysis by United States Environmental Protection Agency (EPA) Method TO-15.

Category B laboratory data deliverables pursuant to sections 2.2 and 2.3 and Appendix 2B of the NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10) were reviewed in accordance with the EPA Contract Laboratory Program National Functional Data Validation Standard Operating Procedures for Data Evaluation and Validation to support completion for each data package of a Data Usability Summary Report (DUSR) addressing the data quality objectives describe in the work plan. DUSRs are compiled in Appendix C, and the red-lined Forms 1 and the chain-of-custody forms are compiled as Appendix D, of the CAM Report (Appendix M).

Validated analytical results were submitted to NYSDEC in an electronic data deliverable format complying with the NYSDEC's Electronic Data Warehouse Standards per the Electronic Submissions section 1.15 of DER-10.

3.3.9.4 Pre-Construction Baseline Monitoring

Pre-construction baseline monitoring was conducted prior to IRM activities from December 17 through 20, 2015 The monitoring included continuous monitoring for TVOCs and particulates at the four perimeter locations; twenty-four hour, time-weighted average, VOC samples; and an odor survey conducted on-site and in the area adjacent to the Site. The results of the preconstruction VOC and particulate monitoring are presented in Section 2.1 of the CAM Report (Appendix M). Results from the odor survey are shown in Figures 3A through 3C of the CAM Report (Appendix M).

3.3.9.5 Contingency Plan

As outlined in the CAMP, the air monitoring contingency plan used a three-tiered classification and warning system based on Action Limits to provide warning and mitigation procedures to prevent emissions from the Site. Action Limit concentrations for TVOCs and PM-10 were developed in accordance with the generic New York State Department of Health (NYSDOH) CAMP (NYSDEC, 2010). The contingency plan's three-tiered warning system was based on real-time contaminant concentrations averaged over a fifteen-minute period.

The contingency plan was implemented when TVOC, particulates, or odors exceeded the Alert Limits or Action Limits. In the case of an Alert Limit or Action Limit exceedance, GEI notified the Construction Manager and the Construction Manager notified National Grid representatives, NYSDEC, NYSDOH, the Engineer, and the Contractor. The Contractor implemented mitigation control measures to abate the emissions and reduce levels to below the alert and/or Action Limit.

Action Limits were monitored throughout the project. Mitigation control procedures based on these Action Limits were designed by NYSDOH to be protective of human health.

3.3.9.6 Summary of Air Data

During intrusive activities associated with remedial operations, there were 15-minute average concentration measurements for particulate matter, benzene, naphthalene, and odors that were above the Action Limit. Particulate exceedances were generally attributed to jack hammering sub-surface concrete structures and the scraping of surficial concrete and asphalt surfaces during windy conditions. Naphthalene, benzene, and odor exceedances were attributed to gaps in the TFS fabric. In response, the Construction Manager was notified and the Contractor instituted necessary controls, such as spraying water on concrete during crushing operations; mending gaps in the TFS; and applying foam, poly sheeting, and BioSolve® to the excavation. After these controls were in place, concentrations returned to below the Action Limits.

Community air monitoring measured several particulate matter and TVOC 15-minute average concentrations that exceeded the Response and/or Action Limits and that were related to non-intrusive activities. These detections were associated with off-site activities such as street sweeping on Kent Avenue, and/or winds blowing surficial backfill dust towards air monitoring stations. There was one measurement of TVOC above the Action Limit during the refueling of construction equipment. The most frequent occurrences of the elevated particulate levels were measured at air monitoring stations located along Kent Avenue and North 12th Street. Several of the TVOC detections also occurred at times when there were no IRM activities occurring, or they were related to third-party activities off-site. Thus, these detections of particulate matter and TVOC appear to be common occurrences in the urban environment.

Laboratory testing of the twenty-four hour, time-weighted average ambient air samples detected low levels of VOCs, indicating that the real-time monitoring stations were effective in controlling concentrations of the VOC constituents of concern.

The CAMP was successfully implemented during remedial activities. Diligent operating techniques provided early detection of TVOC and PM-10 levels, limiting off-site migration of contaminants.

The community air monitoring data demonstrated that the excavation and soil management practices implemented by the Contractor and its subcontractors were effective in controlling off-site emissions and reducing the potential for the community to be exposed to concentrations above the Alert and Action Limits for the duration of the IRM.

3.3.10 Noise, Vibration, and Settlement Monitoring Results

As part of the remedial operations and in accordance with the Vibration, Movement, and Noise Monitoring Plan, GEI conducted continuous, real-time, vibration and noise monitoring at the perimeter of the work area during ground intrusive remedial operations and during the demolition of structures. Noise, vibration and settlement monitoring activities and results are summarized in the Structural Summary Report for IRM (GEI, 2017) included in Appendix N.

Vibration and noise monitors were installed at five combined locations (VP-1/NP-1 through VP-5/NY-5) as identified in the above-referenced plan to protect sensitive receptors including nearby buildings. Five Instantel MicroMates with International Society of Explosive Engineers (ISEE) geophones were used for continuous vibration monitoring. Noise monitoring was conducted using type 1 sound level microphones connected to the MicroMates at each of these five locations. One vibration and noise location (VP-5/NP-5) was eliminated on July 25, 2016 after NYC Parks acquired Parcel 6 and confirmed plans to demolish the one-story garage structure located there, for which monitoring location VP-5/NP-5 had been proposed and installed. This change was approved by NYSDEC in a letter dated June 24, 2016 (in Appendix B).

Each vibration monitor was setup with an event trigger corresponding to the site-specific warning action limit. In cases when the limit was reached at a particular monitoring location, the vibration monitor recorded, saved and sent out the event report through an email message system to the monitoring staff and the Construction Manager. After each event, the monitoring staff and the Construction Manager evaluated sources potentially causing such an event and defined a mitigation measure, if necessary.

Tell-tale crack monitors were used at each receptor as necessary to document the status of existing cracks in the building structures and were manually monitored, photographed, and recorded throughout the duration of intrusive activities. Movement monitoring was conducted for the surrounding buildings and the SOE by recording vertical and horizontal movement using optical survey marks set at the first floor and roof of exterior of buildings and on top of the excavation wall during construction.

Since significant drawdown on the outboard of the sheet pile wall could result in settlement, groundwater monitoring was conducted to guard against potential settlement due to dewatering. Groundwater monitoring was conducted at the recovery wells along N 11th St. and N 12th St. and a piezometer along Kent Ave.

3.3.10.1 Summary of Noise, Vibration, and Settlement Monitoring Data

There were no measurements of vibration above the Stop Work Action Limit and that were associated with remediation activities. There was one measurement of vibration above the Stop Work Action Limit that was attributed to a local, off-site source near the vibration monitor, and that was not related to remediation activity.

Several noise readings exceeded the Warning and Stop Work Action Limits but were not related to remediation activities. This noise was primarily associated with traffic along Kent Avenue. The most frequent occurrences of the elevated noise levels attributed to site activity were measured at monitoring stations located along North 11th Street. Short-lived noise readings were attributed to the slamming of dump truck tailgates during material load-out and backfill delivery activities.

Groundwater elevations were consistently measured above the Warning Action Limit in all five monitoring locations throughout dewatering activities. This prompted the Engineer to request GEI to monitor crack gauges, movement, and settlement points twice a week until backfilling of the deep excavation was completed. There were no exceedances observed in crack gauge movement, or settlement and movement points that were attributed to remediation activities. Following completion of the remediation, AECOM decommissioned the piezometer located along Kent Avenue, which had been part of the groundwater elevation monitoring program. The piezometer was removed through the casing pulling technique. The decommissioning log is included in Appendix G.

The structural data provided the project team with information to effectively respond to Warning and Stop Work Action Limit Threshold Criteria for the duration of the IRM.

3.3.11 Reporting

Project coordination included daily communications between on-site representatives, weekly conference calls conducted to update Site conditions and status, review of completed work, discussion of health and safety issues, and scheduling future activities. Daily documentation of field activities were recorded by the Engineer in a bound field book and by the Construction Manager and the Contractor on daily log sheets. The Contractor submitted daily and weekly reports detailing the remedial activities completed, quantity of waste managed, and schedule. The Contractor was responsible for scheduling haul trucks and tracking manifests for soil disposal and Bills of Lading for backfill.

During IRM activities, the Contractor prepared daily progress reports summarizing the activities performed and equipment used on that day. These reports are included in Appendix E. In addition to the general daily reports, task-related daily reports were also prepared by the Contractor for the Engineer's review during BSM activities, CB grout mixing, sheet pile installation, compaction testing, and tieback installation. Tieback testing reports are included in Appendix J.

The VMS was inspected daily and VOCs were monitored using photoionization detector (PID) and benzene Draeger tubes as necessary during BSM and deep excavation under the TFS. Daily VMS reports are also included in Appendix O.

SWPPP reports were prepared by the Contractor every week or after a storm event with more than 0.5 inch of rain. SWPPP reports were reviewed by the Engineer and the Construction Manager and necessary measures were taken every week to prevent sediment washout. SWPPP reports are included in Appendix F.

All daily and monthly reports are included in electronic format in Appendix E. A digital photo log is included in electronic format in Appendix D.

3.3.12 NAPL Recovery Well Replacement

Two recovery wells along N. 12th Street (NRW-09 and NRW-11) were damaged by the Contractor during tieback installation. Two new NAPL recovery wells were installed to replace these two damaged wells using a sonic drill rig in March 2017 in locations selected by the NYSDEC along N. 12th Street,. The 6-inch diameter recovery wells were constructed of 0.020-slot, continuous wire-wrap, stainless-steel, well screens; schedule 80 PVC risers; and 5-foot long, stainless-steel sumps for NAPL accumulation. These new recovery wells were named NRW-09R and NRW-11R. Each well was finished at the surface with a flush-mounted protective casing and cap. The wells were developed by removing approximately 1,000 gallons of water from each well. The development water was pumped into the on-site WWTP and treated prior to being discharged into the NYC combined sewer under the groundwater discharge permit. The drilling summary, well construction logs, and well development summary are included in Appendix G.

3.4 CONTAMINATED MATERIALS REMOVAL

There were no designated SCOs for the contaminants of concern for this project because the remedy removed soil across the entire Site. The depth of excavation was determined in the NYSDEC-approved IDIP and Design Report. The depth of the shallow excavation was based on the depth to groundwater and the depth of the deep excavation was determined by the depth of the former holder foundations. No confirmatory sampling was required in accordance with the approved plans.

3.4.1 Soil/Fill/Debris Reuse and Disposal

Soil/Fill/Debris was removed from the Site. The depth of excavation is shown on Figure 10. The final contours following backfill are shown on Figure 11.

3.4.1.1 Disposal Details

Approximately 223 tons of material from within the Holder No. 2 tank was disposed at Clean Earth of North Jersey as a characteristic hazardous waste with elevated levels of lead on March 8 and 9, 2016. Approximately 5,933 tons of impacted spoils from the slurry trench excavation were sent to Bayshore Soil Management for thermal treatment and disposal. Approximately 2,181 tons of soils from the east shallow excavation area, 654 tons from the WWTP area, 8,319 tons from the west shallow excavation area, 4,290 tons from the former "no excavation" area excavation, 41,116 tons from the deep excavation Area, 146 tons of sludge from the WWTP, and 2,036 tons of impacted soils from several different shallow areas (primarily areas outside the deep excavation where previously placed fill had become become contaminated during the deep excavation) towards the end of the project were sent to Bayshore Soil Management for thermal treatment and disposal between February 11, 2016 and May 18, 2017.

A total of 201 tons of non-hazardous construction debris was disposed of at the Alloco Recyling facility through the duration of the IRM. A total of 333 tons of asphalt was sent to Bayshore Soil Management for recycling between April 5, 2016 and August 16, 2016.

No waste characterization was performed during excavation as all material had been characterized in place for disposal acceptance purposes prior to excavation. The only exception to this was analysis of soil/debris treated using MAECTITE® to remove the hazardous characteristic of toxicity due to leachable lead. These MAECTITE®-treated soils were analyzed for total and TCLP lead. The results of this post-treatment characterization sampling are included in Appendix L.

Disposal documentation and a summary of quantities transported to disposal facilities are provided in a table and in appendices to this report, as follows:

- Table 3 shows the total quantities of each category of material removed from the Site and the disposal locations.

- Letters from Applicants to disposal facility owners and acceptance letters from disposal facility owners are attached in Appendix P.

- Manifests and bills of lading are included in electronic format in Appendix Q.

3.4.1.2 On-Site Reuse

Soils, brick, and concrete from the east shallow excavation area, west shallow excavation area and the former “no excavation” area were segregated in accordance with the Shallow Soil Reuse Acceptance Plan.

The accepted soils were segregated and stockpiled on-site. The Reuse Material was then taken from the stockpile and crushed using a crusher to less than 4” size. Crushed Reuse Material was used as backfill at depths greater than 13’ ft from the finished grade within the footprint of deep excavation . The approximate locations and elevations where the reuse materials were placed are depicted on Figure 12.

3.4.2 <u>Groundwater and Wastewater</u>

2,171,021 gallons of water (from dewatering, infiltration of storm water, and decon) was treated by the WWTP and discharged into the combined city combined sewer under the NYCDEP discharge permit.

3.4.3 <u>Spent Carbon Disposal</u>

An estimated 122,600 pounds of vapor phase carbon from the VMS units was disposed following decommissioning of the TCB. This carbon was determined to be hazardous due to the characteristic of toxicity for benzene. The carbon was sent to Evoqua Water Technologies Inc. in Darlington, PA for treatment.

3.5 REMEDIAL PERFORMANCE/DOCUMENTATION SAMPLING

There was no post-excavation documentation sampling for this project because the remedy removed soil from across the entire footprint of the site as an IRM. The depth of excavation was determined not by sampling, but by the NYSDEC-approved IDIP and Design Report. The depth of the shallow excavation was based on the depth to groundwater and the depth of the deep excavation was determined by the depth of the former holder tanks. No confirmatory sampling was required in accordance with the approved plans.

3.6 IMPORTED BACKFILL

Following excavation, the excavated areas were backfilled and compacted to final grade elevations. Delivery of Select fill began on December 17, 2015 in the WWTP area. The common backfill was placed in stages as excavation proceeded between December 2015 and May 2017. Backfilling was performed in localized areas where the full excavation depth was reached. Backfilling began before all areas of the Site were excavated to their final depths.

The backfill material was brought to the Site in tri-axle dump trucks and tandem trailers from the Wantage Quarry located in Hamburg, New Jersey, Shamrock Material located in Staten Island, NY, and the Corbett Aggregate Facility located in Quinton, New Jersey. The borrow source backfill material was tested prior to delivery to the Site for metals, PAHs, SVOCs, VOCs, pesticides, PCBs, and herbicides. The laboratory analytical results are included in Appendix R. The analyses were compared to the NYCRR Part 375 restricted residential use criteria (Table 375-6.8 (b)) and were all found to be within the criteria limits.

The imported backfill was placed and compacted as described above in section 3.3.8.

The final cover over the Site consisted of 6-inches of topsoil, imported from the Long Island Compost. Following backfilling, grading activities were conducted in May and June 2017. The top soil from the source material was tested prior to delivery to the

Site and the analytical results are included in Appendix R. The material was tested for the following parameters: metals, PAHs, SVOCs, VOCs, pesticides, PCBs, and herbicides. The analyses were compared to the NYCRR Part 375 restricted residential use criteria (Table 375-6.8 (b)) and were all found to within the criteria limits.

A total of 63,099 tons of gravel backfill material, 2,253 tons of gravel backfill material, and 2,445 tons of topsoil were imported to and placed at the Site.

A table of all sources of imported backfill with quantities for each source is shown in Appendix S. A table summarizing chemical analytical results for backfill, together with the DER-10 Appendix 5 allowable levels for unrestricted and restricted commercial or industrial use is provided in Table 4.

3.7 CONTAMINATION REMAINING AT THE SITE

The IRM excavated or solidified soil and debris in accordance with the approved IDIP and Design Report. Because NAPL at the Site is denser than water, it has migrated to depths greater than those excavated. Additionally, the 2013 URS PDI identified the presence of petroleum product contamination in the form of gasoline odors in west shallow excavation area borings WW-SB-106 and WW-SB-108 and in east shallow excavation area boring WW-SB-102I at depths greater than the excavation performed in these shallow exacavation areas, indicating that petroleum product contamination remains at the Site as well. The IRM was designed to remove soil and fill from those areas in and adjacent to the former Relief Holder and Holder No. 1 foundations, and elsewhere on the Site above the groundwater table, and to solidify soil and fill within the Holder No. 2 tank, but contamination remains below the demarcation barriers placed below the imported clean fill.

3.8 SOIL COVER SYSTEM

Exposure to unexcavated material at the Site is prevented by a soil cover system placed over the entire site. This cover system is comprised of a minimum of 5 ft of clean soil (minimum 4.5 ft of clean backfill and 0.5 ft of topsoil). Figure 13 shows the typical cross section for remedial cover type used on the site.

3.9 DEVIATIONS FROM THE REMEDIAL ACTION WORK PLAN

The following major variations or deviations from the approved Design Report and Contract Documents were implemented during the IRM.

3.9.1 Excavation of the Former "No-Excavation" Area

Originally a 55 ft wide strip extending from N, 11th Street to N. 12th Street at the western end of the property was not included in the IRM to maintain a buffer between the remedial activities and building on the adjacent property. However, after design was approved, the building burned down and was demolished and cleared leaving the adjacent property vacant. Since there was no potential to damage the adjacent property, this zone was excavated during the IRM as described in Section 3.3.8.1.4 above.

3.9.2 Abandonment of Some Recovery Wells

Since the former "no excavation" area was also excavated during the IRM and was restored with grass as park land, three recovery wells, NRW-03, NRW-04, and NRW-05, which were located in this area, needed to be decommissioned prior to restoration as a grass field park. With NYSDEC's approval in a letter dated October 24, 2016, these three recovery wells were abandoned on March 30 and 31, 2017 in accordance with the NYSDEC's guidelines.

In addition NRW-09 and NRW-11 were damaged during tieback installation. These wells, replaced with NRW-09R and NRW-11R, were also abandoned in accordance with NYSDEC's guidelines on April 3 and 4, 2017. Well abandonment logs are included in Appendix G.

3.9.3 Monitoring Well Decommisioning

Drawing 3 of the Design Report identified former monitoring wells to be decommissioned during the IRM. However, not all wells were found in the field during the IRM. Wells MW-2, MW-3, MW-04, MW-100I, and MW-102I were identified and decommissioned in accordance with the NYSDEC guidance. The several wells that could be identified for excavation (due to their location within the deep excavation) during deep excavation were excavated and disposed off-site at Bayshore Soil Management along with impacted soils. MW-6 was within the SOE alignment and was excavated during the CB wall installation instead of being decommissioned in accordance with DEC publication CP-43 as called for by the design. MW-8 was found to be within the Holder No. 2 footprint and was excavated during the BSM instead of being decommissioned in accordance with DEC publication CP-43 as called for by the design. In addition, an unknown well was identified within Holder No. 2 footprint. Since the well bottom did not extend beyond the holder bottom, this well was excavated during BSM activities and disposed of at Bayshore Soil Management along with impacted soils. Monitoring wells MW-1, MW-4, MW-5, WW-MW-17, and WW-MW-102D could not be identified during the IRM. NYSDEC was informed about missing wells in the letter dated April 17, 2017. Based on NYSDEC's recommendation, additional efforts were made to identify wells MW-4, MW-5, and WW-MW-17. NYSDEC acknowledged the efforts and approved not decommissioning these wells in the letter dated during weekly progress meetings.

3.9.4 Shallow Excavation Extended Deeper than Designed

Originally the excavation in the shallow areas was designed to extend to 5 ft from the original grade or to the water table, whichever is encountered first. However, for ease in locating remaining contamination beyond the property lines in the future and to meet NYSDEC's request, excavation in shallow areas extended at least 5 ft from the final grade, which was lower than the original grade, resulting in excavation of more material than originally anticipated for the shallow excavation areas.

3.9.5 Change in Support of Excavation Design

The SOE wall was initially designed to extend to 48 ft bgs and have two rows of tiebacks. The Contractor and its consulting engineer, Glynn, recommended deeper sheet pile installation and one row of tiebacks for cost and time savings. The design was revised to install sheet piles to provide a toe depth of 25 ft below the bottom of the deep excavation (to a total expected depth of approximately 55 ft) and single level of soil tie-back anchors and walers at a depth of 6.5 ft bgs. This change was reviewed and approved by the Engineer and communicated to NYSDEC during weekly progress meetings.

Not all sheet piles were driven to the depth specified in the alternate design due to concerns about vibration and noise resulting from further hammering sheets into the ground once solid obstructions were encountered. However, the overall average depth of the bottom of sheet piles was 55 ft, which was considered acceptable when evaluated against the target depth. The sheet pile installation log is included in Appendix I and the sheet pile embedment depths are depicted on Figure 8.

3.9.6 Excavation to 22 ft bgs instead of 30 ft bgs in Southwest Corner of Deep Excavation

Soils below 22 ft bgs in an approximately 25 × 25 foot area in the southwest corner of the deep excavation area did not exhibit signs of gross contamination and appeared to be native material. Since this depth was greater than the depth of the holder bottom, initiative in a letter dated March 31, 2017 (in Appendix B) NYSDEC approved leaving this area "as is" to comply with the green remediation. Elevation of bottom of excavation in this area is depicted on Figure 10.

3.9.7 Bump-Out in the SOE Wall

Two drill bits were lost deep in the ground while predrilling the western alignment of the Deep Excavation Area SOE. Due to the bits embedded into the ground in this location, trench excavation and sheet pile installation was not possible to the designed depth. To avoid shallow sheet pile embedment and possible instability of the SOE wall, the sheet piles were installed the width of one pair of sheet piles further west in this area, forming a "bump-out" on the western side of the SOE. Corners and corner bracing were added in the design to accommodate the bump-out The SOE alignment, including the bump-out, is depicted on Figure 10. This change was discussed with NYSDEC, and, based on the input from the Engineer and the Construction Manager, the bump out was approved.