



Geotechnical
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**DRAFT Interim Remedial Measure
Pre-Design Investigation Data Summary Report**

Fulton Municipal Works Former Manufactured Gas Plant Site

Brooklyn, New York
AOC Index No. A2-0552-0606
Site No. 224051

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Abbreviations and Acronyms

AOC	Administrative Order on Consent
Boart	Boart Longyear
CAMP	Community Air-Monitoring Plan
cm/s	centimeters per second
CPT	Cone Penetration Tests
CSO	Combined Sewer Overflow
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
GEI	GEI Consultants, Inc., PC
GPR	Ground Penetrating Radar
Hager-Richter	Hager-Richter Geoscience, Inc.
HASP	Health and Safety Plan
ID	Inner Diameter
IRM	Interim Remedial Measure
KeySpan	KeySpan Corporation
LNAPL	Light Non-Aqueous Phase Liquid
MGP	Manufactured Gas Plant
MOSF	Major Oil Storage Facility
NAPL	Non-Aqueous Phase Liquid
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NPL	National Priorities List
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
PAH	Polycyclic Aromatic Hydrocarbons
PDI	Pre-Design Investigation
PID	Photoionization Detector
PM-10	Particulate Matter (Less than 10 microns)
PPE	Personal Protective Equipment
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PUL	Precision Utility Location
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
ROD	Record of Decision

Abbreviations and Acronyms (cont.)

SGH	Simpson, Gumpertz, and Heger
SPT	Standard Penetration Test
USDOT	United States Department of Transportation
UST	Underground Storage Tank
WIA	Wilson, Ihrig, and Associates
WP	Work Plan
Zebra	Zebra Environmental

Executive Summary

On behalf of National Grid, GEI Consultants, Inc., PC (GEI) has prepared this Interim Remedial Measure (IRM) Pre-Design Investigation (PDI) Data Summary Report for the Fulton Municipal Works Former Manufactured Gas Plant (MGP) site (the Site). This report summarizes the findings of the pre-design investigation, identifies IRM components, identifies potential data gaps, and presents a tentative schedule.

As agreed during the February 25, 2013, meeting with the New York State Department of Environmental Conservation (NYSDEC), this report is being submitted in advance of an IRM Design Work Plan (WP). At this time, it is not feasible to design an IRM at the Site given many design uncertainties raised by the issuance of the United States Environmental Protection Agency's (EPA) Gowanus Proposed Remedial Action Plan (PRAP) on December 27, 2012. The Fulton IRM will need to be integrated with elements of the EPA's remedy for the Gowanus Canal. Critical elements of the Canal remedy including targeted dredge depths, bulkhead rehabilitation, CSO controls, and the overall hydraulic effects of the remedy are uncertain at this stage. National Grid acknowledges that EPA plans to issue bulkhead Orders to parties along the Canal and shall coordinate the engineering of the Fulton wall with NYSDEC and EPA to meet the requirements of both. It is also possible that the remedial concepts presented in the PRAP may change once the Record of Decision (ROD) is issued. These uncertainties make it difficult to develop the IRM design. National Grid anticipates that some of this uncertainty will be resolved once the ROD is issued later this year. At that time, National Grid will develop the IRM Design WP.

PDI Summary

The PDI was completed between June and September of 2012. The scope of work was outlined in the NYSDEC-approved work plan titled *Final Interim Remedial Measure Pre-Design Investigation Work Plan*, dated March 2012 (GEI, 2012). The purpose of the PDI was to obtain additional information to support the design of an IRM.

The PDI Scope included:

- Environmental and Geotechnical Investigation;
- Data Collection for Refinement of the Groundwater Model;
- Background Noise and Vibration Survey;
- Utility Survey and Subsurface Infrastructure Investigation;
- Evaluation of the Construction of Adjacent Buildings, Bulkheads and Foundations; and
- Non-aqueous phase liquid (NAPL) Delineation for Potential Future Recovery.

The main goal of the IRM is to prevent migration of potentially mobile tar-like material from the Site into the Gowanus Canal. To meet this goal, the IRM selected is a barrier wall along the Canal with a NAPL recovery system, as appropriate, behind the barrier wall.

Tar-like material related to the Site has been identified in the subsurface on Parcels I and Parcel VI. To prevent the potential migration of this material into the Canal, the barrier wall will border these parcels as an IRM, although the exact extent is yet to be defined.

The RI and PDI findings revealed impacts along the bulkheads that are not directly related to the Site, but rather the result of multiple co-mingled sources, as acknowledged by the NYSDEC in its approval of the Fulton RI Report. West of the Gowanus Canal and at Parcel VII, tar is only encountered in close proximity to the existing bulkheads. It is likely that these materials represent tars that have been released into the Gowanus Canal from multiple sources, and not directly from the Fulton site. Petroleum impacts, unrelated to the Site, are located on the west side of the Canal. The co-mingled nature of tar and petroleum impacts dictates that they will need to be addressed in conjunction with the EPA's remedy for the Gowanus Canal.

Data Gaps

To minimize the overall impact to the design schedule, National Grid will continue to collect necessary information needed to design the IRM. Additional information is needed relating to sub-subsurface obstructions in the IRM area, New York City Department of Environmental Protection (NYCDEP) infrastructure, groundwater modeling, NAPL recovery, and noise and vibration. National Grid expects to collect this information prior to issuance of the ROD. During the same time period, National Grid will be conducting a constructability pilot test for barrier wall elements at the former Citizens MGP site, also located along the Canal. Information collected during this pilot test will influence the design at Fulton.

Schedule

The current schedule for the IRM Design WP is dictated by the completion of the Citizens constructability pilot test and issuance of the Gowanus Canal ROD. National Grid anticipates that the pilot test will be completed prior to issuance of the ROD. The IRM Design Work Plan will be submitted 90 days after the ROD is issued or the Citizens pilot test is completed, whichever is later. Target dates of the anticipated schedule are listed below:

- Additional PDI Data collection - Q2/Q3 2013
- Citizens Pilot Test (present report schedule) - Q3 2013
- EPA Issuance of the Gowanus Canal ROD (anticipated) - Q3 2013
- Submittal of Fulton IRM Design Work Plan - 90 Days after the later of issuance of the ROD or completion of Citizens pilot test.

1. Introduction

On behalf of National Grid, GEI Consultants, Inc., PC (GEI) has prepared this Interim Remedial Measure (IRM) Pre-Design Investigation (PDI) Data Summary Report for the Fulton Municipal Works Former Manufactured Gas Plant (MGP) site (the Site). The Site is under an Order on Consent and Administrative Settlement (AOC) #A2-0552-0606, which was entered into by KeySpan Corporation (KeySpan), the predecessor to National Grid, and the New York State Department of Environmental Conservation (NYSDEC) in 2007.

National Grid has conducted a Remedial Investigation (RI) at the Site. A Final RI Report titled *Final Remedial Investigation Report, Fulton Municipal Works Manufactured Gas Plant (MGP) Site* (GEI, 2012a), dated July 2012, was approved by the NYSDEC in July 2012 (**Appendix A**). In a previous letter dated January 18, 2012, following the submittal of the Draft RI Report, the NYSDEC directed National Grid to prepare a pre-design work plan for an IRM.

National Grid submitted the requested pre-design work plan titled *Final Interim Remedial Measure (IRM) Pre-Design Investigation Work Plan* (GEI, 2012b), dated March 2012, and NYSDEC approved the pre-design plan by letter dated March 23, 2012 (**Appendix A**). In the summer of 2012, National Grid mobilized and completed the pre-design field work.

This IRM PDI Data Summary Report summarizes the findings of the pre-design investigation, identifies IRM components, identifies potential data gaps, and presents a tentative schedule.

As agreed upon during the February 25, 2013 meeting with the NYSDEC, this report is being submitted in advance of an IRM Design Work Plan (WP). At this time, it is not feasible to design an IRM at the Site given many design uncertainties raised by the issuance of the United States Environmental Protection Agency's (EPA) Gowanus Proposed Remedial Action Plan (PRAP) on December 27, 2012. The Fulton IRM will need to be integrated with elements of the EPA's remedy for the Gowanus Canal. Critical elements of the Canal remedy including targeted dredge depths, bulkhead rehabilitation, CSO controls, and the overall hydraulic effects of the remedy are uncertain at this stage. National Grid acknowledges that EPA plans to issue bulkhead Orders to parties along the Canal and shall coordinate the engineering of the Fulton wall with NYSDEC and EPA to meet the requirements of both. It is also possible that the remedial concepts presented in the PRAP may change once the Record of Decision (ROD) is issued. These uncertainties make it difficult to develop the IRM design. National Grid anticipates that some of the uncertainty will be resolved once the ROD is issued later this year. At that time, National Grid will develop the IRM Design WP.

To minimize the overall impact to the design schedule, National Grid will continue to collect information necessary to design the IRM. Section 4 of this report identifies data gaps that will

need to be filled during the design phase. Additional information is needed related to sub-surface obstructions in the IRM area, New York City Department of Environmental Protection (NYCDEP) infrastructure, groundwater modeling, non-aqueous phase liquid (NAPL) recovery, and noise and vibration. National Grid expects to collect this information prior to issuance of the ROD. In the same time period, National Grid will be conducting a constructability pilot test for barrier wall elements at the former Citizens MGP site. Information collected during this pilot test will influence the design at Fulton.

1.1 Data Summary Report Organization

This IRM PDI Data Summary Report has been organized as follows:

- Section 1 Introduction
- Section 2 Summary of the Pre-Design Investigation
- Section 3 Conceptual Design
- Section 4 Next Steps
- Section 5 References

1.2 Site Description and History

The Fulton Municipal Works Former MGP Site is located along the Gowanus Canal in the Gowanus neighborhood of Brooklyn, New York. The Site location is shown in **Figure 1**. The former MGP occupies five current parcels (herein designated Parcels I through V). Three additional off-site parcels (Parcels VI through VIII) were investigated during the delineation of nature and extent of impacts as part of the RI. Parcel identification and historical MGP structures are shown in **Figure 2**. The Site and adjacent areas are currently zoned for manufacturing use.

Parcel I is located at 270 Nevins Street (Block 425, Lot 1). During manufactured gas production, Parcel I housed MGP production facilities including an oil/naphtha tank, generator/retort house, condenser/blower house, coal shed, engine house, gasoline house, and generators. Recent property use includes warehouse storage, currently used as a movie studio.

Parcel II is located at 225 Nevins Street (Block 419, Lot 1). During manufactured gas production, Parcel II housed production facilities including three oil tanks, one hydrogen tank, six gas oil naphtha tanks, nine unknown tanks, a paint shop, blacksmith shop, carpenter shop, pipe shop, garage, and several sheds. The property is currently Thomas Greene Park and includes a playground, swimming pool, wading pool, and handball courts.

Parcel III is located at 537 Sackett Street (Block 426, Lot 1). During manufactured gas production, Parcel III housed production facilities including a gas holding tank, purifying houses,

oxidizing sheds, coal bin, scrubbers, meter house, governors house, and offices. The property is currently used as a textbook warehouse and parking lot.

Parcel IV is located at 560 Degraw Street (Block 426, Lot 27). During manufactured gas production, Parcel IV housed production facilities including a gas holding tank and a coal shed. The property is currently used for storage of roll-off bins, truck maintenance equipment, and construction materials.

Parcel V is located at 191 3rd Avenue, also known as 575 Degraw Street (Block 420, Lot 1). During operation of the Fulton Municipal Works, Parcel V, also known as the 3rd Avenue Holder Station, housed facilities including a gas holding tank (storage only), water tank, engines/blowers, and coal shed. The property is currently used as a rock climbing gym and warehouse. Based on the findings of the RI, Parcel V does not exhibit soil, groundwater, or soil vapor impacts related to the former gas storage operations. The 2012 Final RI Report recommended that no further action be required on this parcel. NYSDEC agreed with this conclusion of the RI Report in their acceptance letter dated July 13, 2012 (**Appendix A**).

Three additional parcels were evaluated as part of the RI that was not part of the former MGP footprint:

- Parcel VI located at 242 Nevins Street (Block 418, Lot 1). The property is currently used for truck repair with a small office and truck parking. Historically, the property was used for petroleum and coal storage.
- Parcel VII located at 228 Nevins Street (Block 411, Lot 24). The property is currently used for truck repair. Historically, the property was used for petroleum storage.
- Parcel VIII located at 479 Degraw Street (Block 417, Lot 21). The property is currently used for movie equipment rental and parking. Historically, the property was used for petroleum storage.

During the PDI, three additional properties were evaluated west of the Gowanus Canal. These properties were not part of the former MGP footprint.

- 510 Sackett Street (Block 431, Lot 17). The property is currently used and owned by Bayside Fuel Oil Depot Corporation. This property was a former Major Oil Storage Facility (MOSF) that used a 1,500,000-gallon compartmented tank to distribute fuel to supply trucks.
- 495 Sackett Street (Block 424, Lot 20). The property is currently used for storage and truck parking.
- 267 Bond Street (Block 424, Lot 1). The property is currently used for truck repair, parking, and equipment storage. Historically, the property was used for petroleum storage.

1.3 The Gowanus Canal and the Fulton Municipal Works Former MGP Site

The EPA added the Gowanus Canal to the Superfund National Priorities List (NPL) on March 10, 2010. The Gowanus Canal has been impacted by multiple contaminant sources, both historically and on an ongoing basis. National Grid is committed to addressing Canal impacts associated with the former MGP operations. MGP-related residues can be reliably identified and National Grid is working to gather all information necessary to ensure that any remedial work is linked to the actual source. National Grid has already identified multiple sources of polycyclic aromatic hydrocarbons (PAHs) in the Canal; Fulton is but one of those sources. In the immediate vicinity of Fulton, there are historic and current operations including coal yards, petroleum processing and storage operations, as well as a large combined sewer overflow (CSO) outfall, all of which are known to be associated with PAH releases. National Grid is herein providing information detailing the multiplicity of historic sources of PAH in the Fulton area as well as known spills and releases in the CSO sewershed (**Appendix B**).

2. Summary of the Pre-Design Investigation

The PDI was completed between early June and late September of 2012. The scope of work was outlined in the NYSDEC-approved work plan titled *Final Interim Remedial Measure Pre-Design Investigation Work Plan*, dated March 2012 (GEI, 2012). The purpose of the PDI was to obtain additional information that would be used to support the IRM design.

The scope of work included:

- Environmental and Geotechnical Investigation;
- Data Collection for Refinement of the Groundwater Model;
- Background Noise and Vibration Survey;
- Utility Survey and Subsurface Infrastructure Investigation;
- Evaluation of the Construction of Adjacent Buildings, Bulkheads and Foundations; and
- NAPL Delineation for Potential Future Recovery.

These activities were completed in accordance with the Site-specific Health and Safety Plan (HASP), Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP). Each PDI activity is described in the subsections below.

2.1 Environmental and Geotechnical Investigation

GEI completed an environmental and geotechnical investigation to investigate the area of the proposed IRM and to acquire geotechnical information along the eastern and western bulkheads of the Gowanus Canal.

The investigation consisted of:

- The completion of 14 delineation borings to a minimum depth of El. -40 feet to further delineate tar-like source material and to delineate the meadow mat within the proposed IRM area.
- The completion of 23 geotechnical borings to a minimum depth of El -60 feet to collect geotechnical data within the proposed IRM area. Three of the borings were completed as Cone Penetration Tests (CPTs).
- The installation of two shallow and two intermediate monitoring wells to collect additional water level data west of the Gowanus Canal.
- The installation of one potential dense non-aqueous phase liquid (DNAPL) recovery well.

East of the Gowanus Canal, the PDI focused on the bulkhead area between Union Street to the south and the head of the Canal to the north. West of the Gowanus Canal, the investigation was

conducted between Union Street to the south and Douglas Street to the north. A summary of the completed borings, their rationale, and sampling plan can be found in **Table 1**. The locations are presented in **Figure 3**. Soil boring, monitoring well construction, and CPT logs are presented in **Appendix C**.

2.1.1 Delineation Soil Borings

Thirteen soil borings were completed along the eastern and western bulkheads of the Gowanus Canal. Eleven of the soil borings (FW-SB-116 through FW-SB-127) were completed by Zebra Environmental (Zebra). These borings were installed using Geoprobe[®] technology, collecting continuous 5-foot cores; to a depth of 50 feet bgs, with the exception of two borings. FW-SB-117A (51 feet bgs) and FW-SB-126 (52 feet bgs) were installed deeper to accommodate the installation of intermediate zone monitoring wells FW-MW-24I and FW-MW-25I, respectively.

Boart Longyear (Boart) completed two borings (FW-SB-115 and FW-SB-128). These borings were installed using rotosonic drilling techniques, collecting continuous 5-foot cores to a depth of 50 feet bgs.

FW-SB-128 was added to the original PDI scope to further investigate impacts observed on Parcel VII. FW-SB-119, located on Parcel VIII, was not completed due to its proximity to FW-SB-110 and FW-SB-110A. This latter change was approved by NYSDEC via e-mail transmittal on August 31, 2012 which is included in **Appendix D**.

Prior to completion, each boring location was pre-cleared to 5 feet bgs. Upon completion, each boring was tremie-grouted with a cement-bentonite grout mixture and the soil cuttings were placed into drums for off-site disposal at an appropriately permitted facility.

2.1.2 Geotechnical Borings

Twenty-three soil borings were completed to collect geotechnical information along the eastern and western bulkheads of the Gowanus Canal. These borings also helped to refine the degree of impacts along the bulkheads. Boart completed these borings using rotosonic drilling techniques in conjunction with spoon sampling using the standard penetration test.

East of the Gowanus Canal, four borings (FW-SB-111 through FW-SB-114) were completed adjacent to the existing bulkheads, approximately spaced every 150 to 200 feet. At each of the four locations, a corresponding boring was installed at an off-set location (FW-SB-111A through FW-SB-114A), approximately 60 feet inland from the original boring.

West of the Gowanus Canal, four borings (FW-SB-107 through FW-SB-110) were completed adjacent to the existing bulkheads, approximately spaced every 150 feet. At each of the four locations, a corresponding boring was installed at an off-set location (FW-SB-107A through FW-SB-110A), approximately 60 feet inland from the original boring.

Four soil borings (FW-SB-101, FW-SB-103, FW-SB-104, and FW-SB-106) and the three CPT locations (FW-CPT-100, FW-CPT-102, and FW-CPT-105) were completed from a barge in the Gowanus Canal. A 30 foot by 90 foot spud barge was used as a platform to install the borings. Boart's drill rig was used to advance ConeTec, Inc.'s instrumentation to complete the CPTs to depths that ranged between 46.1 and 64.5 feet bgs [El. -51.6 to -68.6 feet].

Standard Penetration Tests (SPTs) were performed in each soil boring, generally at a frequency of one SPT every 5 feet in depth. Samples of coarse-grained soil (i.e., sand and gravel) were collected from the split spoon sampler and the sonic cores. Shelby tubes were used to collect undisturbed samples from the organic and fine-grained soils (i.e., silts and clays). These samples were sent to Terra Sense, LLC of Totowa, New Jersey for analysis. Geotechnical laboratory tests were performed on samples collected from the soil borings. A summary of the geotechnical sample rational can be found in **Table 1**. Laboratory results are summarized in **Table 2** and presented in **Appendix E**.

Soil borings completed from land were pre-cleared to 5 feet bgs. Upon completion, each boring was tremie-grouted with a cement-bentonite grout mixture. Soil cuttings were placed into drums for off-site disposal at an appropriately permitted facility.

2.1.3 Monitoring Well Installation

Zebra installed two monitoring well pairs (FW-MW-24S/I and FW-MW-25S/I) to gather additional water level data west of the Gowanus Canal. The shallow monitoring wells FW-MW-24S and FW-MW-25S were screened across the water table, from 3.5 to 13.5 feet bgs (El. 2.9 to -7.1 feet) and from 4.0 to 14.0 feet bgs (El. 4.7 to -5.3 feet), respectively. The intermediate wells, FW-MW-24I and FW-MW-25I, were screened from 39.0 to 49.0 feet bgs (El. -32.4 to -42.4 feet) and from 40.0 to 50.0 feet bgs (El. -31.2 to -41.2 feet), respectively.

The monitoring wells were constructed of 1-inch inner diameter (ID), flush-threaded, schedule 40, polyvinyl chloride (PVC) riser, 10 slot well screen, with a 2-foot sump. The annular space between the well screen and borehole wall was backfilled with chemically inert, #1 sand, to approximately 2 feet above the well screen. A 2-foot thick, bentonite clay seal was placed above the sand pack. The remaining annular space was filled to grade with cement/bentonite grout. Each monitoring well was fitted with a flush-mounted road box secured with cement.

Monitoring well construction information is shown in the boring logs in **Appendix C**. Monitoring well construction details are shown in **Table 3**.

2.1.4 Recovery Well Installation

Boart installed one potential DNAPL recovery well (FW-RW-107A) on Sackett Street, west of the Gowanus Canal, at the location of soil boring FW-SB-107A. The recovery well was constructed of 4-inch ID, flush-threaded, schedule 40, PVC riser, 20 slot well screen, with a 2-

foot sump. The annular space between the sump and borehole wall was filled with bentonite. The annular space between the well screen and borehole wall was backfilled with chemically inert, #2 sand, to approximately 2 feet above the well screen. A 2-foot thick, bentonite clay seal was placed above the sand pack. The remaining annular space was filled to grade with cement/bentonite grout. The well was fitted with a flush-mounted curb box secured with cement. The construction details of FW-RW-107A are presented in **Table 3**.

2.1.5 Summary of Environmental Observations

Tar-like and petroleum impacts were encountered within a majority of the borings completed during the PDI. The observed tar-like impacts ranged from tar stained to tar saturated soils, consistent with what was observed during the RI. The observed petroleum impacts ranged from petroleum staining to rainbow sheen.

Tar-saturated soils were found primarily in soil borings completed adjacent to the bulkheads, mainly between approximate El. -10 and -50 feet. Tar-saturated soils were encountered less frequently within the soil borings installed upland, offset approximately 60 feet from the eastern and western bulkheads.

Petroleum impacted soils were found in soil borings mainly between El. 2 and -32 feet. Petroleum impacted material generally exhibited black staining and/or rainbow sheen. Petroleum impacts were generally encountered at or above the water table. In general, petroleum impacts were encountered shallower than the tar-like impacts.

The observed impacts are described by cross section in the sections below. The discussion is organized by cross sections which are shown in **Figures 4 to 5**. **Figure 4** presents cross sections drawn parallel to the Gowanus Canal along the eastern bulkhead and approximately 60 feet inland of the bulkhead. **Figure 5** presents cross sections drawn parallel to the Gowanus Canal along the western bulkhead and approximately 60 feet inland of the bulkhead. **Figure 6** shows cross sections drawn perpendicular to the Gowanus Canal. A summary of all of the visual impacts encountered during the PDI can be seen in **Figure 7**. Boring logs for soil borings completed during the PDI and for borings from previous investigations are provided in **Appendix C**.

2.1.5.1 East of the Gowanus Canal

Cross Section A-A'

Cross Section A-A' (**Figure 4**) is drawn parallel to the eastern bulkhead of the Gowanus Canal, approximately 60 feet inland of the bulkhead. The majority of the tar-like impacts were observed in subsurface soils between El. 0 and -50 feet. The observed impacts are generally tar-coated and tar-stained soils. Petroleum impacts were encountered between approximate El. 3.4

and El. -22.0 feet and included petroleum sheens and staining. The table below presents a summary of the visual impacts of interest for the purpose of this IRM.

Table 2A – Visual Impact Summary - Cross Section A-A'

Observed Visual Impact Category	Location	Elevation Range** (feet NAVD88)	Borings
Petroleum Sheen or Staining	Union Street ROW	1.1 - -8.9	FW-SB-37
	Parcel I (270 Nevins Street)	3.4 - -22.2	FW-SB-01, FW-SB-02, FW-SB-06*
Tar Coatings; Blebs and Globbs	Parcel I (270 Nevins Street)	-0.2 - -25.2	FW-SB-02, FW-SB-05A/05B, FW-SB-06*, FW-SB-111A
	Parcel VI (242 Nevins Street)	-14.3 - -58.3	FW-SB-113A, FW-MW-11*
	Parcel VII (226 Nevins Street)	62.0 - -63.0	FW-SB-114A
Tar Saturation	Union Street ROW	-41.9 - -42.1	FW-SB-37
	Parcel I (270 Nevins Street)	-15.6 - -16.6	FW-SB-06*
	Parcel VI (242 Nevins Street)	-40.3 - -41.8	FW-MW-11*

Notes:

* Visual impacts in these borings extend deeper than El. -70 feet (extent of cross sections and this table).

**Observations within the elevation ranges noted do not necessarily indicate that the observed condition is continuous through the range, rather that the condition is generally present within that range. For specific detail refer to the appropriate figure.

Wood fragments were not encountered in any of the borings along this cross section.

Cross Section B-B'

Cross Section B-B' (**Figure 4**) is drawn along the east side of the Gowanus Canal, adjacent to the bulkhead. The majority of tar-like impacts were observed between El. -15 and -45 feet. These impacts include tar staining/sheen, blebs and globbs, tar coatings, and tar-saturated soils. The majority of tar-saturated impacts were observed within the subsurface soils beneath Parcel VI and Parcel VII. Intermittent lenses of tar saturation were also observed beneath Parcel I and south of Sackett Street.

Tar coated soils were encountered shallower in Parcel I at FW-SB-05A/05B; approximate El. 0 to -15 feet. Deeper tar-like impacts were encountered below El. -45 feet at FW-SB-51, FW-SB-111, FW-SB-112, FW-SB-114, FW-MW-01, and FW-MW-10.

Petroleum impacts were encountered intermittently along the length of cross section between the ground surface and El. -20 feet. The table below presents a summary of the visual impacts of interest for the purpose of this IRM.

Table 2B – Visual Impact Summary - Cross Section B-B'

Observed Visual Impact Category	Location	Elevation Range** (feet NAVD88)	Borings
Petroleum Sheen or Staining	Parcel I (270 Nevins Street)	0.4 - -20.6	FW-SB-112, FW-MW-01, GC-GP-06
	Parcel VI (242 Nevins Street)	1.5 - 1.2	GCMW-311
	Parcel VII (226 Nevins Street)	0.2 - -12.5	FW-SB-114
	Block 432 Lot 15 (525 Union Street)	-0.9 - -1.3	FW-SB-127
Tar Coatings; Blebs and Globbs	Parcel I (270 Nevins Street)	-0.2 - -57.3	FW-SB-05A/05B, FW-SB-111, FW-SB-112, GC-GP-06
	Parcel VI (242 Nevins Street)	-16.3 - -69.6	FW-SB-113, FW-SB-122/122A, FW-MW-10*
	Parcel VII (226 Nevins Street)	-16.7 - -55.1	FW-SB-114, FW-SB-123/123A, FW-SB-128
	Block 432 Lot 15 (525 Union Street)	-18.9 - -30.7	FW-SB-127
Tar Saturated Lenses	Parcel I (270 Nevins Street)	-30.9 - -59.0	FW-SB-112, FW-MW-01
	Parcel VI (242 Nevins Street)	-27.6 - -42.6	FW-MW-10*
	Parcel VII (226 Nevins Street)	-17.5 - -19.7	FW-SB-114
Tar Saturation	Parcel I (270 Nevins Street)	-30.6 - -54.5	FW-SB-111, FW-SB-112, GC-GP-06
	Parcel VI (242 Nevins Street)	-25.0 - -26.1	FW-MW-10*
	Parcel VII (226 Nevins Street)	-19.7 - -60.9	FW-SB-114, FW-SB-123/123A, FW-SB-128

Notes:

*Visual impacts in these borings extend deeper than El. -70 feet (extent of cross sections and this table).

**Observations within the elevation ranges noted do not necessarily indicate that the observed condition is continuous through the range, rather that the condition is generally present within that range. For specific detail refer to the appropriate figure.

Wood fragments were encountered in every PDI boring presented on this cross section. Wood was observed between El. 3.0 feet (5.0 feet bgs) and El. -15.2 feet (21.4 feet bgs). The wood fragments encountered in these borings are likely from the cribbing structures used in the original construction of the Gowanus Canal bulkheads.

2.1.5.2 West of the Gowanus Canal

Cross Section C-C'

Cross Section C-C' (**Figure 5**) is drawn along the west side of the Gowanus Canal, adjacent to the bulkhead. The majority of the tar-like impacts were observed between El. -10 and -45 feet. Tar-like impacts were observed in soil borings between these elevations consistently throughout the cross section. These impacts ranged from tar staining and sheen to tar-saturated soils.

Deeper tar-like impacts were observed at FW-SB-45, FW-SB-49, FW-SB-108, and FW-SB-110A.

Petroleum impacts were observed between El. -2 and -32 feet throughout the cross section. The petroleum impacts west of the Gowanus Canal are not likely related to the former MGP. A majority of the petroleum-impacted soils were observed near the abandoned fuel storage tank located at 510 Sackett Street and are likely attributed to the use of the property. The table below shows a summary of the visual impacts of interest for the purpose of this IRM.

Table 2C – Visual Impact Summary - Cross Section C-C'

Observed Visual Impact Category	Location	Elevation Range ** (feet NAVD88)	Borings
Petroleum Sheen or Staining	Block 431 Lot 17 (510 Sackett Street)	2.1 - -31.9	FW-SB-115, GCMW-03
	Block 424 Lots 1 and 20 (267 Bond Street and 495 Sackett Street)	-12.5 - -27.5	GCMW-34
	Degraw Street ROW	-10.3 - -11.1	FW-SB-118
	Douglass Street ROW	2.0 - 1.0	FW-SB-120
	Gowanus Canal	-17.0 - -36.0	GC-03-28****
Tar Coatings; Blebs and Globbs	Block 431 Lot 17 (510 Sackett Street)	-7.2 - -42.9	FW-SB-115***
	Block 424 Lots 1 and 20 (267 Bond Street and 495 Sackett Street)	-13.4 - -57.4	FW-SB-108, FW-SB-116, FW-SB-117A/FW-MW24I
	Parcel VIII (497 Degraw Street)	-20.3 - -59.2	FW-SB-45*, FW-SB-110, FW-SB- 110A
	Douglass Street ROW	-22.6 - -28.3	FW-SB-120
	Degraw Street ROW	-14.7 - -29.3	FW-SB-109, FW-SB-118, GC-GP-05
	Sackett Street ROW	-12.8 - -57.9	FW-SB-49*, FW-SB-107
Tar Saturated Lenses	Parcel VIII (497 Degraw Street)	-31.8 - -57.9	FW-SB-45*, FW-SB-110, FW-SB- 110A
Tar Saturation	Block 431 Lot 17 (510 Sackett Street)	-9.3 - -10.3	FW-SB-115***
	Block 424 Lots 1 and 20 (267 Bond Street and 495 Sackett Street)	-17.7 - -26.0	FW-SB-116, FW-SB-117A/FW- MW24I
	Parcel VIII (497 Degraw Street)	-27.9 - -39.9	FW-SB-45*, FW-SB-110, FW-SB- 110A
	Douglass Street ROW	-28.3 - -38.3	FW-SB-120
	Degraw Street ROW	-17.4 - -33.0	FW-SB-109, FW-SB-118, GC-GP-05
	Sackett Street ROW	-14.7 - -64.7	FW-SB-49*

Notes:

*Visual impacts in these borings extend deeper than El. -70 feet (extent of cross sections and this table).

**Observations within the elevation ranges noted do not necessarily indicate that the observed condition is continuous through the range, rather that the condition is generally present within that range. For specific detail refer to the appropriate figure.

***Comingled Petroleum and Tar impacts were observed at this boring.

****Elevations are approximate based on Ocean Surveys, Inc. April 2012 bathymetry data.

Wood fragments were encountered in every PDI boring on this cross section with the exception of FW-SB-107. Wood was observed between El. 2.1 feet (5.0 feet bgs) and El. -15.0 feet (20.0 feet bgs). The wood fragments encountered in these borings are likely from the cribbing structures used in the original construction of the Gowanus Canal bulkheads.

Cross Section D-D'

Cross Section D-D' (**Figure 5**) is drawn parallel to the western bulkhead of the Gowanus Canal, approximately 60 feet inland of the bulkhead. The majority of the tar-like impacts were encountered between El. -22.5 and -40 feet. These impacts included tar staining and sheen, blebs and globs, coatings, lenses of tar saturation, and tar-saturated soils. Deeper impacts were observed below approximate El. -40 feet at FW-SB-46, FW-SB-107A, FW-SB-108A, and FW-SB-110A. Shallow petroleum impacts were observed in FW-SB-120 from El. 2.0 to 1.0 feet (4.0 to 5.0 feet bgs). The table below shows a summary of the visual impacts of interest for the purpose of this IRM.

Table 2D – Visual Impact Summary - Cross Section D-D'

Observed Visual Impact Category	Location	Elevation Range* (feet NAVD88)	Borings
Petroleum Sheen or Staining	Douglass Street ROW	2.0 - 1.0	FW-SB-120
Tar Coatings; Blebs and Globs	Parcel VIII (497 Degraw Street)	-26.8 - -59.2	FW-SB-110A
	Block 424 Lots 1 and 20 (267 Bond Street and 495 Sackett Street)	-52.6 - -55.1	FW-SB-108A
	Douglass Street ROW	-22.6 - -28.3	FW-SB-120
	Degraw Street ROW	-22.0 - -64.6	FW-SB-46, FW-SB-109A, GC-GP-05
Tar Saturated Lenses	Parcel VIII (497 Degraw Street)	-31.8 - -38.8	FW-SB-110A
	Degraw Street ROW	-27.9 - -28.4	FW-SB-109A
Tar Saturation	Parcel VIII (497 Degraw Street)	-28.8 - -31.8	FW-SB-110A
	Douglass Street ROW	-28.3 - -38.3	FW-SB-120
	Degraw Street ROW	-27.0 - -33.0	GC-GP-05
	Sackett Street ROW	-53.6 - -56.3	FW-SB-107A/FW-RW-107A
	Block 424 Lots 1 and 20 (267 Bond Street and 495 Sackett Street)	-53.7 - -53.8	FW-SB-108A

Notes:

*Observations within the elevation ranges noted do not necessarily indicate that the observed condition is continuous through the range, rather that the condition is generally present within that range. For specific detail refer to the appropriate figure.

Wood fragments were not encountered in any of the borings on this cross section.

Borings FW-SB-125 and FW-SB-126 were not shown on the cross sections. The purpose of these borings was to gather information to refine the groundwater model. Slight petroleum impacts were present at both of these locations. Tar-like impacts were not encountered at these locations.

2.1.5.3 Gowanus Canal

Cross Sections E-E', F-F', G-G', and H-H' (**Figure 6**) are drawn perpendicular to the Gowanus Canal. Tar-like impacts were observed intermittently between approximate El -9.5 and -60 feet. Petroleum impacts were observed between approximate El. -3.5 and -25 feet. The table below shows a summary of the observed visual impacts.

Table 2E – Visual Impact Summary – Gowanus Canal (Cross Sections E-E' through H-H')

Observed Visual Impact Category	Location	Elevation Range* (feet NAVD88)	Borings
Petroleum Sheen or Staining	Gowanus Canal	-3.5 - -25.1	GC-SED-01, GC-SED-07, GC-SED-08, GC-SED-09B, GC-SD152
Tar Coatings; Blebs and Globbs	Gowanus Canal	-9.5 - -60.2	FW-SB-101, FW-SB-103/103A, FW-SB-104/104A, FW-SB-106, GC-SED-08, GC-SED-09B
Tar Saturated Lenses	Gowanus Canal	-18.9 - -56.6	FW-SB-101, FW-SB-106
Tar Saturation	Gowanus Canal	-54.9 - -55.1	FW-SB-101

Notes:

*Observations within the elevation ranges noted do not necessarily indicate that the observed condition is continuous through the range, rather that the condition is generally present within that range. For specific detail, refer to the appropriate figure.

PDI borings FW-SB-101 and FW-SB-106 were not shown on the cross sections due to their offset distance from the cross section lines. At FW-SB-101, observed impacts included staining, sheen, tar coatings, lenses of tar, and tar saturation. At FW-SB-106, impacts included staining, sheen, tar coatings, and lenses of tar saturation.

2.1.6 Subsurface Soil Conditions

In general, the subsurface soil conditions encountered in the borings performed during the PDI were similar to what was encountered during the RI. Three major stratigraphic units, in order of increasing depth, were identified during the PDI: (1) fill, (2) alluvial/marsh deposits, and (3) glacial outwash deposits (sand and silty sand). Occasional lenses of silt and clay and gravel were encountered at varying depths. Borings performed during this PDI were not deep enough to encounter the Gardiner's Clay, Jameco Gravel, or Fordham Gneiss. Accumulated sediment, both soft and native, was encountered in the borings performed within the Gowanus Canal.

Fill

The majority of the Site is paved with asphalt or concrete, and was generally encountered at all locations up to 1-foot thick. At FW-SB-115, 5 feet of concrete was encountered. Fill was encountered at all borings except for those performed in the Canal. The fill layer ranged from approximately 5.0-foot thick at FW-SB-107A and FW-SB-115 to approximately 20.0-foot thick at FW-SB-121/121A. It was generally characterized as loose, non-cohesive sand with silt and gravel, with various fill materials mixed in. These fill materials included brick fragments, concrete fragments, plastic, cobbles, slag, and debris.

Wood fragments were encountered in nearly all borings adjacent to the Gowanus Canal. Wood fragments with a treated wood-like odor were observed between El 3.0 (5.0 feet bgs) at FW-SB-112 and El -15.6 (20.0 feet bgs) at FW-SB-116. The wood fragments encountered in these borings are likely from the cribbing structures used in the original construction of the Gowanus Canal bulkheads.

Alluvial/Marsh Deposits

Alluvial/marsh deposits, where present, were found beneath a layer of fill or accumulated sediment. The deposits consist of sub-units of alluvial sand and organic marsh (meadow mat) materials including fine-grained soils including silt, silt-clay, and clay and peat. An organic, dark brown peat is sporadically interbedded with the silty/clayey marsh deposits.

The alluvial/marsh deposits were encountered throughout the investigation area with the exception of borings FW-SB-101, FW-SB-111, FW-SB-111A, and FW-SB-121/121A. It appears that a hole in the meadow mat is present in the vicinity of Parcel I, east of the Gowanus Canal.

The thickness of these deposits, where present, ranged from about 0.2 feet in boring FW-SB-115 to about 19.7 feet in boring FW-SB-108. The deposits were observed as shallow as El. 1.4 feet (7.2 feet bgs) in FW-SB-125 and extended to a maximum depth of El. -22.8 feet (30.0 feet bgs) at boring FW-MW-108.

Glacial Outwash Deposits (Sand and Silty Sand)

Glacial outwash deposits were encountered beneath the alluvial/marsh deposits and fill, where present. The glacial deposits can be classified into two sub-units, a predominantly sandy glacial outwash unit and finer-grained glacial till unit. Glacial outwash was the most extensive unit encountered and is sporadically inter-bedded with glacial till.

The glacial outwash sands are typically brown to gray, loose, non-cohesive, well-sorted, fine to coarse sands with varied amounts of gravel and trace silt. The top of the glacial outwash

deposits were encountered from El. -0.2 feet (10.0 feet bgs) in FW-SB-111A to El. -22.8 feet (30.0 feet bgs) in FW-SB-108 (SPT). The bottom of the stratigraphic unit was not encountered before the termination depth of the PDI borings.

Gravel lenses were occasionally encountered in PDI borings. These lenses were encountered at various depths, but no distinct gravel formation (like the Jameco gravel) was encountered.

Intermittent layers of silt and/or clay were encountered in PDI borings. These lenses were encountered at various depths, but no distinct silt or clay formations were encountered.

Accumulated Sediment

Accumulated sediment is present in the majority of the sediment cores in the Gowanus Canal. Accumulated sediment consists of grayish-black, loose, organic silt and clay, with varying amounts of sand and gravel intermixed with organic material (such as leaves, roots, wood), and trash with organic odors. Accumulated sediment was also observed in each of the PDI borings completed within the Gowanus Canal. The sediment ranged from approximately 5.4 feet thick at FW-SB-106 to 14.0 feet thick at FW-SB-104.

2.1.7 PDI Waste Tracking

All waste generated during the PDI was drummed in United States Department of Transportation (USDOT)-approved 55-gallon drums. A total of 52 drums were generated during the PDI; 26 soil, 7 water, 14 plastic/personal protective equipment (PPE), and 5 concrete/debris drums.

Soil drums were transported by a licensed hauler to Bayshore Soil Management, LLC of Keasbey, New Jersey, for thermal treatment. Water and plastic/PPE drums were disposed of at Clean Water, Inc. in Staten Island, New York. Non-impacted concrete and debris were disposed of at Bayshore Recycling Corporation in Keasbey, New Jersey. Waste manifests are provided in **Appendix F**.

2.1.8 PDI Air Monitoring

Perimeter air quality monitoring was conducted in accordance with the Community Air Monitoring Plan (CAMP) in the NYSDEC-approved PDI Work Plan (GEI, 2012b). Perimeter air-monitoring stations were placed upwind and downwind of the work zone during intrusive activities. A RAE Systems MiniRAETM photoionization detector (PID) was used to monitor the levels of organic vapors in the ambient air in parts per million (ppm) and a DustTrakTM monitor was used to monitor levels of airborne particulate matter (dust) that was less than 10 micron in size (PM-10). Each instrument was calibrated daily prior to use and to record the data at 1-minute intervals. The data were downloaded to a computer.

There were isolated instances when the air monitoring criteria data were exceeded. However, they were short intervals and were likely related to non-intrusive work, moisture affecting the equipment, or the operation of gas-powered equipment and sawing of concrete pavement prior to drilling activities. Diesel equipment exhaust particulates were the cause of elevated dust readings from time to time. A summary of the CAMP data can be found in **Appendix G**.

2.2 Data Collection for Refinement of the Groundwater Model

Additional water level information was gathered to refine the existing groundwater model for the Gowanus Canal and create a model specifically for the Site. Additional monitoring wells were installed and one round of water level gauging was completed.

2.2.1 Groundwater Elevation Gauging

The Gowanus Canal site-wide groundwater model was developed using various gauging events conducted in 2010 and 2011. Additional information was collected during a gauging event in September 2012 to calibrate and refine the groundwater model. Groundwater elevation data was collected from monitoring wells installed during the PDI as well as from previous investigations. The table below presents a summary of the groundwater information collected on September 19, 2012 at both high and low tides.

Table 2F – Monitoring Well Gauging Data – September 19, 2012

Monitoring Well ID	September 19, 2012					
	High Tide (1047)			Low Tide (1732)		
	Depth to Water (feet bgs)	Groundwater Elevation (feet NAVD88)	Time	Depth to Water (feet bgs)	Groundwater Elevation (feet NAVD88)	Time
FW-MW-02	8.00	1.74	1042	8.25	2.16	1647
FW-MW-21S	8.06	2.37	1027	8.23	2.53	1725
FW-MW-21I	8.17	2.38	1030	8.33	2.61	1729
FW-MW-22S	3.19	2.43	1034	3.76	2.20	1733
FW-MW-22I	3.53	2.13	1032	3.69	2.24	1735
FW-MW-24S	3.21	2.94	1015	8.46	-2.05	1717
MW-MW-24I	4.06	2.23	1017	4.55	2.01	1720
FW-MW-25S	5.06	3.30	1013	5.10	3.61	1711
FW-MW-25I	6.09	2.30	1010	6.45	2.35	1708
FW-RW-107A	2.94	2.34	1022	3.71	1.79	1705
GCMW-30D1	6.43	2.29	1045	6.66	2.61	1650

2.3 Background Noise and Vibration Investigation

Wilson, Ihrig, and Associates (WIA) of New York, New York, performed a background noise and vibration investigation at the Site, which included long-term and short-term noise measurements, and short-term vibrations measurements. The survey period lasted eleven days

from September 20 to October 1, 2012. The results from WIA's investigation and full report can be found in **Appendix H**. A summary of their conclusions are presented below.

- The Site is exposed to relatively high levels of noise as would be expected of an industrial/manufacturing area.
- There are numerous noise sensitive land uses (residential and commercial) that are in close proximity to the planned IRM.
- A Construction Noise and Vibration Assessment should be completed at the 50% design phase. This will evaluate the potential for noise and vibration to affect the adjacent community members and nearby buildings, as well as develop conceptual noise and vibration controls to mitigate impacts to a reasonable level.
- Project specific criteria for noise and vibration will be established at a later stage through project team coordination and mutual agreement of stakeholders.
- Vibration criteria for surface or underground utilities and infrastructure should be assessed on a case by case basis. The criteria should be sought from the respective utility companies in developing project-specific vibration limits.

2.4 Utility Survey and Subsurface Infrastructure Investigation

Hager-Richter Geoscience, Inc. (Hager-Richter) performed a utility and subsurface infrastructure investigation in June and August 2012. The geophysical survey was conducted using three complementary geophysical methods: time domain electromagnetic induction, ground penetrating radar (GPR), and precision utility location (PUL). The electromagnetic induction method was only used on areas considered sufficiently large and unobstructed by vehicles or any other metal objects. The GPR and PUL methods were employed Site-wide. Physical obstructions and metallic objects (automobiles) were present throughout the investigation area and limited the accessible areas. Hager-Richter's geophysical survey report is presented in **Appendix I**.

Hager-Richter concluded the following after performing the geophysical survey:

- Two possible underground storage tanks (USTs) were detected in the southern sidewalk of Degraw Street, west of the Gowanus Canal.
- Several utilities were detected throughout the areas of interest.
- Structural elements (possibly tiebacks) were detected next to the Gowanus Canal on Parcel VII.
- A buried structure was detected west of the Gowanus Canal (Block 424, Lot 20).

2.5 Evaluation of Construction of Adjacent Buildings, Bulkheads, and Foundations

Simpson, Gumpertz, and Heger (SGH) performed an investigation and evaluation of the adjacent buildings, bulkheads, and foundations in August 2012. Their scope of work entailed a records search and preliminary inspection for the properties in the vicinity of the proposed IRM (Block 411 (Parcel VII), Block 418 (Parcel VI), Block 425 (Parcel I), Block 432, Block 417 (Parcel VIII and adjacent properties), Block 424, and Block 431).

SGH was unsuccessful at identifying any as-built or design drawings for any of these properties. SGH conducted a search at the New York City (NYC) Department of Buildings, NYCDEP, NYC Department of Design and Construction, and the NY Historical Society (Manhattan and Brooklyn) along with online database searches. The documentation of the physical inspections can be found in **Appendix J**.

Each property was surveyed by KS Engineers PC, of Newark, New Jersey. The surveys located the property features, utilities, soil boring, and monitoring wells. The surveys were completed using the North American Vertical Datum of 1988 (NAVD88) and horizontal North American Datum of 1983 (NAD83).

2.6 NAPL Evaluation

Soil borings completed during the PDI identified areas of tar-saturated soils on Parcel VII and parcels west of the Gowanus Canal along the bulkheads. Tar-saturated soils were present primarily adjacent to the bulkheads between approximately El. -10 and El. -40 (-25 and 50 feet bgs). It is likely that these materials represent tars that have been released into the Gowanus Canal from multiple sources, and not directly from the Fulton site. One DNAPL recovery well was installed at FW-SB-107A, west of the Gowanus Canal. In September 2012, approximately 3.75 feet of tar was measured in the well. Light Non-Aqueous Phase Liquid was not observed during the PDI.

3. Conceptual Design

The purpose of the IRM is to prevent potentially mobile tar-like material from the former Fulton MGP Site from migrating into the Gowanus Canal. In order to fulfill this purpose, the IRM must be integrated with the Gowanus Canal remedy. The EPA issued a PRAP for the Gowanus Canal on December 27, 2012. This document proposed a remedy that includes dredging, ISS, and capping, but many remedial parameters and design details remain unaddressed. Until those issues are addressed, development of a design for the IRM is inappropriate.

This section outlines the conceptual design for the IRM and identifies items in the PRAP that create uncertainty for the design of the IRM.

3.1 IRM Conceptual Design

The main goal of the IRM is to prevent potentially mobile tar-like material from the former Fulton MGP Site from migrating into the Gowanus Canal. To meet this goal, the NYSDEC selected as an IRM a barrier wall along the Canal with a NAPL recovery system, as appropriate, behind the barrier wall.

3.1.1 Barrier Wall Alignment

The preliminary proposed extent of the barrier wall is shown in **Figure 8**. Tar-like material related to the Fulton Site has been identified in the subsurface on Parcels I and Parcel VI. To prevent this material from migrating into the Gowanus Canal, the barrier wall alignment borders these parcels, although the exact extent is yet to be defined. Co-mingled tar-like and petroleum material was observed at Parcel VII and west of the Gowanus Canal in close proximity to the bulkheads. It is likely that the tar-like materials proximal to the bulkheads represent NAPLs that have been released to the Gowanus Canal from multiple sources, not directly from the Fulton site. Because of this uncertainty, these impacts must be addressed in conjunction with the Gowanus Canal remedy.

3.1.2 Barrier Wall Type

The main performance criterion of the barrier wall is its effectiveness in preventing the migration of NAPL into the Gowanus Canal. Given the Site's physical constraints, existing structures, and the potential of future sediment dredging of the Gowanus Canal, the barrier wall must also serve as a retaining structure supporting the adjacent Canal properties. Spatial limitations on Fulton Parcels I and VI, and obstructions along the bulkheads due to historical cribbing dictate that the barrier wall will need to be constructed outboard of the existing bulkheads. Therefore, the barrier wall systems for this application must include structural components such as tiebacks and be rigid enough to serve as a retaining wall. A NAPL barrier wall must also achieve a minimum

permeability of 1×10^{-6} centimeters per second (cm/s), as well as maintain NAPL control over groundwater level fluctuations, storm water infiltration, and seepage. Based on these criteria, the barrier wall will likely be constructed from steel sheet pile.

Sheet pile walls are thin steel panels designed to interlock together to create a continuous wall. Sheet pile walls would meet the structural requirements at the Site. However, their interlocking joints may need to be amended with grouted seals to address environmental concerns. National Grid has undertaken a NYSDEC-approved pilot study to evaluate the suitability of this interlocking joints methodology as well as other parameters under the remedial program for the former Citizens Gas Works MGP located just south of the Site on the Canal. The results of this pilot test will ultimately influence the design of this type of barrier wall system. Details on the pilot test are presented further in Section 4.1.6.

3.2 Fulton Municipal Works IRM and Gowanus Canal Remedy Integration

The PRAP proposed a remedy that includes dredging, ISS and capping. The remedy will not be final until the EPA issues the ROD later this year. The elements of the remedy are not certain at this stage and may change based on the EPA's review of stakeholders' comments. Given the intersecting nature of the IRM and the Canal remedy, a final IRM design cannot be developed until the design of the Canal remedy is determined. Key issues left open by the PRAP that will affect the design of the Fulton IRM are identified below.

Target Dredge Depth in RTA-1 - The design of the Fulton IRM is dependent upon the maximum dredge depth in RTA-1, which currently is undetermined. The structural criteria for the Fulton barrier wall will dictate the bottom elevation and the design of the anchor support system. The final dredge depth is one of the factors that will affect the structural criteria, which will, in turn, affect each of these items.

Bulkhead Rehabilitation Plan - Some bulkheads will need to be rehabilitated for structural reasons and others for both structural reasons and to be used as barriers for contaminants. The Fulton IRM barrier may need to tie into these bulkheads. National Grid shall coordinate the engineering of the Fulton wall with NYSDEC and EPA to meet the requirements of both.

Remedy Effects on Groundwater Hydraulics - Remedial elements proposed in the PRAP (ISS, dredging, and capping) will have significant effects on site groundwater hydraulics. These effects will need to be understood and modeled in conjunction with the Fulton IRM.

Combined Sewer Overflows Piping and Storage Tanks - The PRAP recommends that a CSO storage tank be placed on Thomas Greene Park (Parcel II of the Fulton MGP Site). There are three CSO outfalls at the Site (RH-033, RH-037, and RH-038), all of which penetrate the east side bulkhead. If the CSO storage tank were installed on the Site, outfalls through the bulkhead

may also need to be rerouted. The uncertainty of the sewer line routing and placement of the CSO tank at Thomas Greene Park presents design considerations for installation of a bulkhead on the eastern side of the Canal.

Comingled NAPL Impacts at the Bulkheads - The RI and PDI findings revealed impacts along the bulkheads that are not directly related to Fulton, but rather the result of multiple comingled sources, as acknowledged by the NYSDEC in its approval of the Fulton RI Report. West of the Gowanus Canal and at Parcel VII, tar is only encountered in close proximity to the existing bulkheads. It is likely that these materials represent tars that have been released into the Gowanus Canal from multiple sources, and not only from the Fulton site. Petroleum impacts, unrelated to the Site, are located on the west side of the Canal. Other PRPs in the vicinity of the Fulton site may have contributed to these impacts. The co-mingled nature of these petroleum and tar impacts dictates that they will need to be addressed in conjunction with the EPA's remedy for the Gowanus Canal.

4. Next Steps

4.1 Fulton Municipal Works Data Gaps

The following subsections detail areas where additional data are needed for the effective and integrated design of the IRM:

4.1.1 Foundations of Adjacent Buildings and Historical Bulkheads

The preliminary building survey and department search completed during the PDI was unsuccessful at identifying any as-built or design drawings for any of the buildings adjacent to the IRM area. Information on these foundations is needed to design the IRM.

Private properties within 60 feet of the Gowanus Canal that have buildings and/or structures may conflict with the structural components of the IRM and NAPL recovery system designs. Specific information required from these locations include any documentation on subsurface structures that may exist related to these properties; this includes information on building foundation types (piles or slabs-on-grades), the presence and locations of existing utilities and associated structures (sanitary or storm sewers, piping, treatment systems, underground storage tanks, water, electrical, and gas mains, etc.), documentation regarding the existing bulkheads.

Additionally, the presence of the historical bulkhead structure will need to be determined prior to design. The existence of this wood cribbing could affect the placement and method of installation of the IRM. Therefore, a more focused investigation along the banks of the canal to specifically determine the presence and locations of the cribbing, specifically along the northern end of the canal, may be necessary. This may include the installation of shallow direct push borings and possibly test pits to help verify the locations of the extents of the cribbing along the wall alignment. The use of geophysical method such as GPR may also assist as a non-intrusive method in areas where access constraints may be too difficult to install a boring or a test pit.

4.1.2 Additional Information - Flushing Tunnel, CSOs, and Other Outfalls

The IRM area overlaps several NYCDEP infrastructure facilities. This includes the Flushing Tunnel and CSO discharge points (RH- 033, RH-037, and RH-038). The current NYCDEP as-built drawings will be required to complete the design in this area.

The NYCDEP is currently upgrading the Flushing Tunnel system and plans to begin operating it in 2014. Prior to operation, the NYCDEP plans to complete maintenance dredging in the area of the Flushing Tunnel. The timing of these activities will need to be incorporated into the Fulton IRM schedule. The hydraulic effects of the Flushing Tunnel operation will need to be studied and accounted for in the Fulton groundwater model.

Pipes that discharge to the canal in the area of the proposed IRM will need to be identified and investigated to determine whether they will be incorporated into the design of the IRM. Permitted outfalls are required to be maintained during the IRM. Unpermitted/abandoned outfalls will need to be capped prior to implementation of the IRM.

4.1.3 Additional Information - Noise and Vibration

WIA completed a background noise and vibration investigation, which was summarized in Section 2.3. Their report is presented in **Appendix F**. WIA recommends the following additional steps be completed once at the 50% design level:

- Review the proposed IRM construction means and methods for noise and vibration generation potential.
- Analyze potential impacts from construction noise and vibration on sensitive infrastructure.
- Establish general construction noise and vibration criteria for the proposed IRM.
- Develop noise and vibration mitigation requirements for the contract document.
- Perform fieldwork for acoustic or vibration propagation testing to refine analysis predictions.

4.1.4 Additional Information - Groundwater Modeling

A synoptic groundwater elevation gauging round of all model calibration wells is required to fully develop the groundwater model for use in the proposed IRM design. The existing water level data is based on a compilation of gauging results where different groupings of wells were measured on different dates depending on access, installation date, damage, and purpose. Once this information is gathered, the site groundwater model can be refined for use in the proposed IRM design.

4.1.5 Additional Information - NAPL Recovery Evaluation

During the PDI, areas of tar saturation were not observed on Parcel I and VI. However, tar saturated lenses and tar coated material were observed at one soil boring, FW-MW-10, completed during the RI. Tar recovery may be possible in this area. An updated assessment of NAPL recovery on Parcels I and VI will need to be completed prior to the final design of the IRM.

4.1.6 Citizens Pilot Test Input

The NYSDEC-approved Pilot Test program for the Former Citizens Gas Works MGP Site located just south of Fulton on the Canal is scheduled for Q2/Q3 of 2013. This pilot test will evaluate the permeability limits and constructability of a number of alternative joint designs on steel sheet pile systems. The results of the pilot test will ultimately influence the design of the barrier wall at Fulton. Items of specific interest in the pilot test include:

- Perform laboratory testing of barrier wall sealant materials for compatibility with DNAPL and resulting permeabilities.
- Evaluate chemical corrosivity of steel sheet pile systems when exposed to DNAPL.
- Perform bench-scale tests on the grouted barrier wall interlock seal systems to measure the permeability/hydraulic permittivity of the seals using water and DNAPL as the permeants. Three types of custom made/welded enclosures that are groutable will be evaluated.
- Test the constructability of the three types of custom made/welded and groutable enclosures at a field scale.
- Collect additional data on noise and vibration emissions during construction of a sheet pile barrier wall.

4.2 Schedule

The current schedule for the IRM Design WP is dictated by the completion of the Citizens constructability pilot test and issuance of the Gowanus Canal ROD. National Grid anticipates that the pilot test will be completed prior to issuance of the ROD. The IRM Design Work Plan will be submitted 90 days after the issuance of the ROD is issued or Citizens pilot test is completed, whichever is later. Target dates of the anticipated schedule are listed below:

- Additional PDI Data collection - Q2/Q3 2013
- Citizens Constructability Pilot Test (present report schedule) - Q3 2013
- EPA Issuance of the Gowanus Canal ROD (anticipated) - Q3 2013
- Submittal of Fulton IRM Design Work Plan - 90 Days after the later of issuance of the ROD or completion of Citizens pilot test.

5. References

GEI Consultants, Inc., 2012a. *Final Interim Remedial Measure Pre-Design Investigation Work Plan, Fulton Municipal Works Former Manufactured Gas Plant (MGP) Site, AOC Index No. A2-0552-0606, Brooklyn New York.* March 2012.

GEI Consultants, Inc., 2012b. *Final Remedial Investigation Report, Fulton Municipal Works Former Manufactured Gas Plant (MGP) Site, AOC Index No. A2-0552-0606, Brooklyn, New York.* July 2012.

New York State Department of Environmental Conservation, May 2010, *DER-10 Technical Guidance for Site Investigation and Remediation.*