Ms. Katherine Vater
Project Manager
National Grid
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ENVIRONMENT

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September 2, 2016

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Our ref:
B0036704.0001

Subject:
Former Dangman Park Manufactured Gas Plant Site
In-Situ Treatment IRM Work Plan – Engineered Anaerobic Biological Oxidation (ABOx) through Direct-Push Injection of Gypsum
Brooklyn, New York
NYSDEC Site No. 224047
Index # A2-0552-0606

Dear Ms. Vater:

This letter work plan presents details for implementing the in-situ treatment Interim Remedial Measure (IRM) for Block 7273, Lot 1R that traverses the former Dangman Park Manufactured Gas Plant (MGP) Site (the Site): Engineered Anaerobic Biological Oxidation (ABOx) through Direct-Push Injection of Gypsum. National Grid recommended this IRM to the New York State Department of Environmental Conservation (NYSDEC) in a letter dated August 15, 2016 and NYSDEC's concurrence was presented in a letter dated August 18, 2016 (copies of both letters are provided in Attachment 1).

The in-situ treatment IRM consists of subsurface injection/emplacement of gypsum (calcium sulfate dihydrate [$CaSO_4$*$2H_2O$]) to provide a long-term source of sulfate to accelerate the ongoing ABOx of MGP-related impacts at the Site. Presented herein are details for emplacement of sulfate (non-oxygen electron acceptor) through injection of a weight percent gypsum slurry via direct-push drilling within the area of observed petroleum non-aqueous phase liquid (NAPL) impacts and soil boring LB-52 (NAPL coated soils were observed from 8.3 to 9.3 feet below land surface [ft bls]). The location of the in-situ treatment area is shown on Figure 1 (yellow shaded area). Sulfate addition via gypsum will stimulate indigenous sulfate reducing bacteria (SRB) populations to degrade petroleum and MGP-related constituents of concern (COCs), capitalizing on existing anaerobic (reduced) subsurface conditions to accelerate the ongoing natural source zone depletion (NSZD) within this area.

Injection of gypsum using direct-push drilling is just one component of the comprehensive Site remedy proposed by National Grid in its August 15, 2016 letter to NYSDEC (Attachment 1). These additional Site remedy components are briefly described below and will be the subject of a forthcoming Draft IRM Design Work Plan to be prepared by Arcadis on behalf of National Grid for submittal to NYSDEC:

- **Excavation IRM** - excavation of approximately 7,000 cubic yards of NAPL-impacted materials from three areas of the Site (Figure 1). The excavated materials would be treated/disposed off-site and hundreds of thousands of gallons of groundwater generated during excavation dewatering would also be treated prior to discharge to the local publicly owned treatment works (POTW).
- **Gypsum Emplacement in Excavation Backfill** - placement of gypsum in two of the excavation IRM areas (IRM Excavation Areas 2 and 3) to provide a long-term source of sulfate to the area downgradient of the excavations where petroleum NAPL coated soils were observed (Figure 1), thereby accelerating the ongoing ABOx and NSZD of MGP-related impacts in this area.
- **Engineering Control** - in the form of existing and new ground surface cover (e.g., building, asphalt, sidewalk, etc.) on the Site. A ground surface cover currently exists on the Site, and the Property Owner will construct a new cover on Lot 1R as part of the redevelopment. This new cover will include new structures (e.g., mixed-use commercial in the area of the former MGP) and public areas that will add approximately 4 feet of additional cover, a new building slab, and a vapor barrier that will enhance the existing Site cover.
- **Institutional Controls** - deed restrictions or environmental easements to govern future development of the Site and limit use of groundwater, as well as manage subsurface activities.
- **Site Management Plan** - to be prepared in accordance with current NYSDEC guidance to document (at minimum) protocols and requirements for future Site activities that would disturb or damage the ground surface cover, and methods for reducing and repairing any such disturbances; proper soil management procedures for the potential presence of MGP-impacted material encountered during future subsurface activities; and periodic inspection, certification and reporting.

Provided below is an overview of Engineered ABOx, followed by a description of the implementation details for the comprehensive Site remedy component that is the subject of this letter work plan - injection of gypsum using direct-push drilling.

ENGINEERED ABOx OVERVIEW

ABOx is biological degradation of petroleum hydrocarbons in the absence of oxygen. Engineered ABOx for this Site uses sulfate, in the form of gypsum, as a non-oxygen electron acceptor to provide a long-term source of sulfate within the yellow-shaded area shown on Figure 1. The resultant increase in sulfate from the gypsum injection will accelerate the degradation of dissolved phase COCs, which enhances NAPL dissolution.

Gypsum is sparingly soluble (solubility 2,400 mg/L [1,300 mg/L as sulfate]), and when placed as a slurry will dissolve gradually over a long period of time (years). The gypsum is expected to dissolve to its solubility, and then SRB will use the sulfate to degrade dissolved phase petroleum and MGP-related COCs. As the dissolved phase COC concentrations decrease, more NAPL and sorbed phase mass will dissolve into the groundwater to establish equilibrium. Similarly, as the dissolved sulfate is used by the SRB, more gypsum will dissolve. A Safety Data Sheet for gypsum is provided in Attachment 2.

Injection of gypsum will not result in permanent or widespread secondary water quality effects. Short-term effects of gypsum injection on groundwater chemistry will include an initial increase in sulfate concentrations before consumption by SRB, an increase in the population of SRB, and precipitation of metal sulfides as sulfate is reduced to sulfide in the presence of naturally occurring metals. Long-term effects on groundwater chemistry are expected to be minimal due to consumption of the sulfate and the reaction's byproducts. As identified in the January 2015 Fact Sheet regarding the completion of the Remedial Investigation (RI), people are not drinking the groundwater because the area is served by a public water supply that is not affected by the Site. There are no groundwater supply wells located at or in the vicinity of the Site; New York City's drinking water is supplied from reservoirs located in upstate New York (NYSDEC-approved RI Report).

GYPSUM INJECTION LOCATIONS

Gypsum will be emplaced through injection of an 8 percent by weight (% wt) slurry via direct-push drilling within the area of observed petroleum NAPL impacts and soil boring LB-52 (yellow-shaded area on Figure 1). All observations of petroleum NAPL were in the upper 15 ft and deeper than 6 feet below existing land surface (ft bls) (i.e., at the approximate seasonal high water table; see Attachment 1). Accordingly, the area designated for implementation of engineered ABOx is approximately 15,000 square feet (sf) (100 feet by 150 feet), and the targeted treatment thickness is 9 feet (6 to 15 ft bls).

Assuming a mobile porosity of approximately 10%, the 15,000 sf area corresponds to a groundwater treatment volume of approximately 100,000 gallons. In order to treat this volume with an 8% wt gypsum slurry, approximately 73,200 pounds (lbs) of gypsum will be required. The gypsum will be injected by direct-push drilling into a series of transects spanning the engineered ABOx treatment area. A total of seven transects will be installed on an approximate 20-foot spacing: five transects of approximately 10 gypsum slurry injection points per transect will be installed north of the proposed IRM Excavation Area 3 where the backfill will be amended with gypsum, and two transects of approximately four injection points per transect will be installed adjacent to and east of this IRM Excavation Area 3 (Figure 1). The objective of these injection locations is to adequately distribute gypsum to increase the sulfate concentrations in groundwater and stimulate indigenous SRB populations to degrade petroleum and MGP-related COCs.

Gypsum slurry will be injected using discrete vertical treatment intervals within an injection point over the 9-foot treatment thickness. The approximate target treatment interval per point will range from approximately 2 to 4 feet, and there will be approximately 2 to 5 treatment intervals per injection point over the targeted 9-foot thickness (6 to 15 ft bls). As noted above, the targeted 9-foot thickness incorporates the approximate seasonal high water table, where the petroleum NAPL was observed.

ENGINEERED ABOx IMPLEMENTATION

The in-situ treatment IRM work will be conducted in accordance with the current Arcadis Site-specific Health and Safety Plan (HASP) and Community Air Monitoring Plan (CAMP) that will be amended as necessary for this work. Prior to implementing any intrusive field work, the following activities will be conducted to identify utilities/structures at and in the immediate vicinity of the gypsum slurry injection locations (i.e., direct-push drilling locations):

- Obtaining and reviewing current site utility plans, as available from the Property Owner.
- Performing a visual site inspection and verifying that the gypsum slurry injection area is accessible.
- Contacting New York 811 to identify and mark the location of underground utilities at and in the immediate vicinity of the gypsum slurry injection area.
- Utilizing a private utility locating service to identify and mark the location of underground utilities at and in the immediate vicinity of the gypsum slurry injection area.

All gypsum slurry injection locations will be hand augered/hand dug, and/or air-knifed to a depth of 5 ft bls. Then the gypsum injections will be performed using direct-push drilling. After completion of the injections, the injection locations will be marked in the field with spray paint for subsequent land surveying. As shown on Figure 1, the estimated total number of gypsum slurry injection points is 58; the actual number of injection points and estimated injection volumes may be refined during field implementation based on conditions encountered.

The estimated volume (Vol_{inj}) of gypsum slurry required to achieve a radius of influence (ROI) of 5 feet over a treatment thickness of 9 feet (h_{TT}) will range from 420 gallons to 630 gallons, according to the equation and input parameters below.

$$Vol_{inj} = \pi \times ROI^2 \times h_{TT} \times \theta_m \times 7.48$$

Where:

Vol_{inj} = the estimated gypsum slurry injection volume (in gallons);

π = pi;

ROI = the estimated maximum achievable radius of influence (5 feet);

h_{TT} = the targeted treatment thickness of 9 feet;

θ_m = the percentage of aquifer porosity that influences the injection volume to distribution relationship (as a percentage and referred to as the mobile fraction; estimated to be between 8% and 12%);

7.48 = a numerical conversion from cubic feet to gallons.

Due to its sparingly soluble nature, the gypsum slurry will be continuously agitated in a small (50 to 100 gallon) mixing tank through aggressive circulation and paddle-wheel/physical mixing. A maximum of approximately 250 lbs of gypsum will be added to 100 gallons of water to achieve a 22% by wt gypsum slurry. A 22% wt gypsum slurry is targeted to inject a corresponding mass of gypsum to the 8% wt over the engineered ABOx treatment area.

While being continuously agitated, the gypsum slurry will be injected using direct push rods. The direct push rods will be advanced to the desired treatment interval, and approximately 95 to 280 gallons of gypsum slurry will be injected per treatment interval. The amount of gypsum slurry injected into each point will be documented on a field injection log, which identifies the discrete vertical treatment intervals. If treatment intervals are observed to accommodate substantially less injection solution than anticipated, more injection points will be required to provide sufficient gypsum slurry to the treatment area. During injection activities, slurry injection pressure will be monitored at the surface and will be kept below 50 pounds per square inch (psi). While this represents a maximum value, the injection pressure will be minimized to the extent possible. Upon completing the gypsum slurry injection at each location, the boring will be backfilled to the surface with clean sand and the surface restored with cement (as appropriate).

GROUNDWATER AND SOIL SAMPLING

Prior to injection of the gypsum slurry, groundwater samples will be collected from two temporary wells to document baseline sulfate concentrations (United States Environmental Protection Agency Method 300/SW-846 9056). The well locations are shown on Figure 1 and details for installation and sampling are provided in Attachment 3.

Following the gypsum slurry injection, confirmatory groundwater samples will be collected from the temporary wells for analysis of sulfate to demonstrate that adequate distribution of the gypsum slurry has been achieved. Adequate distribution will be gauged by the comparative increase in sulfate concentrations in groundwater compared to baseline conditions. Inherent variability in the sulfate laboratory analytical procedure in the presence of gypsum and the variable solubility of sources of gypsum may influence the exact achievable dissolved sulfate concentration. Post-injection sulfate groundwater concentrations are expected to be several hundreds of milligrams per liter above baseline sulfate concentrations in groundwater. The temporary wells will also be periodically gauged for the absence/presence of NAPL and measurable NAPL (if any) will be removed to the extent practicable.

Once distribution of the gypsum slurry has been achieved, soil borings will be drilled to visually confirm gypsum slurry distribution and visually observe soil samples as requested by NYSDEC (July 25, 2016 e-mail to National Grid). A total of four borings will be drilled to a target depth of 15 feet bls (Figure 1). Details regarding the soil sampling procedures are provided in Attachment 3. Upon completion of field activities associate with the in-situ treatment IRM, the temporary wells will be decommissioned in accordance with NYSDEC *CP-43: Groundwater Monitoring Well Decommissioning Policy.*

WASTE MANAGEMENT

Wastes generated during these field activities (e.g., disposable materials/equipment) will be temporarily stored on site in a 55-gallon drum(s) at a location to be determined with the Property Owner. The wastes will be transported off site for treatment/disposal by National Grid's waste disposal contractor.

PROPOSED SCHEDULE

We anticipate that the in-situ treatment IRM field work will commence as soon as the entire injection area is available (either prior to or after completion of Phase I building demolition [part of property owner's planned redevelopment]), NYSDEC's approval of this letter and agreement from the Property Owner to access to the property. The field work is expected to take approximately 4 to 6 weeks.

A complete summary of the work is planned to be presented in a summary letter to the NYSDEC approximately 6 weeks after completing the field activities. The summary letter will then be included in the Final Engineering Report to be prepared by Arcadis on behalf of National Grid following completion of the Excavation IRM.

Please do not hesitate to contact me or Cathy Geraci if you have any questions or require additional information.

Sincerely,

Arcadis of New York, Inc.

Megan Miller

Megan A. Miller, P.E.
Vice President

Enclosures:
Figure 1: Excavation and In-Situ Treatment IRMs
Attachment 1: National Grid's August 15, 2016 Letter to NYSDEC re: Recommended IRMs; and NYSDEC's August 18, 2016 Response Letter to National Grid
Attachment 2: Safety Data Sheet for Gypsum
Attachment 3: Soil Boring and Temporary Well Details
Attachment 4: Arcadis *Standard Groundwater Sampling for Monitoring Wells* SOP

Copies:
Steven Feldman, Arcadis
Christopher Keen, Arcadis
Cathy Geraci, Arcadis
Jeff McDonough, Arcadis
Bonnie Barnett, Esq., Drinker, Biddle and Reath
Leigh Bausinger, Esq., Drinker, Biddle and Reath
Linda Sullivan, Esq., National Grid

FIGURE

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:ALS PIC:(Opt) PM:(Re d) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
Z:\ENVCAD\SYRACUSE\ACT\B0036704\0001\01212\36704IST01.dwg LAYOUT: 1 SAVED: 9/2/2016 12:33 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/2/2016 1:08 PM BY: SANCHEZ, ADRIAN

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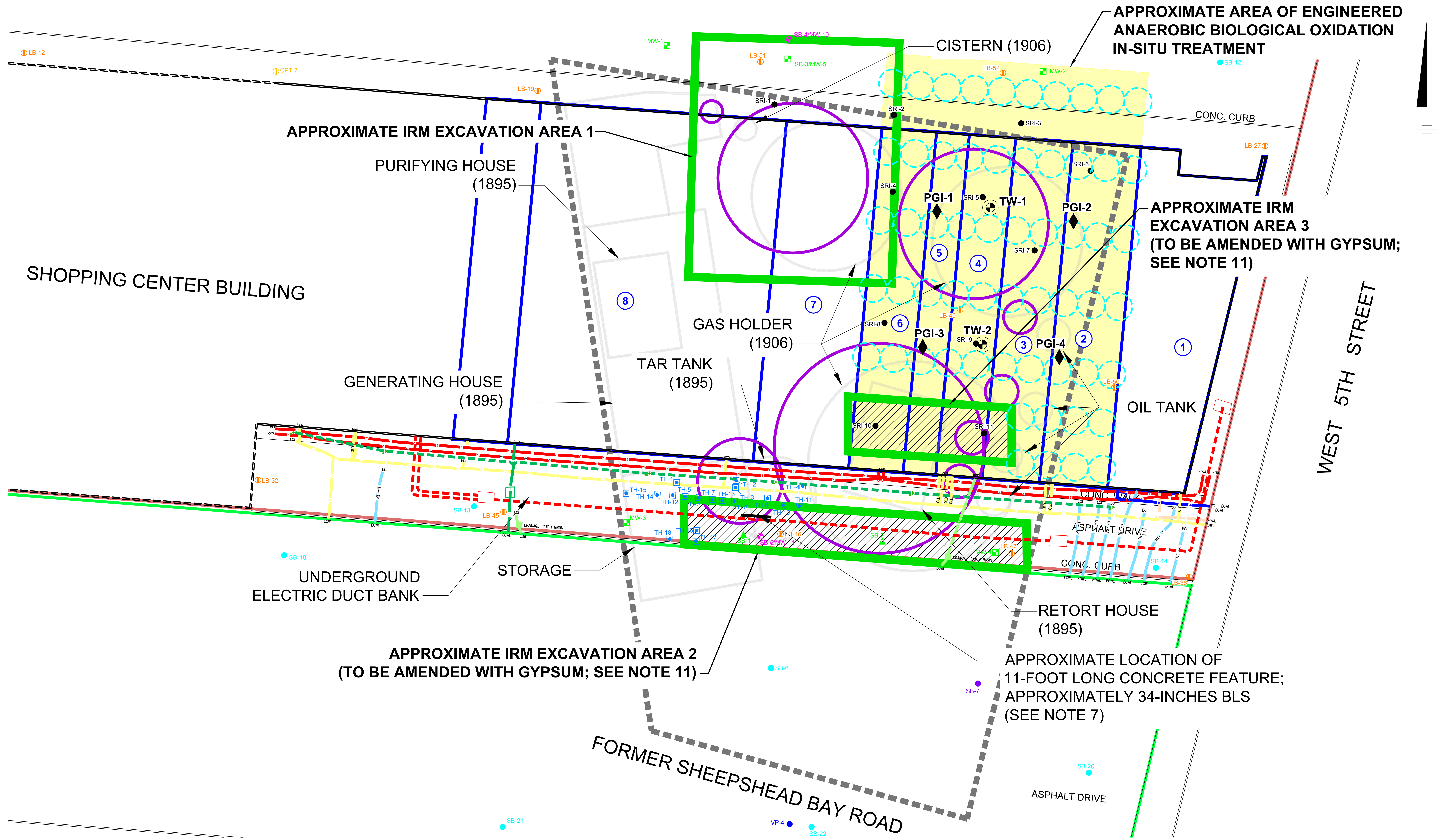
IMAGES: Image_2012-1105.jpg
PROJECTNAME: ----



LEGEND:

- APPROXIMATE BOUNDARY OF BLOCK 7273, LOT 1
- APPROXIMATE BOUNDARY OF BLOCK 7273, LOT 25
- APPROXIMATE FORMER MGP SITE BOUNDARY
- FORMER MGP FEATURE (1895 AND/OR 1906 SANBORN FIRE INSURANCE MAPS)
- FORMER MGP FEATURE (1895 AND/OR 1906 SANBORN FIRE INSURANCE MAPS) ADJUSTED BASED ON FIELD OBSERVATIONS OF POTENTIAL GAS HOLDER WALL AT SOIL BORING LOCATION SRI-1
- TENANT SPACE APPROXIMATE BOUNDARY
- 1 TENANT SPACE DESIGNATION
- COMMUNICATION LINE
- GAS LINE
- SANITARY LINE
- ELECTRIC LINE
- DRAINAGE LINE
- UNKNOWN LINE
- WATER LINE
- QLD QLD GAS LINE
- SANITARY LINE (SUSPECTED ROUTE)
- SB-1 SITE CHARACTERIZATION SOIL BORING LOCATION (ARCADIS, 2009)
- SB-2 SITE CHARACTERIZATION SOIL BORING/GEOPROBE GROUNDWATER SAMPLING LOCATION (ARCADIS, 2009)
- MW-1 SITE CHARACTERIZATION MONITORING WELL LOCATION (ARCADIS, 2009)
- SB-7 REMEDIAL INVESTIGATION NAPL DELINEATION SOIL BORING/ VERTICAL AQUIFER PROFILE TEMPORARY MONITORING WELL LOCATION (ARCADIS, 2011)
- SB-8 REMEDIAL INVESTIGATION NAPL DELINEATION SOIL BORING LOCATION (ARCADIS, 2011 AND 2012)
- MW-6 REMEDIAL INVESTIGATION MONITORING WELL LOCATION (ARCADIS, 2011, 2012, AND 2013)
- VP-1 REMEDIAL INVESTIGATION VERTICAL AQUIFER PROFILE TEMPORARY MONITORING WELL LOCATION (ARCADIS, 2012)
- SRI-10 SUPPLEMENTAL REMEDIAL INVESTIGATION SOIL BORING LOCATION (ARCADIS, 2015)
- LB-10 PROPERTY OWNER DRILLED BORING (LANGAN 2015)
- CPT-5 PROPERTY OWNER CPT BORING (LANGAN 2015)
- TH-1 SUPPLEMENTAL REMEDIAL INVESTIGATION TEST HOLE (ARCADIS 2016)
- APPROXIMATE LOCATION OF GYPSUM SLURRY (6 TO 15' BLS) TO BE INJECTED THROUGH DIRECT PUSH-DRILLING
- TW-1 TEMPORARY MONITORING WELL
- PGI-1 POST-GYPSUM INJECTION SOIL BORING

NOTES:

1. MONITORING WELL, TEST HOLE, AND SOIL BORING LOCATIONS SURVEYED RELATIVE TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, LONG ISLAND ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83).
2. LOCATIONS OF FORMER MGP FEATURES ARE APPROXIMATE.
3. BASE MAP BY DONALD G. DEKENIPP L.S., P.C., PROFESSIONAL LAND SURVEYOR.
4. UTILITY INFORMATION FROM CARDNO FIELD DRAFT DRAWING DATED MARCH 28, 2016; EXCEPT FOR THE APPROXIMATE LOCATION OF THE UNDERGROUND ELECTRIC DUCT BANK, WHICH IS FROM COSENTINI ASSOCIATES DRAWING DATED MARCH 1, 2016 (PROVIDED BY THE PROPERTY OWNER TO NATIONAL GRID).
5. TENANT SPACE LOCATIONS SHOWN ARE APPROXIMATE BASED ON INFORMATION OBTAINED BY ARCADIS DURING THE SITE CHARACTERIZATION AND ADDITIONAL INFORMATION PROVIDED BY THE PROPERTY OWNER IN 2015; LOCATIONS WEST OF CVS PHARMACY (#8) ARE NOT SHOWN.
6. THE PROPERTY OWNER DRILLED AND CPT BORING LOCATIONS ARE APPROXIMATE BASED ON A LANGAN DRAWING DATED OCTOBER 15, 2015.
7. THE CONCRETE FEATURE (e.g., POTENTIAL FOUNDATION) WAS OBSERVED ON APRIL 11, 2016 WITHIN A DEEPER SEGMENT OF THE TRENCH EXCAVATED BY PROPERTY OWNER DURING INSTALLATION OF THEIR UNDERGROUND ELECTRIC DUCT BANK. THE OBSERVED CONCRETE FEATURE IS LOCATED BELOW THE ELECTRIC DUCT BANK.
8. ALL UTILITY LOCATIONS ARE APPROXIMATE.
9. IRM EXCAVATION LIMITS TO BE DETERMINED DURING THE REMEDIAL DESIGN.
10. EXCAVATION BACKFILL TO BE AMENDED WITH GYPSUM TO PROVIDE A LONG-TERM, UPGRADIENT SOURCE OF SULFATE FOR ANAEROBIC BIOLOGICAL OXIDATION IN-SITU TREATMENT.
11. TEMPORARY WELL, GYPSUM SLURRY INJECTION, AND POST-GYPSUM INJECTION SOIL BORING LOCATIONS ARE APPROXIMATE; ACTUAL LOCATIONS WILL BE DETERMINED IN THE FIELD.

TENANT SPACE DESIGNATION	TENANT SPACE IDENTIFICATION
1	APPLE BANK
2	VACANT 2015 (FORMER RADIO SHACK)
3	VACANT 2015 (FORMER MARTIAL ARTS)
4	VACANT 2015 (FORMER MEDICAL SUPPLY)
5	VACANT 2016 (FORMER EASTERN CHINESE RESTAURANT)
6	VACANT 2015 (FORMER KURT CLEANERS)
7	CAPITAL ONE
8	CVS PHARMACY

0 20' 40'
APPROXIMATE SCALE IN FEET

NATIONAL GRID
FORMER DANGMAN PARK MGP SITE
BROOKLYN, NEW YORK
IN-SITU TREATMENT IRM WORK PLAN

EXCAVATION AND IN-SITU TREATMENT IRMs

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

ATTACHMENT 1

NATIONAL GRID'S AUGUST 15, 2016 LETTER TO NYSDEC RE: RECOMMENDED IRMS; AND NYSDEC'S AUGUST 18, 2016 RESPONSE LETTER TO NATIONAL GRID

Katherine Vater
Project Manager
Site Investigation and Remediation

August 15, 2016

Mr. William Wu
Environmental Engineer
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 11th Floor
625 Broadway
Albany, NY 12233

Re: Former Dangman Park Manufactured Gas Plant Site - Recommended IRMs
Brooklyn, New York
NYSDEC Site No. 224047
Index # A2-0552-0606

Dear Mr. Wu:

As a follow-up to our July 21, 2016 meeting in Manhattan, New York and as requested during our August 10, 2016 conference call, this letter provides a description of and basis for the two Interim Remedial Measures (IRMs) recommended by National Grid for the Former Dangman Park Manufactured Gas Plant (MGP) site in Brooklyn, New York (Site): Excavation IRM and In-Situ Treatment IRM. The recommended IRMs are described below, and would be implemented in conjunction with a ground surface cover, Institutional Controls (ICs), and a Site Management Plan (SMP) to provide a comprehensive Site remedy that is protective of human health and the environment. The ground surface cover would include new structures (e.g., mixed-use commercial and residential structure) and public areas that will add approximately 4 feet of additional cover, a new building slab, and a vapor barrier that would enhance the existing Site cover.

National Grid's recommended IRMs address the coated and saturated petroleum and coal tar non-aqueous phase liquid (NAPL) observed within 15 feet of the present ground surface. The recommended IRMs are described herein in order to obtain New York State Department of Environmental Conservation (NYSDEC) input/approval prior to submitting a draft work plan for each of the IRMs. The work plan for the Excavation IRM would be a modification of the *Draft Interim Remedial Measure (IRM) Design Work Plan* (Arcadis, May 2016); the work plan for the In-Situ Treatment IRM would be a letter work plan as requested in the NYSDEC (Gardiner Cross) July 25, 2016 e-mail to National Grid (Katherine Vater).

The descriptions of and basis for the recommended IRMs are provided below, followed by a discussion of next steps/schedule.

Recommended Excavation IRM

The recommended Excavation IRM includes three excavation areas (Figure 1). The limits of the two excavation areas described below were discussed during our July 21, 2016 meeting.

1. **Northwest Holder and Cistern Excavation Area (Area 1):** Excavate the area encompassing the holder footprint (SRI-1), SRI-2, and LB-51. This area, which is approximately 6,600 square feet (sf), will be excavated to a maximum depth of approximately 21 feet below land surface (ft bls) (i.e., bottom of holder) for removal of approximately 5,130 cubic yards (CY) of material.

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2. **Back Alley Excavation Area (Area 2):** Excavate the area encompassing (from west to east) SB-1, SB-5/MW-11, LB-46, SB-2, and LB-47. This area, which is approximately 2,100 sf, will be excavated to a depth of 15 ft bls for removal of approximately 1,170 CY of material.

   During our July 21, 2016 meeting, the subsurface utilities present in the back alley were discussed (Figure 1). The back alley excavation area will require removal and relocation of the underground electric duct bank installed/encased in concrete during Spring 2016 by the Property Owner.

   Within approximately 10 feet south of the shopping center back wall are numerous subsurface utilities: a gas line and associated service lines into the existing (and partially occupied) shopping center building, two electric lines, and a suspected sanitary sewer line (Figure 1; additional details provided in the *Draft SRI Report*). During the July 21, 2016 meeting, NYSDEC asked if these subsurface utilities would be abandoned as part of the redevelopment. As a follow-up to NYSDEC's question, the Property Owner's Team confirmed to National Grid that the subsurface utilities in the back alley will remain active only until Phase II demolition of the shopping center building (i.e., west of CVS Pharmacy; tenant space #8 on Figure 1) and then they will be abandoned, eliminating the subsurface around these utilities as a potential future human exposure pathway for construction workers.

The third IRM excavation area was briefly discussed during our August 10, 2016 conference call:

3. **SRI-10 and SRI-11 Petroleum NAPL Coated Soil Excavation Area (Area 3):** Excavate the area encompassing SRI-10 and SRI-11 within the current shopping center building footprint. This area, which is approximately 1,195 sf, would be excavated to a depth of 15 ft bls for removal of approximately 660 CY of material.

   In this area of the Site (SRI soil borings SRI-10 and SRI-11), a relatively greater degree of petroleum impacts were observed compared to the other 5 SRI soil borings (SRI-3, SRI-6, SRI-7, SRI-8, and SRI-9) where petroleum impacts were observed. Petroleum NAPL in the form of lightly to moderately coated soils was observed at these 7 soil boring locations drilled below the shopping center building. All observations of petroleum NAPL were in the upper 15 ft and deeper than 6 ft bls (i.e., at the approximate seasonal high water table).

   For reference, provided in Attachment A is the previously provided draft photograph log of the soil cores where petroleum NAPL coated soils were observed, along with the draft figure showing the boring log descriptions most recently provided to NYSDEC in the *Draft Supplemental Remedial Investigation Report* (Arcadis, May 2016).[1] As shown on the figure in Attachment A, petroleum NAPL was not observed in soil borings SRI-4 and SRI-5, located downgradient of 5 locations where petroleum NAPL was observed. Groundwater data for the downgradient shallow monitoring wells (MW-1 and MW-2; screened from 6 to 16 ft bls to straddle the water table) document that volatile organic compound (VOC) and semi-volatile organic compound (SVOC) concentrations in these wells are relatively low (e.g., benzene was not detected above 1 microgram per liter [μg/L] in the March 2012 MW-2 groundwater sample). Additionally, NAPL has not been observed in any of the shallow monitoring wells during the 7-year period that investigation/gauging activities have been conducted.

   Collectively, the data fully support that the lightly to moderately petroleum coated soil observed in some soil cores collected more than 6 ft below the shopping center building is not migrating and not releasing significant VOC and SVOC concentrations to groundwater.

[1] Portable document files (PDFs) of the photograph log and figure were originally transmitted to NYSDEC in my July 18, 2016 e-mail; subsequent to our July 21, 2016 meeting, we noticed that the PDF of the photograph log is not as clear as the Word file. Therefore, the Word file of the photograph log is attached to the e-mail transmittal of this letter.

The greatest depth interval of petroleum NAPL coated was observed in soil boring SRI-10 (6.4 to 15 ft bls); ranging from very light to moderate NAPL coating on soils, with trace brown blebs within some intervals. The soil boring that exhibited the second greatest depth interval that included moderately petroleum NAPL coated soil was SRI-11, located approximately 40 ft east of SRI-10. The Excavation IRM would remove the soil and petroleum NAPL at and in the vicinity of these two soil boring locations (approximately 660 CY); and would be combined with the recommended In-Situ Treatment IRM to address remaining MGP-related impacts by capitalizing on existing anaerobic (reduced) subsurface conditions to accelerate the natural rate of biodegradation (i.e., natural source zone depletion [NSZD]) within the area of observed petroleum NAPL.

The recommended In-Situ Treatment IRM is anaerobic biological oxidation (ABOx), which is further described below. As part of the In-Situ Treatment IRM, the backfill for the excavation area encompassing soil boring locations SRI-10 and SRI-11 and the back alley excavation area would include gypsum (calcium sulfate dihydrate [$CaSO_4$*$2H_2O$]). The gypsum would provide a long-term, upgradient source of sulfate to accelerate the ongoing ABOx of MGP-related impacts below this area of the shopping center building where petroleum NAPL coated soils were observed (Figure 1).

Recommended In-Situ Treatment IRM - Anaerobic Biological Oxidation (ABOx)

As discussed during our August 10, 2016 conference call, we have reviewed the available in-situ options, and Arcadis has recommended ABOx (enhanced biodegradation) through injection/emplacement of sulfate (non-oxygen electron acceptor). The available Site data were reviewed with respect to the applicability of available in-situ treatment technologies. In particular, there are two key Site-specific conditions that strongly support ABOx as the preferred in-situ treatment technology: groundwater is moving slowly (RI Report, approximately 0.09 to 0.5 ft/day); and, shallow groundwater is anaerobic (reduced) based on the oxidation reduction potential (ORP) data collected during groundwater sampling and documented in the RI Report.

ABOx (enhanced biodegradation) through injection/emplacement of sulfate is recommended to address the petroleum NAPL, in conjunction with the Area 3 excavation described above where a relatively greater degree of petroleum impacts were observed compared to the other soil borings (Attachment A). Sulfate addition would stimulate indigenous sulfate reducing bacteria (SRB) populations to degrade petroleum and MGP-related COCs, capitalizing on existing anaerobic (reduced) subsurface conditions to accelerate the ongoing NSZD within the area of observed petroleum NAPL.

Site conditions following the significant removal of NAPL-impacted materials, including slow movement of groundwater, support subsurface emplacement of gypsum to provide a long-term, slow release sulfate source for ABOx of COCs. The gypsum would accelerate NAPL solubilization (phase-change remediation) and enhance the degradation of dissolved phase COCs.

Gypsum is sparingly soluble (solubility 2,400 mg/L [1,300 mg/L as sulfate]), and when placed as a slurry will dissolve over a long period of time (years). The gypsum is expected to dissolve to its solubility, and then SRB will use the sulfate to degrade dissolved phase petroleum and MGP-related COCs. As the dissolved phase concentrations decrease, more NAPL and sorbed phase mass will dissolve into the groundwater to establish equilibrium. Similarly, as the dissolved sulfate is used by the SRB, more gypsum will dissolve.

Gypsum would be emplaced in the near-term by injection of a weight percent slurry via direct-push drilling within the area of observed petroleum NAPL impacts and LB-52 (yellow-shaded area on Figure 1). We plan to collect soil samples for visual observation as requested (NYSDEC July 25, 2016 e-mail to National Grid), and plan to also collect groundwater samples from temporary wells to document pre-injection sulfate concentrations. Additionally, following the DPT injection, confirmatory groundwater samples will be collected from the temporary wells for analysis of sulfate to demonstrate adequate distribution of the gypsum slurry has been achieved. The temporary wells will also be periodically gauged for the absence/presence of NAPL and measurable NAPL (if any) removed to the extent practicable. The gypsum emplaced in the backfill of the IRM excavation recommended for this area and described above, would also provide a long-term, upgradient source of sulfate for ABOx.

Consideration of Chemical Oxidation

In-situ chemical oxidation (ISCO) is not recommended for in-situ treatment at this Site due to implementability and safety concerns. Available chemical oxidants used to accelerate NAPL solubilization (phase-change remediation) and breakdown dissolved phase COCs are persulfate, permanganate, peroxide, and ozone (and some combinations of them). These oxidants are appropriate for MGP-related constituents of concern (COCs), except permanganate, which is ineffective for treatment of aromatics (e.g., benzene). Of the remaining three chemical oxidants, sodium persulfate is the most implementable and safest beneath a structure. Even though sodium persulfate is the best option of the available chemical oxidants, it is a strong oxidant that will persist in the subsurface and cause heat and gas generation. Chemical oxidation is limited by contaminant mass transfer from the NAPL and sorbed phases into the groundwater where the oxidation occurs. Furthermore, the injected sodium persulfate would need to satisfy the stoichiometric requirements of the MGP-related COCs plus other non-productive oxidant demands (e.g., reduced mineralogy) in the shallow groundwater which is currently anaerobic (reduced), likely requiring multiple injection events over an extended period of time.

ISCO with sodium persulfate was eliminated from further consideration because the reasonably anticipated adverse effects outweigh the potential remedial benefit. Introducing sodium persulfate would chemically and physically disturb the current steady-state conditions documented at the Site, particularly below the partially occupied shopping center building that has covered the area of observed petroleum NAPL for more than 50 years. Sodium persulfate reaction chemistry is broad and complex. This complicates any reliable estimate of byproducts and potential metals mobilization, and complicates any reliable evaluation of additional measures that may be needed to ensure continued protection of human health and the environment during implementation of injections. Although the benefit of ISCO will be short-lived, the geochemical influence of a sodium persulfate injection is anticipated to persist long after the injection, possibly years at this Site given the slow movement of groundwater. For example, the acidity associated with decomposition of persulfate and interactions with reduced mineralogy raises concerns about chemical compatibility with the steel piles associated with the redevelopment. After detailed review, these drawbacks resulted in eliminating ISCO from consideration at this Site.

Summary, Next Steps, and Schedule

National Grid's recommended Site remedy includes an Excavation IRM, an In-situ Treatment IRM, ICs and a SMP. In addition to the recommended IRMs summarized herein, any impacts remaining on Lot 1R will be further addressed during redevelopment by an additional 4 ft of cover materials, a new building slab, and soil vapor mitigation measures. Collectively, these recommended remedial components comprehensively achieve the best balance of the NYSDEC evaluation criteria set forth in 6 NYCRR 375-1.8(f), and effectively address the potential for future exposure to subsurface soil and groundwater containing MGP-related impacts. The recommended IRMs will remove a significant quantity (approximately 7,000 CY) of NAPL-impacted materials that would be treated/disposed off-site, treat hundreds of thousands gallons of groundwater generated during excavation dewatering, and oxidize the area of petroleum NAPL over the long-term (years) by providing a sparing soluble source of sulfate (gypsum) both within and upgradient of this area.

As identified in my August 10, 2016 e-mail, the draft work plans for both IRMs (excavation and in-situ treatment) are in progress; we plan to submit those to NYSDEC within two weeks of NYSDEC's concurrence of the recommended IRMs presented herein.

In the meantime, if you have any questions or concerns about the recommended IRMs please contact me at your convenience such that we can incorporate any comments prior to submitting the work plan. I can be reached at (608) 826-3663 or at katherine.vater@nationalgrid.com.

Sincerely,

Katherine Vater

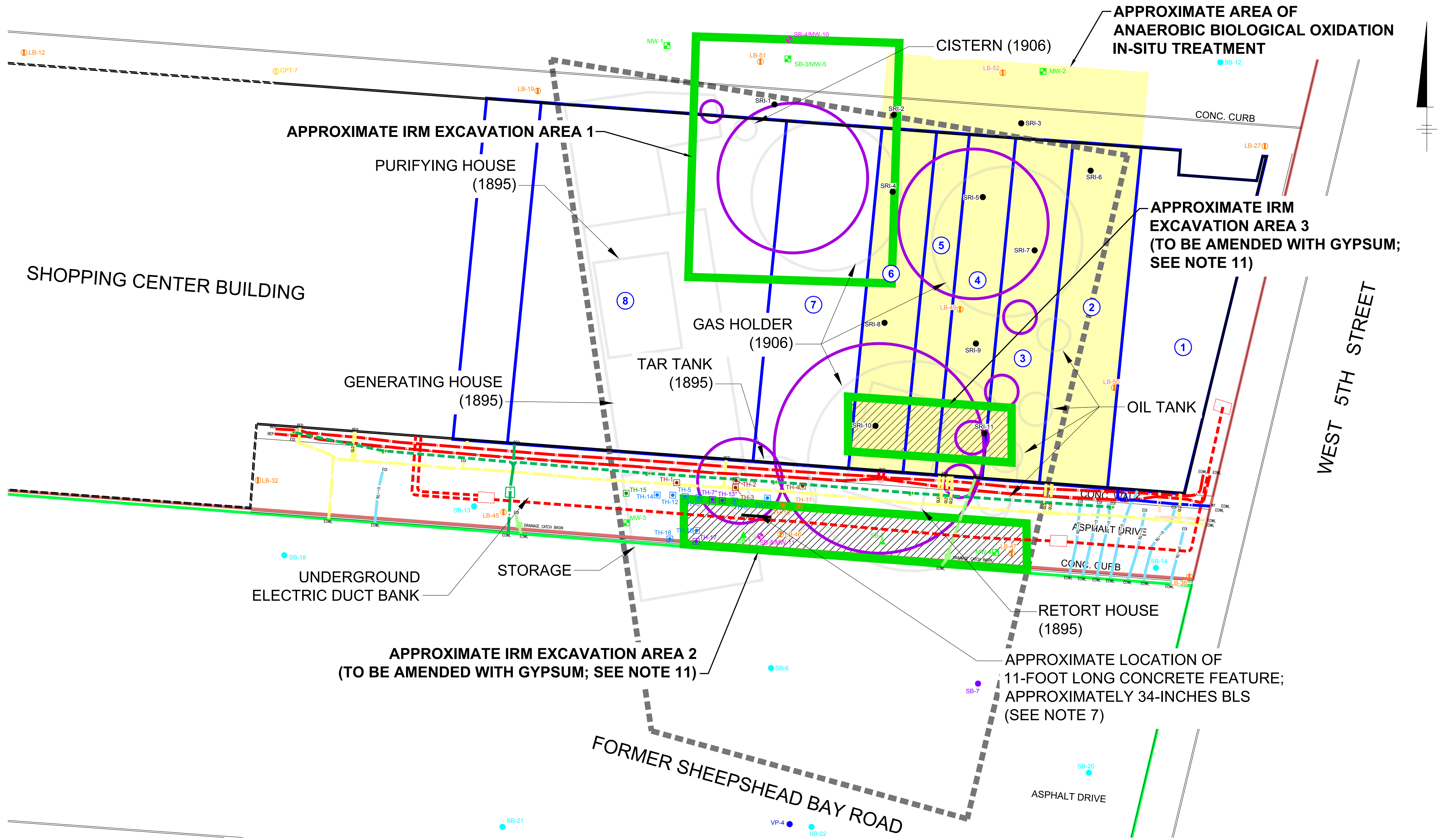
Katherine Vater
Project Manager

Enclosures:
Figure 1: Excavation and In-Situ Treatment IRMs

Attachment A: Petroleum NAPL Observations - Photograph Log and Figure

cc: Gardiner Cross, NYSDEC
Albert DeMarco, NYSDOH
Linda Sullivan, Esq., National Grid
Bonnie Barnett, Esq., Drinker Biddle and Reath LLP
Steve Feldman, Arcadis
M. Cathy Geraci, Arcadis

287 Maspeth Avenue, Brooklyn, NY 11211
T: (608) 826-3663 F: (718) 963-5611 katherine.vater@nationalgrid.com wwww.nationalgrid.com



LEGEND:

- APPROXIMATE BOUNDARY OF BLOCK 7273, LOT 1
- APPROXIMATE BOUNDARY OF BLOCK 7273, LOT 25
- APPROXIMATE FORMER MGP SITE BOUNDARY
- FORMER MGP FEATURE (1895 AND/OR 1906 SANBORN FIRE INSURANCE MAPS)
- FORMER MGP FEATURE (1895 AND/OR 1906 SANBORN FIRE INSURANCE MAPS) ADJUSTED BASED ON FIELD OBSERVATIONS OF POTENTIAL GAS HOLDER WALL AT SOIL BORING LOCATION SRI-1
- TENANT SPACE APPROXIMATE BOUNDARY
- 1 TENANT SPACE DESIGNATION
- COMMUNICATION LINE
- GAS LINE
- SANITARY LINE
- ELECTRIC LINE
- DRAINAGE LINE
- UNKNOWN LINE
- WATER LINE
- QLD QLD GAS LINE
- SANITARY LINE (SUSPECTED ROUTE)
- SB-1 SITE CHARACTERIZATION SOIL BORING LOCATION (ARCADIS, 2009)
- SB-2 SITE CHARACTERIZATION SOIL BORING/GEOPROBE GROUNDWATER SAMPLING LOCATION (ARCADIS, 2009)
- MW-1 SITE CHARACTERIZATION MONITORING WELL LOCATION (ARCADIS, 2009)
- SB-7 REMEDIAL INVESTIGATION NAPL DELINEATION SOIL BORING/ VERTICAL AQUIFER PROFILE TEMPORARY MONITORING WELL LOCATION (ARCADIS, 2011)
- SB-8 REMEDIAL INVESTIGATION NAPL DELINEATION SOIL BORING LOCATION (ARCADIS, 2011 AND 2012)
- MW-6 REMEDIAL INVESTIGATION MONITORING WELL LOCATION (ARCADIS, 2011, 2012, AND 2013)
- VP-1 REMEDIAL INVESTIGATION VERTICAL AQUIFER PROFILE TEMPORARY MONITORING WELL LOCATION (ARCADIS, 2012)
- SRI-10 SUPPLEMENTAL REMEDIAL INVESTIGATION SOIL BORING LOCATION (ARCADIS, 2015)
- LB-10 PROPERTY OWNER DRILLED BORING (LANGAN 2015)
- CPT-5 PROPERTY OWNER CPT BORING (LANGAN 2015)
- TEST HOLE LOCATION METAL FEATURE ENCOUNTERED AT 3' BLS
- TEST HOLE LOCATION NAPL ENCOUNTERED BELOW 5' BLS
- TEST HOLE LOCATION CONCRETE REFUSAL ENCOUNTERED AT 1' BLS
- TEST HOLE LOCATION STAINED SOIL ENCOUNTERED BELOW 5' BLS
- TEST HOLE LOCATION UTILITY DAYLIGHTED
- * LAID-UP BRICK ENCOUNTERED

0 20' 40'
APPROXIMATE SCALE IN FEET

NOTES:

1. MONITORING WELL, TEST HOLE, AND SOIL BORING LOCATIONS SURVEYED RELATIVE TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, LONG ISLAND ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83).
2. LOCATIONS OF FORMER MGP FEATURES ARE APPROXIMATE.
3. BASE MAP BY DONALD G. DEKENIPP L.S., P.C., PROFESSIONAL LAND SURVEYOR.
4. UTILITY INFORMATION FROM CARDNO FIELD DRAFT DRAWING DATED MARCH 28, 2016; EXCEPT FOR THE APPROXIMATE LOCATION OF THE UNDERGROUND ELECTRIC DUCT BANK, WHICH IS FROM COSENTINI ASSOCIATES DRAWING DATED MARCH 1, 2016 (PROVIDED BY THE PROPERTY OWNER TO NATIONAL GRID).
5. TENANT SPACE LOCATIONS SHOWN ARE APPROXIMATE BASED ON INFORMATION OBTAINED BY ARCADIS DURING THE SITE CHARACTERIZATION AND ADDITIONAL INFORMATION PROVIDED BY THE PROPERTY OWNER IN 2015; LOCATIONS WEST OF CVS PHARMACY (#8) ARE NOT SHOWN.
6. THE PROPERTY OWNER DRILLED AND CPT BORING LOCATIONS ARE APPROXIMATE BASED ON A LANGAN DRAWING DATED OCTOBER 15, 2015.
7. THE CONCRETE FEATURE (e.g., POTENTIAL FOUNDATION) WAS OBSERVED ON APRIL 11, 2016 WITHIN A DEEPER SEGMENT OF THE TRENCH EXCAVATED BY PROPERTY OWNER DURING INSTALLATION OF THEIR UNDERGROUND ELECTRIC DUCT BANK. THE OBSERVED CONCRETE FEATURE IS LOCATED BELOW THE ELECTRIC DUCT BANK.
8. ALL UTILITY LOCATIONS ARE APPROXIMATE.
9. TENANT SPACES 2 THROUGH 6 ARE VACANT.
10. IRM EXCAVATION LIMITS TO BE DETERMINED DURING THE REMEDIAL DESIGN.
11. EXCAVATION BACKFILL TO BE AMENDED WITH GYPSUM TO PROVIDE A LONG-TERM, UPGRADIENT SOURCE OF SULFATE FOR ANAEROBIC BIOLOGICAL OXIDATION IN-SITU TREATMENT.

TENANT SPACE DESIGNATION	TENANT SPACE IDENTIFICATION
1	APPLE BANK
2	VACANT 2015 (FORMER RADIO SHACK)
3	VACANT 2015 (FORMER MARTIAL ARTS)
4	VACANT 2015 (FORMER MEDICAL SUPPLY)
5	VACANT 2016 (EASTERN CHINESE RESTAURANT)
6	VACANT 2015 (FORMER KURT CLEANERS)
7	CAPITAL ONE
8	CVS PHARMACY

DRAFT

NATIONAL GRID
FORMER DANGMAN PARK MGP SITE
BROOKLYN, NEW YORK

EXCAVATION AND IN-SITU TREATMENT IRMs

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:ALS PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
Z:\ENVCAD\SYRACUSE\ACT\B0036704\0001\01515\36704IRM-R04.dwg LAYOUT: 1 SAVED: 8/12/2016 5:08 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 8/15/2016 6:32 PM BY: SANCHEZ, ADRIAN
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Attachment A

Petroleum NAPL Observations - Photograph Log and Figure

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 1

Description: (7.6-8.7') Moderate petroleum-like odor, very light coating of yellow NAPL

Location: SRI-3 (7-9')

Photograph taken by:
Will Stephens

Date: 10/13/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 2

Description: Moderate petroleum-like odor, very light coating of yellow NAPL

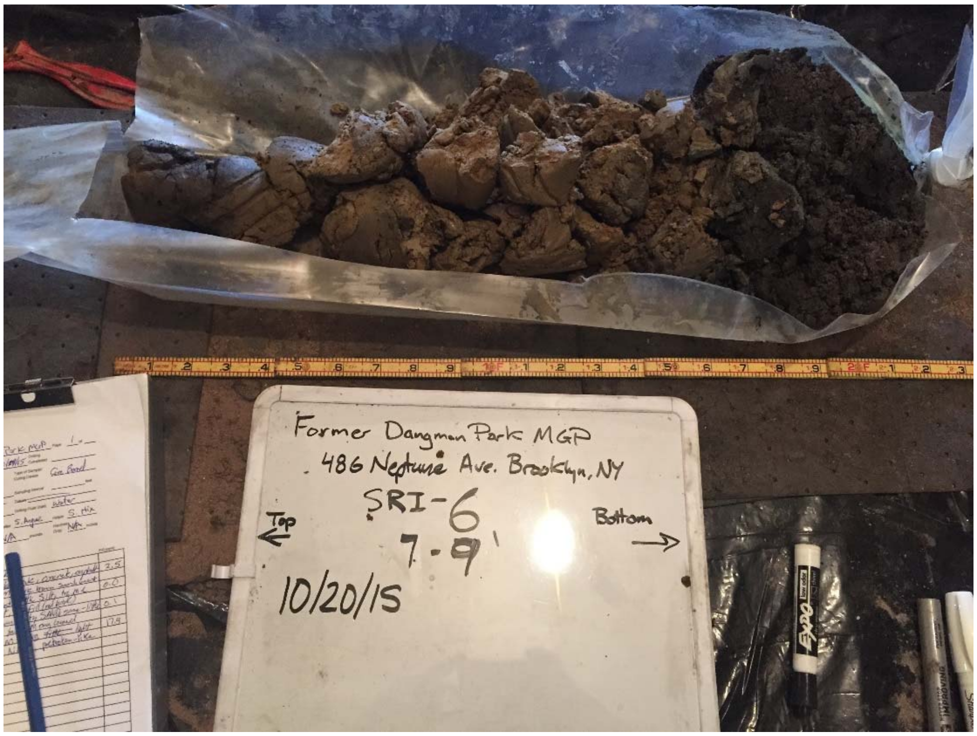
Location: SRI-3 (9-11')

Photograph taken by: Will Stephens

Date: 10/13/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 3

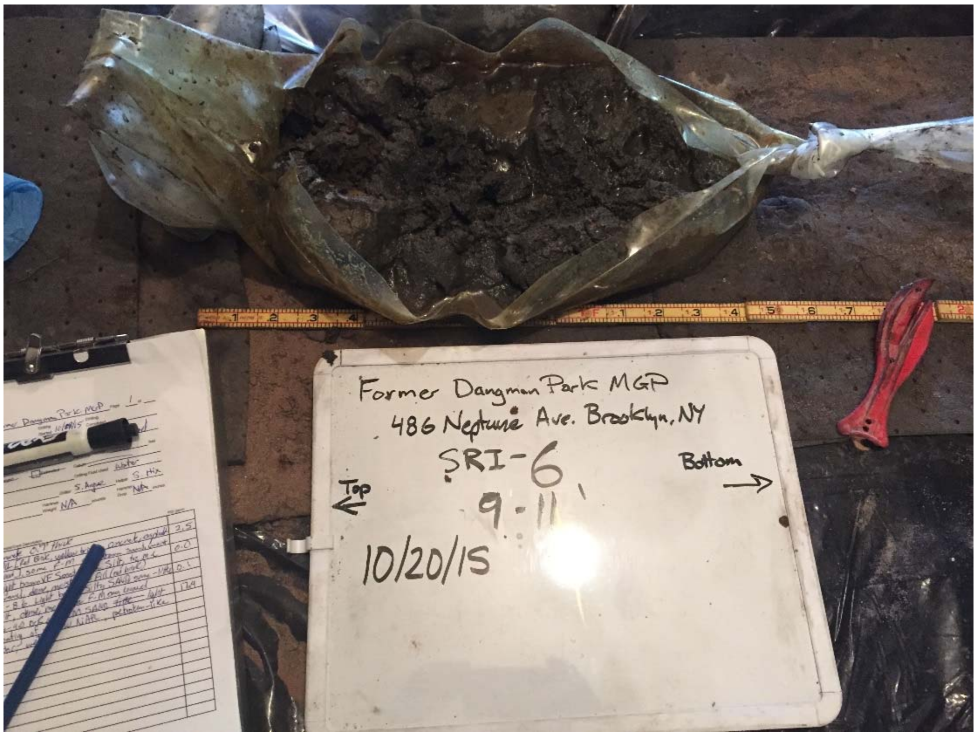
Description: (8.6-9.0') Light coating of yellow NAPL, petroleum-like odor

Location: SRI-6 (7-9')

Photograph taken by: Will Stephens

Date: 10/20/2015

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 4

Description: Light to moderate coating of yellow NAPL, moderate petroleum-like odor

Location: SRI-6 (9-11')

Photograph taken by: Will Stephens

Date: 10/20/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 5

Description: (7.9-9') Moderate petroleum-like odor, light brown NAPL coating

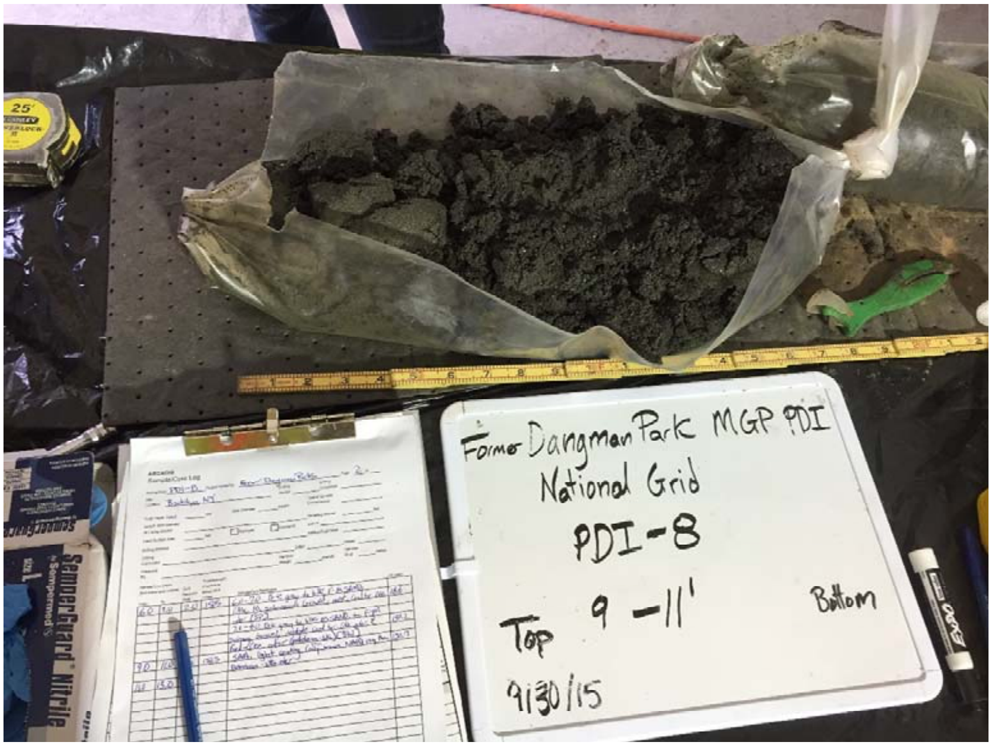
Location: SRI-7 (7-9')

Photograph taken by: Will Stephens

Date: 10/15/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 6

Description: Light coating (very thin, oily brown NAPL), petroleum-like odor

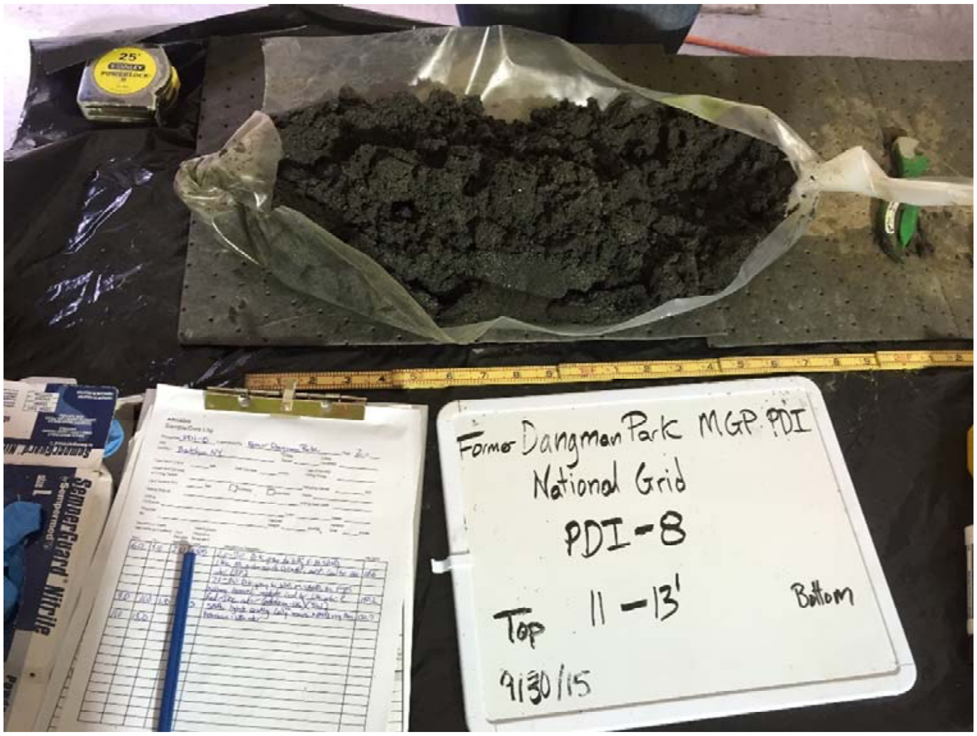
Location: SRI-8 (9-11')

Photograph taken by:
Will Stephens

Date: 9/30/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 7

Description: Light coating (very thin, oily brown NAPL), petroleum-like odor

Location: SRI-8 (11-13')

Photograph taken by:
Will Stephens

Date: 9/30/2015

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 8

Description: (7.8-8.9') Light yellow coating of NAPL, petroleum-like odor

Location: SRI-9 (7-9')

Photograph taken by: Will Stephens

Date: 10/15/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 9

Description: Moderate coating of yellow NAPL, petroleum-like odor

Location: SRI-9 (9-11')

Photograph taken by:
Will Stephens

Date: 10/15/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York

Photograph: 10

Description: (11-11.6') Light coating of yellow NAPL, petroleum-like odor

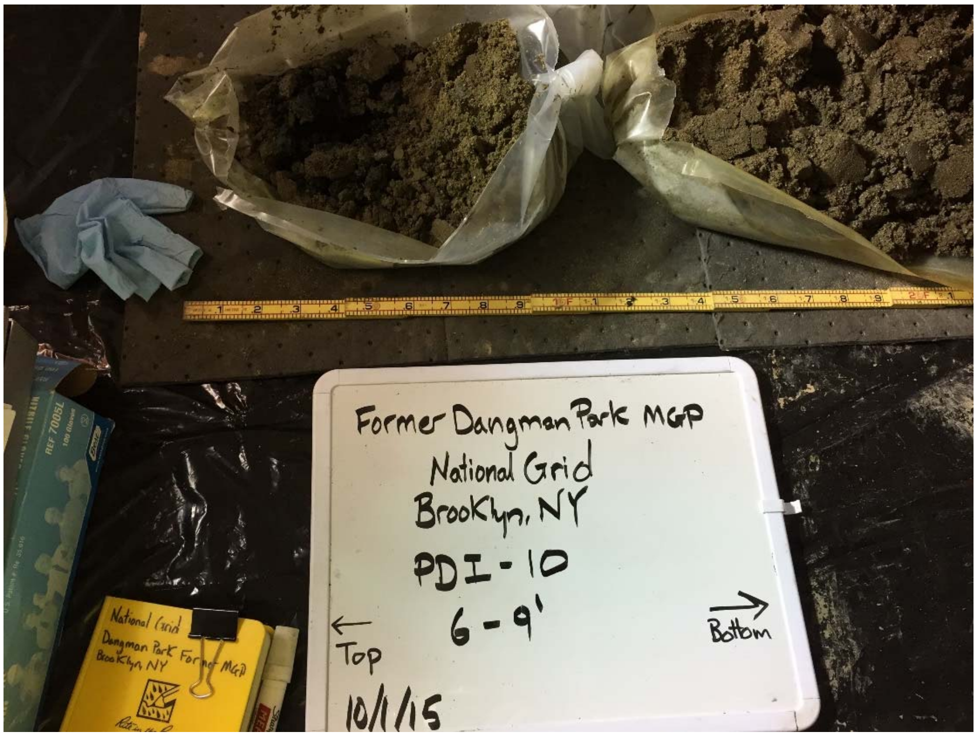
Location: SRI-9 (11-13')

Photograph taken by: Will Stephens

Date: 10/15/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 11

Description: (6.4-8.7') Light brown to yellow light NAPL coating, strong petroleum-like odor

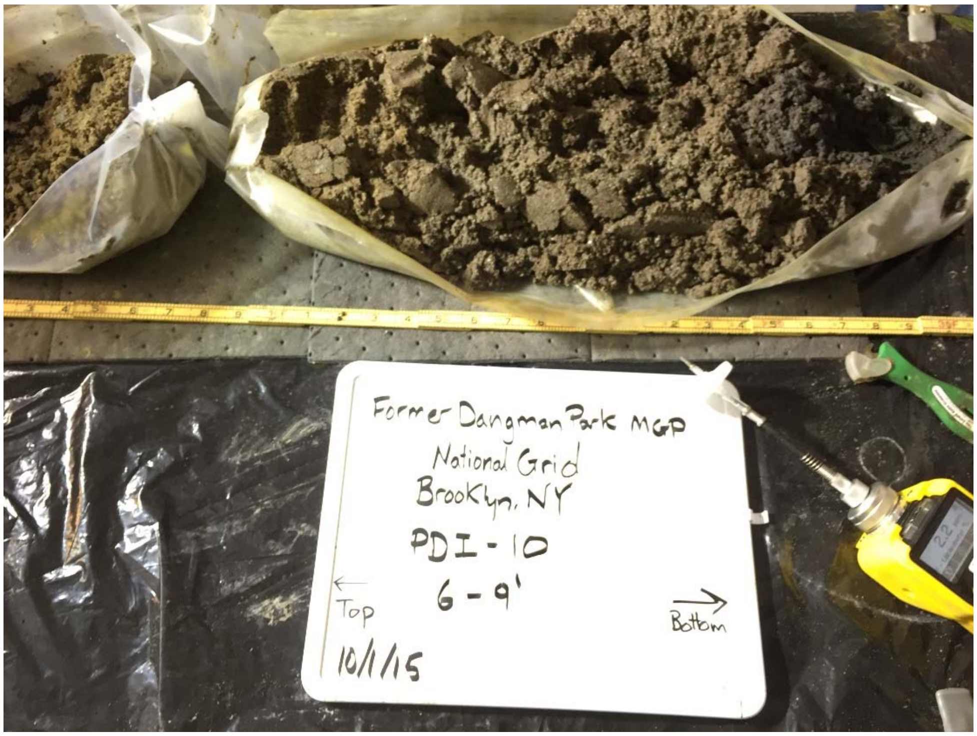
Location: SRI-10 (6-9')

Photograph taken by: Will Stephens

Date: 10/1/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 12

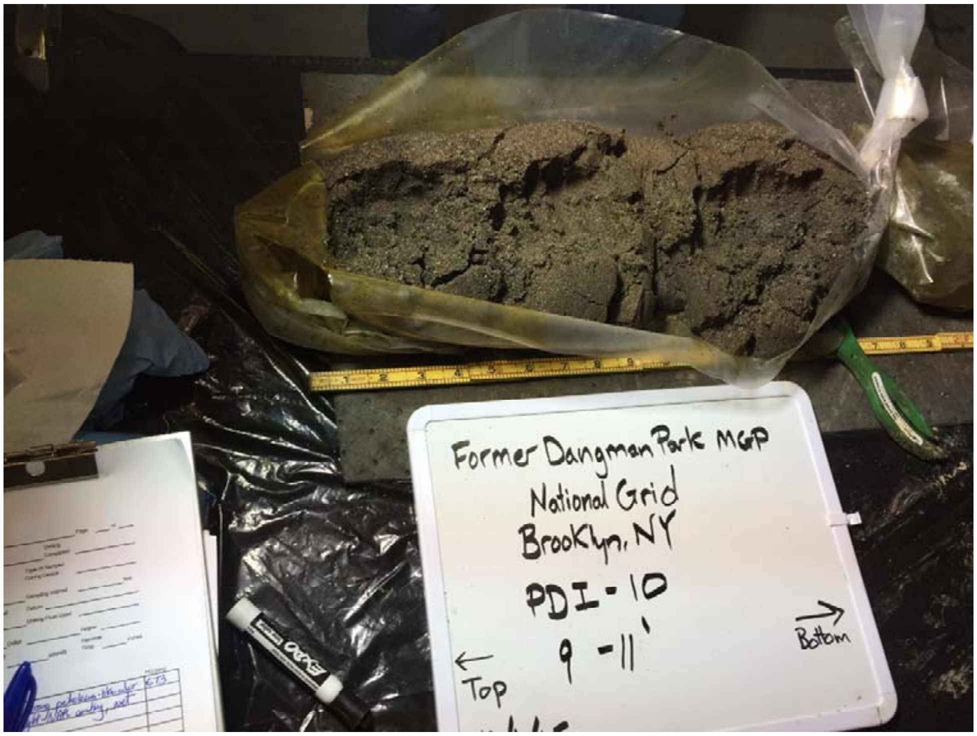
Description: (8.7-9.0') Strong petroleum-like odor, light coating of light brown to yellow NAPL

Location: SRI-10 (6-9')

Photograph taken by:
Will Stephens

Date: 10/1/2015

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 13

Description: Strong petroleum-like odor, light brown to yellow light NAPL coating, trace brown NAPL blebs (~2 mm diameter)

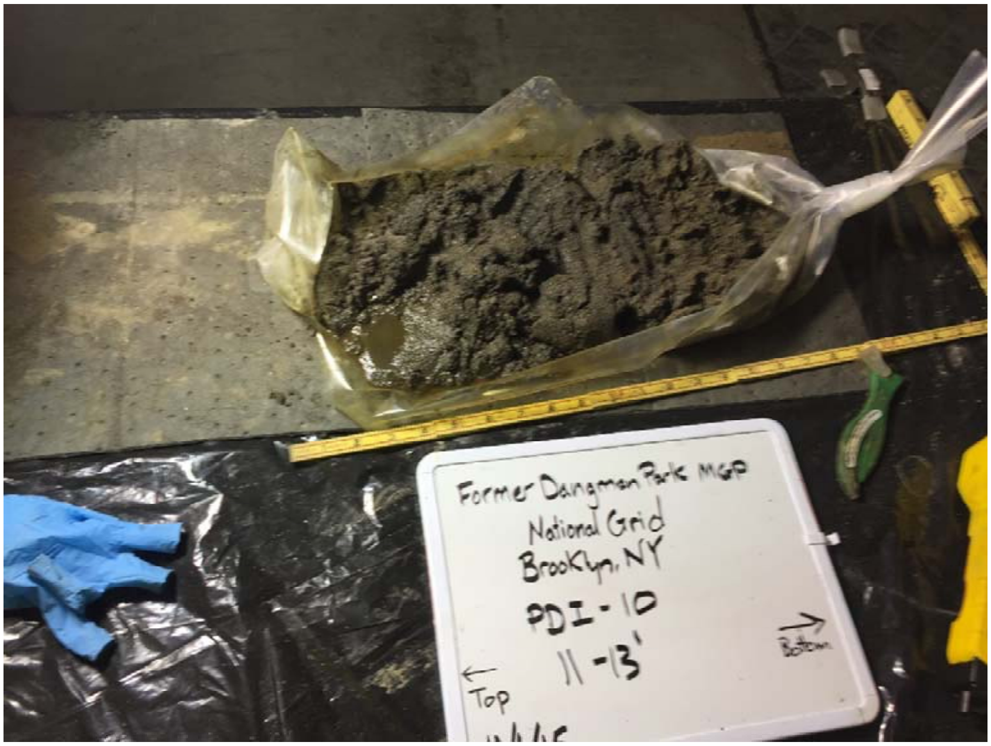
Location: SRI-10 (9-11')

Photograph taken by: Will Stephens

Date: 10/1/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 14

Description: (11.0-12.0') Moderate coating of light brown to yellow NAPL, trace brown NAPL blebs (~2 mm diameter), petroleum-like odor; (12.0-13.0') Strong petroleum-like odor, light yellow NAPL coating

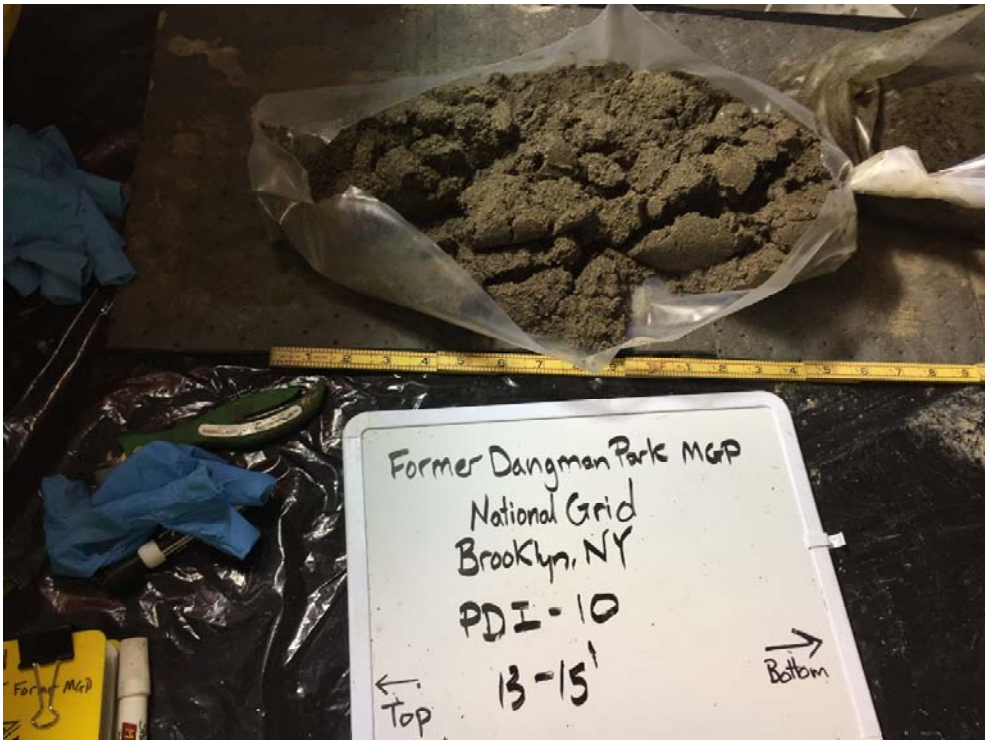
Location: SRI-10 (11-13')

Photograph taken by:
Will Stephens

Date: 10/1/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 15

Description: Moderate petroleum-like odor, very light yellow NAPL coating

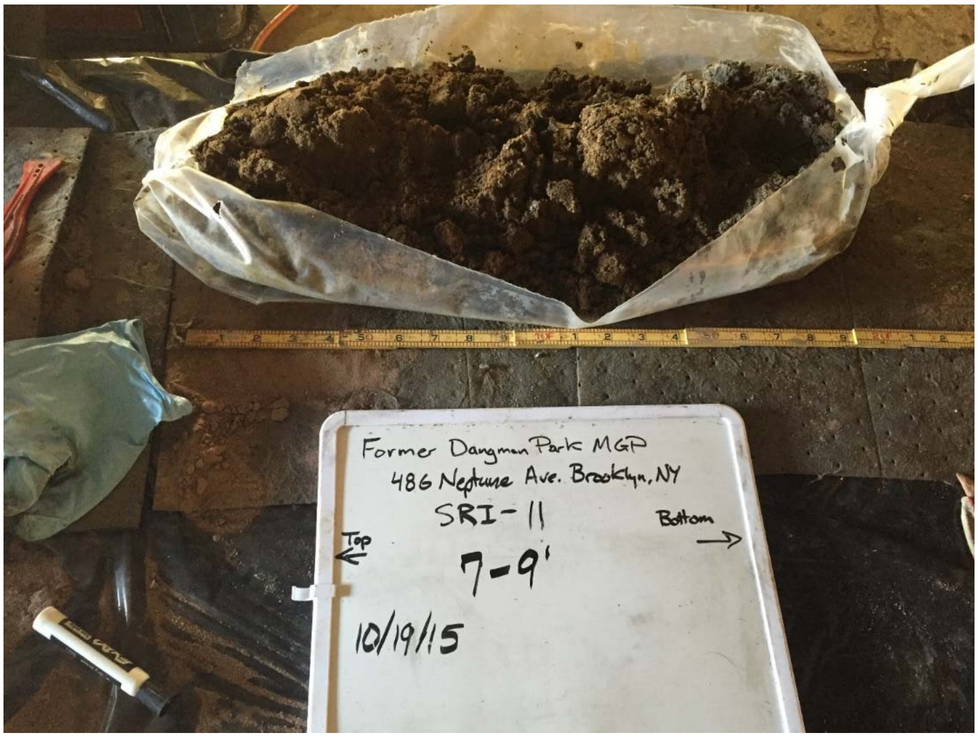
Location: SRI-10 (13-15')

Photograph taken by: Will Stephens

Date: 10/1/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 16

Description: (8.3-9.0') Moderate petroleum-like odor, light coating of yellow-brown NAPL

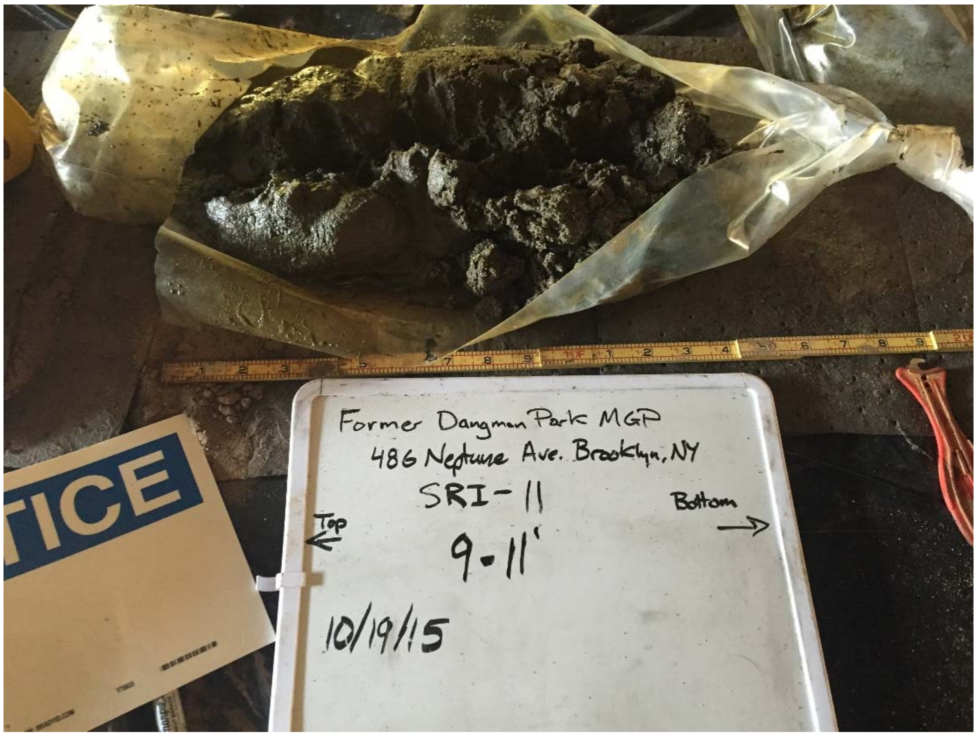
Location: SRI-11 (7-9')

Photograph taken by: Will Stephens

Date: 10/19/2015

PHOTOGRAPH LOG
PETROLEUM NAPL OBSERVATIONS

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 17

Description: Moderate coating of yellow NAPL, strong petroleum-like odor

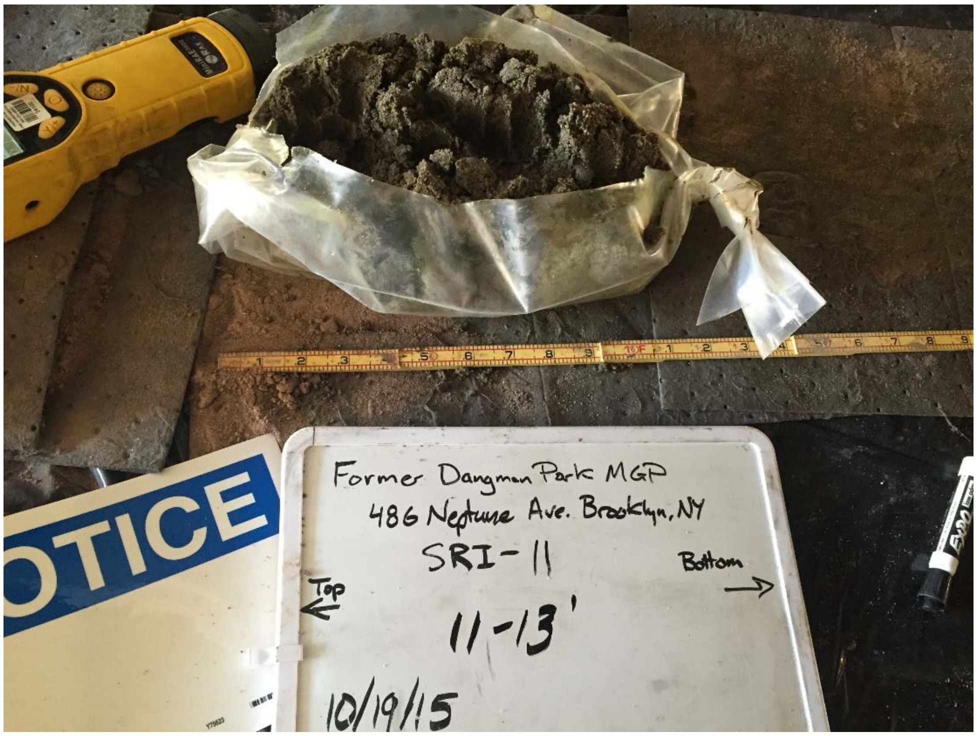
Location: SRI-11 (9-11')

Photograph taken by:
Will Stephens

Date: 10/19/2015

G:\Clients\National Grid\Dangman\01 Agreements and Proposals\2016\2721611222_SRI Borings Photograph Log_062316.docx

National Grid
Former Dangman Park MGP Site
Brooklyn, New York



Photograph: 18

Description: Light coating of yellow NAPL, strong petroleum-like odor

Location: SRI-11 (11-13')

Photograph taken by: Will Stephens

Date: 10/19/2015

CITY:MELVILLE DIV/GROUP:ENVCAD DB:A.SANCHEZ LD:A.SANCHEZ PIC:(Opt) PM:S.FELDMAN TM:C.KEEN LYR:(Opt)ON=*;OFF=*REF*
P:\ENVCAD\SYRACUSE\ACT\B0036704\0001\01616\36704SRI.dwg LAYOUT: 1 SAVED: 6/24/2016 3:04 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 6/24/2016 3:07 PM BY: MEYER, JULIE
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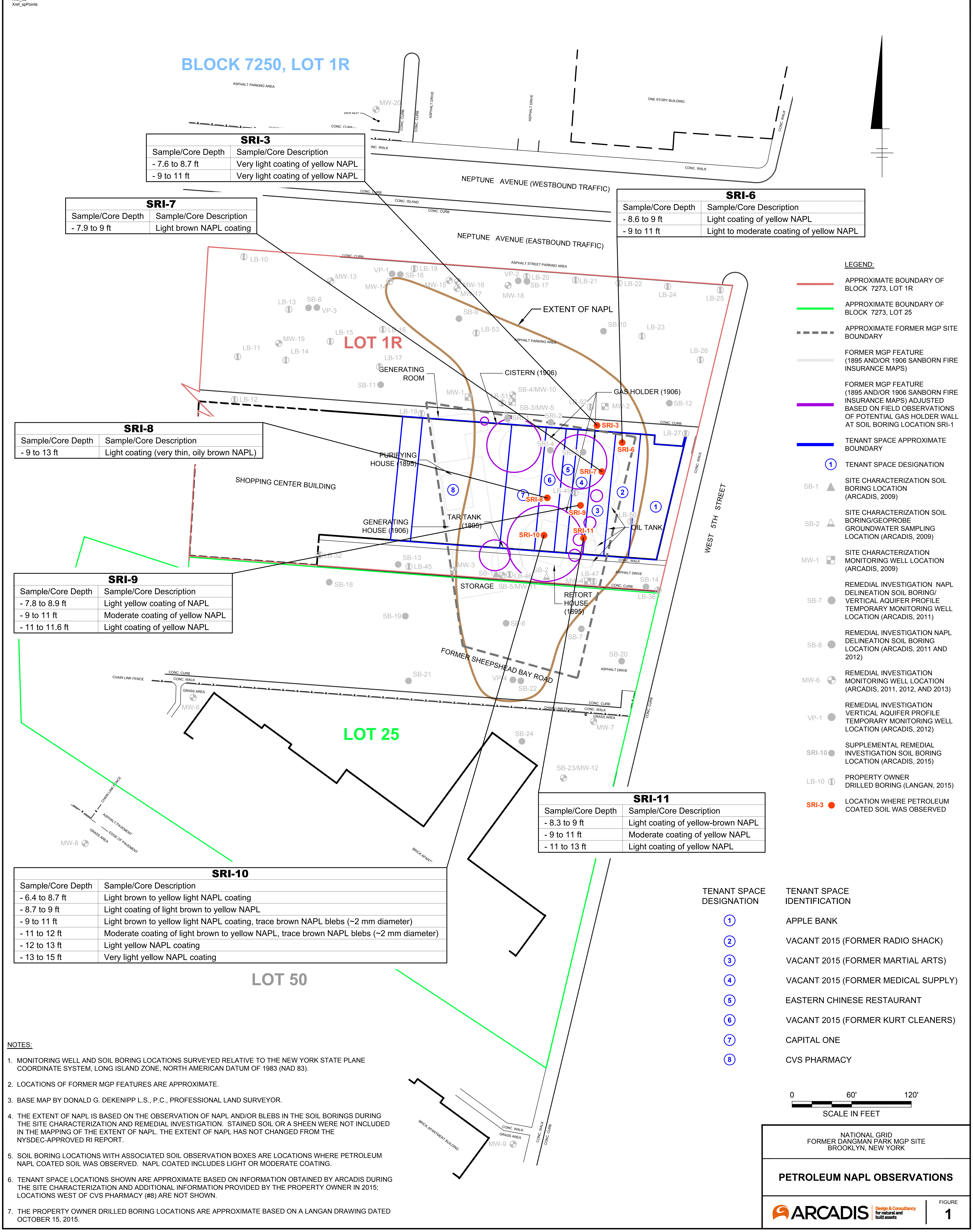

SRI-3	
Sample/Core Depth	Sample/Core Description
- 7.6 to 8.7 ft	Very light coating of yellow NAPL
- 9 to 11 ft	Very light coating of yellow NAPL

SRI-7	
Sample/Core Depth	Sample/Core Description
- 7.9 to 9 ft	Light brown NAPL coating

SRI-6	
Sample/Core Depth	Sample/Core Description
- 8.6 to 9 ft	Light coating of yellow NAPL
- 9 to 11 ft	Light to moderate coating of yellow NAPL

SRI-8	
Sample/Core Depth	Sample/Core Description
- 9 to 13 ft	Light coating (very thin, oily brown NAPL)

SRI-9	
Sample/Core Depth	Sample/Core Description
- 7.8 to 8.9 ft	Light yellow coating of NAPL
- 9 to 11 ft	Moderate coating of yellow NAPL
- 11 to 11.6 ft	Light coating of yellow NAPL

SRI-11	
Sample/Core Depth	Sample/Core Description
- 8.3 to 9 ft	Light coating of yellow-brown NAPL
- 9 to 11 ft	Moderate coating of yellow NAPL
- 11 to 13 ft	Light coating of yellow NAPL

SRI-10	
Sample/Core Depth	Sample/Core Description
- 6.4 to 8.7 ft	Light brown to yellow light NAPL coating
- 8.7 to 9 ft	Light coating of light brown to yellow NAPL
- 9 to 11 ft	Light brown to yellow light NAPL coating, trace brown NAPL blebs (~2 mm diameter)
- 11 to 12 ft	Moderate coating of light brown to yellow NAPL, trace brown NAPL blebs (~2 mm diameter)
- 12 to 13 ft	Light yellow NAPL coating
- 13 to 15 ft	Very light yellow NAPL coating

TENANT SPACE DESIGNATION	TENANT SPACE IDENTIFICATION
1	APPLE BANK
2	VACANT 2015 (FORMER RADIO SHACK)
3	VACANT 2015 (FORMER MARTIAL ARTS)
4	VACANT 2015 (FORMER MEDICAL SUPPLY)
5	EASTERN CHINESE RESTAURANT
6	VACANT 2015 (FORMER KURT CLEANERS)
7	CAPITAL ONE
8	CVS PHARMACY

NOTES:

1. MONITORING WELL AND SOIL BORING LOCATIONS SURVEYED RELATIVE TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, LONG ISLAND ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83).
2. LOCATIONS OF FORMER MGP FEATURES ARE APPROXIMATE.
3. BASE MAP BY DONALD G. DEKENIPP L.S., P.C., PROFESSIONAL LAND SURVEYOR.
4. THE EXTENT OF NAPL IS BASED ON THE OBSERVATION OF NAPL AND/OR BLEBS IN THE SOIL BORINGS DURING THE SITE CHARACTERIZATION AND REMEDIAL INVESTIGATION. STAINED SOIL OR A SHEEN WERE NOT INCLUDED IN THE MAPPING OF THE EXTENT OF NAPL. THE EXTENT OF NAPL HAS NOT CHANGED FROM THE NYSDEC-APPROVED RI REPORT.
5. SOIL BORING LOCATIONS WITH ASSOCIATED SOIL OBSERVATION BOXES ARE LOCATIONS WHERE PETROLEUM NAPL COATED SOIL WAS OBSERVED. NAPL COATED INCLUDES LIGHT OR MODERATE COATING.
6. TENANT SPACE LOCATIONS SHOWN ARE APPROXIMATE BASED ON INFORMATION OBTAINED BY ARCADIS DURING THE SITE CHARACTERIZATION AND ADDITIONAL INFORMATION PROVIDED BY THE PROPERTY OWNER IN 2015; LOCATIONS WEST OF CVS PHARMACY (#8) ARE NOT SHOWN.
7. THE PROPERTY OWNER DRILLED BORING LOCATIONS ARE APPROXIMATE BASED ON A LANGAN DRAWING DATED OCTOBER 15, 2015.

NATIONAL GRID
FORMER DANGMAN PARK MGP SITE
BROOKLYN, NEW YORK

PETROLEUM NAPL OBSERVATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Remedial Bureau C
625 Broadway, 11th Floor, Albany, NY 12233-7014
P: (518) 402-9662 I F: (518) 402-9679
www.dec.ny.gov

August 18, 2016

Ms. Katherine Vater
Project Manager
National Grid – Site Investigation and Remediation
287 Maspeth Ave
Brooklyn, NY 11211-1703

Dear Ms. Vater:

Re: K – Dangman Park MGP
Kings County, site no. 224047
Former Dangman Park Manufactured Gas Plant Site – Recommended IRMs (Received August 16, 2016)

The New York State Department of Environmental Conservation (the Department) has reviewed the referenced letter scope of work. The scope of work is satisfactory to the Department.

However, the Department notes that full excavation of the tar tank area is not feasible at this time, due to the presence of multiple utility lines traversing the area. It is understood that these lines are slated to remain in service during Phase 1 of redevelopment, but may be deactivated as Phase 2 moves forward.

This utility corridor has not been fully investigated, but based on adjacent observations, it appears that the portion of it adjacent to the tar tank may be as contaminated as the rest of the tar tank which has been investigated.

In light of this, when the proposed back alley excavation work has been completed, measures must be taken to prevent recontamination of the backfill material by potentially mobile NAPL in the unremediated soils beneath the utility corridor.

Based on observation of the distribution of source material in the proposed back alley excavation area, a decision will be made as to whether additional remedial work will be required once the adjacent utility corridor is deactivated and becomes available for remediation. It is understood that the developer plans to have the Phase 1 redevelopment completed before the utility deactivation can take place. Given the apparently small size of the contaminated area beneath the utility corridor, and the proximity to the Phase 1 development, the Department would consider a small scale solidification project to address this material if remediation becomes necessary.

Please incorporate this note in the revised IRM work plan that you will submit to the Department. We will review the work plan on an expedited schedule. Please contact me with any questions via email at william.wu@dec.ny.gov, or via phone at (518) 402-9662.

Sincerely,

William Wu
Environmental Engineer 1
Remedial Bureau C
Division of Environmental Remediation

ec: G. Cross, NYSDEC
A. DeMarco, NYSDOH
J. Deming, NYSDOH
S. Feldman, Arcadis of New York, Inc.
M. Cathy Geraci, Arcadis of New York, Inc.

ATTACHMENT 2

SAFETY DATA SHEET FOR GYPSUM

Material Safety Data Sheet

Calcium sulfate, dihydrate

ACC# 90113

Section 1 - Chemical Product and Company Identification

MSDS Name: Calcium sulfate, dihydrate
Catalog Numbers: S76764
Synonyms: Alabaster; annaline; gypsum; gypsum stone; land plaster; magnesia white; mineral white; precipitated calcium sulfate.
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
10101-41-4	Calcium sulfate dihydrate	100	unlisted

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: white solid.
Caution! May cause eye, skin, and respiratory tract irritation.
Target Organs: None known.

Potential Health Effects

Eye: May cause eye irritation.
Skin: May cause skin irritation.
Ingestion: Ingestion of large amounts may cause gastrointestinal irritation.
Inhalation: May cause respiratory tract irritation.
Chronic: Not available.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.
Extinguishing Media: Substance is noncombustible; use agent most appropriate to extinguish surrounding fire.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: ; Flammability: ; Instability:

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Reduce airborne dust and prevent scattering by moistening with water. Clean up spills immediately, observing precautions in the Protective Equipment section.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Wash thoroughly after handling. Use only in a well-ventilated area. Avoid contact with skin and eyes. Avoid ingestion and inhalation.
Storage: Store in a cool, dry place. Keep container closed when not in use.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Calcium sulfate dihydrate	10 mg/m3 TWA (inhalable fraction, listed under Calcium sulfate)	none listed	none listed
Calcium sulfate anhydrous	10 mg/m3 TWA (inhalable fraction)	10 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable dust)	15 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable fraction)

OSHA Vacated PELs: Calcium sulfate dihydrate: No OSHA Vacated PELs are listed for this chemical. Calcium sulfate anhydrous: 15 mg/m3 TWA; 5 mg/m3 TWA (respirable fraction)
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to minimize contact with skin.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance: white
Odor: None reported.
pH: Not available.
Vapor Pressure: Not available.
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: Not available.
Freezing/Melting Point: Not available.
Decomposition Temperature: Not available.
Solubility: Slightly soluble in water.
Specific Gravity/Density:2.32
Molecular Formula:$CaO_4S.2H_2O$
Molecular Weight:172.1644

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Dust generation.
Incompatibilities with Other Materials: No significant incompatibilities identified with common materials and contaminants..
Hazardous Decomposition Products: Oxides of sulfur, calcium oxide.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 10101-41-4: EW4150000
CAS# 7778-18-9: WS6920000
LD50/LC50:
Not available.
Not available.

Carcinogenicity:
CAS# 10101-41-4: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 7778-18-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No data available.
Teratogenicity: No data available.
Reproductive Effects: No data available.
Mutagenicity: No data available.
Neurotoxicity: No data available.
Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	Not regulated as a hazardous material	No information available.
Hazard Class:		
UN Number:		
Packing Group:		

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 10101-41-4 is not on the TSCA Inventory because it is a hydrate. It is considered to be listed if the CAS number for the anhydrous form is on the inventory (40CFR720.3(u)(2)).
CAS# 7778-18-9 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
None of the chemicals in this material have an RQ.
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
Section 313 No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 10101-41-4 can be found on the following state right to know lists: Minnesota.

CAS# 7778-18-9 can be found on the following state right to know lists: Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

Not available.

Risk Phrases:

Safety Phrases:

S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)

CAS# 10101-41-4: 0

CAS# 7778-18-9: 0

Canada - DSL/NDSL

CAS# 7778-18-9 is listed on Canada's DSL List.

Canada - WHMIS

not available.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

Section 16 - Additional Information

MSDS Creation Date: 9/02/1997

Revision #5 Date: 2/18/2008

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

ATTACHMENT 3

SOIL BORING AND TEMPORARY WELL DETAILS

Soil Borings

Soil borings will be drilled to visually confirm gypsum slurry distribution and visually observe soil samples as required by the New York State Department of Environmental Conservation (NYSDEC)-(NYSDEC July 25, 2016 e-mail to National Grid). The borings will be drilled once distribution of the gypsum slurry has been achieved; the proposed post-gypsum injection (PGI) locations (PGI-1 through PGI-4) are shown on Figure 1. These locations will be hand augered/hand dug, and/or air-knifed to a depth of 5 feet below land surface (ft bls). The soil borings will be drilled to a target depth of 15 ft bls using direct push (Geoprobe® or equivalent equipment) drilling techniques.

The Geoprobe® Dual Tube Sampling System will be used. The Geoprobe® Dual Tube Sampling System employs an outer casing and inner rod string assembly. Continuous soil sampling will commence at 5 ft bls by advancing 3.25-inch outside diameter (OD) probe rods (outer casing) and a 5-foot long sample liner. Dual tube sampling uses two sets of probe rods to collect continuous soil cores. One set of rods is driven into the ground as an outer casing. These rods receive the driving force from the hammer and provide a sealed borehole from which soil samples may be collected. The second, smaller set of rods (inner rod string) are placed inside the outer casing. The inner rod string hold the sample liner in place as the outer casing is driven over the sampling interval. The inner rod string is then retracted to retrieve the filled sample liner.

Soil recovered from each sample interval will be visually characterized for color, texture, and moisture content as described in the National Grid Field Descriptions of Samples for Former Manufactured Gas Plant (MGP) Sites (Appendix B [FSP] of the RI Work Plan). The presence (if any) of visible staining, non-aqueous phase liquid (NAPL), and obvious odors will be noted and the soil will be field screened with a photoionization detector (PID). Upon completion, the borings will be backfilled to the surface with clean sand and the surface restored with cement (as appropriate).

Temporary Wells

The proposed temporary well locations (TW-1 and TW-2) are shown on Figure 1. The temporary well locations will be adjusted, as needed, based on the locations of subsurface utilities and subsurface conditions encountered in the field. All drilling locations will be hand augered/hand dug, and/or air-knifed to a depth of 5 ft bls. The wells will be drilled to a target depth of 15 ft bls using hollow-stem auger drilling techniques. The wells will be installed using the protocols presented in the Arcadis *Monitoring Well Installation* SOP (Appendix B [FSP] of the RI Work Plan), and constructed consistent with the NYSDEC-approved shallow wells previously installed at the Site (e.g., MW-1 through MW-4 and MW-15). Specifically, the temporary wells will be constructed with 2-inch diameter Schedule 40 polyvinyl chloride (PVC) casing and ten (10) feet of PVC screen such that the wells will straddle the water table. Each temporary well will be developed by surging and pumping water from the well using the procedures outlined in the Arcadis *Monitoring Well Development* SOP (Appendix B [FSP] of the RI Work Plan),. Surging and pumping will continue until the turbidity is below 50 nephelometric turbidity units (NTUs) or until pH and conductivity measurements have stabilized.

The temporary wells will be purged using traditional purging and sampling methods as described in the Arcadis *Standard Groundwater Sampling for Monitoring Wells* SOP (Appendix B of this Work Plan). The wells will be gauged for the presence/absence of NAPL prior to purging. Following purging, one groundwater sample will be collected from each temporary well using standard sampling techniques and a submersible pump. The groundwater samples will be submitted to the laboratory for the analysis of sulfate (United States Environmental Protection Agency Method 300/SW-846 9056). Field parameters including pH, temperature, conductivity, and turbidity will be collected during groundwater sampling. Once adequate distribution of the gypsum slurry has been achieved, the wells will be decommissioned in accordance with NYSDEC *CP-43: Groundwater Monitoring Well Decommissioning Policy*.

Waste Management

Decontamination procedures will be conducted as necessary and consistent with the procedures described in the RI Work Plan. Soil cuttings and other wastes generated during this work (e.g., plastic sheeting, decontamination water, etc.) will be segregated by waste type and placed in appropriate waste containers (e.g., Department of Transportation (DOT)-approved 55-gallon steel drums). Composite samples of the soil cuttings and water will be submitted to a laboratory for waste characterization analyses (as necessary), and the wastes will be transported off site for treatment/disposal by National Grid's contractor.

ATTACHMENT 4

ARCADIS STANDARD GROUNDWATER SAMPLING FOR MONITORING WELLS SOP

ARCADIS

Infrastructure, environment, facilities

Imagine the result

Standard Groundwater Sampling for Monitoring Wells

Rev. #: 1

Rev Date: July 16, 2008

Approval Signatures

Prepared by: Sonya A Cadle Date: 7/16/08

Reviewed by: __________________ Date: 7/16/08
(Technical Expert)

I. Scope and Application

This Standard Operating Procedure (SOP) describes the procedures to be used to collect groundwater samples using traditional purging and sampling techniques. For low-flow purging techniques, please refer to the Low Flow Purging SOP. Monitoring wells must be developed after installation at least 1 week prior to groundwater sample collection. Monitoring wells will not be sampled until the well has been developed. During precipitation events, groundwater sampling will be discontinued until precipitation ceases or a cover has been erected over the sampling area and monitoring well.

Both filtered and unfiltered groundwater samples may be collected using this SOP. Filtered samples may be obtained using a 1.0-, 0.45-, or 0.1-micron disposable filter.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities should have a minimum of 2 years of previous groundwater sampling experience. Field employees with less than 6 months of experience should be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

III. Equipment List

The following materials shall be available, as required, during groundwater sampling:

- site plan of monitoring well locations and site Field Sampling Plan (FSP);
- appropriate health and safety equipment, as specified in the site Health and Safety Plan (HASP);
- photoionization detector (PID) or flame ionization detector (FID), as needed, in accordance with the HASP;
- monitoring well construction logs or tables and historical water level information, if available;
- dedicated plastic sheeting or other clean surface to prevent sample contact with the ground;
- if bailers are to be used in sampling:

    - appropriate dedicated bottom-loading, bottom-emptying bailers (i.e., polyvinyl chloride [PVC], Teflon, or stainless steel);
    - polypropylene rope;

- if submersible pumps are to be used in sampling:
    - dedicated tubing and other equipment necessary for purging;
    - generator or battery for operation of pumps, if required;
    - a pump selected in accordance with the FSP or Work Plan (parameter-specific [e.g., submersible, bladder, peristaltic]);
- graduated buckets to measure purge water;
- water-level or oil/water interface probe, in accordance with the FSP or Work Plan;
- conductivity/temperature/pH meter;
- down-hole dissolved oxygen meter, oxidation reduction potential meter, and/or turbidity meter, if specified in the FSP;
- water sample containers appropriate for the analytical method(s) with preservative, as needed (parameter-specific);
- filter, as needed, in accordance with the analytical method and parameter;
- appropriate blanks (trip blank supplied by the laboratory), as specified in the FSP;
- Ziploc-type freezer bags for use as ice containers;
- appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- appropriate groundwater sampling log (example attached);
- chain-of-custody forms;
- site map with well locations and groundwater contour maps;

- keys to wells and contingent bolt cutters for rusted locks and replacement keyed-alike locks; and

- drums or other containers for purge water, as specified by the site investigation derived waste (IDW) management plan.

IV. Cautions

If heavy precipitation occurs and no cover over the sampling area and monitoring well can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples.

Remember that field logs and some forms are considered to be legal documents. All field logs and forms should therefore be filled out in indelible ink.

It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives.

Check monitoring well logs for use of bentonite pellets. Make note of potential use of bentonite pellets on the groundwater sampling log. Coated bentonite pellets have been found to contaminate monitoring wells with elevated levels of acetone.

Store and/or stage empty and full sample containers and coolers out of direct sunlight.

To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to more impacted based on previous analytical data. If no analytical data are available, samples are to be collected in the following order:

1. First sample the upgradient well(s).

2. Next, sample the well located furthest downgradient of the interpreted or known source.

3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

Be careful not to over-tighten lids with Teflon liners or septa (e.g., 40 mL vials). Over-tightening can impair the integrity of the seal.

V. Health and Safety Considerations

If thunder or lighting is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lighting.

VI. Procedure

The procedures to sample monitoring wells will be as follows:

1. Don safety equipment, as required in the HASP. Depending on site-specific security and safety considerations, this often must be done prior to entering the work area.

2. Review equipment list (Section III above) to confirm that the appropriate equipment has been acquired.

3. Record site and monitoring well identification on the groundwater sampling log, along with date, arrival time, and weather conditions. Also identify the personnel present, equipment utilized, and other relevant data requested on the log.

4. Label all sample containers with indelible ink.

5. Place plastic sheeting adjacent to the well for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.

6. Remove lock from well and if rusted or broken, replace with a new brass keyed-alike lock.

7. Unlock and open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting.

8. Set the sampling device,meters, and other sampling equipment on the plastic sheeting. If a dedicated sampling device stored in the well is to be used, this may also be set temporarily on the plastic sheeting, for convenience. However, if a dedicated sampling device is stored below the water table, removing it may compromise water-level data, so water level measurements should be taken prior to removing the device.

9. Obtain a water-level depth and bottom-of-well depth using an electric well probe and record on the groundwater sampling log using indelible ink. Clean the probe(s) after each use in accord with the FSP or the equipment

decontamination SOP.

Note: Water levels may be measured at all wells prior to initiating any sampling activities, depending on FSP requirements.

10. Calculate the number of gallons of water in the well using the length of water column (in feet). Record the well volume on the groundwater sampling log using indelible ink.

11. Remove the required purge volume of water from the well (measure purge water volume in measuring buckets). The required purge volume will be three to five well volumes (the water column in the well screen and casing) unless the well runs dry, in which case, the water that comes into the well will be sampled (USEPA, 1996). In any case, the pumping rate will be decreased during sampling to limit the potential for volatilization of organics potentially present in the groundwater.

12. Field parameter measurements will be periodically collected in accord with FSP specifications. The typical time intervals of field parameter measurement are (1) after each well volume removed, and (2) before sampling. If the field parameters are being measured above-ground (rather than with a downhole probe), then the final pre-sampling parameter measurement should be collected at the reduced flow rate to be used during sampling. The physical appearance of the purged water should be noted on the groundwater sampling log. In addition, water level measurements should be collected and recorded to verify that the well purging is in accord with the guidelines set forth in the previous step.

13. Unless otherwise specified by the applicable regulatory agencies, all purge water will be contained. Contained purge water will be managed in accordance with the FSP or Work Plan. If historical concentrations in the well are less than federal or state regulated concentrations appropriate for current land use, *and permission has been granted by the oversight regulatory agency* to dispose of clean purge water on the ground next to the well(s), then purge water will be allowed to infiltrate into the ground surface downgradient from the monitoring well after the well is sampled.

14. After the appropriate purge volume of groundwater in the well has been removed, or if the well has been bailed dry and allowed to recover, obtain the groundwater sample needed for analysis with the dedicated bailer or from the dedicated sampling tubing, pour the groundwater directly from the sampling device into the appropriate container in the order of volatilization sensitivity of

the parameters sampled, and tightly screw on the cap (snug, but not too tight). The suggested order for sample parameter collection, based on volatilization sensitivity, is presented below:

a. volatile organic compounds (VOCs);

b. semi-volatile organic compounds (SVOCs);

c. polychlorinated biphenyls (PCBs)/pesticides;

d. metals; and

e. wet chemistry.

15. When sampling for volatiles, water samples will be collected directly from the bailer or dedicated tubing into 40 mL vials with Teflon-lined septa.

16. For other analytical samples, sample containers for each analyte type should be filled in the order specified by the FSP. If a bailer is used, then the sample for dissolved metals and/or filtered PCBs should either be placed directly from the bailer into a pressure filter apparatus or pumped directly from the bailer with a peristaltic pump, through an in-line filter, into the pre-preserved sample bottle. If dedicated sample tubing is used, then the filter should be installed in-line just prior to filtered sample collection.

17. If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Sample filtration for the filtered sample will be performed in the field utilizing a pump prior to preservation. Attach (clamp) a new 1.0-, 0.45-, or 0.1-micron filter to the discharge tubing of the pump (note the filter flow direction). Turn the pump on and allow 100 mL (or manufacturer recommended amount) of fluid through the filter before sample collection. Dispense the filtered liquid directly into the laboratory sample bottles. If bailers are used for purging and sampling, a proper volume of purge water will be placed in a disposable or decontaminated polyethylene container and pumped through the filter and into the sample container using a peristaltic pump.

18. Place the custody seal around the cap and the sampler container, if required. Note the time on the sample label. Secure with packing material and maintain at approximately 4°C on wet ice contained in double Ziploc-type freezer bags during storage in an insulated, durable transport container.

19. Replace the well cap and lock well, or install a new lock if needed.

20. Record the time sampling procedures were completed on the appropriate field logs (using indelible ink).

21. Complete the procedures for chain-of-custody, handling, packing, and shipping. Chain-of-custody forms should be filled out and checked against the labels on the sample containers progressively after each sample is collected.

22. Place all disposable sampling materials (such as plastic sheeting, disposable tubing or bailers, and health and safety equipment) in appropriate containers.

23. If new locks were installed, forward copies of the keys to the client Project Manager (PM) and ARCADIS PM at the end of the sampling activities.

VII. Waste Management

Purge water will be managed as specified in the FSP or Work Plan, and according to state and/or federal requirements. Personal protective equipment (PPE) and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for IDW management are set forth in a separate IDW management SOP.

VIII. Data Recording and Management

Initial field logs and chain-of-custody records will be transmitted to the ARCADIS PM at the end of each day unless otherwise directed by the PM. The groundwater team leader retains copies of the groundwater sampling logs. All field data should be recorded in indelible ink.

IX. Quality Assurance

Field-derived quality assurance blanks will be collected as specified in the FSP, depending on the project quality objectives. Typically, field rinse blanks will be collected when non-dedicated equipment is used during groundwater sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminates from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities.

X. References

USEPA. 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA. 1991. Handbook Groundwater, Volume ii Methodology, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July, 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston, Virginia.