White Plains Former MGP Site

Operable Unit 2 (OU-2)

WESTCHESTER COUNTY, NEW YORK

Final Engineering Report

NYSDEC Site Number: V00438-3

Prepared for:

Consolidated Edison Company of New York, Inc.
31-01 20th Avenue
Long Island City, New York 11105

Prepared by:

PARSONS
200 Cottontail Lane South
Somerset, New Jersey 08873
Phone: (732) 537-3500
Fax: (732) 868-3110

MAY 2011

CERTIFICATIONS

I, Daniel Martoccia (of Parsons Main of New York, Inc.), certify that I am currently a New York State registered professional engineer, I had primary direct responsibility for the implementation of the subject construction program, and I certify that the Remedial Design (RD) was implemented and that all construction activities were completed in substantial conformance with the Department-approved Remedial Design.

I certify that the data submitted to the Department with this Final Engineering Report demonstrates that the remediation requirements set forth in the Remedial Design and in all applicable statutes and regulations have been or will be achieved in accordance with the time frames, if any, established in the Remedial Design.

I certify that all use restrictions, Institutional Controls, Engineering Controls, and/or any operation and maintenance requirements applicable to the Site are contained in a Declaration of Covenants and Restrictions and that all affected local governments have been notified that such Declaration of Covenants and Restrictions has been recorded.

I certify that a Site Management Plan has been submitted for the continual and proper operation, maintenance, and monitoring of all Engineering Controls employed at the Site, including the proper maintenance of all remaining monitoring wells, and that such plan has been approved by the Department.

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law for the Site.

086936	9/2/11	
NYS Professional Engineer #	Date	Signature

STATE OF NEW YORK
DANIEL M. MARTOCCIA
086936
LICENSED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

Page

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

TABLE OF CONTENTS
(CONTINUED)

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

Acronym	Definition
ACM	Asbestos-Containing Materials
ADT	Aquifer Drilling and Testing
AQAPP	Analytical Quality Assurance Project Plan
ASTM	American Society for Testing and Materials
bgs	below ground surface
CAMP	Community Air Monitoring Plan
CD	computer disk
CEI	Creamer Environmental, Inc.
CHASP	Construction Health and Safety Plan
COC	chain of custody
CQAPP	Construction Quality Assurance Project Plan
CSAP	Construction Sampling and Analysis Plan
Con Edison	The Consolidated Edison Company of New York, Inc.
CWNY	Clean Waters of New York, Inc
CY	cubic yards
DGI	Diversified Geophysics Inc
Dinan	John V. Dinan Associates
ECs/ICs	Engineering and Institutional Controls
ESMI	Environmental Soil Management of New Jersey
FER	Final Engineering Report
Golder	Golder Associates, Inc.
gpm	gallons per minute
GPR	ground penetrating radar
HC	hydraulic conductivity
in/sec	inches per second
IRM	Interim Remedial Measure
ISS	*In situ* stabilization/solidification
LNAPL	Light non-aqueous phase liquids
MGP	Manufactured Gas Plant
Minerva	Minerva Enterprises, LLC
NAPL	Non-Aqueous Phase Liquids
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
Omega	Omega Environmental Services, Inc.
OSHA	Occupational Health and Safety Agency
OU	Operable Unit
PID	Photoionization detector
Pinnacle	Pinnacle Environmental Corporation

LIST OF ACRONYMS
(continued)

Portland	Portland cement
PSA	Preliminary Site Assessment
psi	pounds per square inch
QA/QC	Quality Assurance/Quality Control
RAAR	Remedial Alternatives Analysis Report
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RD	Remedial Design
RDR	Remedial Design Report
SCOs	Soil Cleanup Objectives
slag	Slag cement
SMP	Site Management Plan
SOPs	Site Operations Plans
SVOCs	Semivolatile Organic Compounds
SWPPP	Stormwater Pollution Prevention Plan
TBC	Terry Bergendorff Collins Land Surveying
TLV	Threshold Limit Value
TOGS	Technical and Operational Guidance Series
UCS	Unconfined Compressive Strength
ug/m^3	micrograms per cubic meter
US Bulk	U.S. Bulk Transport, Inc.
VCA	Voluntary Cleanup Agreement
VCP	Voluntary Cleanup Program
VOCs	Volatile Organic Compounds

FINAL ENGINEERING REPORT

1.0 BACKGROUND AND SITE DESCRIPTION

This Final Engineering Report ("**FER**") is required as an element of the remedial program for the White Plains Former MGP Site (hereinafter referred to as the "**Site**") under the New York State Voluntary Cleanup Program ("**VCP**") administered by the New York State Department of Environmental Conservation ("**NYSDEC**"). The Site was remediated in accordance with Voluntary Cleanup Agreement ("**VCA**") Index # D3-0002-00-10, Site # V00438-3, which was executed on September 23, 2002, and modified on August 23, 2005.

Consolidated Edison Company of New York, Inc. ("**Con Edison**") entered into the VCA with the NYSDEC to develop and implement a NYSDEC-approved remedial program for the former grounds of the manufactured gas plant ("**MGP"**) that Con Edison's predecessor companies operated in the City of White Plains, Westchester County, New York. The Site consists of an approximately 2-acre area comprised of the following real properties: (i) a Con Edison electric distribution substation located at 9 New Street in the City of White Plains and designated on the Tax Map of the City of White Plains as Section 125.66, Block 4, Lot 2.1; and (ii) an adjoining commercial office building with a tenant parking area located at 12 Water Street in the City of White Plains and designated on the Tax Map of the City of White Plains as Section 125.66, Block 4, Lot 1.1. The Site is bounded by Water Street to the north, New Street to the south, a parking lot located over the former roadbed of a de-mapped public thoroughfare formerly known as Spring Street to the east, and North Lexington Avenue to the west. Under the VCA, Con Edison is required to investigate and remediate MGP-contaminated media at the Site. The location and boundaries of the Site are provided in Figures 1.1 and 1.2, respectively. The Site was remediated to restricted commercial or industrial use and will be used for parking for the adjoining commercial office building.

In accordance with the VCA, NYSDEC-approved Remedial Action Work Plans ("**RAWPs**") (Parsons, 2007) were implemented for Operable Unit 1 ("**OU-1**") and Operable Unit 2 ("**OU-2**") of the Site. OU-1 consists of the southern section of the Con Edison electric distribution substation property and an off-Site area with MGP-related subsurface contamination, the Saint John the Evangelist Roman Catholic Church property located at 146-148 Hamilton Avenue in the City of White Plains. OU-2 consists of the northern section of the Con Edison's electric distribution substation property and the adjoining 12 Water Street property. The boundaries of the Site are depicted in Appendix A, Survey Map.

An electronic copy of this FER with all supporting documentation is included as Appendix N.

2.0 SUMMARY OF SITE REMEDY

2.1 REMEDIAL ACTION OBJECTIVES

Based on the results of the Remedial Investigation, the following Remedial Action Objectives ("**RAOs"**) were identified in the NYSDEC-approved Remedial Alternatives Analysis Report ("**RAAR**") (Parsons, August 2007), the NYSDEC-approved Remedial Action Work Plan ("**RAWP**") (Parsons, September 2007) and the NYSDEC-approved Remedial Design Report ("**RDR**") (Parsons, November 2007) for the OU-2 portion of this Site:

- Prevent the ingestion of/direct contact with impacted soil and groundwater;
- Prevent the inhalation of volatiles from impacted soil and groundwater; and
- To the extent feasible and consistent with safety and other concerns identified above, undertake the treatment and/or removal of MGP source materials.

2.2 DESCRIPTION OF SELECTED REMEDY

The Site was remediated in accordance with the remedy selected by the NYSDEC in the RAAR and as detailed in the RAWP and the RDR. The NYSDEC approved modifications to the required depth of the *in situ* stabilization/solidification ("**ISS**") due to difficulties encountered by the remedial action contractor in advancing the ISS augers to bedrock. However, no modifications to the RAWP and RDR were required by the NYSDEC as discussed in Section 4.10.1.

The factors considered during the selection of the remedy are those listed in 6NYCRR 375-1.8. The following are the components of the selected remedy:

1. ISS of MGP source materials;
2. Installation of a low-permeability cap or clean soil cover;
3. Institutional controls, and
4. Groundwater monitoring.

3.0 INTERIM REMEDIAL MEASURES (IRMs)

In anticipation of a project to modernize and upgrade the White Plains electric substation, Con Edison conducted a Preliminary Site Assessment ("PSA") between March 2000 and August 2001. The PSA identified subsurface conditions that might pose a risk to the health and safety of workers and the public during the project. In addition, Con Edison submitted the VCP application for the Site to the NYSDEC in July 2000. In the application, Con Edison proposed to coordinate the remediation of any MGP-impacted areas of the Site and adjacent lands with the planned substation project. Con Edison subsequently entered into the VCA for the Site in September 2002.

Phase I of the substation project included changes to electrical equipment and building structures. Phase II included changes to electrical equipment, the installation of new electrical feeder conduits, and the removal of electrical equipment from the OU-1 and OU-2 portions of the Site. The Phase II work allowed temporary access to the former southern relief gasholder and associated MGP-impacted materials in the OU-1 portion of the Site. Therefore, an Interim Remedial Measures (IRM) Work Plan for Phase II Construction Activities ("IRM Work Plan") (Parsons, October 2003) was prepared and subsequently approved by the NYSDEC in March 2004. The IRM Work Plan established the following objectives for the IRM:

- Prevent, to the extent practicable, the potential migration of NAPL in subsurface soils associated with the former southernmost relief gasholder; and
- Protect Site workers and the surrounding community from potential exposure to impacted materials during implementation of the IRM and Phase II construction activities.

The IRM for Phase II was conducted between July 2004 and January 2005 by Creamer Environmental, Inc. ("**CEI**"). To achieve the above objectives, the IRM for Phase II construction activities included the following components:

- Removal of the former southernmost relief gasholder structure, contents and materials visually impacted with NAPL encountered adjacent to and beneath the gasholder and above the groundwater table, to the extent practicable;
- Installation of a NAPL cut-off wall, seven NAPL recovery wells and four piezometers to the south of the former southernmost relief gasholder; and
- Implementation of a post-IRM monitoring and maintenance program.

The information and certifications made in the ***Interim Remedial Measures Report for Phase II Construction Activities*** (Parsons, August 2005) were relied upon to prepare this report and certify that the remediation requirements for the Site have been met.

4.0 DESCRIPTION OF REMEDIAL ACTIONS PERFORMED

Remedial activities completed at the Site were conducted in accordance with the NYSDEC-approved RAWP and RDR for the OU-2 portion of the Site. All deviations from the RDR and RAWP are noted below.

4.1 GOVERNING DOCUMENTS

4.1.1 Site Specific Construction Health & Safety Plans (CHASPs)

A Construction Health and Safety Plan ("**CHASP**") was prepared and submitted as part of the RDR. The CHASP established mandatory safety practices and procedures for Parsons, the remedial engineer, to perform perimeter air monitoring, ISS sampling and quality assurance activities. In addition, the remedial action contractor, WRScompass, prepared and submitted their own CHASP to establish mandatory safety practices and procedures for WRScompass and their subcontractors in performing the remedial action construction. An additional subcontractor HASP for asbestos removal and disposal from the former electric substation was included in the Asbestos Abatement Technical Approach (Section 4.1.4.6).

All observed remedial work performed under this Remedial Action was in full compliance with governmental requirements, including Site and worker safety requirements mandated by the Federal Occupational Safety and Health Agency ("OSHA"). The CHASPs were complied with for all observed remedial and invasive work performed at the Site.

4.1.2 Construction Quality Assurance Project Plan (CQAPP)

The Construction Quality Assurance Project Plan ("**CQAPP**") was included as Appendix H of the RDR approved by the NYSDEC. The CQAPP describes the specific policies, objectives, organization, functional activities and quality assurance/quality control activities designed to achieve the project data quality objectives. The CQAPP included appendices for a Construction Sampling and Analysis Plan ("**CSAP**") and an Analytical Quality Assurance Project Plan ("**AQAPP**").

The CQAPP managed performance of the remedial action tasks through designed and documented quality assurance/quality control ("**QA/QC**") methodologies applied in the field and in the lab. The CQAPP provided a detailed description of the observation and testing activities that were used to monitor construction quality and confirm that remedial construction was in conformance with the remediation objectives and specifications.

The CQAPP included:

- An organization chart, the project team members, their contact information, and their roles and responsibilities (as described in Section 4.2.1);
- Meeting requirements (pre-construction meeting, weekly progress meetings, public meeting (if required) and a construction wrap-up meeting);
- QA/QC testing requirements and responsibilities;
- Documentation requirements (field log books, daily field reports, monthly progress reports, field change forms, Final Engineering Report and record drawings as described in Section 4.2.7);
- Sampling requirements and frequencies (ISS testing, paint filter testing of soil prior to off-site disposal, off-site borrow source testing, construction water and soil testing prior to off-site disposal, and air monitoring); and
- Analytical laboratory requirements (data quality objectives; sampling procedures and holding times; sample tracking and custody procedures; analytical procedures; data validation, reduction and reporting; quality control checking; corrective action; and reporting);

In addition, the remedial action contractor, WRScompass, prepared and submitted their own Quality Control Plan as part of their Site Operations Plan/ISS Work Plan to conform to the contract requirements. The Quality Control Plan established sampling frequencies, procedures and equipment; documentation requirements; testing requirements; non-conformance procedures; and control of subcontractors.

4.1.3 Community Air Monitoring Plan (CAMP)

A ***Community Air Monitoring Plan*** ("**CAMP**") (Parsons, March 2008) was prepared in compliance with the New York State Department of Health's Generic Community Air Monitoring Plan. The CAMP required air monitoring for fugitive dust and volatile organic compounds ("**VOCs**") to protect the health and safety of both Site workers and the community during the remedial action at the Site. Results of the CAMP monitoring are presented in Section 4.2.5 and Appendix D.

4.1.4 Contractor's Statement of Methods

The remedial action contractor, WRScompass, prepared and submitted a comprehensice Statement of Methods that included the following eight plans:

- Site Operations Plan/ISS Work Plan;
- Traffic Control Plan;
- Erosion and Sedimentation Control Plan;
- Dust and Odor Control Plan;
- Construction Water Management Procedures;
- Asbestos Abatement Technical Approach;
- Instrumentation and Monitoring Plan; and
- Jet Grouting Plan

The remedial engineer reviewed all plans and submittals for this remedial project (i.e. those listed above plus contractor and subcontractor submittals) and confirmed that they were in compliance with the RAWP and RDR. All remedial documents were submitted to NYSDEC and NYSDOH in a timely manner and prior to the start of work.

Each plan is discussed in the following subsections.

4.1.4.1 Contractor's Site Operations Plan (SOP)/ISS Work Plan

The remedial action contractor prepared and submitted a ***Site Operations Plan/ISS Work Plan*** (WRScompass, 2009) which detailed the project staff, subcontractors, ISS equipment and procedures, quality control procedures, environmental controls and community protection measures, Site restoration, demobilization, and construction sequencing and schedule.

4.1.4.2 Traffic Control Plan

The remedial action contractor prepared and submitted a ***Traffic Control Plan*** (WRScompass, 2009) to:

- Ensure safe transportation operations to and from the Site;
- Minimize adverse impacts on the surrounding community, businesses and visitors to White Plains;
- Establish transportation routes for trucks transporting materials to and from the Site;
- Establish time periods for truck movements and receipt or shipment of materials;

- Provide trucking firms with guidance for truck movements;
- Limit/restrict truck movements to authorized access and egress routes within the City of White Plains; and
- Establish traffic control measures.

4.1.4.3 Erosion and Sedimentation Control Plan

The remedial action contractor prepared and submitted an ***Erosion and Sedimentation Control Plan*** (WRScompass, 2009) to control soil erosion to the maximum extent possible. The Erosion and Sedimentation Control Plan detailed control measures, sequence of operations, inspections, documentation, spill prevention, waste management and Site contact information. Note that because the Site and area of disturbance encompassed less than one acre, submission of a ***Storm Water Pollution Prevention Plan*** ("**SWPPP**") was not required.

The erosion and sediment controls for all remedial construction were performed in conformance with requirements presented in the New York State Guidelines for Urban Erosion and Sediment Control and the Site-specific Erosion and Sedimentation Control Plan.

4.1.4.4 Dust and Odor Control Plan

The remedial action contractor prepared and submitted a ***Dust and Odor Control Plan*** (WRScompass, 2009) to:

- Minimize dust and odor-related adverse impacts on the surrounding community;
- Identify control methods and practices to be used;
- Identify control products and reagents to be used;
- Establish corrective measures to be initiated in the event of dust or odors emanating from the Site, and
- Establish lines of communication in the event of dust or odor emissions from the Site.

The Dust and Odor Control Plan included: management protocols for odors, dust and VOCs; details for the use of physical barriers, sorbent wicks, odor suppressants, masking agents and foams; and requirements for documentation and communication.

4.1.4.5 Construction Water Management Procedures

The remedial action contractor prepared and submitted ***Construction Water Management Procedures*** (WRScompass, 2009) which established measures to handle, store, reuse, and dispose (if necessary) construction water generated during the remedial action.

4.1.4.6 Asbestos Abatement Technical Approach

The remedial action contractor prepared and submitted an ***Asbestos Abatement Technical Approach*** (WRScompass, 2008) which established the procedures for the removal, handling and disposal of asbestos-containing material ("**ACM**"), namely concrete-encased transite conduits, from the former electric substation. The Asbestos

Abatement Technical Approach included a work plan and HASP prepared by Pinnacle Environmental Corporation ("**Pinnacle**"), the asbestos removal subcontractor. The asbestos air monitoring was conducted by Omega Environmental Services, Inc. ("**Omega**") and retained by Con Edison.

4.1.4.7 Instrumentation and Monitoring Plan

The remedial action contractor prepared and submitted an ***Instrumentation and Monitoring Plan*** (WRScompass, 2009) to prevent damage to adjacent buildings, structures and utilities. The plan included: vibration monitoring, crack monitoring, and deflection surveying methods to be used; locations to be monitored; Threshold Limit Values ("**TLVs**") and precautionary values for each monitoring location; equipment to be used; and the names of the subcontractors who were performing the work. (Note that additional monitoring of the retaining wall located along the southern boundary of the Site using tiltmeters was added later in the project and was not included in the Instrumentation and Monitoring Plan.)

4.1.4.8 Jet Grouting Plan

The remedial action contractor prepared and submitted a ***Jet Grouting Work Plan*** (WRScompass, 2008) describing the jet grouting operations, equipment to be used, monitoring and documentation methods, and quality control methods.

4.1.5 Temporary Excavation Support Plan

The remedial action contractor's subconsultant, Golder Associates, Inc. ("Golder") prepared and submitted a *Temporary Excavation Support Plan* (Golder, 2009) to ensure that ISS and excavation activities at the Site did not adversely affect adjacent buildings, structures and utilities. The plan included a review of underlying subsurface conditions and ISS-treated masses, excavation support and stability design calculations, conclusions and recommendations.

4.1.6 Remediation-Related Permits

The following remediation-related permits were obtained for the project:

- Site-specific asbestos variance (File #08-0764, dated September 23, 2008 issued by the New York State Department of Labor);
- City of White Plains permits:
  - Building – parking lot reconstruction (permit #1370);
  - Cranes;
  - Curb cut permit;
  - Demolition - 9 New Street address/east side of Site (permit #3847);
  - Demolition -12 Water Street address/west side of Site (permit #4073);
  - Excavation - 9 New Street address/east side of Site (permit #0105);
  - Excavation -12 Water Street address/west side of Site (permit #0107);
  - Hydrant use (permit #840);
  - Municipal Separate Storm Sewer System (MS4 permit);
  - Permanent electrical (Site lighting);

- Silo erection (permit #0096);
  - Sidewalk closure/obstruction;
  - Temporary electric service;
  - UST removal/abandonment (permit #2009MECP02499);

- Waste hauling and disposal permits.

4.2 REMEDIAL PROGRAM ELEMENTS

4.2.1 Contractors and Consultants

- Con Edison is ultimately responsible for the remediation of the Site. Con Edison retained both the remedial engineer and the remedial action contractor to complete the work. In addition, Con Edison retained Omega to conduct asbestos air monitoring during the asbestos removal activities.
- The remedial action contractor was WRScompass of Hamilton, New Jersey. WRScompass was responsible for completing the work as defined by the RDR and RAWP. WRScompass employed several key subcontractors to complete the work:
  - Aquifer Drilling and Testing ("**ADT**") – installation of soil borings;
  - Diversified Geophysics Inc. ("**DGI**") – geophysical utility mark-out;
  - Central Industries – fencing;
  - John V. Dinan Associates ("**Dinan**") – instrumentation and monitoring (pre- and post-condition surveys, vibration, crack gauges and tiltmeters);
  - Golder Associates – preparation of Temporary Excavation Support Plan;
  - MoreTrench – jet grouting;
  - Pinnacle Environmental Corporation ("**Pinnacle**") - asbestos removal;
  - Siteworks – Site restoration; and
  - Terry Bergendorff Collins Land Surveying ("**TBC**") – surveying
- Parsons Main of New York, Inc. ("**Parsons**") was the remedial engineer for the project. Parsons was responsible for preparing the RAAR, RDR, RDWP and bid documents. In addition, Parsons was responsible for monitoring the performance of WRScompass and documenting that the work was conducted in accordance with the RDR, for performing the CAMP monitoring, for providing technical support to Con Edison and for preparing this FER. Parsons subcontracted directly with Converse Consultants to perform quality assurance testing of the ISS samples.
- The NYSDEC was the lead agency in ensuring that the remedial action was implemented at the Site. The NYSDEC was the main point of contact for public relations, participated in progress meetings, conducted Site inspections and approved submittals and design changes when required.

4.2.2 Site Preparation

The following items were completed in preparation for the remediation:

- Preconstruction Meeting: A pre-construction meeting was held with NYSDEC, Con Edison, Parsons and all contractors on October 10, 2008;
- Mobilization: Mobilization of contractor personnel to the Site began on October 9, 2008. No office trailers were required for the project because the 12 Water Street Building, which was leased by Con Edison to perform the substation upgrade and remediation, was used for offices;
- Site Preparation: Con Edison demolished the above-grade portion of the former electric substation and cut and removed all former substation cables in 2007 prior to remediation. Demolition of the below-grade portion of the former substation was conducted by the remedial action contractor, WRScompass;
- Topographic Survey: A pre-construction topographic survey was performed on October 9, 2008. Survey targets were installed on the 12 Water Street Building addition, the southern retaining wall and substation to monitor those locations for movement as described in Section 4.2.6.4;
- Utility Mark-out: A utility mark-out utilizing ground penetrating radar ("**GPR**") was conducted on October 13, 2008 to locate and mark utility lines in the work zone;
- Waste Characterization Borings: Twelve soil borings to a depth of 9 feet below ground surface ("**bgs**") were drilled on-site by ADT on October 13, 2008 to collect soil samples for waste characterization analysis (Appendix G);
- Pre-Condition Surveys: Pre-condition surveys were conducted on October 23-24, 2008 to record the pre-remedial conditions of the 12 Water Street Building, substation and retaining wall prior to remediation. A post-condition survey was also conducted following the remedial action (Appendix E);
- Decontamination Facilities: Separate decontamination/wash facilities were provided for Site personnel during asbestos removal and general remediation work. A truck wash facility/pad was not required because the trucks hauling waste off-site were loaded while parked on paved or remediated areas, and
- Stucco Removal: The existing stucco veneer on the southern retaining wall was found to be unfastened and was removed as a safety precaution..

4.2.3 General Site Controls

The following items were utilized to provide general Site controls during the implementation of the remedial action:

- Site Security: Con Edison installed a permanent chain link security fence at the southeast side of the Site prior to remediation to prevent access to the substation. WRScompass installed a temporary chain link fence with privacy screening along the northern and eastern boundaries of the Site to provide Site security. The remaining boundaries of the Site were secured by the 12 Water Street building on the west side of the Site and the retaining wall and fencing along the southern boundary. The fence along the Water Street (north) side of the Site included three vehicle gates which were opened as needed during work hours and kept closed and locked during non-working hours;

- Erosion and Sedimentation Controls: The existing trench drains and outfall pipes were plugged to prevent runoff from the Site. The Site was excavated to approximately two to four feet below original grade in sections to prevent surface runoff and to contain construction water within the work areas. Existing silt fencing along the east side of the ISS staging area was repaired as needed;
- Stockpile Methods: Excavated soil and demolition debris (concrete, reinforcing bars, etc) were stockpiled within the depressed work areas. Stockpiles containing ACM were covered with polyethylene sheeting. Stockpiles generating MGP odors were covered with Rusmar and Biosolve® odor-suppressant foams.
- Equipment Decontamination and Residual Waste Management: Trucks hauling waste off-site were loaded while parked in paved or remediated areas to minimize the amount of decontamination required. For example, transport trucks were parked on the adjacent existing asphalt at the west half of the Site while performing intrusive activities and loading in the east half of the Site. Conversely, transport trucks were parked on backfilled gravel in the east half of the Site while performing intrusive activities and loading in the west half of the Site. A high density polyethylene liner was placed in the truck loading area to catch any spillage during loading. Equipment that contacted contaminated soil was decontaminated in the work area with a high-pressure washer before working in non-contaminated areas or being removed from the Site. Generated fluids from the decontamination procedures were contained within the work area.
- Surveying: The following items were surveyed during the remedial action activities:
  - Ground elevations prior to construction;
  - Horizontal extent of excavator-based ISS cells (note: the locations were marked out based on previous field measurements and surveyed after all of the cells were completed.
  - Top elevation and location of auger-based ISS and jet grout columns;
  - Bottom elevations of auger-based ISS columns (by surveying the top of the Kelly bar);
  - Subgrade elevation after ISS/prior to backfilling;
  - Final elevation and Site improvement for the record drawings; and
  - Deflection surveying of structures adjacent to the Site (Section 4.2.6.4).

4.2.4 Nuisance Controls

The following items were utilized to provide nuisance controls during the remediation:

- Housekeeping: Garbage containers were provided for miscellaneous wastes generated during the project;

- Dust Control: The largest potential source of fugitive dust at the Site was the delivery and use of Portland and slag cements for ISS. The cement was delivered in bulk trailers which were offloaded pneumatically into storage silos. The top of each silo was equipped with a bag filter to minimize dust generation during filling. The cement materials were delivered from the silos to the mixing plant via screw auger pumps and visually did not generate fugitive dust. The ISS-treated soil was wet and did not visually generate fugitive dust;
- Odor Control: Exposed soil and soil stockpiles generating odors were covered with Rusmar and Biosolve® odor-suppressant foams and to minimize the generation of odors;
- Truck Routing: Trucks were required to follow a designated route to and from Interstate Route 287;
- Truck Wash: Trucks hauling waste from the Site did not need to be decontaminated or washed because they were staged and loaded in paved or remediated areas.

4.2.5 CAMP Results

Community air monitoring for fugitive dust and VOCs was conducted at the Site perimeter by Parsons during intrusive activities from November 21, 2008 to August 6, 2010. In addition, background measurements were performed on October 23 and 24, 2008 prior to the start of remedial action intrusive work. Both the dust and VOC monitoring were conducted continuously at locations upwind, downwind and nearest receptor of the work area (Figure 4.1). An additional monitoring location was added at Water Street for six days (May 11-18, 2010) during the drilling work within the Water Street sidewalk (Figure 4.1). Dust and VOCs were monitored with DataRAM 4 particulate monitors and MiniRAE 2000 photoionization detectors ("**PIDs**"), respectively.

Readings were collected for dust and VOCs at one-minute intervals to establish 15-minute averages upwind, downwind and nearest receptor to the work area (Table 4.1 and Appendix D). The upwind, downwind and nearest receptor 15-minute averages were then compared to determine if Site activities were causing an unacceptable increase in dust or VOC levels.

The primary action level for dust was a downwind increase of 100 micrograms per cubic meter ("**ug/m^3**") above background (upwind) for a 15-minute period or visible dust leaving the work area. An increase in the action level for dust to 150 ug/m^3 above background for a 15-minute period was allowed when dust suppression measures were employed as long as no visible dust was leaving the work area.

The data indicate that dust levels exceeded the 150 ug/m^3 action level during portions of 14 days due to cement handling activities (offloading, mixing and silo cleaning) and for portions of three days due to restoration activities. Adjustments to minimize fugitive dust were made to the cement handling activities including decreasing the pneumatic offloading pressure, replacing bag filters on the silos and placing a cover on the mixing hopper access port. Water was applied to the Site to minimize dust generation during restoration activities.

The primary action level for VOCs was a downwind increase of 5 ppm above background (upwind) for a 15-minute period. The data indicate that no exceedences of the primary action level for VOCs occurred due to on-site activities.

Copies of all field data sheets relating to the CAMP are provided in electronic format in Appendix D.

4.2.6 Instrumentation and Monitoring

In order to protect structures adjacent to the Site, namely the 12 Water Street Building, the retaining wall at the south side of the Site, the electric substation (transformer vaults and switchgear buildings) and a gas line just east of the Site, from damage during intrusive work activities, five instrumentation and monitoring methods were employed:

- Pre- and post-condition surveys;
- Crack monitoring;
- Deflection surveys;
- Tiltmeters; and
- Vibration Monitoring.

Each method is described in the following sections.

4.2.6.1 Pre- and Post-Construction Surveys

A visual pre-condition survey of the 12 Water Street Building, retaining wall and electric substation was performed by Dinan to document interior and exterior conditions prior to intrusive work activities. Dinan prepared a pre-condition survey report which included a summation of findings, photographic and video documentation, and recommendations for locations of crack gauges and vibration monitors (Appendix E).

Post-condition surveys were performed after intrusive work activities were completed to document conditions and changes from the pre-condition survey. Parsons performed a visual post-condition survey of the 12 Water Street Building and prepared a post-condition survey report which included a summation of findings, photographic documentation and a conclusion that no apparent structural impacts to the 12 Water Street building were caused by the remedial construction activities. Dinan performed a visual post-condition survey of the retaining wall and substation and prepared a post-condition survey report which included a summation of findings, photographic documentation and a conclusion that no apparent structural impacts to the retaining wall or substation were caused by the remedial construction activities. Copies of the post-condition survey reports are included in Appendix E.

4.2.6.2 Crack Monitoring

After the stucco veneer was removed from the retaining wall, ten full-height vertical cracks were discovered in the retaining wall concrete. Due to concerns that these cracks could potentially be exacerbated by the remedial action construction activities, crack gauges were installed at each crack to measure their movement. A total of ten crack gauges, one at the approximate vertical midpoint of each crack, were installed. The crack gauges were initially installed using epoxy which tended to detach over time, so replacement gauges were installed using screws. The crack gauges measured differential movement of the concrete on each side of the cracks in the vertical and longitudinal (east-west) directions.

The gauges were read once daily from November 19, 2008 to June 24, 2010 and compared against a movement limit of 1/16" (1.59 mm) from the initial baseline readings. The gauges showed that the width of the cracks changed with temperature and sometimes exceeded the 1/16" limit in both measured directions. However, when analyzed along with the other instrumentation and monitoring methods, the crack gauge measurements indicated no apparent adverse movement of the cracks due to the remedial construction activities. The crack monitoring data are included in Appendix E.

4.2.6.3 Tiltmeters

Tiltmeters were installed on either side of each crack in the retaining wall due to concerns that the cracks could potentially be exacerbated by the remedial construction activities. A total of 20 tiltmeters, one on each side of each crack, were installed. The tiltmeters measured the verticality, or perpendicular (north-south) movement, of the retaining wall on each side of the cracks. The tiltmeters were wired directly to a data logger located in the 12 Water Street Building which recorded the readings and two alarm lights, one each for the 10 westernmost and easternmost tiltmeters, which would light up if the horizontal movement limit was exceeded.

The tiltmeters provided automated readings every two minutes on a 24-hour basis from March 27, 2009 to November 28, 2009. The readings were compared against a horizontal movement limit of 1/8" at the top of the retaining wall (0.043 degrees based on a wall height of 13'-8") from the initial baseline readings. The tiltmeters showed that the verticality of the retaining wall changed with temperature and sometimes exceeded the 1/8" limit. However, when analyzed along with the other instrumentation and monitoring methods, the tiltmeter measurements indicated no apparent adverse movement of the retaining wall due to the remedial construction activities. The tiltmeter data are included in Appendix E.

4.2.6.4 Deflection Surveys

A total of 14 deflection targets (two on the 12 Water Street Building, four on the substation and eight on the retaining wall) were installed so that the exact location could be surveyed each time. The deflection surveys measured movement of the structures in the x, y and z directions. The deflection surveys were typically done once daily from November 20, 2008 to July 13, 2010 and compared against a movement limit of 1/8 inch (0.0104 feet) from the initial baseline survey readings. The deflection surveys showed that the structures moved with temperature and sometimes exceeded the 1/8 inch limit in all three measured directions. However, when analyzed along with the other instrumentation and monitoring methods, the deflection survey measurements indicated no apparent adverse movement of the structures due to the remedial construction activities. The deflection surveying data are included in Appendix E.

4.2.6.5 Vibration Monitoring

A total of seven vibration monitors (four on the retaining wall, one in the basement of the substation, one in the parking lot east of the Site and one in the 12 Water Street Building) were installed to measure potential vibrations caused by the remedial action construction activities. The vibration monitors were wired directly to a data logger located in the 12 Water Street Building which recorded the readings.

The vibration monitors were operated for a period of ten days prior to the start of remedial action construction to ensure that the instruments were working properly and to establish baseline levels prior to construction. Following the baseline period, the vibration monitors provided continuous automated readings from one hour prior to the start of work to a half hour after work ended each work day from December 1, 2008 to May 20, 2010. The readings were compared against a precaution value of 0.4 inches per second ("**in/sec**") for the substation and 1.5 in/sec for the other locations and a TLV of 0.5 in/sec for the substation and 2.0 in/sec for the other locations. A total of 13 exceedences of the TLV were recorded, of which seven could be explained as instrument maintenance, accidental disturbance of the instrument or an excavator striking the curb on which the instrument was mounted. The six exceedences which could not be explained were instantaneous readings and did not indicate the on-site construction activities were generating excessive vibrations. The vibration monitoring data are included in Appendix E.

4.2.7 Reporting

Information regarding the remedial action was documented and distributed using meetings, field log books, photographs, daily field reports, field changes and the project website:

- Record Drawings – Parsons recorded changes made to the design drawings during the remedial action and along with as-built surveys provided by the remedial action contractor, prepared record drawings. The record drawings and as-build surveys are included in Appendix B.
- Meetings: The following meetings were held during the remedial action:
  - Pre-Construction Meeting: A pre-construction meeting was held with NYSDEC, Con Edison, Parsons and the remedial action contractor on October 10, 2008
  - Weekly Progress Meetings: Weekly progress meetings were held on most Friday mornings to review progress of the work. Minutes were prepared and distributed after each meeting.
- Field Log Books: Parsons maintained daily field log books during the remedial action. Information recorded in the field log books was incorporated into the daily reports.
- Photographs: Parsons, Con Edison and WRScompass recorded remedial construction activities by taking daily photographs of the Site. Select photographs were incorporated into the daily reports and a photographic log was prepared for

this FER. The digital photo log required by the RDR is included in electronic format in Appendix C.

- Daily Field Reports: Parsons prepared daily field reports that summarized the construction activities performed each day. The daily field reports included details about the work completed, on-site manpower and equipment, subcontractors, Site visitors, weather, health and safety issues, verbal discussions and instructions, Site photographs, CAMP data, instrumentation and monitoring data, material and equipment delivered to the Site, waste disposal, tests and samples taken, test results and figures. The daily field reports were posted to the project website. All daily reports are included in electronic format in Appendix F.
- Field Changes: Changes to the approved RDR implemented during the remedial action were approved by NYSDEC, Con Edison and Parsons prior to implementation. The implemented field changes are described in Section 4.10.
- Project Website: Parsons posted much of the project information to a project website which representatives of Parsons, Con Edison, NYSDEC and WRScompass had access to. Information posted to the website included specifications, drawings, submittals, daily field reports, boring logs, jet grout logs, test results, instrumentation and monitoring results, meeting agendas and minutes, organization chart and CHASP.

4.3 CONTAMINATED MATERIALS REMOVAL

During the remedial activities, various types of contaminated and uncontaminated materials were generated and transported off-site for disposal. These materials consisted of ACM, coal tar contaminated material, construction water, waste oil, and non-impacted concrete and rebar.

Prior to the implementation of ISS operations, surface and subsurface structures within the treatment area were demolished and removed using standard excavators and excavators with hoe ram attachments. The structures included portions of foundations, slabs-on-grade, manholes, conduits and piping from the former MGP and substation. Some subsurface transite piping and conduits associated with the former electrical substation contained ACM and were removed as described in Section 4.3.1. Additionally, the asphalt paving and a fence separating the parking lot and the north substation yard were also demolished and transported off-site for disposal.

During the removal of some piping associated with the former substation, residual oils within the piping were encountered. The residual oils were containerized and transported off-site for disposal.

In order to contain the volumetric expansion (swell) that occurs during ISS, soils were removed from the Site prior to and during the ISS operations. Excavator-ISS operations were conducted on the eastern portion of the Site and auger-ISS operations were conducted on the western portion of the Site. The Site grade within the excavator-ISS area was lowered by 1 to 2 feet bgs during the demolition activities and was further lowered by 1 to 2 feet during the excavator-ISS activities in each ISS cell. The Site grade on the western portion of the Site was initially lowered by approximately 4 feet bgs in order to contain the swell created during the auger-ISS operations. Excavated Site soils and ISS swell material were temporarily stockpiled on-site, loaded into trucks and transported off-site for disposal. In areas throughout the Site where excavator-or auger-ISS operations could not reach bedrock as further explained in Section 4.4, jet grouting was conducted. The jet grouting spoils were temporarily staged on-site in large sumps located in the western portion of the Site. The sumps were constructed by excavating an area approximately 20 by 20 feet and several feet deep. Berms consisting of solidified ISS spoils were also constructed around the sumps for additional on-site storage capacity. The actual number and dimensions of the sumps varied and were frequently modified based on the amount of jet grouting spoils being produced and the location of the jet grouting operations. Jet grout spoils were mechanically pumped or conveyed via trenches from the jet grouting location to the sumps. The suspended solids within the jet grout spoils were allowed to settle to the bottom of the sumps and the liquid wastes were pumped from the sumps into on-site frac tanks and disposed as construction water as described in Section 4.3.3. The settled solids were allowed to cure within the on-site sumps for approximately 2 to 3 days (to improve the workability of the material) and were loaded into trucks and disposed off-site.

Table 4.2 below shows the total quantities of each category of material removed from the Site and the disposal locations. A summary of the samples collected to characterize the waste, and associated analytical results are summarized in Table 4.2.

TABLE 4.2, CONTAMINATED MATERIAL DISPOSAL QUANTITIES

Material	Quantity	Disposal Location
Asbestos-Containing Materials (ACM)	682.76 tons*	Minerva Enterprises, LLC
Coal-Tar Contaminated Materials	28,057 tons	Environmental Soil Management of New Jersey
Construction Water	447,894 gallons	Clean Waters of New York, Inc
PCB-Contaminated Materials/Waste Oil	613 gallons	Triumverate Environmental
Concrete (non-impacted)	1,400 tons	Evergreen Recycling
Rebar (non-impacted)	9.32 tons	Pascap Co., Inc

* = quantity does not include last three shipments (weight tickets not provided)

Letters from the Applicant (Con Edison) to the disposal facility owners, acceptance letters from disposal facility owners, waste hauler permit certificates, facility permits, tabulated load summaries, manifests and bills of lading are included in Appendix G.

4.3.1 **Asbestos-Containing Materials (ACM)**

Some subsurface transite piping and conduits associated with the former electrical substation located in the eastern portion of the Site contained ACM. The former piping and conduits were removed primarily from under the former concrete pad (Appendix G, Drawing C004). The ACM abatement and asbestos air monitoring were conducted by Pinnacle and Omega, respectively.

Prior to commencing the ACM abatement activities, a personnel decontamination area was erected near the entrance to the regulated work area. The regulated area was demarcated using caution tape and asbestos warning signs. An excavator was used to lift the transite piping from the subsurface and the pipe runs were mechanically broken into manageable sections. When possible, removed sections were double wrapped in plastic sheeting and staged on-site for off-site disposal. The larger sections were rinsed with water and loaded into transport trucks for off-site disposal. The transport trucks were lined with plastic sheeting prior to being loaded.

The ACM abatement activities commenced on November 2, 2008 with the establishment of decontamination structures and baseline readings for asbestos air monitoring. The ACM abatement work was generally conducted in a north to south direction and continued until December 29, 2008 when Pinnacle demobilized equipment and decontamination structures from the Site. Pinnacle returned to the Site between June 2 and 4, 2010 to demolish a small wall that contained ACM.

4.3.1.1 Disposal Details

The ACM was loaded into trucks and hauled by U.S. Bulk Transport, Inc. ("**U.S. Bulk**"), a Con Edison-approved transporter, from the Site and disposed at the Minerva Enterprises, LLC ("**Minerva**") facility located in Waynesburg, Ohio. Each truck was loaded on a temporary decontamination pad and the weight of the ACM placed into each truck was estimated. According to the waste manifests, a total of 682.76 tons of ACM was disposed at the Minerva facility between December 5 and 29, 2008 and on June 4, 2010 as determined by the disposal facility scale.

4.3.2 Coal Tar-Contaminated Materials

As previously mentioned, Site soils were removed when the Site grade was lowered during the demolition and ISS activities. In addition, Site soils were contained within the ISS swell material. Excavated Site soils and ISS swell material were temporarily stockpiled on-site, loaded into trucks and transported off-site for disposal.

4.3.2.1 Disposal Details

The excavated Site soils and ISS swell material were loaded into trucks and hauled by Con Edison-approved transporters from the Site and disposed at the Environmental Soil Management of New Jersey ("**ESMI of NJ**") facility located in Keasbey, New Jersey. Each truck was loaded on a temporary decontamination pad and the weight of the excavated material placed into each truck was estimated. According to the waste manifests, a total of 28,057 tons of coal tar-contaminated materials was disposed at the ESMI of NJ facility between February 2, 2009 and April 30, 2010 as determined by the disposal facility scale.

4.3.3 Construction Water

No Site dewatering was conducted during the ISS operations as groundwater and rain water was incorporated into the ISS operations. However, construction water was generated during the jet grouting operations as previously indicated. Jet grout operations were conducted from August 21, 2009 through April 8, 2010 and liquid wastes generated during the jet grouting operations were containerized on-site in a frac tank for off-site disposal.

4.3.3.1 Disposal Details

Generated liquid wastes were hauled by Con Edison-approved transporters from the Site and disposed at the Clean Waters of New York, Inc ("**CWNY**") facility located in Staten Island, New York. According to the waste manifests, a total of 447,894 gallons of liquid wastes were disposed at the CWNY facility between September 8, 2009 and June 23, 2010.

4.3.4 PCB-Contaminated Materials/Waste Oil

During the demolition of the subsurface transite piping and conduits associated with the former electrical substation located in the eastern portion of the Site, residual oils within the piping were encountered. The residuals oils were containerized and transported off-site for disposal.

4.3.4.1 Disposal Details

Containerized residual oil impacted water was hauled by Triumverate Environmental (a Con Edison-approved transporter) from the Site. According to the waste manifests, a total of 613 gallons of residual oil impacted water was disposed at the Triumverate Environmental facility in Astoria, New York on January 21, 2009.

4.3.5 Non-Impacted Concrete and Rebar

Concrete and rebar were generated during the demolition of the former MGP and substation structures between November 21, 2008 and January 4, 2009. Concrete and rebar were also generated during miscellaneous demolition that continued throughout the ISS operations as subsurface structures were encountered. In addition, remaining structures and Site features that interfered with the construction of the parking lot were also demolished and generated materials were transported off-site for disposal.

4.3.5.1 Disposal Details

Concrete and rebar that were generated during the demolition were hauled by Con Edison-approved transporters from the Site and disposed at various Con Edison-approved disposal facilities. According to the waste manifests, a total of 1,400 tons of concrete were disposed at the Evergreen Recycling facility located in Flushing, New York between December 29, 2009 and April 30, 2010. According to received bills of lading, approximately 9.32 tons of scrap metal (e.g., steel rebar) were disposed of at the Pascap Co., Inc. facility located in Bronx, New York on December 8, 2008.

4.4 *IN SITU* STABILIZATION/SOLIDIFICATION (ISS)

The ISS operations at the Site involved the mixing of grout with MGP-impacted soils. Excavator-based ISS was used in the eastern portion of the Site where the anticipated depth to bedrock was generally less than 20 feet. Auger-based ISS was used in the western portion of the Site where the anticipated depth to bedrock was greater than 20 feet. Jet grouting was conducted along the Site perimeter and throughout the Site interior where excavator-based or auger-based ISS operations could not reach bedrock as approved by the NYSDEC.

4.4.1 Grout Mix Design

Based on the results of the ISS Treatability Study included in the RDR, three grout mixes were specified that provided the most-effective combination of contaminant reduction, decrease in hydraulic conductivity ("**HC**") and increase in unconfined compressive strength ("**UCS**"). The grout mix selected by the remedial action contractor consisted of 25% Portland cement ("**Portland**") and 75% slag cement ("**slag**") at an addition rate of 15% reagent to soil (on a wet soil weight basis). This grout mix was used throughout the project with the exception of an alternate mix, 100% Portland cement at a rate of 20% reagent to soil (on a wet soil weight basis), used during jet grouting operations on November 7 and 9, 2009. This alternate grout mix was also specified in the RDR and was used on a trial basis to determine if the amount of metal fragments being magnetically removed by the jet grout mixing plant using the above grout mix could be reduced. The trial was not successful in reducing the volume of metal fragments, so use of the alternate mix was discontinued.

4.4.2 Grout Mixing Plant

A temporary grout mixing plant was erected in the ISS Staging Area at the southeastern corner of the Site as depicted on Drawing C002 (Appendix B). This area of the Site was initially leveled and timber matting was placed to support the batch plant. The grout mixing plant consisted of two storage silos (one each for Portland and slag), two mixing tubs equipped with high-speed, high-shear mixers, and ancillary equipment such as screw conveyors, pumps and hoses. The Portland and slag were delivered to the Site in tankers and pneumatically off-loaded into the silos.

Batches of grout were made by adding approximately 600 gallons of potable water from an on-site water line to a mixing tub, then adding slag until density of 100 lbs/ft^3 was reached. Portland was then added to the water and slag mixture until a target density of 108.6 lbs/ft^3 was reached. The grout density was measured with a mud balance scale. After some initial problems with control of the reagent volumes added, a scale was installed under one mixing tub to directly weigh individual reagents. Once weighed, each reagent was transferred to the second mixing tub where it was mixed with potable water. This procedure was used during both the excavator-ISS and auger-ISS.

The jet grouting operations used the same storage silos; however, a separate grout mixing plant consisting of a Tecniwell TWM 30 grout mixer and a Tecniwell TW 600 high pressure triplex pump was erected. The grout was mixed in the mixing plant which accurately measured the amount of water and reagents added to each batch, thus bypassing the original mixing tubs and scale. Due to the nature of jet grouting, the percentage of reagent added to each jet grout column was well above the required 15% as explained in Section 4.4.6.

4.4.3 Excavator-ISS

The excavator-ISS operations consisted of using an excavator to mix the grout into the underlying soil to bedrock. The ISS cells were initially approximately 20 feet by 20 feet in area, but varied as the excavator-ISS operations progressed. First, one to two feet of Site soil was removed from the cell area to create a depression to hold the grout. Grout was then pumped from the mixing plant into the depression and the excavator mixed the grout into the underlying soil. The soil and grout were mixed until the material appeared to be adequately homogenized.

In order to determine the amount of grout to be added to an ISS cell, the ISS cell volume was initially calculated by multiplying the cell area by the estimated depth to bedrock from the historic borings. During mixing, the actual depth to bedrock was measured using depth markings on the bucket arm of the excavator and the initial cell volume and required grout volume were adjusted as needed.

4.4.3.1 Excavator-ISS Field Test

The field test for the excavator-ISS was conducted by the remedial action contractor from January 22 to 30, 2009 and consisted of ISS cells TP1 through TP5 as depicted on Figure 4.2 and Table 4.3. An equipment malfunction within the grout mixing plant and metering problems caused less than 15% reagent to be added to ISS cells TP1, TP2 and TP3. ISS cells TP2 and TP1 were subsequently re-mixed with additional grout on February 19 and 20, 2009, respectively. TP3 was not remixed because the reagent percentage was greater than 14% as approved by the NYSDEC as described in Section 4.10.2.

As described in Section 4.5.3.1, samples were collected from the top, middle and bottom of ISS test cells TP1 through TP4 and from the bottom of TP5 using the excavator bucket. With the exception of TP5, the samples were tested for UCS and HC at 3, 7, 14 and 28 days. As approved by the NYSDEC, the testing frequency for TP5 was reduced to 3, 7 and 28 days for UCS and 14 and 28 days for HC. The testing results for the samples collected from the ISS test cells passed the established performance criteria for UCS and HC.

Following the initial mixing of TP1, TP2 and TP3, cores CL-1, CL-2 and CL-3 were collected continuously through these ISS cells, respectively, on January 30, 2009 and February 3, 2009. As detailed in the coring logs (Appendix H), ISS material was observed throughout the ISS cells to the encountered refusal depths. The boreholes were grouted to the ground surface upon completion. Cores were not collected from TP4 and TP5.

4.4.3.2 Excavator-ISS Implementation

Full production excavator-ISS operations began on February 2, 2009 with the mixing of ISS cell P7 as depicted on Figure 4.2 and Table 4.3. Excavator-ISS operations continued with the mixing of P8 through P15, followed by the mixing of EM11, EM2,

EM3, P5, EM4, P4, P3, P16, EM5, EM7, P2, P11, and concluding with EM9 through EM13. ISS cell P11 was remixed on February 23, 2009 due to metering problems which resulted in less than 13% reagent. As described in Section 4.10.2, less than 15% reagent was also added to ISS cells P9, P12 and P6 due to improper metering. However, these ISS cells were not remixed since the reagent percentage was greater than 14% as approved by the NYSDEC.

When performing excavator-ISS operations along the perimeter of the Site, grout density measurements were collected from the perimeter ISS cells using a mud balance scale to verify that the ISS material had enough unit weight for a stabilized perimeter.

As described in Section 4.5.3.2, samples were collected from the completed ISS cells and tested for UCS and HC.

The swell material generated during the volumetric expansion that occurred during the excavator-ISS operations were temporarily stockpiled on-site and transported off-site for disposal. The volume of displaced Site soils requiring off-site disposal due to excavator-ISS operations is estimated to be 27% based on the waste disposal records.

Following the completion of full production excavator-ISS operations, a topographic survey revealed that the top elevations of the ISS cells were within the frost zone (42 inches below final grade) for the Site. Due to potential adverse impacts on the ISS resulting from freeze-thaw cycles, the top elevations of the ISS cells were removed to elevations below the frost zone using an excavator bucket.

4.4.3.3 Excavator-ISS Boring Program

An analysis of the depths of the completed ISS cells versus the anticipated bedrock depths from the historic Site borings indicated that the excavator-ISS operation may not have reached the anticipated bedrock depths. Therefore, a boring program was implemented to assess the depth of the ISS cells relative to the bedrock elevations between April 22 to May 21, 2009, with the installation of 24 borings (Figure 4.2 and Appendix H). The boring program revealed the presence of untreated soils between the bottom of the ISS cells and bedrock in fourteen ISS cells (P2, P4, P5, P8 through P14, P17, EM2, EM13, and TP4). The untreated soils ranged in thickness from 6 inches in TP5 to approximately 15 feet in P9. In order to contain the untreated soils, a jet grout curtain wall was installed around the northern, eastern and southern perimeter of the excavator-ISS area as described in Sections 4.4.6 and 4.10.1. The boreholes were grouted to the ground surface upon completion.

4.4.4 Auger-ISS

The auger-ISS operations consisted of using a 4000-series Manitowoc 4000 crane equipped with an attached Hain 450K S-2 drilling platform, Kelly bar and varying diameter augers to mix the grout into the underlying soil to bedrock. The grout was pumped to the top of the crane boom and through the Kelly bar to nozzles located on the auger. The advancement of the auger was driven by the weight of the Kelly bar and the drilling action of the auger which rotated at approximately nine revolutions per minute. Grout was constantly pumped into each ISS column being mixed and the mixing duration was recorded. The auger was withdrawn by the crane to the top of the ISS column and subsequently advanced again. The number of full passes (defined as either up or down) for each ISS column ranged from four to six passes or until the material appeared to be adequately homogenized. The auger-ISS operations were performed by mixing in both sequential and intermittent columns.

The location and ground elevation of each column was surveyed prior to drilling. As the auger was positioned at ground level at each location, a point near the top of the Kelly bar was also surveyed. In order to determine the amount of grout to be added to an ISS column, the ISS column volume was initially calculated by multiplying the column area by the estimated depth to bedrock from the historic borings. During mixing, the actual column depth and elevation were determined by surveying the point on the Kelly bar when positioned at the deepest point during drilling. The initial column depth and required grout volume were adjusted as needed.

4.4.4.1 Auger-ISS Field Test

The field test for the auger-ISS was conducted by the remedial action contractor on March 30 and 31, 2009 and consisted of columns M10, N14 and N15 as depicted on Figure 4.3 and Table 4.4. A 9-foot diameter auger was used for the auger-ISS field test.

As described in Section 4.5.3.1, samples were collected from the top, middle and bottom of the ISS test columns M10, N14 and N15 using an *in situ* wet sampler. The samples were tested for UCS at 3, 7, 14 and 28 days and HC at 14 days as approved by the NYSDEC. The testing results for the samples collected during the ISS test columns passed the established performance criteria for UCS and HC.

Following the mixing of test columns M10, N14 and N15, cores CL-1 through CL-6 were collected continuously through the test columns from April 7 to 14, 2009. As detailed in the coring logs (Appendix H), ISS material was observed through the test columns, but the bottom elevations of the columns were above the anticipated bedrock elevations (Table 4.4). The boreholes were grouted to the ground surface upon completion.

4.4.4.2 Auger-ISS Implementation

Even though the field test revealed that the auger-ISS columns were not advanced to bedrock, full production auger-ISS operations commenced on April 2, 2009 with the installation of three additional columns on April 2 and 3, 2009 using the 9-foot diameter auger. As depicted on Figure 4.3 and Table 4.4, different diameter augers were used throughout the auger-ISS operations in an attempt to reach bedrock. An eight-foot diameter auger was used from April 7 through 10, 2009 to install 11 columns in the western central portion of the auger-ISS area. Since the eight-foot diameter ISS columns did not reach bedrock, smaller diameter augers were then used in an attempt to reach bedrock. A seven-foot diameter auger was used from April 16 to 30, 2009 and to install 33 columns in the eastern central and southeastern portions of the auger-ISS area. A six-foot diameter auger was used on May 12, 2009 to install 3 columns in the southern portion of the auger-ISS area. A four-foot diameter auger was used on May 29 and 30, 2009 to install 5 columns near the four boundaries of the auger-ISS area. Since the ISS columns did not reach bedrock using the reduced diameter augers (i.e., seven-, six- and four-foot diameter augers), an eight-foot diameter auger with a more aggressive cutting teeth configuration was used from June 1 to July 28, 2009 to install 124 columns in the central and northeastern portions of the auger-ISS area. Lastly, the four-foot diameter auger was used from July 29 to August 4, 2009 to install 24 columns in areas with space constraints created by previously installed columns. A total of 206 columns of varying diameter were installed.

As detailed on Table 4.4, the nine-, eight-, seven-, six-, four- and aggressive eight-foot diameter auger were advanced on average to within 6.4, 5.6, 6.3, 6.3, 6.5 and 11.1 feet, respectively, of the anticipated bedrock depths. It appears that the ISS columns were not able to advance though dense soil formations or through soil formations that contained gravel using the equipment mobilized to the Site.

As described in Section 4.5.3.2, samples were collected from the completed ISS cells and tested for UCS and HC.

The swell material generated during the volumetric expansion that occurred during the auger-ISS operations were temporarily stockpiled on-site and transported off-site for disposal. The volume of displaced Site soils requiring off-site disposal due to auger-ISS operations is estimated to be 27% based on the waste disposal records.

4.4.5 Rotosonic Borings

The inability of the excavator-ISS and auger-ISS operations to reach the underlying bedrock was discussed with the NYSDEC. The remedial action contractor speculated that subsurface geologic conditions not previously identified contributed to the auger advancement not reaching bedrock. In an effort to gather additional data on the Site's subsurface geologic conditions, 15 rotosonic borings (RSB-1 through RSB-15) were advanced between May 15 and 22, 2009 (Figure 4.3 and Appendix H). The rotosonic borings were advanced to the apparent bedrock and samples were continuously collected in five foot lengths. The boreholes were backfilled to the ground surface with bentonite chips upon completion.

An evaluation of the data collected during the rotosonic drilling program indicated a general consistency with the previous soil borings drilled at the Site.

4.4.6 Jet Grouting

Jet grouting techniques were used to construct a double row of jet grout columns around the perimeter of the entire ISS area, to advance ISS to bedrock in the interior areas of the Site that contained MGP source material (i.e., NAPL) not treated via auger-ISS, and to treat interstitial spaces where the auger-ISS columns did not overlap. Prior to beginning full production jet grouting, the proposed layout of the jet grout columns was provided to the NYSDEC for review. The layout was adjusted during jet grouting operations based on Site conditions and additional borings and explained in the following sections.

Jet grouting operations were performed by Moretrench (the jet grouting subcontractor). A Casagrande M9 jet grouting unit was used to construct the test columns while a Comacchio MC1200 jet grouting unit was used for the production jet grouting. Both units were connected to the Tecniwell TW 600 high pressure triplex grout pump capable of volumes up to 145 gallons per minute ("**gpm**") and pressures up to 400 bar (5,800 pounds per square inch ("**psi**")). The grouting units contained a digital readout screen which constantly displayed drill stem depth, penetration rate and grouting pressure. The jet grout columns were constructed using the double fluid (grout and air) method. This method injects compressed air with the grout to reduce friction loss, allowing the grout to travel farther from the injection port, thereby producing greater column diameters.

The location and ground elevation of each column were surveyed prior to jet grouting. The drill stem was then advanced using rotary drill methods to approximately 18 inches into bedrock to create a rock socket. Grout was then injected continuously with the high pressure pump as the drill stem was rotated and withdrawn from the drill hole. (Note that the grout nozzle was located 18 inches above the drill bit, so the nozzle was located at the top of bedrock when beginning jet grouting.) Grout injection continued until the nozzle was three feet below the ground surface or three feet within an excavator-ISS cell or auger-ISS column. The continuous high-pressure grout injection resulted in a grout addition well above the required 15% and a high volume of displaced Site soils requiring off-site disposal (estimated to be 187% based on the waste disposal records). The actual column depth was determined by recording the drill stem depth when positioned at the deepest point during drilling.

4.4.6.1 Jet Grouting Field Test

The field test for jet grouting was conducted from June 26, 2009 to July 1, 2009 and consisted of jet grout test columns JGT-1 through JGT-6 as depicted on Figure 4.4 and Table 4.5. JGT-1, JGT-2 and JGT-3 were installed near the center of the Site ("northern jet grout test location") and JGT-4, JGT-5 and JGT-6 were installed in the southwestern corner of the Site ("southern jet grout test location"). The two jet grout test sections were conducted to account for the varying depth of bedrock throughout the Site.

The jet grouting contractor selected the grouting parameters to be used in the field test based on past experiences in similar Site conditions. The jet grouting field test used a nozzle diameter of 5 millimeters (twin nozzles), a rotation of 11 revolutions per minute, a lift rate of 30 centimeters per minute (12 inches per minute) and a pressure of 400 bar (5,800 psi). The jet grouting contractor estimated the effective diameter of the jet grout columns would be 4.9 feet based on these parameters.

As described in Section 4.5.3.1, samples were collected from jet grout test columns, JGT-1 through JGT-6 using an *in situ* wet sampler. Samples were collected from the top, middle and bottom of jet grout test columns JGT2, JGT-3, JGT-5 and JGT-6. Only one sample was collected from jet grout test columns JGT-1 and JGT-4 as approved by the NYSDEC. Four pairs of samples were tested for UCS at 3, 7, 14 and 28 days and two samples were tested for HC testing at 14 and 28 days (one sample for each test). The testing results for the samples collected during the ISS test sections passed the established performance criteria for UCS and HC.

<u>Northern Jet Grout Test Location:</u>

Following the installation of jet grout test columns JGT-1 through JGT-3, eight cores (JG1, JG2, JG2R, JG3, JG1-2-3, JG3R, JG2-3, and JG1-3) were collected continuously through the jet grout columns at the northern jet grout test location from July 15 to 21, 2009 (Appendix B, Drawing C006 and Appendix H):

- JG1, JG2, and JG3 from the center of test columns JGT-1, JGT-2 and JGT-3, respectively;
- JG2R from test column JGT-2 approximately one foot from its center due to mechanical problems and poor sample recovery experienced during the coring of JG2;
- JG1-2-3 at the intersection of test columns JGT-1, JGT-2 and JGT-3 at a radial distance of 2.45 feet from their centers which is equivalent to an effective column diameter of 4.9 feet;
- JG2-3 at the intersection of test columns JGT2 and JGT3 at a radial distance of 2.45 feet from their centers which is equivalent to an effective column diameter of 4.9 feet;
- JG3R at a radial distance of 2.45 feet from the center of test column JGT3 which is equivalent to an effective column diameter of 4.9 feet; and
- JG1-3R at the intersection of test columns JGT1 and JGT3 at a radial distance of 2.75 feet from the column centers which is equivalent to an effective diameter of 5.5 feet.

The purpose of the cores was to confirm that complete mixing of the columns was achieved and to evaluate whether the jet grout test columns had an effective diameter equal to or greater than 4.9 feet. As detailed in the coring logs (Appendix H), jet grout material was observed to be continuous through the jet grout columns. However, less than 85% sample recovery was observed at the following locations and depths:

- JG1 - 83% sample recovery from 27.5 to 31.3 feet bgs;
- JG2 - 58% sample recovery from 6 to 11 feet bgs
  - 35% sample recovery from 11 to 16 feet bgs
  - 50% sample recovery from 26 to 31 feet bgs
- JG2R - 67% sample recovery from 25.5 to 31 feet bgs;
- JG3 - 10% sample recovery from 27.5 to 30 feet bgs;
- JG1-2-3 - 23% sample recovery from 5 to 10 feet bgs;
- JG3R - 52% sample recovery from 18 to 21 feet bgs;
  - 30% sample recovery from 25 to 30 feet bgs; and
- JG2-3 - 40% sample recovery from 25 to 28.5 feet bgs,
  - 39% sample recovery from 28.5 to 30 feet bgs.

The less than 85% sample recovery in the above intervals was attributed to either mechanical problems (e.g. core barrel getting plugged) experienced at some intervals and/or to the granular nature of the material being sampled (e.g., at the transition depths to bedrock). There is a possibility that the less than 85% sample recovery at some intervals was due to a localized shadowing effect caused by subsurface features that were not displaced by the jet grouting operations, but there is no way to be certain. Localized shadowing effects caused by non-displaced subsurface features were estimated to be isolated by adjacent ISS columns.

<u>Southern Jet Grout Test Location:</u>

Following the mixing of jet grout test columns JGT-4 through JGT-6, seven cores (JG4, JG5, JG6, JG4-5-6, JG4-5, JG5-6 and JG4-6) were collected continuously through the jet grout columns at the southern jet grout test location from July 8 to August 11, 2009 (Appendix B, Drawing C006 and Appendix H):

- JG4, JG5, and JG6 from the center of test columns JGT-4, JGT-5 and JGT-6, respectively;
- JG4-5-6 at the intersection of test columns JGT-4, JGT-5 and JGT-6 at a radial distance of 2.45 feet from their centers which is equivalent to an effective column diameter of 4.9 feet;
- JG4-6 at the intersection of test columns JGT-4 and JGT-6 at a radial distance of 2.75 feet from the column centers which is equivalent to an effective diameter of 5.5 feet.
- JG4-5 at the intersection of test columns JGT-4 and JGT-5 at radial distances of 2.45 feet from the jet grout column centers which is equivalent to an effective column diameter of 4.9 feet. This core was collected due to poor sample recovery experienced during the coring of JG4-6; and
- JG5-6 at the intersection of test columns JGT-5 and JGT-6 at radial distances of 2.45 feet from the column centers which is equivalent to an effective column diameter of 4.9 feet. This core was collected due to poor sample recovery experienced during the coring of JG4-6.

The purpose of the cores was to confirm that complete mixing of the columns was achieved and to evaluate whether the jet grout test columns had an effective diameter equal to or greater than 4.9 feet. As detailed in the coring logs (Appendix H), jet grout material was observed to be continuous through the jet grout columns. However, less than 85% sample recovery was observed at the following locations and depths:

- JG4 - 20% sample recovery from 50 to 55 feet bgs;
  - 50% sample recovery from 55 to 59 feet bgs;
- JG5 - 39% sample recovery from 5 to 8 feet bgs;
  - 25% sample recovery from 32.5 to 34.5 feet bgs;
- JG4-5-6 - 62% sample recovery from 49 to 53 feet bgs;
- JG4-6 - no recovery from 17 to 44 feet bgs;
- JG4-5 - no samples that were collected, and
- JG5-6 - no recovery from 25 to 57 feet bgs.

The less than 85% sample recovery in the above intervals was attributed to either mechanical problems (e.g., core barrel getting plugged) experienced at some intervals and/or to the granular nature of the material being sampled (e.g., at the transition depths to bedrock). The lack recovery in cores JG4-6, JG4-5 and JG-5-6 was attributed to verticality issues associated with the coring that caused the core to “walk out” of alignment with the jet grout columns.

In an effort to close out this “data gap”, an additional core (WI23-24) was collected from the double intersection location of jet grout columns WI23 and WI24 on September 30, 2009 (Figure 4.4). This location was selected because these two jet grout columns were located in close proximity to JGT-4 to JGT-6 and because the more conservative production jet grouting lift rate was used as described in Section 4.4.6.2. As detailed in the coring log (Appendix H), jet grout material was observed throughout the jet grout column. However, less than 85% sample recovery was observed at the following locations and depths:

- WI23-24 - 37% sample recovery from 5.5 to 8.5 feet bgs;
  - 38% sample recovery from 53.5 to 58.5 feet bgs; and
  - 80% sample recovery from 58.5 to 63.5 feet bgs.

The less than 85% sample recovery in the above intervals was attributed to the granular nature of the material being sampled (e.g., at the transition depths to bedrock). There is a possibility that the less than 85% sample recovery at some intervals was due to a localized shadowing effect caused by subsurface features that were not displaced by the jet grouting operations, but there is no way to be certain. Localized shadowing effects caused by non-displaced subsurface features were estimated to be confined by adjacent ISS columns.

The results of the field test coring program indicated that the minimum effective diameter of the jet grout columns was approximately 4.9 feet. The boreholes were grouted to the ground surface upon completion.

4.4.6.2 Jet Grouting Implementation

Full production jet grouting operations were conducted at the Site between August 21, 2009 and April 8, 2010 (Figure 4.4 and Table 4.5). Jet grouting operations began in the western area of the Site and continued along the southwest and southern areas of the ISS area. Remnant subsurface structures in close proximity to the retaining wall at the south side of the Site were cored through to facilitate the jet grouting operations in this area. The remnant structures were not removed during the prior demolition activities due to concerns that demolition could potentially damage the adjacent retaining wall. The jet grouting operations then proceeded in a general south to north direction. Upon completion of jet grouting at the west side of the Site, the jet grouting operations were moved to the eastern side of the Site to install a double row of jet grout columns around the perimeter of the excavator-ISS area.

As previously indicated, a lift rate of 12 inches per minute was used during the jet grouting field test. However, a more conservative lift rate was used during the production jet grouting operations to ensure that a column diameter of 4.9 feet was achieved in the denser soils: six inches per minute in the bottom 4 feet of each jet grout column, eight inches per minute in the middle portions of each jet grout column, and 12 inches per minute in the upper 25 feet of each jet grout column. As the drill stem was withdrawn from depth, it was rotated at eleven revolutions per minute as grout was jetted from the nozzles at a flow of approximately 98 gallons per minute and a pressure of 400 bar (5,800 psi).

Each jet grout column was advanced to depth utilizing rotary drilling methods. The anticipated bedrock depths were estimated based on previous soil boring information. Since the jet grouting operations involved drilling through previously mixed ISS columns, subsurface soils and bedrock, the following Site-specific advancement rates were established and used as a guide during the jet grouting operations in confirming the anticipated bedrock depths.

Subsurface Material	**Drill Advancement Rate (inches/min)**
Untreated Soils/Sands	96 - 144
Harder Soils/Sands	40 - 96
Cementitious Material	12 - 35
Dense Soils/Sands	6 - 12
Bedrock	2 - 4

Each jet grout column was advanced to the anticipated bedrock depth as confirmed by the drilling action of the jet grout rig and drill advancement rate. In cases where the drilling action indicated that bedrock was at an elevation higher than anticipated, the drill was advanced to the anticipated bedrock elevation. Once the drill bit reached bedrock, it was advanced approximately 18 inches into bedrock to create a rock socket prior to grouting.

Jet grout columns SI9, WI-19R, and WO-17R were not constructed because the drill advancement rates indicated those locations already contained continuous columns of cementitious material.

4.4.6.3 Additional Delineation Borings

In order to further delineate areas of the Site that contained MGP source material (i.e., NAPL) not treated via auger-ISS, additional borings were installed by ADT using a mud rotary track-mounted drill rig. Fifteen borings (DB-1 through DB-15) (Figure 4.3 and Appendix H) were installed throughout the auger-ISS area between July 23 and September 16, 2009. With the exception of DB-8, the additional borings were installed through previously installed ISS columns and split spoon samples were collected from the underlying soil for visual observation and PID readings. The borings were cored approximately 5 feet into bedrock. The borings were grouted to the ground surface upon completion.

4.4.6.4 "Hot Spot" Area Analysis

An analysis of the data collected from the historic soil borings, the rotosonic borings and the additional delineation borings was conducted to determine the locations and depth intervals where NAPL was observed. This information was compared to the bottom elevations of the auger-ISS columns to determine if that depth interval was treated by ISS. In areas where the soil boring data indicated a NAPL-containing depth interval below the bottom elevations of the ISS columns, those ISS columns were designated as "hot spot" ISS columns and needed to be extended to bedrock using jet grouting techniques. Figures 4.3 and 4.4 depict the hot spot areas of the Site that were extended to bedrock using jet grouting techniques.

4.4.6.5 Interstitial Jet Grout Areas

Because not all of the auger-ISS columns were installed in locations that overlapped previously installed columns, untreated "interstitial areas" were created between the auger-ISS columns. Jet grouting was used to treat these interstitial areas. As approved by the NYSDEC, interstitial areas less than 3 square feet in size were considered to be infeasible to jet grout due to potential adverse effects on the jet grouting equipment (i.e., rebounding effects, excessive wear).

The depths of the jet grout columns within the interstitial areas varied depending on the proximity of the adjacent hot spot ISS columns. In interstitial areas that abutted a hot spot ISS column, the jet grout columns were advanced to bedrock. In interstitial areas that did not abut a hot spot ISS column, the jet grout columns were advanced to the elevation of the deepest adjacent auger-ISS column.

4.4.6.6 Eclipsing Effect of ISS Auger Columns

An evaluation of the proposed jet grout column layout plan revealed that previously installed auger-ISS columns were causing an "eclipsing" effect to some jet grout columns in that the radius of influence was contained within the ISS columns. In order to compensate for this eclipsing effect, jet grout columns WO19A, WO18B, WO18A, WI14B, WI14A, WI10A, WO10A, WO9A, and SO18A were added to the jet grout column layout plan (Figure 4.4).

4.4.6.7 Jet Grout Panel Wall

During jet grouting operations in the northern portion of the auger-ISS area, jet grout spoils were observed flowing onto the adjacent Water Street sidewalk during the installation of jet grout columns XO1, WI1, XO3, XO5 through XO8, and XO18. It appeared that jet grout spoils were migrating off-site through subsurface preferential pathways. In an effort to minimize the off-site migration of jet grout spoils in the northern portion of the auger-ISS area, a jet grout panel wall was constructed to a depth of approximately 50 feet bgs along the northern boundary as depicted on Figure 4.4. Jet grout panels JGW1 through JGW22 were installed between January 18 and February 12, 2010. Each jet grout panel except JGW1 was constructed by grouting two overlapping segments or "legs" approximately 150 degrees apart by locking the drill stem in position when lifting during grouting. Jet grout panel JGW1 was installed at the western terminus of the jet grout panel wall with only one leg. Because this jet grout panel wall wasn't being constructed to treat Site soils via ISS, the grout pressure was reduced to approximately 300 bar (4,350 psi) and the grout flow was reduced to approximately 47 gpm. The jet grout logs are included in Appendix I.

4.4.6.8 Jet Grout Half Columns

In lieu of installing a jet grout panel wall around the perimeter of the excavator-ISS area, jet grout half columns were installed in lieu of full diameter jet grout columns as depicted on Figure 4.4. The existing jet grout rig was re-tooled to allow the jet grout drill stem to rotate only 180 degrees with the nozzles spraying toward the interior of the Site. It was anticipated that the jet grout half columns would reduce the potential for off-site migration of jet grout spoils. The grout pressure, flow rates, and lift rates for the jet grout half columns were the same as for the full diameter jet grout columns.

4.4.6.9 Re-Work of Auger-ISS Columns

As previously discussed, in areas where jet grouting operations took place beneath previously installed auger-ISS columns, the ISS columns were drilled utilizing rotary drill methods. During the drilling of ISS columns located at the northern perimeter of the auger-ISS area, high drill advancement rates were observed over sustained depth intervals in some of these ISS columns. To evaluate whether the high drill advancement rates were attributable to untreated soils within ISS columns 8a2, 8a3, 8T1, 8a5, and 8a6, exploratory cores ATC-1 through ATC-5 were drilled between March 2 and 4, 2010 (Figure 4.4). As detailed in the coring logs included in Appendix H, intervals of improperly mixed ISS material were observed. The boreholes were grouted to the ground surface upon completion.

Based on the results of this exploratory coring program, the NYSDEC requested that the above ISS columns be regrouted at the depths where untreated soils were observed. The regrouted depth intervals were extended approximately 18 inches above and below the specified intervals to establish overlap. As detailed in the jet grouting logs (Appendix I), 11 jet grout columns (XI-1R, WI-1R, XI-3R, XI-7R, XI-9R, XI-12R, XI-13R, XI-13R2, XI-14R, XI-15R, and XI-17R) were installed to regrout the deficient auger-ISS columns. One additional jet grout column (WI-4R) was installed due to the high drill advancement rates observed in ISS column 8c2 when jet grout column WI-4 was being installed.

4.4.6.10 Pre-Coring for Eastern Jet Grout Columns

In an effort to expedite the jet grouting operations, a pre-drilling program was conducted in the eastern portion of the Site while jet grouting operations were being performed in the western portion of the Site. A mud rotary track mounted drill rig was used to pre-drill the proposed locations of the perimeter jet grout columns around the excavator- ISS area as depicted in Figure 4.4. The pre-coring program was conducted by ADT between February 2 and March 2, 2010. The drill advancement rates, drill action, and visual observations recorded during the pre-drilling program were evaluated to confirm the depths of the excavator-ISS cells and the depths to bedrock.

4.4.6.11 Off-site Migration of Jet Grout Spoils Through Electrical Duct Banks

During the jet grouting of EO-21 on March 1, 2010, the grout levels in nine previously installed jet grout columns (EO-13, EO-12, EO-11, EO-11A, EO-11B, EO-18, EO-19, EO-20, and EO-21) were observed to drop within the pre-drilled borehole. After a film of grout-like material was observed in off-site electrical manhole #5617, jet grouting operations were suspended. Con Edison mobilized a vacuum truck that pumped the grout material and associated groundwater from off-site electrical manhole #5617. Approximately two feet of grout was observed in off-site manhole #5617. Grout material was later observed in off-site electrical manholes #4047 (approximately six to twelve inches), #7652 (approximately four to six inches), #7653 (approximately two to four inches) and #7653 (approximately one inch).

Due to the proximity of other electrical duct banks located at the off-site perimeter near ISS cells P1 and P9, the locations of the perimeter jet grout columns were moved away from the estimated location of these duct banks. As depicted on Figure 4.4, jet grout columns XO-21, XO-21A, XO-22A and XI-21 through XI-23 were installed at a distance of more than 10 feet from the perimeter electrical duct bank. In addition, jet grout columns ASI-51 through ASI-55 and ASO-54 through ASO-58 were relocated to an approximate distance of 2 to 5 feet from the Site perimeter. Jet grout columns SO-54 through SO-58 were installed to reduce the amount of untreated soil within the southeast corner of the Site.

Jet grout half columns AEO-9 through AEO-19 were initially proposed to be installed away from the adjacent perimeter electrical duct banks but existing remnant structures under the ISS cells and above bedrock would have made the jet grouting operations ineffective in treating soil. Therefore, this jet grouting perimeter "arch" was not completely installed. Rather, the perimeter jet grout columns east of this arch were installed as depicted on Figure 4.4.

4.4.6.12 Water Street Sidewalk Investigation

As previously indicated in Section 4.4.6.7, grout spoils were observed flowing onto the Water Street sidewalk during the installation of jet grout columns XO1, WI1, XO3, XO5 through XO8, and XO18. At the NYSDEC' request, in order to investigate the depth and lateral extent of this grout material, five soil borings (SW-1 through SW-5) were installed within the sidewalk to the south of Water Street in proximity to the above jet grout column locations as depicted in Figure 4.4. As requested by the NYSDEC, an additional soil boring (SW-6) was installed to the north of the excavator-ISS area to investigate whether grout material migrated into the sidewalk area during the excavator-ISS. The soil borings were installed to a depth of 20 feet bgs between May 11 and 18, 2010.

During the utility clearance hand excavations, grout material was observed in SW-1 (approximately 8 to 9 inches bgs), SW-2 (approximately 2½ feet bgs on the southern sidewall of the excavation), and SW-4 (approximately 4 to 12 inches bgs). Grout material was not observed in the other borings. Other than SW-2, the grout material was only observed within the subbase stone under the sidewalk. As such, the grout material observed at locations SW-1 and SW-4 was removed based on visual observations during the sidewalk replacement work. The excavation for the sidewalk replacement at the SW-2 location was increased to approximately 2½ feet wide, 3 feet long and 3 feet in depth on July 26, 2010. However, grout material was not observed during the July 26, 2010 excavation, likely due to a minimal volume of grout within the removed soil.

4.4.7 ISS Summary

The estimated in-place volumes for the three types of ISS treatment, excluding overlaps, are 5,058 cubic yards ("**CY**") for excavator-ISS, 7,541 CY for the auger-ISS and 7,071 CY for jet grouting. The total estimated in-place volume of the ISS formation is 19,670 CY.

Isometric views showing the spacial relationship between the three types of ISS treatment are provided in Figures 4.5, 4.6, 4.7 and 4.8.

4.5 REMEDIAL PERFORMANCE/DOCUMENTATION SAMPLING

4.5.1 Laboratory Testing

Samples were collected from the excavator-ISS cells, auger-ISS columns and jet grout columns during both the testing and full production phases. The samples were tested for UCS and HC by Converse Consultants under contract with Parsons.

4.5.1.1 Unconfined Compressive Strength (UCS) Testing

UCS testing was performed in accordance with the procedures of American Society for Testing and Materials ("**ASTM**") D2166. Collected samples were tested for UCS in pairs at 3, 7, 14 or 28 days (or as specified below) with one pair reserved for testing at 56 days if the 28-day test pair did not pass the performance criterion. The acceptable minimum UCS was 50 psi.

4.5.1.2 Hydraulic Conductivity (HC) Testing

HC testing was performed in accordance with the procedures of ASTM D5084, Method A – Constant Head Method. Collected samples were tested for UCS at 3, 7, 14 or 28 days (or as specified below) with one sample reserved for testing at 56 days if the 28-day test did not pass the performance criterion The required HC for the ISS and jet grout materials was 1×10^{-6} cm/sec or less.

The duration of the HC test was controlled by meeting the equilibrium criteria specified in Section 9.5 of the ASTM D5084, Method A procedures. Specifically, this requires the tests to be conducted at a maximum hydraulic gradient of 20; the ratio of outflow to inflow rate to be between 0.75 and 1.25; and, the HC should be determined to be steady over four or more consecutive readings (i.e., the HC readings are within +/- 25% of the mean value determined for the HC). As approved by the NYSDEC and as allowed by ASTM D5084, the hydraulic gradient was reduced from 20 to 15 and then to 10 as summarized in Table 4.1.

4.5.2 General Sample Preparation, Curing and Storage at the Site

Samples collected for UCS and HC testing were prepared in 2-inch by 2-inch cube containers and 2.8-inch diameter by 5.6-inch tall sample containers, respectively. The sample containers were filled and the sides of the sample container were tapped in an attempt to remove air pockets. Care was taken not to under or over fill the sample containers and a trowel was used to level the surface of the sample so that it was flush with the top edge of the sample container. The samples were stored at room temperature in a cooler within the 12 Water Street Building to prevent damage or disturbance during the curing period. Prior to transport to the testing laboratory, the samples cured a minimum of 48 hours to minimize disturbance during transport. Each sample was labeled with the sample ID, casting date and time and accompanied by a completed Chain of Custody ("**COC**") form.

4.5.3 ISS Testing Results

4.5.3.1 Test Section Results

During the excavator-ISS test sections, samples were collected from the top, middle and bottom of ISS test cells TP1 through TP4 and from the bottom of TP5 using the excavator bucket. With the exception of TP5, the samples were tested for UCS and HC at 3, 7, 14 and 28 days. As approved by the NYSDEC, the testing frequency for TP5 was reduced to 3, 7 and 28 days for UCS and 14 and 28 days for HC.

During the auger-ISS test sections, samples were collected from the top, middle and bottom of ISS test columns M10, N14 and N15 using an *in situ* wet sampler. Four pairs of samples were tested for UCS at 3, 7, 14 and 28 days. One sample was tested for HC at 14 days as approved by the NYSDEC.

During the jet grouting test sections, samples were collected from jet grout test columns JGT-1 through JGT-6 using an *in situ* wet sampler. Samples were collected from the top, middle and bottom of jet grout test columns JGT2, JGT-3, JGT-5 and JGT-6. Only one sample was collected from jet grout test columns JGT-1 and JGT-4 as approved by the NYSDEC. Four pairs of samples were tested for UCS at 3, 7, 14 and 28 days and two samples were tested for HC testing at 14 and 28 days (one sample for each test).

The testing results for the samples collected during the ISS and jet grouting test sections passed the established performance criteria for UCS and HC. Tables 4.6, 4.7 and 4.8 summarize the results of the UCS and HC testing for the excavator-ISS, auger-ISS and jet grouting samples, respectively. The raw laboratory testing data is included in Appendix J.

4.5.3.2 Production Testing Results

During full ISS and jet grouting production, samples were collected once every day or once every 500 cubic yards of treated *in situ* soil, whichever produced the greater number of tests.

Three pairs of samples were normally tested for UCS at 3, 7 and 28 days and one additional pair of cylinders/cubes was retained for UCS testing at 56 days in case the 28-

day UCS results did not pass the minimum 50 psi requirement. During jet grouting, testing for UCS at 7 days was eliminated after it became apparent that the 3-day UCS results normally passed the minimum 50 psi requirement. Although not required, pairs of test samples were tested for UCS at 56 days in auger-ISS columns N5, N7, M3, N3, J3, N2, 7N1, M1, 7008, 7M10, 7K8, 7O9, 7P8, 7M8 and 7L7 and provided additional UCS data for the project. The remaining pairs of test samples were not required to be tested for UCS at 56 days.

Two samples were normally tested for HC testing at 14 and 28 days (one sample for each test). One additional sample was retained for HC testing at 56 days in case the 28-day HC result did not pass the HC requirement of less than 1×10^{-6} cm/s. During both excavator-ISS and jet grouting, testing for HC at 14-days was eliminated after it became apparent that the 14-day HC results normally did not meet the HC requirement. During auger-ISS, HC testing was modified throughout the ISS and jet grouting operations and the results were considered to be acceptable if the HC was less than 1×10^{-6} cm/s at either 14 days, 28 days or a duration greater than 28 days.

The testing results for the samples collected during the ISS and jet grouting production passed the established performance criteria for UCS and HC. Tables 4.6, 4.7 and 4.8 summarize the results of the UCS and HC testing for the excavator-ISS, auger-ISS and jet grouting samples, respectively. The raw laboratory testing data is included in Appendix J.

4.6 IMPORTED BACKFILL

Following the completion of ISS, the Site was backfilled/restored using four types of backfill imported from off-site sources:

- Backfill (New York State Department of Transportation ("**NYSDOT**") Item 304-1 subbase) from Tilcon (Haverstraw, New York quarry in 2009 and West Nyack, New York quarry in 2010) - paved areas;
- 2" crushed stone (NYSDOT Item 703-02) from Tilcon (West Nyack quarry) – ISS Staging areas and between planter and retaining walls;
- Sand from Tilcon (West Nyack quarry) – between planter and retaining walls;
- Topsoil from Clearwater Excavating Corporation (Terrevest project in Brewster, New York) – landscaped areas.

The backfill, crushed stone and sand were analyzed for geotechnical properties, certified that the materials were from a virgin source, and found to meet the project specifications. Contaminant testing was not required for the backfill, crushed stone and sand stone because those materials consisted of sand, gravel or crushed stone from a certified virgin source having 10% or less material passing through a size 200 sieve. The topsoil was analyzed for contaminants and geotechnical properties, certified that the materials were from a virgin source, found to meet the project specifications including 6 New York Codes, Rules and Regulations ("**NYCRR**") Part 375-6.8 Soil Cleanup Objectives ("**SCOs**"), and approved by NYSDEC prior to use. Additional quality control testing of all backfill materials was performed when quantities reached 500, 1,000, 2,000, 3,000 and 5,000 CY. The testing results and supplier certificates for backfill materials are included in Appendix K.

The east half of the Site was backfilled from March 20 to 24, 2009 following the completion of excavator-ISS. In addition, supplemental backfilling was conducted along the perimeter of the east half of the Site from April 23 to May 6, 2010 following jet grouting. The backfilling on the west half of the Site began on May 12, 2010 following the completion of auger-ISS and jet grouting and was completed on August 20, 2010 with placement of topsoil within the landscaped areas of the Site.

Compaction testing was performed on backfill placed throughout the Site and in utility trench excavations. Based on the results of nuclear density testing, 94% (162 of 173) of all compaction testing met the specification requirement of minimum 95% as determined by ASTM standard D1557, Modified Standard Proctor Analysis. Eleven compaction tests were slightly below the specification requirement of minimum 95% with results from 92 to 94%. The compaction testing results are included in Appendix J.

The quantity of off-site materials placed is provided in the following table:

TABLE 4.9, IMPORTED MATERIAL QUANTITIES

Material	**Tons**	**CY**
Backfill	6,588	4,000 (Estimated)
Crushed Stone	Not measured	30
Sand	186	115 (Estimated)
Topsoil	Not measured	155
Total		**4,300**

4.7 CONTAMINATION REMAINING AT THE SITE

As described in Section 4.10.1, the inability to advance the excavator- and auger-ISS to the anticipated bedrock depths in all areas of the Site leaves a potential for contamination to remain in soil that was not treated by ISS. However, this contamination is contained because a perimeter jet grout wall was installed to bedrock. In addition, the interior "hot spot" areas of the western portion of the Site estimated to contain MGP source material (i.e., non-aqueous phase liquids (NAPL)) were treated using a combination of auger and jet grouting ISS techniques, thus reducing the potential for remaining contamination in Site soils.

Previous Site investigations revealed that MGP-related impacts (visual NAPL and elevated BTEX and PAH concentrations in soil) existed in close proximity to subsurface utilities located beneath the southern Water Street sidewalk. The MGP-related impacts are located at depths below 7.5 feet, thus the majority of the utilities present in this area are above this depth and limit access to the MGP-impacted soil. As such, the southern Water Street sidewalk was not included in the remedial action defined by the RDR.

Previous Site investigations did not identify MGP-related impacts east (Hamilton Ave parking lot) or west (western portion of the Site and the eastern sidewalk of North Lexington Avenue) of the Site. MGP-related impacts to the south of the Site are part of OU-1.

Previous Site investigation results indicate groundwater in the vicinity of the former MGP structures was impacted by MGP residuals. NAPL was present as either a sheen, a thin layer of light non-aqueous phase liquid (LNAPL) (0.01 feet to 0.18 feet in thickness), or floating globules of a brownish oily material. Select VOCs and semi-volatile organic compounds (SVOCs) were also detected in groundwater samples above the NYSDEC groundwater quality standards (GWQS) and guidance values presented in NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 [NYSDEC, 1998].

Since contaminated soil and groundwater remains in some areas beneath the Site after completion of the Remedial Action, Institutional and Engineering Controls are required to protect human health and the environment. These Engineering and Institutional Controls ("**ECs/ICs**") are described in the following sections. Long-term management of these EC/ICs and residual contamination will be performed under the Site Management Plan ("**SMP**") approved by the NYSDEC (Parsons, 2011).

4.8 CAP SYSTEM

Exposure to remaining contamination in soil at the Site is prevented by a cap system over the entire Site. The cap system has a combined minimum thickness of 42 inches which is equal to frost depth to prevent the detrimental effects of freezing and thawing cycles on the underlying ISS-treated soil. The cap system is comprised of imported soil, asphalt and/or concrete depending on location within the Site:

- Asphalt Parking Areas – 38 inches of clean soil and 4 inches of asphalt;
- Dumpster Storage Area – 30 inches of clean soil and 12 inches of concrete;
- Landscape Areas – 46 inches of clean soil; and
- Planter Wall/Retaining Wall Area – Varying thicknesses of concrete, masonry and soil fill totaling more than 42 inches.

Appendix B, Drawing C008 shows the location of each cover type built at the Site. Appendix B, Drawings C010, C011 and C012 show the as-built cross sections for each remedial cover type used on the Site. An Excavation Work Plan, which outlines the procedures required in the event the cover system and/or underlying residual contamination are disturbed, is provided in Appendix A of the SMP.

Other site restoration activities included:

- Retaining wall improvements (placement of cellular concrete in voids under the existing footings, crack patching and new stucco system finish);
- New reinforced masonry planter wall;
- New sidewalk on Water Street adjacent to the Site and 12 Water Street Building in accordance with the City of White Plains sidewalk standards;
- Power washing of the substation firewall;

- Application of a new concrete coating on the lower retaining wall;
- Drainage system improvements (trench drains and hydrodynamic separators at each parking lot entrance);
- Wooden guide rail along the Water Street sidewalk;
- Chain link fencing with Hedgelink privacy screening;
- Site lighting; and
- Landscaping.

Test results for the cellular concrete and concrete placed for the planter wall footings, trench drains, sidewalks, dumpster pad and site lighting bases are included in Appendix J.

4.9 INSTITUTIONAL CONTROLS

The Site remedy requires that a Declarations of Covenants and Restrictions be placed on the property to (1) implement, maintain and monitor the Engineering Controls; (2) prevent future exposure to remaining contamination by controlling disturbances of the subsurface contamination; and, (3) limit the use and development of the Site to restricted commercial or industrial uses only.

The NYSDEC-approved Declarations of Covenants and Restrictions for the Site (Appendix L) have been executed by Con Edison and the owner of the 12 Water Street property and have been filed with the Westchester County Clerk's Office for recording. Proof of recording of the NYSDEC-approved Declarations of Covenants and Restrictions will be submitted to the Department (as required under the VCA) when it is received from the Westchester County Clerk's Office.

4.10 DEVIATIONS FROM THE REMEDIAL ACTION WORK PLAN AND REMEDIAL DESIGN REPORT

Four deviations from the RAWP and RDR were implemented during the remedial action and are described below.

4.10.1 Depth Modification of ISS

The RAWP and RDR required the ISS to extend downward to bedrock. However, the equipment used for both the excavator- and auger-ISS could not be advanced to the anticipated bedrock depths due to undetermined subsurface conditions as described in Sections 4.4.3 and 4.4.4. As a result, the following modifications to the ISS depths were requested and approved by the NYSDEC:

- The interior ISS columns will be advanced to the maximum depth feasible utilizing existing ISS equipment;
- The perimeter ISS columns will be advanced to bedrock using a combination of auger and jet grouting ISS techniques to create a perimeter curtain on the northern, western and southern sides of the auger-ISS area;

- The excavator-ISS cells will remain as constructed and a jet grout perimeter curtain will be advanced to bedrock on the northern, eastern, and southern sides of the excavator-ISS area; and.
- The interior areas of the Site that contain MGP source material (i.e., NAPL) will be treated using a combination of auger and jet grouting ISS techniques.

NYSDEC agreed that the above ISS depth modifications did not change the components of the Site's selected remedy and would allow the remedial construction activities to occur within the established project schedule. NYSDEC approved the changes via letter dated July 16, 2009 (Appendix M). No modifications to the RAWP and RAR were required by NYSDEC.

4.10.2 ISS Cells and Columns Having Less than 15% Reagent

Due to reagent metering issues, less than 15% reagent was added to ISS cells TP3, P9, P12 and P6. The calculated reagent percent for TP3, P9, P12 and P6 was 14.41%, 14.51%, 14.84%, and 14.60%, respectively. As approved by the NYSDEC, these ISS cells were not remixed because the reagent percentage was over 14% and the collected ISS samples passed the performance criteria for UCS and HC.

Due to reagent metering issues, less than 15% reagent was added to ISS columns 7008, 7L10, 7N11, 7L9, 7m9, 7n10, 7o9, 7p9 and 7q8. The calculated reagent percentage for these ISS columns was 14.11%, 14.17%, 14.68%, 13.92%, 14.31%, 14.39%, 12.60%, 14.55% and 14.66%, respectively. As approved by the NYSDEC, these ISS columns were not remixed because these ISS columns are located in the interior of the Site and the collected ISS samples passed the performance criteria for UCS and HC.

4.10.3 ISS Columns Not Overlapping by 15%

As depicted on Figure 4.3, a minimum overlap of 15% was not achieved for many of the auger-ISS columns. This was caused by sequencing issues during the auger-ISS work that allowed previously installed columns to cure, thus making subsequent overlapping problematic. Because not all of the auger-ISS columns were installed in locations that overlapped previously installed columns, interstitial areas were created between the auger-ISS columns as previously described in Section 4.4.6.5. Jet grouting techniques were used to treat these interstitial areas. As approved by the NYSDEC, interstitial areas less than 3 square feet in size were considered to be infeasible to jet grout due to potential adverse effects on the jet grouting equipment (i.e., rebounding effects, excessive wear).

The depths of the jet grout columns within the interstitial areas varied depending on the proximity of the adjacent hot spot ISS columns. In interstitial areas that abutted a hot spot ISS column, the jet grout columns were advanced to bedrock. In interstitial areas that did not abut a hot spot ISS column, the jet grout columns were advanced to the elevation of the deepest adjacent auger-ISS column.

4.10.4 Less than 85% Sample Recovery in Field Test Cores

As described in Section 4.4.6.1, less than 85% sample recovery was observed in some field test cores. The less than 85% sample recovery was attributed to either mechanical problems that were experienced at some intervals and/or to the granular nature of the material being sampled (e.g., at the transition depths to bedrock). This deviation from the minimum sample recovery percentage was approved by the NYSDEC.